

## Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 2

Serial #: 677

Page 1

Sample: KAT\_06\_run1  
Operator: Feroz BHUIYAN  
Submitter: IPPT  
File: C:\WIN3020\DATA\IPPT\KAT\_02.SMP

Started: 28.07.2017 8:55:38	Analysis Adsorptive: N2
Completed: 28.07.2017 21:58:09	Analysis Bath Temp.: 77.350 K
Report Time: 31.07.2017 8:48:01	Sample Mass: 3.0673 g
Warm Free Space: 11.1719 cm <sup>3</sup> Measured	Cold Free Space: 32.3133 cm <sup>3</sup> Measured
Equilibration Interval: 10 s	Low Pressure Dose: None
Sample Density: 1.000 g/cm <sup>3</sup>	Automatic Degas: No

### Summary Report

#### Surface Area

BET Surface Area: 58.5246 m<sup>2</sup>/g

#### Pore Volume

Single point adsorption total pore volume of pores  
less than 181.4722 nm diameter at  $p/p^0 = 0.989229564$ : 0.094363 cm<sup>3</sup>/g

t-Plot micropore volume: -0.003479 cm<sup>3</sup>/g

BJH Adsorption cumulative volume of pores  
between 1.7000 nm and 300.0000 nm diameter: 0.098140 cm<sup>3</sup>/g

#### Pore Size

Adsorption average pore width (4V/A by BET): 6.44945 nm

BJH Adsorption average pore diameter (4V/A): 5.7337 nm

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Analysis Bath Temp.: 77.350 K  
Sample Mass: 3.0673 g  
Cold Free Space: 32.3133 cm<sup>3</sup> Measured  
Low Pressure Dose: None  
Automatic Degas: No

## Isotherm Tabular Report

Relative Pressure (p/p <sub>0</sub> )	Absolute Pressure (mmHg)	Quantity Adsorbed (cm <sup>3</sup> /g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.009642757	7.044125	9.1593	01:17	730.455017
0.014422790	10.534917	9.7050	02:40	730.509460
0.019486230	14.234564	10.1301	02:57	730.435425
0.023884695	17.444908	10.4282	03:13	730.493469
0.029223098	21.339090	10.7396	03:24	730.380188
0.034560878	25.235415	11.0134	03:35	730.213135
0.039613159	28.920906	11.2456	03:46	730.172852
0.049212760	35.927670	11.6417	03:57	730.083313
0.075146644	54.860077	12.5472	04:08	730.047852
0.096821632	70.685654	13.2117	04:21	730.040283
0.117260134	85.601257	13.8030	04:32	730.060547
0.136922740	99.953835	14.3543	04:43	730.011597
0.156614673	114.321877	14.8969	04:53	730.001709
0.176341448	128.721680	15.4374	05:03	729.956360
0.196245596	143.222046	15.9814	05:13	729.957031
0.244409499	178.396423	17.3209	05:23	729.810242
0.297520011	217.177460	18.8604	05:36	729.907898
0.344480323	251.411407	20.3170	05:53	729.959167
0.401000123	292.624969	22.2188	06:07	729.828064
0.451723870	329.593964	24.1213	06:27	729.737854
0.501435012	365.904602	26.2303	06:49	729.635925
0.551556824	402.513000	28.6180	07:12	729.714905
0.600589022	438.424377	31.2275	07:35	729.776123
0.643172819	469.620972	33.6418	07:58	729.990662
0.702558164	513.114624	36.3348	08:14	730.162964
0.737229671	538.405029	37.3750	08:30	730.351807
0.765973851	559.424683	38.1512	08:46	730.308411
0.793304539	579.460449	38.8866	08:57	730.344360
0.814696560	595.229370	39.5210	09:06	730.438843
0.835950352	611.029297	40.2179	09:16	730.614807
0.855697919	625.736206	40.9455	09:25	730.939697
0.871029710	636.993958	41.6192	09:34	731.258301
0.887717748	649.195618	42.4328	09:44	731.311401
0.901802104	659.475098	43.2248	09:53	731.308594
0.912187834	667.094421	43.9468	10:02	731.285828
0.923582912	675.301514	44.8230	10:12	731.312561
0.930963761	680.881348	45.5222	10:21	731.175842
0.938405822	686.352905	46.3163	10:30	731.372559
0.945296096	691.581543	47.1808	10:39	731.403076
0.951909371	696.544983	48.0496	10:48	731.603088
0.956780998	700.048462	48.8668	10:57	731.734558
0.961391651	703.578613	49.6951	11:06	731.670532
0.964557152	705.989075	50.4684	11:14	731.833496
0.968166956	708.641602	51.2239	11:22	731.930786
0.970348748	710.329102	51.9281	11:29	731.941528
0.972596173	712.025940	52.6274	11:36	732.034851
0.975247990	713.943970	53.2922	11:43	732.087952
0.976833559	715.154968	53.8607	11:49	732.064026
0.977907925	716.052307	54.4153	11:55	732.115479
0.979511339	717.042236	54.9561	12:01	732.228760
0.981605239	718.727234	55.9858	12:06	732.040771
			12:16	732.195801

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Page 3

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Analysis Adsorptive: N2  
Analysis Bath Temp.: 77.350 K  
Sample Mass: 3.0673 g  
Cold Free Space: 32.3133 cm<sup>3</sup> Measured  
Low Pressure Dose: None  
Automatic Degas: No

## Isotherm Tabular Report

Relative Pressure (p/p <sup>o</sup> )	Absolute Pressure (mmHg)	Quantity Adsorbed (cm <sup>3</sup> /g STP)	Elapsed Time (h:min)	Saturation Pressure (mmHg)
0.982283765	719.260620	56.4911	12:22	732.233032
0.983050254	719.943970	56.9863	12:27	732.357239
0.985975966	722.187256	58.8488	12:43	732.459290
0.989229564	724.604980	61.0052	13:01	732.494263

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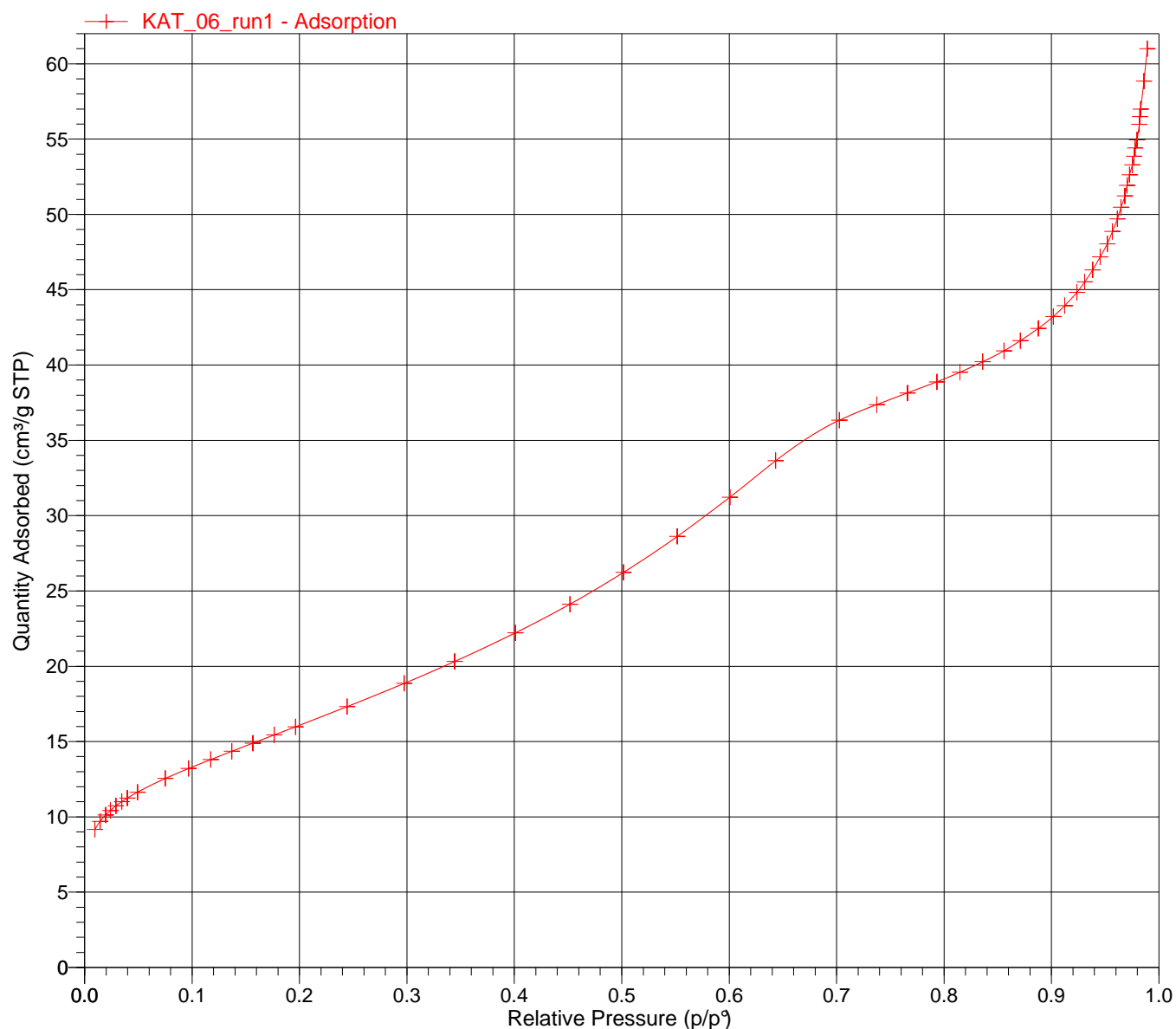
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Isotherm Linear Plot



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Low Pressure Dose: None  
Automatic Degas: No

### BET Surface Area Report

BET Surface Area: 58.5246 ± 0.4255 m<sup>2</sup>/g  
Slope: 0.073439 ± 0.000536 g/cm<sup>3</sup> STP  
Y-Intercept: 0.000944 ± 0.000072 g/cm<sup>3</sup> STP  
C: 78.818797  
Qm: 13.4440 cm<sup>3</sup>/g STP  
Correlation Coefficient: 0.9998403  
Molecular Cross-Sectional Area: 0.1620 nm<sup>2</sup>

Relative Pressure (p/p <sup>0</sup> )	Quantity Adsorbed (cm <sup>3</sup> /g STP)	1/[Q(p <sup>0</sup> p - 1)]
0.049212760	11.6417	0.004446
0.075146644	12.5472	0.006476
0.096821632	13.2117	0.008114
0.117260134	13.8030	0.009624
0.136922740	14.3543	0.011052
0.156614673	14.8969	0.012466
0.176341448	15.4374	0.013869
0.196245596	15.9814	0.015278

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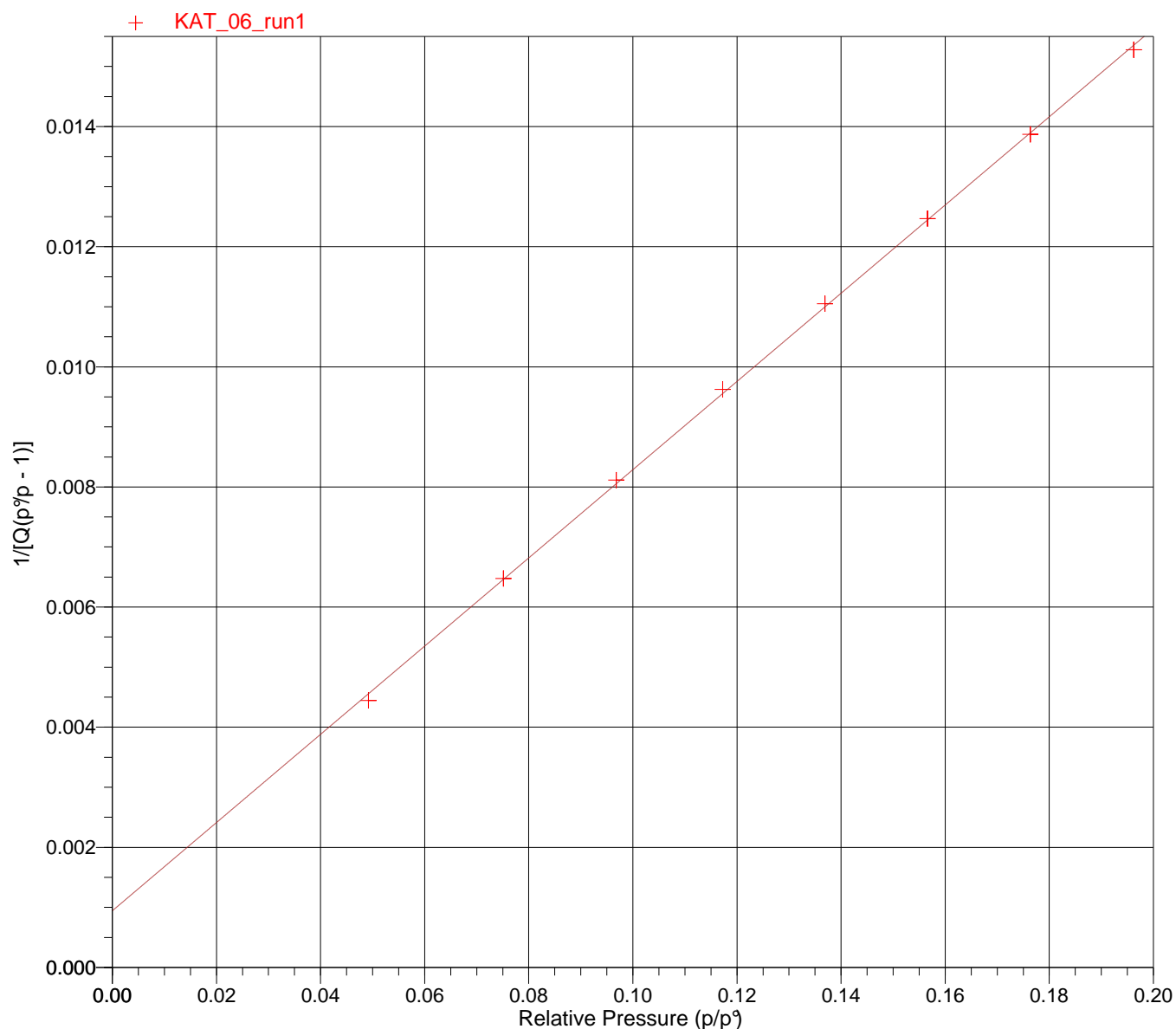
Page 6

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Automatic Degas: No

BET Surface Area Plot



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Page 7

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Cold Free Space: 32.3133 cm<sup>3</sup> Measured  
Low Pressure Dose: None  
Automatic Degas: No

## t-Plot Report

Micropore Volume: -0.003479 cm<sup>3</sup>/g  
Micropore Area: \*  
External Surface Area: 65.1083 m<sup>2</sup>/g  
Slope: 42.092252 ± 0.513326 cm<sup>3</sup>/g-nm STP  
Y-Intercept: -2.249007 ± 0.217305 cm<sup>3</sup>/g STP  
Correlation Coefficient: 0.999554  
Surface Area Correction Factor: 1.000  
Density Conversion Factor: 0.0015468  
Total Surface Area (BET): 58.5246 m<sup>2</sup>/g  
Thickness Range: 0.35000 nm to 0.50000 nm  
Thickness Equation: Harkins and Jura  
$$t = [ 13.99 / ( 0.034 - \log(p/p^0) ) ] ^{0.5}$$

Relative Pressure (p/p <sup>0</sup> )	Statistical Thickness (nm)	Quantity Adsorbed (cm <sup>3</sup> /g STP)	Fitted
0.009642757	0.26125	9.1593	
0.014422790	0.27316	9.7050	
0.019486230	0.28321	10.1301	
0.023884695	0.29067	10.4282	
0.029223098	0.29867	10.7396	
0.034560878	0.30586	11.0134	
0.039613159	0.31211	11.2456	
0.049212760	0.32288	11.6417	
0.075146644	0.34757	12.5472	
0.096821632	0.36536	13.2117	*
0.117260134	0.38078	13.8030	*
0.136922740	0.39481	14.3543	*
0.156614673	0.40830	14.8969	*
0.176341448	0.42145	15.4374	*
0.196245596	0.43445	15.9814	*
0.244409499	0.46541	17.3209	*
0.297520011	0.49961	18.8604	*
0.344480323	0.53064	20.3170	
0.401000123	0.56983	22.2188	
0.451723870	0.60746	24.1213	
0.501435012	0.64740	26.2303	
0.551556824	0.69169	28.6180	
0.600589022	0.74008	31.2275	
0.643172819	0.78735	33.6418	
0.702558164	0.86421	36.3348	
0.737229671	0.91693	37.3750	

\* The micropore area is not reported because either the micropore volume is negative or the calculated external surface area is larger than the total surface area.

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Page 8

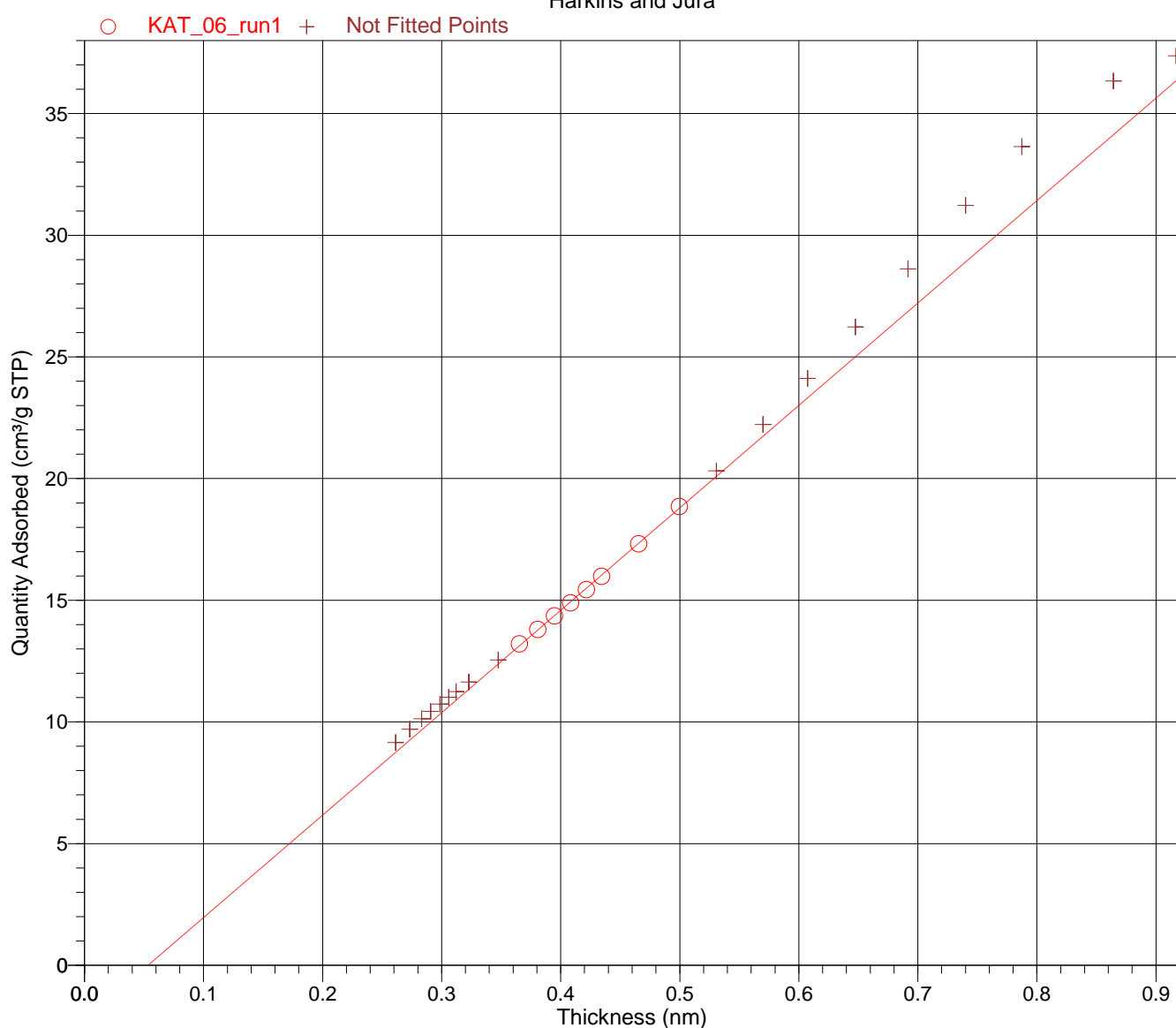
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## t-Plot

Harkins and Jura





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Page 9

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Low Pressure Dose: None  
Automatic Degas: No

## BJH Adsorption Pore Distribution Report

Faas Correction

Halsey

$$t = 3.54 \left[ -5 / \ln(p/p^0) \right]^{0.333}$$

Diameter Range: 1.7000 nm to 300.0000 nm

Adsorbate Property Factor: 0.95300 nm

Density Conversion Factor: 0.0015468

Fraction of Pores Open at Both Ends: 0.00

Pore Diameter Range (nm)	Average Diameter (nm)	Incremental Pore Volume (cm <sup>3</sup> /g)	Cumulative Pore Volume (cm <sup>3</sup> /g)	Incremental Pore Area (m <sup>2</sup> /g)	Cumulative Pore Area (m <sup>2</sup> /g)
181.4 - 139.9	155.2	0.003557	0.003557	0.092	0.092
139.9 - 116.1	125.7	0.003089	0.006646	0.098	0.190
116.1 - 111.2	113.5	0.000824	0.007470	0.029	0.219
111.2 - 107.1	109.1	0.000843	0.008313	0.031	0.250
107.1 - 96.4	101.2	0.001716	0.010029	0.068	0.318
96.4 - 89.5	92.7	0.000899	0.010928	0.039	0.357
89.5 - 85.4	87.4	0.000932	0.011860	0.043	0.399
85.4 - 80.1	82.6	0.000952	0.012813	0.046	0.445
80.1 - 72.5	75.9	0.001109	0.013922	0.058	0.504
72.5 - 67.1	69.6	0.001181	0.015104	0.068	0.572
67.1 - 62.6	64.7	0.001197	0.016300	0.074	0.646
62.6 - 56.4	59.2	0.001276	0.017576	0.086	0.732
56.4 - 51.9	53.9	0.001324	0.018900	0.098	0.830
51.9 - 46.5	48.9	0.001414	0.020314	0.116	0.946
46.5 - 41.9	43.9	0.001406	0.021720	0.128	1.074
41.9 - 36.9	39.1	0.001496	0.023217	0.153	1.227
36.9 - 32.9	34.7	0.001508	0.024725	0.174	1.401
32.9 - 29.5	31.0	0.001392	0.026117	0.180	1.581
29.5 - 26.7	27.9	0.001235	0.027352	0.177	1.758
26.7 - 23.3	24.8	0.001552	0.028904	0.251	2.008
23.3 - 20.9	22.0	0.001296	0.030200	0.236	2.244
20.9 - 18.4	19.5	0.001425	0.031626	0.293	2.537
18.4 - 16.0	17.0	0.001484	0.033110	0.348	2.885
16.0 - 14.4	15.1	0.001249	0.034358	0.330	3.216
14.4 - 12.7	13.4	0.001357	0.035715	0.404	3.620
12.7 - 11.3	11.9	0.001321	0.037037	0.445	4.065
11.3 - 10.1	10.6	0.001224	0.038261	0.461	4.526
10.1 - 8.9	9.4	0.001448	0.039709	0.613	5.140
8.9 - 8.0	8.4	0.001592	0.041301	0.760	5.900
8.0 - 7.0	7.4	0.002263	0.043563	1.220	7.120
7.0 - 5.8	6.3	0.006511	0.050074	4.143	11.263
5.8 - 5.2	5.4	0.006193	0.056267	4.553	15.815
5.2 - 4.5	4.8	0.006830	0.063097	5.682	21.498
4.5 - 4.0	4.3	0.006310	0.069407	5.931	27.429
4.0 - 3.6	3.8	0.005578	0.074986	5.879	33.308
3.6 - 3.2	3.4	0.004973	0.079958	5.849	39.157
3.2 - 2.9	3.0	0.004877	0.084835	6.432	45.589
2.9 - 2.6	2.7	0.003619	0.088454	5.302	50.891
2.6 - 2.3	2.5	0.003648	0.092102	5.940	56.831
2.3 - 2.1	2.2	0.002950	0.095053	5.349	62.180
2.1 - 2.0	2.1	0.001097	0.096150	2.134	64.314
2.0 - 1.9	2.0	0.001032	0.097182	2.103	66.417
1.9 - 1.8	1.9	0.000958	0.098140	2.048	68.465

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Page 10

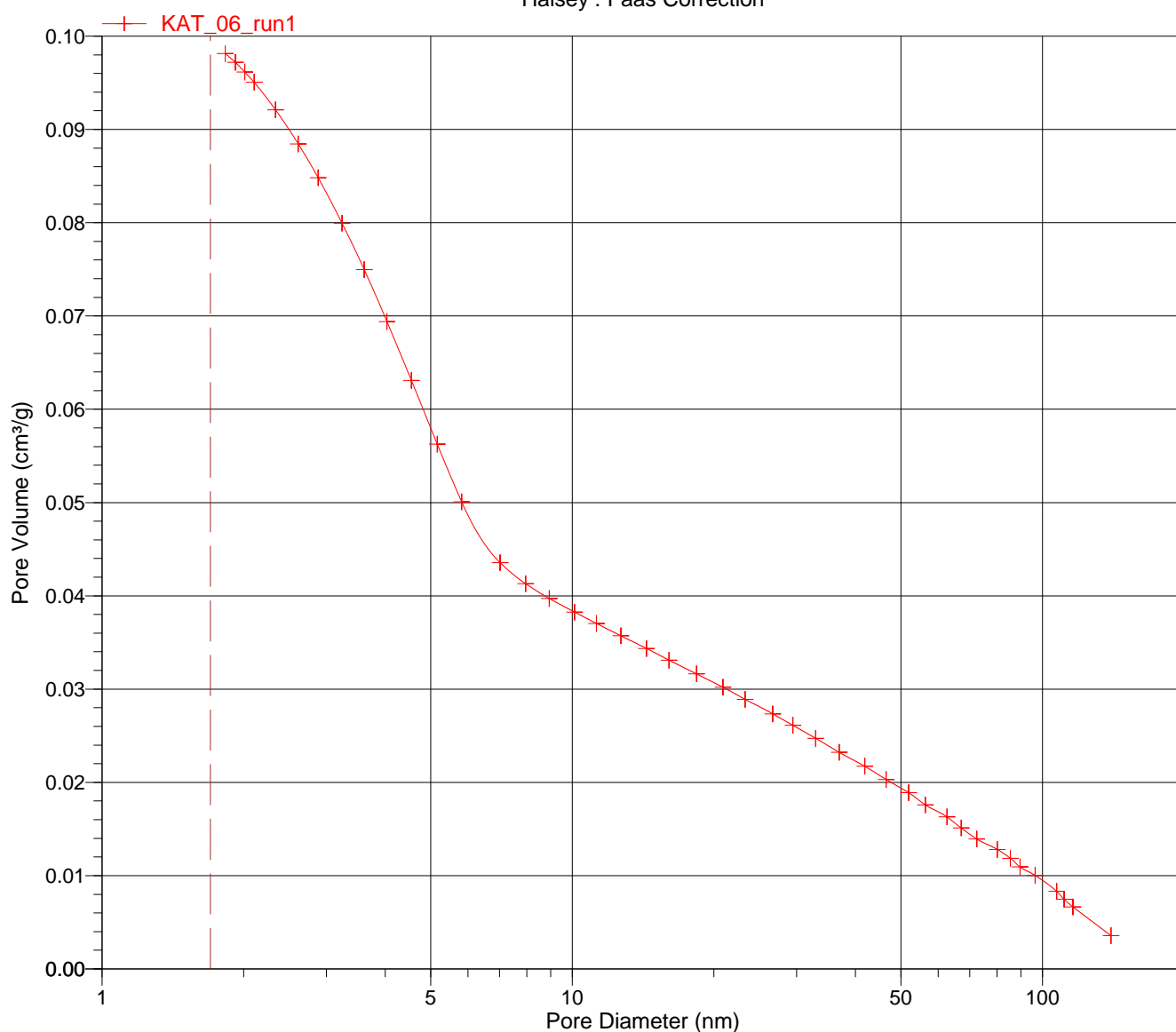
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## BJH Adsorption Cumulative Pore Volume (Larger)

Halsey : Faas Correction



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Page 11

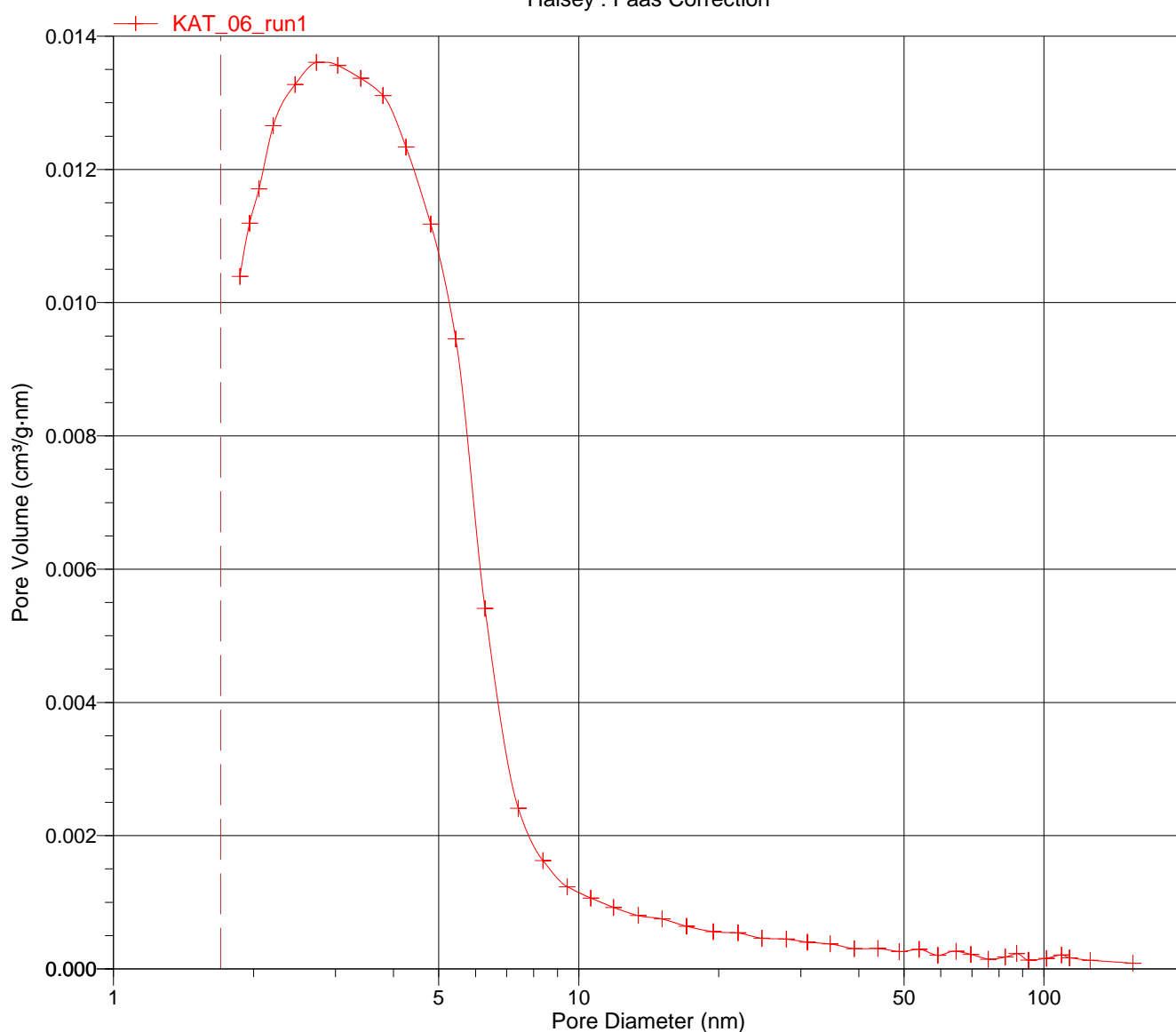
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## BJH Adsorption dV/dD Pore Volume

Halsey : Faas Correction



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Page 12

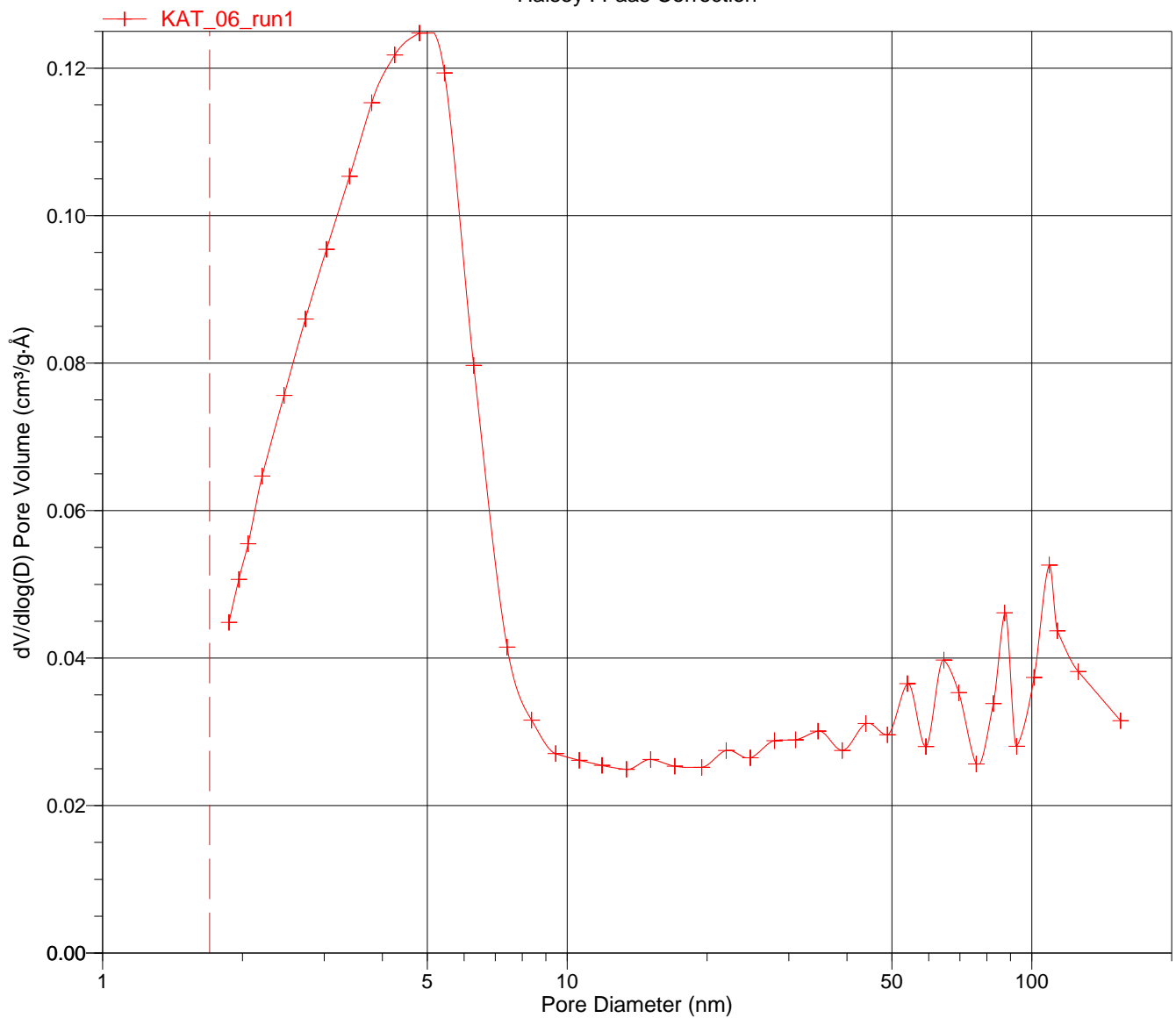
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Operator: Feroz BHUIYAN  
Submitter: IPPT  
File: C:\WIN3020\DATA\IPPT\KAT\_02.SMP

Started: 28.07.2017 8:55:38  
Completed: 28.07.2017 21:58:09  
Report Time: 31.07.2017 8:48:01  
Warm Free Space: 11.1719 cm<sup>3</sup> Measured  
Equilibration Interval: 10 s  
Sample Density: 1.000 g/cm<sup>3</sup>

Analysis Adsorptive: N2  
Analysis Bath Temp.: 77.350 K  
Sample Mass: 3.0673 g  
Cold Free Space: 32.3133 cm<sup>3</sup> Measured  
Low Pressure Dose: None  
Automatic Degas: No

## BJH Adsorption $dV/d\log(D)$ Pore Volume

Halsey : Faas Correction



## Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 2

Serial #: 677

Page 13

Sample: KAT\_06\_run1  
Operator: Feroz BHUIYAN  
Submitter: IPPT  
File: C:\WIN3020\DATA\IPPT\KAT\_02.SMP

Started: 28.07.2017 8:55:38	Analysis Adsorptive: N2
Completed: 28.07.2017 21:58:09	Analysis Bath Temp.: 77.350 K
Report Time: 31.07.2017 8:48:01	Sample Mass: 3.0673 g
Warm Free Space: 11.1719 cm <sup>3</sup> Measured	Cold Free Space: 32.3133 cm <sup>3</sup> Measured
Equilibration Interval: 10 s	Low Pressure Dose: None
Sample Density: 1.000 g/cm <sup>3</sup>	Automatic Degas: No

### BJH Desorption Reports

#### Primary Data

1045- Fewer than 2 points available for BJH Desorption calculations.  
1045- Fewer than 2 points available for BJH Desorption calculations.

## Full Report Set

TriStar II 3020 V1.03 (V1.03)

Unit 1 Port 2

Serial #: 677

Page 14

Sample: KAT\_06\_run1  
Operator: Feroz BHUIYAN  
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File: C:\WIN3020\DATA\IPPT\KAT\_02.SMP

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Equilibration Interval: 10 s	Low Pressure Dose: None
Sample Density: 1.000 g/cm <sup>3</sup>	Automatic Degas: No

### Options Report

#### Sample Tube

Warm free space: 3.7700 cm<sup>3</sup>  
Cold free space: 3.7700 cm<sup>3</sup>  
Non-ideality factor: 0.0000620  
Use Isothermal Jacket: Yes  
Use Filler Rod: No  
Vacuum seal type: None

#### Analysis Conditions

##### Preparation

Fast evacuation: No  
Evacuation rate: 5.0 mmHg/s  
Unrestricted evacuation from: 5.0 mmHg  
Evacuation time: 0.50 h  
Leak test: Yes  
Leak test duration: 120 s  
Use TranSeal: No

##### Free Space

Free-space type: Measured  
Lower dewar for evacuation: Yes  
Evacuation time: 0.30 h  
Outgas test: Yes  
Outgas test duration: 60 s

##### p° and Temperature

p° and T type: Measure p° in the p° tube for each isotherm point. Enter the Analysis Bath Temperature below.  
Temperature: 77.350 K

##### Dosing

Use first pressure fixed dose: No  
Use maximum volume increment: No  
Target tolerance: 5.0% or 5.000 mmHg

##### Equilibration

Equilibration interval: 10 s  
Minimum equilibration delay at p/p° ≥ 0.995: 600 s

##### Sample Backfill

Backfill at start of analysis: Yes  
Backfill at end of analysis: Yes  
Backfill gas: N2

##### Adsorptive Properties

Adsorptive: Nitrogen  
Maximum manifold pressure: 1050.00 mmHg  
Non-ideality factor: 0.0000620  
Density conversion factor: 0.0015468  
Molecular cross-sectional area: 0.162 nm<sup>2</sup>