

27th November 2014 Thursday

13:00 discovered problem with data processing again.
 U_1 & U_2 were put in ~~not~~ mld into column of
m/s

Therefore again changing the data in
Symbolic regression file symregression_2
& running it again.

Model ~~term~~ equation, logarithmic, bootstrap,
bootstrap model, error minimisation. Every
thing has to be done again.

$$\begin{array}{r} 157 \\ 5 \\ \hline 162 \end{array}$$

13:48 Bootstrapping the original data & putting it in
the calculation format easily done.

There is not ^{see observable} much difference between the
~~actual~~ observed & predicted pressure drop.

Therefore keeping the same figure. At least till
we get the model out of symbolic regressi.

$$\text{day} = 24 \times 3600 = 86400$$

28th November 2014 Friday

The model looks like

$$P_r = 6.79e5 + \frac{5.869 NC w^{NC}}{\text{sqrt}(K)}$$

Not bad; only two coefficients

R^2 0.84 Mean absolute error 1.99×10^6 Pa/m

correlation coefficient 0.925

$$\ln(P_r) = \ln(6.79e5) + \ln 5.869 \\ + \ln NC + NC \ln w - \frac{1}{2} \ln K$$

20th Nov 2014

16:00 Putting the equation in Alvarez 3

$$Pr = \frac{6.08 \times 10^3 N c \omega^{Nc}}{\text{Sqrt}(K)}$$

The problem with single coefficient is that it does not fit very well with our own results.

30th November 2014 Sunday

10:42: No change in above ~~per~~ equation; Therefore keeping this equation ~~as~~ constant.

$$\ln Pr = \ln 6078 + \ln Nc + Nc \ln \omega - \frac{1}{2} \ln K$$

6	7	8	9	10	11	12	13	14	15	16
948	1106	1264	1422	1580	1738	1896	2054	2212	2370	2528
2686										

Cumulative distribution function for single parameter
($x, \mu, \sigma, \text{true}$)

Bill's work

Outline: → Foam: test Mirador formation, Cusiana field

Long time Diversion in Field Trial
Injection log results

Pore volumes of gas injected
Injectivity calculation } layers

Average mobility reduction
skin factor

Estimated mobility reduction

Probability

Jakobien: ~~partial~~^{probability} estimation of effect of variable:

Ehsaan : data validation; parameter estimation
use of dimensionless numbers

6 Dec. 2014 Saturday

Managed to figure out changing the font in termic centre in windows.

④. tools → options → Editor text format
→ (choose (there you can select font size)
etc.)

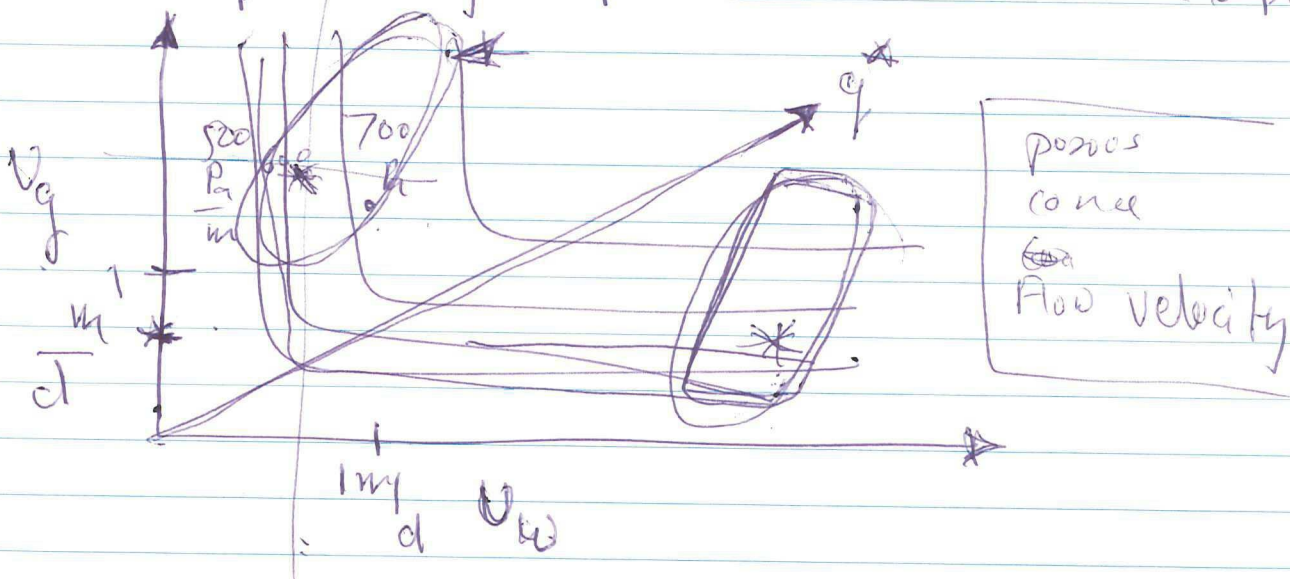
Figures, tables at the end of the paper.

8 Dec 2014 Monday

- fixing image sizes
- fixing @ table / figure titles
- fixing references
- writing support information (Table 157 data points)
- Visual basic code to generate the Bootstrap

Fixing image sizes: \rightarrow

For TOC entry : a sans serif font type such as "Helvetica" preferably 8 pt but no smaller than 6 pt.



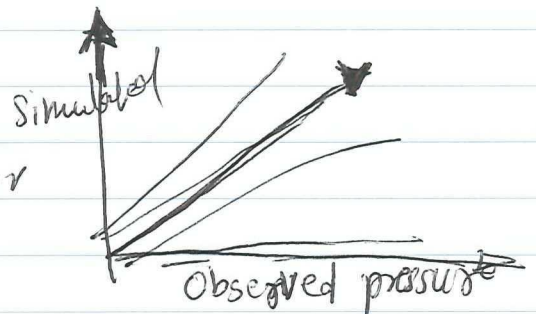
Variance with respect to slope

should not go through zero

Least squares: → Page 776
maximum likelihood estimator

Fitting to a straight line

Error in the fitting line for



Error in the ~~is~~ slope only

$$b = \frac{S_{xy}}{\underbrace{\Delta x}_{S_x^2}} = \frac{S_y}{S_x}$$

$$\Delta P_{ob} =$$

$$\Delta P_{Pre} = A \frac{\dot{N}_C u_w \dot{N}_C}{\sqrt{K} \phi_{observed}}$$

$$\Delta P_{ob} = \epsilon \Delta P_{Pre}$$

$$\ln(\Delta P) = \ln \epsilon + \ln(\Delta P_{Pre})$$

$$\ln \epsilon = \ln(\Delta P) - \ln(\Delta P_{Pre})$$

$$= \dots$$

Error in slope $\rightarrow b = \frac{s_y}{s_x}$

$$s_y = \sum_{i=0}^{N-1} \frac{y_i^2}{s_i^2}$$

~~6.2~~

$$s_x = \sum_{i=0}^{N-1} \frac{x_i^2}{s_i^2}$$

$$s_b^2 = \sum_{i=0}^{N-1} \frac{[y_i - y(x_i)]^2}{(N-m)}$$

\uparrow \uparrow
 s_y 1

Error in slope $s_b^2 = \frac{s}{\Delta}$ variance

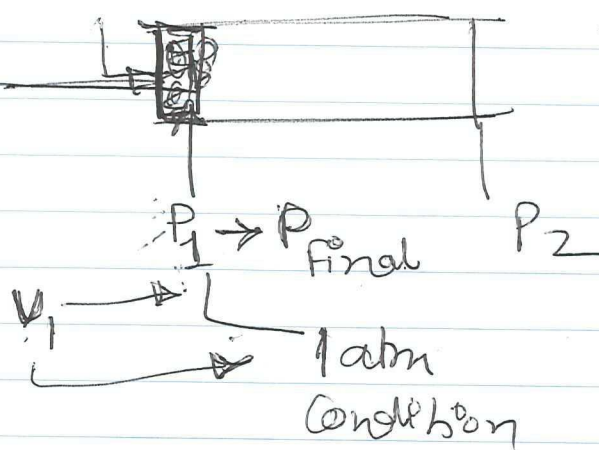
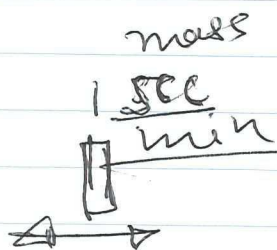
variance in the estimate of b is s_b^2

$$s = \sum_{i=0}^{N-1} \frac{1}{s_i^2}$$

$$\Delta = s s_{xx} - (s_x)^2$$

$$s_{xx} = \sum_{i=0}^{N-1} \frac{x_i^2}{s_i^2}$$

$\frac{SCC}{min}$ mass flow controller



Exp. - Contr.
 \rightarrow Expenditure
 Experimental results

$$P_1 V_1 = P_2 V_2$$

$$q \left[\frac{cm^3}{min} \right] \times \left(\frac{T}{T_0} \right)$$

where K we

$$(P/P_0) A$$

ignore the temperature fluctuation and take $T = T_0 = 1$, $T_0 = 293K$, $P_0 = 1 bar$, $A =$ cross-section, which is ... for uncom. and for Bentham coils

~~Expt A~~

Meeting with Hans on 18 Dec 2019

Expt A & B & expt F should be put into Appendix

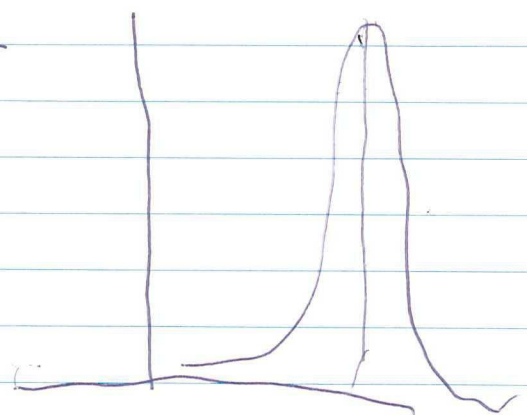
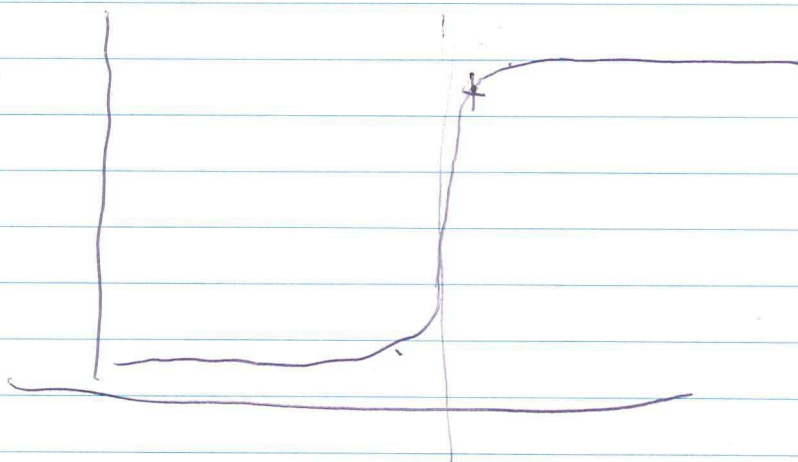
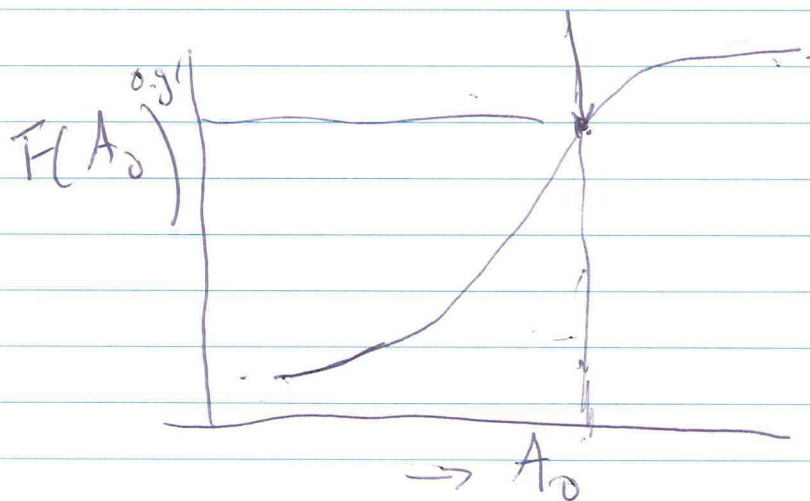
$$\begin{array}{ccc} \text{39} & \text{39} & \text{39} \\ \text{309} & & \text{299} \\ \frac{3}{58.5} = \end{array}$$

Akhil Gupta Error

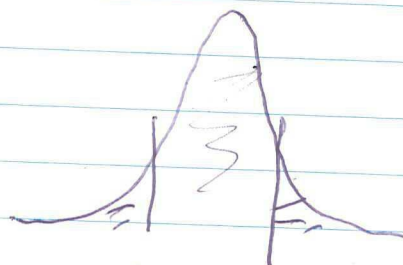
Error distribution will be normalized,
which function vs which function.

what GRG ~~non~~ nonlinear solver

Find out if error is normally distributed



1
100
31
100



$y(x)$

Grace : from Athil Datta Gupta

99/100

21st December 2014 Sunday

- Changing ~~at~~ cmc into concentrations.

- Finally decided to add the schematic set up. Otherwise it is still bit difficult to express.

24th December 2014 Wednesday

Considering $\sigma_i^2 = \frac{\sum_{i=0}^{N-1} (y_i - x_i)^2}{N-2}$

Excel file
Error in pre vs obs 1

$N-2$
↑
no of unknown

Intercept = 1.76×10^6 Palm
Slope = 0.85

devia = 3.22×10^5 Palm
devia = 0.031

EXCEL GAVE THE SAME THING

if we we average

$$\sigma_i^2 = \frac{\sum_{i=0}^{N-1} (y_i - \bar{y})^2}{N-2}$$

Excel file
Error in pre. vs obs 2

Intercept = 1.76×10^6 Palm dev = 7.6×10^5 Palm
Slope = 0.85 dev = 0.074

$N-2$

↑

no of unknown

1m

25th December 2014

Reading NiTi Paper

- Check what is precipitation hardening?

AA2124

↑↑↑

Cu 3.93 mg 1.41

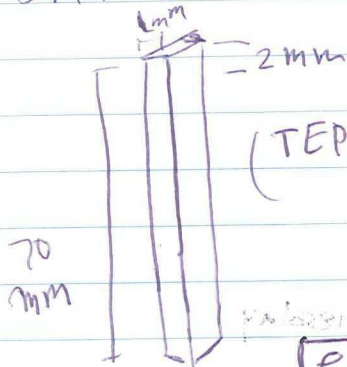
Mn 0.64 Fe 0.0624

Si 0.21 Al Balance

Solution 768 K (1h) + water quench wt%

AGED 768 K (1h) + water quench + 463 K (12h)

Differential Scanning Calorimetry



TEP = Seebeck effect

GPB zones

The presence of the NiTi particulates accelerates the precipitation reactions in the aluminium matrix.

Need to check about Graduate school courses

① Positive ~~psychology~~ psychology

② Conflicts of Interest

③ Negotiation techniques

④ Group dynamics

(Zinc coating)

What is galvanisation?

(be lazy)

Tell ~~them~~ in the first interview from February & then when negotiation comes from March

Galvanisation → Hot-dip; electroplating, galvannealing;

(question to Laurens)

What type galvanisation

Tata Steel use?

What new method or technique you can think of for coating steel?

Saturday two o'clock with Patrick van Hemert.

Problem with working with galvanised steel

- ① ~~the~~ Welding (Show him about the welding work you did)
- ②

Nanoceramic conversion coating (Tectalis)

Conventional coatings

Zinc \rightarrow phosphate \rightarrow electrocoat
then painting
primer, base coat \rightarrow clear top coat

Sept 22, 2004 news: \rightarrow

400 [↑] thousand tonnes of galvanised (corrosion resistant)

<How zinc reacts with steel during galvanisation?>

MagneZinc

Zinc-Mg-Aluminium

I am thinking more on chemistry point of view like (surface change)

(Range of such coated products)

Testing of coatings for products (Rolling, laboring, welding,

26th December 2014 (Friday)

Where is the role of fluid dynamics? Liquid zinc / Liquid metal alloys

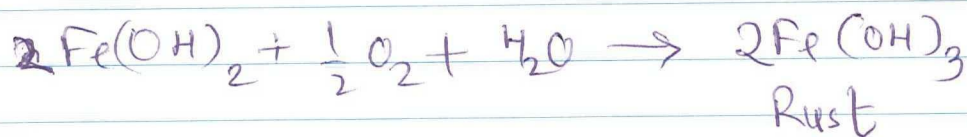
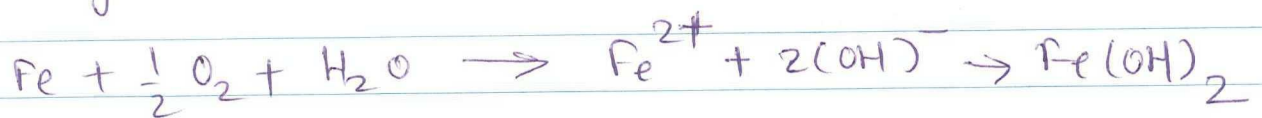
Process engineering: Manufacturing technology

~~Contri~~ Continue strip galvanising, electroplating & vacuum deposition techniques.

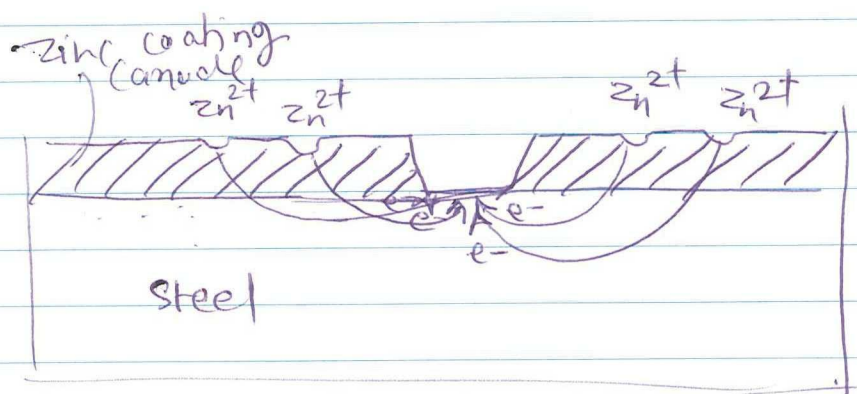
Are there any ~~inbuilt~~ inhouse tests where I can check how much I have learned in six months.

~~How much~~ What would be the criteria for permanent contract? When would be that told so that I could look forward to the position?

Rusting of ^{dissolved oxygen} water in iron



Oxidation \rightarrow giving up electron \rightarrow hence becoming +
Reduction \rightarrow taking up electron \rightarrow hence becoming -



Steel making: \rightarrow From tude/At channel from
 Fe_2O_3 (CaCO_3

processing \rightarrow Pig-iron \rightarrow desulphurisation ($< 0.01 \text{ wt\%}$)
 by
 lime powder

{ Oxy steel }
 { Electric arc } furnaces

De oxidation by adding Aluminium.
 $\text{Al} + \text{vd} + \text{Ti} + \text{Zn} + \text{Mn} + \text{Mg} +$

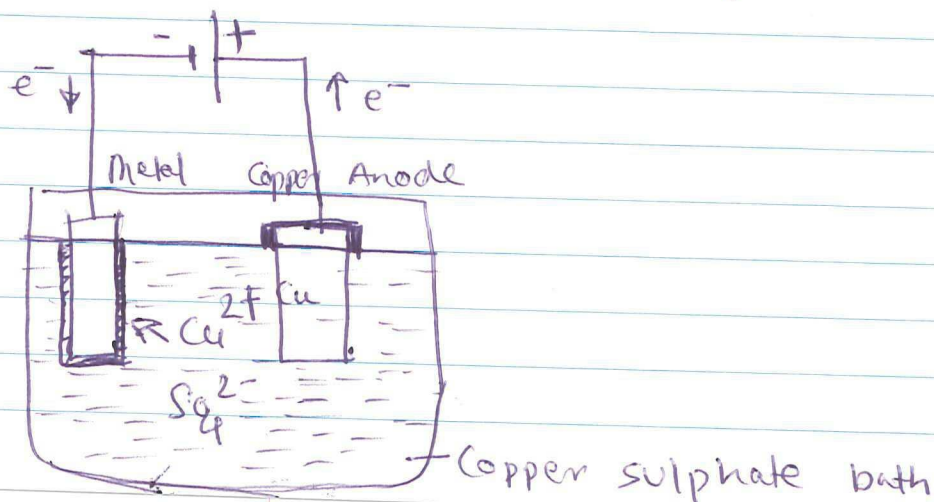
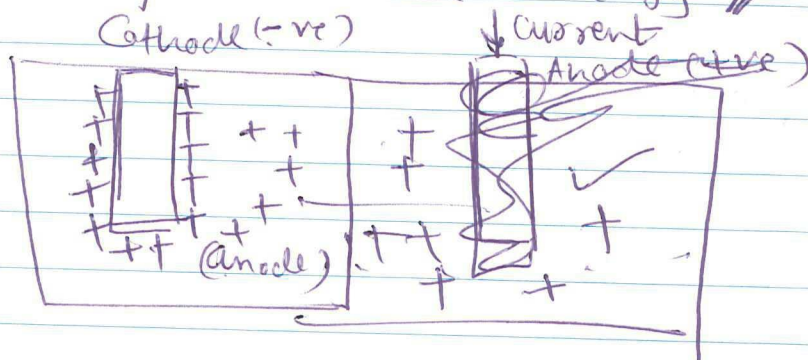
ways to what plan does principle researcher have
 for one year?

Metallic coated steel products \rightarrow colorcoat®

structural steel; Advance sections, structural hollow
 sections; corefast; plates;

what is electroplating: \rightarrow

Brain wave: Steel with 'Chloroplast (Chlorophyll)',
 So that they can make energy \rightarrow



Physical Vapor deposition: →

When the vapor source is solid or liquid PVD

When the vapor source is Chemical ^{vapor} precursor CVD

plasma assisted CVD, plasma enhanced CVD,

low pressure CVD

27th December 2014 Saturday

- Research department

-

-

March-April X August 1 - September 1

5 interview - 4 meetings

(2) HR people + (4)

Ask during interview what would be the time

- Head of the group

- Head of the different groups

(Old boys network to professional)

① Shift in the culture of company

② England * *

- Trying ~~to be~~ (to be careful)

- El. English - dutch - Indian

one company

(customer satisfaction)

Most Important

What is important for Tata

Specific quality steel
+
Cheap

(Galvanising too thick / too thin)

Make sure quality is ok ; as soon as possible.
blemish / marks /

Customer - focused company.
preferred supplier for steel industry.

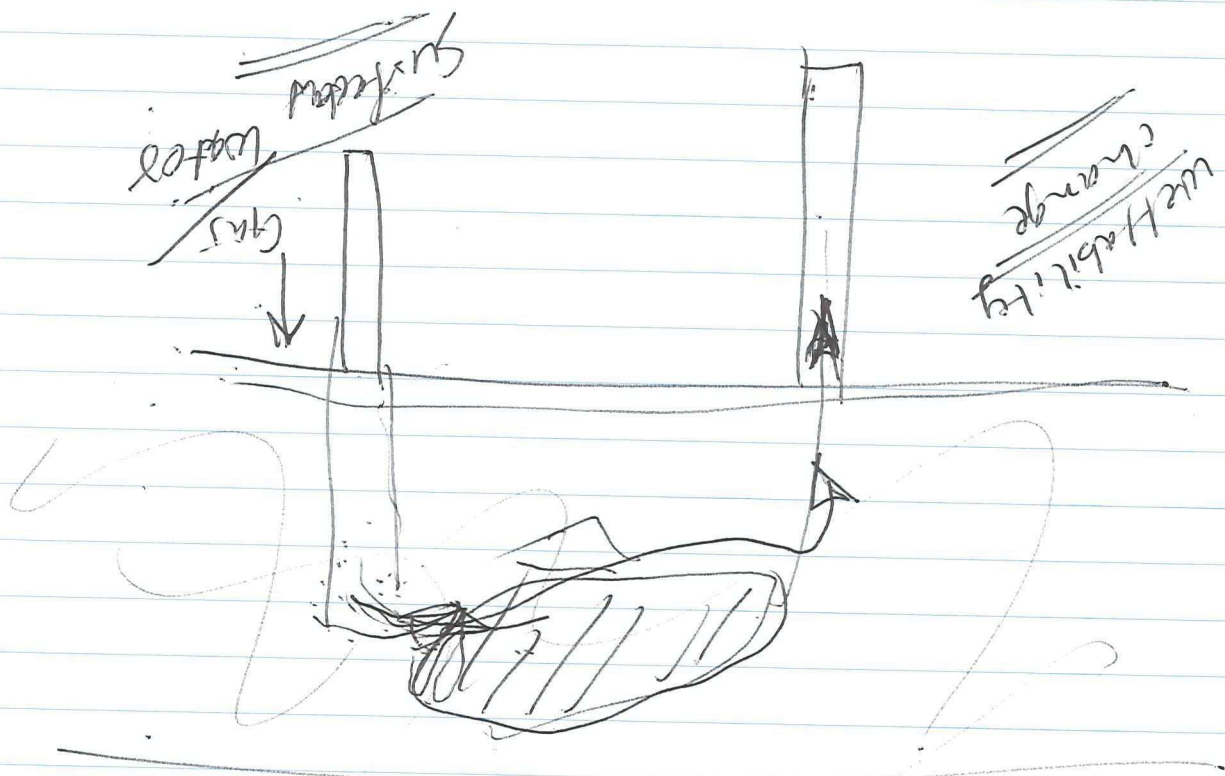
Tata values - Integrity, openness,

~~prepare~~ prepare some question & ~~for~~
(I prefer four days)

Environment University (more)

28th December 2014 Sunday

Peter Beentjes : → Senior researcher coating technology
Tata steel ; process & product technologist rolling
& coating of steel strip.



Interview

Process Technology :- product + process

leidenschap + positive

Automotive applications

① Inhouse testing

②

③

Budget allotted

①

②

knowledge

knowledge group

opdrachten

Principal Scientist

Principal
researcher

Laboratory	}	3 kwartier
Pilot line		1 kwartier
Actual line		

Duitsland + Commercial + Onderzoek



~~Goed~~ Een keer per maand

Philosophy verschil



5-6 jaar

Twee maanden

Ask Hans if we can add Funder in the

Efficiency & sustainability
Fossil Fuels

section to be
published

Get the expression for 14 data points only
try to fit to it whole set of data points

What is the mean std deviation of sand size

Still not able to ~~decide~~ decide whether to
keep or remove the figure 1. It is a nice Figure
but slightly unnecessary as we explain in the photo
graphs about the flow set up

Removing now to see how it looks like.

2.5

4th January 2015

(multipage)

Trying to add long table inside but not working.
with supertabular it goes caption seems outside
the table, how?

Finally managed

```
\begin{center}
```

```
\begin{supertabular}
```

```
\end{supertabular}
```

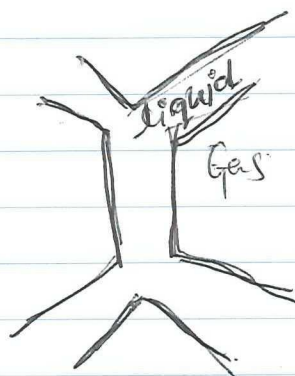
```
\end{center}
```


If you want to use Svorstøl in bibliographic file
then use Svorstøl

7th January 2015

Effect of temperature on foam flow in porous media

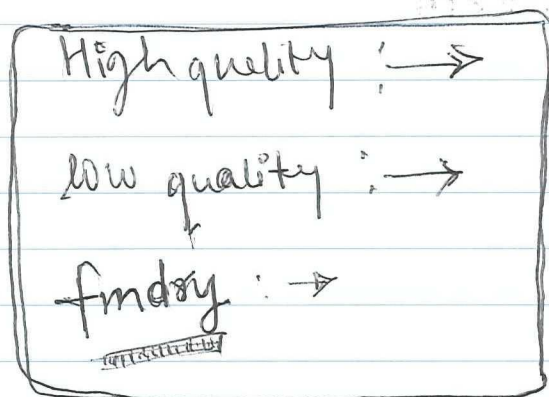
Leon Kapitash



Add Leon/Rouhi temperature effect on pressure drop
SPE

Janke & Osterloh (1992)

Kinematic viscosity



Foam quality on volume base.

Running Eureka again without ~~the~~ non steady state
pressure drop; ~~if~~ If the values are too different then
we ~~change~~ ^{assume} consider non-steady state pressure drop
to be steady state & continue with current
case. If we get conditions change then we
change it again.

8th January 2015 Thursday

$$y = b^x$$

$$x = \log_b(y)$$

$$a_{H^+} = 10^{pH}$$

$$pH = \log_{10}(a_{H^+})$$

Volume of gas m^3

volume of water m^3

Velocity of water m/s

Velocity of gas m/s

$$Q = \frac{m}{s}$$

$$\frac{m}{s} \times m^2 = \frac{\text{Volume}}{s}$$

$$\frac{m^3}{s} \times \frac{kg}{m^3} = \left(\frac{m^3}{s}\right) Q = \frac{m^2}{s} \times \frac{m}{s}$$

$$Q \times \rho = m \frac{kg}{s^2}$$

$$\rho g z = P$$

$$1000 \frac{kg}{m^3} \times 9.81 \frac{m}{s^2} \times 0.06 m = \frac{kg}{m s^2}$$

$$F = m a \quad P = \frac{F}{A}$$

$$= \frac{kg m}{s^2}$$

$$9810 \times 0.15 \times 0.30$$

$$98.1 \times 6 = \frac{kg}{m s^2}$$

$$588.6 \frac{N}{m^2} = P_a$$

$$441.45 Pa$$

$$7357 \frac{Pa}{m}$$

$$P = \rho g H + P_{atm}$$

214th January 2014 Wednesday
 Non-physical Oscillations ← simulation of
 in Foam
 Jakolien v d Meer

12:45 Amount of surfactant
 Mangan - Injection of gas

⑧ Oscillation due to grid size

$$\frac{\partial S_w}{\partial t} = q_{fw} + \text{fractional flow of water}$$

$\frac{\partial}{\partial x}$ distance

STARS (Foam model)

- K_{rg}^f with heaviside function

discontinuous function is transformed into
 continuous function

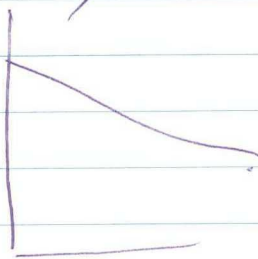
Mojtaba: Critical water saturation (0.2 to 0.3)

R = mobility ~~red~~ reduction factor

< Steepness Factor >

Heat equation

(Finite volume method)



Discretization : — Various average

Finding a solution by discretization

saturation & pressure

Arithmetic (average (mean)) X Integrated

Ashoozi & Eigen values } Finite difference

Δt

Jakolien: Artificial diffusion; do not want to use

IMPES: \rightarrow Implicit pressure - Explicit saturation
Seltan

① Buckley Leverett - ② Foam model

Eulerkin: \rightarrow ~~the~~ ~~IBV~~ ^{Boundary} IBV ~~value~~ value?
Algebraic flux correction (AFC)

Discontinuous problem not good with (finite element problem)

Zitha $f(u)$ (use reference
Kam ~~in~~ in our paper
for bubble population?)

physical oscillation + Non physical oscillation

weblogin.tudelft.nl

On Rahul Thorat (iTG \rightarrow Activate \rightarrow Citrix
receiver \rightarrow Connect to Remote Desktop \rightarrow
~~Or application~~ PC ~~to~~ Name (TUD414282)
 \rightarrow Password \rightarrow

Saving manuscript as text file then correcting
the text file - Supporting information

Page numbers

Otherwise another file as a last attempt

16th January 2015

Geochemical modelling of water flooding oil in calcite reservoirs at high carbon dioxide pressure.

- Thermodynamics

Enthalpy, Entropy

Heat at constant pressure = Enthalpy

ΔG free energy

$$\Delta G = \Delta H - T\Delta S < 0$$

Useless

Energy

negative or zero

always positive

always positive

that means

we need to put that much energy to get the work done.

Boltzmann

$$dG = -SdT + Vdp$$

$$\Delta G = RT \Delta \ln P$$

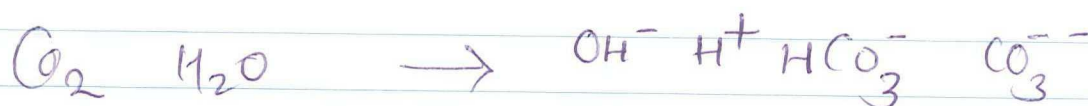
$$\Delta G = \Delta G^0 + RT \ln \frac{a_C a_D}{a_A a_B}$$

activities

activity = concentration x activity coefficient
 $a = \gamma C$

$\frac{\text{mol}}{\text{litre sol}}$ (molarity)

$\frac{\text{mol}}{\text{kg water}}$ (molality)



$$N_f = N_s - N_r - N_c - P + 2$$

$$= 6 - 3 - 1 - 1$$

Equilibrium constants



$$K_w = \frac{a_{\text{OH}^-} a_{\text{H}^+}}{a_{\text{H}_2\text{O}}}$$

$$K_w = \frac{a_{\text{H}^+} + a_{\text{OH}^-}}{a_{\text{H}_2\text{O}}}$$

$$= \frac{\Delta G_2^0}{RT} \quad \left(\begin{array}{c} \text{Reference} \\ \text{state} \end{array} \right)$$

Dividing the activity by reference activity

Using concentration as unit $\frac{\text{mol}}{\text{L}}$ behaves

like ideal solution;

In appollo it is temperature reference?

~~Reference~~ ~~1 kg~~ ~~→ 1 litre~~ ~~in~~

In appollo it is in ~~1 kg~~ (molality)

Activity coefficient for water is 1

Activity is a function of ionic strength.

chemical potential μ
(free energy per mol)

$$\mu_1 = \frac{\partial G}{\partial n_1}$$

Activity coefficients A, B

12:30 Session

Surface charge on calcite & oil surface

- 15:30 Journal of petroleum science & engineering
Journal of dispersion science and Technology
Petroleum exploration & development
→ Chemical Engineering science
Water resources research X
Computers & Geosciences
Plasma physics Control Fusion
Journal of chemical Information & Modeling X
→ AIChE Journal



Journal of chemical physics

* Experimental thermal & fluid sciences

* international journal of multiphase flow

much more ^{foam articles} ~~write~~ than ~~the~~ previous one.

AIChE journal - more foam articles

// I guess this is the only journal //

~~No physical d~~

saturday morning ~~20~~ 2015 17th Jan Schiphol

Review #2

- No physical discussion of the origin of the generation rate is given nor is it even recognized that the history-matched bubble generation function is actually the difference between generation rate & a coalescence rate

① Physical discussion of the origin of the generation rate
② Recognize bubble generation function = $\text{Generation rate} - \text{coalescence rate}$

- Foam generation does not depend on surfactant concentration whereas foam coalescence strongly does.

(Hirasaki 1985 paper where they first mention bubble density; there must be the surfactant equation)

Shall we put Benthimer in the Appendix?
we will see that at the end.

(Need to check Kovscek paper / Simjoo paper ^(thesis))

We just do what Simjoo did; only n is considered as a pressure drop.

on reviewer #2 objection of water ~~permeability~~ measurement?
Can we say that we ~~use~~ use AP & that we use as ^{no} ~~ing~~

On Review #1 about D_n make sure to mention the term to be constant

Bubble diffusion term is basically a ^{coalescence} ~~convection~~ term. After thinking, the diffusion should not be constant ~~but~~ during transient state.

Mention Kovscek paper that discuss transient & steady state.

Need to check why we use low pH foam: ^(for Bentheimer) application other than ~~to~~ oil recovery (Reference)

for putting the effect of surfactant concentration, ~~case~~ I needs to check one equation that Hans put sometime back. But need to check why it should be in first place. why can't we just use AP to explain what is happening in the porous media

Consider ~~to~~ unconsolidated sand as main experiment to create & ~~test~~ ^{verify} the model and Bentheimer ~~or~~ Unconsolidated fine sand to make validation.

I remember somewhere Hans has capillary pressure part plugged in the water gas & bubble equation
(For water saturation)

Find in the old file (It is written, thus we may use it)

P_c^* \rightarrow surfactant formulation, concentration, temperature, pressure, formation properties, and other factors including total superficial velocity

↳ But do we have to use it?

$S_w^* \rightarrow S_w(P_c^*)$

we do have velocities ~~matched by~~ from the experiment & we do have relative permeability calculation for the model. Can we do something with that?

If we think to add surfactant effect check
~~Cheng~~ Cheng (2002)

~~Lake~~ Lake (2003) about the surfactant concentration
effect using Langmuir Isotherm

Can STARS do co-injection cases?

~~Rossen~~ Rossen ~~also~~ told about the difficulty in
simulation of saturation.

Checking if someone has used bubble-population
bubble density as a pressure difference

(1997)

Cohen "Onset of mobilization & the Fraction of Trapped
Foam in porous Media" Transport in porous media

(1998)

Gergui "Berlin 1998, Transient aqueous foam flow in
porous media: experiments & modeling
Journal of petroleum science & Engineering

Very Important paper : Need to read it!

Regarding Cohen about trapping of foam flow

A pore network simulator is used to ~~convert~~
simulate the pressure drop. The results can predict
the fraction of foam that is trapped in a porous
medium under given flow conditions.

Volume averaged population balanced of foam
bubbles.

$$\begin{array}{ccc} 27 & + & 41 \\ \uparrow & & \uparrow \\ & = & 68 \end{array}$$

$$\begin{array}{ccc} 68 & - & 27 \\ 100 & - & ? \end{array}$$

$$\frac{2700}{68} = 39.27$$

Goal by Cohen is to predict the pressure drop require
to mobilize a bubble train in a porous medium.

(1992)
de Gennes speculated that the system remains close to the mobilization threshold because trapped regimes coarsen while bubble density increases in flowing regimes as more lamellae are formed.

Kovscek & Radke (1994) - Constant fraction of trapped foam during steady foam flow.

Rosson & Praeglitz hypothesis ~~confirmed~~: the mobilization pressure drop is a function of the number of lamellae in a channel in the direction of flow.

« Hypothesis confirmed by Cohen! »

An analytical expression for the trapped fraction as a function of imposed pressure drop.

Discusses coarsening of foam: bubble density of foam decreases

Zitha did not see trapped foam during ^{unsteady state by} the tracer ~~condition~~.
Therefore once ~~steady state~~ trapped foam is for steady state conditions. (Ref: X-ray computed tomography Nguyen Zitha transient flow)

References where pH is acidic →

Acidic pH decreases hydrophobic forces in surfactant free foam films.

At low ~~at~~ surfactant concentration (0.0375 wt%) at low pH should play a role in formation of foam lamellae ~~at~~ for Bentheimer. ~~The~~ The contribution factor for pH (mol/d) should be added in case of Bentheimer experiment.

Motive behind using ^{low} high pH (acidic) was to see if we can use such acidic water to generate foam.

If ~~the~~ surface tension is considered the property of ~~the~~ surfactant; it is unaffected by the addition of HCl (lowering pH) ~~;~~ However in addition of NaCl; ~~it becomes~~ surface tension becomes dependent on pH (?)

The adsorption of surfactant ~~on~~ ^{Sandstone &} ~~adsorpti~~ Bentheimer is ^{well} studied (Chou, Mannhardt 1992). However most studies are at normal pH 7-8. Therefore we are interested in 3 pH.

Foam stability decreases for ~~at~~ acidic conditions
Chang 2001 proceedings in SPE For CO₂ foam

Schechter & Shook

Why relative permeability is not measured?

Falls et al. view: - The variables that affect the relative permeability of a gas in a foam have not yet been conclusively identified. The relative permeability depends on the area through which gas flows.

The area in turn depends on the pressure gradient and the density of stationary bubbles (texture).

They use $M_{g,app} = M_s + \frac{6\eta L}{r_g} \frac{v_g}{v_l}$
Geometric factor \rightarrow $\frac{6\eta L}{r_g}$ \rightarrow $\frac{v_g}{v_l}$
 $K_{rg} \ll 1$ but we use K_{rg} as K_{gi} ?
Annotations: $\frac{6\eta L}{r_g}$ is Hirasaki viscosity, $\frac{v_g}{v_l}$ is surface tension, r_g is velocity of gas, L is capillary radius, η is no. of lamellae.

Falls shows in fig 8 on page 885 how important bubble size is as ~~compared~~ compared to relative permeability

(Bubble density)

Talk about the mechanisms that alter texture in situ.

capillary snap-off, division, coalescence & mass transfer between bubbles caused by diffusion or condensation & evaporation.

① \ll for snap-off to occur, the capillary pressure must be sufficiently low (liquid saturation high) \gg

② \ll for division, some lamellae already present & mobile \gg
if the pressure gradient is ~~the same~~ large enough to mobilize lamellae in both branches simultaneously.

③ coalescence foam bubble density decreases when lamellae rupture

④ mass transfer between bubbles can diminish foam-bubble density. Pressure driven diffusion can be a fairly slow process, especially if the gas is relatively insoluble & has a low diffusivity in water.

The model by Falls is ~~due to~~ with bubble density due to capillary snap-off

Falls & other people (Zithu's) population balance accounts for stable foam aka steady state foam.

The fraction of gas ^{flowing water} taken ~~for the~~ constant for the simulation. Therefore it is steady state flow.

Bertin et al. Development of a Bubble generation function
bubble density = $f(\text{physical properties of porous medium, gas saturation})$

use Patzek 1988 ACS as original resource for bubble population approach.

$$\begin{aligned} G_f &= \text{generation rate} & C_f &= \text{coalescence rate} \\ &= K_g v_g^{1/3} v_w & &= K_c v_g n_f \\ & & & \quad \downarrow K_c^0 \left(\frac{1 - S_w}{1 - S_w^*} \right) \end{aligned}$$

the aqueous phase, containing the surfactant solution called water for simplicity, and the gas (or foam) phase.

for gas & water co-injection

$$q_g + q_w = q_o \quad \text{at } x=0$$

$$p_g = p_w = p \quad \text{at } x=L$$

The effect of surfactant composition & concentration are included in the viscosity coefficient α

Bertin ~~writes~~ writes about ~~total~~ correlation function

$$n_f = n_s S_g n_f f(p_c)$$

\uparrow no of generation sites per unit bulk volume \uparrow a function that should vanish at p_c^*

~~But~~ Leverett capillary pressure relationship

$$P_c = \sigma (\phi/k)^{1/2} \left(\frac{S_w - S_{wr}}{1 - S_{wr}} \right)^{-0.2}$$

$$S_{wr} = S_{wc}$$

$\alpha = 2.0 \times 10^{-13} \text{ Pa s}^{2/3} \text{ m}^{10/3}$ best fit parameter

$$K_c^0 = 1.0 \times 10^{-1} \text{ m}^{-1} \quad K_g = 1.0 \times 10^7 \text{ s}^{1/3} / \text{m}^{-13/3}$$

Berlin fits three parameters

They also did not measure the bubble density experimentally. ~~In this case~~ Berlin came to same procedure where only α needs to be determined through the optimal fitting of the experimental data.

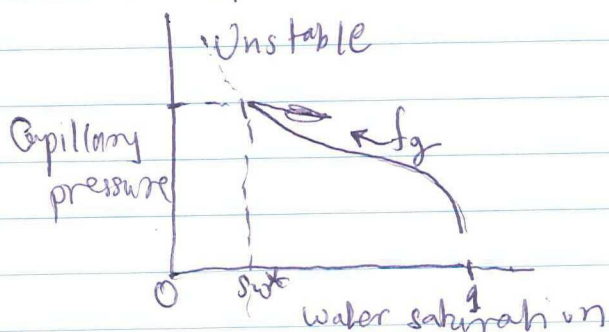
Berlin gives experimental results for unconsolidated and consolidated sandstone by ① Bubble population model ② Adding bubble correlation model.

We take the philosophy of Berlin of describing bubble correlation in both: unconsolidated & consolidated porous media.

Berlin points out that the correlation could be improved by taking into account an expression of the trapped gas saturation that depends on the gas velocity & foam texture.

Khatib, Hirasaki & Falls "Effects of Capillary Pressure"

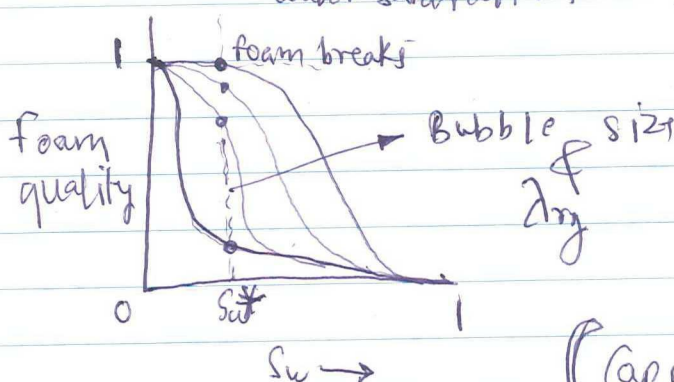
If critical capillary pressure exceeds a limit, foam films break down.



$$\lambda_{rg}^* = \frac{\rho_g}{1 - f_g} \lambda_{rw} [S_w^* (P_c^*)]$$

$$\lambda_{rg} \geq \lambda_{rg}^*$$

The equality holds for capillary pressure at limiting value.



Inequality occurs when coalescence is fairly attractive & convection or generation mechanisms are predominant.

(Capillary pressure & mobility are measured simultaneously)

$$P_c = \frac{6\sqrt{\phi}}{K} J(S_w)$$

J Function

~~At~~ Critical capillary pressure for Khatib is corresponds to $F_g = 0.9$. Beyond it foam would not exist.

Tell Reviewer two about Khatib's observation ~~about~~ «about bubble size measurement» At low values of gas fractional flow, the relative gas mobility is nearly constant, appearing to decrease slightly with gas fractional flow. Interpretation is that the foam texture remains nearly constant, corresponding to what was pregenerated. etc.

Use this in argument about not measuring bubble size directly.

KK Travels 020 66097979 / 9822979797 / 9011979797

Shiv Padma, Left Bhusari Colony, Near Borse Hospital, Kothrud, Paul Road Exit highway from Chandni Chowk towards Kothrud, take immediate left turn (200 mtrs from exit) from Cafe Coffee Day, 4th Building First Floor.

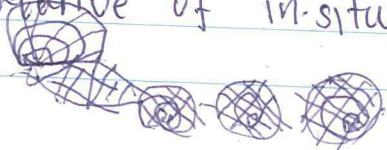
ॐ भाग्य देशमुख 12 दाना 20 जानेवारी

The easiest way to solve a problem is ~~to~~ to deny that ~~the~~ the problem exist.

From Ettinger

Treinen et al. 10 examined foam bubbles exiting sandpacks for different surfactant concentrations, but at flow velocities close to 1 mld. These researcher found that bubble sizes observed in visual cells were a factor 10 larger than typical pore sizes in the sandpacks. Hence they were hesitant to correlate their flow results with texture.

Foam bubbles can be produced at the exit face of a porous medium without much foam actually being present inside the medium ~~Ranshoff~~ Ranshoff / Radke in Ettinger. «Accordingly bubble sizes measured in external visual cells may not be representative of in-situ texture.



This issue could have been addressed as ~~shown by~~ ~~Ettinger~~ by reducing the flow velocity below the critical velocity for bubble generation by snap-off and/or division. Friedmann, Ranshoff & Ettinger. However the velocity ^{& fraction of flow} region is below ~~the~~ what we ~~want~~ our scope of discussion. In essence, we want to avoid the question of representing bubble size outside the porous medium.

A second concern about bubble-size validity is possible coalescence in the lines leading to and from the viewing cells. In addition the photographs are ^{taken for steady state flow} outside the porous. Therefore validation of bubble size ^{to the bubble size inside} the porous medium is no trivial matter. ~~that~~

Liquid saturations observed between 30% & 40% for various flow rates. :- Ettinger, ~~Ranshoff~~ Friedmann, Persoff de Vries 1990

Effluent bubble density for the pregenerated & in situ foam is same; the porous medium shapes the foam texture.

Generation & coalescence mechanism shape the foam over short distances near the core inlet.

Ettinger takes the trapped gas to be a constant in the modelling effort.
 ← Darcy's law "liquid saturation"

① ~~non~~ moving liquid ② Non moving gas

③ foam as a bubble caravan Hirasaki

Ettinger's idea about three ~~phases~~ in porous media flow regions

$$u_g = -K K_{rg} F / \mu_e \nabla P_g \quad \text{--- ①}$$

$$(\mu_e - \mu_g) / \mu = \underbrace{A n_f}_{\text{Scaling factor}} \underbrace{d_p^3}_{\text{Pore body diameter}} (S / \mu_{fg})^{4/3} \quad \text{--- ②}$$

We can copy-paste generation-coalescence mechanism from page 87 of Ettinger & later refine it to our needs.

(Rate of generation & coalescence)

Ettinger claims that bubble density \hat{n} is constant except at the inlet where a net generation takes place.

rate of generation & coalescence are determined as

$$r_c = k_{-1} v_g^n n_F$$

↑ (liquid saturation, surfactant dependent)

$$r_g = k_1 v_g^m$$

↑ Activated once snap off occur

when Damköhler number, $k_{-1} v_g^{n-1} L$, is greater than about 50, then the rates of bubble creation & decay almost balance throughout the porous medium.

« Calculate for us how many parameters to fit »

Small errors in measuring fine bubble sizes result in rather large changes in n_F .

coalescence regime → liquid saturation is low enough & the corresponding capillary pressure approach its limiting value, so that coalescence rates come into balance with generation rates. During transient displacement, coalescence should be minimum when liquid saturations are high.

Find the latest Bentheimer & coarse sandpack COMSOL file & Effect of (1) trapping (for steady state) (2) Surfactant (Entire case)

30 January 2016 Friday

Checking which COMSOL file to select to work on
13 July finalised. for unconsolidated sand

$$\rho \frac{\partial}{\partial t} (S_w C + S_g C_{sig} n)$$

$$+ C \frac{k k_{rw}}{\mu_w} \Delta P_w - \rho g + C_{sig} n \frac{k k_{rg}}{\mu_g(n)} \Delta P_g - \rho g$$

$$+ 10 D_0 C_x = 0$$

~~generation~~ ~~saturations~~ Surfactant saturation
= generation
Convection of surfactant in gas & water

2nd February 2015 Monday

We have surfactant saturation in a liquid & surfactant in the water that forms a bubble

We consider not to have ~~diffused~~ concentration C_x diffused between gas & water phase or ~~top~~ water & bubbles.

We have to consider the alpha value as $\frac{C_{\text{bubbles}}}{C_{\text{bubbles}} + C_{\text{surfactant}}}$
Original surfactant

For Reviewer one better explanation for ~~the~~ D_n should be given after discussion with Hans.

In 13 July file

① $C_{\text{sig}} \equiv \frac{1}{n_{\text{inf}}} = \text{concentration in bubbles}$

$$= \frac{1}{480} = 2 \times 10^{-3} \frac{\text{mol}}{\text{l}}$$

② for unconsolidated sandpack $1.9 \times 10^{-2} \frac{\text{mol}}{\text{l}}$

$$\frac{1.9 \times 10^{-2}}{2 \times 10^{-3}} = \frac{2 \times 10^{-2}}{2 \times 10^{-3}} = 10 \text{ times of surfactant}$$

is there in the bubbles (lamellae).

$$\alpha = \frac{C_{\text{sig}}}{C} = 0.01 = C_{\text{sig}}$$

$\alpha =$ Depletion of surfactant Viscosity coefficient

$$= \frac{C_{\text{bubbles}}}{C_{\text{bubbles}} + C_s} = \frac{2 \times 10^{-3}}{2 \times 10^{-2}}$$

$$\alpha = 0.1$$

$$\alpha = \frac{\text{Concentration in bubbles}}{\text{Concentration in water before gas injection}} = \frac{2 \times 10^{-3}}{2 \times 10^{-2}} = 0.1$$

However,

The fitting coefficient $\alpha = 0.01$ therefore 10 times smaller effect of gas viscosity ^{coefficient} should be on the gas viscosity ~~in terms of~~ when foam is present.

Is it due to trapped gas? How it plays a role

$C_{sig} = \frac{1}{n}$ so that at maximum condition $n \rightarrow n_{inf}$ & α is 0.1

$$\alpha = \frac{1}{n \times 2 \times 10^{-2}} = \frac{0.5 \times 10^2}{n} = \frac{50}{n} = \frac{C_{sig}}{C} \quad C = 2 \times 10^{-2} \frac{mol}{l}$$

$$\mu_f = \mu_g + \frac{\alpha n}{\nu_g^{1/3}} = \mu_g + \frac{50 \times n}{\nu_g^{1/3}}$$

$\alpha = \frac{50}{n}$ where n varies from 7 to 480

$$C_{sig} = \frac{1}{n}$$

Then μ_f varies only with

$$\boxed{\nu_g^{1/3}}$$

$$\frac{1}{0.02 n} = \frac{100}{2 n} = \frac{50}{n}$$

$$\mu_f = \mu_{ug} + \frac{50}{\nu_g^{1/3}} \quad \text{Resistance to flow}$$

16:49 Running with above case $\mu_f = \mu_{ug} + \frac{50 \times n}{\nu_g^{1/3}}$

sorry C_{sig} should be changing; not α

thus $C_{sig} = \frac{1}{n}$ & $\alpha = \frac{C_{sig}}{C}$ _{constant}

But even then it $\alpha = \frac{1}{n \times 2 \times 10^{-2}} = \frac{50}{n}$ which we put in analytical expression.

16:55 Optimisation disabled. Therefore no alpha optimised.

But we did not yet considered trapped gas

3rd February 2015, Wednesday

Not bad; not bad at all.

§ The saturation profile is matched with which the slope can be adjusted & height can be changed.

$$x_f = \frac{\gamma}{s_g} \left(\frac{f_c | \Delta P |}{k^{1/2} n} \right)^\eta$$

$$x_f = \frac{\gamma}{s_g} f_c$$

$$\frac{\Delta P}{L} = \frac{\alpha n \cancel{u_g^{2/3}}}{k_g}$$

$$n = \frac{\Delta P k_g}{L \alpha \cancel{u_g^{2/3}}}^{2/3}$$

$$\cancel{\Delta P} \cancel{u_g} = - \cancel{k_g} \frac{\Delta P}{\mu_f L}$$

$$\frac{\Delta P}{L} = \frac{\alpha \cancel{u_g} \cancel{k_g}}{\mu_f}$$

$$x_f = \frac{\gamma}{s_g} \left(\frac{f_c \cdot \cancel{\Delta P k_g}}{k^{1/2} \frac{\Delta P k_g}{L \alpha \cancel{u_g^{2/3}}}} \right)^\eta$$

$$x_f = \frac{\gamma}{s_g} \left(\frac{f_c \cdot \alpha \cdot u_g^{2/3} L}{k^{1/2} \cdot k_g} \right)^\eta$$

$$\alpha = \frac{50}{\eta}$$

$$x_f = \frac{\gamma}{s_g} \left(\frac{f_c \cdot 50 \cdot L \cdot u_g^{2/3}}{k^{1/2} \cdot k_g \cdot \eta} \right)^\eta$$

Bubble generation rate vs surfactant concentration

Res)

$$\left(\frac{dn}{dt} \right)$$

4th February 2015 Wednesday.

6 terms contributing to pressure drop for Bentheimer

PPb18-21 & PPb22 (Rcm)

PPb18 $\cdot n \psi \frac{\partial S_g}{\partial t}$

PPb19 $\psi S_g \frac{\partial n}{\partial t}$

PPb20 $- n \partial \left(\frac{K K_{rg} (P_x - S_g)}{\mu_f} \right)_x$

PPb21 $- \frac{K K_{rg} (\Delta P - S_g)}{\mu_f} \cdot \frac{\partial n}{\partial t}$

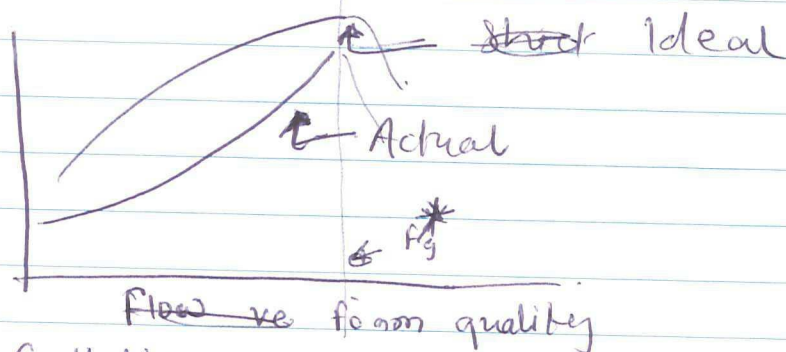
PPb22 $a_{n11}(n) \psi S_g$

All at mp2

Error parameter name should not be empty

It looks much better without logarithm

Sian Jones: Playing with bubbles: Liliput Foam Flood experiments and micromodel tests



Foam Flow Gillette

$$x_f = \frac{\psi}{S_g} \left(\frac{f_c \cdot 50 L \cdot U_g^{2/3}}{K^{1/2} \cdot K_{rg} \cdot n} \right)^\eta \quad \text{or} \quad \frac{\psi}{S_g} \left(\frac{f_c \cdot \Delta P}{K^{1/2} \cdot n} \right)^\eta$$

$\eta = 0.4$ $\psi = 1.4$ f_c ~~is~~ minimum number of bubbles required to flow the bubbles?

Could not find de Gennes PoFo 1992, conjectures on foam mobilization

We can use f_c as a fitting parameter

The equation for water saturation is found with bubble density as well.

for unconsolidated sandpack
 S_{bound} in the manuscript

$$S_{wm} = -0.020 \log(n) + 0.5627$$

$$S_g \sim (f - f_c)^\eta$$

Percolation Fraction

f_c critical fraction flow of gas required for bubbles to flow

Put ΔP in the form of η

$$x_f = \frac{\psi}{S_g} \left(\frac{f_c \Delta P}{k^{1/2} \eta} \right)^\eta$$

$$\frac{P_x - \rho_g(p) g}{K_{rg} \text{ perm}}$$

$$\eta = \frac{K_{gaw}}{\alpha (v_g)^{2/3}} \frac{P_x - \rho_g g}{x_R x_L}$$

$$x_f = \frac{P_x - \rho_g g}{K_{rg} \text{ perm}}$$

Instead of $1-S \rightarrow S_g$ using $x_f \rightarrow \eta^{-0.4}$

$$x_f(n)$$

$$\psi (S_w + S_{g/p}) \frac{\partial P}{\partial t} + K \left(\frac{K_{rg}}{\mu_g} (\Delta P - \rho_g g) + \frac{K_{rw}}{\mu_w} (\Delta P - \rho_w g) \right)$$

$\frac{\partial P}{\partial x}$ test(P_x)

$$+ K \left(\frac{K_{rg}/P}{\mu_g} (\Delta P - \rho_g g) + \frac{K_{rw}}{\mu_w} (\Delta P - \rho_w g) \right) \text{ test}(P) P_x$$

$$\gamma (S_w (w + S_g (g)) \partial_t P - \partial_x \left(\frac{k_g}{\mu_g} (\partial_x P - S_g (w) g) \right) - \partial_x (P)$$

Now $(1-XF)$ just checking

$$S_{ini} + (S_{bound} - S_{ini}) X_{mix}(t)$$

$$- 0.020 \log(n) + 0.5627$$

Saturation equation

$$\gamma \frac{\partial s}{\partial t} + \frac{k k_{rw}}{\mu_w} (\Delta P - S_g) + \text{diff} * S_x * \text{test}(x)$$

16:38 Back to $(1-S_w)$

May be add some value to it $(1-S_w + X)$

$$S_w = 0.52 \quad S_g = 0.48 \quad 1-S = 0.48 - 0.$$

$$S_{init} + (S_{wn}(n_{init}) - S_{init}) \cdot r_{mi}(t)$$

17:00 Trying to see if saturation does things as
Did not yet succeed!

$$X_f \cdot S_g \quad X_f(n) \cdot (1-S) \quad X_f > g$$

↑
This works

The slope is much better now

$$S_{wn} = -0.020 \log(n) + 0.5627$$

Just fixing starting saturation

$$0.5744$$

5 Feb 2015
Thursday

surfactant concentration in the lamellae
↓

$$\gamma \left(\frac{\partial (S_w c)}{\partial t} + \frac{\partial (\rho_w c_s(c))}{\partial t} + \frac{\partial (S_g + S_{geps})}{\partial t} n c_{sig} \right)$$

\uparrow surfactant concentration in water \uparrow starting surfactant concentration ?

$$c_s = \tanh\left(\frac{c}{\text{delt}}\right)$$

$$c_{ini} = c_{bound} = 0.019 \text{ mol/l}$$

$$c_{sig} = \frac{1}{n}$$

Nothing changes as $c = c_{init} = c_{bound} = 0.019 \text{ mol/l}$

Addition of bubble diffusion term in bubble density equation

$$\partial_x (\gamma S_g D_n \partial_x n)$$

$$\partial_x (\gamma S_g D_n \partial_x n)$$

$$\gamma D_n \partial_x (S_g \partial_x n) + \gamma D_n \partial_x (S_g) + \gamma D_n \partial_x (n)$$

Changing contributing terms; everywhere multiplied by flowing fraction.

If we use diffusion term $R(n)$ goes further away from $\frac{\partial n}{\partial t}$ term ?

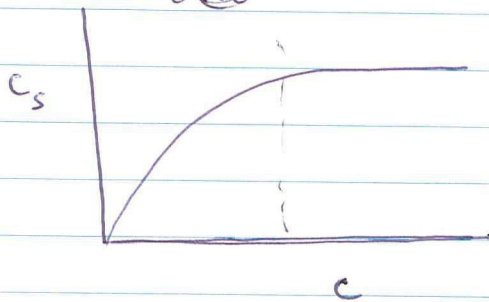
$$\partial_x (S_g D_n \partial_x n) + \partial_x (D_{ap} n \partial_x S_g)$$

\uparrow
 D_n

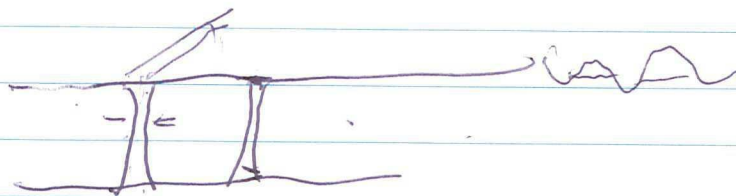
D_n being ~~dependent~~ ^{depends} on S_w of bubbles
 $D(n)$ increases or decreases with water saturation

Checking September 2013 when we were trying to include the surfactant concentration effect for Benthimer

$$C_s = C_s(c) = \frac{Kc}{1 + Ac}$$



480 x



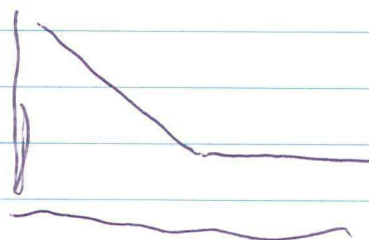
$$(0.1 \mu)^3 \times (1 \mu)^2 \times 480$$

$$= 48 \times 10^{-10} \text{ m}^3 =$$

$$= 48 \times 10^{-8} \left(\frac{\text{mm}}{10^3} \right)^3 \frac{1}{\text{mm}^3}$$

$$\approx 4.8 \times 10^{-8} \frac{\text{mm}^3}{\text{mm}^2}$$

0.25



If α depends on
 $\uparrow \downarrow \uparrow$

$$\alpha = \frac{1}{6^{1/3}} \text{ for lamellae } \alpha =$$

$R(n) = \text{creation \& destruction}$

$R(n) = R(n, c)$ when below or at cmc

G = surface tension

$$\frac{0.075 \text{ g/l}}{315 \text{ g/mol}} = 2.38 \times 10^{-3} \frac{\text{mol}}{\text{l}}$$

$$\alpha = \frac{1}{G^{1/3}}$$

↑ for $\frac{\text{mN}}{\text{m}}$ $30 \frac{\text{mN}}{\text{m}}$

for ~~Bentheimer~~; ~~for~~ $\alpha = 0.27$

~~0.075~~ w/w %. $G = 27.8 \frac{\text{mN}}{\text{m}}$

$$\alpha = \frac{1}{27.8^{1/3}} = 0.33$$

Using constant for unconsolidated sandpack

Slightly better than earlier result; therefore keeping it like this.

6th February 2015 Friday

Bentheimer surfactant concentration $9.5 \times 10^{-6} \frac{\text{mol}}{\text{l}}$

for us
AOS % ~~at cmc~~ $0.0375 \frac{\text{g}}{100 \text{ g of water}}$ $0.0375 \frac{\text{g}}{\text{g}}$ ~~at cmc~~

$1000 \text{ g} \approx 1000 \text{ ml} \approx 1 \text{ l of water}$ ~~$0.375 \frac{\text{g}}{\text{l}}$~~

~~$0.375 \frac{\text{g}}{100 \text{ g of water}}$~~ $0.375 \frac{\text{g}}{100 \text{ g of water}}$ $0.375 \frac{\text{g}}{\text{l}}$

Therefore AOS in $\frac{\text{mol}}{\text{l}}$ for our situation is

$$\frac{0.375 \text{ g/l}}{315 \text{ g/mol}} = 1.19 \times 10^{-3} \frac{\text{mol}}{\text{l}}$$

at cmc = $9.5 \times 10^{-6} \frac{\text{mol}}{\text{l}}$

Therefore our concentration is slightly higher than cmc

Therefore in Eureka we did it wrong

$$0.075 \text{ w/w. } 2.38 \times 10^{-3}$$

$$\& \text{ not } 1.19 \times 10^{-2} \text{ mol}$$

$$0.15 \text{ w/w. } 4.76 \times 10^{-3}$$

$$\frac{105}{315} =$$

Excess adsorption

$$b = -0.0066 \ln C - 0.0151$$

$$\alpha = \frac{1}{b^{1/3}}$$

How to put ^{surfactant} varying expression

directly saying

$$\alpha = \frac{1}{(-0.0066 \ln C - 0.0151)^{1/3}}$$

C varies from 0 to C_{mc}

$$C_{ini} = 0.3 \times \text{conc} = 0.3 \times 1.19 \times 10^{-3} = 3.57 \times 10^{-4}$$

d(C, t) * test(c)

$$C_s = 0.3 \tanh\left(\frac{C}{\text{delt}}\right)$$

$$\text{delt} = 0.04$$

$$C_s = 0.28$$

$$C_s = 0.3$$

for $\text{delt} = 0.038$ Retardation Factor

$$\alpha = 1.38747e-6 \rightarrow$$

Problem with function M_f : Analytical expression generates 2D plot. However when program run, error message about alpha appears as

function called with wrong number of arguments
Number of arguments used: 1
Number of arguments expected: 2

Where c is generating

$$\alpha = \frac{1}{\delta^{1/3}}$$

$$\delta = -0.0066 \ln C - 0.0151$$

C changes from $\overset{C_{ini}}{3.57 \times 10^{-4}}$ to $\overset{C}{1.19 \times 10^{-3}} \frac{\text{mol}}{\text{L}}$
over 25-30 pV

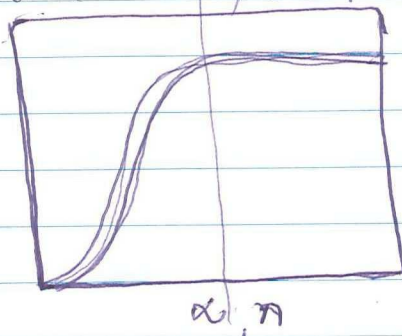
$$\alpha = f(C)$$

$$\mu_f = \mu_g + \frac{\alpha(C) n}{u_g^{1/3}} \quad \alpha = 1/(-0.0066 \ln C - 0.0151)^{1/3}$$

Directly putting values of C & n in μ_f

11:58 constant α

13:00 ~~word amp~~ Saved as HB; checking



Multivariable calculus - McCullum

Everywhere there is @ $\mu_f(n) \rightarrow \mu_f(n, c)$

problem solved; but now concentration equation

dcs - dcs - e - internal argument problem

Removing CS(C)

$$\phi \left(\partial_t (s_w c) + \partial_t (s_w c_s(z)) + \partial_t ((s_g + s_{geps}) n c_{sig}) \right)$$

$$\partial \quad \phi(n) ((1-s) + s_{geps})$$

Removing c_{sig} & c_{ccc}

The surfactant concentration at end (0.17 cm) goes higher than 1; ~~that~~ that is crazy.

$$\phi \quad s_g D_n \frac{\partial^2 n}{\partial x^2} \quad \text{unconsolidated sand}$$

$$\phi (s_g D_n n - D \cdot n s_x) \text{ test } n_x$$

$$-\phi \quad s_g D_n \frac{\partial^2 n}{\partial x^2} - \phi n D_n \frac{\partial^2 s_g}{\partial x^2}$$

\uparrow
 D_{cap}

Somewhere we have saturation ~~equation~~ ^{values mixed up.} ~~different~~

$$s_{init} + (s_{wn}(n_{init}) - s_{init}) \times m_1(t)$$

$$s_{wn} = -0.05 \log(x) + 0.8$$

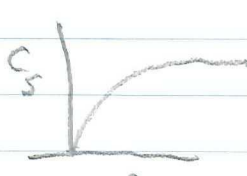
$$C_s =$$

$$\varphi \frac{\partial}{\partial t} (c + c_s) + \frac{\partial}{\partial x} u c = 0$$

$$\varphi \frac{d(c + c_s)}{dc} \frac{\partial c}{\partial t} + \frac{\partial}{\partial x} u c = 0$$

$$\varphi \left(1 + \frac{dc_s}{dc} \right) \frac{\partial c}{\partial t} + u \frac{\partial}{\partial x} c = 0$$

$$-\frac{\partial c}{\partial t} / \frac{\partial c}{\partial x} = \left(\frac{\partial x}{\partial t} \right)_c$$

$$\left[\begin{array}{l} dc = \frac{\partial c}{\partial x} dx + \frac{\partial c}{\partial t} dt \\ \left(\frac{\partial x}{\partial t} \right)_c = - \frac{\partial c / \partial t}{\partial c / \partial x} \end{array} \right] \quad \begin{array}{l} \text{point} \\ dc = 0 \end{array}$$


$$\left(\frac{\partial x}{\partial t} \right)_c = \frac{u}{\varphi} \frac{1}{1 + \frac{dc_s}{dc}} \quad \frac{L}{\left(\frac{\partial x}{\partial t} \right)_c} = t_b$$

$$u = \frac{u}{\varphi} \frac{1}{1 + \frac{dc_s}{dc}} \quad = \frac{u}{\varphi} \frac{1}{1 + dc_s/dc}$$

$$\frac{u}{L} = \frac{u t A}{\varphi L A} \frac{1}{1 + \frac{dc_s}{dc}}$$

$$\varphi t_b \frac{u}{\varphi}$$

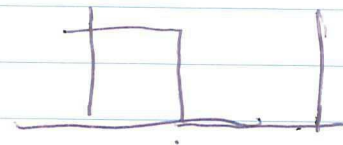
$$1 = \frac{u t}{\varphi L} \frac{1}{1 + \frac{dc_s}{dc}} \Rightarrow t = \frac{\varphi}{u}$$

$$t = \frac{\varphi L (1 + dc_s/dc)}{u}$$

at the end of the tube

$x = L$ and $\frac{u+A}{\phi L A}$ is the dimensionless amount of water injected. i.e.

$$wid = \frac{u+A}{\phi L A}$$



$$wid \cdot \frac{1}{1 + \frac{dc_s}{dc}} = 1 \text{ and}$$

$$wid = \frac{1}{1 + \frac{dc_s}{dc}}$$

$$c_s = ac$$

$$(1+a)$$

the production is equal to

$$N_{pd} = \int_0^{wid} c d\tilde{wid} = \text{(integrating by parts)}$$

$$= c \tilde{wid} - \int \tilde{wid} dc$$

$$\Rightarrow x/L = c \tilde{wid} - \int \left(1 + \frac{dc_s}{dc}\right) dc$$

$$= c \left(1 + \frac{dc_s}{dc}\right) - (c + c_s)$$

$$N_{pd} = \left(c \frac{dc_s}{dc} - c_s\right)$$

if $c_s = ac$

$$c \tilde{wid} = \left(c + \frac{dc_s}{dc} c\right)$$

$$\frac{\phi L A}{u k_{of} A} = 1 + \frac{dc_s}{dc}$$

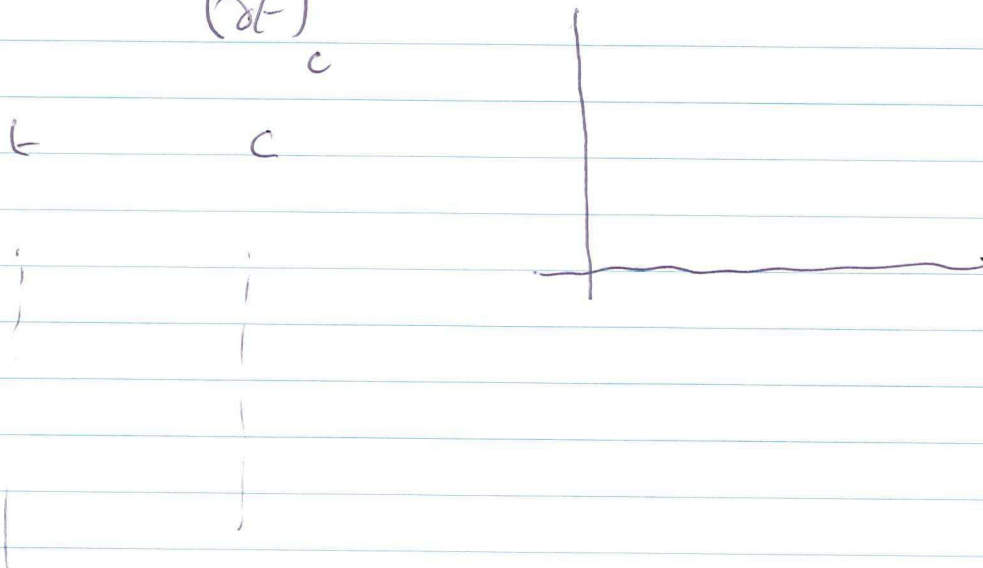
$$\frac{L}{\left(\frac{\phi L A}{u k_{of} A}\right)} = t_{ot}$$

$$= \frac{L}{\frac{\phi L A}{u k_{of} A} \left(1 + \frac{dc_s}{dc}\right)} = \frac{u k_{of} A}{\phi L A \left(1 + \frac{dc_s}{dc}\right)} = \frac{L}{\frac{u k_{of} A}{\phi L A} \left(1 + \frac{dc_s}{dc}\right)}$$

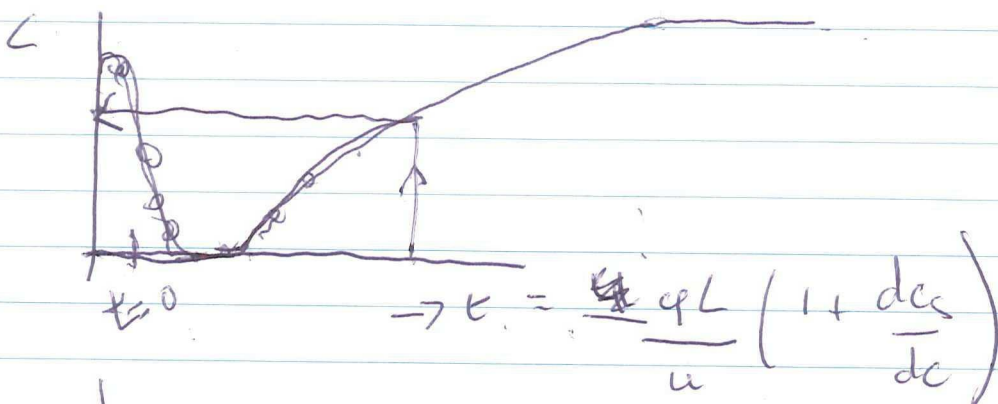
choose a concentration \Rightarrow

$$\text{calculate } \left(\frac{\partial x}{\partial t} \right) = \frac{u}{\bar{\varphi}} \frac{1}{1 + \frac{dc_s}{dc}}$$

$$\Rightarrow L \int \left(\frac{\partial x}{\partial t} \right) \Rightarrow t_{arr}$$

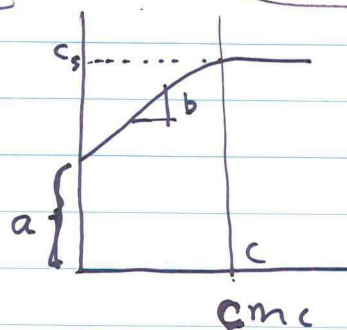


$$Q_c = \int u c dt$$



$$\frac{ut}{\varphi L} = \left[1 + \frac{dc_s}{dc} \right] = 20$$

$$q \frac{\partial}{\partial t} \int_{w c} + \frac{\partial}{\partial t} \int_{c s}$$



$$1 + \frac{dc_s}{dc} = 22.6$$

$$\frac{dc_s}{dc} = 21.6$$

$$dc_s = 21.6 dc$$

$$\int dc_s = 21.6 \int dc$$

$$\int_{0.31}^1 dc_s = 21.6 \int_{0.31}^1 dc$$

$$= 21.6(1) - 21.6(0.31) = 13.1$$

$$c_s = \frac{1}{a + bc}$$

↑
0.3

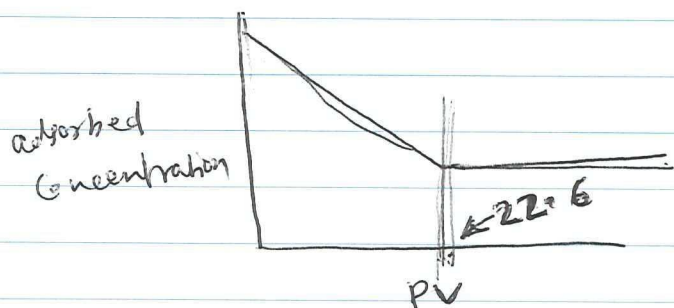
$$c_s = \tanh\left(\frac{c}{delt}\right)$$

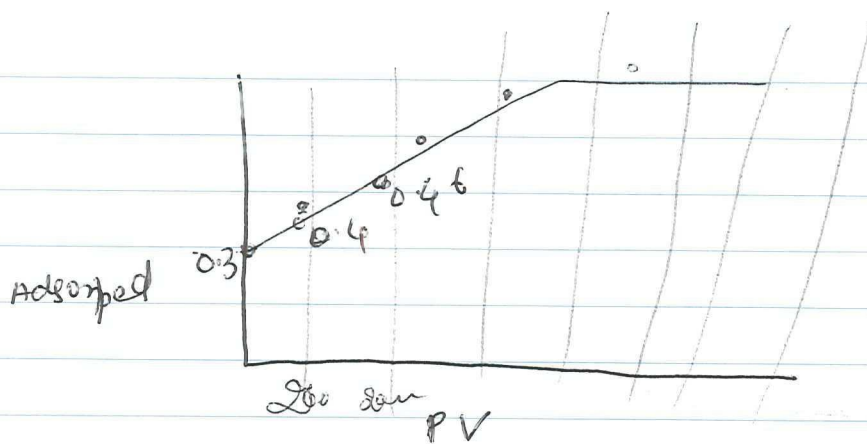
0.038

$$c_s = \frac{K_{ads} * c}{1 + K_{ads} * c}$$

K_{ads} * c < constant
K_{ads} = 22.6

For c varying from 3.57×10^{-4} to $1.19 \times 10^{-3} \text{ mol/l}$





$$C_s = \frac{K_{ads} * C}{1 + K_{ads} * C}$$

$$\frac{C_{out}}{C_{in}} = 0.0117 PV + 0.3733$$

$$1 - \frac{C_{out}}{C_{in}} = \frac{C_{in} - C_{out}}{C_{in}} = \frac{C_{retain}}{C_{in}}$$

$$1 - 0.0117 PV + 0.3733 = \frac{C_{retain}}{C_{in}}$$

$$0.6267 - 0.0117 PV C_{in} = \frac{C_{retain}}{C_{in}}$$

$$0.6267 - 0.0117 PV$$

Adding relation $C_s = 0.0117C + 0.3733$

Adding $C_{sig}(n)$

$$C_{sig} = \frac{C}{10}$$

13:00 Benlheimer file is not running mumps allocation
Factor increased to 1.44

13:44 Starting all over again with Bentheimer to find the file which runs.

Bentheimer_17december2013_optimisation_04Feb2015 runs.

① ~~Muf(n) to ~~xxxxxx~~ muf(n, e)~~

① Fraction inclusion $\alpha_F = n^{-0.4}$

② $muf(n)$ to $muf(n, c)$

the problem with muf is over; the problem with c starts.

$$c_{init} + (c_{bound} - c_{init}) \times r_{mi}(t)$$

Nonlinear solver did not converge. No convergence, even when using the minimum damping factor.

Last time step is not converged.

saturation at the exit side is higher than one.

maximum no of ~~and~~ iterations are reached, did not converge

length of the specimen is correct?

Something with the tolerance or equation $c_s(c)$?

$$c_s = \frac{1}{0.0117c + 0.3733} \quad ? = \text{---}$$

$$c_s = 0.0117c + 0.3733$$

$$\text{if } \frac{dc_s}{dc} = 22.6$$

$$\frac{dc_s}{dc} = 21.6$$

$$\int dc_s = \int 21.6 dc$$

$$(c_{s_f} - c_{s_i}) = 21.6 (c_{f_{ini}} - c_{i_{ini}})$$

$$c_{s_{final}} - c_{s_{ini}} = 21.6 (c_{final} - c_{ini}) +$$

$$\frac{c_s}{c_0} =$$

15:39 Even after removing c_s the saturation at the end is high.

How somebody actually used the saturation equation with concentration

csig silenced

$$\phi \left(\partial_t (s_w c) + \partial_t (s_w c_s(c)) + \partial_t \left(s_g + s_{g,eps} \right) n: \overset{\text{sig}}{\overset{\text{XF(n)}}{\partial_t}} \right) + c \frac{k k_{rw}}{\mu_w} (\Delta P_w - \rho_w g) + c_{sig} n \frac{k k_{rg}}{\mu_g} (\Delta P_g - \rho_g g) = 0$$



8th Feb. 2015 Sunday

Trying $c_s = c \tanh\left(\frac{c}{c_{deit.}}\right)$

Add X_F in concentration solution ? no
let us assume that there is no water which is immobile
only some gas is immobile & it does not contain
any surfactant.

Troglus model : \rightarrow

$$\textcircled{9} \quad \frac{\partial^2 c}{\partial x^2} - \frac{q}{A \phi} \frac{\partial c}{\partial x} = \frac{\partial c}{\partial t} + \frac{A_s}{\phi} \frac{\partial c_s}{\partial t} \quad \text{Total adsorption capacity} \quad 22.6 \text{ PV ?}$$

$$\textcircled{10} \quad \frac{\partial c_s}{\partial t} = \cancel{k_a (Q_s - c_s)} k_a (Q_s - c_s) c - k_d c_s$$

\uparrow adsorption \uparrow desorption

c_s Chemical concentration on the solid surface per unit area
 A_s rock interstitial area per unit volume (total volume)

Shall we put two $PDES$ then?

we have to consider dynamic adsorption model.
We consider CDA model convection, dispersion & adsorption model.

four parameters

$$Pe = \frac{VL}{D}$$

v = interstitial velocity u_0
 A = area

D = mass dispersion coefficient Dif in our case?
 $= D_m(1 + \tau_m) + a(v)^{\frac{1}{2}} \cdot 1.25$
 $\uparrow \quad \uparrow$
 molecular diffusion coefficient mass tortuosity $\frac{1}{2}$ - constant

If $D=0$ $Pe=\infty$ the flow becomes plug flow
shall we consider that there is no dispersion
(diffusion) etc.

$$La = \frac{A_s Q_s}{\phi C_0} \quad J = \frac{V}{L K_a C_0} \quad E = \frac{K_d}{K_a C_0}$$

How to put ~~adsorption~~ CDA in context & how to define boundary conditions?

Hans actually consider langmuir isotherm where adsorption & desorption reach equilibrium instantaneously & equation 9 & 10 can be combined as

$$D \frac{\partial^2 c}{\partial x^2} - \left(\frac{q}{A\phi} \right) \frac{\partial c}{\partial x} = \left[1 + \frac{A_s a}{\phi(1+bc)^2} \right] \frac{\partial c}{\partial t}$$

$$a = \frac{K_a Q_s}{K_d} \quad b = \frac{K_a}{K_d}$$

How to find K_a & K_d then for langmuir Isotherm?

For from fig. 7 $K_a = 0.0015 \text{ cm}^3/\text{g-hr}$

$$K_d = 0.01 \text{ mg/g-hr}$$

$$Pe = 150 = \frac{VL}{D}$$

$$A_s = 16000 \text{ cm}^2/\text{cm}^3$$

$$D = \frac{150}{VL}$$

$\uparrow \uparrow$ length of the core

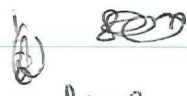
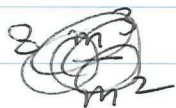
Satter A Y Chemical transport in porous media with dispersion & Rate controlled Adsorption

inhal concentration 200 mg/l

N = adsorbed concentration
 C = equilibrium concentration

C_o basic C_{ads} adsorbed C out concentration

As Bentheimer



each sq.m. contains 8 m³ surface volume

$$\frac{m^2}{m^3} = \frac{8}{1}$$

each one m² surface area contains 8 m³ volume

specific surface area for Bentheimer is 0.35 m²/g

specific surface ~~volume~~ ^{area} per volume

$$\frac{1 m^2}{8 m^3}$$

$$\boxed{0.125 \frac{m^2}{m^3}} \text{ As}$$

without including porosity ^{excluding} $\frac{1 m^2}{10 m^3}$ 0.1 m²/m³ As

Adsorption capacity of the rock surface is 181.0 mg surfactant (0.45 mg per gm of rock)

from Simjoo page 6227 IECR 2013

Reference

"Adsorption in Bentheimer Sandstone" Internal Report by DU 2007

We assume same core size as Simjoo

Surface balance equation $\frac{d\Gamma}{dt} = D \frac{\partial C}{\partial x} \bigg|_{x=0}$

Diffusion equation

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2}$$

$$\left(\frac{\text{mN/m}}{\frac{\text{mol}}{\text{kg}}} \right) \frac{\text{K} \cdot \text{mol}}{\text{K} \cdot \text{J}} = \frac{\text{mN}}{\text{m}} \cdot \frac{\text{l}}{\text{mol} \times 1000}$$

$$\frac{\text{mN}}{\text{m}} \cdot \frac{\text{l}}{\text{J}} = \frac{\text{mN}}{\text{m}} \cdot \frac{1000 \text{ J}}{\text{mol}} \cdot \frac{\text{l}}{\text{mol}} \\ = 1000 \frac{\text{l}}{\text{m}} = \frac{1000 \text{ l}}{1000 \text{ mm}} = \boxed{\frac{\text{l}}{\text{mm}}}$$

How to get constants for langmuir isotherm?

At equilibrium; rate adsorption = rate desorption

Γ_{max} surface energy

Eq. 9 & 10

$$\phi D \frac{\partial^2 c}{\partial x^2} - u_w \frac{\partial c}{\partial x} = \phi \frac{\partial c}{\partial t} + A_s \frac{\partial C_s}{\partial t}$$

$$\frac{\partial C_s}{\partial t} = k_a (Q_s - C_s) c - k_d C_s$$

~~Eq. 11~~

$$\phi D \frac{\partial^2 c}{\partial x^2} - u_w \frac{\partial c}{\partial x} - \phi \frac{\partial c}{\partial t} + A_s \frac{\partial C_s}{\partial t} = 0$$

$$\phi \frac{\partial c}{\partial t} + A_s \frac{\partial C_s}{\partial t} + u_w \frac{\partial c}{\partial x} - \phi D \frac{\partial^2 c}{\partial x^2} = 0$$

$$\phi \frac{\partial c}{\partial t} + A_s (k_a (Q_s - C_s) c - k_d C_s) + u_w \frac{\partial c}{\partial x} - \phi D \frac{\partial^2 c}{\partial x^2} = 0$$

If ~~langmuir~~ adsorption & desorption is in equilibrium

$$D \frac{\partial^2 c}{\partial x^2} - \frac{u_w}{\phi} \frac{\partial c}{\partial x} = \left[1 + \frac{A_s a}{\phi (1 + bc)^2} \right] \frac{\partial c}{\partial t}$$

$$\left[1 + \frac{A_s \cdot a}{\phi (1 + bc)^2} \right] \frac{\partial c}{\partial t} + \frac{u_w}{\phi} \frac{\partial c}{\partial x} - D \frac{\partial^2 c}{\partial x^2} = 0$$

No dispersion

$$\frac{0.45 \text{ mg}_{\text{surfactant}}}{175 \text{ m}^2 \text{ rock}}$$

$$\frac{2.57 \times 10^{-3} \text{ mg}_{\text{surfactant}}}{\text{m}^2 \text{ Rock}}$$

$$\frac{2.57 \times 10^{-6} \text{ g}}{\text{m}^2}$$

$$K_d = \frac{0.0015 \text{ cm}^3}{\text{g} \cdot \text{hr}} = \frac{0.0015 \times 10^{-6} \text{ m}^3}{\text{g} \times 3600 \text{ sec}} \quad 1 \text{ cm} = 10^{-2} \text{ m} \quad 1 \text{ cm}^3 = 1 \times 10^{-6} \text{ m}^3$$

$$= \cancel{0.0015 \times 10^{-6}} \frac{4.16 \times 10^{-13} \text{ m}^3}{\text{g} \cdot \text{sec}}$$

$$K_{ad} = \frac{0.01 \text{ mg}}{\text{g} \cdot \text{hr}} = \frac{0.01 \times 10^{-3} \text{ g}}{\text{g} \cdot 3600 \text{ sec}} = 2.7 \times 10^{-9} \frac{\text{g}}{\text{g} \cdot \text{sec}}$$

$$Q_s = 1.73 \times 10^{-5} \frac{\text{mg}}{\text{cm}^2} \text{ but we have } 181 \frac{\text{mg}}{\text{cm}^2}$$

$$= \frac{1.73 \times 10^{-8} \text{ g}}{10^{-6} \text{ m}^2}$$

$$= \frac{181 \times 10^3 \text{ g}}{10^{-6} \text{ m}^2}$$

$$= \cancel{1.73} \frac{1.73 \times 10^{-2} \text{ g}}{\text{m}^2}$$

$$= 181 \times 10^3 \frac{\text{g}}{\text{m}^2} \text{ HUGE}$$

$$C_0 = \frac{200 \text{ mg}}{\text{L}} = \frac{200 \text{ mg}}{1000 \text{ mL}} = \frac{0.2 \text{ g}}{\text{L}} = \frac{0.2 \text{ g}}{1000 \text{ L}} = \frac{2 \times 10^{-4} \text{ g}}{\text{cm}^3} = \frac{2 \times 10^{-4} \text{ g}}{1 \times 10^{-6} \text{ m}^3} = \frac{200 \text{ g}}{\text{m}^3}$$

$$U_w = 3.76 \times 10^{-5} \frac{\text{m}}{\text{s}} \quad L = \cancel{0.0017 \text{ m}} \quad L = 0.09 \text{ m}$$

$$\left(1 + \frac{A_s K_d Q_s}{K_d} \right) \frac{\partial C}{\partial t} + U_w \frac{\partial C}{\partial x}$$

$$\frac{\text{m}^2}{\text{m}^3} \times \frac{\text{m}^3}{\text{g} \times \text{sec}} \times$$

$$\frac{\text{m}^3}{\text{g} \cdot \text{sec}} \times \frac{\text{g} \cdot \text{sec}}{\text{g}}$$

volume of rock

$$\frac{K_d}{K_a} = \frac{0.15 \text{ cm}^3}{\text{mg}} \text{ volume of rock}$$

$$= 0.15 \frac{\text{mg}}{\text{mg}} = 0.15 \times \frac{10^{-6}}{1 \times 10^{-3}} = 0.15 \times 10^{-3} \frac{\text{m}^3}{\text{g}}$$

$$\frac{\frac{\text{cm}^2}{\text{cm}^3} \times \frac{\text{cm}^3}{\text{mg}} \times \frac{\text{mg}}{\text{cm}^2}}{\frac{\text{cm}^3}{\text{mg}} \times \frac{\text{mg}}{\text{cm}^3}}$$

$$PV = \frac{Q \times \frac{m}{L} \times S}{\phi \times L} = \frac{m}{L} \quad \frac{Q \times L}{\phi L} \quad \frac{m^3 \cdot s}{\phi \times L \times A}$$

$$C = \frac{g}{\text{ml}} \quad \frac{g}{100 \text{ g of water}} \quad \frac{g}{100 \text{ ml}} = \frac{g}{\text{ml}}$$

$$0.375 \frac{g}{L}$$

$$= \frac{\text{mg}}{\text{ml}} = \frac{g}{L}$$

$$\frac{\frac{\text{m}^2}{\text{m}^3} \times \frac{g}{L} \times \frac{g}{\text{cm}^2}}{\frac{\text{m}^2}{\text{m}^3} \times \frac{g}{L} \times \frac{g}{\text{cm}^2}}$$

d
Term more equation g & 10 inside

$$\frac{\partial^2 C}{\partial x^2} - \frac{V_{ax}}{\phi} \frac{\partial C}{\partial x} = \frac{\partial C}{\partial t} + \frac{A_s}{\phi} \frac{\partial C_s}{\partial t} \quad C_s(c)$$

$$\frac{\partial C_s}{\partial t} = K_a(Q_i - C_s)C - K_d \cdot C_s$$

$$K_a = 4.6 \times 10^{-13} \frac{\text{g}}{\text{g} \cdot \text{sec}}$$

$$K_a = 4.16 \times 10^{-13} \frac{\text{g}}{\text{g} \cdot \text{sec}}$$

$$\frac{\partial C_s}{\partial t} = K_a(Q_i - C_s)C - K_d \cdot C_s$$

$$K_d = 2.7 \times 10^{-9} \frac{\text{g}}{\text{g} \cdot \text{sec}}$$

9th ~~January~~ February 2015 Monday

Implemented eqn 9.410 in PDE2P weak form

$$150 \text{ N} = \frac{D \cdot V_L}{D} \quad \text{Hence } D = \frac{3.75 \times 10^{-5} \times 0.03}{150}$$

tolerance change ?

$$D = 2.25 \times 10^{-8}$$

Need to find right K_{ay} & K_{col} from expt results.

damping factor $1e-8$
 $1e-2$

$$\frac{b \times \frac{m}{s}}{\gamma \times m} =$$

$$Q_s = 182 \frac{\text{mg}}{\text{g}} \quad E_s =$$

$$C_e = 200 \frac{\text{mg}}{\text{L}} \quad C_o = 64.4 \frac{\text{mg}}{\text{L}}$$

$$V = \frac{3.76 \times 10^{-5} \times \left(\frac{\pi}{4} \times (0.04)^2\right) \times 0.8}{b \times \frac{m}{s} \times m^2 \times}$$

$$= \frac{\text{mg}}{\text{L}} \quad \frac{\text{mg}}{\text{L}}$$

$$q_{he} = \frac{(200 - 64.4) \times 22.6 \times 1}{500 \text{ mg}} = 6.12$$

$$q_e =$$

$$22.6 = \frac{3.76 \times 10^{-5} \times 116 \times 60}{0.21 \times 0.09}$$

$$116 = \frac{1.89 \times 10^3}{10^{-5}} = 189 \text{ s}$$

$$3.76 \times 10^{-5} \text{ m}^3 = 37.6 \text{ cm}^3 = 37.6 \text{ ml}$$

$$q_e = \frac{(200 - 64.4) \times 3.76 \times 10^{-5}}{500 \text{ g}}$$

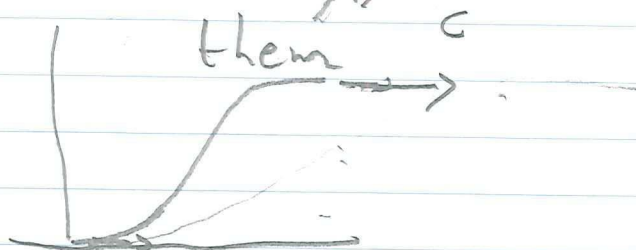
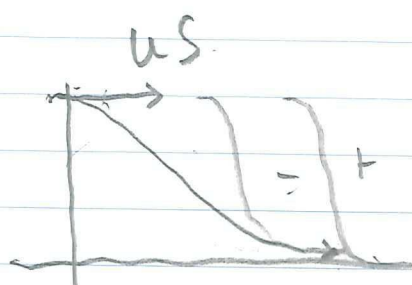
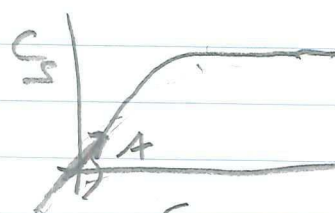
$$q_e = 1.019 \times 10^{-5} \frac{\text{mg}}{\text{g}}$$

$$\phi \frac{\partial x}{\partial t} + \frac{\partial c_s}{\partial t} + u \frac{\partial c}{\partial x} = 0$$

$$\phi \left(1 + \frac{dc_s}{dc} \right) \frac{\partial c}{\partial t} + u \frac{\partial c}{\partial x} = 0$$

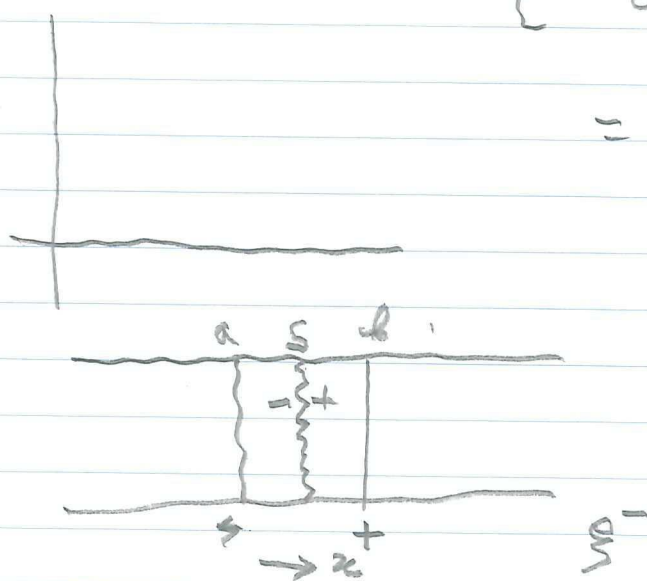
$$\left(\frac{\partial x}{\partial t} \right)_c = \frac{u}{\phi} \frac{1}{1 + \frac{dc_s}{dc}} = -1$$

$$\left(\frac{\partial x}{\partial t} \right)_c = \frac{u}{\phi} \frac{1}{1 + \frac{dc_s}{dc}}$$



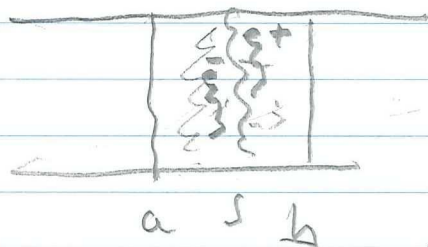
$$US: \quad v_s = \frac{u}{\phi} \frac{c_{a+} - c_{a-}}{\left[1 + \frac{dc_s}{dc} \right]_+ - \left[1 + \frac{dc_s}{dc} \right]_-}$$

$$= \frac{u}{\phi} \frac{0 - 1}{1 - (1 + A)} = \frac{u}{\phi A}$$



$$u_a c_a - u_b c_b = \phi \int_a^b (c + c_s) dx$$

$$+ \phi \int_{\xi^+}^{\xi^-} (c + c_s) dx$$



$$u_c - u_c = \varphi \int_a^b \left(\frac{dc}{dt} + \frac{dc_s}{dt} \right) dx$$

$$+ \varphi \int_{\xi^+(t)}^b \left(\frac{dc}{dt} + \frac{dc_s}{dt} \right) dx +$$

$$\varphi \left(\frac{\partial c}{\partial t} + \frac{\partial c_s}{\partial t} \right) + \frac{\partial u_c}{\partial t} = 0$$

then

$$\frac{\partial c}{\partial t} = 0$$

$$u_c - u_c = \varphi \frac{d}{dt} \int_a^b c dx$$

$$= \frac{d}{dt} \varphi \int_a^{\xi^-(t)} (c + c_s) dx + \frac{d}{dt} \varphi \int_{\xi^+(t)}^b (c + c_s) dx$$

Leibnitz's rule

$$= \varphi \int_a^{\xi^-(t)} \frac{\partial (c + c_s)}{\partial t} dx + \varphi \int_{\xi^+(t)}^b \frac{\partial (c + c_s)}{\partial t} dx$$

$$+ \varphi \frac{\partial \xi^-(t)}{\partial t} (c + c_s) - \varphi \frac{\partial \xi^+(t)}{\partial t} (c + c_s)$$

$$u c_a - u c_b = - \phi \int_a^b \frac{\partial u c}{\partial x} dx$$

$$\frac{1}{\phi} - \int_{\xi^+}^b \frac{\partial u c}{\partial x} dx + c(\xi^+) = c^+$$

$$\phi \frac{\partial \xi^-}{\partial t} (c + c_s) = \phi \frac{\partial \xi^+}{\partial t} (c + c_s)^+$$

$$u c_a - u c_b = u c_a - u c^+(\xi^-)$$

$$- u c_b + u c^+(\xi^+)$$

$$+ \phi \frac{\partial \xi^-}{\partial t} (c + c_s^+(\xi^-)) = \phi \frac{\partial \xi^+}{\partial t} (c + c_s^+(\xi^+))$$

$$\frac{\partial \xi^-}{\partial t} = \frac{\partial \xi^+}{\partial t} = \partial V_s$$

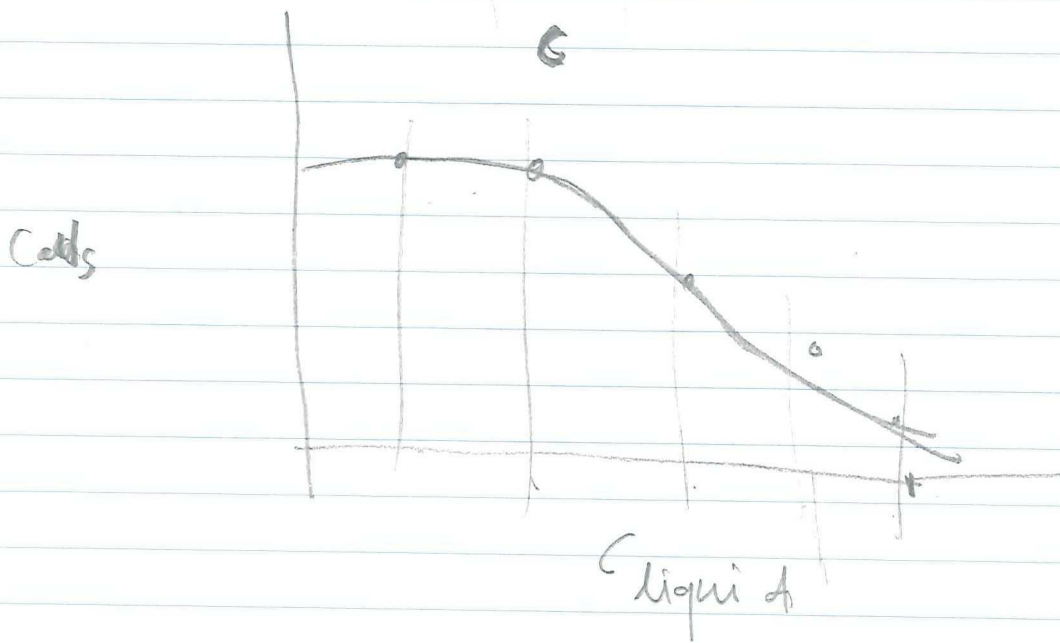
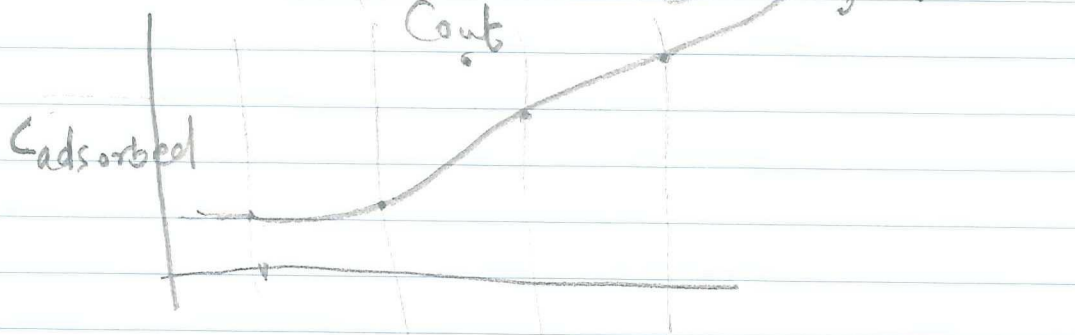
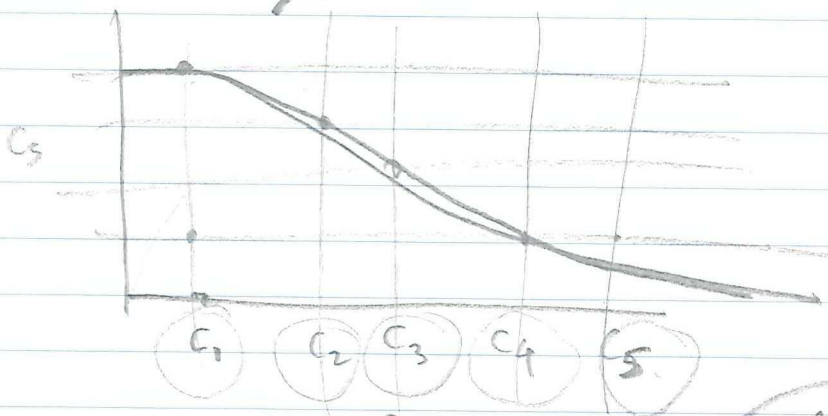
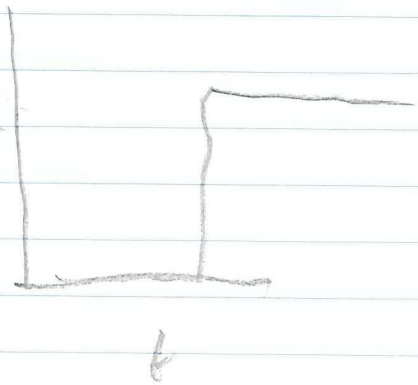
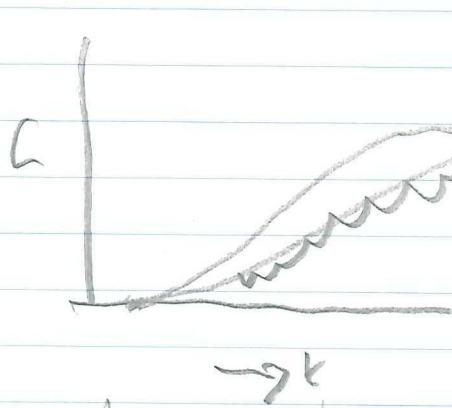
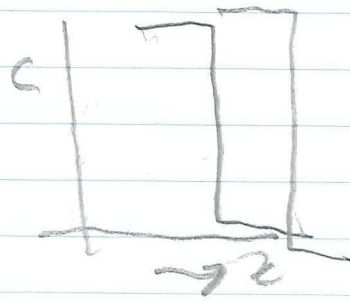
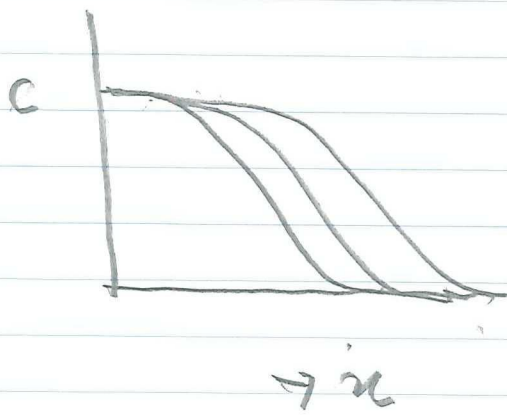
$$u c(\xi^-) - u c(\xi^+) = \phi \partial V_s$$

$$(c(\xi^-) + c_s(\xi^-) - (c(\xi^+) + c_s(\xi^+)))$$

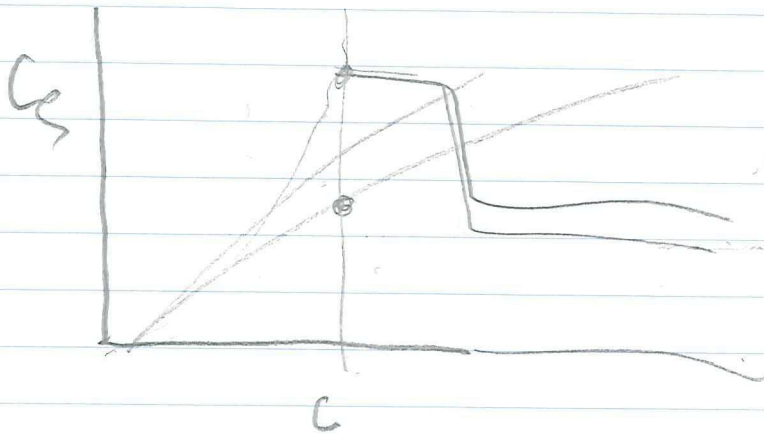
$$V_s = \frac{u}{\phi} \frac{c(\xi^-) - c(\xi^+)}{c(\xi^-) + c_s(\xi^-) - (c(\xi^+) + c_s(\xi^+))}$$

$$+ \boxed{V_s = \frac{u}{\phi} \frac{1 - 0}{1\xi + c_s^{\max} - 0}}$$

2000



bringham adsorption



Surfactant adsorption from breakthrough curve

To determine the dynamic adsorption isotherm, the amount of surfactant adsorption is calculated as a function of concentration by integrating the area above the breakthrough curve.

$$\Gamma_i = -\frac{1}{RT} \left(\frac{\partial \gamma}{\partial \ln C_i} \right)_{T, p}$$

$$= \frac{1}{\frac{J}{m \cdot l}} \left(\frac{\frac{mN}{m}}{m} \right) = \frac{1}{m^2} = \frac{m^3}{m^2} \text{ surface excess}$$

$$\frac{1}{J} \frac{mN}{m} = \frac{\frac{mN}{m^2} \times \frac{1}{J}}{m^2} \times 10^3 = \frac{1}{m^2} \times 10^3 = \frac{m^3}{m^2}$$

Surface excess for our case 4.109×10^{-6}

$$\frac{1 \times 10^{-7} m^3}{m^2} \quad \frac{1 \times 10^{-4} l}{m^2} \quad \frac{10 ml}{m^2} \quad \frac{1 \times 10^{-7}}{m^2} \quad \frac{4.109 \times 10^{-6}}{1.345 \times 10^{-7}} \quad \frac{m^3}{m^2}$$

Referendation batchy assume = 25-20

$$\frac{C_{s2} - C_{s1}}{C} = \frac{C_{s2}}{C} - \frac{C_{s1}}{C}$$

$$\frac{C_{s2} - C_{s1}}{C} \text{ vs } t$$

$$\frac{C_s}{C} \text{ vs } t \quad \left(\frac{\partial C_s}{\partial C} \right)_t$$

$$\frac{\partial C_s}{\partial C} = \frac{C_{s2} - C_{s1}}{C_{in} - C_{out}}$$

$$(C_{in} - C_{out}) \text{ vs } t$$

C_s Surface excess $10 \frac{\mu\text{m}}{\text{m}^2}$ At the end

C_0 is dilute therefore dispersion term can be neglected without any loss to accuracy $\langle \text{Tropus} \rangle$

Optimising for K_{ay} 4.16×10^{-13} 4.16×10^{-15} 4.16×10^{-10}
 K_{ads} 2.7×10^{-9} 2.7×10^{-11} 2.7×10^{-7}

$C_{init} = 0$ does not work $ly = \infty$

~~C_{init}~~ $C_{init} = C_{bound} = 0.375 \text{ g/l}$

input $int_2(t)$

What kind of value we need to put inside

$$Q_s = 0.109 \text{ g/m}^2$$

$$Q_s = 0.37 \text{ g/m}^2$$

C_s = surfactant surface concentration
 = the unadsorbed surface \times the surfactant solute

$$C_s = 0 \text{ at } t = 0 \text{ for all } x \in L$$

$$C = 0 \text{ at } t = 0 \text{ for all } L$$

$$C = C_0 \text{ at } L = 0 \text{ for all } t$$

$$C = 0 \text{ at } L = 10 \text{ for all } t$$

$$1 + \frac{dC_s}{dC} = 22.6$$

$$\frac{dC_s}{dC} = 21.6$$

$$dC_s = 21.6 dC$$

$$\int C_s = 21.6 \int C + \text{con}$$

$$C_{tot} - C_s = 21.6 (C_{at x=L} - C_{at x=0}) + \text{con}$$

10 Feb 2015 Tuesday.

Checking what boundary conditions we used.

$$C_s = 0$$

$$C = C_{init}$$

Applying Du result to our case

~~each PV contains 200 mg of AOS~~ [?] ~~the weight of the core~~

$$1 \text{ PV} = 20 \text{ ml}$$

$$15 \text{ PV} = 15 \times 20 = 300 \text{ ml}$$

$$300 \text{ ml}$$

$$\text{Sample contains } 200 \text{ mg surfactant}$$

$$1 \text{ PV contains } 20 \text{ ml, with } 0.0375 \text{ wt\% of AOS, } 1 \text{ PV of AOS contains } 20 \times 0.0375 \frac{\text{g}}{100 \text{ ml}} = 7.5 \times 10^{-3} \text{ g} = 7.5 \text{ mg}$$

Weight of the core is 220 g

$$0 \text{ to } 15.27 \text{ PV}$$

$$7.5 \text{ mg} \times 15.27 = 114.52 \text{ mg}$$

adsorption density

$$\frac{\text{mg}}{\text{g}}$$

$$\frac{114.52}{500} = 0.22 \frac{\text{mg}}{\text{g}}$$

wt of Benthamer core

equilibrium adsorption density.

$$0 \text{ to } 22.6 \text{ PV}$$

$$7.5 \text{ mg} \times 22.6 = 169.5 \text{ mg}$$

adsorption density

$$\frac{\text{mg}}{\text{g}}$$

$$\frac{169.5}{500} = 0.34 \frac{\text{mg}}{\text{g}}$$

Need to have separate equations for C_s & C

$$\frac{\text{mg}}{\text{g}} \quad K_a (Q_s - C_s) C - K_d C_s = \left[\frac{dC_s}{dt} \right]_t \quad \frac{\text{g}}{\text{m}^2}$$

convert $\frac{\text{mg}}{\text{g}}$ to

$$\frac{W_t}{Q_L} = \frac{\partial C_s}{\partial t} = 1 + \left(\frac{\partial C_s}{\partial t} \right) = K_a (Q_s - C_s) C - K_d C_s$$

maximum (PV) $22.6 = K_a (Q_s - C_s) C - K_d C_s$

problem 10/07/04 0:

$$\frac{\partial C_s}{\partial t} = \frac{\partial C_s}{\partial c} \frac{\partial c}{\partial t} = \left(\frac{\partial C_s}{\partial c} \right) \left(\frac{\partial c}{\partial t} \right)$$

$$\frac{\partial C_s}{\partial c} = 1 + \frac{A_s c}{\phi(1+bc)^2} \quad \text{in eq 11}$$

$$\frac{\partial C_s}{\partial t} = K_a (q_s - C_s) c - K_d C_s \quad \text{--- 10}$$

①

② Formulation of Surfactant Flow

③ Parameters

④ Boundary conditions

⑤ Units

Running now

Something to do with C_{in} value

	molecular wt	cmc	Adsorbent Capacity $\frac{\mu\text{mol}}{\text{g}}$	K_a $\frac{cc}{\mu\text{mol}}$	K_1 $\frac{cc}{\mu\text{mol} \cdot \text{sec}}$	K_2
AOS	315	301 mg $\frac{1}{L}$	0.32 $\frac{1}{L}$	13	2×10^{-4}	1.5×10^{-5}
		95 $\frac{\mu\text{mol}}{L}$	\uparrow from propus			

$$\left(1 + \frac{dc_s}{dc} \right)_{x=L} = \frac{uL}{\phi L} \quad \text{PV}$$

A_s should be changed to $\frac{m}{cc}$

$$\frac{m^2}{m^3} = \frac{1m \cdot 100cm \cdot 1 \times 10^6 cm^2}{1 \times 10^{-4} cc} = \frac{1 \times 10^{-6} cm^3}{1 \times 10^{-6} cm^3}$$

11 Feb 2015 Wednesday

$$K_a (Q_s - C_s) C - K_d C_s$$

$$\frac{m^3}{g \cdot sec} \left(\frac{\mu mol}{g} - \frac{g}{m^2} \right) \frac{\mu mol}{l} - \frac{m^3}{g \cdot sec} \left(\frac{g}{m^2} \right) = \frac{1}{sec}$$

$$Q_s, C_s \text{ can be in } \frac{m^3}{cm^2 (\text{Surface area})} \text{ or } \frac{m^3}{g (\text{cf Benthamer})} \text{ or } \frac{m^3}{m^3 (\text{Volume})}$$

$$K_a = 2 \times 10^{-4} \frac{cc}{\mu mol \cdot sec} = 2 \times 10^{-10} \frac{m^3}{\mu mol \cdot sec} = 2 \times 10^{-7} \frac{l}{\mu mol \cdot sec}$$

$$K_{ad} = 1.5 \times 10^{-5} \frac{1}{sec}$$

$$\frac{\mu mol}{\mu mol \cdot sec} \left(\frac{\mu mol}{g} - \frac{\mu mol}{g} \right) \frac{\mu mol}{l} - \frac{1}{sec} \frac{\mu mol}{g}$$

$$\frac{\alpha_s}{\partial t} = \frac{\mu mol}{g \cdot sec}$$

$$\frac{mN}{m} \times 10^{-3}$$

$$M_{uf} = M_{uf} = \frac{\alpha_n}{v g^{1/3}}$$

$$\frac{N_s}{m^2} =$$

$$\frac{1}{\mu mol} \times \frac{m^3}{m^3}$$

$$\frac{m}{s} \times \frac{N}{m^3}$$

$$= \frac{N}{m \cdot s}$$

$$\boxed{\frac{N \cdot s}{m^2}}$$

Change in the function of M_{uf}

Error undefined variable C_s

$$\frac{A_s}{\varphi} K_a (Q_s - C_s) C - K_d C_s$$

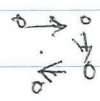
$$\frac{m^2}{m^3} \times \frac{\mu mol}{g \cdot sec}$$

$$U_w \cdot \frac{\partial C_s}{\partial x} \quad \frac{m}{s} \times \frac{\mu mol}{g \cdot m}$$

12:45-

Multiscale Method For heterogeneous Fractured Reservoirs

Matei Tene

Multiscale scaling  Effect of one block on the other blocks

low degree of freedom pays off. No need to increase Dof. \rightarrow

$$C_{\text{bound}} = Q_s$$

Velocity turns -ve in the weak Formulation.

New Adsorption control File

Point probe 1 - $u_w * C$ $\frac{m}{s} * \frac{\mu\text{mol}}{L}$

Diffusion coefficient 2×10^{-7}

$$\frac{3.6 \times 10^{-2}}{0.2} \times \frac{1 \text{ m}}{1 \text{ m}} \frac{\text{ut}}{\phi}$$

$$3.6 \times 10^{-2} \times 10$$

$$\frac{3.6 \times 10^{-2} \times 10}{0.2} = 18 \times 10^{-2}$$

$$= 0.018 \text{ PV}$$

$$3.6 \times$$

Optimisation function t vs $u_w * C$

by optimising $\text{int}(Ct) - \text{point probe 1}$
 K_{ads}
 $K_{\text{desorption}}$

12th February 2015

$$\begin{array}{ccc} K_a & K_d & Q_s \\ 2.0 \times 10^{-3} & 1.5 \times 10^{-4} & 10 \end{array}$$

$$\cancel{K_a} K_a (Q_s - C_s) C - K_d C_s = \frac{\partial C_s}{\partial t}$$

Suppose $\frac{\partial C_s}{\partial t} = 0$ initially,

$$K_a (Q_s - C_s) C = K_d C_s$$

$$K_a (Q_s - C_s) C = 1.5 \times 10^{-4} \times 0$$

$$Q_s = C_s = 0$$

$$\begin{array}{ccccc} \text{Initially} & K_a & K_d & Q_s & C_{\text{bound}} \\ & 2.0 \times 10^{-3} & 1.5 \times 10^{-5} & 0.3 & 1.19 \frac{\mu\text{mol}}{\text{g}} \end{array}$$

$$K_a (0.3 - C_s) 1.19 - K_d C_s = 0$$

$$K_a (0.3 - C_s) 1.19 = K_d C_s$$

$$\frac{K_a}{K_d} = \frac{C_s}{(0.3 - C_s) 1.19}$$

$$= \frac{0.1}{(0.3 - 0.1) 1.19} = 0.028$$

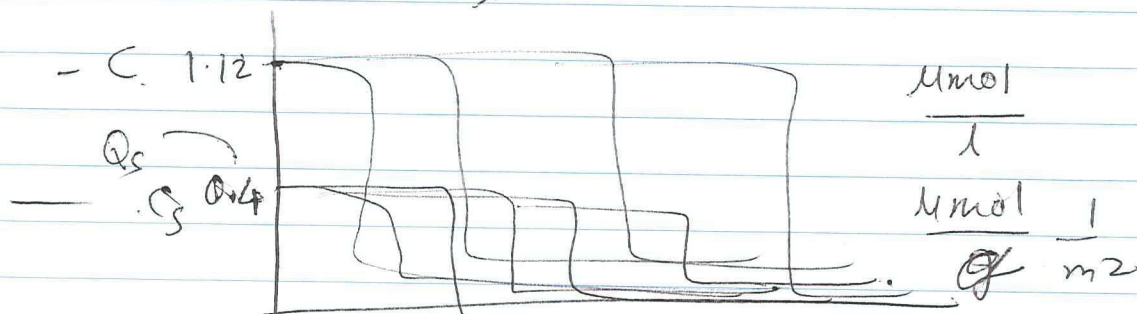
~~0.042~~

$$\text{for } K_d 1.5 \times 10^{-4} \quad K_a 0.042 \times 10^{-4} \approx 4.2 \times 10^{-6}$$

Q_s & C_s are in $\frac{\mu\text{mol}}{\text{g}}$

$V_w \times C$

C is in $\frac{\mu\text{mol}}{\text{L}}$



$$\frac{A_s}{m^3} \times \frac{m^2}{m^3} \times C = C$$

$$\text{inf}(C) t - V_w \times C$$

concentration at the start

$$c_{init} = 1.$$

$$\frac{m^2}{m^3}$$

$$1 m^3 =$$

$$k_f (Q_{max} - c_s) c - k_d c_s = 0$$

$$(k_d + k_f c) c_s = k_f Q_{max} c$$

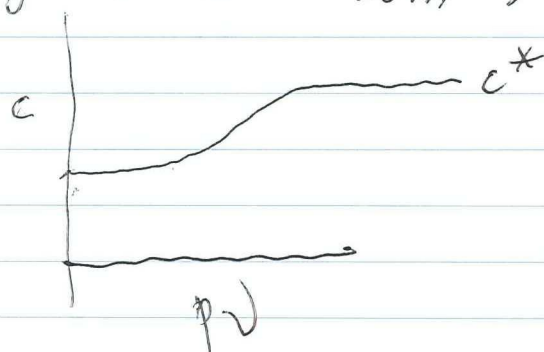
$$c_s = \frac{k_f Q_{max} c}{k_d + k_f c}$$

$$c = \frac{\mu mol}{l}$$

$$c \rightarrow \infty$$

$$\Rightarrow \frac{k_f Q_{max}}{k_f} = Q_{max} = c_s$$

$$= \frac{\mu mol}{g} \times \frac{m^2}{1000 l} \times \frac{1 g}{50 m^2}$$



exp the
(uwc) (uwc)

Brady

surface area

$$0.1 \frac{m^2}{g} \quad 10-100 \frac{m^2}{g}$$

clay

$$= \frac{\mu mol}{g} \times \frac{m^2}{1000 l} \times \frac{1 g}{50 m^2}$$

$$= c_s \times \frac{A_s}{1000} \times \frac{1}{50}$$

Hang - June 1 - June 30
- March 18 - April 12

12th February 2015 Thursday

closest

C_{init} 0.064

C_{bound} 0.66

K_d ~~2.4~~ 2×10^{-4}

C_{sinit} 0.1

Q_s 0.5

K_d ~~2~~ 1.5×10^{-5}

constant needs to be higher
start $\begin{cases} U_w \times C = 2.4 \times 10^{-6} \text{ expt} \\ U_w \times C = 1.38 \times 10^{-5} \text{ then} \end{cases}$

C_{init} 0.64

C_{init} 0.344

C_{sinit} 0.1 Q_s 0.5

~~1~~

Q_s 10^4
 C_s 10^3

$R(n, C)$
piece of text $R(n, C)$

↑ most of the time constant
unconsolidated sandpack : \rightarrow constant function
Bentheimer : \rightarrow changes with time.

X_F = fraction of flowing gas, dimensionless
from Bill

$$X_F = \frac{\eta_F}{\eta_{ini}}$$

/ unique optimisation /

K_a ~~1.2~~ 9×10^{-4}

9×10^{-3}

2×10^{-3}

K_d 5×10^{-7}

~~1×10^{-7}~~

1×10^{-7}

There is no effect of change in K_d whatever

$$K_a(Q_s - C)C - K_d C_s = 0 \quad \frac{\partial C_s}{\partial C}$$

$$\frac{K_d C_s}{K_a} = (Q_s - C)C$$

$$C = \frac{K_d C_s}{K_a (Q_s - C)}$$

$$188 = \frac{1 \text{ sec}}{1 \text{ mol sec}}$$

Experiment 2: Gas production

$$C = \frac{K_d C_s}{K_a (C_s - C_s)}$$

$$\frac{\mu\text{mol}}{\text{g} \cdot \text{l}} = \frac{\frac{1}{\text{sec}} \frac{\mu\text{mol}}{\text{m}^2}}{\frac{\mu\text{mol}}{\text{g} \cdot \text{sec}} \left(\frac{\mu\text{mol}}{\text{m}^2} - \frac{\mu\text{mol}}{\text{m}^2} \right)}$$

$$\frac{\mu\text{mol}}{\text{l}} = \frac{\frac{1}{\text{sec}} \frac{\mu\text{mol}}{\text{g} \cdot \text{l}}}{\frac{\mu\text{mol} \cdot \text{sec}}{\text{l}} \left(\frac{\mu\text{mol}}{\text{g} \cdot \text{l}} - \frac{\mu\text{mol}}{\text{g} \cdot \text{l}} \right)}$$

$$\frac{\mu\text{mol}}{\text{l}} = \frac{\mu\text{mol}}{\text{l}}$$

There for $C = \frac{\mu\text{mol}}{\text{l}} ; K_d C_s = \frac{\mu\text{mol}}{\text{m}^2} ; Q_s = \frac{\mu\text{mol}}{\text{m}^2}$

$$K_a = \frac{\mu\text{mol}}{\text{g} \cdot \text{sec}} ; K_d = \frac{1}{\text{sec}}$$

$$\frac{\mu\text{mol}}{\text{l}} \times \frac{\text{m}^2}{\text{m}^3} = \frac{\text{m}}{\text{s}} \times \frac{\mu\text{mol}}{\text{l}}$$

$$U_{wc} = C = \frac{C}{C_0} \times 1.19 \frac{\mu\text{mol}}{\text{l}}$$

Suppose the expt did not use any ethylene ; then what would have happened.

13 Feb 2015 Friday

C_s in terms $\frac{\mu\text{mol}}{\text{g}}$

$C = 0.6 \frac{\mu\text{mol}}{\text{g}}$

$C_s = 0.1 \frac{\mu\text{mol}}{\text{g}}$ $A_s = 0.1 \frac{\text{m}^2}{\text{m}^3}$ $\frac{1}{\text{g}} \frac{\text{m}^2}{\text{m}^3}$ Surface area

$\frac{0.1 \times 0.1}{0.1} \frac{\mu\text{mol}}{\text{g}} \times \frac{\text{m}^2}{\text{m}^3} \times \frac{\text{g}}{\text{m}^2}$

Vinegar 1995, ~~Berea sand~~ Bentheimer ~~to~~
Diffusion coefficient $1.9 \times 10^{-9} \text{ m}^2/\text{s}$ (Vinegar, 1995)

Bentheimer contains 91.70 wt%, 97.78 mol%, 91.62 vol%
quartz \rightarrow $(0.1 \text{ m}^2/\text{g})$
Kaolinite 0.62 wt%, 2.50 wt%, 2.55 vol%
— $10^{-38} \text{ m}^2/\text{g}$

Anna Petka
Bentheimer CATO

Therefore considering Bentheimer with $0.1 \frac{\text{m}^2}{\text{g}}$ surface area

Specific surface area for Bentheim $1.69 \frac{\text{m}^2}{\text{g}}$

surface area of Bentheimer core

C is in $\frac{\text{mmol}}{\text{g}}$

$$\frac{\text{mmol}}{\text{g}} = \frac{1}{\text{sec}} \frac{\text{mmol}}{\text{m}^2}$$

$$\frac{\text{mmol}}{\text{g} \cdot \text{sec}} \left(\frac{\text{mmol}}{\text{m}^2} \frac{\text{mmol}}{\text{m}^2} \right)$$

50 mmol $C_s = 50 \frac{\text{mmol}}{\text{g}}$

$$\frac{\partial C_s}{\partial t} = k_a (C_s - C) C - k_d C_s$$

$$=$$

Specific surface from van Os $0.35 \frac{\text{m}^2}{\text{g}}$

$200 \text{ mg} \rightarrow 1.19 \text{ mmol}$ $200 \text{ mg} \rightarrow 1.19 \text{ mmol}$
 $1 \text{ mg} \rightarrow 5.95 \text{ mmol} \times 10^{-3}$
 $0.45 \text{ mg} \rightarrow 2.67 \text{ mmol} \times 10^{-3}$

$$\begin{aligned}
 C &= \frac{K_d C_s}{K_a (Q_s - C_s)} \\
 &= \frac{2.5 \times 10^7 \times 10}{2.5 \times 10^6 \times \left(\frac{50 \times 10^7}{50 - 10} \right)} \\
 &= \frac{0.10 \times 10}{40} = \frac{1.0}{40} = 0.22 \frac{\text{mmol}}{\text{L}}
 \end{aligned}$$

$$1.19 \times 0.3 = 0.357 \frac{\text{mmol}}{\text{L}} \quad \text{should be starting concentration}$$

fixing K_a ; K_d for given Q_s & C_s

making pressure drop

may be it is pressure drop that is not able to help

Valentine's day

14th February 2015 Saturday

Solving stationary problem & then using that equations in regular study 1 to start going.

15th February 2015 Sunday

writing procedure of ~~exp~~ adsorption experiment

AFTER 2.78 PV KI becomes w/w. conc 1 (stable) but for Berthelmer it never reaches 1

16th February 2015 Monday

Air liquide, Akzo Nobel, ASML, Dow Benelux, DynaFlow, Fluor, NLR, Shell, SKF, Stork,

~~full~~ ^{past} expt
Ka 1×10^{-6}

Ka 2×10^{-4}

C_{init} ~~100~~ 0.375

~~diff 2×10^{-5}~~

C_{init} ~~200~~ 500

~~past of the~~ ^{full} expt

0.5×10^{-5}

2.5×10^{-4}

0.975

100

Adsorption 11 Feb 2015 is being corrected for Bentheimer case.

17th February 2015 Tuesday

Trying to solve Bentheimer plus adsorption 16 Feb 2015

There are some PDE's with inconsistent unit. May be that is good lead to take it.

$$K \frac{K_{rg}}{\mu_f} \Delta P - \rho g$$

cw was the culprit in the inconsistent unit for pressure

$$\psi \frac{\partial (S_g n)}{\partial t} + K \frac{K_{rg}}{\mu_f} (\Delta P - \rho g) = \frac{\partial (v_g n)}{\partial x}$$

it runs after removing cw from pressure

Checking unconsolidated sandpack case

Copied PDE, PDE2, PDE3 from Unconsolidated sand
no effect !!!

Why the heck saturation turns 13 at the end?
What is the saturation dependent on?

What if we put concentration constant.

checking equation of stationary related.

If u_g is 0

File from 14th February.

Discretization - linear

Idea is to add the concentration equations in the running Bentheimer file WITHOUT putting $\alpha(c)$

diff $2 \times 10^{-6} \text{ m}^2/\text{s}$

Ramp function ~~to~~ slope 1

Change in bubble density equation

Check if ~~Ben~~ running Bentheimer & unconsolidated sandpack has same bubble density equation

// Hans is working on optimisation of //
Bentheimer program

Instead of ramp function use $(1 - \tanh(x))$

Do the same thing for concentration as well
or saturation as well.

smaller

~~How to~~ ~~the~~ tanh function gives the
bubble density at the point where you
want.

tolerance was chosen 0.000001

18th February 2015 Wednesday

Change in time step - maximum step 2 s ~~1/2~~

Bentheimer Sandstone - the rock commonly used in our laboratory

Anna Peksa

Quartz 91.7% Clay 2.68 $\rightarrow 0.1 \text{ m}^2/\text{g}$

AVIZO - pore size distribution

S_g Surface area = $0.45 \text{ m}^2/\text{g}$

~~18:00~~

Putting surfactant concentration equations in the file Bentheimer. 18th February 2015. ~~1/2~~ \rightarrow

Weak expression (in built)

-test $(C_s, x) \cdot C_s x + 1 [\text{m}^2] + \text{test}(G)$

$d(C_s, t) * \text{test}(C_s)$

14:38 Running of the file with surfactant concentration equations

15:00 xfcn) is added; Running. <<slow>>

16:00 Reading weak form theory from COMSOL

19th February 2015 Thursday

Yesterday's program: run properly but no pressure drop build up; due to no effect of gas viscosity?

Saved as a new file 19th February & going to put inside ~~no~~ concentration in ϕ nco.

3.73 PV of water injected before gas started.

At the end it was for water $24.73 - 3.73 = 21$ PV
Total PV was 32.10 therefore $32.10 - 21 = 11.1$ PV was of gas.

As 24.73 PV of water was injected we claim that the adsorption is satisfied.

$$C_{\text{bound}} = 0.975$$

α was wrongly taken; therefore changing the values

$$\frac{N}{m} = -1.58e-05 \frac{\text{mmol}}{1} + 4.58e-5$$

$$\alpha = \frac{\phi}{\phi^{1/3}} \text{ ranging } 7.47e3 \text{ to } 1.23 \times 10^6$$

$$\Delta u_f =$$

Our initial ~~value~~ α was 0.0587×10^{-5}

OK trying with $\alpha = \phi^{1/3}$ as gives reasonable Δ

Starts OK but then gives a spike at the initial boundary w

Run bar 43.72 seconds

Relative tolerance decreased

multiplying in Dirichlet boundary condition
 $\text{swin}(\text{ninit}) * (1 - \tanh(x))$

Relative tolerance 1×10^{-6} — Shouldn't it be n

$$S_{\text{bound}} = 0.4$$

$$S_{\text{bound}} = 0.625$$

$$S_{\text{bound}} = 0.35$$

No change

maximum seconds 50.856

11:30 →

Real problem seem to lie ~~in~~ with formulation of the problem.

$$u_g^{1/3}$$

~~Meeting~~

Meeting with Hans

manually inserting derivatives for u_{uf} & x_f

running again : it is slow

some time analytical solution helps to prevent crashing the program.

14:30 Changed in all PDEs : Dirichlet boundary conditions
14:45 ~~removed~~ decreased the ~~tolerance~~
14:49 ~~removed~~ finer mesh; linear elements

$S_{\text{bound}} = 0.62$ maximum ^{time} step 1, 0.5, 0.25
Peter King : - History matching

$$u_{uf} = \frac{x_n}{u_g^{1/3}}$$

$$\frac{x_n}{(u_{\text{tot}}^{1/3})}$$

$u_{uf} = \text{smaller}$
 $u_{uf} = \text{bigger}$

18th February b & 19th February c

↓
time step

time step ~~up~~ as a function P_{in} but does it change so much?

C

bubble diffusion $2 \times 10^{-5} \text{ m}^2/\text{s}$

range (0, 1, 40)

in PDF3 ^{bubble density}

to $\tanh(x)$ multiplied to $\text{aml}(x)$ to get ~~delayed~~ bubble density ϕ away from the ~~start~~ injection points.

$$X_F = \left(\frac{n_{\text{in}}}{n_{\text{in}}} \right)^{0.4} = \left(1 \right)^{0.4}$$

lowering the concentration ~~at~~ at the start

Spike still occurs; therefore ~~is~~ reverting back to

injected gas velocity $1.9 \times 10^{-5} \text{ m/s}$ remains same throughout the experiment; therefore no need for it to be varying.

com offshore

20th February 2015 Friday

9:15

Replaced all 1-tanh(x) function with $\text{rml}(t)$ function. Now running; little bit haphazard, but ok at least running.

We put a Dirichet boundary condition $\text{rml}(0)$; next time we check on that.

$$U_f = 4.92 \times 10^{-6} \text{ m/s} - 50 \text{ sec}$$

Stopped after 1556. sec.

Dirichet boundary condition

PDF3

$$\text{initial value} \quad n_{\text{init}} + (n - n_{\text{init}}) * \text{rml}(t)$$

Dirichet boundary condition $n_{\text{init}} + (n - n_{\text{init}}) * \text{rml}(0)$

$$U_f = 5.41 \times 10^{-5} \text{ m/s} \quad 34 \text{ sec}$$

(crashed after 50 seconds; therefore switching back to $n_{init} + (n_{inj} - n_{init}) * r_{m1}(t)$ Initial values of n 10:51
 element size decreased by one order. Therefore it is going to run bit slower.

Now running smoothly with reciprocal of step size 1 : 11:11
 50 seconds complete in 50 minutes running time.

13:00 Bentheimer_19th February 2015C_rm1 with $S_{bound} = 0.38$ crashes at 50 sec
 Bentheimer_19th February 2015C_rm1_2 with $S_{bound} = 0.62$
 $S_{bound} s = 0.62$
 Bubble diffusion $1 \times 10^{-7} \text{ m}^2/\text{s}$ ~~instead of~~ $1 \times 10^{-5} \text{ m}^2/\text{s}$
 $C_s = 200$ So some adsorption ~~needs to happen~~ ^{sh'll possible}
 Yes now it is running OK.

Reciprocal of time step seems to ~~increase~~ decrease as bubble diffusion is decreased (1×10^{-5} to $1 \times 10^{-7} \text{ m}^2/\text{s}$)

Boundary condition for water saturation
 $(S_{bound} - S_{init}) * r_{m1}(t) ?$

Bentheimer_19th February 2015C_rm1 stuck at 156.8 sec
 Sw on for Bentheimer ?

Change maximum no. of bubble density to 7000

$$\gamma = -0.05 \ln(x) + 1.066$$

$$= 1 + (0.86 - 0.1) r_{m1}(0)$$

$$\frac{v_g}{v_{tot}} = \frac{K_{rg}(S_w)}{\mu_{nf}(n)} \times \frac{K_{rg}(S_w)}{\mu_{nf}(n)}$$

Checking sw_n - Berthelmer - 12 Dec 2013

α is taken constant^{to} calculate relation
between ~~and~~ water saturation & bubble density
 $S_w = -0.05 \ln(n) + 1.066$

Need to check how $\mu_{eff}(n)$ changes over time.

$$\mu_{eff} = \frac{\alpha n}{v_g^{1/3}}$$

$\alpha =$

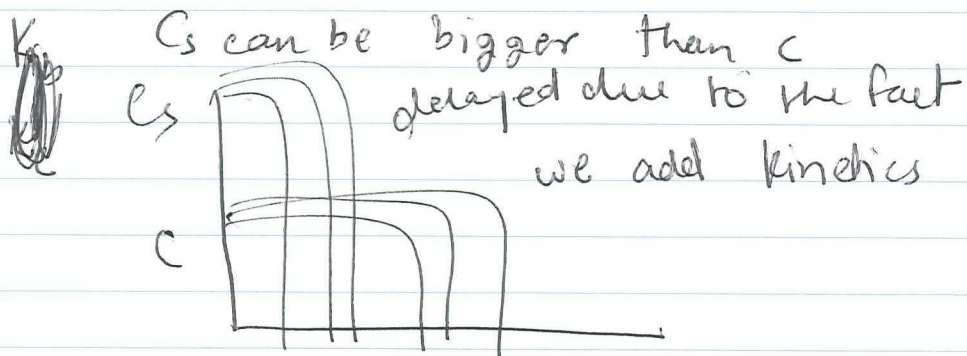
Running - 19th February 2015 c - rmi_3 - with change in sw & n

$S_{init} = 0.74$ $S_{bound} = 0.46$ question

$S_{init} = 1$ & mesh size one order shorter

next time putting S_{init} back to 0.74

The problem with $S_{init} = 1$ is that it does not
develop further to ~~and~~ accommodate the gas saturation
(decrease) - from there by foam



$r_m(0) \rightarrow r_m(t)$

21st February 2015 Saturday

domain component of ODE & DAE

distributed ODE for C_s
stabilization of mass coefficient
(ODE & DAEs)

saved as Bentheimer-19th February 2015 C_3 - with
change in swon & n_{Hans2}

Checking ~~the~~ the stabilisation of the program

$$0 \quad K_a (Q_s - C_s) C - K_d \cdot C_s = 0$$

$$\left(\frac{K_a}{K_d} Q_s - \frac{K_a}{K_d} C_s \right) C = C_s$$

$$\frac{K_a}{K_d} Q_s C - \frac{K_a}{K_d} C_s \cdot C = C_s$$

$$\left(1 + \frac{K_a}{K_d} C \right) C_s = \frac{K_a}{K_d} Q_s C$$

$$C_s = \frac{\frac{K_a}{K_d} Q_s \cdot C}{\left(1 + \frac{K_a}{K_d} \cdot C \right)}$$

□

$$C_s = \frac{Q_s \cdot C}{\left(\frac{K_d}{K_a} + C \right)} = \frac{K_a \cdot Q_s \cdot C}{K_d + K_a C}$$

$$\frac{\text{mmol}}{\text{m}^2} = \frac{\frac{\text{mg}}{\text{g}} \times \frac{\text{mmol}}{\text{g}} \times \frac{\text{mmol}}{\text{m}^2}}{+ \frac{\text{mmol}}{\text{g}} \times \frac{\text{mmol}}{\text{m}^2}}$$

Equilibrium adsorption density according to Du
 $0.45 \frac{\text{mg}}{\text{g}}$ surface area for Bentheimer $0.1 \frac{\text{m}^2}{\text{g}}$

$$0.45 \frac{\text{mg}}{\text{g}} \times \frac{1}{0.1 \frac{\text{m}^2}{\text{g}}} = 0.045 \frac{\text{mg}}{\text{m}^2}$$

Q_s maximum adsorption capacity $0.045 \frac{\text{mg}}{\text{m}^2}$

$$\frac{1}{2} \times 1 \times 0.9 = 0.45$$

$$\frac{1}{2} \times 0.9 (200 \text{ mg}) \times 1 \left(\frac{C}{C_0} \right) = \underline{\underline{90 \text{ mg}}}$$

OK leave it for now how Q_u calculated adsorption

$$0.225(PV) = 0.225 \times 200 \text{ mg} = 45 \text{ mg}$$

wt of the core 200 g

$$Q_s \text{ in } \frac{\text{mmol}}{\text{m}^2} \Rightarrow 0.045 \frac{\text{mg}}{\text{m}^2} \neq \frac{315 \text{ g}}{1000 \text{ mmol}}$$

$$\frac{315 \text{ g}}{0.045 \times 10^{-3} \frac{\text{g}}{\text{m}^2}} = \frac{315}{4.5 \times 10^{-3}}$$

$$\frac{0.045 \times 10^{-3} \frac{\text{g}}{\text{m}^2}}{0.315 \frac{\text{g}}{\text{mmol}}} = \frac{0.045 \times 10^{-3} \text{ mmol}}{0.315 \text{ m}^2}$$

$$Q_s = 1.428 \times 10^{-4} \frac{\text{mmol}}{\text{m}^2} \quad C_{\text{ini}} = 8.2 \times 10^{-6} \frac{\text{mmol}}{\text{m}^2}$$

Putting value in adsorption model to get K_d
fitting K_a & K_d

$$C_s \times A_s = \frac{\text{mmol}}{\text{m}^2} \times \frac{\text{m}^2}{\text{m}^3} = \frac{\text{mmol}}{\text{m}^2} \times \frac{\text{m}^2}{1000 \text{ l}} = \frac{\text{mmol}}{1000 \text{ l}}$$

What if we take A_s specific surface area
 $0.1 \frac{\text{m}^2}{\text{g}} \times \frac{0.1 \text{ m}^2}{200 \text{ g}} = \frac{0.1 \text{ m}^2}{200 \text{ g}}$

$$\frac{16000 \text{ cm}^2}{\text{cm}^3} = \frac{16000 \times 1 \times 10^{-4}}{1 \times 10^{-6}} = 1600000 \frac{\text{m}^2}{\text{m}^3}$$



specific surface area $10 \frac{\text{m}^2}{\text{g}}$ wt of the core 200 g (PV) $20 \times 10^{-3} \text{ l}$

$$10 \frac{\text{m}^2}{\text{g}} \times 200 \text{ g} \times \frac{1}{20 \times 10^{-3} \text{ l}} = \frac{1000 \text{ m}^2}{10^{-3} \text{ l}}$$

$$= \frac{1000 \text{ m}^2}{1 \times 10^{-6} \frac{\text{m}^3}{\text{m}^3}} = 1 \times 10^9 \frac{\text{m}^2}{\text{m}^3}$$

for $0.1 \frac{\text{m}^2}{\text{g}}$ $1 \times 10^7 \frac{\text{m}^2}{\text{m}^3}$

for specific surface area $10 \frac{\text{m}^2}{\text{g}}$

$$A_s = 10 \times 200 \times \frac{1}{100 \text{ ml}} = 20 \frac{\text{m}^2}{\text{ml}} = \frac{20 \text{ m}^2}{1 \times 10^{-6} \text{ m}^3}$$

$$= 20 \times 10^6 \frac{\text{m}^2}{\text{m}^3} = 20 \times 10^6 \frac{\text{m}^2}{\text{m}^3}$$

$$Q_s = 0.45 \frac{\text{mg}}{\text{g}} / 10 \frac{\text{m}^2}{\text{g}} = 0.045 \frac{\text{mg}}{\text{m}^2}$$

$$0.045 \frac{\text{mg}}{\text{m}^2} \times \frac{1}{315 \frac{\text{g}}{\text{mol}}} = \frac{0.045 \times 10^{-3}}{315} \times \frac{\text{mol}}{\text{m}^2}$$

$$= 1.4 \times 10^{-7} \frac{\text{mol}}{\text{m}^2}$$

$$= 1.428 \times 10^{-4} \frac{\text{mmol}}{\text{m}^2}$$

for K_a 1×10^{-4} K_d 2.0×10^{-4}

$$C_s = \frac{K_a \cdot C_{\text{init}} \cdot Q_s}{K_d + K_a C_{\text{ini}}}$$

$$A_s \times C_s = \frac{\text{m}^2}{\text{m}^3} \times \frac{\text{mmol}}{\text{m}^2} = \frac{\text{mmol}}{\text{m}^3} = \frac{\text{mmol}}{1000 \text{ l}}$$

$A_s \times C_s \times 1000$ to get $\frac{\text{mmol}}{\text{l}}$

12:00 Running of comsol Bentheimer 21st Feb
with updated values of Q_0 , C , K_a & K_d

Domain ODEs & DAEs mass coefficient $e_a = 0$

16:00 Running Bentheimer 21st Feb with lower tolerance

Crashes after 1600 sec ; therefore working on
PDES

22nd Feb. 2015

Somehow the ~~set~~ water saturation has to go
down & it is not going down

$$s_{wn}(ninit) @ -0.45 \ln(x) + 0.85 = 0.65$$

$$s_{init} + (s_{wn}(ninit) - s_{init})$$

$$1 + (0.65 - 1) = 1 - 0.35 = 0.65$$

we don't use s_{bound} anywhere

$$s_{wn}(n)$$

for unconsolidated sand

initial value s_{init}

$$DBC \quad s_{init} + (s_{init}(ninit) - s_{init}) * r_{m1}(t)$$

Switching between PFFS & ODE to somehow
run it longer time & still gives water saturation
lower.

May be faster diffusion for surfactant water or
remove the diffusion term at all.

$$DBC \quad s_{bound} +$$

Sinit 0.45

$$sum = -0.045 \ln(x) + 0.45$$

U_{tot} should be 3.7×10^5

U_{eq} should be 1.9×10^5

Stable value should occur after 5000 sec
~~max~~ ^{Stable} value 2.2×10^6

Does C ^{or C_s} have anything to do with it

$$\alpha = \frac{U_{eq}}{U_{g1/3}} = \frac{K_n}{U_{g1/3}}$$

$$\alpha = \frac{1}{\delta^{1/3}} = \alpha = \delta^{1/3} =$$

Changed values of $C_s, C,$

Again Fitting parameters

Seems to be the problem with parameters (K_a & K_{ad} ?)
then

$$\frac{N_s}{m^2} = \frac{N}{m}$$

Calculation problem with relation between

$$\alpha = \delta^{1/3}$$

$$\frac{\frac{N}{m} \times m^3}{\frac{m}{s}} = \frac{N_s}{m^2}$$

Try Sinit 1 then

23rd Feb. 2015 Monday

9:14 - $S_{init} = 0.99$

imatic ~~thereborn~~

9:26 $S_{init} = 0.9$

$$\mu_{app}^{shape} = \frac{\mu_L \Delta P R^2}{8 \sigma}$$

capillary radius

$$= 0.85 \frac{\mu \mu_L R}{r_c / R} \left(\frac{3 \mu \sigma}{\sigma} \right)^{-1/3} \left(\left(\frac{r_c}{R} \right)^2 + 1 \right)$$

radius of curvature of gas liquid interface

Suppose $R = r_c$

$$= 0.85 \frac{\mu \mu_L R}{1} \left(\frac{3 \mu \sigma}{\sigma} \right)^{-1/3} \cdot 2$$

$$= 1.7 \frac{\mu \mu_L R}{1} \left(\frac{3 \mu \sigma}{\sigma} \right)^{-1/3}$$

$$\mu_{app}^{shape} = 1.7 \frac{\mu^{2/3} \cdot \mu_L R \sigma^{1/3}}{\sigma^{1/3}} \Rightarrow \frac{\mu^{2/3} R}{\sigma^{1/3}}$$

$\frac{n_B}{n_L} = \frac{3}{2}$

$$\alpha = \frac{1.7 \mu^{2/3} R}{\sigma^{1/3}} \times \frac{1}{3^{1/3}} \sigma^{1/3}$$

$$\alpha \equiv 1.76 \mu^{2/3} R \frac{1}{1.53} \sigma^{1/3} \frac{2}{3}$$

$$\alpha = 1.18 \mu^{2/3} R \cdot \sigma^{1/3}$$

$10^{-3} \times 1 \times 10^{-3} \times \sigma^{1/3}$

$R = 0.1$ cm in Hirasaki Fig-15 page 186
1985 SPE

$$\alpha = \frac{\mu^{2/3} R}{\sigma^{1/3}} \times \frac{N}{m}$$

$$\frac{\alpha \mu^{2/3} R}{\sigma^{1/3}} \times \frac{N}{m} \times \frac{m}{\sigma}$$

$$\mu_{ef} = \frac{\alpha n}{\sigma_g^{1/3}} \times \frac{NS}{m^2} \quad \frac{\frac{N}{m} \times \frac{1}{m^3}}{\frac{m}{s}} \quad \frac{NS}{m^5}$$

$$\frac{NS}{m^5} \times m^3$$

Must be multiplied with volume?

$$\cancel{20 \text{ m}} \quad 0.2 \times \frac{\pi}{4} \times d^2 \times l = 0.2 \times \frac{\pi}{4} \times 0.01^2 \times 0.17$$

$$= 0.2 \times 8.54 \times 10^{-6}$$

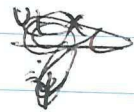
$$= \frac{1.7 \times 10^{-4}}{4}$$

$$\alpha = (6)^{1/3} \times \text{vol} \quad \mu = \frac{\alpha \times n}{\sigma_g^{1/3}}$$

Multiplying phi total volume to $\sigma^{1/3}$ in μ equation

10:15 Derivatives of μ_{ef} automatic

$$\frac{\frac{8 \times m}{8}}{m}$$



10:30 Considering pore volume to put inside, but thought against it as μ_{ef} becomes too complicated.

it should actually divided by volume; right?

$$\cancel{\frac{NS}{m} \times m^3} \quad \frac{m}{s}$$

$\frac{NS}{m^5} \times m^3$, no, multiplied

Especially multiplied by the amount of water?

$$S_{init} = 0.99$$

vol = 0.01 for simple condition

In principle σ should be multiplied with volume of water to get correct idea of increasing or decreasing μ_{ef}

$$20 \text{ ml} = 20 \times 10^{-3} \text{ l} = \boxed{20 \text{ m}^3}$$

20

$$1 \text{ l} = 1 \times 10^{-3} \text{ m}^3$$

$$= 20 \times 10^{-3} \times 10^{-3} \text{ m}^3$$

$$20 \times 10^{-6} \text{ m}^3$$

$$\mu_f = \frac{\alpha \cdot \eta}{v_g^{1/3}} + \mu_g$$

$$\eta = \frac{(\mu_f - \mu_g) v_g^{1/3}}{\alpha}$$

$$\mu_f = \mu_g = \frac{K k_2}{\mu_g} \cdot \frac{\Delta P}{L}$$

$$\eta = \frac{(\mu_f - \mu_g)}{\alpha} \cdot \left(\frac{K k_2}{\mu_g} \right)^{1/3} \cdot \frac{\Delta P}{L}$$

$$\eta = \frac{\mu_g^{2/3} (K k_2)^{1/3} \Delta P}{\alpha L}$$

$$\eta = \frac{\frac{\text{Ns}}{\text{m}^2} \cdot \text{m}^2 \cdot \frac{\text{Pa}}{\text{m}}}{\alpha}$$

$$\eta = \frac{\frac{\text{Ns}}{\text{m}^2} \cdot \cancel{\text{m}^2} \cdot \frac{\text{N}}{\text{m}^2} \cdot \text{m}}{\alpha}$$

$$\eta = \frac{\frac{\text{Ns}}{\text{m}^2} \cdot \frac{\text{N}}{\text{m}}}{\alpha} \cdot \frac{\text{N}}{\text{m}} \cdot \text{m}^3$$

volume needs to be multiplied in α to get
in right

For calculating α is taken to be fitting value 5.8×10^{-7}

12:00 $Sw_n = -0.045 \ln(\alpha) + 0.95$

~~12:00~~ M_{ij} should be ~~of~~ small & then increase. The values of α, n , are not enough

problem is that it runs into imaginary numbers that makes it difficult

Added object of PV available or flowing on 15:06 M_{ij} .

Bentheimer 23rd February with PV

3:15 Better result so far; though not taking the slope nor maximum value; shows characteristic from where things can be improved

15:22 $Sw_n = -0.045 \ln(\alpha) + 0.85$ x

α	$0.03 \times 2 \times 10^{-5}$	$= 6 \times 10^{-6}$	- 10 times higher than projected.
α	$1 \times 2 \times 10^{-5}$	$= 6 \times 10^{-5}$	
α	$10 \times 2 \times 10^{-5}$	$= 6 \times 10^{-4}$	

16:15 $4.23 \times 10^{-5} \text{ m}^3 \text{ (Vol)}$

~~Fitting~~ ~~managing~~

checking with m_{ij} function

16:30 $Sw_n = -0.045 \ln(\alpha) + 0.85$

PV x Vol & $Sw_n = -0.045 \ln(\alpha) + 0.65$
 $\alpha \rightarrow$ Not working

Should PV in terms of n so that it can be multiplied

5:4
17:45 Nice profile; but U_{tot} was there in the map
therefore replacing the U_{tot} with U_g

Ⓢ Not working → Switch back U_{tot}

$$K = 5^{1/3}$$

$$\frac{N}{m} \times m^3$$

$$\frac{Nm^2}{\frac{m}{s}} \frac{1}{m^3}$$

$$\frac{U_t \times t}{\psi \times L}$$

$$= \frac{Ns}{m^2}$$

$$\frac{\frac{m}{s} \times s}{xm} \times \psi \times m^3$$

$$p \times m^3 \times$$

18:00 Putting inside $\chi F(\chi)$ to try
crashed ~~by~~ at 2550

$$K_a = 5e-4$$

Gas fraction

Next time remove χF as we include it wherever
(1-s) is used.

Tomorrow working everything out till now

24th February Tuesday

9:15 Trying with PV of gas crashed at 93 seconds

9:30 Changing, K_a, K_d, C_s

11 841.8 // Delete the point probe expression 1
It is misleading.

Checking with values of K_a, K_d, C_s

~~There~~ Trying with both PV gas & total PV

24th February \leftarrow 23rd February
runs well

putting values of 23rd February C_s, K_a, K_d in 24th Febru.

How was the first fitting? with U_{tot} ?

Check 16th July 2014 console file

Upper limit of concentration increased to $1.19 \frac{\text{mmol}}{\text{L}}$

PV gas fluctuates a lot therefore PV total is better.

Meeting with Hans

n ;

α - surfactant concentration

$$\mu_{uf} = \mu_{ug} + \frac{\alpha n}{U_{gf}^{1/3}} ; \mu_{uf} \approx \frac{2n}{U_{gf}^{1/3}}$$

$$n = \frac{\mu_{uf} \cdot U_{gf}^{1/3}}{\alpha} \quad \alpha = \sqrt[3]{\sigma}$$

$$U_{gf} = \frac{K E_{rg}}{\mu_{uf}} \cdot \left(\frac{\Delta P}{L} \right)_f$$

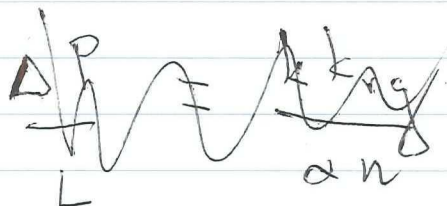
question provided #42

$$n = \frac{\mu_f \cdot \left(\frac{k k_y \Delta P}{\mu_f L} \right)^{1/3}}{\alpha \cdot (cc)}$$

$$= \cancel{\text{scribbles}}$$

$$\mu_f = \frac{\frac{1}{3} n}{\mu_f} = \frac{\alpha h}{\left(\frac{k k_y \Delta P}{\mu_f L} \right)^{1/3}}$$

$$\mu_f^{2/3} = \frac{\alpha h}{\left(\frac{k k_y \Delta P}{L} \right)^{1/3}}$$



$$\mu_f^{2/3} = \frac{\alpha h}{\left(k k_y \right)^{1/3} \left(\frac{\Delta P}{L} \right)^{1/3}}$$

$$\Delta P, \quad \frac{\Delta P}{L}, \quad U_{total}, \quad U_g,$$

$\alpha_n -$

theoretically - pressure gradient

$$\alpha = \alpha_1, \alpha_2, \alpha_3,$$

17.19 what happens when you add U_{tot} in M_{ug} instead of U_g ?

If it works we can always take out that $\left(\frac{1}{2}\right)^{1/3}$ factor & use as fitting parameter. looks ok

saved as U_{tot}
Other way would be to calculate η as a function U_g .

α should be changed in the initial value of η

Initial $\alpha = \cancel{PV} \times 10^{-3}$

α_{in}	5.94×10^{-4}	-	7.06×10^{-8}
α_{A^0}	3.58×10^{-4}	-	
	1.19×10^{-3}	-	6.39×10^{-8}

$$\frac{5.98 - 3.58}{5.98 - 1.19} = \frac{7.06 - \alpha}{7.06 - 6.39}$$

$$\frac{2.4}{-5.92} = \frac{7.06 - \alpha}{0.67}$$

$$1.608 = -41.7952 + 5.92\alpha$$

$$5.92\alpha = 43.4032$$

$$\alpha = \cancel{0.7} \cdot 7.633 \times 10^{-8}$$

$$6.39 \times 10^{-8}$$

$$0.3 \times 891.22 \quad n_{\text{init}} = \begin{matrix} \text{Alpha} \\ \left\{ \begin{array}{l} 7.33 \times 10^{-8} \\ 6.9 \times 10^{-8} \\ 6.39 \times 10^{-8} \end{array} \right\} \end{matrix} \quad \begin{matrix} \text{begin} \\ \text{end} \end{matrix}$$

$$109707.82 \quad n_{\text{finish}} = \left\{ \begin{array}{l} 6.9 \times 10^{-8} \\ 6.39 \times 10^{-8} \end{array} \right\}$$

g00 ~ 100000

Change in n

Change in $\text{arr}(t)$ function

Change in swr function

~~Ben~~ Benheimer ~~with~~ 23rd February new n as

S

n_{zero} & n_{zero} 60000

The one with U_{tot} crashed; the one with new n is still running

25th Feb. 2015 Wednesday

leaving ρ vol out of μ_{mf} equation as it is ~~now~~ already considered while calculating ρ n

$$\alpha = \sigma^{1/3} \times \text{vol} \quad \mu_{\text{mf}} = \frac{\alpha n}{\mu_g^{1/3}}$$

If I could make it to run little faster

Removing $\text{prct}()$ - does not work

$$\alpha = \sigma^{1/3} \times \text{vol}$$

Put another analytic function of α in
Now runs smoothly. till 1130

Removing again $\text{Prct}()$ to check what happens

20

Original α was 5.87×10^7 where vol is included

Now it is running slow ~~for~~ ^{around} 1134 seconds

It should be $89.6 \approx n_{in} \approx 90$ — 15000

$$C_{init} = 0.3856 \approx 0.3856$$

Same old - same old 1129 stop

Adding $PV(t)$

Should run with t & without t

11:35 ~~Final~~ Initial value for c C_{init}
& Dirichet Boundary condition is ~~at~~ ~~C_{init}~~ Silenced

let it take whichever value is there.
~~there~~

But now it is going above ~~at~~ 1100 easily.

11:45 Next step should be without $PV(t)$
 $0.2 \times 10^5 = 2 \times 10^4 = \underline{\underline{2000}}$

~~But now~~ But does not get enough ΔP

Even with $PV(t)$ removed it stops at 1129

Again ~~$c = c_{init}$~~ Initial value for $c = c_{init}$

Problem lies with Dirichet boundary

Again initial value for $c = c_{init} + (c_{bound} - c_{init}) \times m_1(t)$

May be again we have to take a look soon?

~~C_{bound}~~ $C_{bound} = 0.9$ initial value = $c_{init} + (c - c_{init}) \times m_1$

C should be between 0.3856 & 1. $\frac{\text{mmol}}{\text{L}}$

$$K_a (Q_s - C_s) C - K_d C_s = 0$$

$$C = \frac{K_d C_s}{K_a (Q_s - C_s)}$$

$$C_s \ 3 \times 10^{-6} \quad K_a \ 5 \times 10^{-5}$$

Checking how it affects C because C is bigger than given concentration

$$M_{ug} = \frac{\mu_{ug} \cdot n}{v_g^{1/3}}$$

$$n = \frac{M_{ug} \cdot v_g^{1/3}}{\alpha}$$

$$u_g = \frac{K K_{mg}}{M_g} \left(\frac{\Delta P}{L} \right) f$$

$$\mu_{ug} = \frac{K K_{mg}}{v_g} \left(\frac{\Delta P}{L} \right) f$$

$$n = \frac{K K_{mg}}{v_g} \left(\frac{\Delta P}{L} \right) f \cdot v_g^{1/3} \cdot \bar{\alpha}$$

$$n = \frac{K K_{mg} \left(\frac{\Delta P}{L} \right) f}{v_g^{2/3} \alpha}$$

$$\alpha = v_g^{1/3} \times \text{Vol}$$

$$n =$$

$$\frac{\partial c_s}{\partial t} + \frac{\partial c}{\partial t} + \partial_x u = \partial_x D \frac{\partial c}{\partial x}$$

$$\frac{\partial c_s}{\partial t} = k_d (Q_s - c_s) c$$

$$r_f = k_f (Q_s - c_s) c$$

$$r_b = k_b c_s$$

$$\frac{\partial c_s}{\partial t} = r_f - r_b =$$

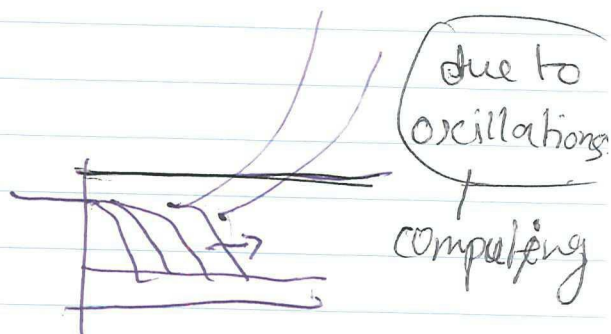
$$k_a (Q_s - c_s) c - k_b c_s = 0$$

$$\boxed{c_s = \frac{k_a Q_s c}{k_a c + k_b}}$$

$$k_a (Q_s - a Q_s) c - k_b a Q_s = \left(\frac{k_a c}{a} - k_a a c - k_b a \right) Q_s$$

$$\text{if } a = \frac{k_a c}{k_a c + k_b} = 0$$

$$a) \frac{k_a c}{k_a c + k_b} \text{ negative}$$



Change in concentration, diffusion coefficient, tolerance, grid size

16:39 Running. Berthelmer 25th February 2015. Hans 2
~~with time~~ for the range ~~20 to 10000~~ 10000

Still problem with concentration going burserk and above maximum prescribed concentration

C_s , K_a , K_d should be the culprit.

17:04 Adsorption comsol

Checking to get the K_a K_d values.

~~values~~.

Removing $\text{Dif} * (C_s - \text{test}(C_s))$ just to check

change in the signs of transport term & diffusion term

Cannot find ~~the reason~~ ^{it} but K_a , K_d should be the reason.

Thursday 26th Feb 2015

K_a	5×10^{-5}
K_d	9×10^{-5}
C_s	2.51×10^{-5}

Checking all forms.

Value
initial ~~condition~~ for saturation S_{init}

Initial value for bubble density n_{init}

$$K_a (q_s - C_s) - K_d C_s$$

Remove S from the ~~equation~~ concentration equation $\frac{d}{dt}$

13:00 Nice result but we still need to check with why n is increasing crazy.

Bentheimer - 25th February 2015 - Hans 2 b

There was a "n" extra term in transport part of bubble density equation, which was not there in the original console file.

multiplying s again inside concentration equation
(reshes)

In ~~per~~ working model it has been

$$s_{wn} = -0.05 \ln(x) + 0.8 \rightarrow$$

$$s_{wn} = -0.245 \ln(x) + 0.89$$

water saturation ϕ n ϕ dif

Best result so far

Beuthemer_25th Feb 2015 - Hang 2C saved 16:28 @
on 26th Feb 2015

2f is with s , n in PDE3 running 18:05
 $s_{wn} = -0.05 \ln(x) + 0.8$
 2c is without s in PDE4 ϕ n in PDE3 running
 ~~$s_{wn} = -0.05 \ln(x) + 0.8$~~ 18:05

Friday 27th Feb. 2015

~~2C~~ 2C to run till 4969.7 with 5.71×10^7 m/s
 The best result so far.
 running again with low deb ϕ

$$\partial_x (n \cdot v_g)$$

$$v_g \partial_x n + n \partial_x v_g$$

$$= v_g \text{ test}(nx) + n \text{ test}(v_g)$$

$$n \frac{k_{rg} (P - P_g)}{\mu_g} \text{ left}(nx)$$

$$\partial_n (n u_y)$$

$$-n u_y \text{ test}(n_x)$$

$$\cancel{\partial P} \partial_n (u) = 0 \rightarrow P$$

$$\partial_t s + \partial_x (u) = 0 \rightarrow s$$

$$\Rightarrow \begin{cases} -u \text{ test}(P_n) = 0 \\ \partial_t s + \partial_x (s) - u \text{ test}(s_n) = 0 \end{cases}$$

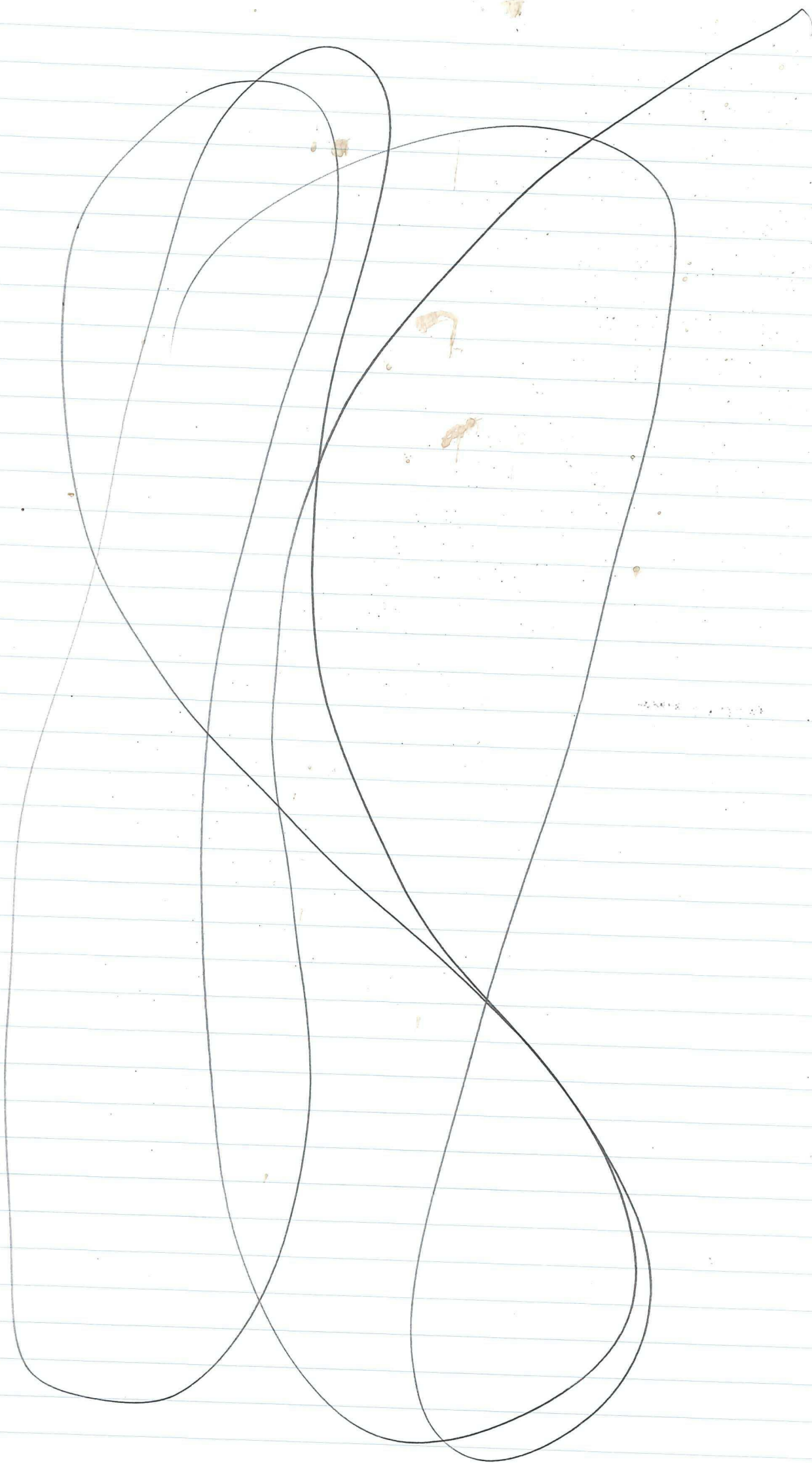
$$\int \overbrace{\partial_n (n u_y)}^{\partial v} \times \overbrace{\text{test}(u)}^u = \cancel{n u_y \text{ test}(u)} \Big|_{b_1}^{b_2}$$

$$\int_{b_1}^{b_2} u dv = uv \Big|_{b_1}^{b_2} - v du \quad -n u_y \text{ test}(n_x)$$

⇒ Hans is right; there has to be n inside that means in unconsolidated sandpack n has to be added as well. And water saturation should be there in concentration equation.

13:48 unconsolidated sandpack 27 Feb 2015

added n in PDE 3 diffusion for
 surfactant 2×10^{-8} & bubble diff. 2×10^{-9}
 (diffusion) in the console file
 It was very high & therefore gave false positive
 result.



The whole thing should be changed for unconsolidated sandpack as well.

$$\alpha = \text{Vol} \times 6^{1/3} = 4.31 \times 10^{-7}$$

$$\mu_{uf} = \mu_{ug} + \frac{\alpha n}{v_g^{1/3}}$$

$$\mu_{uf} = \frac{\alpha n}{v_g^{1/3}}$$

$$n = \frac{\mu_{uf} \cdot v_g^{1/3}}{\alpha}$$

$$\mu_{uf} \cdot v_g^{1/3} = \mu_{ug} \cdot v_g^{1/3} + \alpha n$$

$$n = \frac{\mu_{uf} v_g^{1/3} - \mu_{ug} v_g^{1/3}}{\alpha}$$

$$\mu_{uf} = \mu_{ug} + \frac{-k k_{rg} \cdot \Delta P}{\mu_g}$$

$$\mu_{uf} = \mu_{ug} + \frac{-k k_{rg} \Delta P}{\mu_g}$$

$$n = \frac{-k k_{rg} \cdot v_g^{1/3} \Delta P - \mu_{ug} \cdot v_g^{1/3}}{\alpha}$$

$$n = \frac{-k k_{rg} \mu_{uf}^{2/3} - \mu_{ug} v_g^{1/3}}{\alpha} \rightarrow 0$$

$$= \frac{-k k_{rg} v_g^{2/3}}{\alpha} = \frac{-k k_{rg} \cdot v_g^{2/3}}{\alpha \cdot v_g^{2/3}}$$

28th Feb. 2015 Saturday

Did not get the fit with Bentheimer 25th Feb 2015 - Hans. Therefore changing some things.
increase in $\frac{C}{C_0}$ diffusion = 2×10^8
decreasing mesh size for faster result.

Saving as Bentheimer - 28th Feb. 2015

14:37 without water saturation inside the concentration equation but with n

14:50 Bentheimer - 25th Feb 2015 - Hans 2C without water saturation but with n

Mesh size reduced, no n , tolerance decreased.

Let us try multiplying $n \times$ instead of n & However in the transport of concentration it is not the case.

Bentheimer - 25th February 2015 - Hans 2d

Everything above s is included

Bentheimer - 25th Feb. 2015 - Hans 2g
no n , no s .

I still believe s shouldn't be there in concentration equation. Otherwise put s everywhere in case of C_s or C .

Bentheimer - 28th Feb. 2015. no s ;

Bentheimer - 25th Feb Hans F

Trying with $x_f = (x)^{0.4}$

Bentheimer - 28th Feb 2015 - change x_f to n

& little bit higher diffusion concentration
 $D_c = 2 \times 10^8$

~~29th Feb~~ at 12:00:00

1 March 2015 Sunday

not much change ~~in the~~ from the previous case

Checked $s_{wn} = -0.037 \ln(x) + 1$

Changed $\alpha = \text{Vol} \cdot (-6.6 \log(x) + 3.05 \times 10^{-5})^{1/3}$

$$1 - 0.84$$

$$- 0.48$$

~~Not~~ Smooth result but still no pressure development
Increase in n etc.

Bentheimer - 1 March 2015

$$s_{wn} = -0.037 \ln(x) + 0.65$$

[REDACTED]

[REDACTED]

[REDACTED]

Not working with $s_{wn} = -0.037 \ln(x) + 0.65$
stuck at 1%.

~~slow~~ Slowing diffusion of saturation, bubble &
concentration. everything 2×10^{-9}

Therefore the progress is also slow.

Crashed 1200s.

now without S.

Bentheimer - 1 March 2015 - a

(without S, change in initial value, diff 2×10^{-8}

Bentheimer - 1 March 2015 without S & without n

Going fast now

17:00 Bentheimer - 1 March 2015 with s & n but dif 2×10^{-8}

17:20 Bentheimer - 1 March 2015 - a : ~~to~~ ~~not~~ not enough
elevation Thus $sw_n = -0.037 \ln x + 0.8$
~~Change in~~ initial value is ninit

not enough initial value

Combination of saturation sw_n & diffusion coefficient
needs to be explored.

2nd March 2015

9:48 Bentheimer - 1 March 2015 - a : $sw_n = -0.037 \ln x + 0.8$
dif for all 2×10^{-7}

No building of bubble density

Adding s inside PDE & equation $sw_n = -0.037 \ln x + 0.75$

10:43 bubble diffusion 2×10^{-8} } Bentheimer - 1 March 2015
Saturation $- 2 \times 10^{-7}$
Concentration $- 2 \times 10^{-7}$

Bentheimer - 1 March 2015

$sw_n = -0.037 \ln x + 0.8$ dif 2×10^{-8} everywhere

11:05 Bentheimer - 1 March 2015 - a

$sw_n = -0.037 \ln x + 0.75$

diffusion 2×10^{-7} s, n included

Original bubble diffusion was 2×10^{-6}

Therefore bubble diffusion ~~is~~ it taken to be

11:26 $2 \times 10^{-6} \text{ m}^2/\text{s}$

Problem continues with no development of n

$$X_F = (n)^{-0.4}$$

12:15

Stuck at 1%

Diffusion { Saturation 2×10^{-7}
Bubble 2×10^{-8}
Concentration 2×10^{-9}

14:49 Diffusion (all) 2×10^{-6}

Langmuir adsorption isotherm & water saturation equation

coefficient

$n_x = 0$ at the origin

~~After~~ ① ~~$x(t)$~~ disregarded in source term, S_g

② convection ≈ 0

{ Bubble are generated }
{ Not moving with gas }

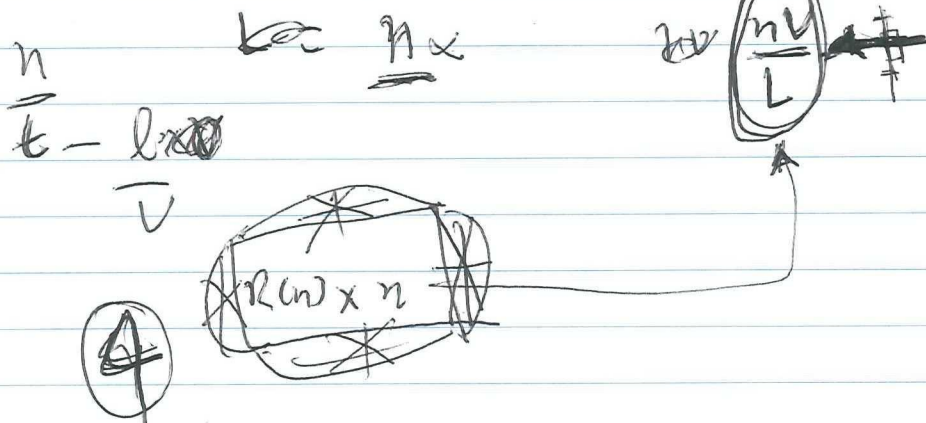
diffusion & convection of bubbles = 0

③ ~~$x(t)$~~

Generation - Coalescence rate Patzek -

$\frac{dn}{dt}$ in Bill's paper

~~$\frac{n}{t}$~~ $\frac{v_g \times n}{t L}$ formation rate
Darcy's velocity



Try

Trying

16.22 ① $x f(n)$ multiplying inside ^{bubble} convection term
still the same problem.

② convection zero diffusion zero
not running

Actually in Figure 10 we showed that term $n \partial_g (u_g, x)$
increases substantially

③ $X_F \equiv 1$ Diffusion everywhere 2×10^7

④ $X_F = 0.1$ no $x f(n)$ in source term &
no $x f(n)$ in convection term.

$$\frac{\partial}{\partial t} (\phi S_g x_f n_f + \phi S_g (1-x_f) n_t) + \nabla \cdot (n_f u_g) = \phi S_g (C_F - C_F)$$

~~$S_{g,eps}$~~ , ~~$S_{g,eps}$~~ $((1-X_F)(1-S))$

$n_f = n_t$
flowing = trapped



$S_{g,eps} = 0.1 \times$ $S_{g,eps} = 0.05$

$U_f = 3.34 \times 10^{-4}$ - high, should be low $\times 10^{-5}$
Now develops ~~but~~ bubble very high at the start of n
then decreases as time passes by.

$$\phi \frac{\partial}{\partial t} (X_F S_g n) + n \frac{K_{rg}}{\mu_{rg}} (\Delta P - P_g)$$

$$- \phi S_g R_n = 0$$

↑

$$\cancel{\phi \frac{\partial}{\partial t} (s_g n)} +$$

$$\frac{\partial}{\partial t} (\phi s_g n) + \frac{\partial}{\partial x} (n u_g) = \phi s_g R$$

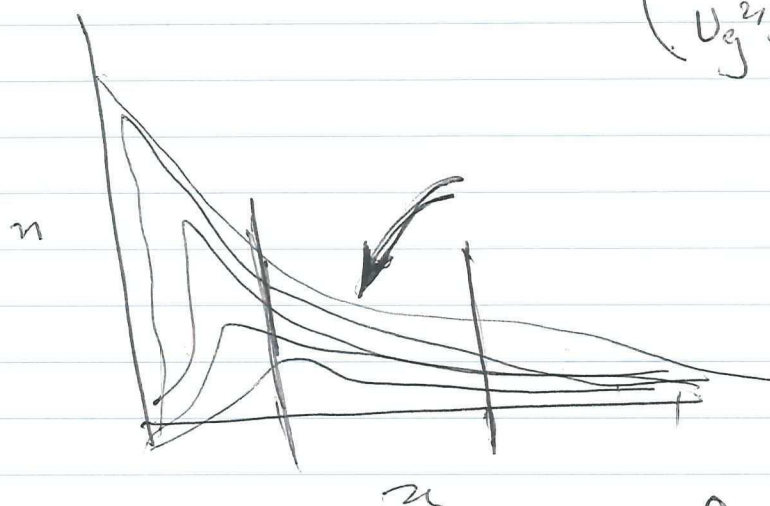
$$\cancel{\phi \frac{\partial}{\partial t} (s_g n)}$$

$$\phi \frac{\partial}{\partial t} (x_f s_g + s_{\text{geps}}, n)$$

~~Remember~~ Let us only consider ^{only flowing} gas fraction of gas.

~~Let~~

DBC for n is $n_{\text{init}} + \left(\frac{K k_{rg} \cdot \Delta P}{\mu_{\text{wg}} \cdot U_g} - n_{\text{init}} \right) \times \alpha$



$$\frac{\partial}{\partial t} (n \phi s_g) + s_g \frac{\partial n}{\partial t} + n \frac{\partial u_g}{\partial x} + u_g \frac{\partial n}{\partial x} = \phi s_g R$$

$$S_{wn} = -0.037 \ln(x) + 0.7$$

$$\frac{S_{wn} - 0.7}{-0.037} = \ln(x)$$

$$10^{\frac{S_{wn} - 0.7}{-0.037}} = x$$

$$10^{\frac{S_{wn} - 0.1}{-0.037}} = n_{\text{imag}}$$

~~DBE~~ DBC $n_{init} + (n_{imag}(s) - n_{init}) * \text{imp}(t)$

should we try reinput bubble diffusion

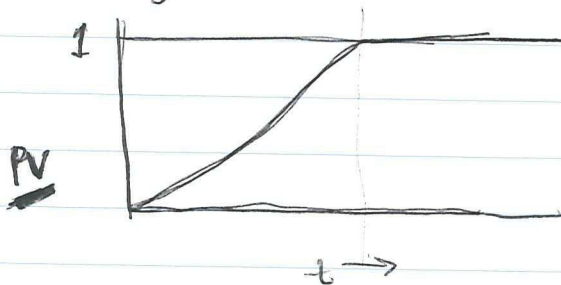
21:00 Diffusion added

3 March 2015 Tuesday

9:38 Removing diffusion

Ok with Slope but not ok with k yet

11:11 Removing s from Concentration equation, pulling back again

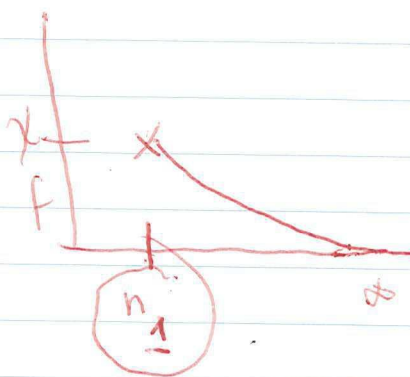


$$\mu_g \approx \frac{\partial n}{\partial t} \frac{1}{u_g^3}$$

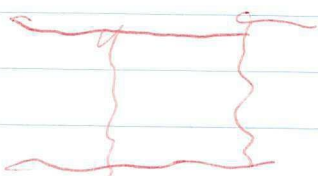
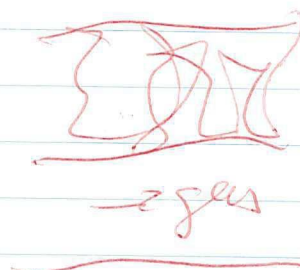
$$u = \frac{R^2}{8\mu} \frac{dp}{dx}$$

$$\frac{N}{m^2} s = \frac{m^{-3}}{(m^{1/3})^3}$$

$$\mu = \frac{u \Delta p R^2}{\rho u}$$



$$\frac{N}{m^2} s = \frac{m^3}{m^{2/3}} \frac{1}{m^{1/3}} \frac{1}{s}$$



$$\frac{\Delta p}{L} = \frac{\mu u_g}{k_g}$$

$$\frac{n \alpha}{u_g^3}$$

$$\frac{u \left[\frac{m^3}{m^2 s} \right] \left[\frac{\#}{m^3} \right]}{m}$$

Darcy's

velocity flow through

$$\frac{\Delta P}{L} = \frac{\mu_f u_g}{k}$$

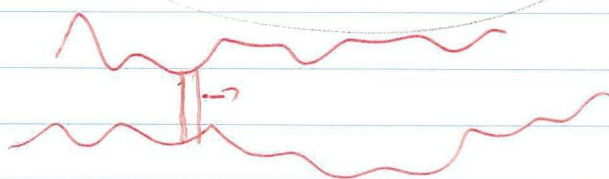
$\mu_f = \mu_g + \frac{\alpha n}{u_g^{1/3}}$

$\alpha = \frac{\partial(\alpha n)}{\partial t}$

(3) (5)

$$\frac{d}{dt} \frac{\Delta P}{L} = \frac{u_g}{k} \times \frac{dn}{dt} = \frac{u_g}{k} \times R(n)$$

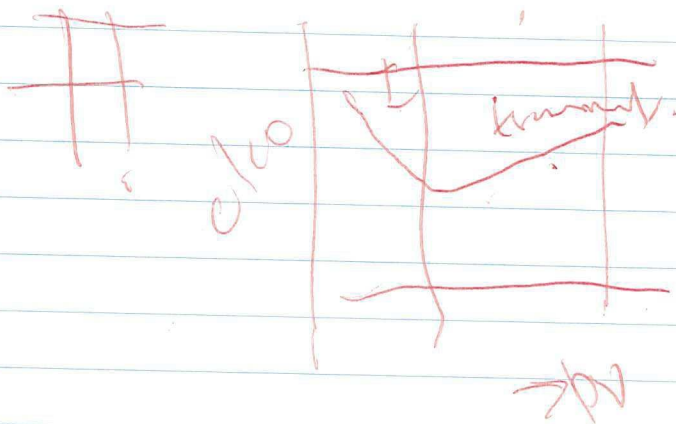
$$\frac{dn}{dt} = R(n)$$



$$R(n) = \frac{1}{k_f} (n - n_{eq}) - k_b n = A n + B$$

$$R(n) = \frac{R_0(n)}{\alpha} = A n + B$$

$$k = \frac{q R^2}{8} \quad R^2 = \sqrt{\frac{8 k}{q}}$$



$$n = \frac{\mu_0 \mu_B \omega^2}{\frac{N S}{m^2} \times \left(\frac{m}{S}\right)^{1/3}}$$

$$= \frac{\mu_0 \mu_B \omega^2}{\frac{N S^{2/3}}{m^{2/3}}}$$

$$\mu = \frac{N S^{2/3}}{m^{2/3}}$$

Bubble down

$$\partial_t(Sgn) + \partial_x(Vgn) = R(n)$$

$$\partial_t(Sgn) + \partial_x(Vgn) = R(n)$$

$$+ \partial_x(Vgn) = R(n)$$

$$m \left(\frac{N S}{m^2}\right)^{2/3} \left(\frac{N}{m}\right)^{1/3}$$

$$m \frac{N^{2/3} S^{2/3}}{m^{2 \times \frac{2}{3}}} \cdot \frac{N^{1/3}}{m^{1/3}}$$

$$\frac{N S^{2/3}}{m^{2/3}}$$

$$\frac{N^{\frac{2}{3} + \frac{1}{3}} S^{\frac{2}{3}} m}{m^{5/3}}$$

$$N S^{2/3} m^{-2/3}$$

$$R(n) = k_c (n_{eq} - n) n - k_b n$$

$$\frac{N S^{2/3}}{m^{2/3}}$$

Simjoo

$$\propto \frac{N S^{2/3} m^{10/3}}{m^2}$$

$$5.8 \times 10^{-16}$$

Our

$$\propto \frac{N S^{2/3} m^{10/3}}{m^2}$$

$$3 \times 10^{-10}$$

$$\frac{N^{2/3} S^{2/3}}{m^{2 \times \frac{2}{3}}} \cdot m \cdot \frac{N^{1/3}}{m^{1/3}}$$

$$\left(\frac{N S}{m^2}\right)^{2/3} \cdot m \cdot \left(\frac{N}{m}\right)^{1/3}$$

$$\left(\frac{N S}{m^2}\right)^{2/3} m$$

$$\gamma = -0.043 \ln x + 1.3577$$

$$n_{init} = 217819$$

$$n_{max} = 35352240$$

$$\begin{aligned} \alpha &= 1.18 \times M^{2/3} \times R \times \delta^{1/3} \\ &= 8.297 \times 10^{10} \left(\frac{Ns}{m^2} \right)^{2/3} \cdot m \cdot \left(\frac{N}{m} \right)^{1/3} \end{aligned}$$

Crashes after 0.3 sec

So added steps

slow keeping low } Not yet

running with high (104) convergence 0.84 sec

$$n = \frac{\mu_g \times v_g^{1/3}}{\alpha} = \frac{\frac{Ns}{m^2} \times \left(\frac{m}{s} \right)^{1/3}}{\frac{Ns^{2/3}}{m^{2/3}}}$$

$$= \frac{m^{2/3} \cdot s^{1-\frac{2}{3}}}{m^2} \cdot \frac{m^{1/3}}{s^{1/3}}$$

$$= m^{\frac{2}{3}-2+\frac{1}{3}} \cdot s^{1-\frac{2}{3}-\frac{1}{3}}$$

$$= m^{-1} \cdot s^0$$

~~पॉवहोइ~~

पॉवहोइ

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Pwahzoy

पॉवहोइ पॉवहोइ पॉवहोइ

Rahul talk

working on ^{the} foam flow experiments
initially

②

don't talk to the title sheet

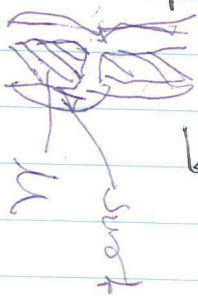
Why are conditions not written

You are talking to Hestley, write points you addressed

3) Can be directly derived except for the contact & stickle to what you write on the sheet

write that situation. $c < c_{mc}$ Hypothesis Hypotheses \rightarrow write them all

Point at symbols does not make sense, mention meaning



$k_g = k$ at low water saturation

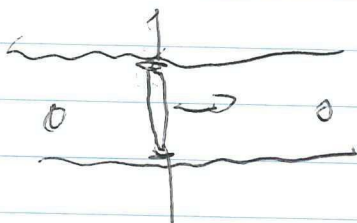
Purafseui

6)

$$/m = /[m]$$

Why not γ versus $\ln c$
What γ vs c

You talk too much.

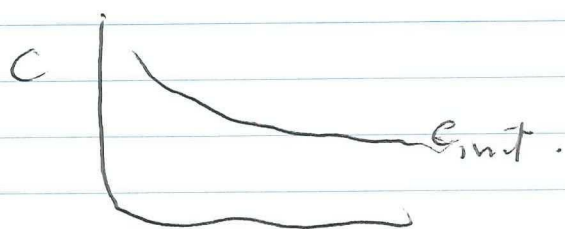


$$(vc) = [vc] \cdot \frac{dc}{c}$$

Langmuir isotherm is equilibrium equation

Units of ϵ_s does not matter
they can be put in K_a , k_d

10) but what about α ?

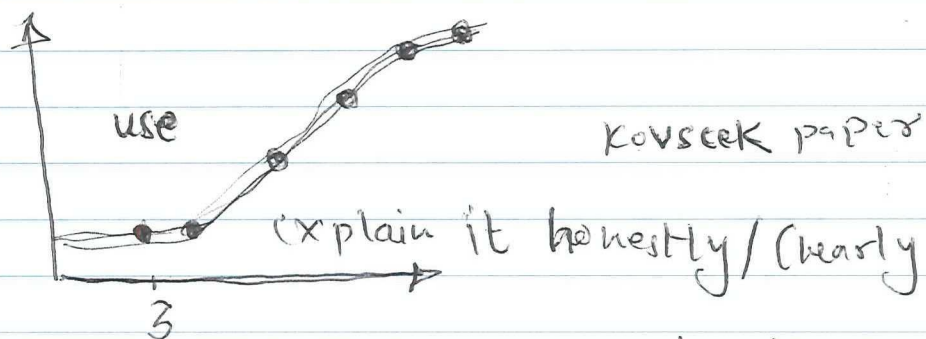


Lamellae density profile looks unstable (13)

Leave a non-optimal data for future work

Change μ ~~from~~ α :

α is not from Hirasaki



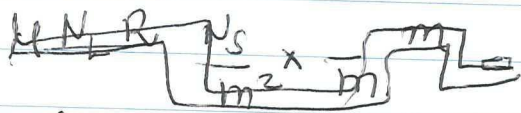
Hamid & Nick - suggestion about difference between adsorption behavior in single phase flow & foam flow.

pu is interstitial & injected velocity is different.

We can say that α is found by fitting the relationship initially taking it as $\times 10^{16}$ from simjoo of Apaydin. We still show the effect of concentration of adsorption. We don't yet connect the effect of change in surfactant concentration to ~~the effect of~~ α .

Change in α can be done by 5.87×10^{18} for start? viscosity coefficient being linear function of C ? Tomorrow unconsolidated sandpack? Check Kovscek for trapped gas fraction. We need to solve it.

What if we take α^n instead of only n ?
 ~~single~~ Resistant ~~for~~ single bubble or
 ~~due~~ single lamellae



(Chen paper for low concentration?)

I am not really comfortable with Bentheimer results

water content in terms of pressure drop (bubble density)

Use in our paper; Discussion of the experimental results is deferred ~~not~~ until after description of the foam displacement model.

$$\frac{\partial (S_f n_f + S_t n_t)}{\partial t}$$

$$S_f = 1 - S$$

$$S_t = 1 - S - S_f$$

$$S_t = S_f$$

$$S_f + S_t = 1 - S$$

If $n_f = n_t$

$$\frac{\partial (S_f + S_t) n_f}{\partial t}$$

This would make it easier but how much true u_g in equation is Darcy velocity $n_f = n_t$ or superficial velocity

$$u_{gD} = \frac{u_g}{\phi} \quad ? \quad No$$

$$\alpha = 2.5 \times 10^{14} \text{ Pa.s}^{2/3} \text{ m}^{10/3}$$

Apaydin 100-120 mesh Ottawa sand

check Apaydin to connect surfactant concentration to viscosity coefficient.

$$u_g = u_g \frac{P_{inj}}{P_{res}}$$

We assume interstitial velocity = ~~super~~ Darcy velocity

or Interstitial water velocity $= \frac{U_w}{\phi S_w}$
 interstitial gas velocity. $U_{g \text{ inter}} = \frac{U_g}{\phi X_F S_g}$

Darcy Velocity of gas $U_g = U_{g \text{ injected}} \frac{P}{P_{in}}$
 or Superficial

or Darcy velocity should be $\frac{U_{g \text{ injected}}}{\phi}$?

$$q_f = \phi S_g \left(k_1 v_w v_f^{1/3} - k_{-1} (C_s, P_c) v_f^{n_F} \right)$$

| Interstitial velocity

give
 We cannot better explanation about generation & coalescence than ~~Kovscek~~ Kovscek 1995

Put in the paper

$$v_f = \frac{K k_{rf}}{\mu_f} \left(-\frac{\partial P_g}{\partial x} \right)$$

Does not imply Darcy's law because μ_f is not constant

$$\mu_f = \mu_g + \frac{\alpha n_F}{v_f^{1/3 - 1/3}}$$

Effective foam viscosity which increases as texture increases, but is also shear thinning.

"Because wetting aqueous liquid flows in the smallest pore space, its relative permeability is unaffected by the presence of flowing and stationary stationary foam; hence the relative permeability to the aqueous phase remains solely a function of S_w ."

$$K_{rw} = K_{rw}^0 S_{wd}^f$$

$$K_{rg} = K_{rg}^0 S_{fd}^g$$

$$S_{fd} = X_f (1 - S_{wd})$$

$$\lambda_F = \frac{J_F}{S_g}$$

$$S_{wd} = \frac{S_w - S_{wc}}{1 - S_{wc}}$$

Knowledge of the fraction of foam trapped in the porous medium is needed to complete the flow model.

$$x_t = \frac{S_t}{S_g}$$

$$x_t = 1 - x_f$$

$$\approx 1 - \left(\frac{n}{n_{init}} \right)^{-0.4}$$

I knew it mol- $n_f = n_t$;

$$\frac{\partial}{\partial t} (S_f n_f + S_t n_t) \rightarrow \frac{\partial}{\partial t} (x_f S_g n_f + x_t S_g n_f)$$

$$(x_f S_g n_f + (1 - x_f) S_g n_f)$$

$$x_f S_g n_f + S_g n_f - x_f n_f S_g$$

We can use a graph of $x_f \approx \left(\frac{n}{n_{init}} \right)^{-0.4}$

$$x_f = \frac{\Psi}{S_g} \left(\frac{f_c \cdot |VP|}{K^{1/2} n_f} \right)^\eta$$

$$\mu = 8.6 \times 10^{-16} \text{ Pa s}^{2/3} \text{ m}^{10/3}$$

Kovscek ~~2015~~ 1995

(Relative permeabilities for Bentheimer)
?

We do not need separate fitting parameter to calculate flowing gas fraction.

"We discover here that the origin of the unique flow behavior of foam in porous media is due to texture alteration with changing gas and liquid velocities, in addition to shear-thinning rheology. It is because of this changing texture that classical fractional flow theory does not apply to foam."

~~x_t~~

The trapped fraction $x_t = 1 - x_f$ strongly influences the foam flow resistance by reducing gas-phase relative permeability.

"A region of net foam generation exists near the inlet by implication."

α in Hirasaki. Lawson equation is same as α in

$$M_f = M_g + \frac{\alpha n}{V_g^{1/3}}$$

$$\alpha = \left(\frac{\partial P}{\partial \Gamma} - \frac{\partial Q}{\partial \Gamma} \right) \Gamma_0$$

\uparrow rate of desorption \uparrow rate of adsorption
 \uparrow Surface excess concentration \uparrow value when surface is in equilibrium with the bulk fluid

Γ

" α increases with Plateau border curvature (Hirasaki and Lawson 1985) and hence with, decreasing water saturation "

Relation between $\frac{mN}{m}$ & $\frac{N}{m}$ $1 mN = 1 \times 10^{-3} N$

mmol & mol $1 mmol = 1 \times 10^{-3} mol$

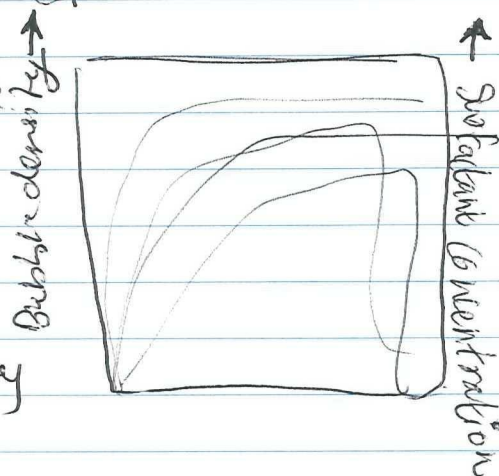
$$\text{Excess concentration } \Gamma = - \frac{1}{RT} \frac{d\gamma}{dc} \quad \text{Surface tension} \quad \frac{mol}{m^2}$$

\uparrow concentration

Water $72 \frac{dyne}{cm}$ $72 \frac{mN}{m} = 0.072 \frac{N}{m}$

When surfactant added

Try to give the profile like



$$K_{rf} = K_{rg} S_{fd}$$

K_{rg} gas relative permeability at SWC ; Our K_{rg}

$$K_{rg} = K_{rg}^0 (1 - S_{we})^2 (1 - S_{we}^{\frac{2+\lambda}{1}})$$

$$S_{we} = \frac{S_w - S_{wc}}{(1 - S_{wc} - S_{gr})} \quad We$$

$$S_{fd} = (1 - S_{we})^2 (1 - S_{we}^{\frac{2+\lambda}{1}})$$

$$v_g \equiv \frac{k_g}{\mu_g} \times \left(-\frac{\partial P_g}{\partial x} \right)$$

$$u_g = \frac{KK_{rg}}{\mu_{gf}} \quad \text{local interstitial} \rightarrow V_F = \frac{u_F}{\phi S_F} \text{ Velocity}$$

Equation for Foamed gas or Foam

$$u_{fg} = \frac{KK_{rfg}}{\mu_{fg}} \left(-\frac{\Delta P}{\Delta x} \right)$$

Equation for viscosity of this foamed gas

$$\mu_{fg} = \mu_g + \frac{\alpha n_{fg}}{\left(\frac{u_{fg}}{\phi S_{fg}} \right)^{1/3}} \quad \leftarrow \text{local Interstitial velocity of foamed gas}$$

$$\mu_{fg} = \mu_g + \frac{\alpha n_{fg} (\phi S_{fg})^{1/3}}{\left(\frac{KK_{rfg}}{\mu_{fg}} \left(-\frac{\Delta P}{\Delta x} \right) \right)^{1/3}}$$

$$\mu_{fg} \left(\frac{KK_{rfg}}{\mu_{fg}} \left(-\frac{\Delta P}{\Delta x} \right) \right)^{1/3} = \mu_g + \alpha n_{fg} (\phi S_{fg})^{1/3}$$

$$\mu_{fg}^{2/3} KK_{rfg}^{1/3} \left(-\frac{\Delta P}{\Delta x} \right)^{1/3} = \mu_g$$

$$\frac{\mu_{fg}^{2/3} KK_{rfg}^{1/3} \left(-\frac{\Delta P}{\Delta x} \right)^{1/3}}{\alpha \cdot (\phi S_{fg})^{1/3}} = n_{fg}$$

$$n_f =$$

$$u_f = \frac{KK_{rf}}{\mu_f} \left(-\frac{\Delta P}{\Delta x} \right) \quad \text{Velocity of Foamed gas or foam}$$

$$\mu_f = \mu_g + \frac{\alpha n_f}{\left(\frac{u_f}{\phi S_f} \right)^{1/3}} \quad \text{Viscosity of foamed gas or foam}$$

$$u_f = \frac{KK_{rf}}{\mu_g + \frac{\alpha n_f}{\left(\frac{u_f}{\phi S_f} \right)^{1/3}}} \left(-\frac{\Delta P}{\Delta x} \right)$$

$$u_f (\mu_g) + \frac{\alpha \cdot n_f \cdot u_f}{\left(u_f / \phi S_f \right)^{1/3}} = KK_{rf} \left(-\frac{\Delta P}{\Delta x} \right)$$

$$\left[\frac{u_f^{4/3} (\mu_g) + \alpha \cdot n_f \cdot u_f^{2/3}}{u_f^{1/3}} \right]$$

$$\cancel{u_f} \left(\cancel{\mu_g} + \dots \right)$$

$$\left(KK_{rf} \left(-\frac{\Delta P}{\Delta x} \right) - u_f \mu_g \right) \left(\frac{u_f}{\phi S_f} \right)^{1/3} = \alpha \cdot n_f \cdot u_f$$

$$n_f = \left(\frac{KK_{rf} \left(-\frac{\Delta P}{\Delta x} \right) - u_f \cdot \mu_g}{\alpha \cdot u_f} \right) \left(\frac{u_f}{\phi S_f} \right)^{1/3}$$

~~$K_{rf} = x_f \cdot K$~~

$K_{rf} = x_f \cdot K_{rg}$

$S_f = x_f \cdot S_g$

~~However~~ ~~However~~ Simple way $x_f = 0.10$

Difficult way $x_f = \left(\frac{n_f}{n_{ini}} \right)^{-0.4}$

$n_f = n_{ini}$ Initially

$x_f = 1$

$K_{rf} = K_{rg}$

$S_f = S_g$

$$\frac{n_f = -K K_{rf} \left(\frac{\Delta P}{\Delta x} \right) - v_f \cdot \mu_g}{\alpha \cdot v_f} \cdot \left(\frac{v_f}{\phi S_f} \right)^{1/3}$$

If you want to calculate ~~n_{ini}~~ ^{n_{ini}} here, you need to assume that ~~x_f~~ $x_f = 1$

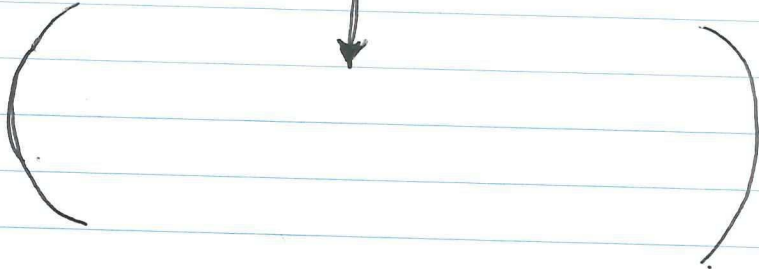
$$\frac{n_f = -K x_f \cdot K_{rg} \left(\frac{\Delta P}{\Delta x} \right) - v_f \cdot \mu_g}{\alpha \cdot v_f} \cdot \left(\frac{v_f}{\phi x_f \cdot S_g} \right)^{1/3}$$

$$\frac{n_f}{x_f} \cdot x_f^{1/3} = \frac{-K K_{rg} \left(\frac{\Delta P}{\Delta x} \right) - v_f \cdot \mu_g / x_f}{\alpha \cdot v_f} \cdot \left(\frac{v_f}{\phi S_g} \right)^{1/3}$$

$$\frac{n_f}{x_f^{2/3}} =$$

$$\frac{n_f}{\left(\frac{n_f}{n_{ini}} \right)^{2/3}} =$$

$$n_f^{1/3} = n_{ini}^{2/3}$$



$$n_F^{1/3} = n_{init}^{2/3} \left(\frac{-k K_{rg} \left(\frac{\Delta P}{\Delta x} \right) - U_F \cdot M_g}{\alpha \cdot U_F} \right) \left(\frac{U_F}{\phi X_F S_g} \right)$$

$$n_F = \frac{-X_F^k K_{rg} \left(\frac{\Delta P}{\Delta x} \right) - U_F \cdot M_g}{\alpha \cdot U_F} \left(\frac{U_F}{\phi X_F S_g} \right)^{1/3}$$

for easy way take $X_F = 0.1$

or
for n_{init} $X_F = 1$

$$n_{init} = \frac{+k K_{rg} \left(\frac{\Delta P}{\Delta x} \right) - U_F \cdot M_g}{\alpha \cdot U_F} \left(\frac{U_F}{\phi S_g} \right)^{1/3}$$

$$X_F = \left(\frac{n_F}{n_{init}} \right)^{-0.4}$$

$$n_F = n_{init} \text{ at } X_F = 1$$

$$0.1 = \left(\frac{n_F}{n_{init}} \right)^{-0.4}$$

$$0.1 \times n_{init}^{-0.4} = n_F^{-0.4} \rightarrow$$

20:38 unconsolidated coarse sand-05032015

① adding n in bubble-equation

② Cheeking $\left(\frac{\Delta P}{\Delta x} \right)$ experimental function

Analytical function

~~X_F~~ ~~X_F~~ , ~~X_F~~

$$n = \frac{X_F^k K_{rg} \left(\frac{\Delta P}{\Delta x} S_g \right) \cdot U_F^{1/3} - U_F^{4/3} \cdot M_g}{(\phi X_F S_g)^{1/3} \alpha \cdot U_F}$$

$$\eta = \frac{3 \times 10^{-2} \times 35500 - 4.0 \times 10^{-6} \cdot 1.8 \times 10^{-5}}{1 \times 10^{-5} \cdot 1.8 \times 10^{-5}} \frac{(4.0 \times 10^{-6})^{1/3}}{(0.2 \times 1)^{1/3}}$$

Wherever η is there should $\eta(s, t)$?

But we still use the expression from $a_{11}(t)$?

If I could just get $\frac{dn}{dt}$ form from $\eta \rightarrow \frac{dp}{dx}$ without excel

Do U_q has to be transformed?

It should be injected velocity as compressibility is taken care in Φ

~~Super~~ \odot Superficial Velocity $U_w = \frac{Q_A}{A}$
Darcy Velocity

~~Darcy velocity~~ interstitial velocity = $\frac{U_w}{\Phi}$

It should be back pressure divided; then rest is what $\frac{1}{P}$ should take care.

P is developed as the time goes by with
 $p_{exit} + (U_{tot} * \mu_{eff}(n_{init}, s_{init}) * (len - x) / (perm))$

How to get $\frac{dn}{dt}$ form from $\eta \rightarrow \frac{dp}{dx}$ without excel

$$\eta_f = \frac{-x_f \cdot k K_{rg} \left(\frac{\Delta P}{\Delta x} \right) - U_f \cdot \mu_g}{\alpha \cdot U_f} \left(\frac{U_f}{\Phi x_f \cdot S_g} \right)^{1/3}$$

$$x_f^{-1+\frac{1}{3}} = x_f^{-\frac{2}{3}}$$

$$\eta_f = \frac{-k K_{rg} \left(\frac{\Delta P}{\Delta x} \right) \left(\frac{U_f \cdot \mu_g}{x_f} \right)}{\alpha \cdot x_f^{-2/3}} \left(\frac{U_f}{\Phi S_g} \right)^{1/3}$$

α'

For now we can think of $K K_{rf} = K K_{rg}$ and all the effect that foam has accumulates in α

$$\frac{K_{rg}}{\mu_g} = A_g$$

check the derivation with capillary pressure

Saturday 7th March 2014

10:00 "How to change" course: →

- Impact outside the world
- Know thyself
- Accept change
- Social ~~entrepreneurship~~ entrepreneurship
- Leadership (making decisions)
- (Asking questions - controlling the conversation)
- Ask question with ~~possible~~ maximum range of ~~ex~~ answers.
- Convincing people.
- ~~be~~ selling strategies :- Puppy dog strategies
- Dave Pollard: Finding the sweet spot

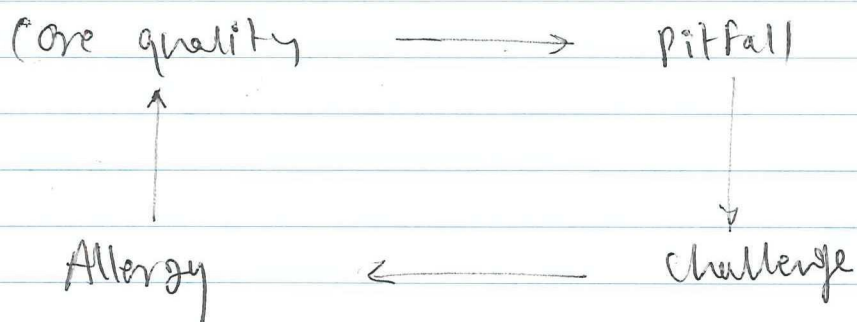
Exercise: what are you good at?

My colleagues have been telling that
~~Perseverance~~ Perseverance

- Labview, data acquisition, solar cells,
- Neutral, middle point
- Dr. Martin Seligman

We manage our weakness not our strength.
When we overdo our strength. It leads to
our pitfall.

Core qualities study: →



Feeling the emotions / Take decision before
getting emotionally involved in.

Proud: - inquisitiveness, first of many people
dutch language, physical condition,

16:00 Rossen, SPE 28940 :

"Unfortunately, there is no way to separate the effects of lamella generation and destruction in history-matching coreflood results, since an increase in one mechanism is equivalent to a decrease in the other."

Use it to defend not ~~using~~ dividing the generation-coalescence term.

We can apply

$$\mu_f = \frac{\alpha n}{\left(\frac{v_f}{\phi}\right)^{1/3}}$$

without using μ_g as

it ~~is~~ we inject ~~from~~ bubbles inside the porous media

There is no μ_g , v_g , etc.

$n_{inj} = n_{init} \neq 0$ if it is zero

That is, little bit of problem

~~If we start~~

let it be

$$\mu_g + \frac{\alpha n}{\left(\frac{v_f}{\phi}\right)^{1/3}}$$

interstitial velocity

$$\mu_f = 0 \quad v_f = \frac{k_{rf} \Delta p}{\mu_f \Delta x}$$

In Rossen 1994 SPE 28940

Expt. Δp is used to fit the ~~expt~~ fractional flow method.

Rossen uses only S_w^* to fix the experimental linear flow data whereas BD requires two parameters.

Page 496 of SPE ~~28940~~ 28940

The condition is given with surfactant concentration

what P_c^* model; we also do the same by defining S_w^* at a particular point; ~~like~~ from bubble density $S_{wn} = 0 - 0.043 + 0.85$ or 0.35

As it is proven earlier that processes of foam generation-^{coalescence} in porous media are complex (Chou 1991, Apaydin 2001; we don't want get into describing generation-coalescence mechanism.

write in the introduction about SPE 28940 about what Bill says: ~~ads~~ adsorption has been incorporated into FF approach by assuming a shock front in surfactant adsorption, which is what Langmuir isotherm produces.

~~or to obtain~~ Nice critique of our approach; ~~to~~ in the paper by Zou & Rossen 1995
empirical curve fitting & history matching.

measure drawback of ff to unsteady foam flow is that it ~~rep~~ assumes gas to be incompressible

Kam & Rossen model incorporates a different lamellae creation mechanism, specifically one that depends on pressure gradient.

$$M_g^f = M_g + \frac{\alpha n}{U_g^{1/3}}$$

② ~~U_f~~ unconsolidated sand pack case

$$n = \frac{K_{rgf} \left(\frac{\Delta P}{\Delta x} \right)}{\alpha \cdot U_f} \left(\frac{U_f}{\phi \chi_f \cdot S_g} \right)^{1/3}$$

$$S_g = 1 \quad K_{rgf} = 1 \quad \chi_f = 0.1$$

$$U_f = 1.01 \times 10^{-5} \text{ m/s} \quad \alpha = 1.8 \times 10^{-5}$$

Then we get previous fit

$$S_{wn} = -0.020 \log x + 0.5637$$

$$S_{wn} = -0.031 \log x + 0.8934$$

Removing diffusion from the saturation equation

Adding again the saturation equation

Taking $\alpha = 2.5 \times 10^{-14} \text{ Pa s}^{2/3} \text{ m}^{10/3}$

Just like fractional flow theory with fixed P_c model.
We also have to start at S_{wn} very low ≈ 0.4
Therefore

$\alpha =$

Better take α based on something than a random fitting value.

Good result with unconsolidated sandpack however the ΔP did not reach the ~~measured~~ experimental pressure drop.

Therefore next time removing the bubble diffusion (should not matter much; but anyway)

keeping it after what we saw for Bent

Bentheimer case is started without bubble diffusion; with change in ~~everything~~

$$\mu_{\text{app}}^{\text{liq}} = \mu L_s \cdot \eta_L = \mu \left(\frac{1-F}{\eta_L} - \frac{2R}{3} \right) \eta_L$$

$$= \mu (1-F) - \frac{2}{3} R \cdot \mu \cdot \eta_L$$

$$\mu_{\text{app}}^{\text{liq}} = \mu \cdot \left(1 - \frac{u_g}{u_t} \right) - \frac{2}{3} R \cdot \mu \cdot \eta_L$$

$$\mu_{\text{app}}^{\text{liq}} = \mu - \mu \frac{u_g}{u_t} - \frac{2}{3} R \cdot \mu \cdot \eta_L$$

$$\alpha = \frac{2}{3} R \cdot \mu \cdot \left(\frac{u_g}{\phi S_H} \right)^{1/3} =$$

After adding diffusion; it goes very fast in case of Bentheimer; too fast.

11th March 2015 Wednesday

Very clear cut result though pressure drop did not reach to high value.

Increasing each diffusion by 2×10^{-6}

$$\begin{aligned} \mu_{uf} &= \frac{\alpha n}{\left(\frac{u_f}{\phi x_f} \right)^{1/3}} \\ &= \frac{4 \times 10^{-9} \times 10^6}{\left(\frac{1.97 \times 10^{-5}}{0.2 \times 0.15} \right)^{1/3}} \end{aligned}$$

\approx

The problem is that μ_{uf} is not developing.

Need to try once without x_f in
— No effect of x_f ^{removing} as it will be also removed ^{be}
from the calculation of n .

Increase in pressure drop but ~~all other~~ ~~can be~~
effect of other elements are kind of muffled.

Diffusion (all) in both case $2 \times 10^{-5} \text{ m}^2/\text{s}$ (Very high)

$$\frac{\text{mmol}}{\text{m}^2} \times k_d = \left(\frac{\text{mmol}}{\text{m}^2} - \frac{\text{mmol}}{\text{m}^2} \right) k_a \times \frac{\text{mmol}}{\text{m}^2}$$

$$k_d = \frac{\text{mmol}}{\text{m}^2} \times k_a$$

$$\frac{\text{g}}{\text{s} \cdot \text{cm}^2} = \quad \times \frac{\text{m}^3}{\text{mmol}}$$

Flow of a cross-linking polymer in porous media.

Nikita Lenchenkov

What is water cut?

PEI - Poly Ethyle Imine ?

- Electrostatic intermolecular interactions
- Bulk test

Permeability Boise core $2148.59 \times 10^{-15} \text{ m}^2$

$\left(\frac{U_w}{\phi} \times c \right)$ instead of $(U_w \times c)$ for finding adsorption test

Meeting with Hans

Literature

$$n_L = \frac{\pi \text{ bubbles}}{L}$$

$$\mu = \frac{R^2 \Delta P}{8 \eta L} (\text{no lamellae}) n_L$$

$$\mu = \frac{R^2 \Delta P}{8 \eta \underset{\substack{\uparrow \\ \text{length of capillary}}}{L}} \times \text{no. of bubbles}$$

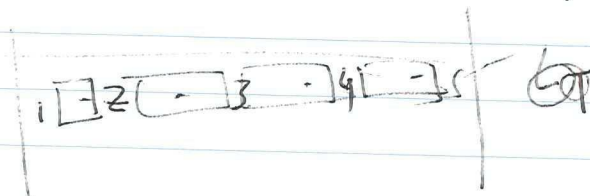
$$\mu = \frac{R^2 \Delta P}{8 \eta} \cdot n_L$$

$$\mu = \frac{n_L R^2 \Delta P}{8 \eta n_{\text{bubble}}}$$

$\mu \propto \text{no of bubbles}$

L_T is put into Poiseuille's law

no of bubbles = no of lamellae + 1



n_L no of lamellae per unit length

App. ② Viscosity from Hirasaki

velocity effect with respect to surface tension gradient

~~the~~ slug - $\frac{1-\Gamma}{n_L R}$

$$K_{rf} = K_{rg} S_{fd}$$

$$S_{fd} = X_f \text{ (or) } S_g = X_f$$

$$K_{rf} = K_{rg} \cdot S_f = K_{rg} \cdot S_g \cdot X_f$$

$$K_{rf} = \underline{K_{rg} X_f (1-S_w)}$$

$$\eta_f = \frac{K_{rg}^1 \left(\frac{\Delta P}{\Delta x} \right)}{\alpha \cdot U_f} \left(\frac{U_f}{\phi} \right)^{1/3} X_f^1 S_g^1$$

$$\eta = \frac{m^2 \cdot \frac{N}{m^2} m}{m} (m)^{1/3}$$

η_f is ^{no of bubbles} per unit Volume of flowing gas

μ no of lamellae = no of bubbles + 1

$$2\eta = 3\eta_f \quad 2n = \frac{3}{2}\eta_f$$

$$\eta_f = \frac{2}{3} \times n$$

$$\frac{2}{3} \frac{\text{no of bubbles}}{\text{Volume of flowing gas}} \Rightarrow \frac{\text{no of bubbles}}{\text{length of the capillary}}$$

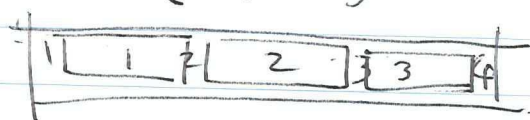
$$\mu_{app}^{2rad} = (\mu n_L R) \left(\frac{3\mu U}{6} \right)^{-\frac{1}{3}} \sqrt{N_s} \frac{(1 - e^{-N_L})}{(1 + e^{-N_L})}$$

$$= \mu \times (n+1) R \left(\frac{3\mu U}{6} \right)^{-\frac{1}{3}}$$

$$= \sqrt{N_s} \frac{\mu n R \left(\frac{3\mu}{6} \right)^{-\frac{1}{3}}}{U^{\frac{1}{3}}} \cdot 6^{\frac{1}{3}} + \mu R \left(\frac{3\mu U}{6} \right)^{-\frac{1}{3}} \sqrt{N_s}$$

$$= \boxed{\frac{\sqrt{N_s} (1 - e^{-N_L}) \mu R 6^{\frac{1}{3}}}{(1 + e^{-N_L}) (3\mu)^{\frac{1}{3}}} \frac{\eta}{U^{\frac{1}{3}}}}$$

$$= 0.7 \mu^{2/3} R 6^{1/3} \frac{\eta}{U^{1/3}} \frac{\sqrt{N_s} (1 - e^{-N_L})}{(1 + e^{-N_L})}$$



① ~~loss~~

Surface tension gradient effect is 10 times more than shape effect.
For given velocity of gas

~~n_L x no of~~

$$\frac{2}{3} \frac{\text{no of bubbles}}{\text{Volume of flowing gas } m^3} \frac{\text{no of bubbles}}{\text{length of the capillary } m}$$

$$\frac{4.32 \times 10^8}{3.17 \times 10^7} = 0.1362$$

$$\frac{4.32 \times 10^8}{3.17 \times 10^7}$$

$$\frac{4.32 \times 10^8}{3.17 \times 10^7} = 136.25$$

$$X_F = \left(\frac{n}{n_{init}} \right)^{-0.4}$$

$$K_{rf} = K_{rg}^0 \cdot X_F \cdot S_g = K_{rg}^0 \cdot X_F (1-S)$$

$$n_{max} = 65442$$

$$n_{min} = 308349$$

Therefore everywhere $K_{rg}(s)$ is; it should be $K_{rf}(s, n)$?

$$s_{wn} = -0.045904 \ln(x) + 1.1549$$

or Put $X_F = 0.15$

or multiply in the equation wherever K_{rg} is $X_F(n)$

$$K_{org} K_{rf} = \frac{W_e}{2} (1-S_e) \left(1 - S_e^{\frac{2}{1+S_e}} \right)$$

Good result except no fit; X_F develops nicely etc.

Multiplying a factor 100 in $\frac{\log \alpha n}{\left(\frac{U_F}{\phi S_F} \right)^{1/3}}$

$$U_F = \frac{K_{Krf} \left(\frac{\Delta P}{\Delta x} \right)}{\mu_F}$$

$$\left(\frac{\Delta P}{\Delta x} \right) = \frac{\mu_F \cdot U_F}{K_{Krf}}$$

$$\mu_F = \frac{\alpha n}{\left(\frac{U_F}{\phi S_F} \right)^{1/3}}$$

$$U_F = \frac{K_{Krf} \left(\frac{\Delta P}{\Delta x} \right)}{\frac{\alpha n}{\left(\frac{U_F}{\phi S_F} \right)^{1/3}}}$$

$$n = \frac{K_{Krf} \left(\frac{\Delta P}{\Delta x} \right)}{\alpha} \cdot \left(\frac{U_F}{\phi S_F} \right)^{1/3}$$

The starting value of α should be different than the one which we put in comsol finally.

12th March 2015 Thursday

Trying $x_F = (n)^{-0.4}$

Just going to play until I get the fit
 x_F ,

have to change α in n calculation so as ~~fit~~ get lower saturat

Running again with high diffusion

S_{wn} has to change, no other way around

$$S_{wn} = -0.045 \log(x) + 0.8$$

0.7

whole ~~set~~ S_{wn} concept has to be cleaned in visual basic

Going back to the values of fitting

$$\frac{U_p}{U_t} = \frac{U_p}{U_w + U_p} = \frac{\frac{Krg(n) \cdot x_F(n)}{\mu_{uf}(n)}}{\frac{Krg(n)}{\mu_{uw}(n)}} = \frac{Krg(n) \cdot x_F(n)}{\mu_{uf}(n)}$$

$$= \frac{\frac{K_{nw}}{S_{nw}} + \frac{Krg(n) \cdot x_F(n)}{\mu_{uf}(n)}}{1}$$

~~Change~~

change n_{init} , n_{max} , a range n_{ini} to n_{max} in
 μ_{uf} , μ_{uf} , S_{wn} , x_F ,

change diffusion parameters.

Change values of K_{FR} , $an(n)$ fitting parameters &

Change S_{wn} function

$$S_{wn} = -0.0506 \log(x) + 0.8$$

$$U_{tr} = U_{tr} = 5.76 \times 10^{-5} \quad - \text{transient.}$$

$$U_{tr} = 6.7 \times 10^{-5} \quad - \text{Constant.}$$

multiplying K_{FR} again in μ_{uf} ?

$$= -0.0316 \ln(n) + 0.75 \quad ?$$

$$K_{FF} = 100 \quad \text{w Diffusion} = 2 \times 10^{-5} \text{ m}^2/\text{s}$$

X_F needs to be changed or something needs to be done.

$$X_F = \left(\frac{n}{n_{\text{init}}} \right)^{-0.4}$$

lower diffusion 2×10^{-7}
 & B diffusion 2×10^{-7}

$$\lambda = 0.51$$

Initial saturation may be lower

$$S_{wn} = -0.0616 \ln(n) + 0.85$$

$$S_{bn} = -0.096 \ln(n) + 0.99$$

we can increase initial liquid saturation a bit
 from 0.85 to 0.87

$$S_{wn} = -0.0666 \ln(n) + 0.87$$

Both diffusion 2×10^{-6}

$$\lambda = 0.51$$

Best result $S_{wn} = -0.0616 \ln(n) + 0.87$
 $\lambda = 0.51$ Diffusions = 2×10^{-5} } 8 pm
 peak at 2000 seconds Bubble diffusion = 2×10^{-6} }
 second best $S_{wn} = -0.0616 \ln(n) + 0.805$ } 2 pm
 $\lambda = 0.5$ both Diffusions = 2×10^{-5} }
 (peak closer to 4000 seconds)

$$S_{wn} = -0.0616 \ln(n) + 0.88$$

$$\lambda = 0.5 \quad \text{both diffusions } 2 \times 10^{-5}$$

$$S_{wn} = -0.0616 \ln(n) + 0.86$$

$$\lambda = 0.49 \quad 2 \times 10^{-5} \quad 2 \times 10^{-5}$$

$$S_{wn} = -0.0666 \ln(n) + 0.87$$

$$\lambda = 0.49 \quad 2 \times 10^{-5} \quad 2 \times 10^{-6}$$

$\lambda = 5$ in

Bentham

Singh

Chapter 5

13th March 2015 Friday

Next attempt

$$S_{wh} = -0.0616 \ln(n) + 0.853$$

$$\lambda = 0.5 \quad \text{Both diffusions } 2 \times 10^{-5}$$

X

Is it $S_{wh} = -0.0616 \ln(n) + 0.85$

$$\lambda = 0.5 \quad \text{Diffusion } 2 \times 10^{-5}, 2 \times 10^{-6}$$

Hans
results

not good $\left. \begin{aligned} S_{wh} &= -0.0616 \ln(n) + 0.853 \\ \lambda &= 0.5 \quad \text{or } 2 \times 10^{-5} \quad 2 \times 10^{-6} \end{aligned} \right\} \begin{aligned} &\text{D drive} \\ &\text{or} \end{aligned}$

$\left. \begin{aligned} S_{wh} &= -0.0616 \ln(n) + 0.855 \\ \lambda &= 0.5 \quad 2 \times 10^{-5} \quad 2 \times 10^{-6} \end{aligned} \right\} \begin{aligned} &\text{Pen drive} \\ &\text{or result} \end{aligned}$

$$S_{wh} = -0.0616 \ln(n) + 0.80$$

$$\lambda = 0.5 \quad 2 \times 10^{-5} \quad 2 \times 10^{-5}$$

It is difficult to believe that there is a gas at (whether gas or foam) at the outlet after 100 sec.

Hans
results_1

$$S_{wh} = -0.0616 \ln(n) + 0.845$$

- Pen drive

fm

Hans

results_2

$$S_{wh} = -0.0616 \ln(n) + 0.855 - \text{D drive}$$

better

Hopeful

(3000 sec)

(Hans_results is saved in both drives)

1 0.85 , both diffusion 2×10^{-6} $\lambda = 0.5$

2 0.855 2×10^{-5} , 2×10^{-6} $\lambda = 0.4$

1 0.852 2×10^{-5} 2×10^{-6} $\lambda = 0.49$

2 0.851 2×10^{-5} , 2×10^{-6} $\lambda = 0.5$

⊙

2 Pexit 3.18 Pa $\lambda = 0.5$ $S_{wh} = 0.851$

1 $\lambda = 0.5$ $S_{wh} = 0.85$ Pexit 4.18 Pa (check diffusion 1)

Yes it was 2×10^{-6} for dealer

1 $\lambda = 0.5$ $S_{wh} = 0.85$ Pexit 4.18 Pa 2×10^{-5} 2×10^{-6}

2 Pexit 3.18 $\lambda = 0.5$ $S_{wh} = 0.851$ 2×10^{-5} , 2×10^{-6}

initial guess result 4

$$\textcircled{1} \quad P_{exit} = 4.18 \quad S_{wh} = -0.0616 + 0.855 \quad \lambda = 0.5$$

$$D_s = 2 \times 10^{-5} \quad D_B = 2 \times 10^{-5}$$

$$\textcircled{2} \quad P_{exit} = 4.18 \quad S_{wh} = -0.0616 + 0.875 \quad \lambda = 0.5$$

$$D_s = 2 \times 10^{-5} \quad D_B = 2 \times 10^{-6}$$

$$\textcircled{3} \quad P_{exit} = 4.18 \quad S_{wh} = -0.616 + 0.85 \quad \lambda = 0.5$$

$$D_s = 2 \times 10^{-5} \quad D_B = 2 \times 10^{-5} \quad \times$$

$$\textcircled{4} \quad P_{exit} = 4.18 \quad S_{wh} = -0.0316 + 0.75$$

$$D_s = 2 \times 10^{-5} \quad D_B = 2 \times 10^{-6} \quad \lambda = 0.5 \quad \checkmark$$

$$\textcircled{2} \quad P_{exit} = 4.18 \quad S_{wh} = 0.87$$

$$D_s = 2 \times 10^{-5} \quad D_B = 2 \times 10^{-5}$$

$$\textcircled{3} \quad \lambda = 0.45 \quad S_{wh} = 0.87$$

$$\textcircled{5} \quad -0.0216 + 0.75 \quad -$$

$$\textcircled{6} \quad -0.0316 + 0.80 \quad -$$

\times

$$\textcircled{7} \quad -0.0316 + 0.7 \quad D_s = 2 \times 10^{-6} \quad \times$$

Optimisation program for Hans result 4

for $S_{wh}, \lambda, D_s, D_B$

① Reading of Reviewer's comment

pp $\partial_k S$

or

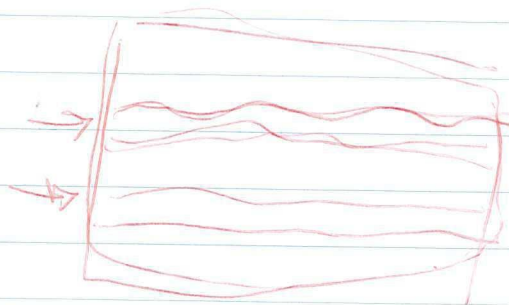
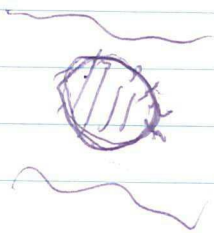
$$\partial_k(pqs) + \partial_k up$$

$$\frac{1}{s} \frac{kg}{m_l} \frac{m_p^3}{m_{pm}^3} \frac{m_e^3}{m_p^3}$$

$$u = \frac{m_e^3}{m_{pm}^3} / s$$

$$p = \frac{kg}{m_l^3}$$

$$\partial_k \frac{1}{m_{pm}}$$



$$\frac{m^2}{m^3}$$

Case without multiplying any factor like 10.

Has result without any factor multiplication

You cannot change λ just like ^{that} as it was also used in the calculation of

$$-0.0216 \log(x) + 0.86 \quad \text{Good result}$$

$$-0.044 \log(x) + 0.99 \quad \frac{u_g}{u_{tot}} \text{ varies from } 0.34 \text{ to } 0.10$$

with change at 4010 sec from 0.11 to 0.10
at 6800 sec from 0.10 to 0.11

with factor 10

Previously we used sum of objectives if we get for $\lambda = 0.52667$ diff 2×10^{-6} diff 3.6×10^{-6} should give $3.162 e 6$

Something like that

Objective

Checking for both $-0.0216 + 0.86$ &
 $-0.044 + 0.99$

Best result

Better ~~and~~ interpretation
 Interpretation

for $-0.044 + 0.99$

2×10^{-5} 10^{-6}
 10^{-7} 10^{-6}
 10^{-5} 10^{-5}
 10^{-7} 10^{-5}

objectives
 $3.63 e6$ ✗
 $3.60 e6$ ✗
 $3.60 e6$ ✗
 $-1.49 e7$

14th March 1

for $-0.021 + 0.86$

~~2×10^{-5} 2×10^{-6}
 5×10^{-5} 2×10^{-6}
 2×10^{-5} 6×10^{-6}
 2×10^{-7} 5.32×10^{-6}
 2×10^{-5} 4×10^{-6}
 3.5×10^{-5} 4×10^{-6}~~

objective

~~$6.26 e5$
 $8.15 e5$
 $4.65 e5$
 $3.13 e6$
 $5.36 e5$
 $7.28 e5$~~

value you get at
 after subtrahing
 (pb2 pb3)
 0.09

14th March

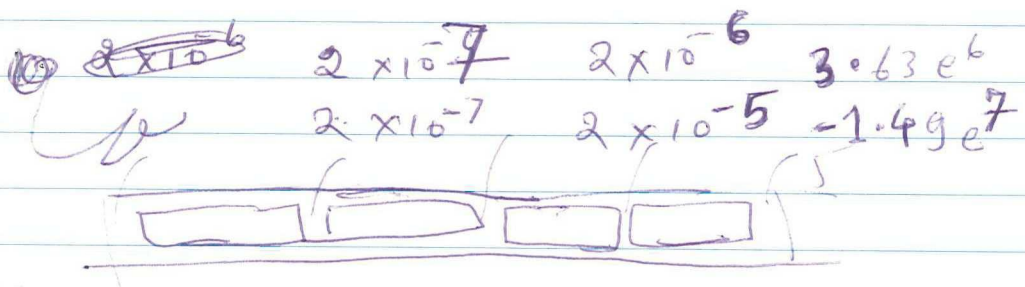
14th March 1 $-0.021 \ln(x) + 0.86$

14th March 2 $-0.044 \ln(x) + 0.99$

2×10^{-7} 2×10^{-5} Very high

2×10^{-7} $6e-6$ Bentheimer-14 March 2 - without any factor 2

2×10^{-7} $9e-6$ Bentheimer-14 March 2 - without any factor.
 Better result



1000
 1000x1

$$\frac{5}{4} = \frac{n_L}{n_B} \quad n_B = \bar{n}_L$$

① Bentheimer-14 March 2 - without any factor - big optimisation

using parameters of objective - result $3.30e6$

② Bentheimer-14 March 1 - Best result

	2e-6 2.5e-6	$-0.021 \ln(x) + 0.86$
①	$2e-6$; $7.5e-6$	Best result 4.5e-6 2.2×10^6
②	$9e-6$; $7.5e-6$	7×10^5
③	$5e-6$; $7.5e-6$	1.5×10^6
④	$3e-6$; $7.5e-6$	1.8×10^6
⑤	$2e-6$; $9e-6$	2.0×10^6
⑥	$2e-6$; $1e-7$	4.6×10^5
⑦	$1e-6$; $9e-6$	Best result
⑧	$2e-6$; $1e-7$	4.5×10^5

~~1e-6~~ $1e-6$ $9e-6$ $-0.021 \ln(x) + 0.85$ ~~$-0.021 \ln(x) + 0.84$~~ Peak $5 \times 10^6 - 3980e6$
~~3300e6~~

~~1e-6~~ $1e-7$ 0.85
 ~~$9e-7$~~ $9e-6$ 0.845

$1e-6$ $9e-6$ 0.845
 $9e-7$ $9e-6$ 0.845
 $1e-6$ $1e-7$ 0.845

trial 2 - Best result
 14th March 2 went further
 15th March 1 & higher
 went lower

$$\frac{\text{no of lamellae}}{\text{no of bubbles}} = \frac{2}{3}$$

$$\frac{\alpha n_L}{U_g^{1/3}} = \frac{n_B}{n_L}$$

$$\alpha n_L = \alpha n_B$$

$$\frac{\alpha n_L}{n_B} = \alpha$$

$$\frac{n_f}{n_b} = n_{init} n_{inj}$$

$$X_F = \left(\frac{n}{n_{inj}} \right)^{-0.4}$$

$$n_{inj} = \frac{232}{150} \quad n_{init} = 232$$

$$1e-6 \rightarrow 9e-7$$

$$X_{sw} = -0.045 \ln(n) + 0.99$$

$$\frac{\frac{n_f}{g}}{\frac{m^2 \times \cancel{mmol}}{g}} \quad \frac{mmol}{m^2}$$

n_{inj} should be closer to n_{ini} to ~~make sense~~ get closer result.

Bentheimer_16th March_nL is n_b_{trial}

$$n_{inj} = n_{init} = 232$$

Bentheimer_16th March_nL is $n_b_{trial} 2$ X
 $n_{inj} = 200$

Bentheimer_16th March_nL is n_b
 $n_{inj} = 150$

lowering water ~~saturation~~ ^{dibbusion} increases pressure drop & shifts the curve further towards right
 lowering bubble dibbusion decrease pressure drop & shifts the curve towards left.

◀ Bubble dibbusion needs to be slightly higher! ▶

i. lowering water dibbusion

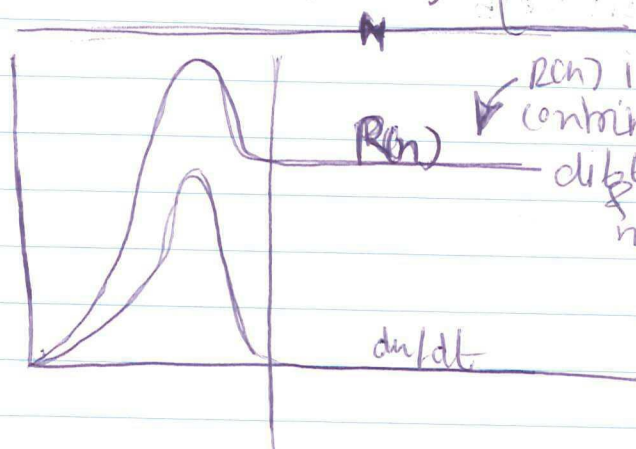
Gradual rise in the concentration

$$n_{inj} = 150 \quad n_{ini} = 230 \quad \text{Varying } \alpha$$

maximum & minimum values of n ; and that would show discrepancy.

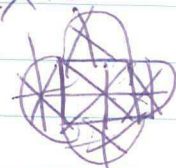
$$(n > 232) \times \{ \quad \}$$

$$(n > 232) \times (\quad) \times (n < 40000)$$



$$4.78 \times 10^{-7}$$

$$4.39 \times 10^{-7}$$



$$R(n)$$

$$\text{and } (n) \neq \frac{dn}{dt}$$

Because $R(n)$

in case of ~~Penetration~~ Penetration

Contribution of terms over whole domain

$$\frac{u_2}{u_{tot}} \frac{S_r}{S_g + S_w} \frac{S_g}{1} = 0.9$$

Unconsolidated sandpack

$$n_{min} \ 139 \quad n_{max} \ 9000$$

$$\mu_{uf} = \mu_{ug} + \frac{\alpha n}{\left(\frac{u_f}{\phi S_g}\right)^{1/3}}$$

$$\frac{u_g}{b_{tot}} = \frac{\frac{k_{og}(s) \times X_{f-m}}{\mu_{f-m}}}{\frac{k_{og}(sw) \times f_m}{\mu_{f-m}} + \frac{k_{rw}(s)}{\mu_{rw}}}$$

Somehow it is difficult to get $\eta = 0.33$ all the time.

$$\begin{aligned} & -0.044 \ln(x) + 0.99 \\ & -0.044 \ln(x) + 0.86 \end{aligned}$$

18 March 2015

Unconsolidated sandpack - OK result but still pressure drop needs to be higher

Trying

Water diffusion $2 \times 10^{-7} \text{ m}^2/\text{s}$ (Li 2007)

Bubble diffusion $2 \times 10^{-8} \text{ m}^2/\text{s}$ (Nguyen 2009)

Ensemble based optimisation under Geological Uncertainty

Rehul-Mark Fonseca

Optimisation problem
Enopt.

Gradient Formulations

Research objectives \rightarrow finding the \rightarrow

Beta distribution - ratio

Traditional

- no of points you achieve hypothesis

Rosenbrock Function

The Angle test

Pop Perturbation size \uparrow

Ensemble size \uparrow 3

lower the angle : worse match

Sample

Rosebrook with uncertainty: \rightarrow

The egg model $40 \times 8 = 320$ controls

mean angle less than 10; Finite difference

Determinist case: $\{$ Robust case $\} \gg$ steeper & flatter region

Recommendation $\frac{\text{steeper}}{\text{flatter}} = 1$

$$\text{Exit} + v_{tot} \frac{\mu_f(n)}{K} \times \Delta l = \Delta P$$

$$v_{tot} = P \quad v_{tot} = u_f + u_w$$

$$u_{tot} = \frac{K_f \Delta P}{\mu_f L} + \frac{K_w \Delta P}{\mu_w L}$$

$$u_{tot} = - \frac{K \Delta P}{L} \left(\frac{1}{\mu_f} + \frac{1}{\mu_w} \right)$$

Initial condition $u_{tot} \left(\frac{\mu_f \mu_w}{\mu_f + \mu_w} \right) \frac{1}{K} \frac{L}{P}$

Considering K same for both gas & water

Actually $\frac{\mu_f \mu_w}{\mu_f + \mu_w} = 0.0006895$

$\mu_f = 0.00221$
One order small to multiply u_{tot}

$$\frac{8.5 \times 10^{-3} \times 5 \times 10^{-3}}{5 \times 10^{-3} + 8.5 \times 10^{-3}} = 0.031$$

Instead of

$$= \frac{139 \times 475 \times 10^{-7}}{\left(\frac{1.01 \times 10^{-5}}{0.38} \right)^{1/3}} = \frac{6.6 \times 10^{-5}}{0.031} = 0.031$$

$$= 2 \times 10^{-3}$$

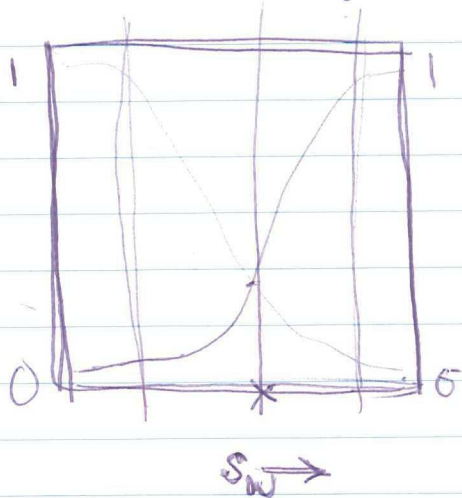
Not much difference between taking single phase
At the start or double phase?

or may be we are wrong?

$$U_{tot} = U_f + U_w$$

$$= \frac{KK_{rf}}{\mu_f} \frac{\Delta P}{L} + \frac{KK_{rw}}{\mu_w} \frac{\Delta P}{L}$$

$$= \left(\frac{KK_{rf}}{\mu_f} + \frac{KK_{rw}}{\mu_w} \right) \frac{\Delta P}{L} \quad \text{without capillary pressure}$$



If ~~if~~ $K_{rf} = 1$

$K_{rw} \approx 0$

then what Hans

has written is right

or

If $K_{rw} = 1$

$K_{rf} \approx 0$

$$U_{tot} = U_f + U_w$$

$$\frac{U_f}{U_{tot}} = 0.33$$

$$\frac{U_f}{0.33} = U_f + U_w$$

$$\frac{KK_{rf}}{\mu_f} \frac{(\Delta P)}{L} = \frac{KK_{rf}}{\mu_f} \frac{(\Delta P)}{L}$$

$$U_f + U_w = 4 \left(1 - \frac{1}{0.33} \right)$$

$$\frac{\Delta P}{L} \frac{KK_{rw}}{\mu_w} = \frac{KK_{rf}}{\mu_f} \frac{\Delta P}{L} + \frac{0.67}{0.33}$$

$$\frac{\Delta P}{L} \frac{KK_{rw}}{\mu_w} = + \frac{KK_{rf}}{\mu_f} \frac{\Delta P}{L}$$

$$U_{tot} = \frac{KK_{rf}}{\mu_f} + 0.2 \frac{KK_{rf}}{\mu_f} = \frac{KK_{rf}}{\mu_f} \frac{\Delta P}{L}$$

It is OK to use $U_{tot} = \frac{K_f \Delta P}{\mu_f L}$

19th March 2015 Thursday

Sandpack case \Rightarrow Initial value drops below -10000;
 Checked ~~everything~~ equations, parameters etc.
 Not sure where the problem lies. Going to check
 file where the result is OK.

α in the old file was 0.01; now it is $4.75e-7$

$$x_n \text{ in previous case} = 102.3 \times 10^3 \times 3.77 \times 10^{-9} = 384 \times 10^{-6}$$

$$x_n \text{ now} = 4.75 \times 10^{-7} \times 139 = 660.25 \times 10^{-7}$$

One order less

$$dib^n = 2 \times 10^{-7} \text{ Both cases previously.}$$

However previously we did not consider $Xf(n)$ in
 $Krg(s)$ but in μ_{uf}

$$\leftarrow -0.047 \ln(x) + 0.9224 \text{ previously}$$

Currently $-0.047 \ln(x) + 0.67$ as lower
 initial saturation does give better fit

$$-0.0216 \log(x) + 0.66$$

$$P_{exit} = 1.2e5 + \frac{4.75 \times 10^{-5} \times 0.0021 \times 0.15}{8.168 \times 10^{-9}}$$

$$\mu_{uf} = \mu_{ug} + \frac{x_n}{\left(\frac{U_F}{P_{hi}}\right)^{1/3}}$$

$$= 8.5 \times 10^{-5} + \frac{4.75 \times 10^{-5} \times 139}{\left(\frac{1.01e-5}{0.38}\right)^{1/3}}$$

37100

20th March Friday

PPb10 goes banana

$$gwm = -0.044 \ln(139) + 0.95$$

$$S_{w1} = 0.95 + (-0.044 \ln(139) + 0.95 - 0.95) * \delta m_1(t)$$

$$PPb10 \quad n \quad \psi(s_g, t)$$

$$\frac{\partial s_g}{\partial t}$$

The pressure in case of sandpack is simply not developing.

$$\begin{aligned} dif &= v_w * x * \text{len} \\ difn &= v_f(1-x) * \text{len} * x * f(n) \end{aligned}$$

$$\frac{KK_{sf} \left(\frac{\Delta P}{\mu} \right)}{\theta \mu_{sf} \left(\frac{\Delta P}{\mu} \right)}$$

taken ~~diff~~ Surfactant concentration diffusion same as water diffusion

$\mu_{sf}(n)$ goes down instead of going up for sandpack

$$\mu_{sf} = \mu_{sg} + \frac{\alpha n}{\left(\frac{v_f}{\phi} \right)^{1/3}}$$

Putting ~~the~~ Diffusion equation -ve

The diffusion function in the bubble density must be the one which has something to do with all this

21st March Saturday
 $4 S_g D(n) n_x - \text{dif}(S) \cdot n_x S_x \text{ best}(n_x)$

$$\partial_x (4 S_g \cdot D_n \partial_x n) + \partial_x (D_{cap} n \partial_x S_g)$$

$$\begin{aligned} & \partial_x (D_{cap} \cdot \partial_x S_w) \\ &= \partial_x D_{cap} \cdot \partial_x S_w + \boxed{D_{cap} \partial_x (\partial_x S_w)} \\ & \partial_x \boxed{\text{difn}(S, n)} \end{aligned}$$

$$\partial_x D_{cap}$$

$$\partial_x S_w \partial_x D_{cap} + \partial_x S_g \partial_x D_b$$

$$D_{cap} (\partial_x^2 S_f + \partial_x^2 S_w)$$

$$D_{cap}(S_w)$$

No point in changing things now! Diffusion keeping constant

double differentiation of diffusion needs to be avoided.

Nice smooth running with $n_{inj} = 150$ but no development of pressure; therefore $n_{inj} = 232$; & saturation

$$-0.015 \ln(x) + 0.86$$

TUD 414282 \ localadmin
 Welkom!

$$\frac{-k_{rg} \times k_{rw}}{\mu}$$

$$d \frac{k_{rg}}{K} \left(\frac{k_{rf}}{\mu_f} \times \frac{k_{rw}}{\mu_w} \right)$$

K K

22nd March 2015 Sunday

Capillary diffusion: multiphase

$$\left(\frac{\lambda_2}{\lambda_1} + \lambda \right) k = \text{derivative capillary}$$

$$K_{vf} \neq X_f K_{rg}$$

This changes everything

Removing where there is this case & putting it
as $S_f = X_f - S_g$ therefore wherever
 S_g is there put $X_f - S_g$ for the calculation

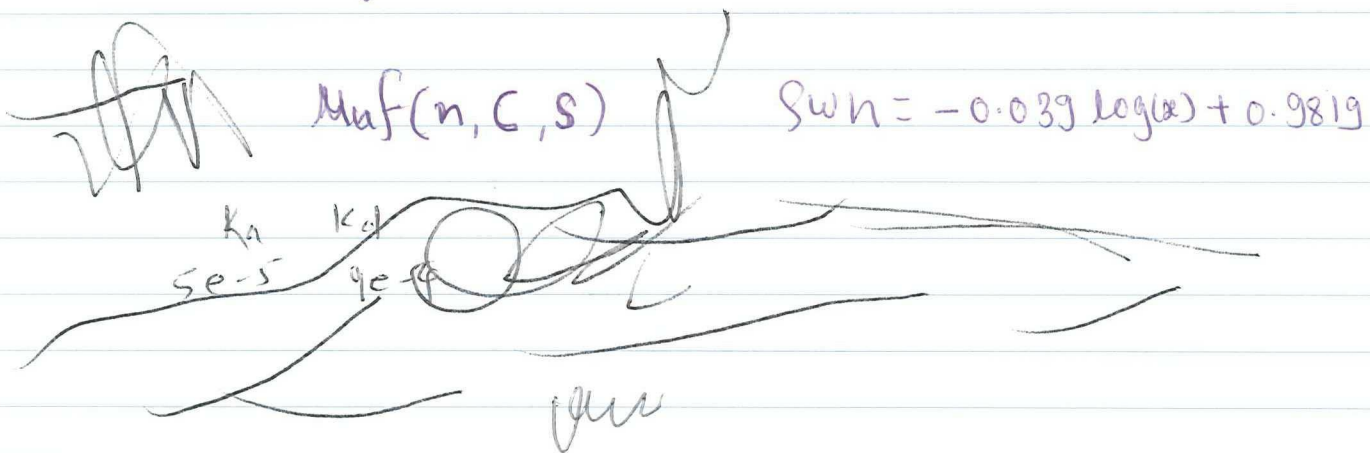
$10^{-5} \frac{\text{cm}^2}{\text{s}}$ for normal liquids

$$1 \text{ cm} = 1 \times 10^{-2} \text{ m} \quad 1 \text{ m}^2 = 1 \times 10^4 \text{ m}^2$$

$$10^{-9} \frac{\text{m}^2}{\text{s}}$$

(1) Making diffusion constant term

(2) Removing X_f from K_{rg} equation & putting
in S_g .



X

23rd March 2015 Monday

X_F should not be there in right side of the equation i.e.

(p.s. $R(n)$)
What ^{about} pressure equation

Because we say $\phi S_f \frac{dn}{dt} = \phi S_f \cdot R(n)$
claiming $R(n) = \frac{dn}{dt}$

let us not take diffusion into account in pressure equation to make our life bit easier.

~~X_F~~ $X_F(n)$ is not there in right hand side of the equations. Remember

$$\frac{v_F}{\phi \cdot X_F(n) \cdot (1-s)}$$

(1-s)

$$\left(\frac{v_F}{(\phi \cdot X_F(x) \cdot (1-s))} \right)^{1/3}$$

$$0.38 \times 1 \times (1 - 0.83)$$

When error is ~~multiplied~~ divided by zero; simply multiply with that part & ~~not~~ raise it to -1.

(whether to multiply $X_F(n)$ in diffusion term or not)

Checking with sandpack what happens if you include ~~diffusion~~ $X_F(n)$ in diffusion of bubbles

(Finally late development of pressure in case of Berthelmer however without multiplying $X_F(n)$ in diffusion terms.)

This is good result; where ~~partly~~ some time $R(n) \approx \frac{dn}{dt}$

7000/18:00 depth 1.28

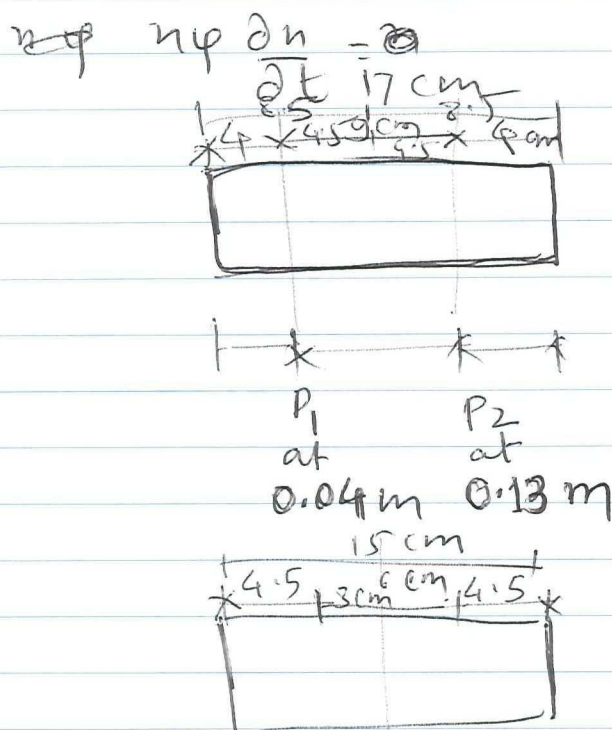
The curve is nice; therefore need to tackie again ~~with~~^{the} diffusion part.

16:00

Remember Bentheimer : without $\chi f(n)$ in diffusion part
Sandpack : with $\chi f(n)$ in diffusion part

Removing $\chi f(n)$ from diffusion for Sandpack case.

The Bentheimer profile is getting ^{better} with every iteration.



11-5
15-9
14-8
13-7
12-6
10-4

(unconsolidated
sandpack
averaging of the terms)

up $\frac{ds}{dt}$

for Bentheimer Best Combination so far
dib 2×10^{-6} difn 2×10^{-5} Rest of the terms as it is

Unconsolidated sandpack check: something is wrong there!

<Probe plot not developing: some problem>

PPb6 develops nicely
PPb8 goes negative nicely
Rest are not doing much.

$$PPb6 \quad -n \cdot d(\text{Perm} \cdot \frac{k_{rg}(S_g)}{\mu_{uf}(n, S_g)} \cdot (P_x - p(\theta) \cdot g), x)$$

$$-i-l \cdot \Rightarrow -n \cdot d(U_f, x) \quad \text{flow convection of bubbles}$$

PPb8 $d(Fn \cdot d(n_x, x))$
diffusion of bubbles; ~~show~~

shall we keep it very low

Does it mean we have to multiply by $Xf(n)$ in diffusion equation

let us do it then.

$D_{ifn} = 2 \times 10^{-7}$ $\times Xf(n)$ multiplied to diffusion
diff is now 2×10^{-5} should it not be also smaller?

If this works out then we can put $Xf(n)$ in diffusion equation of Bentheimer; it is complicated but at least we will be much closer to the result.

$d(b^n \times Xf(n) \cdot d(n_x, x))$ is enormous as compared to PPb9.

Need to check $d_{ifn} \times d(n_x, x)$ in case of Bentheimer

$$\begin{aligned} & \partial_x (\varphi S_g D_n \partial_x n) + \partial_x (D_{cap} n \partial_x S_g) \\ & \varphi S_g D_n \partial_x^2 n + \cancel{D_n \varphi \partial_x S_g \partial_x n} \quad \text{not zero} \quad \rightarrow 0 \\ & + D_{cap} n \partial_x^2 S_g + \cancel{D_{cap} \partial_x n \cdot \partial_x S_g} \quad \text{not zero} \\ & (D_n \varphi + D_{cap}) \partial_x n \cdot \partial_x S_g \end{aligned}$$

$$- (D_n \psi + D_{ap}) \partial_x n \partial_x s_g \quad \text{SAXF} \quad \text{constant}$$

~~ψD_n~~

$$(\psi (1-s) D_n n_x - D_{ap} n_x s_x) \text{ test } n_x$$

$$\frac{D_n \psi (1-s) n_x \text{ test } n_x}{-} = \frac{D_{ap} n_x s_x \text{ test } n_x}{-}$$

Frustrating; therefore just cut the whole diffusion term from unconsolidated sandpuck case.

« Bubble diffusion needs to be very small. »

Tomorrow putting bubble diffusion low in the Bentheimer to see the effect.

$$X_F (D_n \psi + D_{ap}) \partial_x n \partial_x s_g$$

$$\psi \partial_t (s_g n) + \partial_x (n v_g) = \psi s_g R(n)$$

$$\psi \partial_t (X_F(n) s_g n) + \text{---} = \psi X_F(n) s_g R(n)$$

$$\psi \partial_t (s_g \underline{X_F(n)} n) = \psi X_F(n) s_g R(n)$$

$$\underline{\underline{X_F(n) n \psi \partial_t (s_g) + s_g \psi \partial_t (X_F(n) n)}} = \psi X_F(n) s_g R(n)$$

$$\psi \partial_t (s_g n) + \partial_x (n v_g) = \psi s_g R(n)$$

$$\psi \partial_t (X_F(n) s_g n) + \text{---} = \psi s_g R(n)$$

$$\psi \partial_t (\underline{s_g \cdot X_F(n) \cdot n}) + \text{---} = \psi s_g R(n)$$

$$X_F(n) \psi \partial_t s_g + \psi s_g \partial_t (X_F(n) n)$$

$$\overset{SF?}{\downarrow} \partial_x (\psi S_g D_n \partial_x n) + \partial_x (D_{cap} n \partial_x S_g)$$

$$(\psi (1-s) \cdot D_n \cdot n_x - D_{cap} \cdot n \cdot S_x) \text{test } n_x$$

$$\text{---} \left(\frac{n}{n_{inj}} \right)^{-0.4}$$

$$(\psi (1-s) \cdot D_n \cdot n_x - D_{cap} \cdot n \cdot \partial_x f(n) \cdot S_x) \text{test } n_x$$

~~shouldn't~~ shouldn't it be mixed with D_{cap} term than diffusion term.

$$\partial_x (\psi X f(n) \cdot S_g \cdot D_n \partial_x n) + \partial_x (D_{cap} n \partial_x X f(n) S_g)$$

$$\psi \partial_x S_g \cdot D_n \cdot X f(n) \cdot \partial_x n + \partial_x^2 n \left\langle \right\rangle$$

$$+ D_{cap} \cdot n \cdot X f(n)$$

Nice profile however not the magnitude and not the slope

$$\text{ppb12: } n X f(n) \psi d(1-s, t)$$

$$19: \psi (1-s) d(X f(n) n, t) \leftarrow$$

$$22: R(n) \cdot X f(n) \psi (1-s) \leftarrow$$

cutting ~~terms~~ diffusion ^{terms} off. from bubble density equation

$$(\psi (1-s) D_n \cdot n_x - D_{cap} \cdot n \cdot S_x X f(n)) \text{test}(n_x)$$

Next step would be decrease D_{cap} ; may be 2×10^{-7} ?

$$\partial_x (\psi S_g D_n \partial_x n) + D_{cap} \cdot n \partial_x^2 S_g$$

$$+ \psi D_n \cdot \partial_x n \partial_x^2 S_g + D_{cap} \partial_x^2 n \cdot \partial_x S_g$$

currently $\left(\frac{\partial x (4 S_g D_n \partial x n)}{\partial x} + \frac{\partial x (D_{cap} n \partial x S_g)}{\partial x} \right) X_{Fen}$

diff 2×10^{-6} Nicest result so far
 difn 2×10^{-5}

In principle we should have lower value of diffusion

~~cap~~ ~~diff~~ ~~difn~~ dif difn

2×10^{-8} 2×10^{-7} 2×10^{-7}
 2×10^{-8} 2×10^{-7} 2×10^{-6}

The problem is that if you put ~~too many~~ diffusion too low.

$$U_F = - \frac{K K_r F (\Delta P - \rho g)}{\mu_{uf}}$$

$$\mu_{uf} = \mu_{ug} + \frac{\alpha n}{\left(\frac{U_F}{\phi S_F X_F} \right)^{1/3}}$$

$$U_F = - \frac{K K_r F (\Delta P - \rho g)}{\alpha n} \left(\frac{U_F}{\phi S_F X_F} \right)^{1/3}$$

dif 2×10^{-6}
 difn 2×10^{-6}

This is taking long; I did not lead higher result.

dif 2×10^{-6} next ~~diff~~ dif 2×10^{-6} dif 1×10^{-6}
 difn 2×10^{-5} dif 2×10^{-4} or difn 2×10^{-5}

- ✓ ① multiplication ~~at all~~ with ~~both cases~~ diffusion
- ✓ ② Next time removing X_{Fen} & the try
- ✓ ③ removing from bubble diffusion only
- ✓ ④ removing from Capillary diffusion part
- ⑤ At the end dif 2×10^{-6} difn 2×10^{-5} or best result optimisation in the night

25th March 2015, Wednesday

Highest ~~diff~~ Capillary 2×10^{-6} Bubble 2×10^{-5}
 1×10^{-6} 1×10^{-5}
 0.5×10^{-6} ~~0.5×10^{-5}~~
 0.5×10^{-5}

You If you get good result now just save it now.
 Tomorrow morning; if we did not get
 good result; we can save them under
 different name or just scrap it after
 finding noting least difference combination.

Multiply both diffusion gives the best (highest) result
 so far

① multiplication with bubble diffusion only
 2×10^{-6} 2×10^{-5}

② without multiplying X_F at all
 5×10^{-7} 1.75×10^{-5} - 2.6691e6

③ multiplication with both diffusion
 2×10^{-6} 2×10^{-5} - 3.7107e6

④ multiplying with capillary diffusion only
 5×10^{-7} 1.75×10^{-5} - 2.6535e6

⑤ multiplication with both diffusion
 2×10^{-6} 1.5×10^{-6} 2×10^{-6} 1.8×10^{-6}
 2×10^{-5} 2×10^{-5} 1.8×10^{-5} 1.6×10^{-5}
 nearest
 2×10^{-6}
 1.8×10^{-5}

$1e-6$?
 $9e-6$?
 2×10^{-6}
 1.4×10^{-5}

Need to increase q_p ~~sat~~ saturation ?

Effect of p_{ov}

$$X_F = \left(\frac{n}{n_{inj}} \right)^{-0.4}$$

$$\frac{U_w * C}{\phi S}$$

$$\frac{m}{s} \times \frac{mmol}{l}$$

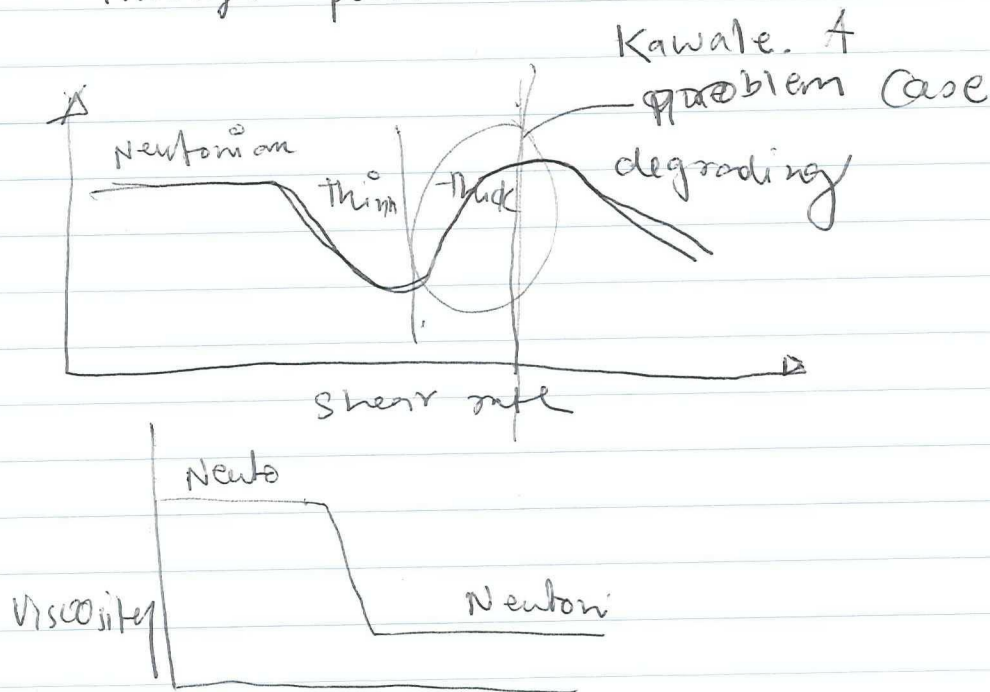
VPN

For now leaving it as
 it is.

K_a K_d
 $5e-5$ $9e-4$

$$U_w \times \frac{C}{C_0} \times C_0 = U_w \times \frac{C}{C_0} \times \frac{n}{s} \times \frac{mmol}{l}$$

Effect of pore shape on polymer rheology through porous media



- ①
- ②
- ③ viscoelasticity - property of polymer

low Reynold's number
Weissenberg's number
Relaxation time / Processing time scale } Deborah number

230 microm size

0.3 ~~Darcy~~ 0.3 ~~Permeability~~ porosity

"A streamline is a curve made of the tangent points to a velocity field everywhere"

Data Acquisition & (DAQ)

Newtonian ~~flow~~ fluid flow through 2D pm

How to implement polymer in comsol: →

~~Trying~~ to see

Trying to see where $\alpha f(n)$ should be multiplied in
 $\alpha f(n)$ to n or to S_g as it is a
 function of n

Do you think $k_{rf} = k_{rg} \cdot x_f \cdot S_g$ as well as

$$\mu_f = \frac{\alpha n}{\left(\frac{U_f}{\phi_{SF}}\right)^{1/3}}$$

$$\frac{k_{rg} \cdot x_f \cdot S_g}{\alpha n} \left(\frac{U_f}{\phi_{SF}}\right)^{1/3}$$

We have to assume ~~k_{rg}~~ ~~k_{rf}~~ the effect of
 foam in ~~k_{rf}~~ ~~αf~~ μ_f only

$$\lambda = 5$$

Brooks Corey relation for Bentheimer

Wide distribution $\lambda < 2$

Homogeneous ~~consolidated~~ consolidated rock $\lambda = 4.17$
 pore size distribution parameter $\lambda = 2.225$

For each case water saturation goes slightly down
 with increasing λ

λ	0.5	2.225	5
		$-0.0495 + 0.9369$	$-0.0495 \ln(x) + 0.9024$

For Bentheimer manuscript $D_n 1 \times 10^{-6}$ $D_{ap} 2 \times 10^{-5}$

Multiplying ~~the~~ ^{with} x_F ~~in~~ Krg again

$$\phi \partial_t (S_F \cdot n_f) + \phi \partial_x (n \cdot v_f) = \phi S_g R(n) + \text{Diffusion terms}$$

constant $S_{g \text{eps}}$

$$\phi \partial_t ((S_F + S_T) n_f) + \partial_x (n \cdot v_f) = \phi S_g R(n) + \text{Diffusion terms}$$

$$S_F \cdot n_f = S_T \cdot n_t$$

$$S_F \cdot n_f = S_T \cdot n_f$$

$$\left(\frac{n}{n_{ini}} \right)^{-\alpha \phi}$$

$$x_T = (1 - x_F)$$

$$S_F = S_g(x_F)$$

$$S_T = S_g(1 - x_F) = S_g - S_g \cdot x_F$$

$$n_{init} \rightarrow S_T \text{ or } S_{g \text{eps}}$$

$$S_F + S_T = S_g$$

$$S_F n_f \neq S_T n_f$$

$$\alpha S_F n_f = (S_g - S_F) n_f$$

$$S_F \cdot n_f = S_g \cdot n_f - S_F \cdot n_f$$

$$2 S_F \cdot n_f = S_g \cdot n_f \quad S_F = \frac{S_g}{2}$$

$$n_f = n_t$$

$$S_F \cdot n_f \neq S_T \cdot n_f$$

$$S_T = S_g - S_F$$

$$S_F n_f + S_T n_t = S_g n \quad S_F \cdot n_f = (S_g - S_F) n_f$$

$$\text{For } n_f = n_t$$

$$S_F + S_T = S_g$$

$$x_F \cdot S_g \cdot n_f = S_g \cdot n_f - S_F \cdot n_f$$

$$x_F \cdot S_g \cdot n_f = S_g - x_F \cdot S_g$$

$$2 x_F \cdot S_g = S_g \quad 0$$

$$\textcircled{1} \quad \psi \partial_t (S_g n_f) + \partial_x (v_g \cdot n_f) = \psi S_g R(n) + \left(\psi S_g \cdot D_n \frac{\partial^2 n}{\partial x^2} + n_f \cdot D_{ap} \left(\frac{\partial S_g}{\partial x} \right)_n \right) \quad \#$$

$$\textcircled{2} \quad \psi \partial_t (S_f \cdot n_f) + \partial_x (v_f \cdot n_f) = \psi S_f \cdot R(n) + \text{XF} \cdot S_g \text{ ? or } S_g \cdot \left(\psi S_g \cdot D_n \frac{\partial^2 n}{\partial x^2} + n_f \cdot D_{ap} \left(\frac{\partial S_g}{\partial x} \right)_n \right)$$

Best result so far

$$\psi \partial_t (S_f \cdot n_f) + \partial_x (v_f \cdot n_f) = \psi S_g \cdot R(n) + \psi S_g \cdot D_n \frac{\partial^2 n}{\partial x^2} + n_f \cdot D_{ap} \frac{\partial n}{\partial x} \frac{\partial S_g}{\partial x}$$

from the probe terms XF should be out

14:46

optimisation of

$$\psi \partial_t S_g n_f + \partial_x (v_f \cdot n_f) = \psi S_g R(n) + \left(\psi S_g \cdot D_n \frac{\partial^2 n}{\partial x^2} + n_f \cdot D_{ap} \left(\frac{\partial S_g}{\partial x} \right)_n \right)$$

checkup of XF in diffusion terms

checkup if XF is multiplying in R(n) as well.
Cannot help it as R(n) turns out to be much much bigger than dn/dt. Perhaps check on ~~scale~~ domain probe.

$$\left(\psi S_g \cdot D_n \frac{\partial^2 n}{\partial x^2} + n_f \cdot D_{ap} \left(\frac{\partial S_g}{\partial x} \right)_n \right) \cdot \frac{S_f R(n)}{S_g R(n)} \Rightarrow \text{XF} \cdot S_g R(n)$$

Does not work with XF(n) * R(n).

Best d(n,t) = R(n) for the case

$$17:21 \quad \psi \partial_t (S_g \cdot n) + \partial_x (v_f \cdot n_f) = \psi S_g R(n) + \text{XF}(n) (\text{Diffusion})$$

Also

$$\psi \partial_t (S_g \cdot n) + \partial_x (v_f \cdot n_f) = \psi S_g R(n) + (\text{Diffusion})$$

17:30 Optimisation running for both cases

Best result is from the one with XF multiplying diffusion terms

$1e-6, 2e-5$ objective $1.94e+6$

$3e-6, 1.175e-5$ objective $3.9939e+6$

Both values have decreased.

C

~~Very small decrease in both cases~~

Capill diffusion increase, bubble diffusion decreased

$1.5e-6$	$2.5e-5$
$1e-6$	$2e-5$
$0.5e-6$	$1.5e-5$

13:20

Bentheimer 26th March without XF in saturation term 1

2×10^{-7} 1.89×10^{-5} objective $-1.7977e6$

Question remains whether to multiply XF or not to multiply XF

Applying Bentheimer model to Sandpack

9.5e-7 1.9e-5 objective 1.53e6

The one with no XF in diffusion gives nice shape but no magnitude. The one with XF is closer but shape is not good. It is thought to put optimisation for u_f & u_w as the velocity really set things going therefore Optimising for velocities; K_a, K_d, A_s & Q_s and God knows what!

K_a $9e-6$, K_d $5e-5$, A_s $2e-6$, Q_s $1.428e-4$

$$S_F \rightarrow S_F^{n_F} + S_T^{n_T} \rightarrow S_F^{n_F} +$$

29th March 2015

Everything is alright in sandpack except pressure is not developing & Saturation is not moving forward.

checking with boundary condition: \rightarrow

15:45 Skype

Meeting with Huns: \rightarrow

$$\phi(S_g n_f) +$$

$$S_g = S_{gf} + S_{et} n_t$$

$$\mu_g$$

$$X_f \cdot S_g = 1$$

~~g~~

19th April

30th March 2015 Monday

Running with X_f without optimisation

Sandpack $\frac{PPb3 - PPb2}{0.06}$; This is what I think; rest I

don't know; where the problem lies

16:00

Putting g -ve; & $\frac{PPb3 - PPb2}{0.06}$

1.9×10^{-5}

I guess it was all the time ~~ppb3-ppb2~~ due to gravity -ve.

Plot 28

PPb10 $n \psi \partial S_g$

PPb11 $\psi S_g \partial_t n$

PPb12 $-n \psi \partial_x u$

PPb13 $-u g \partial_t n$

PPb14 $\psi S_g \partial_x^2 n$

PPb15 $n \psi S_g R(n)$

During transient time

$\frac{dn}{dt}$ $R(n)$ is dominated by $\partial_x S_g$

During Steady state

$R(n)$ is dominated by $\partial_t n$

$$d(n_x, x) \quad d(c_s x, x) \quad \frac{\partial^3}{\partial x^2}$$

$$\phi X_f S_g D_n \frac{d(n_x, x)}{dx} + X_f(n) \cdot n D_{cap} \frac{d(S_g, x)}{d(n_x, x)}$$

dimension of α

$$\alpha = 1.88 \mu_w^{2/3} (R)^{1/3}$$

$$= m \left(\frac{Ns}{m^2} \right)^{2/3} \left(\frac{N}{m} \right)^{1/3} = m_x \frac{N^{2/3} s^{2/3} N^{1/3}}{m^{2 \times 2/3} m^{1/3}}$$

$$\alpha = \frac{N^{2/3 + 1/3} s^{2/3}}{m^{4/3 + 1/3 - 1}} = \frac{N s^{2/3}}{m^{4/3}}$$

$$n = \frac{K(\mu_f)^{1/3}}{v_f^d \alpha} \cdot \frac{\Delta p}{\Delta L}$$

$$n = \frac{m^2 \left(\frac{m}{s} \right)^{1/3}}{\frac{m}{s} \times \frac{N^{1/3} s^{2/3}}{m^{4/3}}} \cdot \frac{N}{m}$$

$$= \frac{m^2 m^{1/3} \times m^{4/3}}{\frac{m}{s} \times s^{1/3} s^{2/3} \times m} \cdot \frac{1}{m}$$

$$1 - \frac{1}{3} = \frac{2}{3}$$

$$= \frac{m^{2 + \frac{1}{3} + \frac{4}{3}}}{m^2} = m^{\frac{2 + \frac{1}{3} + \frac{4}{3} - 2}{1}} = m^{\frac{5}{3}}$$

$$\alpha = R \cdot \mu_w^{2/3} \cdot R^{1/3} = \left(\frac{Ns}{m^2} \right)^{2/3} \left(\frac{N}{m} \right)^{1/3}$$

$$n = \frac{m^2 \left(\frac{m}{s} \right)^{1/3}}{\frac{m}{s} \left(\frac{N^{2/3} s^{2/3}}{m^{2 \times 2/3}} \right) \left(\frac{N}{m} \right)^{1/3}} \cdot \frac{N}{m^2}$$

$$= \frac{m^{2 + \frac{1}{3} - 1 - 1 + \frac{1}{3} + \frac{4}{3} - 1}}{\frac{s^{1/3}}{s} \times s^{2/3} \times N^{2/3} N^{1/3}} \cdot N = m^{\frac{6}{3}} = m^2 = m$$

$$\alpha =$$

$$\mu_{app}^{shape} = 0.85 \left(\frac{\mu_w n_L R}{\left(\frac{r_c}{R} \right)} \right) \left(\frac{3 \mu_w U}{6} \right)^{-\frac{1}{3}} \left(\left(\frac{r_c}{R} \right)^2 + 1 \right)$$

$$= \frac{\frac{NS}{m^2} \times n_L \times m}{\left(\frac{NS}{m^2} \times \frac{m}{s} \right)^{-\frac{1}{3}} \left(\frac{N}{m} \right)} \left(1 + 1 \right)$$

$$= \frac{\frac{NS}{m^2} \times m \times \left(\frac{NS}{m^2} \right)^{-\frac{1}{3}} \times \left(\frac{m}{s} \right)^{-\frac{1}{3}} \times n_L}{\left(\frac{N}{m} \right)^{-\frac{1}{3}}}$$

$$= \left(\frac{NS}{m^2} \right)^{\frac{2}{3}} \times m \times \left(\frac{m}{s} \right)^{-\frac{1}{3}} \times \left(\frac{N}{m} \right)^{\frac{1}{3}} \times n_L$$

$$= \left(\frac{NS}{m^2} \right)^{\frac{2}{3}} \times m^{1 - \frac{1}{3} - \frac{1}{3}} \times N^{\frac{1}{3}} \times n_L \times s^{-\frac{1}{3}}$$

$$= \frac{N^{\frac{2}{3} + \frac{1}{3}} s^{\frac{2}{3} + \frac{1}{3}}}{m^{2 \times \frac{2}{3}}} \times m^{\frac{1}{3}} \times n_L$$

$$\mu_{app} = \frac{NS}{m} \times n_L$$

$$= \frac{NS}{m} \times \frac{1}{m}$$

n_L has to be per m

$$\alpha = \frac{m^2 \left(\frac{m}{s} \right)^{\frac{1}{3}}}{\frac{1}{m} \times \frac{m}{s}} \times \frac{N}{m^2} = \frac{\frac{m^{2+1-2}}{s^{\frac{1}{3}}} \times \frac{N}{m^2}}{s}$$

$$= \frac{Nm}{s^{-2/3}}$$

$$\alpha = Nms^{2/3}$$

$$n = \frac{m^2 \left(\frac{m}{s}\right)^{1/3}}{\frac{m}{s}}$$

$$v_f = \frac{k \mu_f}{\mu_f} \left(\frac{\Delta P}{L} \right) \quad \mu_f = \frac{\alpha n}{(v_f)^{1/3}}$$

$$v_f = \frac{k \mu_f \left(\frac{\Delta P}{L} \right)}{\frac{\alpha n}{(v_f)^{1/3}}}$$

$$\alpha n = \frac{v_f^{1/3} k \mu_f (\Delta P / L)}{v_f}$$

$$n = \frac{m^2 \times \left(\frac{m}{s}\right)^{1/3} \times \frac{N}{m^2}}{\frac{m}{s} \times N m^{-2/3}}$$

$$= m^{2 + \frac{1}{3} - 2 - 1 - 1} s^{\frac{1}{3} - 1 + \frac{2}{3}}$$

$$= m^{-\frac{5}{3}} s$$

$$n \propto \frac{1}{m}$$

$$\alpha =$$

$$\frac{k \left(\frac{v_f}{m}\right)^{1/3} \left(\frac{\Delta P}{L}\right)}{m^2 \left(\frac{m}{s}\right)^{1/3} \frac{N}{m^3}}$$

$$\frac{1}{m} \times \frac{1}{m} \times \frac{m}{s}$$

$$\text{Darcy } \mu_f = \frac{k}{\mu} \frac{\Delta P}{L}$$

$$= \frac{k \mu^2}{\mu s} \times \frac{N}{m^2 \times m}$$

$$= \frac{m^2}{s \cdot m} = \frac{m}{s}$$

$$\alpha = m^{2 - 1 - 3 - 1 + 1}$$

$$s^{\frac{1}{3} - 1}$$

$$= m^{-\frac{1}{3}} s^{2/3}$$

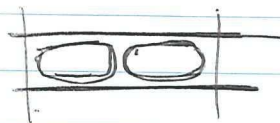
$$= N m^{-\frac{4}{3}} s^{2/3}$$

$$n = \frac{m^2 \times m^{1/3} \times \frac{N}{m^3}}{s^{1/3}}$$

$$\frac{m}{s} \times (N m^{-4/3} s^{2/3})$$

$$= \frac{m^2 \times m^{1/3} \times N \times m^{4/3}}{s^{1/3} \times \frac{m}{s} \times N \times s^{2/3} \times m^3} = m^{2 + \frac{1}{3} + \frac{4}{3} - 1 - 3} = m^{\frac{5}{3} - 2} = m^{\frac{2}{3}}$$

$$\alpha = \frac{m^2 \times m^{1/3} \times N \times s \times m}{s^{1/3} \times m^3 \times m \times \phi} = N m^{2 - \frac{1}{3} + 1 - 3 - 1} s^{\frac{2}{3}} = N m^{-\frac{4}{3}} s^{\frac{2}{3}}$$



All combination gives same result.

dif	difn	objective
2×10^{-5}	2×10^{-5}	} 4.4374e6 & Finally stops at 2×10^{-5} Both.
2×10^{-5}	2×10^{-6}	
2×10^{-6}	2×10^{-5}	
2×10^{-5}	2×10^{-5}	

Trying 1×10^{-5} 1×10^{-6}

hbruining Welkom21

TUD413787

Bentheimer Case

Dif	Difn	Ka	Kd	Qb
9.5e-7	1.9e-5	9.0e-4	5e-5	9.8127E5

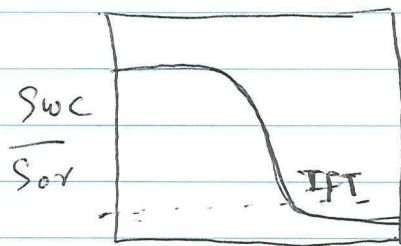
- ① TUD PC - Bentheimer XF_optimisation 4 parameters
- ② Laptop - Sandpack - XF_Optimisation 2 parameters
- ③ Hans PC - Bentheimer XF_indibb_opt 4 parameters
- ④ Hans PC - Sandpack - XF_indibb_opt 2 parameters

1st April 2015 Wednesday

- ① Laptop stopped yesterday therefore no sandpack results.
- ② Office PC come out with no objectives reached; therefore now running optimisation with very narrow band.
- ③ Soon will check with Hans PC. →
Same story therefore working on narrow ~~at~~ diffusion ranges

Experimental Studies on ASP Flooding Elisa Battistutta

Alkali — reduces adsorption
Surfactant — reduces surface tension
Polymer — mobility control



Surfactant-Brine-oil phase behavior : →

High - low - Intermediate

Intermediate stage 3 phases; S_{wc} , S_{or} , mix

- No well defined optimum salinity.

Reducing capillary number is not the only mechanism that can explain oil recovery.

Experimental setup : →

Primary → Oil inhibition → Brine drainage - ASP Flooding
inhibition ————— Polymer Flooding
~~what is inhibition~~ (for waterwet condition)

oil breakthrough
produced oil

better to use
under optimum
condition

0.3-0.5 PV

{ cannot get out
{ Chemical EOR
{ water injection

dif	draft	dif	difn	objective	
9.2×10^{-5}		9.2×10^{-7}	2.1×10^{-5}	$2.5497e5$	closest +ve
		9×10^{-7}	2.2×10^{-5}	$-2.3041e5$	closest -ve
		9.2×10^{-7}	2.3×10^{-5}	-230154	-25130
		9.3×10^{-7}	2.2×10^{-5}	-23829	

Should have used same ~~di~~ ~~eq~~ capillary diffusion & surfactant diffusion

Sandpack 29th March in Hans PC with XF;

① using small variation from 2×10^{-5} 2×10^{-6} to get somewhere closer. Currently stuck in $4.3e6$ objective
Hans PC

② Bentheimer 1st April All three diffusion optimisation
(Not sure if it is a good idea, but tomorrow we have to decide to stop ~~it~~ & choose the best solution.)
Our PC

③ Sandpack 29th March XF $1.5e-6$ $2e-6$ $2.5e-6$
for both diffusion; however cannot trust the computer as it stops unexpectedly some time.

④ Hans PC Sandpack without XF running
Stopping the run as I see little hope with it.
Tomorrow: Final run for Bentheimer & selection on whatever thing you can see!

n has developed nicely; though; No way I can get $R(n) \approx \text{dudat}$

① Deciding on what to do with Bentheimer

9.3×10^{-7}	2.2×10^{-5}	2×10^{-7}
dif	difn	Dif

~~Std deviation~~

~~(pencil)~~ - [mean absolute error = $\frac{1}{n} \sum_{i=1}^n (f_i - y_i)$]

y_i - true value
 f_i - Prediction]

Hans PC : \rightarrow $U_F 1.25e-5$

4th April 2015 Saturday

Slight change in n and t for using ρ hug
 ~~$7-n$ to $9-n$~~ n_{inj} ~~7 to 9~~ n_{inj} g

$$g_{wh} = -0.0433 \ln(x) + 0.9344$$

Trying $S_{init} = 0.94$

g_{wh} has to be low; no other way it can get anywhere.

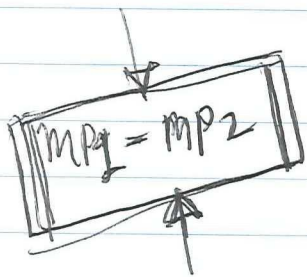
$$g_{wh} = -0.0433 \ln(x) + 0.7363$$

$$g_{wh} = -0.0433 \ln(x) + 0.5363 \text{ in Hans PC}$$

⊗

⊗ interfacial tension
 - change in α

$$\boxed{-n \frac{\partial u_g}{\partial x} + v_g \frac{\partial n}{\partial x}}$$



$$v_g = \frac{(P - P_g)}{\Delta x}$$

$$u_g = -\frac{k_0}{r} \left(\frac{\Delta P}{L} \right)$$

$\Delta P \neq$ ① Not able to match

②

$$\boxed{R(n) \approx \frac{dn}{dt}}$$

blue diff
 green source
 red conve
 cyan accumulation

(domain graphs)



$$\begin{array}{r}
 1.7 \\
 + 2.7 \\
 \hline
 4.4
 \end{array}$$

$$3.7$$

$$\underline{\underline{0.7}}$$

Try to get a point where there is not much influence of diffusion.

searching for the file where we run full & get the results for contribution of terms plot.

$$6 \sqrt{\frac{4}{K}}$$

$$\sqrt{\frac{0.2}{3 \times 10^{-12}}}$$

ppb10 - D₅₂
ppb15 - Rn

ppb11 chdt - ucl(ugx) - ucl(ugx)
ppb14 dibb

10

8th April 2015 Wednesday

- 1.1 ~~why~~ Introduction ~~data~~ Data Analysis: Take it to the max()
- 1.2 why spreadsheets
- 1.3 Strings Functions to prepare data

$$= \text{LEFT}(C2, 4)$$

$$= \text{LEFT}(C2, \text{FIND}(" ", C2) - 1)$$

↓ Finds the value

$$= \text{LEFT}(C2, \text{FIND}(" ", C2) - 1)$$

↳ number of characters from left

Getting data from the web - Easy

$$= \text{LEFT}(D2, \text{FIND}("'", D2) - 1)$$

$$= \text{RIGHT}(D2, \text{LEN}(D2) - \text{FIND}("'", D2) - 4)$$

Rule 45 Clean up your own mess

Effect of permeability on Foam-model parameters

Sebastien V-B

The presence of the foam does not change ~~flow of~~ water mobility.

Brooks-Corey relative permeability

Data paper may be for our 2nd paper

$$K_{rf} = X_f \cdot K_{rg} \rightarrow$$

Perm \uparrow critical water saturation \downarrow
critical gas saturation \uparrow

So at high permeability you can inject more gas without breaking lamellae or collapsing foam.

Foam strength $F_{mob} \times N_c$

$$u = \frac{k}{\mu} \cdot \frac{\Delta P}{L}$$

$$u = \frac{k}{\mu} \cdot \Delta P$$

$$u_1 = \frac{k_1}{\mu_1} \cdot \frac{\Delta P}{L}$$

$$u_2 = \frac{k_2}{\mu_2} \cdot \frac{\Delta P}{L}$$

$$u_3 = \frac{k_3}{\mu_3} \cdot \frac{\Delta P}{L}$$

Environmental Science & Technology : Journal

9th April 2015 Thursday

Morning-EdX course

1:41 Trying to select the journal for the second paper

← No of times the journal is referred in that paper

Energy & Fuels 4

Transport in Porous Media 4

J. of Petroleum Science & Eng 4 ←

SPE Journal 10 ←

SPE Reservoir Engineering 9

Left & find ~~find~~
Right

Left (Left(A2, find("A2")-1)

cannot find middle part of the exercise

Birthday ~~under~~ 10th April 2015 Friday

Bert van der Zwann (UU) →

Utrecht and Eindhoven connection : →

~~Urban~~

Majid Majid Hassanizadeh : →

- ① Darcy's Visiting professorship
- ② Website
- ③ Joint Masters
- ④ Joint EU proposals

Jos Keurentjes - Akzo Central Research in Arnhem.
Chemical Energy Ambitions

"From global Fossil to Sustainable local"

<< Photo Voltaics >> Coming game changer

Energy storage and conversion

- Chemical energy

Hans van Dijn - some observations regarding
hysteresis in porous media

Bear shows hysteresis

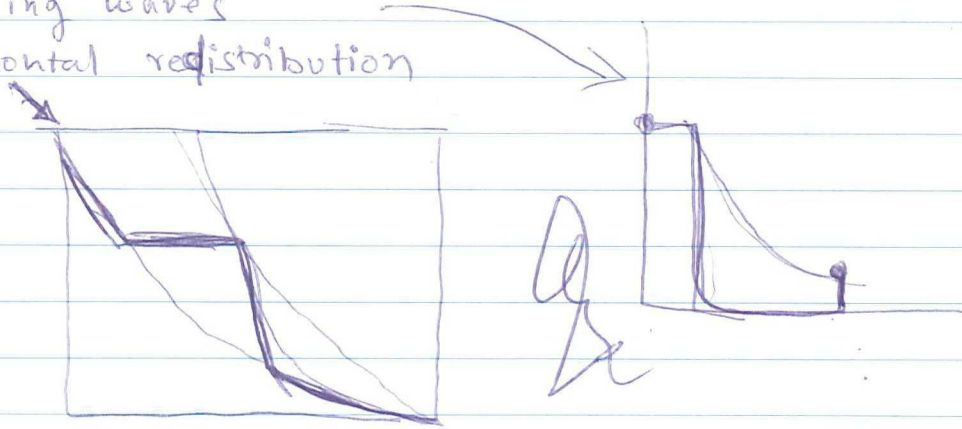
Relative permeability &
Capillary pressure

Inhibition & Drainage

Gravity forces & viscosity forces

Special cases for benchmarking

1. Traveling waves
2. Horizontal redistribution



Rodrigo Rosetti

Modelling & Simulations across PPG
porous media based products

Modified Richard's equation : \rightarrow

Wheeler : \rightarrow



CO_2 modeling : \rightarrow ① Residual trapping ② Mineral trap
③ Solubility trapping ④ Structural trapping

Reading colloidal paper in the library

14 April 2015 Tuesday

2.1 Look up Search Data Analysis to the Max (2)

COUNTIF() Function counts the number of cells within a range that meet a single criterion that you specify.

15th April 2015 Wednesday

Data Analysis to max. 2.2. Simple look up

Lookup Function : name of the person, directory of City

In case you want to know ^{Return} where this person lives.
(, range, row or column)

(A2, range, 2)

~~column~~ row (however it is called, column index number)

2.3 Fourth parameter : usually going to use FALSE
Default function is True ;

2.4 when to use "true"

IF ~~you~~ you are classifying with ifs, VLOOKUP is better.
"IF" function can be used for one or two cases;
however more classification use VLOOKUP.

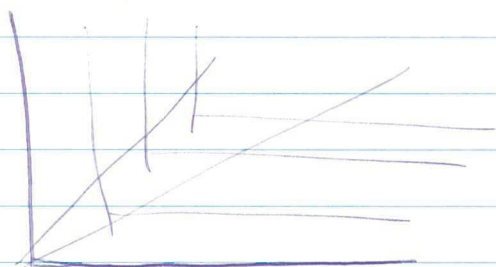
Effect of oil on foam For EOR

Jinyu Tang

Introduction : - poor sweep efficiency with gas Flooding

Solution :- Gas mobility control with foam

Research schedule :- Hexadecane and
Oil composition works



Modeling foam flow behavior

Three ways to do experiments

-
-

F_m : Effective relative permeability

$$\textcircled{\otimes} K_{rg}^f = K_{rg} + F_m$$

Results by fixing S_D and $\log \mu$

Modeling foam flow behavior

Capillary pressure: disjoining pressure

STARS^{FM} model

Effect of salinity on critical

critical water saturation

If lower the foam will collapse.

Corey Relative Permeability vs Stone's model

Multiscale Reservoir Management

Ⓡ

Rafael

① Petrobras

② Combination of ~~stochastic~~ multiscale and uncertainty assessment techniques to perform reservoir management activities

Algebraic multiscale (AMS)
development (C++)

2.4 Exercise

A lot of money :-:

For each order they get 0.5% of the money that the order goes over \$4000.

For example; \$5000 $0.5\% \times \$1000 = \cancel{\$500} \$5$

SUMIFS and COUNTIFS

How much ~~money~~ bonus for Jardine

VLOOKUP (G2,
Jardine

COUNTIF ("Jardine"; VLOOKUP (G2,

SUMIF ("Jardine", ~~False~~ VLOOKUP (G2, ^{table array} ~~Range~~, 2, True)))

~~Tell me something at~~

Relativeren

Risky Resources - Extraction in Conflict Zones
Rund Kloppenburg

~~See See~~

Security Risk Management

investment - Operational - Divestment

Mitigation challenges

Contingency planning

60

verschil bubble flow
sluy flow

Cavitation, computational fluid dynamics,

pipe flow module - water hammer

~~2~~ $\rho g h +$

Viscous effect + ~~int~~ inertia effect

$$m_{in} = m_{out}$$

$$K_g = \frac{kg}{m^3} \times m^3 \quad gW$$

$$gW = g$$

Reference list: →

- Akhil Datta - Gupta
- Katya Vladislavleva
- Seung Kim
- Henry Bertin

Foam in carbonate formations

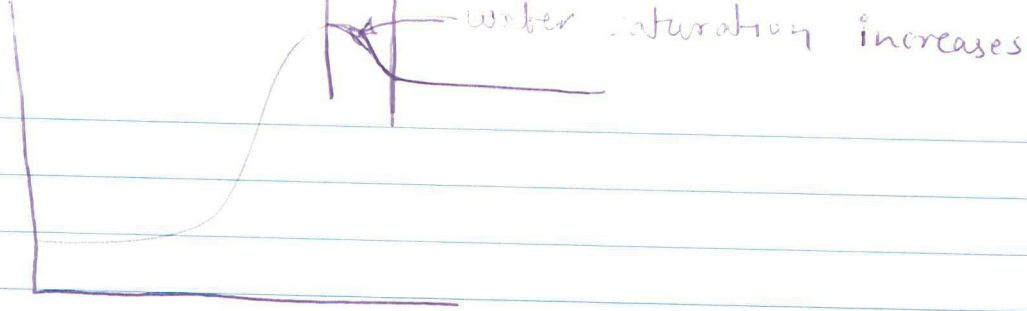
Experiments in oil-wet media of
low-permeability carbonate rocks

① Use of foam in EOR

- ① oil-wet nature
- ② low permeability
- ③

Foam strength proportional to absolute permeability
(Khatib et al. 1988)

Foam floods in bead-packs (oil-wet)
hydrophobic



0.37 = Steady state saturation

small pores contain all the water

Vug?

You need to submit bibliography file as manuscript file.

1.2 startup weekend

→ YES!Delft organisation
 <motivation and skills>

1.2 startup committees

During 1.2 startup participants create their own company within 72 hours. Entrepreneurs, coaches & investors guide the process & assess the results.

Cem - Sengul - Business affairs - Virgil

15 May 2015 - Event

Entrepreneurs are leaders willing to take risk and exercise initiative, taking ~~opportunities~~ advantages of market opportunities by planning, organizing, and employing resources.

Motivation: - Motivatie : op die flyer ik zie dat we get the chance to pitch your idea, form a team ^{stichten} ~~bezoeken~~ een klein bedrijf. Ik wil graag die ervaring leren omdat ik heb zo'n plan om mijn eigen bedrijf te stichten over de passen van applicaties in India. Solar panel.

Eigenlijk outsource van kennis and verder beter verbinding tussen kennis & economy tussen India & Netherlands.

Onderzoeks programma als een soort ~~entreprenu~~ ^{entrepreneurship}

entreprenuer entrepreneur

— Hungarian-Austrian —

P Istvan Deak SKF Group trainee Since April 2015

VP Berber Renckens, Civil Engineering,

T Ludo van den Buijs — treasurer — ①

EM Stephanie Lanphen — DSC, Civil

Recruit Yuri van Engelhoven, Civil, Teaching assistant — ②

Koen Emmer, Virgiel, Full time Test Delft

Rond - 4-5 mensen in een team

YES! Delft incubator

^{Lunch}
PE meeting

Value of information assessment in closed-loop
reservoir management.

Eduardo Barros :-

Production strategy, Reservoir surveillance

Knowledge → Decision → Value

Methodology
(Workflow)

Uncertainty characterization: →

① assessment of assumptions

MRS T matlab reservoir simulating tools

VOC - Value of conveyance — Acts as an upper
VOI - Value of Information bound

Eduardo doing time plus optimisation

0 t_1 t_2 T

Discussion →

Opportunity to combine two powerful concepts

① VOI ② CLRM

"Updating permeability & porosity data."

NPV : →

① Steric
exclusion

Pauli principle - DLVO

George Hirasaki
Structural forces

~~Israelachvili~~

② Hesseling - Polymer - entropy

Brady paper - ~~Phreeqc~~ Phreeqc : - Charge calculation
as a function pH surface charge

→ "Surface complexity modification for EOR"

[Charges as a function pH]

Silica - 1.5-3 Alumina - 8-9

At pH = 3 Silica - vely charged

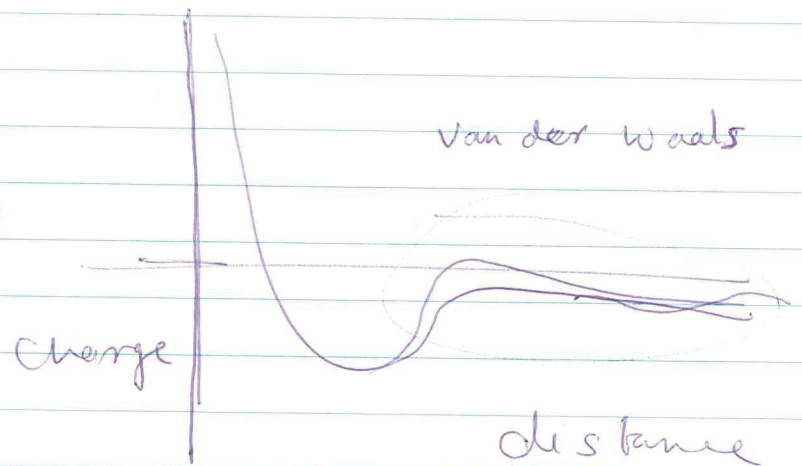
Stern layer

Calculation of charge distribution ↔ Composition

① Composition ② pH

↓
Charge

Sedimentation rate as a function of pH.



6.4 V

5.8 - 7 Mix

6.2 - 7.2 Ash only

eg 5.9 - Mix only
6.4 - Ash only

0.2 M Mie scattering

6 V - 10.0 V

① previous figure → Benchmark

Mix 9.39 pH :-

turbidimetry

What is orange

2.3 μ e

=

Stoke's equa

$$\rho \frac{4\pi}{3} R^3 g = 6\pi\eta Rv$$

$$v = \frac{4\pi/3}{6\pi} \frac{\rho R^3 g}{\eta R}$$

$$v = \frac{2}{9} \frac{\rho R^2 g}{\eta} = \frac{2}{9} \frac{2300 (10^{-7})^2}{10^{-3}}$$

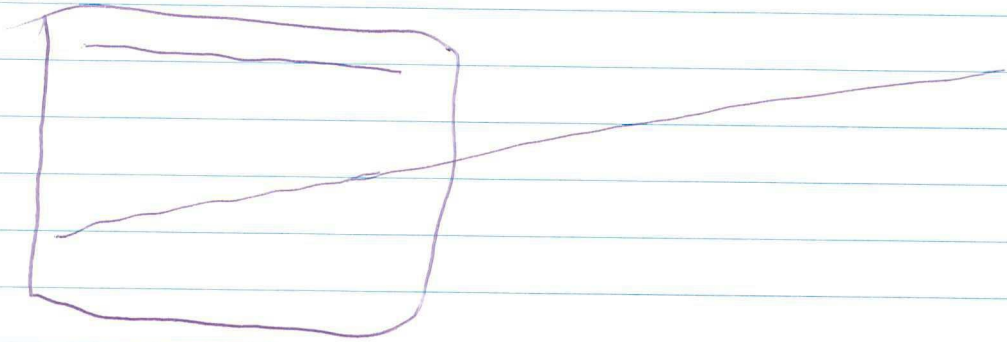
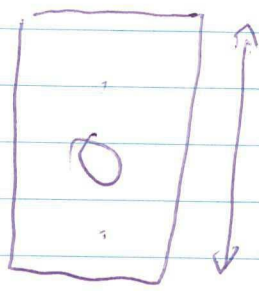
$$= 4.6 \times 10^6 (10^{-7})^2$$

$$= 4.6 \times 10^{-8} \frac{m}{s}$$

$$1.8 \times 10^{-2} \frac{cm}{hr}$$

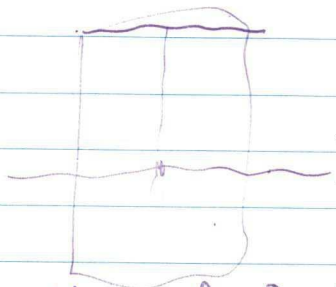
$$18000 \times 10^{-8} \frac{m}{s}$$

$$1.8 \times 10^{-4} \frac{m}{hr} \quad 1$$



3 10000 s

$$7 \times 10^{-4}$$



$$\frac{2 \times 10^{-2}}{10^4} = 2 \times 10^{-6} \text{ s}$$

Result of Fluid Flow experiment
Intensity is per gram.

Intensity of the particles coming in & coming out

- ① How many particles
- ② Agglomeration
- ③

Apollo — Composition of the particles ①
— Sulphonate absorption

- ② Effluent of Benches
- ③ Bench mark of
- ④ Agglomeration rate (bedline)

7 May 2015 Thursday

Samples of before & after flow

mix inlet 54

mix outlet 47

Ash inlet 58

Ash outlet 51

mix
Signal

Signal mix inlet > Signal mix outlet

DARSIM 2015

Computational Geoenvironment
Rafid Al

8 May 2015 Friday

The samples with foam flow are done with change in the set up. Therefore they are different from ~~only~~ bulk sample results.

Phreeqc :-

Composition of the stuff, pH, cation exchange.
"Qualitative"

11th May 2015 Monday

Reading paper carefully; building introduction / cross checking @ references, zeta potential.

Investigation of foam generation and propagation in a synthetic laboratory scale fracture.

- Pre-generated foam is injected between glass plates
from Yan et al 2006
- Fracture Apparatus Design
- System Sawh Core Fracture A Microfluids

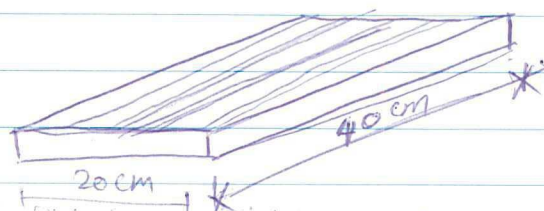
Decreasing roughness

Interferometer

Glass surface characterisation : →

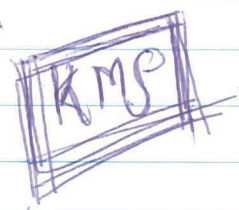
2400 - 7800 μm

~~Wavelength~~



Nice design!

Semi-Variogram



$$N_{Ga} = \frac{\text{Viscous Force}}{\text{Capillary Force}}$$

responsible for

no of ions of type i
per unit volume

2.3.7. Poisson-Boltzmann equation

Potential distribution

$$\nabla^2 \psi = \frac{d^2 \psi}{dx^2} = - \frac{1}{4\pi\epsilon_0 D} \sum_i n_i z_i e \exp\left(\frac{-ze\psi}{kT}\right)$$

\uparrow electric charge \uparrow no of valence of type i per unit volume

$8.854 \times 10^{-12} \frac{\text{Farad}}{\text{m}}$

surface potential?

16 May 2015 ~~Friday~~ Saturday

~~16~~ An analysis of zeta potential & Surface charge

- ① Electrostatic attraction ② London-van der Waals attraction ③ Hydrogen bonding ④ Chemical reactions at the surface

↑

Way adsorption of one species over another

The relationship between charge & electric potential is governed by the Poisson-Boltzmann equation
Whose solution for a planar surface yields

$$q = \pm \left[\frac{kTE}{2\pi} \sum_i \overset{\substack{\text{dielectric constant} \\ \uparrow}}{\epsilon_{i0}} \left\{ \exp\left(-\frac{z_i e \psi_0}{kT}\right) - 1 \right\} \right]^{1/2}$$

Bulk concentration of the i th species in solution
 ψ_0 surface potential

18 May 2015 Monday

Steric forces

Steric hydration forces

Below 2 nm there is an additional repulsion due to "steric hydration" forces. Page 302 Israechivli

The effective charge density of the anionic lipid headgroups is about 1e per 14 nm².

Need to check the work during September-October about the calculation of ionic strength.

<found> Now find the references

The problem is that the ~~project with~~ the work constitutes of disjoining pressure for liquid films & not for particle in ^{aqueous} dispersion.

How to model particle stability and then confirm our results to that.

① Energy barrier calculation for our system: Page 208
Israelabbu

Vander Waals forces (Molecular attraction)
- London Dispersion forces, Dipole Attractions
& Hydrogen bonding
↑
weakest (not to be
(due to poles) able.)
dipole bonding (stronger)

H-F - super strong case of dipole-dipole
interaction
← super electronegative →

Summary

Particles in liquids are balanced by attractive
Vander Waals forces & repulsive electrostatic forces

Surface charge density → Graham equation

20th May 2015,

Pitching workshop

mobility / Immigration workshop

- Immigration issues, ~~etc~~

- work permit, Residence permit, healthcare

& scientific research directive

Orientation year highly educated migrants

- to within three years of graduation;
- work permit is required to work
- No ~~no~~ income criterion?

- Apply for orientation year, regardless of age*

Scientific research under directive 2005/71

- No employment contract
- no work permit is required

www.careerinholland.nl

-basis zorg verzekering

Public register recognized Institute

Enhanced oil recovery by water-soluble ~~solutions~~ solvents

Mohammad Chahardouli

↑ inhibition rate → EOR bon mwpww
Inhibition experiments : →

Solvent ~~increases~~ decreases → the oil viscosity
residual oil saturation ↓

Polymer to aqueous phase

Polymer lower the effective mobility

① Carbonated solvents

②

Driving forces

Capillary forces

gravity forces

→ Bond number

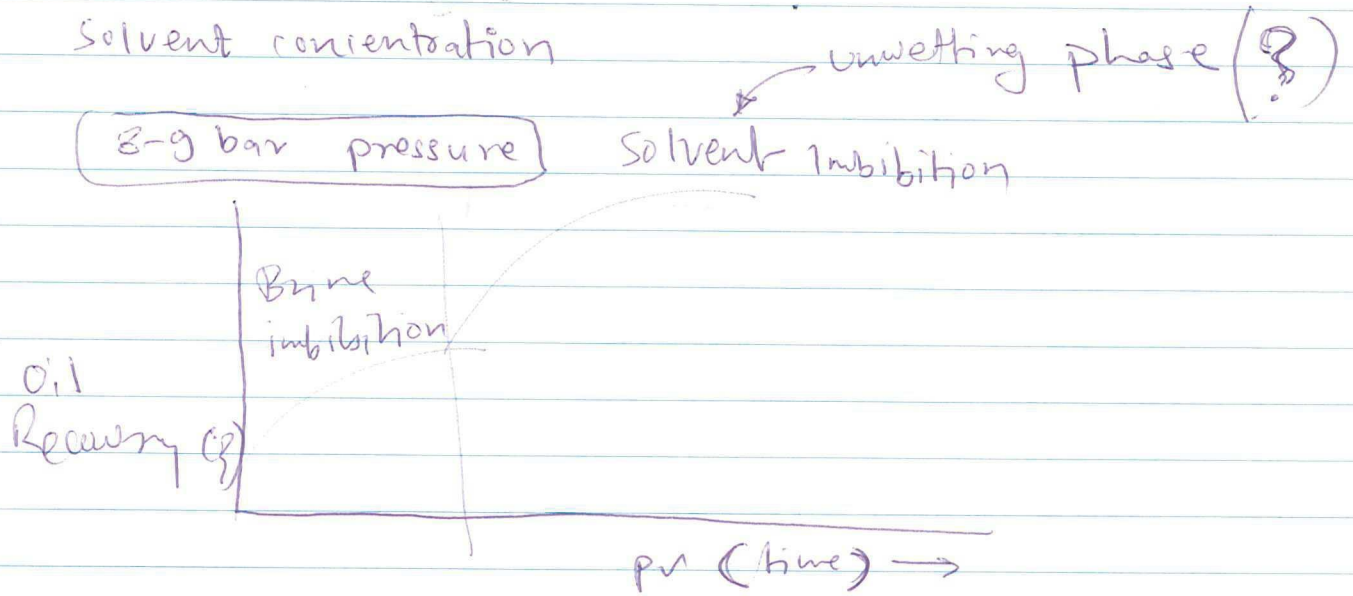
Viscous forces

Capillary forces

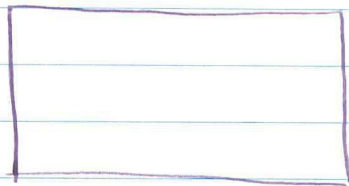
→ Capillary number

③ Ammott cell

spontaneous imbibition experiments



Recoveries are the same for bottom & top ends open

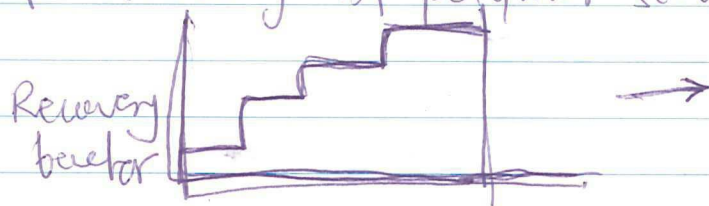


Initial condition affect the imbibition condition

HPAM &

Core Flooding Experiments

(Oil recovery by polymer solvent flooding)



Code product solution

Virtual product development

Injection modeling Simulations

E-Semble :→ XVR is virtual reality training software for safety & security.

Geosignum :- Geomatics Engineering.

Carleste :- Design company

Incentro :- IT consultants

Witterveen+Bos :- Civil Engineering company

Tenuki :- Software ~~using~~ Verkeersinformatie

CZ :- insurance

Text :- Digital presence management

3M :- Design, Display company.

21st May 2015 Thursday

① Pitching exercise studies

22nd May 2015 ~~Wednesday~~ Friday

Dennis Voskov \rightarrow Numerical modelling

Plasticity, thermal effects
Simulator \otimes AD-GPRS, version 3.0

Target models \rightarrow Petroleum reservoirs, CO₂ storage,
Enhanced Steam Injection, enhanced-geothermal

Thermodynamic equilibrium \rightarrow

Thermal simulation: Phase behavior

K value \rightarrow Non-iterative phase behavior computation

Full EoS \rightarrow Repetitive partial differential equations

Steam assisted gravity drainage \rightarrow (SAGD)

Why geomechanics important for (SAGD)

Solution strategies \rightarrow

Phase equilibrium calculation \rightarrow

26th May 2015 Tuesday

Hirasaki paper 1991 is about three phases; slightly different than our case?

$$\frac{0.04}{100}$$

$$\frac{1.004}{1.00}$$

light scattering, Turbidity, particle size, ϕ 2P,

Right nomenclature for light scattering

Turbidimetry in Overbeck Hunter

$$[Gm] = [v^2 n]$$

Absorbance measurement

The electrical charge at a surface : \rightarrow

Molar concentration

$$\begin{aligned} &= \text{mass} \times \text{molar concentration} \\ &= \text{mass concentration} \end{aligned}$$

mass concentration \rightarrow velocity concentration

Cubiks online assessment : instructions & practice

6 practice numerical test questions

0.646 0.677 0.70 0.46

largest increase in people in employment
1996 to 2001

21.3 \leftrightarrow 28.8	0.11
19.0 \leftrightarrow 20.7	-0.082
19.4 \leftarrow 19.5	-5×10^{-3}
22.9 \leftarrow 22.3	0.026

1996

$$90 \times 0.2 = 18$$

$$\begin{array}{r} 91.8 \\ + 18.3 \\ \hline \end{array}$$

$$\begin{array}{r} 1997 \\ 108 \\ \times 0.2 \\ \hline 16 \end{array}$$

$$\begin{array}{r} 91.8 \\ \times 0.2 \\ \hline 18.36 \end{array}$$

$$\begin{array}{r} 1998 \\ 129.6 \\ + 25.92 \\ \hline \end{array}$$

$$\underline{\underline{155.52}}$$

$$\underline{\underline{1999}}$$

$$^3 22 \times 15 = \underline{330} \text{ \$}$$

$$\begin{array}{r} 150 \text{ \$} \\ \hline 180 \end{array}$$

$$\begin{array}{r} 150 \\ \hline 220 \end{array}$$

$$\begin{array}{r} 220 \text{ \$} \\ 198 \\ \hline 418 \text{ \$} \end{array}$$

4

12 \$ each if ^{of you} ~~buy~~ bought 20 = 240

$$^3 18 \times 4 =$$

$$^1 72 \times 5 = \begin{array}{r} 360 \\ 120 \end{array}$$

$$\begin{array}{r} 80 \\ 20 \end{array}$$

~~$$80 \rightarrow 100$$~~

$$80 \rightarrow 100$$

$$20 \rightarrow 3$$

$$\frac{20 \times 100}{80} = 25$$

$$45 \rightarrow 100$$

$$30 \rightarrow 22$$

$$\frac{230 \times 100}{345} = 66.6$$

$$0.35$$

$$0.18$$

$$0.32$$

$$0.20$$

$$0.28$$

$$0.28$$

$$0.53$$

$$0.23$$

$$1596 \quad 2001$$

24

$$39$$

$$39 \rightarrow 36.5 \downarrow$$

$$40$$

$$40 \rightarrow 38.3 \downarrow$$

$$49.1 \uparrow$$

$$49.1 \rightarrow 49.2 \uparrow$$

$$19.7$$

$$19.7 \rightarrow 19.1 \downarrow$$

1996 1997

$$50 \rightarrow 70$$

$$140$$

$$2.5$$

$$100 \rightarrow 7.2$$

$$1.7$$

$$90 \rightarrow 125$$

$$0.6$$

$$1$$

$$138$$

$$100 \rightarrow 2$$

$$\begin{array}{r} 90 \times 0.02 \\ \times \end{array} \quad ($$

$$\begin{array}{r} \cancel{90 \times 0} \\ \times \end{array} \quad ()$$

$$\begin{array}{r} 90 \times 0.2 \\ = 18 \end{array} \quad \begin{array}{r} 108 \\ \times 0.2 \\ \hline 21.6 \end{array} \quad \begin{array}{r} 108.0 \\ + 21.6 \\ \hline 129.6 \\ \times 0.2 \\ \hline \end{array}$$

$$\begin{array}{r} 155.12 \\ \hline 80 \end{array}$$

$$136,500 \text{ km}^2 \quad 11.28$$

$$\begin{array}{r} 136,500 \text{ km}^2 \\ 100 \end{array} \quad \begin{array}{r} 12,100 \text{ km}^2 \\ - \\ \hline \end{array}$$

612000 arable land: →

$$367200 \text{ km}^2 \quad \cancel{\text{km}^2}$$

$$1 \rightarrow 0.82 \text{ km}^2$$

$$x \leftarrow 367200 \text{ km}^2$$

20 injuries per 1000000 hours

1 injury per 50000 hours

40 injuries per year

1000000

Topics

Demanding - leaves free

- know what you want

- say carefully

- willing to compromise

insecure overachiever

Thoughts → words → actions

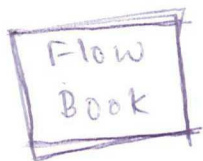
- think about research, - conference

- talking to others

- free association

- mind mapping

Goals →



Specific

Measurable

Action-oriented

Realistic

Time-bound

Process →

Flow →

(Meaning)

~~Brain~~

Communication →

show
Do Not A very much information in presentation

1/20 rule

Sans-serif font

↑ Paper
↑ font

Build silence & then
ask to tell more.

Brain Rules
Jan Medina

Time management

Conflicting Interest

vs

Conflict

[Yes = NO]

Temptation

Temptation & Habits

12th June 2015 Friday

The use of tracers for characterising
Flow processes in Shale-Gas Reservoirs
Peter Rose PhD

Hydrofracture

Danckwerts 1958 : chemical flow reactor

Conservative vs reactive tracers

↓
Naphthalene sulfonates

~~using~~ ~~schematic laboratory~~

Adsorption equilibrium constant ~~with the~~
~~help of~~ Calculated ~~after~~ From the delay
of the tracers.

Geothermal Field-active wells

Interrogating surface area in single-well
Tracer Tests

Nexen Laboratory study

pH Independent tracers
Reversible tracers study

Surface area, pore volume and pore size distribution
study (BET surface area)

The field experiment

~~note~~ Naturalisatieverzoek

14015 8.30 en 17.00

Dynamics of Rock Transport Properties in
Reacting Porous Media
Amir Raef

Realistic Pore space Representation

From saturated to partially-saturated
Monday 22-06-2015

Modeling Dispersion and mixing in EOR processes
Alex van El

Dispersion : — convection + diffusion

Analytical vs. Numerical

Taylor Expansion series ?

check TQM & JPSE websites

Materiaalkundige Proces Engineer Nijwald

23rd June 2015

Analysing Han's 28th May Excel sheet

Particle size
determination
Rate of
Sedimentation
(terminal sedimentation velocity)

$$v = \frac{2}{9} a^2 \frac{(\rho_{\text{particle}} - \rho_{\text{water}})g}{\eta}$$

Radius of
spherical
particles

liquid viscosity

$$m = m_0 - 36$$

$$\frac{-(m - m_0)^2}{2}$$

$$\frac{2}{9} \left(\frac{3M}{4\pi \rho g} \right)^{\frac{2}{3}} \frac{m_0 - 36}{\eta}$$

② Einstein equation for particle diameter

Stokes - Einstein Equation for diffusion of spherical particles through a liquid with low Reynolds numbers

$$D_r = \frac{k_B T}{6\pi \eta r^3}$$

$$\left(\frac{3M}{4\pi \rho g} \right)^{\frac{2}{3}} = a^2$$

$$a = \left(\frac{3M}{4\pi \rho g} \right)^{\frac{1}{3}}$$

$$\frac{8000 \text{ nm}}{8 \text{ nm}}$$

$$\text{If } e^{\frac{(m-m_0)^2}{2}} * \frac{6}{10} \sqrt{2\pi \sigma^2}$$

$$\Delta m = P(m) \cdot \Delta \delta$$

Bottom line as I ~~remember~~ remember was that depending on particle size & particle size distribution the particles would sediment.

$$\leq e^{\frac{(m-m_0)^2}{2}} \frac{6/10}{\sqrt{2\pi \sigma^2}}$$

For values

$$0.08 < x < 0$$



Tyndall Effect

(momentum?)

$v \cdot d$
↑ diameter of the particle
↑ terminal velocity

$$M_i = P(m_i) \cdot \Delta \delta$$

$$\Delta m_{i+1} = \Delta m_i + P(m_i) \Delta \delta$$

$$\Delta m_{i+1} = \Delta m_i + P(m_i) \Delta \delta$$

$$\Delta m_i = P(m_i) \Delta \delta_i$$

26th June 2015 Friday

Presentation preparation & print out just to discuss with Keith Johnston.

CO₂ in water foams stabilized with Surfactants and/or Nanoparticles for EOR & Fracturing

Highly compressible - CO₂ = 100 bar

~~Minimum~~ Minimum

Langevin

for sandstone — anionic surfactants

Protonated state

~~nanoparticles~~ nanoparticles - ~~not~~ as surfactants

Wormlike micelles increase the foam viscosity

Farajzadeh, Hirasaki, Rossen 2012.

29th June 2015 Monday

Lezing lecture room A, ChemE

MV symposium: Hisarna - A New & Highly Energy Efficiency Way of Ironmaking

Koen Meijer Tata Steel

Refractories: ~~red~~ reactors, ladles, stills, kilns, & so forth

ceramics processing

Questions to Patrick

- ① Job specification — coke ovens? fused silica
- ②
- ③ Salen's
- ④ when can I start

Coke oven battery \rightarrow Byproduct cokesoot
 \uparrow
Coal to coke

5 sand 4 bricks 140 bricks 130 sand

Iron ore + Limestone \rightarrow Sintering
Dolomite
Dunnite

Blast Furnace

steel making

0638304965

Design of refractories

Project engineering: everything is in order

customer is the factory

companies that build stuff.

Internal procedure: Tata Steel;

How we see here doing this job. How do you fit in this job. Communicate with different jobs,

①-
centre of ~~expert~~ expertise is different

more of facilitator \rightarrow

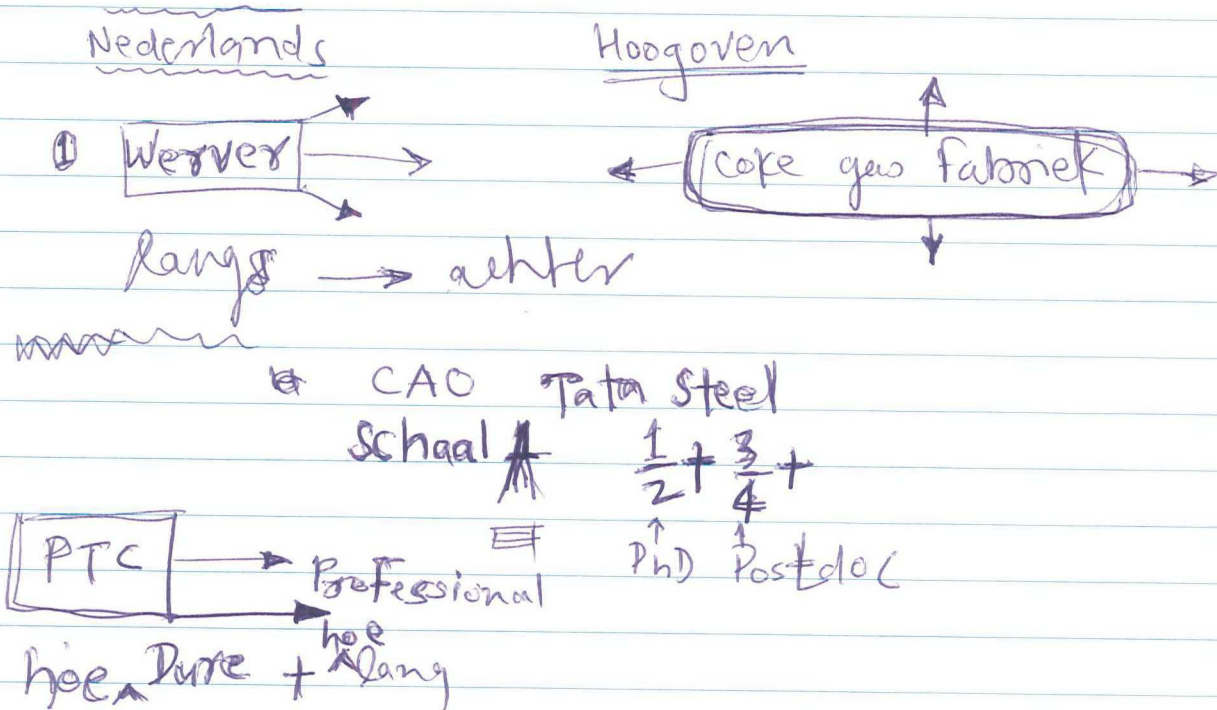
Fully independent

If you can given four

Patrick van Hemert

Tata steel Engineer

6-7 years



Notes

- Call the lady
- for talk to dutch
- Ask for more information
- It is not research position but engineering position

Effect of pH on the dispersability of silicon carbide powders in aqueous media

Three parts of studies

- ① Zeta potential
- ② Particle size / size distribution
- ③ rheological behavior (absorbance &)
- ④

Search for particle size distribution ~~case~~ data from our for our ~~data~~ experiments

Write the formula for SO_4^{--} & Na^+ for our ~~set~~ surfactant.

Find the calculation of surface potential part from the second paper. Use the ionic strength calculation from the second paper.

Extensional viscosity aspects of HPAM in porous flow

Tom van den Ende

meeting with Tracey

Sunday

14:00

About job interview

Monica Reulink

- Try to make yourself more attractive.
- Type of questions - Open versus closed, probing, Hypothetical, competency based

• Google yourself

- ~~Pre~~ Prepare yourself some introduction
- prepare questions
- half an hour prior to the interview

Mock interview : Tell the situation from work not from the Hockey case.

STAR method

Focus - ~~off guard~~ Do not get ^{caught} off guard

Tata steel : Mission & Vision : Read Tata steel



monicareulink@hotmail.com

1. Karl-Heinz
2. Pacelli
3. Rouhi
4. Hans
5. J.D. J.
6. Kravtsev
- 7.

~~Walking~~ 5:15

At station 6:10 Platform 1

At Beverwijk Station 7:30

At Dudokhuis 3H-18 8:30

€50000

Questions to

Vak gebieden:

① R&D

② Techniek & Engineering

③ ICT

④ Productie/Manufacturing

Projects & Technical consultancy
300 hoogopgeleide mensen

Verbeteringen ~~in~~ ⁱⁿ - en ~~de~~ ondersteuning
van de productieprocessen.

- het verbouwen van installaties of het neerzetten van complete nieuwe fabrieken. PTC zorgt als ~~een~~ onafhankelijke partner van de afdeling manufacturing voor de technische en economische beste oplossing.

Investeringen — Tata Steel investeert ~800 M€ in IJmuiden

Innovaties: —

~~Project~~ Op onze expertise wordt vaak een beroep gedaan bij productontwikkeling, ~~prestatie~~ prestatieverbeten en technische innovaties.

We hebben altijd ~~vacatures~~ vacatures voor uitstekende project managers en project engineers

Equating the gravity force ($\frac{4\pi}{3} R_i^3 \rho g$) to the resistance force $6\pi\eta R_i v$ leads to

$$v_i = \frac{2}{9} \frac{R_i^2 \rho g}{\eta} = \frac{2}{9} \cdot 10^{-2} \frac{10^4 (1)}{10^{-3}} = 2 \cdot 10^{-6} \frac{\text{m}}{\text{s}}$$

We use that the volume $\Omega_i = \frac{4\pi}{3} R_i^3$ and thus $R_i^2 = \left(\frac{3}{4\pi} \Omega_i \right)^{2/3}$

Therefore

$$v_i = \frac{2}{9} \left(\frac{3}{4\pi} \Omega_i \right)^{2/3} \rho g \quad (2)$$

Any particle with volume Ω_i has a constant velocity v_i and satisfies the equation.

$$\frac{\partial w_i}{\partial t} + v_i \frac{\partial w_i}{\partial x} = 0 \quad (3)$$

where $\frac{\partial w_i}{\partial t}$ is the concentration of particles with volume Ω_i .

The solution of Eq. (3) is

$$w_i = w_i^{\text{initial}}(x - v_i t) \quad (4)$$

Let $P(\Omega_i)$ be the probability that a particle has a volume between Ω_i and $\Omega_i + d\Omega_i$.

$$P(\Omega_i) d\Omega_i = P(v_i) dv_i \quad (5)$$

where $P(v_i)$ is the probability that a particle has an initial velocity between v_i and $v_i + dv_i$.

For the initial condition the $w_i = 1$ for $x \geq 0$ and $w_i = 0$ for $x \leq 0$.

Hence Eq (4) reduces to

$$w_i = H(x - v_i t) P(\Omega_i) \text{ where}$$

H is the unit step function

Therefore

If velocity becomes too high
volume distribution Ω goes

$$w(x, t) = \int P(\Omega_i) H(x - v_i t) d\Omega_i$$

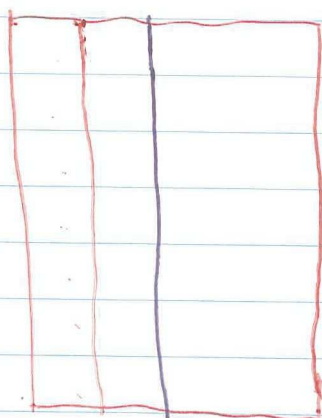
$$P(\Omega_i) d\Omega_i = P(v_i) dv_i$$

$$\text{but } \frac{dv_i}{d\Omega_i} = \frac{2 \left(\frac{3}{4\pi} \right)^{2/3}}{3} \frac{2}{3} \left(\Omega_i \right)^{-1/3} \rho g$$

Redundant

$$P(\Omega_i) = P(v_i) \frac{dv_i}{d\Omega_i} = 1$$

$$\frac{2 \left(\frac{3}{4\pi} \right)^{2/3}}{3} \frac{2}{3} \left(\Omega_i \right)^{-1/3} \rho g$$

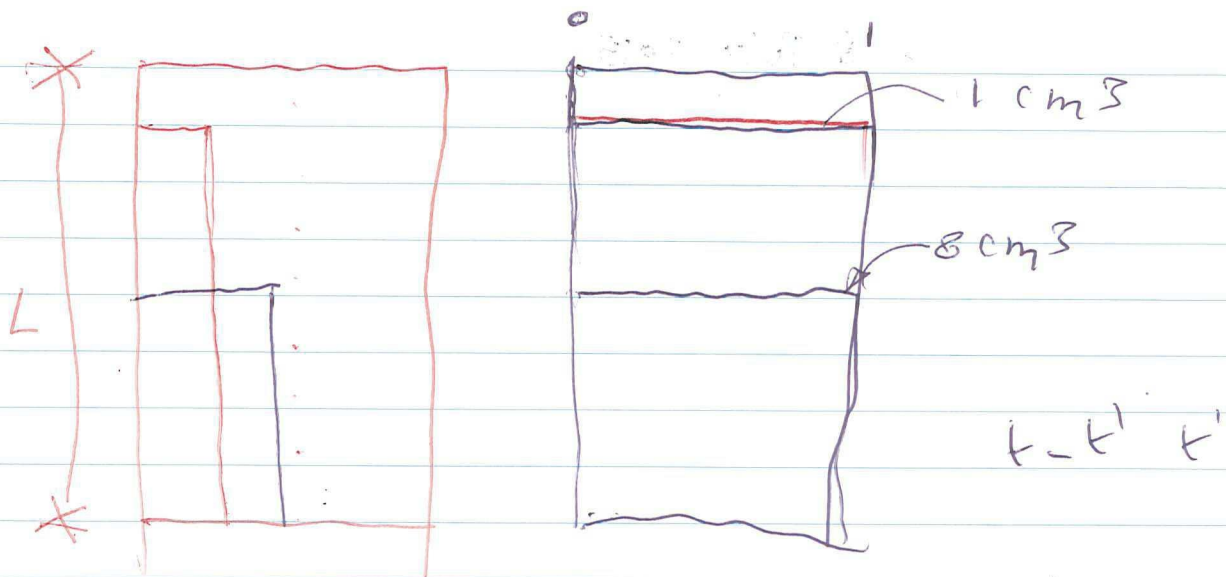


$\frac{1}{3}$ have volume 1 cm^3
 $\frac{2}{3}$ have volume 8 cm^3
 ~~$\frac{1}{3}$ have volume 27 cm^3~~

$$P(\Omega_1) = \frac{1}{3}$$

$$P(\Omega_2) = \frac{2}{3}$$

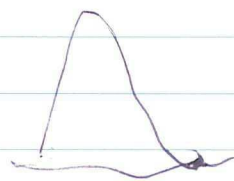
Attenuation formula :



$$w(\vec{x}, t) = \int P(\Lambda_i) \cdot H\left(\frac{L}{2} - \frac{2}{g} \left(\frac{3}{4\pi} \Lambda_i\right)^{2/3} \rho g t\right) d\Lambda_i$$

$\Lambda = L/2$

Let $P(\Lambda_i) = \Lambda_i \exp\left(-\frac{\Lambda_i}{\Lambda}\right)$



what is the distribution of our particles exp

$$w(L, t) = \sum P(\Lambda_i) \cdot H\left(\frac{L}{2} - \frac{2}{g} \left(\frac{3}{4\pi} \Lambda_i\right)^{2/3} \rho g t\right)$$



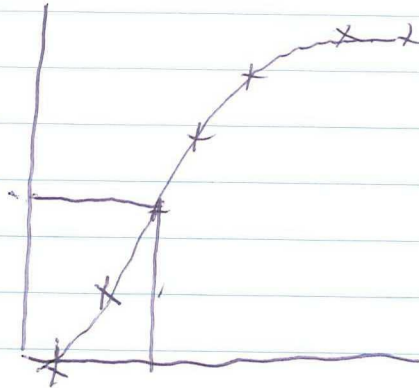
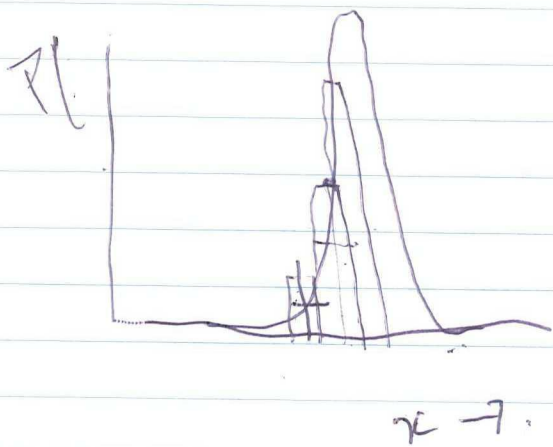
$$w(L, t) = \sum \left(\Lambda_i \exp\left(-\frac{\Lambda_i}{\Lambda}\right) \right) + \frac{2}{g} \left(\frac{3}{4\pi} \Lambda_i \right)^{2/3} \rho g t$$

look into kepler bar details about Mie scattering

8 July 2015

Calling Mina 0611585932

Found the particle size distribution, volume distribution & number distribution



$$\frac{4\pi}{3} R^3 \rho g = 6\pi \eta R v$$

$$v = \frac{2}{9} \frac{R^2 \rho g}{\eta} = \frac{2 \times 10^{-7})^2 \times 3000 \times 10}{9 \times 10^{-3}}$$

$$\frac{2 \times 10^{-14} \times 3 \times 10^7}{9} = 10^{-7} \text{ m}$$

Melvern instrument

Number density \times volume

- Only the big particles get sedimented

~~Ex~~
In the experiment; you see the ~~particles~~ light scattering changes

The results are for the sample which are through.
Zeta potential: How does it work
Explanation

Does the

Zeta potential / particle size distribution

vs

~~particle size from~~ turbidity experiment

How does both ~~turbidity~~ ~~things~~ results match.

~~Given the particle size from melvion~~

Electrophoretic mobility

= Zeta potential

= Particle size

at Peak is the highest peak; 1000 nm is ~~inter~~ detector

What does the pick from One um? Setting rates in hour time.

Mie scattering \rightarrow omic.org



Theoretical particle / intensity / setting rate from mie scattering.

Setting rates can be used as a screening procedure.

(checking materials for energy conversion & storage group)
They use uv-vis spectroscopy

10 July 2015 Friday

Correction of paper $n = 1.7662$ Alumina



① write a mail to Transport in Porous media

Average particle ~~1.545~~ 1.55
refractive index
from the paper

Total attenuation coefficient calculation

Trying to get scattering coefficient

158 ~~negative~~ imaginary = 0 $\Rightarrow \mu_s = \mu_{TA}$
imag = -0.041 $\mu_s = 116.08$ $\mu_s = 159.3$

13 July 2015 Monday

Attenuation & Scattering coefficient - mie scattering

Checking how to structure the colloidal paper.

writing experiments & results part.

Send an email to Transport in porous media

16 July Thursday

Agglomeration rate / Flocculation rate

does particle aggregate & then sediment

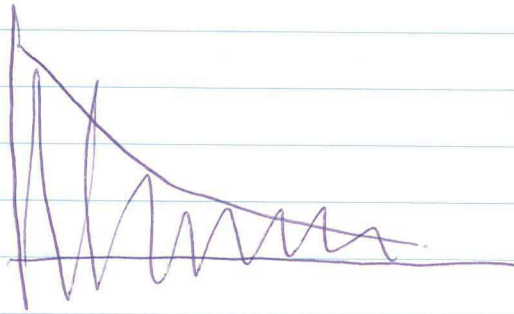
coagulation rate

molar concentration
~~saturation~~ at which

Calculate critical coagulation concentration by using Schulz Hardy model & Smoluchowski equation.

Page 290 Hunter

Laplace transform - Fourier transform



Rate at which sedimentation goes.

$$C_{0.2} = \frac{0.04 \text{ g}}{90.2 \text{ ml}} \times \frac{0.04 \text{ g of Ash}}{1 \text{ gm of water}}$$

$$\begin{aligned} x &= 0.04 \text{ g} \times 90.2 \text{ gm} \\ &= \frac{3.6116 \text{ gm}}{90.29} \end{aligned}$$

Initial coagulation rate @ 1 sec

Coagulation occurs without surfactant increasing the particle

Ash 2.82 pH Sedimentation & particle size

Cumulative distribution function of particle size

Attenuation \longleftrightarrow ~~settle~~ turbidity

17th July 2015 Friday

Particle size analysis (from zeta sizer instrument)

we also measured sample like ash 6, ash 7, mix 5-2 mix 7-2

HCl 0.1 M \Rightarrow $100 \times 10^{-5} \text{ mol/l}$

Surfactant $95 \times 10^{-5} \text{ mol/l}$ at cmc

~~NaCl $0.01 \times 10^{-5} \text{ mol/l}$~~

Surfactant $1.19 \times 10^{-3} \text{ mol/l}$ at 0.0375 w/w \%

$$I = \frac{1}{2} \sum_{i=1}^n C_i Z_i^2$$

$$= \frac{1}{2} \left[\overset{\text{H}^+}{0.01 \times 10^{-5} \times (-1)^2} + \overset{\text{Cl}^-}{0.01 \times 10^{-5} \times (+1)^2} + \overset{\text{Na}^+}{1.19 \times 10^{-3} \times (-1)^2} + 1.19 \times 10^{-3} \times (+1)^2 \right]$$

$$= \frac{1}{2} \left[\right]$$

Tonic strength for samples acidic solution

$$I = \frac{1}{2} \left[0.02 \times 10^{-5} + 2.38 \times 10^{-3} \right]$$

$$= \frac{1}{2} \left[2.4 \times 10^{-5} \right] = 1.2 \times 10^{-5} \frac{\text{mol}}{\text{l}} \text{ M}$$

Debye length

$$K = \sqrt{\frac{e^2}{\epsilon_0 \epsilon k_B T} I}$$

Find the excel sheet where we did this calculation.

Hamaker constant Silica particles in water
A =

Ionic strength of our sample if only surfactant considered.

$$I_{\text{surf}} = 1.19 \times 10^{-3} \frac{\text{mol}}{\text{l}}$$

The effect of H^+ & Cl^- can be considered in pH.

The effect of pH can be contributed to ~~the~~ Hydrogen ion
 $\text{pH } 5.5 = 1 \times 10^{-5} \text{ mol/l}$

Ionic strength of the sample if H^+ (or H_3O^+), Cl^- & Na^+ & -ve molecule of surfactant is considered
 for ~~the~~ acidic case considered.

$$I = \frac{1}{2} \left[\underset{\substack{\uparrow \\ \text{HCl}}}{0.02 \times 10^{-3}} + \underset{\substack{\uparrow \\ \text{surfactant}}}{2.38 \times 10^{-3}} \right]$$

$$= \frac{1}{2} [0.02 + 2.38] \times 10^{-3}$$

$$I = [1.2] \times 10^{-3} \frac{\text{mol}}{\text{l}}$$

$$\text{pH} = -\log(\text{H}^+)$$

$$\text{pOH} = -\log(\text{OH}^-)$$

Hamaker constant

$$\rho = 80 \times 10^{21} \text{ cm}^{-3} \text{ For } \text{SiO}_2 \quad \leftarrow \text{no of atoms per cc}$$

$$1 \text{ cm} = 0.01 \text{ m}$$

$$A = \pi^2 \rho^2 \underset{\substack{\uparrow \\ \text{London van der Waals constant}}}{C} =$$

$$C = 10^{-77} \text{ J m}^6 \text{ from Israelachvili}$$

$$A = \pi^2 (80 \times 10^{21})^2 \times 10^{-77}$$

$$A = 6.31 \times 10^{-19} \text{ J}$$

vdW force

$$-\frac{A}{6D^2} \left(\frac{R_1 R_2}{R_1 + R_2} \right)$$

$$= -\frac{A}{6D^2} \left(\frac{R^2}{2R} \right) = -\frac{AR}{12D^2} = -\frac{AR}{12D^2}$$

Calculated van der Waals force within range of 10^{-9} (?) from last equation.

Trying to see if I can get electrostatic force as well for two SiO_2 particles.

~~As~~

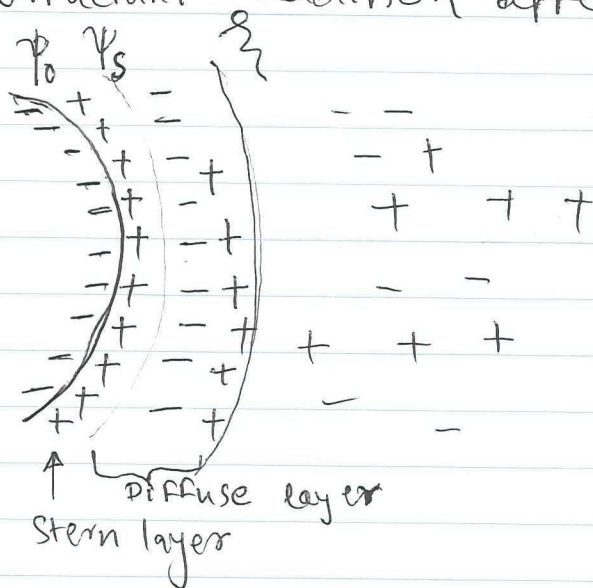
As we ~~can~~ adjust the interparticle distance; the forces on the potential needs to be taken in terms of interparticle distance D or D .

we assume $\zeta = \psi_0$ ϕ distance between two particles $2R$
 Zeta potential surface potential

addition of HCl or NaOH

How ~~much~~ pH affects the ionic strength of the solution?

How surfactant addition affects the ionic strength



$$\zeta = \psi_0 e^{-KD}$$

$$\psi_0 = \frac{\zeta}{e^{-KD}}$$

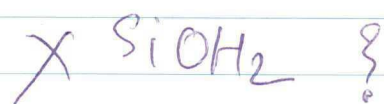
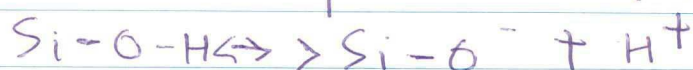
Only with heterodyne

21st July 2015 Tuesday
meeting with Hans.
electrophoretic mobility

~~(1) Zeta potential~~
Zeta potential $u = \frac{e\zeta}{4\pi\eta}$

~~ka ka~~ ~~IP~~ ~~ka~~ (kappa a)

Read paper Brady & refer it in the



Carboxylic acid

surface charge from ~~the~~ phreeqc.

what does phreeqc does.

Everything for Applo per kg water.

~~Electric~~ Electric double layer charge Φ .
 \uparrow
Surface charge

Alumina +

Hesseling \rightarrow polymer/surfactant
entropic repulsion

Tail of surfactant does Van der Waals interaction
to form connections around particle

~~the~~ Surfactant gives only negative charge

~~Can we put the surfactant~~

I reach Mumbai 21:40 LX154

22nd July 2015 Wednesday

- @ phreeqc with surface charge

What are the possible reactions?

23rd July 2015 Thursday
Phreeqc file ash surface complexation

log equilibrium constant search.

Robert W. Talbot

Qualitative model of Heterogeneous Equilibria
in a Fly Ash Pond

meeting in the evening.

Phreeqc



File saved; charges calculated

Complexes

Si-OH Si-OH₂ Al-OH Al-OH₂

Brady model surface complex model

For silicon it goes OK.

QBRN

CD-Music

EDL - Electric double layer

Gouy-Chapman model

Finally got surface potential in V

checking how to make from pH 1 to pH 12

ex8pH2n plots can be manipulated by asking output

You can get the pH result by changing the HCl in the program.

Aluminium species are still not right.

① pH 2 to 6 } combine by znle-7
② pH 6 to 12 } \downarrow
 znle-7d

Print file Need to write stuff about the things we are doing.
pqi printing file

Two o'clock ?

Anionic surfactant adsorption on oxides from book Zeta potential ~~book~~ Hunter page ~~308~~ 316
page 308

Densely packed, vertically oriented ionic surfactant layers are established on low-charge surfaces only near the bulk cmc value.

The additional adsorption energy involved in chemical binding ~~makes~~ ^{during} the interaction between oleate ions & haematite & calcite makes it possible for these ions to adsorb on a hydrophilic surface even when the electrostatic potential is unfavorable.

$$\Gamma_+ = \frac{G_i}{ze} = 2rc \exp(-\Delta G_{ads}^\circ / kT)$$

\uparrow
adsorption density

interaction between
Head group & surface

$$\Delta G_{ads}^\circ = 2e\psi_i + \Delta G_{HG} + n\Delta G_{CH_2}$$

electrostatic

\uparrow adsorption energy
of each of nCH_2 groups

P.z.c. point of zero charge

sulphonate group ~~is~~ has a pK_a value of ~ 1.5
Hunter 2002 Page 260

We have a hydrophilic surface. If the surface charge is ^{very} high, the number of adsorbed surfactant molecules may be so great that they are close enough together to encourage other surfactant molecules to adsorb into the spaces between them, interacting laterally by van der Waals forces. The apparent sign of the surface charge may then be changed from $+$ to $-$ or vice versa, but this is usually only possible near the c.m.c. of the surfactant.

27th July 2015 Monday

14:30 meeting with Hans

- ①
- ②
- ③

20th August - Revision of TIPM

Phreeq.c - Alumina results are not working

Introduction : Many people have studied but there are varieties of research.

2
or
3

pages

- ①
- ②
- ③

Conclusion

Introduction & conclusion should be mirror part

Write Conclusion for all four chapters & then write Introduction

The burden of ^{the} lonely heart has grown heavier over the PhD years.

29th July 2015 Wednesday

Plan of action :- ① Correction of ^{the} ~~the~~ paper

② Methodology of Thesis by adding three ~~methodology~~ methods & experiments including particle paper

शिवपदम सोसायटी, भूसारी कॉलनी, चांदनी चौक जवळ कोथरुड,
हॉयल फिल्ड्स सो रुम

KK Travels : +91 20 66097979 - 24 369797

Mobile ~~+91 98 22979797~~ - 98 22979797

12 August 2015 Wednesday

- Switch to English if you feel difficult
- Zorg dat ze weet wanneer ik klaar ben
- Proactive try to be
- STAR method
- Goie voorbeelden
- ten beetje ~~an~~ assertive
- een beetje meer duidelijk
- Onder de druk < (where the pressure is from)

7:49 Harkem 8:52

Station Delft → Station Beverwijk

Platb ~~inter~~
orm 1
Refractories for

Blast furnace, coke ovens, Bes vessels, hot metal &
steel ladles, tundishes, reheat & annealing furnaces

Tech & Quality control

benutting : profiter

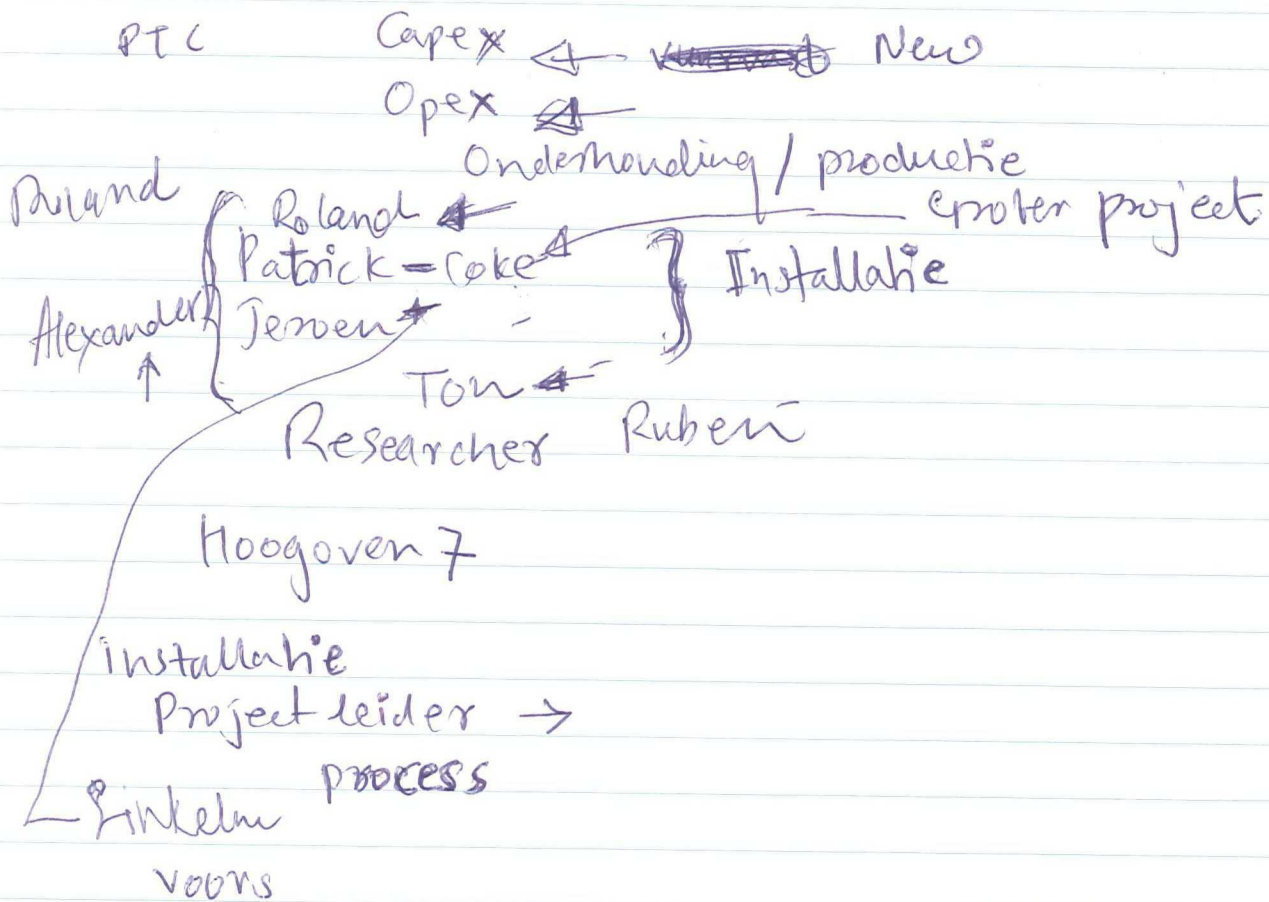
Introduction to refractories

Fick's second law

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2}$$

Heat transfer equations

Heat transfer — Conduction, convection, Radiation,



Roland 25 - R&D - half jaar in ~~PTC~~ Vuurvast

Hoogoven 7 Reparatie

gebruiker
project management

Business case

PTC - Project leider group

① 4 warmbandoven

② ~~2~~

③

Ton

walking beam

pushing oven

Qualiteit dienst



levgrandier omschrijving
↓
Product description

CRG Chemische / physical

project organisatie - begeleiden - Rijken van mogelijkheden

Correction to First paper

Comment on convergence of the numerical solution, and discuss not just spatial grid density but also temporal.

The diffusion of water & ~~gas~~^{bubble} were great problem.

we used objective function to get close to the experimental pressure drop.

$D_{nf} \quad 2.2 \times 10^{-5} \text{ m}^2/\text{s}$

$D_{cap} \quad 9.3 \times 10^{-7} \text{ m}^2/\text{s}$

Searching for the file where we run full & get the results now in journal paper.

Bentheimer_5th April - Quadratic_high diffusion.mph comes close but not exactly

mp2 figure is shown but we do not know where the information over domain is. that is the figure that is ~~observed~~ shown in ~~Domain~~ the journal.

$$2.3 \pm 0.1$$

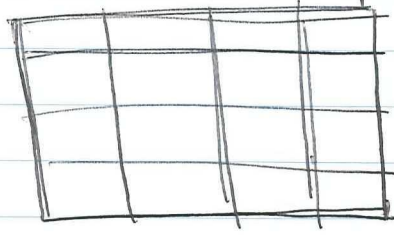
- Perturbation study

~~was for~~ The selected parameters are from optimised values. of ~~Diff~~ Bubble, capillary diffusion, K_a & K_d

with the objective of minimising the difference between experimental & simulated pressure drop.

18 August 2015 Tuesday

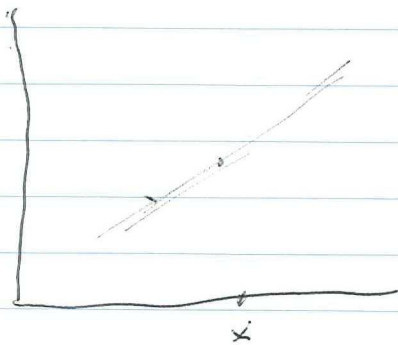
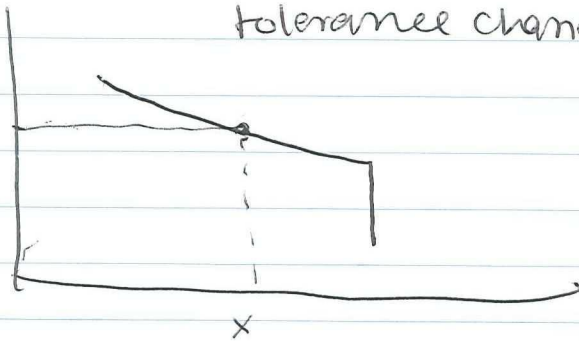
We give here one such example.



Spatial density \rightarrow
 0.00017 to 0.017 m
Does give the same result?

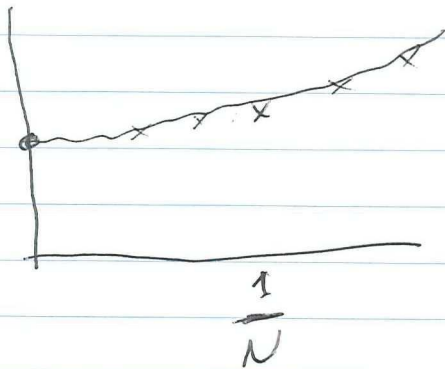
Temporal density \rightarrow Time tolerance

1×10^{-8} to 1×10^{-6} Does it give the
tolerance change same



ΔN

$\frac{1}{N}$



Convergence and xx

Convergence of numerical models

did not run 0.00017 so that
using 0.00034 mesh

Non linear partial differential equations in Engineering Ames

Plot of reciprocal of step size vs time step for
ideal condition

In the output Figure while running; You can
ask for Figures

Convergence analysis:-

As it is nonlinear problem ~~we cannot~~ it is outside of
our scope. Refer to the ~~code~~ article from Hans Bruining

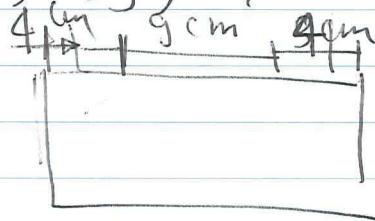
for second question : optimisation

Spatial geometry temporal geometry
(Second paper)

2. Capillary number, capillary ^{end effect} ~~number~~.

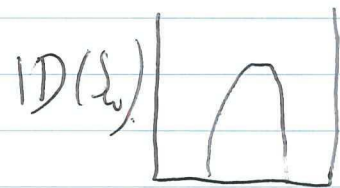
K1 near K2 Yortsos (eg lingen PhD Thesis
Y.C. Yortsos & Tincui Chang, Capillary effects
is steady state flow in heterogeneous core

TIPM 5 399-420 1990



$$\phi \frac{\partial}{\partial t} S_w + \frac{\partial}{\partial x} u_w = - \frac{\partial}{\partial x} \left(\frac{D(S_w)}{S_w} \right) \frac{\partial}{\partial x} S_w$$

$$\frac{\partial}{\partial x} D \frac{\partial}{\partial x} S_w = \frac{\partial}{\partial x} u_w$$



$$\frac{\partial}{\partial x} S_w = \frac{u_w - u}{D} = \frac{u}{S_w D_{av}} (f_w - 1)$$

$$\frac{D_{av}}{u} = \frac{k \lambda_w \lambda_{ss} \frac{dP_c}{dS_w}}{\lambda_w + \lambda_g}$$

19 Aug 2015

Trying to find the right file.

5th April ^{change Diff.}
Running last boy with $2.2 \times 10^{-5} \text{ m}^2/\text{s}$

$$\text{SWR} = -0.0390 \ln(2e) + 0.9819$$

I guess we just have to live with

Bentheimer - 5th April - Quadratic - high diffusion
mesh size 0.00017

Corrected S_{bound} estimated from the bubble density

Grid

~~Spatial~~ geometry 0.0017

Bentheimer - 5th April - Quadratic - high diffusion - Spatial geometry

① Grid 0.00017 Original

Optimum → ② Grid 0.0017 6 minutes, 25 seconds, 1118 DOF

③ Grid 0.000017 Taking too long 110007 DOF

④ Grid 0.017, 40 minutes 19 139 DOF
⑤ ~~Grid 0.17~~ 1 seconds

3:25 ① Tolerance 1×10^{-8} Original

3:50 ② 1×10^{-6} 27 min 14 seconds } 11029

4:33 ③ 1×10^{-4} DOF ~~11029~~

④ 1×10^{10}

5:19 ④ Parametric sweep for

5.18

~~5.18~~ 9.3×10^{-7}

2.2×10^{-5}

20 Aug 2015 Thursday

Writing description of the results

Capillary entry & end effects that affects foam mobility measurements.

How far from the ends the measurement should be taken?

Yortsos paper &

What is the point of CEG Lingen Thesis heterogeneity studies. & Yortsos paper is also related to it; Why Hans wanted to study Yortsos & Lingen?

Bill's paper on Numerical challenges in foam simulation

Apaydin Transport in porous media end effects on foam flow in porous media

Leverett Capillary behavior

~~Voron~~ Virovsky, SPE 30541, Steady state Relative permeability measurements corrected for capillary effects

Capillary end effect

during immiscible displacement ① In the bulk of the core plug, $P_c = f(S_w)$ & ② at the outflow face $P_c = 0$ $S_w = 1$

The saturation gradient from the bulk of the core plug to the outflow face is the "Capillary End Effect"

⑥ For higher flow rate it is lower than for lower flow rate. Capillary end effect can be eliminated by measure saturation far enough away from outflow face (e.g. Penn State method) & use high flow rates to make error in measured saturation negligible.

Trying to get data values for each case of parametric sweep

Found the way to plot the solutions

~~edit~~ settings : Global plot

Plot group 16 Global 1

Data set study 1 / Parametric Solutions 1
Parameter selection (edit, difn) All
Time selection all

How to plot the data

Dap & Dnf

Tommorrow add the fig. (uneditd) & discuss with
Hans description.

① ② ③ $9.6e-7$ $2.2e-4$
④ $9.0e-7$

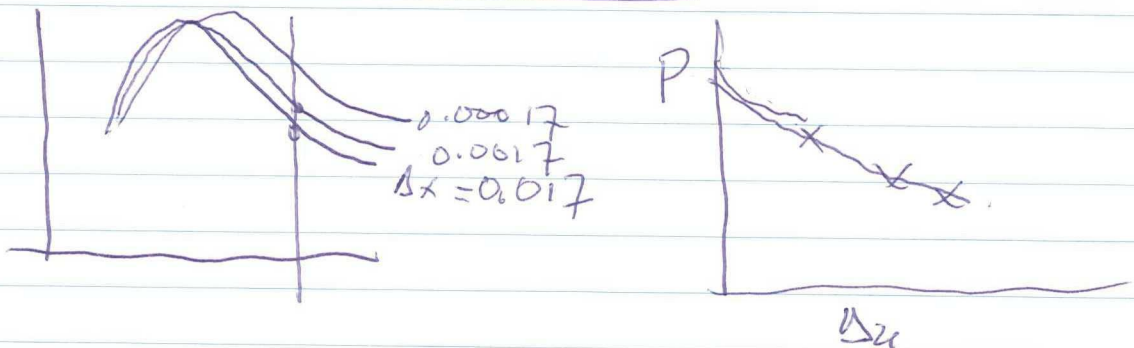
QGRSPYBI

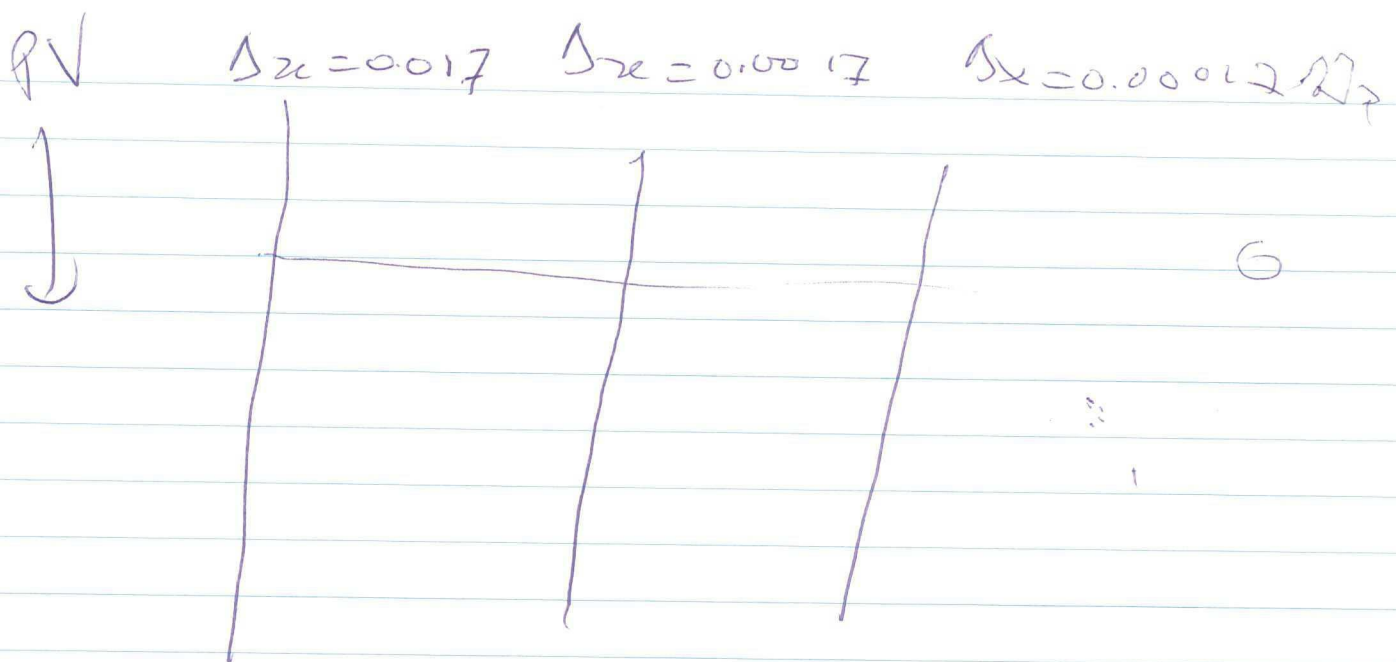
~~edit~~ Meeting with Hans

Consistent solution ; limited grid density,
↑
search google

Solution where extrapolate to zero

Convergence, consistency & stability on wikipedia





$\Delta x \rightarrow 0$ proving convergence,
 Comsol: \rightarrow Tolerance

Hans's presentation 1D simulation with Comsol

Tolerance - spatial density \rightarrow grid

Temporal $\rightarrow \Delta t$ time space
 combination of

Program cannot separately change Δt ,
 Tolerance (eps)

Plot graphs with $1e-08$; $1e-06$, $1e-04$

~~we did~~ If I change ^{single} parameter; what change
 I get
 What is the most sensitive parameter.

IF your solution changes ~~sp~~ drastically, then
~~it is~~ the ~~solution~~ ^{parameters} have lot of impact.

Second paper: Why would AP depend on salinity

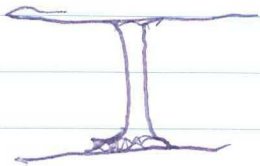
Larger the pressure drop
 Why ~~the~~ would it be square root of K

Moll 0.5 mol/l $1 \times 10^{-7} \text{ mol/l}$
 $(1.19) \times 10^{-3} \text{ mol/l}$

~~AR~~
Eq. 1 represents experimental data

Pressure drop
Hirasaki shows

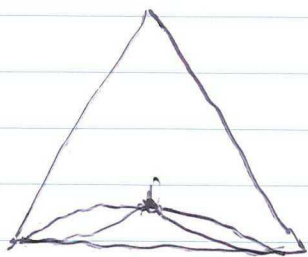
①
②



① Very little is known

②

Salt concentration vs interfacial tension



Shah & Schechter

U_g & U_L

③ We are in low quality foam where $\Delta P \propto U_L$
The formula gives average trends;

~~The data results we are~~ The goal is to search for better representation with more parameters. However it is not ^{warranted for} ~~substantiated~~ no of data set which we had to derive more complex relationship with

predicted pressure drop is same for cases where the permeability

Generated trend is that gas velocity has no effect because most data is low quality. In case high quality points, at same permeability

& sensitivity : we find predicted data clustered contrary to observed data. This indicates that more experiments are required in high quality regime.

Convergence plot in consol

Time dependent ~~study~~ ^{study} was used with solver
Mumps

~~Mumps~~

Linear solver was direct, restrictions of step size update 10.

Termination techniques was on tolerance based with maximum number of iterations 5 & tolerance factor 1.

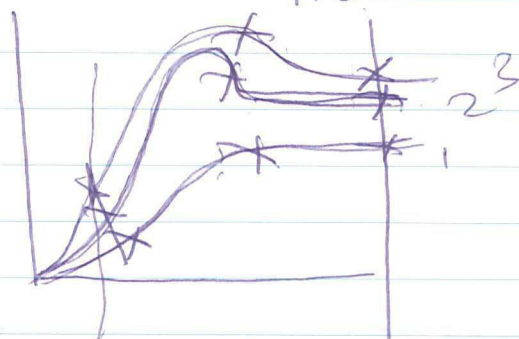
~~Tolerance error~~ 25th August 2015 Tuesday
Meeting with Hans

Tolerance consol

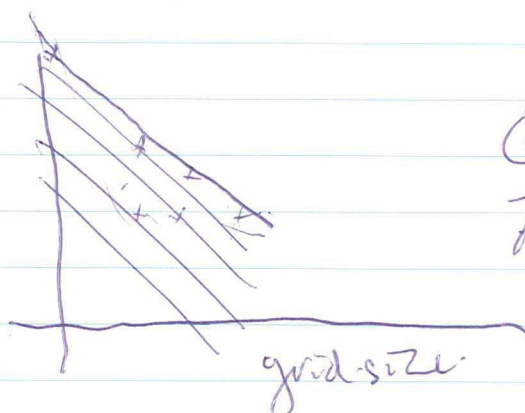
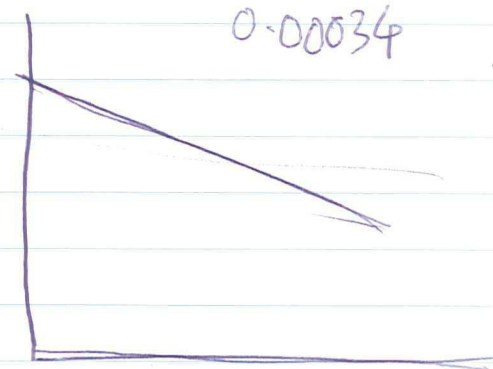
— Absolute + relative error
Extrapolation

Try 0.000017

Some mesh size in between 0.017 & 0.0017
0.00034



into extrapolation



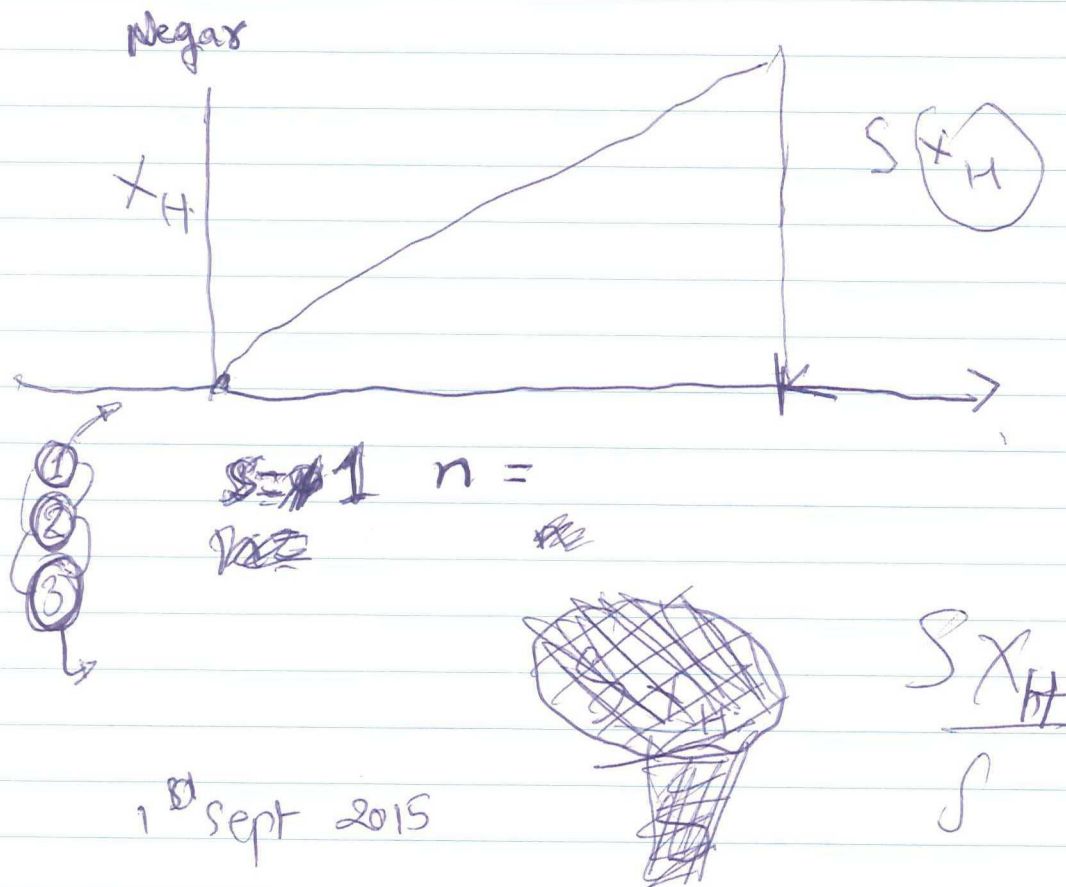
$$\frac{Q}{A} = \frac{k}{L} \frac{\Delta P}{\Delta L}$$

26 August 2015, Wednesday

~~Revis~~ Using 0.000017 mesh & abandoned around 1.0 sec
Using 0.000085 only 639 sec & then crashed.
Original was 0.00017.

Correcting big 4b

Writing ~~re~~ comment on reviewer



Splitting the equation

For certain blow rates

LaTeX: Solved the problem of ^{single} references by putting all chapters in the dissertation file.

changes by Hans

- ① Grid 0.00017 original
- ②
- ③
- ④ Grid 0.00005

} After trick by
Hans of splitting
the equations

Side by side running latex to check ~~for~~ error, warning, Bad box etc.

① Orin ② Pavell ③ Wolf ④ Bouli ⑤ Hans
 ⑥ ~~Ge~~ Kaper ⑦ Koster ⑧ Rector magnificus ⑨ Timmo Himoveren
 Kraaikamp
 ⑩ Henri Bestin

Running box ^{higher} ~~lower~~ tolerances $1e-6$

How much different the results are with splitting the equation

Probably initial 100 sec line needs to be changed for all cases.

$$\begin{aligned} & \partial_{\eta} \eta \partial(s, t) \\ & \eta \partial_{\eta} \partial(n, t) \end{aligned} \quad \begin{aligned} & - K(K \eta \times f(n)) \quad A_X - \gamma \log(p) \\ & \partial_{\eta} \partial_{\eta} \end{aligned}$$

Checking the Figure 14 result. Actually ~~no~~ only first data points changes which cannot be seen in the results anyway.

It is almost same, so not changing anything there.

$$9.3 \times 10^{-7} \quad \times 10^{-6} \quad , \quad \times 10^{-5} \quad , \quad 10^{-8}$$

Dep 1st Sept 2015

$$9.3 \times 10^{-7}$$
$$9.3 \times 10^{-5}$$
$$9.3 \times 10^{-6}$$

$$9.0 \times 10^{-7}$$
$$9.6 \times 10^{-7}$$

29th Sep

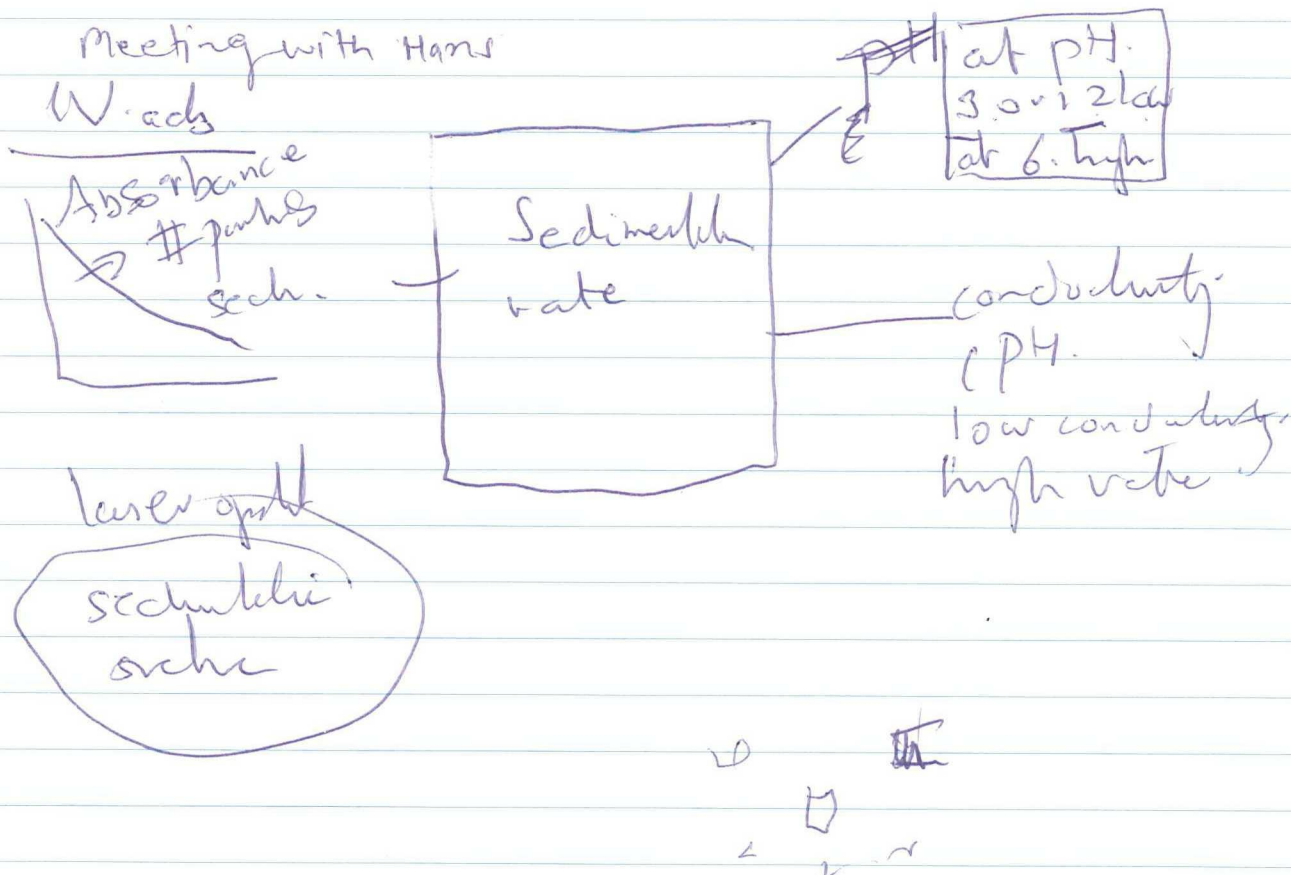
Parametric sweep Dnf
 2.2×10^{-5} ✓
 2.2×10^{-4} ✓
 2.0×10^{-5}
 2.4×10^{-5}
 ~~2.6×10^{-5}~~
 2.2×10^{-6}

~~Putting~~ putting the ~~equation~~ two figures
 inside & then done
 with

3rd September 2015

submitted the first paper.

4th September 2015



Need to add figures of each ~~sample~~ ~~meas~~ instrument

Need to define ~~each~~ each measurement
 Zetapotential; particle size electrical conduct
 ivity etc. low strength;

8 Sept 2015

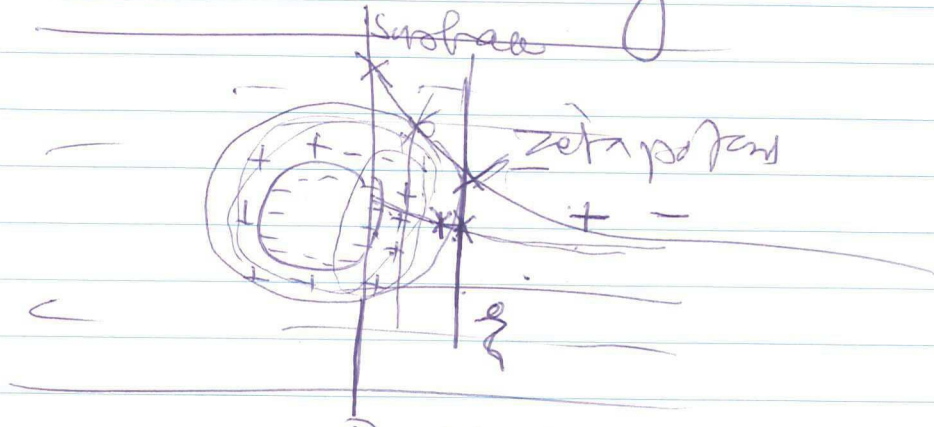
measuring

~~establishing colloidal~~

Title: ~~investigating~~ - stability of

silica based nanoparticles
for enhanced oil

recovery



Double layer

Either small particle or low sedimentation rate
particle size is small.

write unit

Surfactant containing samples for DLVO
Mie scattering picture.

~~Assor~~

9 September 2015 Wednesday

Mindstress relief course

10 September 2015 - Donderdag

Course : Assessiviteit = relatie
communicatie

Concentration sedimentation size.

Friday 11 Sept

defector 6 ÷ digital manual 8

Mie scattering
uv spectrophotometer - Shimadzu

Attenuation is same

$$\ln \frac{I_1}{I_{10}} = -k \quad I_1 = I_{10} \exp -k.$$

$$\ln \frac{I_2}{I_{20}} = -k \cdot \quad \underline{\underline{I_2 = I_{20} e^{-k \cdot t}}}$$

$$I_1 + I_2 = (I_{10} + I_{20}) \exp -k$$

$$\frac{I_1 + I_2}{I_{10} + I_{20}} \ll \exp^{-k}$$

Training :- Constructive thinking

- ① More enthusiasm about jobs
- ② More focus on finishing PhD
- ③ More ~~exercise~~ motivation for exercise

S Specific
M measurable
A Acceptable
R Realistic
T Time bound

Acceptance & Commitment theory

$$\frac{Q}{A} = \frac{k}{\mu} \frac{\Delta P}{L}$$

u

Pressure ~~drop~~ profile across x direction

The error of babel english is removed by deleting ~~the select~~ "language = English" from reference files.

ASH-AOS

Sample	wavelength	Absorb	Sample	wavelength	Absorb
2.92	971	0.411	4.12	976	0.389
2.92	979	0.346	4.12	967	0.322
2.92	968	0.306	4.12	969	0.277
9.36	966	0.225	11.05	967	0.385
9.36	969	0.203	11.05	971	0.320
9.36	969	0.203	11.05	975	0.275

molar concentration of particles ?

$$0.04 \frac{g}{l}$$

$$1.19 \times 10^{-3} \text{ mol/l}$$

$$\approx 0.0375 \text{ w/w}$$

$$0.375g$$

$$\bar{e}$$

$$\frac{0.375g}{315 \frac{g}{mol}} = 1.19 \times 10^{-3} \frac{mol}{l}$$

$$1 \text{ dm}^3 = 1 \text{ l}$$

Silica molecular weight 60.08 g/mol

Alumina molecular weight 101.96 g/mol

Silica Al₂O₃ CaO ironoxide 159.6g g/mol

60 20 10 10

Calcium Oxide 56.07 g/mol

Fly ash molecular weight =

$$0.6 \times 60 + 0.2 \times 102 + 0.1 \times 159.6g$$

$$44.97 \frac{g}{mol}$$

$$77.9$$

$$+ 0.1 \times 56.07$$

0.04 g of water
100 ml

4 g of water

0.0375 g of water
100 ml

0.04 g of ash per 100 ml of water

$$\frac{0.04 \text{ g}}{100 \text{ ml}} \approx 0.04 \times 10^{-2} \frac{\text{g}}{\text{ml}} \approx 4 \times 10^{-4} \frac{\text{g}}{\text{ml}}$$

$$4 \times 10^{-4} \frac{\text{g}}{\text{ml}}$$

$$\frac{4 \times 10^{-4} \frac{\text{g}}{\text{ml}}}{77.77 \frac{\text{mol g}}{\text{mol}}} \approx \frac{5.13}{889} \times 10^{-5} \frac{\text{mol}}{\text{ml}}$$

Fly ash	$2.89 \times 10^{-3} \frac{\text{mol}}{\text{l}}$
Concentration	5.13
Aos	$1.19 \times 10^{-3} \text{ mol/l}$

Figure effect of pH on the absorbance of the samples at wavelength 975 nm.

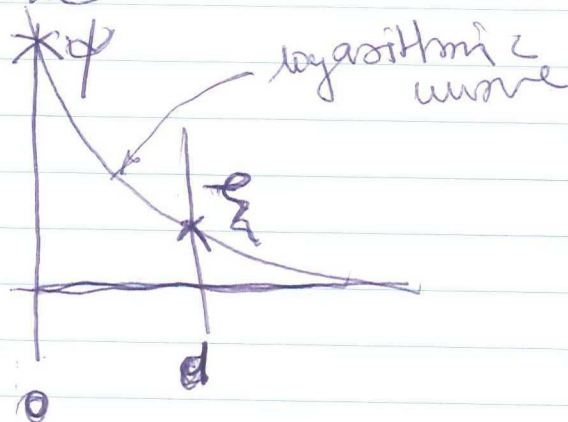
pH 9.0 shows lowest absorbance

Zeta potential & distance

$$K_a =$$

$$\xi = 10^d$$

$$\psi = 10^0 = 1$$



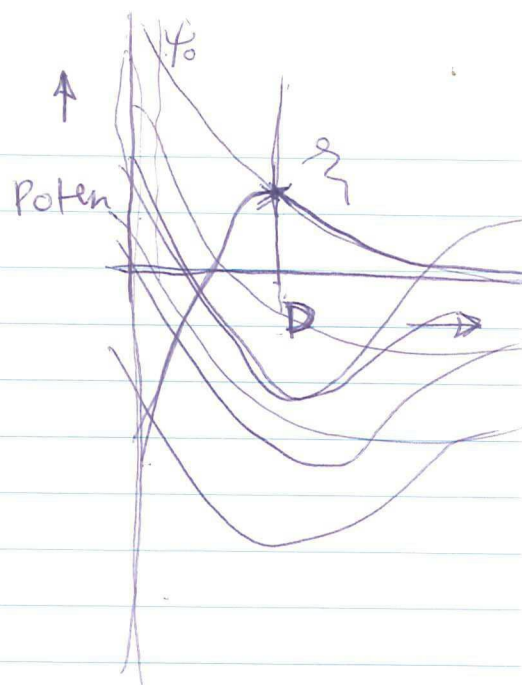
$\log \xi = d \log x$ find out
↑ ↑
I know I know

potential
 y
 $b = x$ distance

$$y \log b = \log x$$

$$\log b = \frac{\log x}{y}$$

$$y \log b = 10 \text{ nm}$$



If we consider $\psi_0 = 3 \times \zeta$ then you get ~~rather~~ desired results. But is it also correct.

Do interaction constant

$$Z = 9.2 \times 10^{-9} \tanh^2 \left(\frac{\psi}{103} \right)$$

$$\psi = \zeta \exp(-Kx)$$

$$Z = 9.2 \times 10^{-9} \tanh^2 \left(\frac{\zeta \exp(-Kx)}{103} \right)$$

Density of fly ash

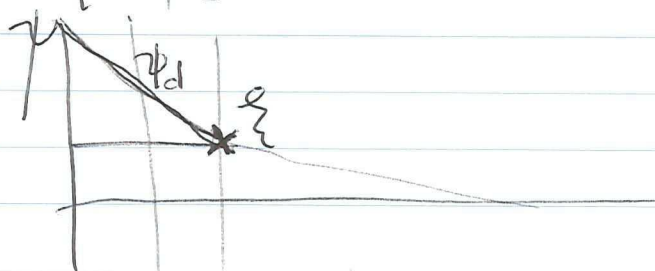
$$= 0.6 \times \text{Silica den} + 0.2 \times \text{Al den} + 0.1 \times \text{Fe}_2\text{O}_3 \text{ den} + 0.1 \times \text{CaO density}$$

$$= 0.6 \times 2.2 + 0.2 \times 3.95 + 0.1 \times 5.24 + 0.1 \times 3.35$$

$$= 2.969 \text{ g/cc}$$

$$\psi = \zeta \exp(-Kx)$$

$$\psi = \zeta \exp(-Kx) \quad \text{hydrodynamic radius?}$$



Mix samples

	282	462	52	7	9	11
R	667	577	846	759	2059	1016.5
R	-46.8	-74.6	-38.4	-35.5	-69	-51.7
I	0.0015	0.00191	0.00190	0.00190	0.00191	0.00241

intermolecular expansion factor

Flory radius $R_F = \alpha R_g$

Radius of gyration of polymers
monomer length

Flory 1953 paper
1969

$$R_F \approx l n^{3/5}$$

no of segment

$$R_g = \frac{l \sqrt{n}}{\sqrt{6}} = \frac{l \sqrt{M/M_0}}{\sqrt{6}}$$

molecular weight

Flory-Huggins interaction parameter

Short-range protrusion boxes

$$\epsilon(z_i) = \pi \delta V_i z_i = \chi_p z_i$$

distance from the surface

interaction parameter

Protrusion decay length $\lambda = \frac{kT}{\chi_p} = \frac{kT}{\pi \delta V_i}$

$$\delta = 0.3 \text{ nm} \quad V_i = (20-50) \text{ mJ/m}^2$$

For amphiphilic hydrocarbon molecules

The interfacial width of an immiscible polymer interface

$$a_I = \frac{2b \text{ segment size}}{\sqrt{6} \chi}$$

$$\chi = 6 \left(\frac{30}{-1.41 \times kT} \right)^2$$

six

$$\chi = \frac{6}{\text{six}} \left(\frac{V_i}{b^2 kT} \right)^2$$

number density of monomers

Γ protrusion sites per area $\sim 1/\delta^2$

$$w(D) \approx 36 \Gamma k T e^{-D/R_g}$$

$$V_s = 30 N_A \pi r^2 (0.5 - \gamma) \left(1 - \frac{h}{2g}\right)^2 / (8^2 \text{ Mvol})$$

Surface potential

$$\psi_0 = \frac{RT}{F} \ln \left(\frac{a_{H^+}}{a_{H^+}^{PZC}} \right)$$

\uparrow Faraday constant \uparrow point of zero charge
 \nwarrow activity of H^+ ions in soln

What is the point of zeta potential then? PZC?
 PZC for us is 3.75 pH

Debye ———— Debye-Huckel equation

$$\log \gamma = \frac{-0.51 z^2 \sqrt{\mu}}{1 + (z \sqrt{\mu} / 305)}$$

~~exp~~ ~~ionic strength~~ ~~M~~

	0.001	0.005	0.01	0.05	0.1
γ_{H^+}	0.967	0.933	0.914	0.86	0.83

~~log~~ $pH = -\log[H^+]$

For pure water molar & molal concentration are same.

$$pH = -\log a_{H^+}$$

$$\psi_0 = \frac{J}{\cancel{\text{mol} \cdot K}} \times \frac{K \times \cancel{\text{mol}}}{C} = \frac{J}{C} \quad \checkmark$$

$$pH = -\log_{10} a_{H^+}$$

$$e^{pH} = e^{-\log_{10} a_{H^+}}$$

$$\pi_{\text{static}} \propto \frac{k_B T}{s^3} \left[\left(\frac{2s}{h} \right)^{3/4} - \left(\frac{h}{2s} \right)^{3/4} \right] \text{ at } 0 < 2s < h$$

$$\pi = 0 \text{ at } 2s \geq h$$

↑
layer

~~Flory-Huggins~~ Flory-Huggins parameter

$$V_s = 30 N_A \underbrace{4\pi r^2}_{\text{Absorbed weight}}^2 (0.5 - \chi) \left(1 - \frac{h}{2s} \right)^2 \underbrace{\left(\frac{1}{s^2} \text{ MVol} \right)}_{\text{layer thickness}}$$

water density
of water

$$\left(\frac{2s}{h} \right)^{3/4} - \left(\frac{h}{2s} \right)^{3/4} = \left[\left(\frac{2s}{h} \right)^3 - \left(\frac{h}{2s} \right) \right]^{3/4}$$

$$\left[\frac{2s(2s)^3 - h^2}{h \cdot 2s} \right]^{3/4}$$

$$\left[\frac{2s \cdot h \left(\frac{(2s)^2 - h}{h \cdot 2s} \right)}{h \cdot 2s} \right]^{3/4}$$

$$\left[\left(\frac{2s}{h} \right)^3 \frac{h}{2s} - 1 \right]^{3/4} \Rightarrow \left[\left(\frac{2s}{h} \right)^3 \frac{h}{2s} - 1 \right]^{3/4}$$

$$\left[\left(\frac{2s}{h} \right)^4 - 1 \right]^{3/4} \approx \frac{2s}{h} \left[\left(\frac{2s}{h} \right)^3 - 1 \right]^{3/4}$$

$$W(D) = 30 \Gamma K T (L/s) e^{-\pi D/L}$$

Penetration energy two brush layers

$$\pi_{\text{static}} = \propto \frac{k_B T \Gamma}{s} \left[\right]$$

$\phi =$

Steric potential due to PEG coating

$$= 2 \pi K T R \Gamma^2 N A \sim$$

Surface potential in case of PEG coated silica particles in contact with AOS solution

Particle size correction

Debye Hückel approximation $\gamma_{d,0} = \frac{1}{2}$

for isolated surfaces $\gamma_0 = \frac{RT}{F} \ln \left(\frac{a_{H^+}}{a_{H^+}^{\text{PZC}}} \right)$

Finally got the things right with our own formulae from Israelachvili.

y

Using the ~~Debye~~ Debye-Hückel approximation

The problem with using ~~surface~~ activity based surface potential is that it ~~has~~ has drawbacks in case of oxide particles

Potential-determining ions & indifferent ions

Potential determining ions are the ions that actually generate the surface charge

$$\sigma_0 = \sum_i z_i F \Gamma_i$$

i.e. $P = p \cdot z \cdot c$ in case of SiO_2 ?

Specific adsorption of an anion causes a shift in the opposite direction, of the point at which ζ changes sign. Fuerstenau : point of zeta potential reversal (P.Z.R.) When it is caused by a specific adsorption process.

James & Parks 1980 model for ^{specific} adsorption on oxide
Eilers & Korff 1940 ζ potential & coagulation behavior
Schulze - Hardy rule CCC

Modi & Fuerstenau 1957 for Al_2O_3

- ① PdI H^+ & OH^-
- ② the indifferent ions Cl^- & NO_3^- , Na^+ , & Ba^{2+}
- ③ Specifically adsorbed ions SO_4^{2-} & $\text{S}_2\text{O}_3^{2-}$

Alpha-Olefin sulphonates ^{head group}

Point of zero charge for fly ash is between 3 & 4

~~Surface complexation~~ Surface complexation models. $\therefore \rightarrow$ comes back to phreeqc

26th september

~~DR~~ Doctoral Regulations (DR)

Doctoral timeline. - 11 weeks - 14 weeks

Printing company ~~→~~

Talk to Hans \rightarrow about money for printing cost, travel cost for committee members.

Check for plagiarism

Check 10.4 for regulation about rule for checking Hans

Form B, C & D can be signed by the other supervisor

Draft dissertation should be complete.

Three slots: 10:00, 12:30 & 15:00

~~Ad~~ Fix the committee \rightarrow Check their approval

23rd December is free?

To UG's

[Scanned Form B

PDF version of draft dissertation & proposition

Form C inviting the form C

Take contact committee members to ~~read~~ read form C.

~~still~~ two weeks before the ~~print~~ Thesis

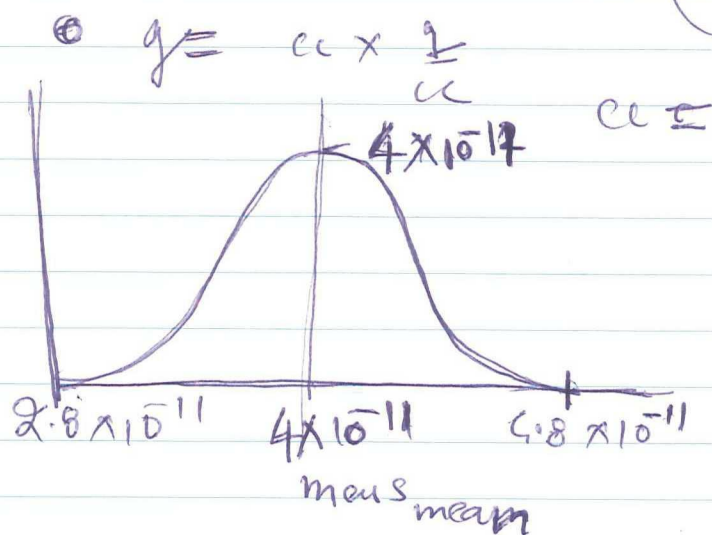
Board of doctorates \rightarrow ~~Choose the the one someone~~

Karel Luybens

At least one ~~member~~ ^{from} member ~ outside

29th September 2015 Tuesday

$$\text{mass} = \frac{4\pi r^3}{3} \times \rho \quad r = \left(\frac{\bar{m} \times 3}{4\pi \rho} \right)^{1/3}$$



Mass - mean mass

$$\frac{1}{\sqrt{2\pi}\sigma^2} \exp \left(-\frac{(\text{mass} - \text{mean mass})^2}{2 \text{Std dev}^2} \right) \times \frac{5}{10}$$

$$f(x) = a \exp \left(-\frac{(x-b)^2}{2c^2} \right)$$

$a = \frac{1}{\sqrt{2\pi}\sigma^2}$ $b = \text{mean mass}$ $c = \text{Std dev.}$

Probability density Function of a normally distributed random variable with expected value $\mu = b$ variance $\sigma^2 = c^2$

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp \left(-\frac{1}{2} \left(\frac{x-\mu}{\sigma} \right)^2 \right)$$

mean mass maximum no of particles

size of the particles r
Volume of the

For case pH 2.82

Total Volume

$$\text{Volume} = \frac{4}{3} \pi r^3$$

~~$$r = 0.072$$~~

$$\frac{7x}{100} = \frac{4}{3} \pi r^3$$

255.0019

$$x = \frac{4}{3} \times \frac{100}{7} \times \pi r^3$$

$$\left(\frac{255.0019}{2} \right)^2$$

$$\text{mass} = \frac{4}{3} \pi r^3 \times \rho$$

$$\text{mass} = \text{volume} \times \text{density}$$

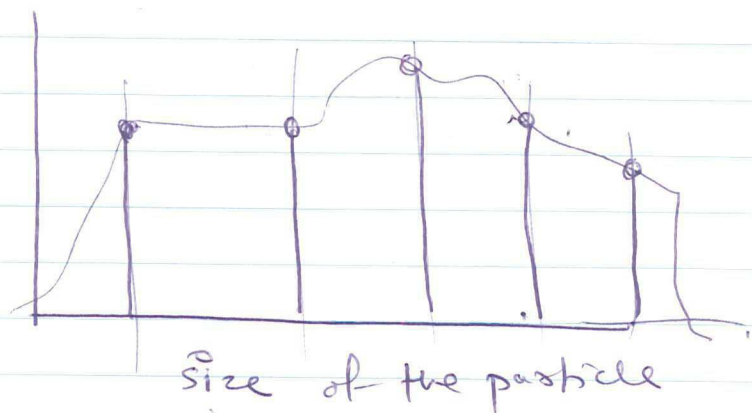
what would be the total volume

$$\text{Volume per particle} = \frac{4}{3} \pi r^3 = \frac{4}{3} \pi$$

$$\text{Total mass} = m_1 + m_2 + m_3 + m_4$$

$$m_1 = n_1 \times \frac{4}{3} \pi r^3$$

$$V = \frac{4}{3} \pi r^3$$



$$m = \frac{4}{3} \pi r^3 \times \rho$$

$$\text{Total volume} = 2 \times 10^{-20} \text{ m}^3$$

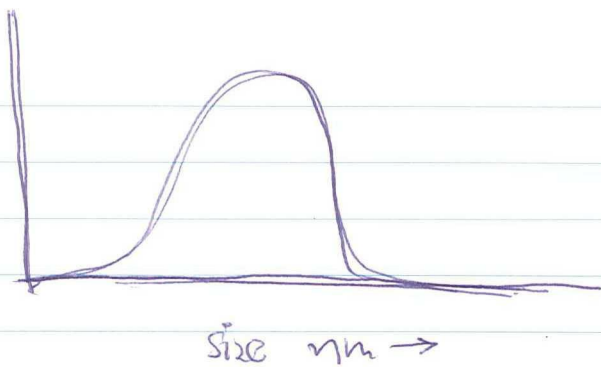
$$v = \frac{2}{g} \frac{(p_f - p_i) g r^2}{\mu}$$

$$\text{Standard deviation} = \sqrt{\frac{(x - \mu)^2}{n}}$$

Std deviation -

Average mass -

$$\frac{M - \text{mean}}{\sigma}$$



Comparison between sedimentation rate calculated from particle size distribution and light intensity experiments

① Sedimentation rate from particle size distribution

velocity $V_i = \frac{2}{9} \frac{r_i^2 \rho_i g}{\eta}$ $f = \text{constant}$

$$m_i = \frac{4}{3} \pi r_i^3 \rho_i$$

mass distribution $\Delta m = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{(m-m_0)^2}{2\sigma^2}\right) \Delta m$

$m_i + \Delta m$

$$\frac{\Delta r}{r} = \frac{6}{10}$$

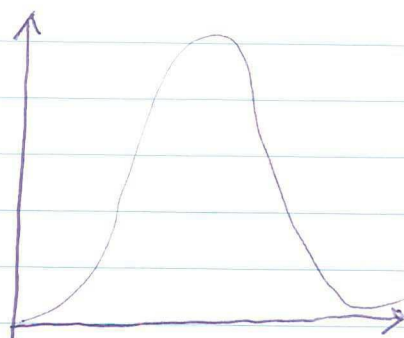
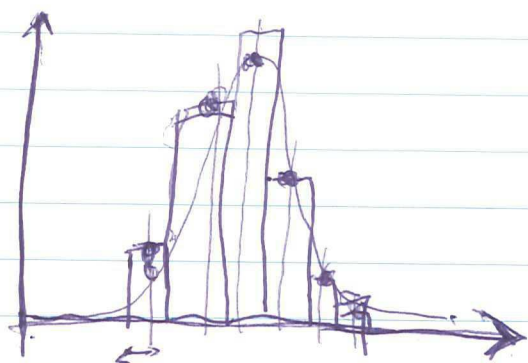
probability distribution function

0.04 g/ml ?

$m_i + \Delta m = m_{i+1}$

$m_{i+1} = m_i + \Delta m$

Normal distribution function



Recht, Mann, Ressen, Wolf, Paulli, Tino, ~~DT~~

$$I(\omega_i)$$

$$\phi \frac{L}{2}$$

$$V_i(t) = \frac{L}{2}$$

Intensity : \Rightarrow as a function of volume (ω)
Table of mie scattering as a function of the volume.

$$2\pi R \text{ (real imaginary)}$$

For zero scattering coefficient = total attenuation coefficient

The angles does not effect 100, 200 or 5

Complex refractive index for ash particles

Relative attenuation coefficient

$$P(\omega_i) \sim \text{concentration}$$

$$P(\omega_i)$$

$$\ln \frac{I_0}{I} = (\sum \alpha_i c_i) l \quad \alpha_i / \text{mm}$$

Total attenuation coefficient = Absorbance

$$\frac{I}{I_0} = \exp(-\sum \alpha_i c_i l)$$

$$\frac{dI}{I} = k dx$$

$$\ln \frac{I}{I_0} = -kx$$

$\sum_{i=1}^n (\alpha_i c_i)$

$$L = 10 \text{ mm}$$

$$c_i = c_{i0} H\left(\frac{L}{2} - v_i t\right) \quad \left[\frac{\text{count}}{\text{m}^3} \right]$$

$$\alpha_i = \text{mm}^{-1} (\text{count} / \text{m}^3)$$

$$\alpha_i = 1 / \text{mm}^{-1} (\text{count} / \text{m}^3)$$

$$\bar{M}_w =$$

mol

average molecular weight

mol fraction

No of particles is calculated using number frequency of the ped from Panda & Lake

$$255 \times 10^{-9} \text{ m}$$

$$255 \text{ nm}$$

$$255 \times 10^3 \text{ m}$$

$$255 \times 10^3$$

$$1.0$$

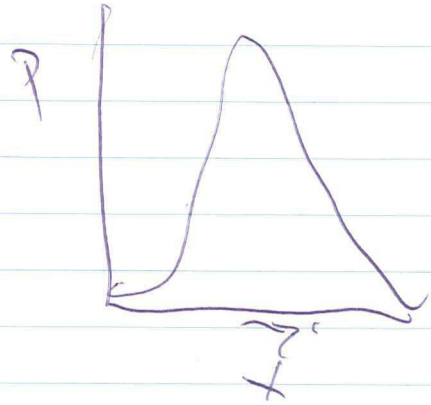
35817427 no of particles per for

$$8.68 \times 10^{-21} \text{ m}^3$$

n no of particles 1 m³

$$\exp I(t) \quad \bar{I}^{\text{Her}}$$

$$P(x) \cdot [x^{-1}]$$



$$nm_p = C_i \quad ?$$

$$\frac{35817427}{8.68 \times 10^{-21}} = \text{no of particles per m}^3$$

$$1 \text{ m} = 1 \times 10^{-6} \text{ } \mu\text{m}$$

$$1 \text{ m}^3 = 1 \times 10^{-18} \text{ } \mu\text{m}^3$$

$$\frac{35817427}{8.68 \times 10^{-3}} = \text{no of particles per micron}$$

$$kg \quad n \equiv \boxed{\boxed{lg \, n}}$$

2nd October 2015

per ml of water $4 \times 10^{-4} \text{ g}$

1 ~~litre~~ ltr of water

~~1 ml~~ 1 ml = 1×10^{12} cubic micron

1 ml

$$1 \text{ cu.m} = 10^{18} \text{ cu.micron}$$

$4 \times 10^{-4} \text{ g}$ per ml

$4 \times 10^{-4} \text{ g}$ per 1×10^{12} cubic micron

$$4 \times 10^{-16} \text{ g per cu.micron}$$

Total mass $4 \times 10^{-16} \text{ g}$ per cu.micron

$$4 \times 10^{-4} \text{ g/ml} \Rightarrow \frac{4 \times 10^{-4} \text{ g}}{1 \text{ ml}}$$

$$\frac{0.4 \text{ g}}{\text{m}^3} \rightarrow \frac{0.4 \times 10^{-18} \text{ g}}{\text{cu.micron}} \rightarrow \frac{4 \times 10^{-19} \text{ g}}{\text{cu.micron}}$$

$$\frac{I}{I_0} \quad -\log_{10} \left(\frac{I}{I_0} \right) = \epsilon \cdot c \cdot l$$

$$\epsilon = -\log_{10} \left(\frac{I}{I_0} \right) \frac{1}{\epsilon \cdot l}$$

$$-\log_{10} \left(\frac{I}{I_0} \right) \frac{1}{\epsilon \cdot l} = \sum_{i=1}^{\infty} P(\Omega_i) H \left(\frac{L}{2} - \nu_i t \right)$$

$$c = \frac{n}{V}$$

Number concentration

$$C_i = N_A \cdot c_i$$

$$N_A \cdot c_i = N_A \cdot -\log_{10} \left(\frac{I}{I_0} \right) \frac{1}{\epsilon \cdot l}$$

Constructive thinking : →

2

Norms : → Gives structure to life

Fear of failure → Fear

Fear → Flight

Anger → Fight

① Try to think about norm

i- Relationships : — It makes me feel complete

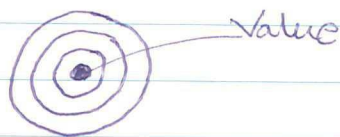
Guidelines vs. law

Value → life goal

↓
norms

Homework : Bull's eye exercise

from Paula



Complex
Refractory Index of
ash

$\propto C$

$$\frac{m \cdot l}{l} \propto m$$

Total attenuation

$\frac{m}{m} \propto \frac{m}{m}$ particles
concentration

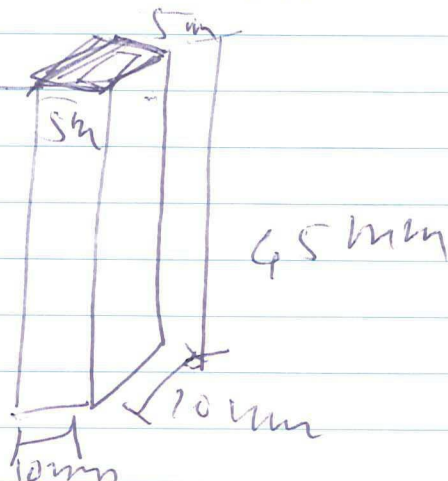
Concentration of spheres per cubic micron

↑
Is this volume of water

$$\kappa(l) = 3.5716$$

$$El = \propto$$

$5 \times 5 \times 45$
volume



Particle of $1 \mu\text{m} \rightarrow$

Volume $\frac{4\pi}{3} 10^{-10} \text{ m}^3$

Weight $\frac{4\pi}{3} \times 10^{-10} \rho$

Mol wt $6.0225 \times 10^{23} \frac{4\pi}{3} \times 10^{-10} \rho$

$40 \times 10^5 = 4.0 \times 10^6 \text{ mol wt}$

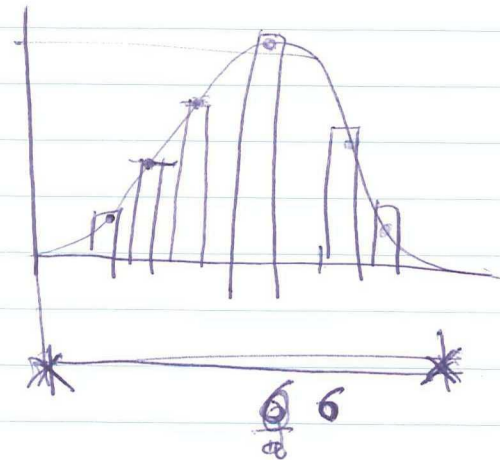
$M_{wt} = \sum x_i M_i$

Mass density ρ $\frac{\rho}{M_{wt}} = \text{molar density}$

1125 mm^3

$1 \text{ mm} = 1 \text{ mm}^3 = 1 \times 10^{-9} \text{ m}^3$

Total Volume.



Probability density of the normal distribution

$m - 3\sigma$ & $m + 3\sigma$

$\Delta m = \frac{6}{10}$

$$A = -\log_{10} \left(\frac{I}{I_0} \right) = \sum_{i=1}^{\infty} \epsilon_i l c_i$$

i is the radius for which we measure the absorbance.

$$\epsilon_i = -\log_{10} \left(\frac{I}{I_0} \right)$$

$$c_i = \frac{\sum_{i=1}^{\infty} \epsilon_i}{l}$$

$$\text{Theoretical } -\log_{10} \left(\frac{I}{I_0} \right) = \sum_{i=1}^{\infty} \epsilon_i l p(\Omega_i) \quad \left(L_{1/2} - v_{it} \right) \Delta \Omega$$

$D_{\text{min}} 0.255$	0.458	0.295	0.396	0.341
$E_{\text{Per mm}} 0.76698$	10.052	1.5088	5.467	2.916

$$-\log \left(\frac{I}{I_0} \right) = 1.54 \times 10^{-22}$$

$$-\log \left(\frac{I}{I_0} \right) = 1.54 \times 10^{-22} \quad \frac{I}{I_0} = e^{-1.54 \times 10^{-22}}$$

$$6.4 = x(0.33)$$

$$0.125 = -\log \left(\frac{I}{I_0} \right)$$

$$0.125 = -\log \left(\frac{I}{I_0} \right) = -\log \left(\frac{I}{I_0} \right)$$

$$\exp(-0.125) = \frac{I}{I_0}$$

$T =$

$$I_0 = \frac{6.4}{\exp(-0.125)}$$

$$N_A \times \epsilon \times l \times \text{PDF} \times \frac{6}{600} \times (0.02 - 0.01) = 6.213$$

1	- 6.213
10	- 6.2133
50	- 6.2136
100	- 6.2141
1000	- 6.2219
2000	- 6.2306
3000	- 6.2389

~~attenuation~~ attenuation constant mm^{-1}

$$A = \epsilon l c \quad \begin{matrix} \text{mm} \\ \text{mol} \\ \text{l} \end{matrix}$$

$\frac{\text{mol}}{\text{mol mm}}$

$\epsilon c = \text{Attenuation constant} =$

$$-\log_{10} \left(\frac{I}{I_0} \right) = \epsilon c l$$

$$C_p = \sum_{i=1}^{\infty} P(\Omega_i) \left(\frac{L}{2} - v_i t \right) \Delta \Omega_i$$

$\text{per } m^3$

mass per unit volume of particle

molecular wt = mass

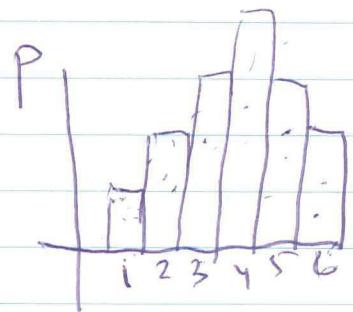
$$\rho_p = \frac{g_p}{\text{cm}^3}$$

$$\frac{\rho_p}{M_{av}} = \frac{\# \text{ particle}}{m^3}$$

$$M_i = \frac{g}{\text{particle}}$$

mass/particle

v_i	$i =$	v_i	$v_i p_i$ (mass %)
...	1	...	x
...	2	...	x
...	3	...	x
...	4	...	x
...	5	...	x



$$\begin{array}{c} p_1 \\ a_1 \\ a_2 \\ \vdots \\ a_5 \\ \hline \sum a_i \end{array}$$

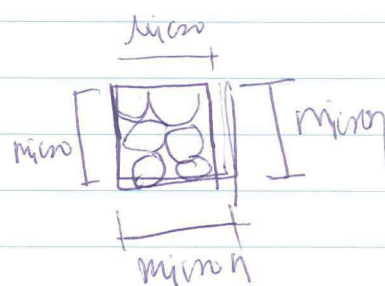
$$\boxed{x_i}$$

$$M_i$$

$$\boxed{M_{av}}$$

$$1 \text{ ml} = 10^{-6} \text{ cm}^3$$

$$\begin{array}{c} p_i \\ 1 \\ 2 \\ 10 \end{array}$$



$$4 \times 10^{-4} \frac{g}{\text{ml}}$$

$$4 \times 10^{-7} \frac{\text{kg}}{\text{ml}}$$

$$\frac{4 \times 10^{-7} \text{ kg}}{10^{-6} \text{ cm}^3}$$

$$= 4 \times 10^{-5} \frac{\text{kg}}{\text{m}^3} \quad 0.4 \frac{\text{kg}}{\text{m}^3}$$

mass mol fraction average molecular weight

Smith & van Ass

& C

7th October Wednesday

12:45

PE meeting : Nanoash Form for EOR (An experimental investigation)
Ali Akbar Eftekhari
(Ehsan)

foam Reduces IFT increases capillary number
- or +

- or +
○ hydrophilic head (charged)

hydrophobic tail

Capillary pressure ^{vs} & disjoining pressure
(function of S_w)

Q Relative perm For gas & liquid

Class F & Class C Fly ash

4

nicht in CaO

< Surfactant 0.03 wt% >

8TARS model: \rightarrow

Local equilibrium

Numerical ~~problems~~ in methods

<http://github.com/simulKade/FVTool>

IF you consider smolousov's equation with 100% success rate of collision, particles would collide & aggregate ~~the KT barrier~~ in no time.

We can use RT barrier for that

margreet

Networking workshop 15:00

~~Try to see how other people~~

Try to see where other people are working? may be ask questions about job possibilities.

Call the guys just in case for job position before applying for the position.

8th October Thursday ~~to 45~~

10:45 Kinetics of Flocculation

$$\sum_{i=1}^{\infty} v_i = \frac{v_0}{1 + \frac{t}{T}}$$

$$T = (8\pi D_1 a v_0)^{-1}$$

v_0 original number concentration of particles

a average diameter of the particles

D_1 Diffusion constant for the primary particles

$$v = \phi / \frac{4}{3}\pi a^3$$

ϕ volume fraction

due to van der Waal's correction } $\frac{R}{a} > 2$
viscosity correction } $R < 2a$

$$T = \frac{1}{8\pi D_1 a v} = \frac{3\eta}{4kT} \frac{1}{v} = \frac{2 \times 10^{11} \text{ s cm}^{-3}}{v}$$

$$T = \frac{10^{12} a^3}{\phi} \text{ s cm}^{-3} \quad \text{average particle radius?}$$

ϕ particle volume fraction

Slow Coagulation $T = \frac{T_{\text{fast}}}{\alpha}$ What is α ?

→ margriet.jacobs@me.com →

margreet.jacobs@me.com

KT - activation barrier

For particles of diameter $2a = 2\mu$ $\frac{J_{ortho}}{J_{peri}} \approx 1$

Relation between Flocculation & sedimentation of ash particles in α -AOS solution.

M_w weight or mass average "molecular weight"

$$M_w = \frac{\sum_i C_i M_i}{\sum_i C_i} = \frac{\sum_i P_i M_i^2}{\sum_i P_i M_i}$$

The number average of "molecular weight"

$$M_n = \frac{\sum_i P_i M_i}{\sum_i P_i}$$

mass of particles of i batch
no of particles of i ~~size~~ batch

Aggregation number on x axis & y axis
time required sediment

① Aggregation ② Sedimentation ③ Forces

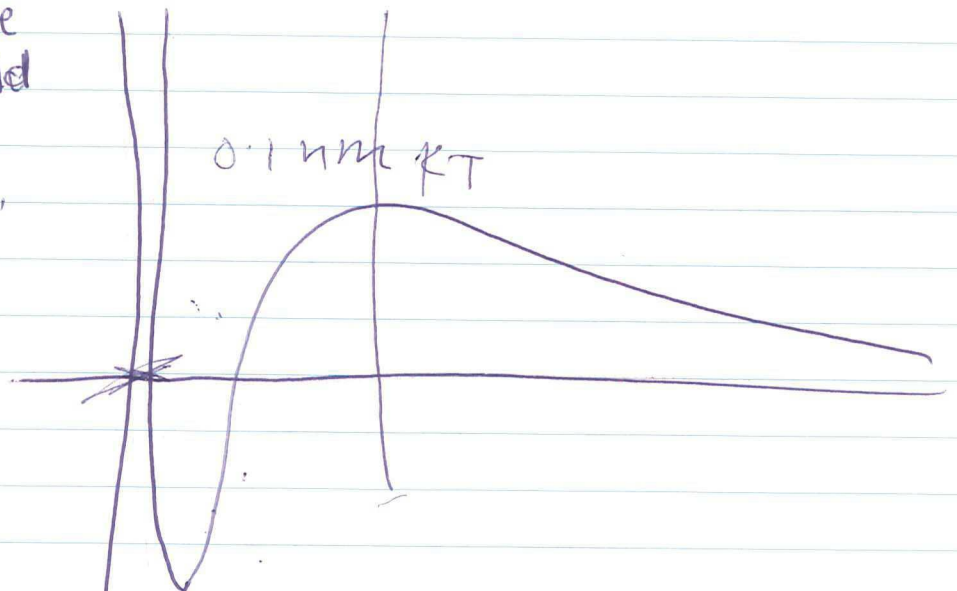
12 October 2015 Monday

- 0611737268 Bea Peinkoff } AKzo Nobel

Moreth

Geert Hofstede
Pauline Kleingeld

MSD, Segula,
↑
called



$$\psi = \psi_0 \exp(-kx) \quad \psi$$

$\psi =$

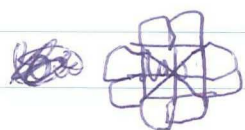
~~Mojtaba~~ // PE meeting Mojtaba //

12:40 Mechanistic modeling ASP Flooding
process at under

Alkaline : - Reaction of soap \rightarrow @ AFT
surfactant adsorption

Levers Leverett [1939] paper

/ Optimal salinity condition for ASP //



Flory-Huggins Equation

5 centipoise \rightarrow 5 $\frac{Ns}{m^2}$

Debye-Hückel approximation $\rightarrow \psi$ is small in magnitude

"Eilers & Korff Rule" $\frac{\xi^2}{\kappa}$

~~$\nabla^2 \psi = \kappa^2 \psi$~~ Boltzman

~~ψ~~ $\frac{d\psi}{dx} = -\kappa\psi$

midplane potential

$\psi = \psi_0 e^{-\kappa x}$ when $\psi_0 < \frac{25.7 \text{ mV}}{Z}$ at 25°C



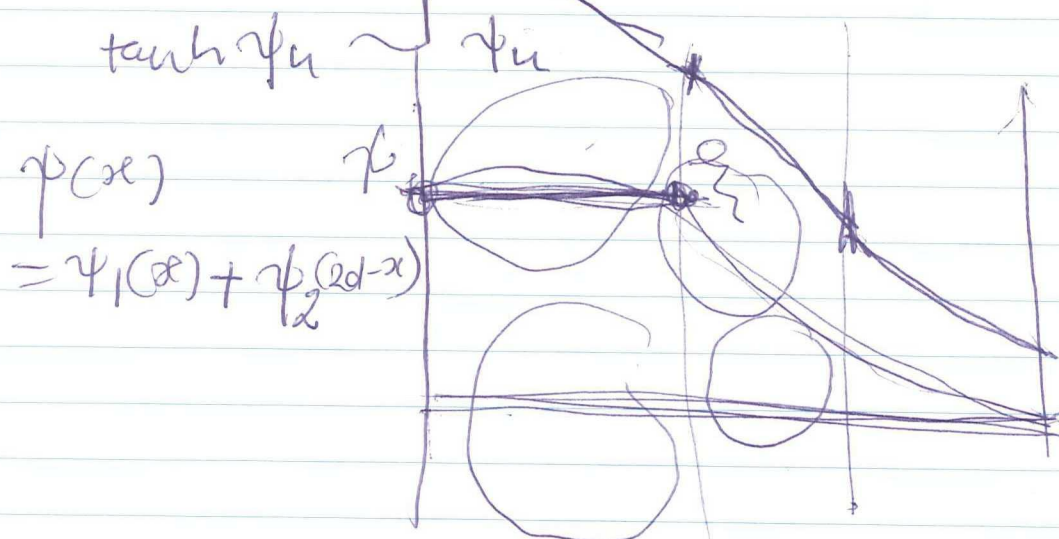
\therefore But not satisfied in colloidal system

$\psi = \psi_u \cosh \kappa x \rightarrow \xi = \psi_u \cosh \kappa d \rightarrow$ ②

$\psi(x) = \xi \frac{\cosh(\kappa x)}{\cosh(\kappa d)} = \frac{①}{②}$

$x=0$ on a plate

$\psi(x) = \xi \frac{\cosh(\kappa(d-x))}{\cosh(\kappa d)}$



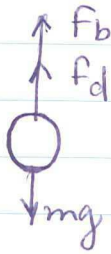
why

~~15~~ 15 October 2015 Thursday

Stoke's

law

viscosity of water



drag $F_d = 6\pi\eta v$

buoyancy $F_b = \frac{4}{3}\pi r^3 \rho_w g$

weight of the displaced fluid

$$F_b + F_d = mg$$

density of the particle

$$\frac{4}{3}\pi r^3 \rho_w g + 6\pi\eta v = \frac{4}{3}\pi r^3 \rho_p g$$

$$6\pi\eta v = \frac{4}{3}\pi r^3 (\rho_p - \rho_w) g$$

$$\frac{18}{4}\pi\eta v = \pi r^3 (\rho_p - \rho_w) g$$

$$v = \frac{2r^2 (\rho_p - \rho_w) g}{9\eta}$$

Hesseling F.T., Vrij, Overbeek

Debye-Hückel linear approximation

$$\psi_x \approx \psi_0 e^{-Kx} \quad \text{for low } \psi_0 \leq 25 \text{ mV}$$

$$\psi_x \approx \frac{2KT}{e} r e^{-Kx}$$

16 October 2015 Friday

Preparation for the meeting with YER

YER meeting is ~~cancelled~~ rescheduled to 3 PM Mon 19 Oct

Research Background slides for David Bruhn

Project Sure (Novel productivity enhancement concept for a sustainable utilization of a Geothermal Resource 42-month for a Postdoc, project starts in January 2016

Project Dostress, aimed at creating EGS (Enhanced geothermal systems) reservoirs with sufficient permeability, fracture orientation and spacing for economic use of underground heat - 48 months for a postdoc, project starts in March 2016

19 October 2015 Monday

Preparation for YER meeting

Flow Architect

Flow Analyst position: Jeroen Broeren, Automotive & Engineering, YER Interim solutions Bv

ASML Development & Engineering
Environmental Control & Infrastructure

Questions: Which place, how many people,
what is the way of contract (one year?) What
are the benefits (Insurance Pension?)
~~How many people~~ What is the procedure?
What is the time schedule?

At ASML or some other co-developer

YER-Eindhoven

500 Engineers Bachelors & 1

ASML :- 100 Engineers

21 October 2015 Wednesday

Nernst-Einstein relationship

Double layer

k_B

Relation between electrophoretic mobility & diffusion
 Potential $\rightarrow \frac{V}{E} = \frac{\epsilon \epsilon_0 \zeta}{\eta} f(ka)$
 Field strength

Electrical conductivity calculate

ka
 thick layer Debye $ka \ll 1$
 thin layer Smolouchowski $ka \gg 1$

$$v_p = \frac{4\pi a^2 Q}{6\pi \eta a} E \rightarrow D = \frac{kT}{6\pi \eta a}$$

$$6\pi \eta a = \frac{kT}{D}$$

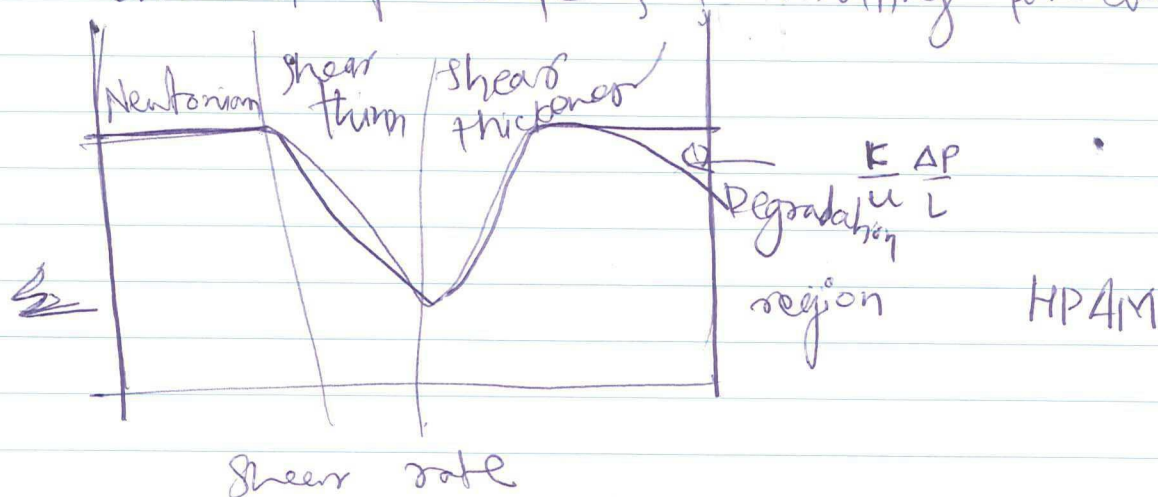
$$v_p = \frac{4\pi a^2 Q}{kT} D E$$

surface charge

$f(ka)$ } Hunter function (ka)
 Adamson

Better references with conductivity

Effect of pore shape & the resulting pore diameter



Carr-Pan-Yasuda Model

Polymer - Apparent viscosity

$$\Delta P = \frac{K}{A} \frac{Q}{\mu} \frac{\Delta P}{L}$$

$$\mu = \frac{K A}{Q} \frac{\Delta P}{L}$$

★ Power spectral density



discrete Fourier transform

Shear rate increase as ρ

Molecular Interpretation by Gelmer

Streamline visualization

Reynold's number 0.01

$$\frac{\rho V D}{\mu}$$

visualization using particles or DNA

Coagulation & sedimentation

Coagulation \rightarrow sedimentation

Successful barrier

Professional editor

Write a discussion with coagulation sedimentation & without surfactant.

When two particles ~~coagulation~~ coagulate into one particle, scattering intensity would increase therefore transmission intensity would decrease

22nd October 2015
Thursday

	Sm	Henry	Debye	Sm
PH	2.82	4.62	9.09	11.09
Ka	15.26	5.66	0.401	23.94

If $Ka \leq 1$ thick layer ~~Debye~~ Huckel-Onsager Formula
 If $Ka \gg 1$ thin layer Smolouchowski formula

Net velocity of particles $\vec{v} = \frac{\epsilon \epsilon_0 \zeta}{\eta} f(Ka)$ $Ka \gg 1$ particle size very large
 local field strength $(\frac{V}{e})$ $\vec{v} = \frac{2}{3} \frac{\epsilon \epsilon_0 \zeta}{\eta}$ $Ka \ll 1$ Huckel. particle size very small

Strong parallel between ionic mobility & the mobility of colloidal particles

Velocity of double layer $\frac{V}{E} \propto \zeta$ $\frac{\epsilon \epsilon_0}{\eta}$ constant

$$\frac{V_{dl}}{E} = \frac{\epsilon \epsilon_0 \zeta}{\eta} f(Ka, \zeta)$$

Net velocity of the particle is the difference between the velocity of the particle itself and the velocity of its surrounding double layers

Total number of particles $\sum_{i=1}^n n_i = \frac{n_0}{1 + \frac{t}{T}}$

n_0 ← Bulk concentration
 n_0 ← Initial number of particles
 t ← Time of measurement
 T ←

for equal sized spherical particles

$(2\pi D_1 a n_0) \frac{1}{3}$

radius (avg)
 Volume Fraction $\phi / 4/3\pi a^3$

Diffusion constant at the start

	Particle size large	Particle size small
Number large	PH 9.09	PH 11.0
	PH 4.82	PH 2.82

23rd October 2015 Friday

9:58 Effect of Coagulation of two particles on their light intensity

$$v = \frac{\phi}{3} \cdot \frac{4\pi a^3}{3} \quad \begin{array}{l} \text{Volume fraction} \\ \uparrow \\ \text{radius} \end{array}$$

At each instant in time, the concentration will be constant at all points on a plane parallel to the original source, so c is a function of x & t only. Therefore

$$C(x, t) = C_0 \left[\frac{1}{4\pi Dt} \right]^{1/2} \exp\left(\frac{-x^2}{Dt}\right)$$

$$x = \frac{L}{2} \quad L = 45 \text{ mm}$$

$$C\left(\frac{L}{2}, t\right) = C_0 \left(\frac{1}{4\pi Dt} \right)^{1/2} \exp\left(-\frac{(L/2)^2}{Dt}\right)$$

where $D = \frac{kT}{6\pi\eta r}$
 \uparrow radius of the particle

~~The~~ macroscopically visible aggregates are called Flocs.

$$\text{Mobility} = \frac{2\epsilon\epsilon_0}{3\eta} f(ka) \quad \text{Henry}$$

$$1 \leq ka \leq 1.5 \quad \text{for } 0 \text{ to } \infty$$

diameter	attenuation (per mm)	
0.2 μ \rightarrow	0.65	} For 0.1 spheres per micron
0.6 μ \rightarrow	96.402	
1 μ \rightarrow	306	

Attenuation constant calculation 2.82 0 2 4
4.62

$$\begin{array}{r} 2.82 \\ 4.62 \\ 9.0 \\ 9.09 \end{array} \quad \begin{array}{r} 13.53 \\ 69.44 \end{array}$$

Mie scattering does not work where particle size is very big & as compared to wavelength of light intensity.

This can be seen from pH at 0 minutes. There we need to use Rayleigh scattering to calculate

24th October 2015 Saturday

Removing the (silencing) omic.org part as it is too complicated as shown above & (due to some particle sizes equal to ^{incidenting} wavelength (Mie scattering) & some particle sizes ~~equal to~~ bigger than incidenting wavelength (Rayleigh scattering))

retardation factor $\frac{V}{W} = \frac{e^{\frac{K T}{2 \pi^2 \text{distance}}}}{2 \pi^2 \text{distance}}$ (Integrand of retardation factor would be the barrier to cross for slow coagulation)

~~Rapid~~

Total number of particles of size i

Particle number $\rightarrow V$
Original particle number $\rightarrow V_0$

$\frac{V}{V_0}$

$1 \text{ cm} = 0.01 \text{ m}$
 $1 \text{ cm}^3 = 1 \times 10^{-6} \text{ m}^3$

$T = \frac{10^{12} a^3}{\phi} \frac{s}{\text{cm}^3}$

$= \frac{10^{12} a^3}{\phi} \times 10^6 \frac{s}{\text{m}^3}$

$= \frac{10^{18} a^3}{\phi} \frac{s}{\text{m}^3}$

Flocculation time with correction

$$T = \frac{10^{12} a^3}{\phi} \frac{s}{\text{cm}^3}$$

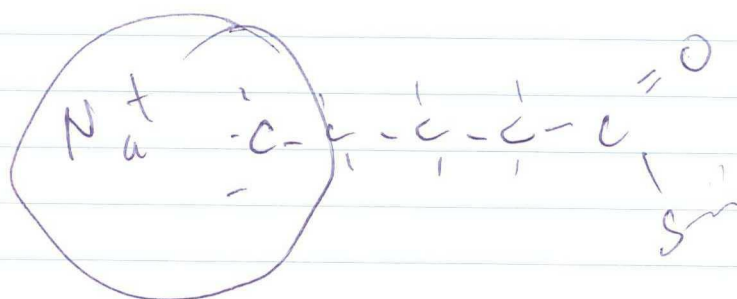
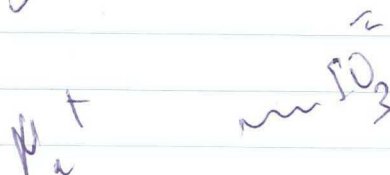
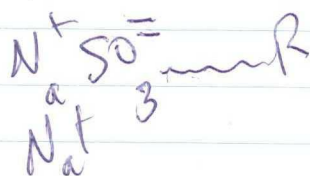
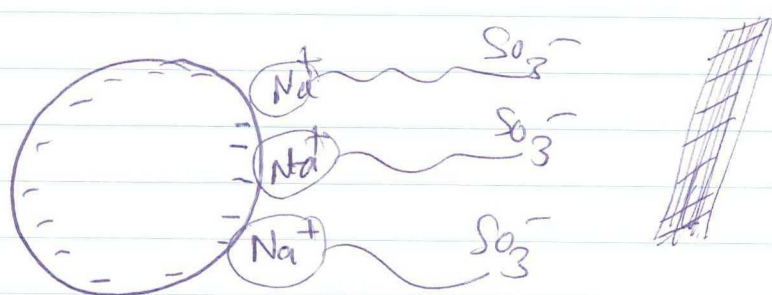
Fraction of size a

$$T = \left(8 \pi D a, V_0 K \right)^{-1} = \frac{1}{8 \pi D a V} = \frac{3 \eta}{4 k T} \cdot \frac{1}{V}$$

$\frac{24}{\pi}$

~~Floccul~~ Particles one micron and above take the order of minutes to flocculate.

10



28 October 2015 Wednesday

Oil recovery from outcrop rocks by nanoparticles
Nikita

- ① Blocking ~~low~~ high permeability areas
- ② Creating wedge film

HPAM polymer with some functional group

③ Dispersion coefficient of particles

Nanoparticles flow in porous media

Traces concentration.

If ~~the~~ only nanoparticles are used; ~~the~~ most of them are in porous media.

29th October 2015

Thursday

AMS Research & Valorisation programs

Life cycle of soot

Nanoparticles in air: Model

Pollution particles

Reaction with water droplets

Reaction with sunlight

Evaporation of water

Academic, private & public platforms

Ramon Rooij AMS TUD education programme managers

Research

Connected

Vital

Circular

① Additional support for Horizon 2020, ERC

Dr. Ir. Marie-Claire ten Veldhuis

Amsterdam

rainproof

Solution oriented

Urgent + problems

+ multidisciplinary

+

NWO proposals; Horizon 2020;

160% of the budget Research projects

16% of the budget Living Lab projects

50%

Stimulus of the projects

TNO TUDelft

Veni, Veli, Vici

AMS — Consortium

$$E = \bar{E}_0 \exp i \omega t \exp i \frac{2\pi n}{\lambda} z$$

$$n = n_R + i n_I$$

$$\ln \frac{I_0}{I} = -2cl$$

Hydraulic Fracture Modeling using fully
Coupled Simulation


Fractured simulation :-

Fractured Geometry prediction

Numerical modeling (Wikipedia read)

Type of fluids (Newtonian, Non Newtonian)

Triaxial load tests

Fenix Delft 

What is Tracing ? Scishow You tube channel

Geomechanical ~~problem~~ model

Boundary Element Approach

Pore pressure change at the Free Tip

Monday 2nd November 2015

Applied to Segula technologies for post doc position from Vlaanderen.

Tuesday 3rd November 2015

Meet Yang & Erik offayman

Melting of Steel

A

Recycling Technology

Wednesday 4th ~~8~~ November 2015

Applied to Erik Offerman, David Smuelders,

Thursday 5th November 2015

Experiment with high concentration with particles & without particles.

Benthimer

test040

test042

test046

test052

test056

Test063

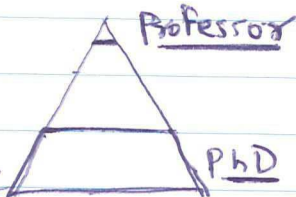
Test066

1

10th November 2015 Tuesday
PhD Day

1. PCDI

Postdoctoral
development initiative



PhD Candidate

PCDI - Consultancy
workshop 2 Dec 2015

70% PhDs get a job via

Important :- Entrepreneurship, Grant writing,
Role models? Networking, learning about the jobs on the job

PCDI VSNU :- What you learn ~~an~~ academic skill?
Perseverances

Orientation on Entrepreneurship

Marcelien Breedveld
UtrechtInc

15th November Sunday

Sandpack experiments permeability check

Test Ko 240811

L 290811

Li 300811

L2 030911

L3 130911

— 69 Darcy 120911

— 112 Darcy 190911

~~the~~ Night-off Enterprises

- Het collectief Delft (theme: Design 1)
- MWH Global (theme: General 2)
- Nen (theme: General 1)
- RPS Nederland Safety, health theme General 1

23rd November 2015

C8:MS #2 - 26 November

You are required to

- share concrete development points
- bring forward examples of specific situations in which you wish to make improvements in your time management behavior.

Ms. Manike Mulder-Pol

Energy sector Enexis B.V.

↖ what does she ~~do~~

Network strategist and project manager

What does she ~~do~~?

Engineering doctorate;

what color is your parachute? ~~10 years~~

Corefly-Suvez

① Specific

② What current research topics companies do?

2nd December

Geothermal exploration in Indonesia by means of water-rock geochemistry: Case study Lamongan East Java Indonesia

Florenza Deon

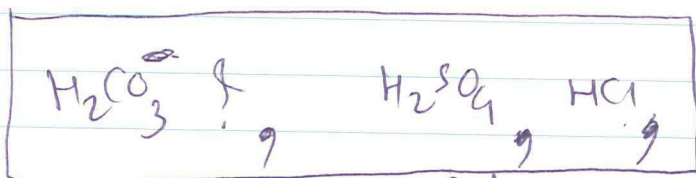
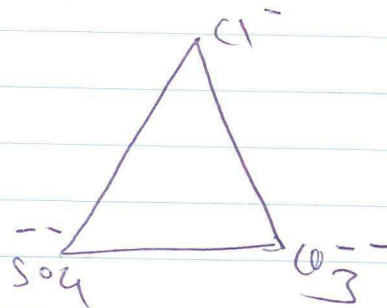
① Geocap

Badung

Fluid geochemistry
lake Toba samples

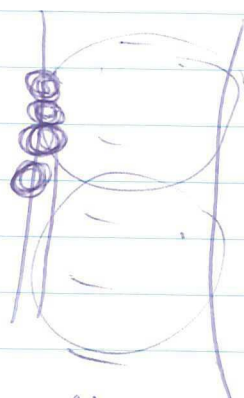
fluid geochemistry : →

anorthite : lava

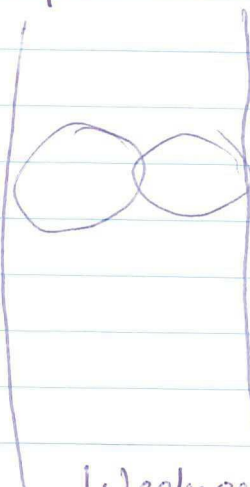


HNO_3 ?

Phreeqc : - Chemical Equilibrium program



Gas



9th December

Wednesday



Pressure distribution in naturally
And its relation to unsteady heat

fractured reservoirs
conduction

Tijmen Anonys

Eclipse : →

Peclet numbers :-

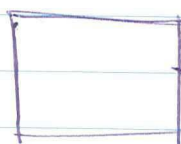
$$\frac{\partial T}{\partial t} \propto \nabla^2 T$$

Larry Lake

Peclet number
= $\frac{\text{Conduction}}{\text{diffusion}}$?

What ^{you mean} do boundary condition ?

matrix - fracture



(Fluid Flow)
Assuming

two phase

water saturation oil
residual water 0.1004

Single phase flow of oil

conduction, convection & diffusion

10 December 2015 Thursday

CCS

EOR Weyburn project CO_2 from
La Barge - (Exxon) Acid gas injection

Capture - 80% of the cost

Public perception examples

Darendrecht / Netherlands

Carl Rogers

15 December 2015 Tuesday

2.02

$$\frac{0.0023 \times 0.31}{0.31} = Kt$$

$$\ln\left(\frac{L_3 - L_1(t)}{L_3 - L_1(0)}\right) = -\frac{Kt}{L_3 - L_2}$$

$$\ln\left(\frac{L_3 - L_1(0)}{L_3 - L_1(t)}\right) = \frac{Kt}{L_3 - L_2}$$

$$L_3 - L_2 \times \ln\left(\frac{L_3 - L_1(0)}{L_3 - L_1(t)}\right) = Kt$$

~~Kt~~

$$K = \frac{K \rho g}{\mu (L_3 - L_2)}$$

$$\frac{m^2 g}{m^3} \times \frac{m}{s^2}$$

$$\frac{cm}{s}$$

$$\frac{m \cancel{kg} s}{s^2 m^2} \times m$$

$$N = \frac{K \rho g m}{s^2}$$

$$= \frac{m^3 s^2 m^2}{m^3 s^2 m s m}$$

$$= \frac{m^5 s^2}{m^5 s^3} = \frac{1}{s}$$

Aos - Ash Inlet & Outlet 10th Oct — Tested 22-23 Jan 2013
 Aos inlet ~~26th Sept~~ — Tested 23 Jan 2013
 Ash outlet — no sig.

Aos - Ash Outlet 10th Oct

The figure is the best we have got.

Post-doc Biological production of Biomimetic High-performance Materials

015 2782853 Marie-Eve Aubin Tam

Body simulating fluid

$CaCO_3$ & biopolymers

earth abundant constituents

biomimetic, shell like coating materials

Structure of cytochrome
 c at the interface with
 magnetic $CoFe_2O_4$
 nanoparticles

① When does this ~~phd~~ post doc starts

② Hydroxynphate and apatite wollastonite

Post-doc in Global water resources modelling
and re-analysis

STW Financial program manager

- ① is de vacature open voor buitenlanders
- ② how veel beheersing heb je nodig
- ③

Post-doc in Mineral Resource modeling

- Do not ~~not~~ show that you are an expert
- References JD Jansen 2009, Closed loop management
- knoxxe
- Kalman-filter best-square method updating

- Comsol, Symbolic regression, Fortran

deze informatie

- Rahul Fonseca → Jacobian

Newton Raphson methode - afgeleiden

(Production - optimisation)

5 Januari 2016

Optimal SAG Design for Heterogeneous reservoir
Arash

Surfactant slug size

Surfactant alternating gas

Simulation 3-layered reservoir

Fractional flow theory (FFT)

Foam weakens near SW & completely collapses at S_{wr}

① STARS model ② Namdar Zangeneh extension

~~A~~ $u = \frac{k}{\mu} \cdot \frac{\Delta P}{L}$

~~$\frac{1}{k} \cdot \frac{\mu}{L} \cdot \Delta P$~~

8 Januari 2016 Friday

Dr. Mark Boneschanscher

Programma coördinator

meeting with Hans

- Brede achtergrond

- IRP's

- Creative ?

- ~~Financing~~ Financiering

- belangen van bedrijven en ~~opte~~ onderzoekers

- verschillende groepen werken

- LinkedIn

Jennifer Kocke

9 January 2016

Jennifer Kockx

TU Delft program manager Global Initiative

~~Kees~~ Maas Maessen, NWO BOO

~~the~~ Industrial Partnership programme (IPP)

Checking questions for Pieter de Witte & Michiel van den Hout

checking earlier interview ~~results with~~
discussion with Madleen,

20

① Zijn er mogelijkheden ^{om} ~~voor~~ Nederlands ^{te} doorstuderen?
verbeteren?

12 January 2016

Cutler mining

Cross-Over Technology
from Civil Engineering to Mining
"BAUER mining"

"Piling Rigs" ?

Dauliganga, India

Rotary Drilling Rigs

BHP Diamonds

Technip

- Quality & design of teeth to fit specific ore properties

- Questions to Joerg

- What kind of software do we use for optimisation

- Do you have some other candidates?

- Kalman filter

Algorithm that uses a series of measurements observed over time, containing statistical noise and other inaccuracies, and produces estimates of unknown variables that tend to be more precise than those based on a single measurement alone.

- production-optimisation process

- least square method updates

Meeting with Joerg

- ① Admin related - Technical coordination
- ② Guidance for PhD ① Geostatistics
- ③ Operation Research - Abilities → Discontinuity / Prof. H. G.
- ④ Project environment mathematical
- ⑤ Two year contract STW proposal / NWO Uncertainty

Career Counseling

- ① Updating LinkedIn profile / edit CV
- ② ~~Get~~ Getting very early
- ③ Try to engage to meet the ~~per~~ person
- ④ Really target

Next topic: How to manage with ~~not~~ diff conversation

- ① Technical overview / project coordinator
- ② Research proposals
- ③
- ④ Blue mining / compiling reports / cutting boxes
Academic freedom
- ①
- ② Optimisation : value

Low salinity carbonated waterflooding

Tijman Blom

Phreege → Symbolic regression → COMSOL

20th Jan 2016

specific questions for Margaret Walten

- ① Shall we contact your professor (with whom you had fight?)
- ② What are your strengths and weaknesses
- ③ Where do you see yourself five years from now?

① Keep the contacts. ② Extending the network

Proud of yourself: Do you like doing it? ^{Hockey, salsa, Volunteer}
Relative to ~~still~~ the job

What is the positive part of the broad experience

① Get back to the jobs

what have done or willing to do on the weakness
Example: --- priority response

Short & concise, repeat the question

~~Wanneer~~

Abraham

Bram

Questions to M. H. Loeb; A. Bergman

① Wanneer krijg ik beoordeling?

②

Hoe zit deze ~~werd~~ positie met ^{Nederlands} wetenschapsagenda en circulair economie.

Onderzoekslijnen van het NKWK

① waterkrijg ② National water model

③

Smart Urban Regions in the Future (SURF)

↑ kennis programma

⑤ vijf grote en dertien middelgrote projecten

27 January 2016

Leiden University Scientific Coordinator

Complexity & Simplicity in
Modeling Foam Enhanced Oil Recovery
Bill Rossen

Complexity in the foam bubble size

Minimum velocity foam does not generate V_c

90% trapped gas 10% trapped gas

Petrol Exploration in exhumed basins - Insights from
the Illizi Basin, Algeria

Dr. Kara English Petroletic

What is exhumation?

3rd Feb 2016

Margaret Wallen

Alfred: → how can ~~we~~^I explore my career options.

- ① Teaching
- ② Policy Housing
- ③ financial marketing

Research ① modeling aspect

Try to call people ~~if~~ ~~if~~ you would like get
into

Try to do ^(find) something which goes deeper?

4 February 2016 Thursday

Fractured Reservoirs a geologist attempt to improve reservoir simulations

Giovanni Bestetti

Faults & Fractures

Things happen at the borders; much less inside

- ① Power law ~~as~~ form of the model
- ② Aperture ^{length} method
- ③ Non-matching boundaries

Bill: Ensemble Kalman Filter

8 February 2016

Journals for next publications

Advances in Colloid and Interface science 1111

Colloids & Surfaces A: Physicochemical & Eng. Asp 11

Water Resources Research 11

Journal of Nanoparticle Research 11

Chemosphere

SPE Journal 1111111111

Journal of Colloid & Interface Science 1111 ←

Energy & Fuel 1111

AIChE Journal 11

J Dispersion Sci. 1

Energy Procedia 1

Chemical Engineering Science 11

J P S E 1111

SPE Reservoir Eng 1111111

TIPM 111111

Langmuir 111

18 February 2016 Thursday

Skype meeting with Alexey

Clarification ~~to~~

① 4 & 6

① Top & bottom

② CMC & concentration of particle

③ ~~CMC~~ foam pressure drop

④ change ~~130~~ 130 Darcy \rightarrow 112 Darcy

Big variation

soften the statement

comment

① 0.15 w/w %

② M1 & M2 check

③ Page 60

⑤ 5 Areas

① Pay 48. coarse sandpack question ~~Re~~
on fig 4.5 page 52 L, J

Reverse trend?

② Fig 4.4 : Sharp decrease ?
pressure is increasing

why AP is decreased

\rightarrow due to low surfactant concentration

\rightarrow discussion point : ~~surfactant~~ ~~con~~

low surfactant concentration; How

~~stable~~ foam is stable enough,

AP foam at CMC

What are
the cause of
what are
the implication

③ Fig 4.6 Expt M. liquid injection rate are
~~no~~ surfactant solution Velocity
EQU 4.1

instead of increasing ; decreasing
Use equation 4.1

[according
to
formulas]
~~formulas~~

Search

Impact of experimental result on modeling
Change of physics

④ Comment chapter 4
Hierarchy of variables in summary

⑤ Page 86, 85 expts

~~Surfactant concentration~~

particle concentration effect

~~Part~~ Whether particle help or not ;

In case high

surfactant concentration, particles are more effective.

• ⑥ Stability of dispersion
Criteria in oil field

— Stable dispersion

= Extreme pH [lower 4
higher 9]

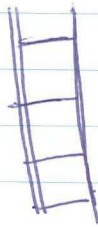
Saturday 10th February

Webinar Bianca

- Get up one hour earlier

4:30

- Vertical Goals



- Before lunch time : 3 Before 12
important lunch

- Exercise : move prefrontal cortex
: when wake up / ~~when~~ 3-5

- Eat Breakfast Vegetables / proteins (eggs, steaks)

- write Gratitude Journal

-

Power poses : →



- E - Fasting

Daily sunlight

Vitamin D

No coffee

Sleep

Body
habits

Visualisation : Making Image of success

5 successes

Appreciative & compassionate

7:2:6 Breathing ~~teehnig~~ technique

Be in silence

Be where you are

Throw away the television

Perseverance

read read read

worry : ☹️

learn to say "No"

FOMO → JOMO

↑

Fear

↑

Joy

Mind
habits

Joy Umbrella : ~~Conducting~~ make ~~web~~

If takes 2 minutes ; do it.

Environment : Clean the house

Be positive ; donot complain, Self date

Inbox 0 : In the morning & in the evening

What is your leverage : →

Start with easiest

Rooibos tea ; green tea

Preparing for the interview

1. Schrift opdrachten

1. DST-NWO : - Indian problems Traffics : Kumbh mela, sustainability issues, proposal calls

Equip launch : ~~but~~ Awareness

which IITs, IISc, IIT Delhi, Hyderabad, industry collaborations

They want to look for tough problems.
✓ Evaluations. difficult to understand

~~Info~~

computer science & electrical engineering
Yearly budget : Identify Important fields & areas.

Budget allocation :

well connected with some professors

← Niche areas before call for proposals →

Asmid Zuurboer
Roosmanic

→ NWO

Access with IISC

memorandum of understanding

Delft IISRO, MOU, IISC, Raman Research Institute

How do you think things further

Bosch employees / Philips / Shell

~~xxxxxx~~

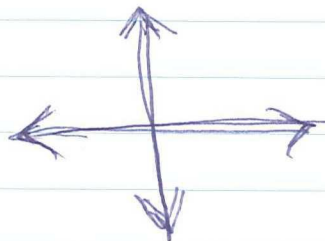
multidisciplinary & multinational

① Rubicon: - topic of the research <new idea>
<Fresh students>

Final aspect long term ^{effects} ~~consequences~~ ~~repercussions~~

<Positive discrimination> at the end

Engineering



Bright people with bright ideas

3-5 years

~~Biggest~~ ~~Biggest~~

22 Feb 2016

Correcting PhD Thesis : correction by Vincent.

23.4°, 61, 67-71

meeting with George

- ① Blue mining
- ② Development of own ideas: materials side, power mining
- ③ Administrative report who are the partners
- ④

~~6000~~

$$\text{SGL} \quad \frac{\text{kg}}{\text{m}^3} \frac{\text{m}}{\text{s}^2} \text{LH} \quad \frac{\text{kg}}{\text{m}^2 \text{s}^2}$$

~~N = ma~~

$$F = ma$$

$$\frac{\text{kg m}}{\text{s}^2} \Rightarrow \text{Pa} \Rightarrow \frac{\text{N}}{\text{m}^2}$$

$$\text{N} \rightarrow \frac{\text{kg m}}{\text{s}^2}$$

$$\frac{\text{N}}{\text{m}^2}$$

$$\frac{\text{kg m}}{\text{m}^2 \text{s}^2}$$

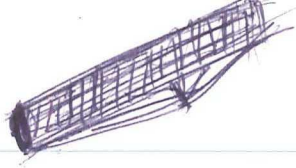
$$\frac{\text{kg}}{\text{m s}^2} \text{Pa}$$

$$\text{SGL} \quad \frac{\text{kg}}{\text{m}^3} \frac{\text{m}}{\text{s}^2} \text{m} \Rightarrow \frac{\text{kg}}{\text{m s}^2}$$

$$\text{SGL} \rightarrow \text{Pa}$$

just ask Hans

$$R = \frac{8\sqrt{k}}{\psi}$$



Highlights of the figure

① →

few notes



Cover design

	✱ Thickness of the spine
Ø 27.94 cm + 8.37	(160 pages)
7.58	(144 pages)

Not
met

16

$$\begin{array}{r}
 3 \\
 0.5 \\
 + 17.5 \\
 + 17.5 \\
 + 0.837 \\
 + 0.5 \\
 + 6.5 \\
 \hline
 43.337
 \end{array}$$

$$\begin{array}{r}
 17 \\
 6 \\
 \hline
 23
 \end{array}$$



Tuesday 01st March 2016

Meeting with Pacelli

- ① Question about calculating
⟨Hirasaki, & Rouhi⟩
water saturation
⟨Read & explain it⟩
- } Chapter 3 & 4

Chapter 4

why

↓

- ① Relation to work of others
- ② Method is better than others
- ③ High water saturation → Too much dispersion
- ④ Chapter 4 exp. A, B

Salinity N_c

Use 1

What is the PhD for

- ① People do not know anything
- ② Try to be patient

Miller & Nyogi → Text Book

Meeting with ~~Jan Dirk Jansen~~ Joerg
Bennhardt

Six months test period

Project researchers

} 2 years contract

April → July/August →

22 Color pages

300 mm \updownarrow

460 mm \longleftrightarrow

170 \longleftrightarrow 170 \longleftrightarrow 70

$$\begin{array}{r} 410 \\ + 10 \\ \hline 8 \\ \hline 428 \end{array}$$

250 x 350 mm \longleftrightarrow

11.81 x 18.11

ArchB

meeting with Jeorg

~~18th~~ Report

① Blue mining proposal tasks Report writing

② Creating acceptance : opportunities

~~18th~~

- Technically better -
- web based
- Psychological
- ~~not~~ focus on solution & opportunities
- Green peace legislation

~~18th~~

Meeting with Jeroen van den Hoven

search Peter Kruyt

(more earth metals which)

- STW/NWO Opportunities
 - Industry contact
- } Assignment } calls
old mining

First part of the

(Top sector mining)

9 March 2016

PE Seminar

Computer derivatives for gradient based algorithms - A multiscale approach

Rafael Moraes

Closed loop reservoir management

Robust optimisation

The data assimilation (history matching)

optimization (minimization) problem

(the objective function)

Sensitivity matrix

{Permeabilities are managed to fit history matching}

OF gradient calculation

- ① finite difference
- ② Pensea Enopt
- ③ Oliver

ECMOR ~~Direct method~~

Direct method ~~change~~
parameter proportional

Adjoint method

ISAPP

~~u~~

ϵ @

$u =$

K

ΔP

$\frac{1}{\mu}$

Δx

$\mu_w =$

16 March 2018

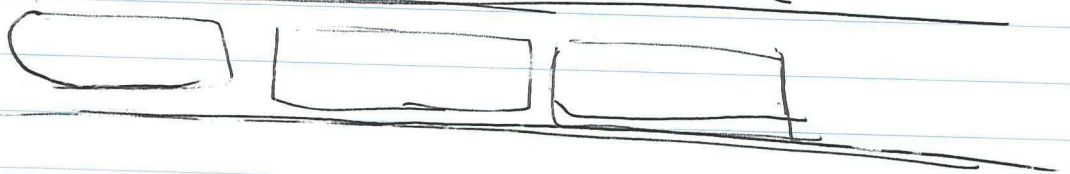
wednesday

Flow of a two-dimensional aqueous foam flow
through model porous media

Sian Jones

$$\Delta P_{cap} = \frac{2\gamma}{r}$$

(Hirasaki 1985)



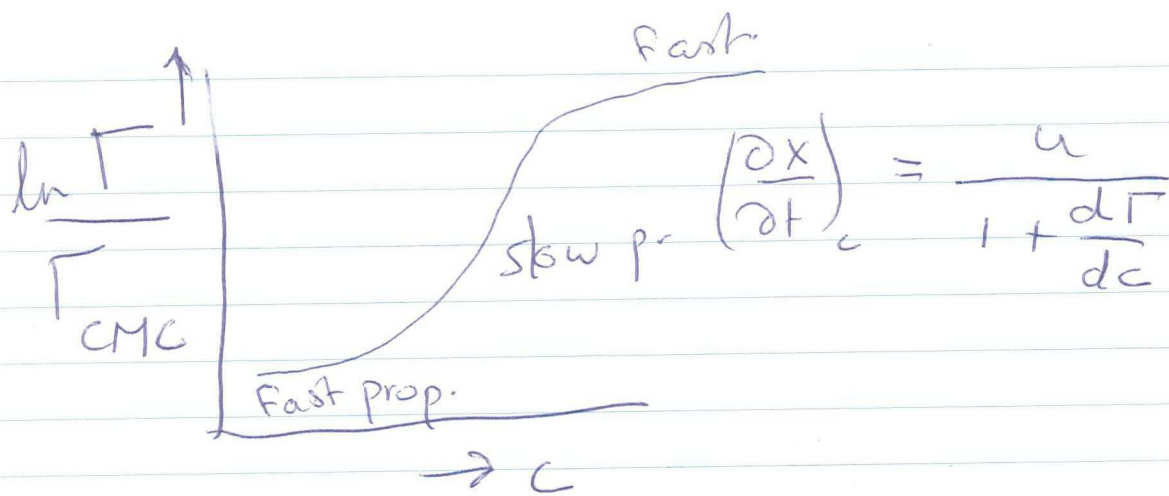
PhD Career course

write in the contract of 6 months that after 3 months they will let me know about contract-period

Meet Dian

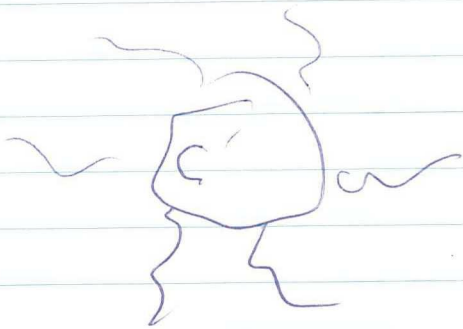
Secretary of Joerg

write information about Smoluchowski in the presentation

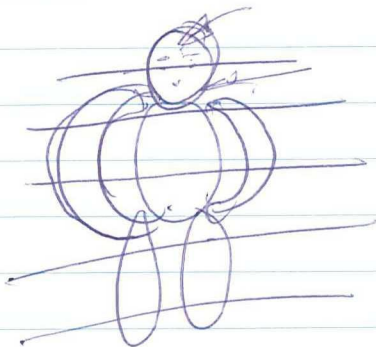
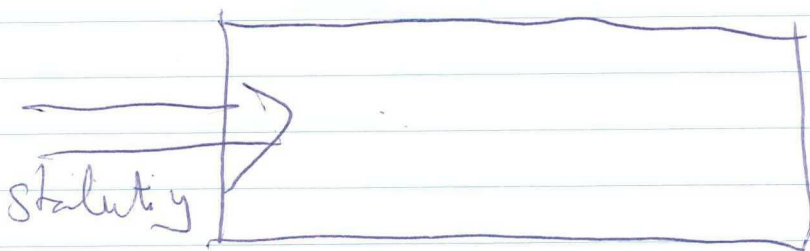


$$\frac{\partial c}{\partial t} + \frac{\partial (Cs)}{\partial t} + u \frac{\partial c}{\partial x} = \lim_{D \rightarrow \infty} \left(D \frac{\partial c}{\partial x} \right)$$

$$\left(\frac{\partial x}{\partial t}\right)_c = \frac{u}{1 + \frac{d\Gamma}{dc}}$$



—	•
—	•
—	~
—	✓



19 March 2016

Saturday

10:00 Lek draaie in nederlands (20 min) met
engelse verklaring; in 'practice' infont of
Hannie Zwiers

Concentrate on colloid chemistry
Propositions: ~~have it~~ try to find answers to
the questions

~~Also Concentrate on Alexey and Kraster~~
Sitting arrangement Alexey, Kraster, Rund, 8
Sebastien, Timo, Paelli, Hagen & Hans.
10 8 min 8 min 2 minutes 2 minutes

Alexey chapter 4 & 5

Kraster chapter 5 & 6

Rund

Sebastien chapter general

Timo

Paelli chapter 3 & chapter 4

21 March 2016

Monday

write an email to Alexey about the questions that
he addresses and the answers to those questions

Acrobat Pro DC • for ~~editing~~ editing PDF bestanden

Alex

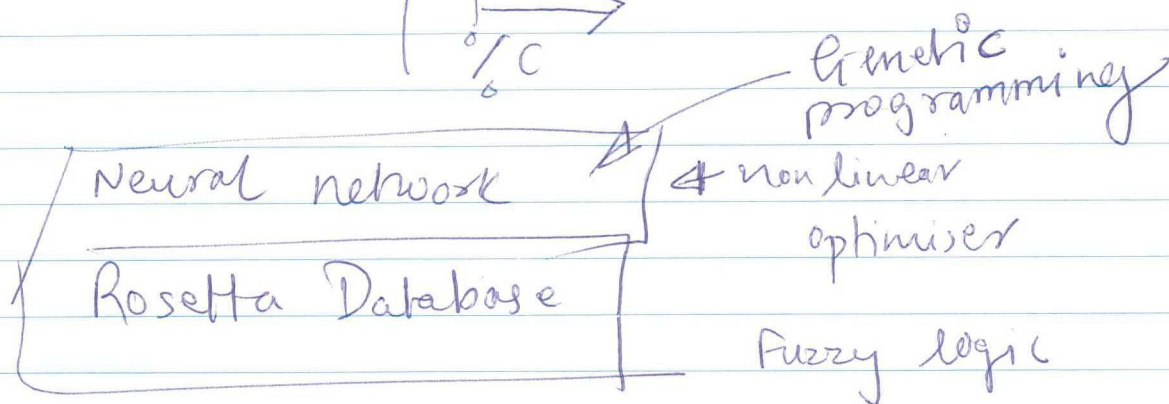
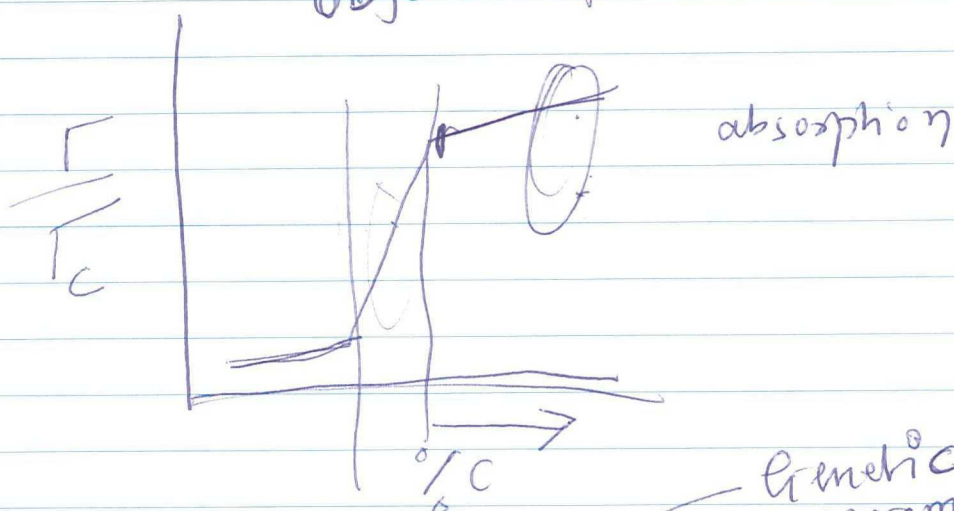
22 March 2016

Tuesday

Meeting with Timo
Preparation for presentation

Notation

- ① Check again about the notation
- ② Statistics, model error, data error & total error
objective function of



- ① Read paper of schmidt.

Calibration

pH ~~me electrode~~ electrode measurement

Why did you calibrate pH 4 & 7.

Meeting with Hans

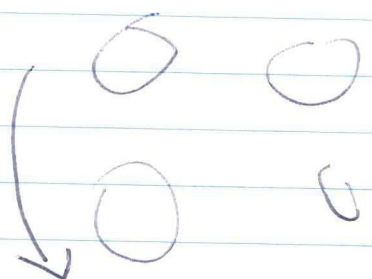
15:30

1
Slow down

• \Rightarrow why not ~~ble~~ all
emphasis on slide 3

5! from the experiments
(pressure gradients)

Connection ?? \rightarrow
= Relation.

1
 counter clockwise

⑦ what connection to pollution?

8 Many items

10 point out internal legs
more emphatically

11) Symbolic regression
explanation

12 pH 3 and pH 11

⑩ ?

pH 3 - pH 11

12) What does the lower set-up measure?

12) → but the Σ potential is at the slipping plane

⑬ How α ? ξ

14/ Never talk in symbols!

and also not this is or here.

14) is it R or do you need to consider convection.

15) Debye-Hückel ~~linear~~

approximation?

~~to~~ accumulation term

17 Can explain =
describe

17 Not a random cloud
but also not a clear
relation

Our work parts not
clearly indicated

18 green NW }
blue SE

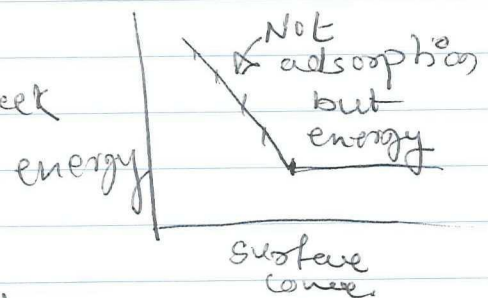
① Sandpack variation Wiegel; Packing of sand particles, geodelft lowest possible permeability

1

High concentration ~~not~~ and low concentration

surface is saturated Overbeck

$\sim \ln c$



< concentration at interface changes due to surface tension >

more lamellae under the cmc with

① Ease of with which lamellae forms (surface concentration)

② ~~Permeability~~ ~~decrease the rate~~
destruction of lamellae

③ ~~concentration~~ Flow rate

Can call Krastev email Alexey

$\Delta P \Rightarrow \frac{\Delta P}{L}$

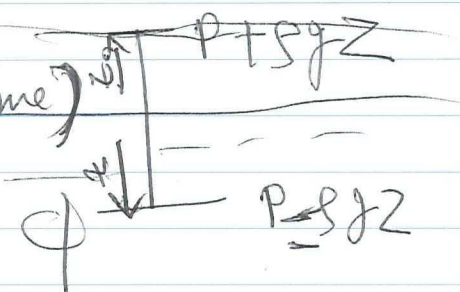
+ down
- up

$$\phi = P + \rho g z$$

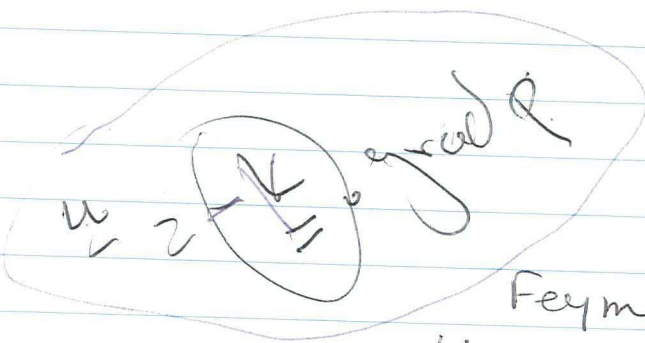
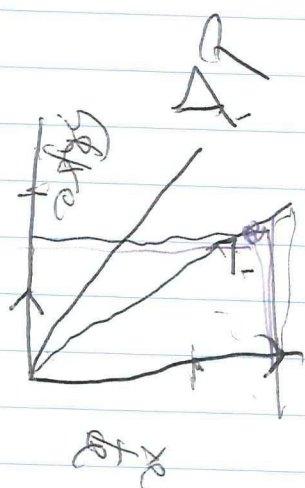
when you go down $P - \rho g z$

If I go down pressure increases

therefore (ϕ remains same)
still water



Permeability is a tensor



Feyman & Hans notes on the course

$$\begin{pmatrix} u_x \\ u_y \\ u_z \end{pmatrix} = \begin{pmatrix} k_{xx} & k_{xy} \\ k_{yx} & k_{yy} \end{pmatrix} \begin{pmatrix} \frac{\partial p}{\partial x} \\ \frac{\partial p}{\partial y} \end{pmatrix}$$

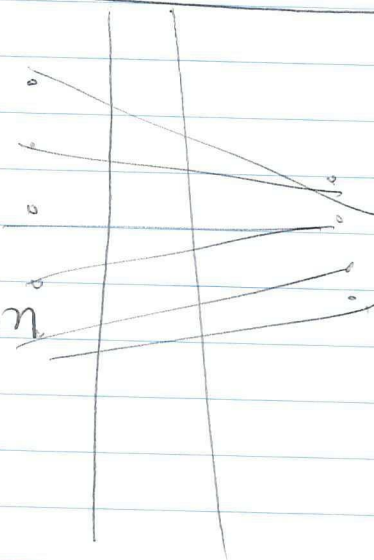
Alexey : — Fig 4.4 destruction of lamellae

Fig. 4.6 Tell Overbeek

We donot take into account of foam quality

Make slide for each question

what is the difference between Neural networking & Symbolic Regression



Alexey :

<for each committee members>
Make Question & answers during Easter Page

Hans : ~~69~~ Why ~~is~~ the blue curve (lowest turbidity) is considered optimal ?

Friday

$$\frac{AP}{L} = A_0 \frac{U_w N_c}{\sqrt{K}}$$

$$\frac{N}{\cancel{m}} = A_0 \frac{\left(\frac{m}{s} \right)^{\frac{1}{2}} \frac{\text{mol}}{e}}{\text{Parameter } m}$$

Take ~~pauses~~ pauses

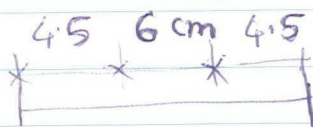
①

②

③ Acid diversion

④

The sand pack length
Order



① Alexey → chapter 4 & 6

② Ruud →

③ Sebastien →

④ Pacelli → Chapter 3

⑤ Timo → chapter 4 & Appendix

⑥ JDT → ?

⑦ Chairman →

⑧ Hans → ~~Chapter 5~~ Chapter 5 : turbidity

~~stimulus~~

— Zitha

① What is different between our approach & approach by other researchers.

We have a PB model while Rouhi & Hirataki (2015) ~~have~~ use Implicit texture (IT) where the effect of bubble size is measured implicitly through mobility reduction factor that depends on saturations, superficial velocities, and other factors

Sunday 27th March 2016

Time → make a slide of symbolic regression concept from Schmidt paper

Andrianov : → Effect of surfactant concentration, velocity & permeability on the pressure drop

Slide

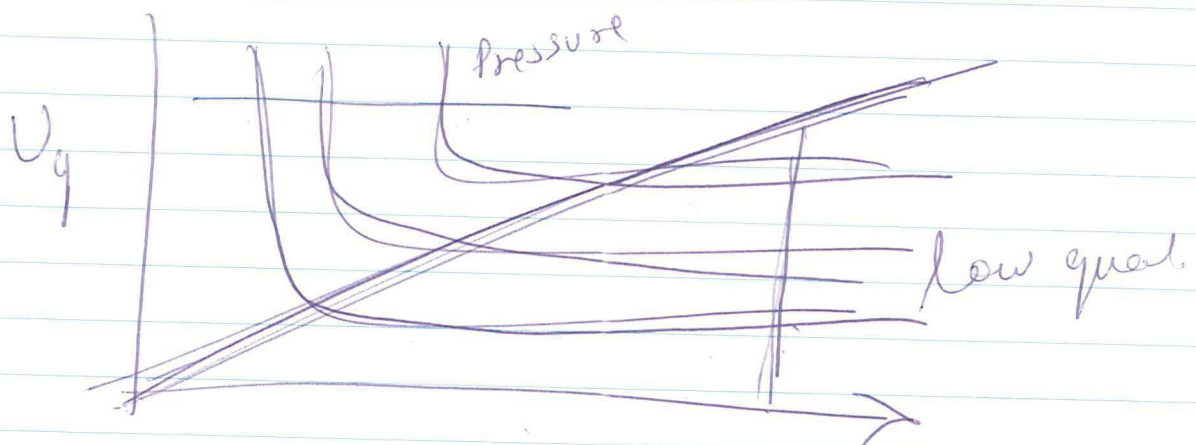
Surfactant concentration	↑	ΔP ↑	Clear trend
Total superficial velocity	↑	ΔP ↑	
Permeability	↑	ΔP ↓	Clear trend
Total superficial velocity	↑	ΔP ↓	NOT clear

→ Effect of permeability supersedes effect of surfactant concentration

Make a slide of
Use the Kuhlman paper graph of Somasundaram to explain the retardation

make a slide of error: It is there somewhere in the presentations

⊗ Absolute error, expt error, model error,



Jan 1992 U_w C_s K

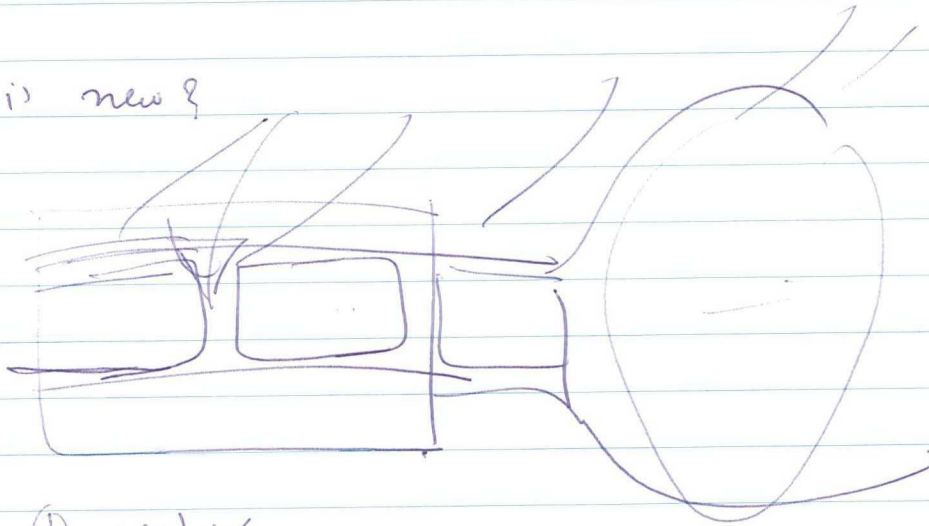
① destruction of the beam is less with particles.

② Creation rate ⊗ dependent on
⊗ Salinity

Tuesday

Meeting with Prof. Ruud Schotting

what is new?



- ① water
- ② Gas
- ③ Bubble density
- ④ Surfactant concentration

① Diffusion parameter

② fit Page 35 simulation & experiment-
~~steepness~~ < Steepness >

problem why it is more in simulation

parameters fitting

D_{np}
 P_{cap}
surfactant diffusion

② Carman-Kozeny equation

water saturation

n_{max}
 n_{min}

$S_w = 1$
 $S_w = 0$

S_w

① Capillary forces are neglected

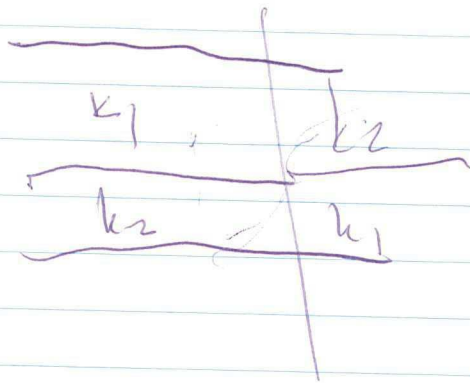


Fig- 3.1 generation-coalescence function purely polynomial regression.

there can be diffusion

we don't about bubble ~~density~~ diffusion mechanism.

number averaged particle diameter
Volume averaged particle diameter

change in permeability & porosity values.

Look into the Hanks' cases of dimensional analysis; Perry's handbook

$$\oint E \cdot ds = \frac{Q}{\epsilon_0} \quad \text{Coulomb}$$

$$4\pi R^2 E = \frac{Q}{\epsilon_0} \Rightarrow E = \frac{Q}{4\pi R^2 \epsilon_0}$$

$$e^{-\epsilon/kT}$$

G_{ps} is the most non wetting phase

$$\textcircled{\otimes} U_w = - \frac{\cancel{K}}{\cancel{\pi}} \frac{\Delta P}{L}$$

$$U_w =$$

↓ ↑

low foam than quality regime it behaves differently
~~generally~~ general trends

Start with what other people generally know

Give the new thing

Reservierungsnummer 12666407

- ① meer technische informatie
- ② minder persoonlijke informatie
- ③ minder over commissie lid
- ④

C24CA1570 Kloeg

$$n_{f \text{ exp}} = \frac{(K K_{\text{rot}} \cdot \frac{dP}{dx})}{U_g}$$

↑
not Constant

~~Sw = 0~~
Sw = Swc

when calculating

$\frac{U_g}{U_{\text{rotol}}}$

2

We consider $K_{\text{rot}} = x_f K_{\text{reg}}$ $M_f(Sw, n, \alpha)$

z is positive downside & flow is top to bottom



$$\bar{q} = -\frac{k}{\mu} (\Delta P + \rho g)$$

$$\bar{g} = \begin{bmatrix} 0 \\ 0 \\ -g \end{bmatrix} = \rho g \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$\bar{q} = \begin{pmatrix} q_x \\ q_y \\ q_z \end{pmatrix}$$

$$= \begin{pmatrix} -\frac{k}{\mu} \frac{\partial P}{\partial x} \\ -\frac{k}{\mu} \frac{\partial P}{\partial y} \\ -\frac{k}{\mu} \left(\frac{\partial P}{\partial z} + \rho g \right) \end{pmatrix}$$

$$\rho g = \rho g \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$\bar{q} = -\frac{k}{\mu} \left(\frac{\partial P}{\partial z} - \rho g \right)$$

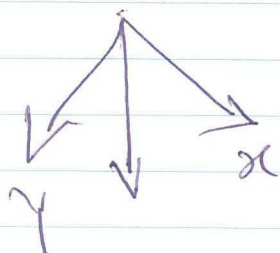
Panda-Lake : permeability porosity & particle size distribution

Carmen Kozeny equation

$$\frac{\partial(\rho s g)}{\partial t} + \frac{\partial(\rho g \bar{q})}{\partial x} = \rho \omega + \text{diffusion}$$

Darcy law

$$\bar{q} = -\frac{k}{\mu} (\nabla p - \rho \bar{g})$$



$$\bar{g} = \begin{bmatrix} 0 \\ 0 \\ g \end{bmatrix}$$

$$= g \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$= g \bar{e}_z$$

$$\bar{q} = -\frac{k}{\mu} \begin{bmatrix} \frac{\partial p}{\partial x} \\ \frac{\partial p}{\partial y} \\ \frac{\partial p}{\partial z} - \rho g \end{bmatrix}$$

$$\bar{q} = -\frac{k}{\mu} (\nabla p - \rho \bar{g})$$

check the expr with Beuthheimer Expt 17 & 18