A "Zero" emission biofuel

Glucose microbial transformation:
Using the thermophile *Moorella Thermoacetica* to convert 1x glucose into 3x acetic with a close to the theoretical yield of 100% with a growth temperature of 58 degrees Celsius.[1]

Second substrate methanol:
Injecting MeOH/water (60/40) mixture from the Lurgi process (see this company)[2], isolated MeOH. Methane (natural gas) can also be cheaply transformed into MeOH.

Biocatalytic transformation:
Extracellular expressing of an thermophile esterase or lipase in the bacterium for the esterification esterify acetic acid and MeOH to MeOAc. The expression of an extracellular esterase has already been successfully demonstrated in a bacterium.[3]

In situ product isolation:
1) Increasing the productivity by applying an organic phase (nonane or diesel) that shifts the equilibrium towards ester formation.
2) Breaking the azeotropes MeOH/water, MeOH/MeOAc and MeOAc/water with the same organic phase (nonane/diesel) and obtaining 99.5% purity.[4] This has already been successfully demonstrated.
3) Increasing the productivity by applying in situ distillation of the MeOAc (the boiling point of MeOAc is approximately the same as the growth conditions of the microbe). The boiling point of the substrates MeOH and AcOH are higher than MeOAc.
4) Increasing the productivity by applying slight reduced pressure and MeOAc collection.

Product properties:
1) MeOAc has a higher calorific value than MeOH
2) The calorific value of MeOAc is approximately the same as that of EtOH
3) Less modifications needed to gasoline car than EtOH
4) Is stable and non-toxic

Economics:
Overall reaction:
180g glucose + 96g methanol → 222g methyl acetate and 54g water

In:
Glucose:
400 EUR per 1000 kg
0.4 EUR per 1 kg
0.072 EUR per 0.18 kg

MeOH:
400 EUR per 1000 kg
0.4 EUR per 1 kg
0.038 EUR per 0.096kg

Total = 0.072 + 0.038 **= 0.11 EUR for 0.18 kg glucose and 0.096 kg MeOH**

Uit:
MeOAc:
1200 EUR per 1000 kg (marktprijs)
1.2 EUR per 1 kg
0.266 EUR per 0.222 kg
Total = 0.266 EUR for 0.222 kg MeOAc

21.5 MJ per kg MeOAc
1.2 EUR per kg MeOAc
1.2 EUR / 21.5 MJ
0.056 EUR / MJ (marktprijs)

Costs of substrates in leads to:
21.5 MJ per kg MeOAc
0.6105 EUR per kg MeOAc
0.6105 EUR / 21.5 MJ
0.028 EUR / MJ (prijs/MJ op basis van de kosten van de substraten)

Petrol:
46.4 MJ per kg petrol
1.85 EUR per liter petrol (with accijns)
0.999 EUR per liter petrol (without accijns)
1.329 EUR per 1.33 liter per 1 kg (density = 0.75 g/L)
1.329 EUR per 46.4 MJ
0.0286 EUR / MJ (huidige benzineprijs per MJ)

Energie:
Het betreft continue process. De reactor wordt op 58C gehouden en zo nodig geïsoleerd. Alleen de substraten glucose en methanol dienen op te worden gewarmd. Bij een batch ethanol productie proces van suiker dient het geheel te worden opgewarmd tot het kookpunt van ethanol dat ook hoger ligt dan dat van methyl acetaat. Ongeveer 20% van de gemaakte ethanol dient te worden verbrand om de alcohol te scheiden van het water. Bij mijn methyl acetaat proces is de schatting 1-5% van de methyl acetaat dat verbrand moet worden.

Homogeniseren:

Gezien dat het een continue proces is en reactieve extractieve distillatie plaatsvindt zal homogeniseren mogelijk niet nodig zijn wat de reactor simpeler zal houden en energie besparen.

References:

[1]

https://pubs.acs.org/doi/10.1021/cr400309c

[2]

https://www.zeroemissionfuels.com/

[3]

https://pubmed.ncbi.nlm.nih.gov/19915035/

[4]

https://folk.ntnu.no/skoge/prost/proceedings/aiche-2004/pdffiles/papers/232f.pdf