UNIVERSITEIT
iYUNIVESITHI
STELLENBOSCH
UNIVERSITY

100
1918 · 2018

Comparative assessment of alternative fuel production pathways for sustainable road freight transport

Oseweuba V. Okoro *, Abdul M. Petersen* and Johann Gorgens*

*Department of Process Engineering, Stellenbosch University

Email address: jgorgens@sun.ac.za

Key discussion points

1. Background and motivation for study

2. Methods employed in the study

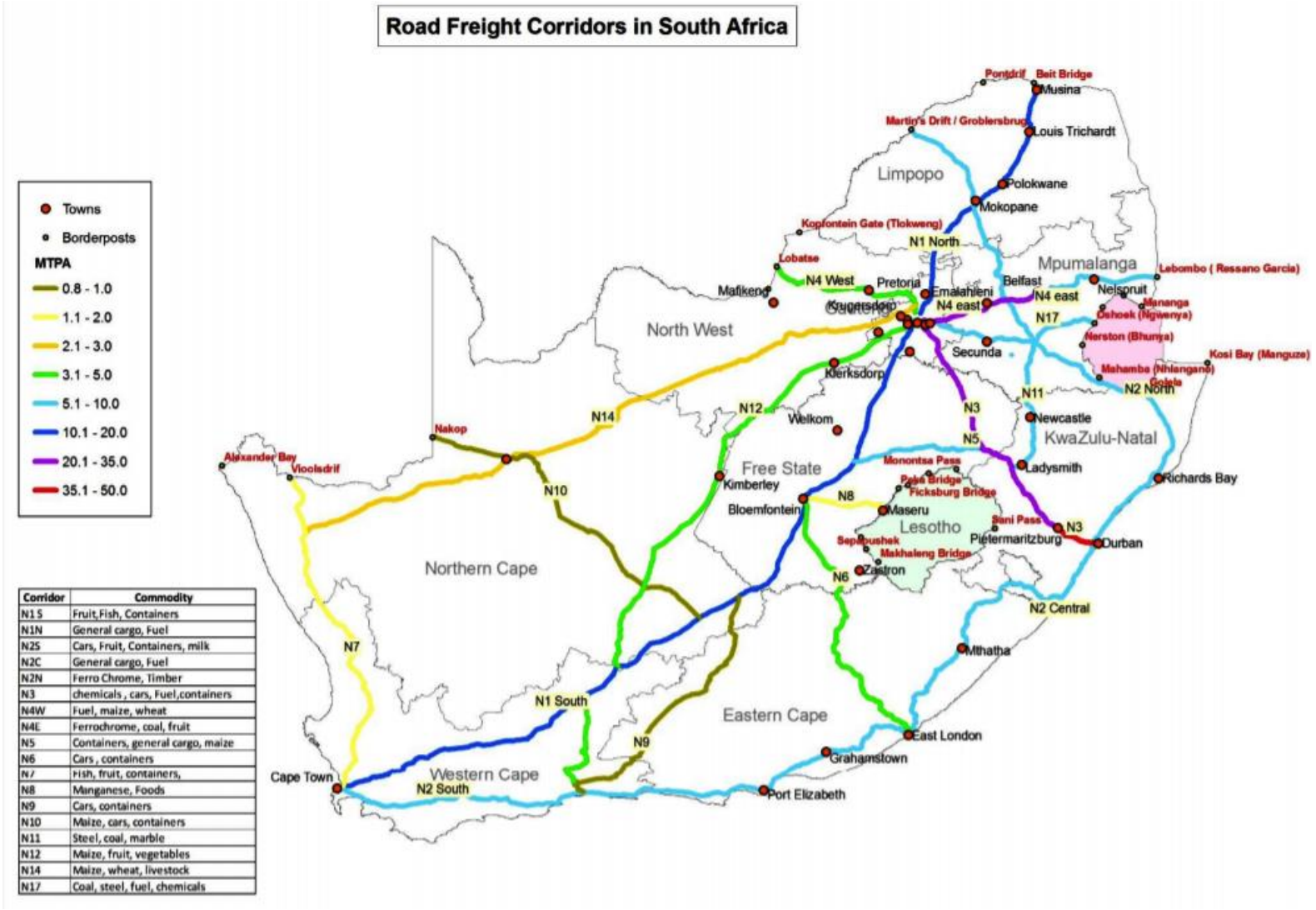
3. Results summary

4. Conclusions and recommendations from the study

Background

Fig 1. Environmental outcomes of fossil fuel use in cargo (road) transport (source: REecoTrans)

Background



Corridor	Commodity
N1 S	Fruit,Fish, Containers
N1N	General cargo, Fuel
N2S	Cars, Fruit, Containers, milk
N2C	General cargo, Fuel
N2N	Ferro Chrome, Timber
N3	chemicals , cars, Fuel,containers
N4W	Fuel, maize, wheat
N4E	Ferrochrome, coal, fruit
N5	Containers, general cargo, maize
N6	Cars , containers
N7	Fish, fruit, containers,
N8	Manganese, Foods
N9	Cars, containers
N10	Maize, cars, containers
N11	Steel, coal, marble
N12	Maize, fruit, vegetables
N14	Maize, wheat, livestock
N17	Coal, steel, fuel, chemicals

Fig 2. Road freight corridors in South Africa-presented for illustrative purposes (source: Agbizgrain.co.za)

Background

- The transportation sector is therefore recognised, globally, as a major source of greenhouse gases (i.e. CO2, NOx and SOx) responsible for the aforementioned environmental issues (Fig. 1).

- In South Africa, specifically, roads constitute a crucial component of national freight systems with ~ 77.3% of freight achieved via land of which road freight accounts for ~73.8% of total land freight income (Fig.2)

- The dominant role of roads in cargo transport in South Africa also leads to an increase in the unfavourable environmental impacts traditionally associated with vehicular transport. One way to reduce the unfavourable impacts of vehicular transport is the use of biofuels.

- Opportunities exist for the production of biofuels from biomass resources with the biofuels capable of being employed directly via blending with fossil-petrol /diesel, or as intermediate products for the generation of higher value products i.e. jetfuels.

- The current study explores the exploration of under-utilised triticale as a sustainable biomass resource for the aforementioned biofuel production.

Triticale for transportation fuel production

- Triticale has a high starch content (up to 70.9 wt%) .
- Triticale may be cultivated on poor and marginal lands because its high drought resistance and is characterised by low-inputs and high-yields-on-marginal-lands. It is therefore a practical alternative to the grain sorghum.
- Availability of significant areas of marginal lands SA. For instance a conservative estimate of marginal lands in Western Cape alone 110,000 hectares are estimated to be available (Greencape).Triticale can therefore be cultivated in many regions of SA
- Improved national security due to reduced dependence on energy/fuel imports.

Methods employed in this study

- The biochemical pathway for the production of the transportation fuels of ethanol (case A) and butanol (case B) and thermocatalytic pathway for the production of HCs (case C) and butanol (case D) were compared.
- HCs of jetfuel, diesel, LPG and gasoline were generated in case C.
- The pathways were compared using Minimum Fuel Energy Prices (MFEP).
- All pathways have been modelled and simulated using ASPEN plus V11 simulation tool.

Biochemical ethanol production

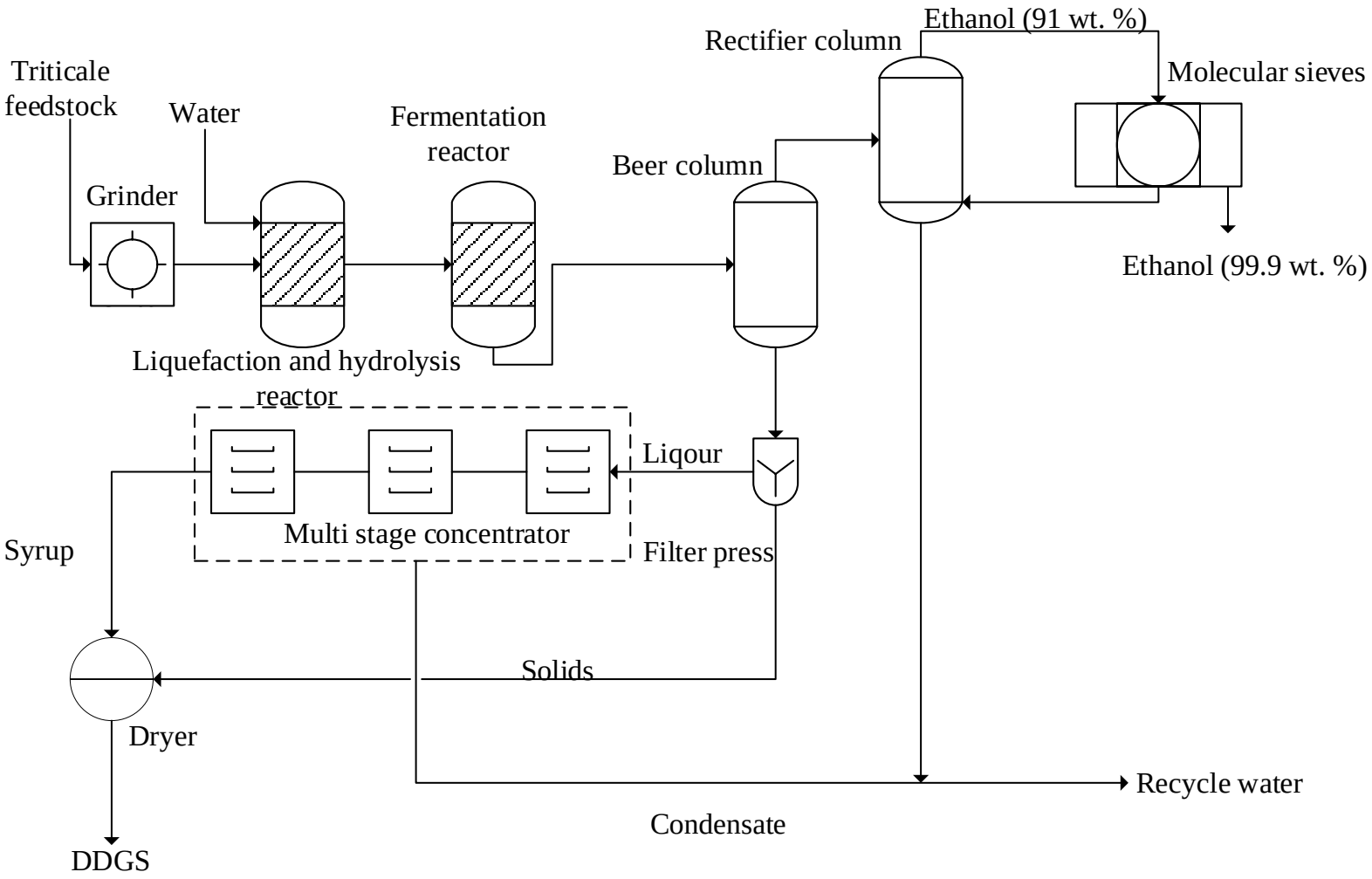


Fig 4. Ethanol production process

Biochemical butanol production

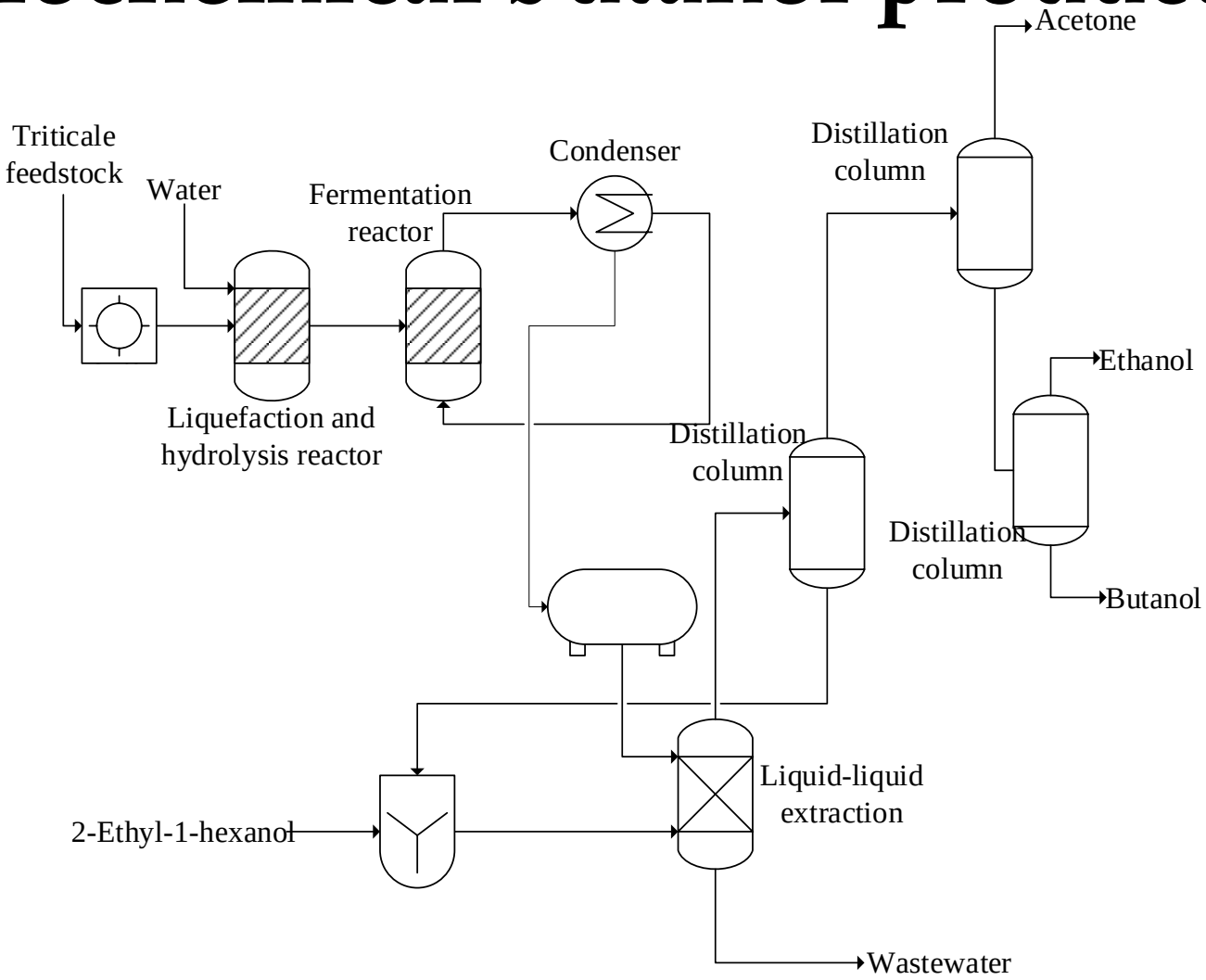


Fig 5. Butanol production process

Thermocatalytic production of HCs

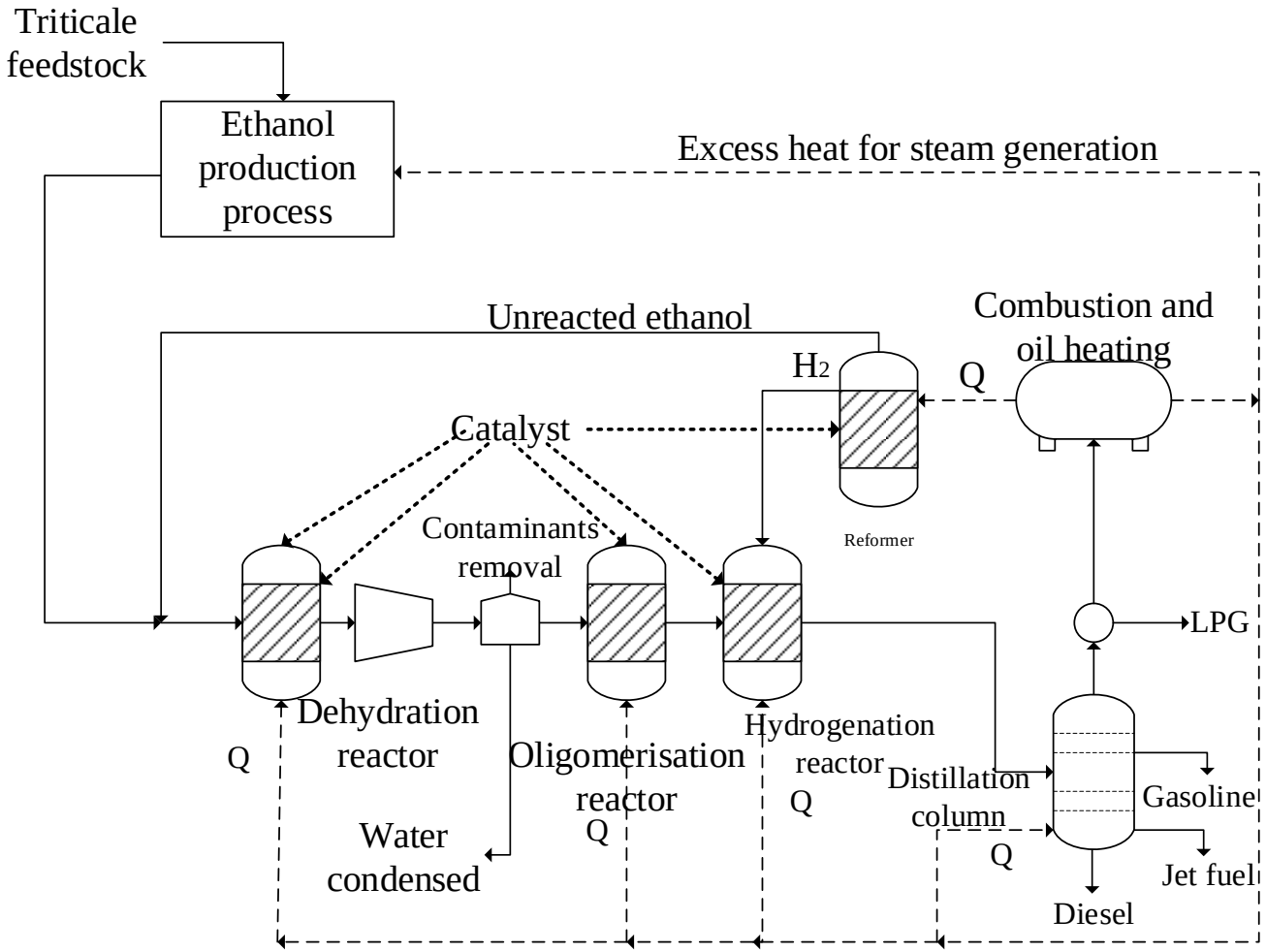


Fig 6. Thermocatalytic production of hydrocarbons (HCs)

Thermocatalytic butanol production

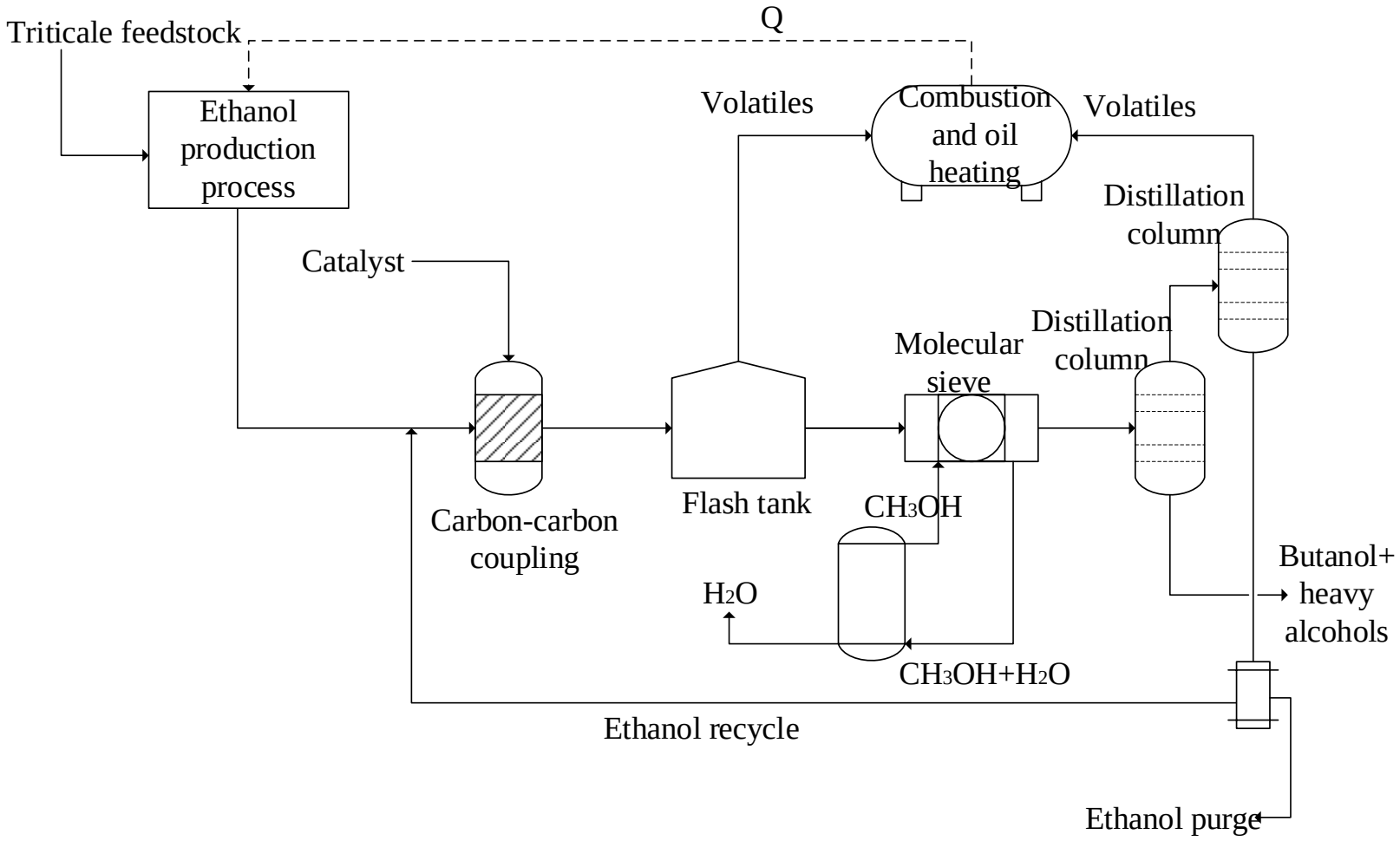


Fig 7. Butanol production process (thermocatalytic)

Results summary

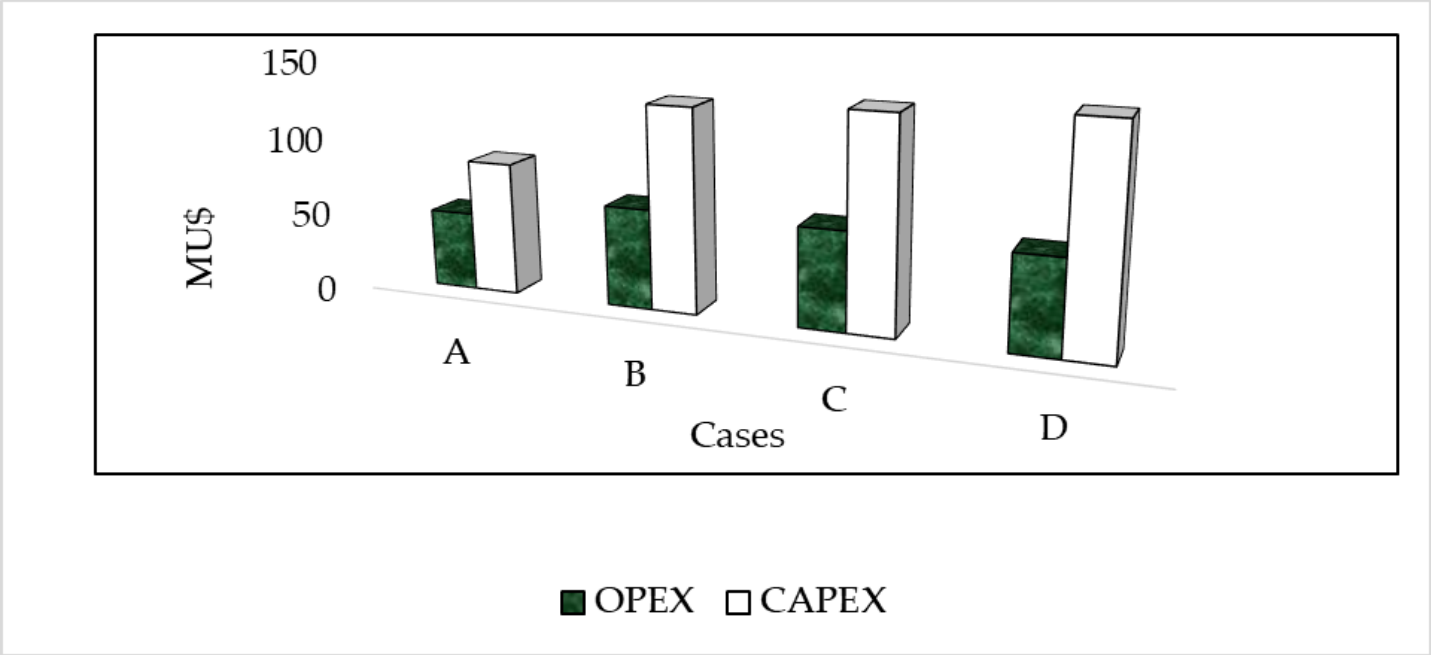


Fig 8. OPEX and CAPEX for the cases (production of ethanol [case A] and butanol [case B] and thermocatalytic pathway for the production of HCs [case C] and butanol [case D].

- Why are there differences in the OPEX /CAPEX results?

Results summary

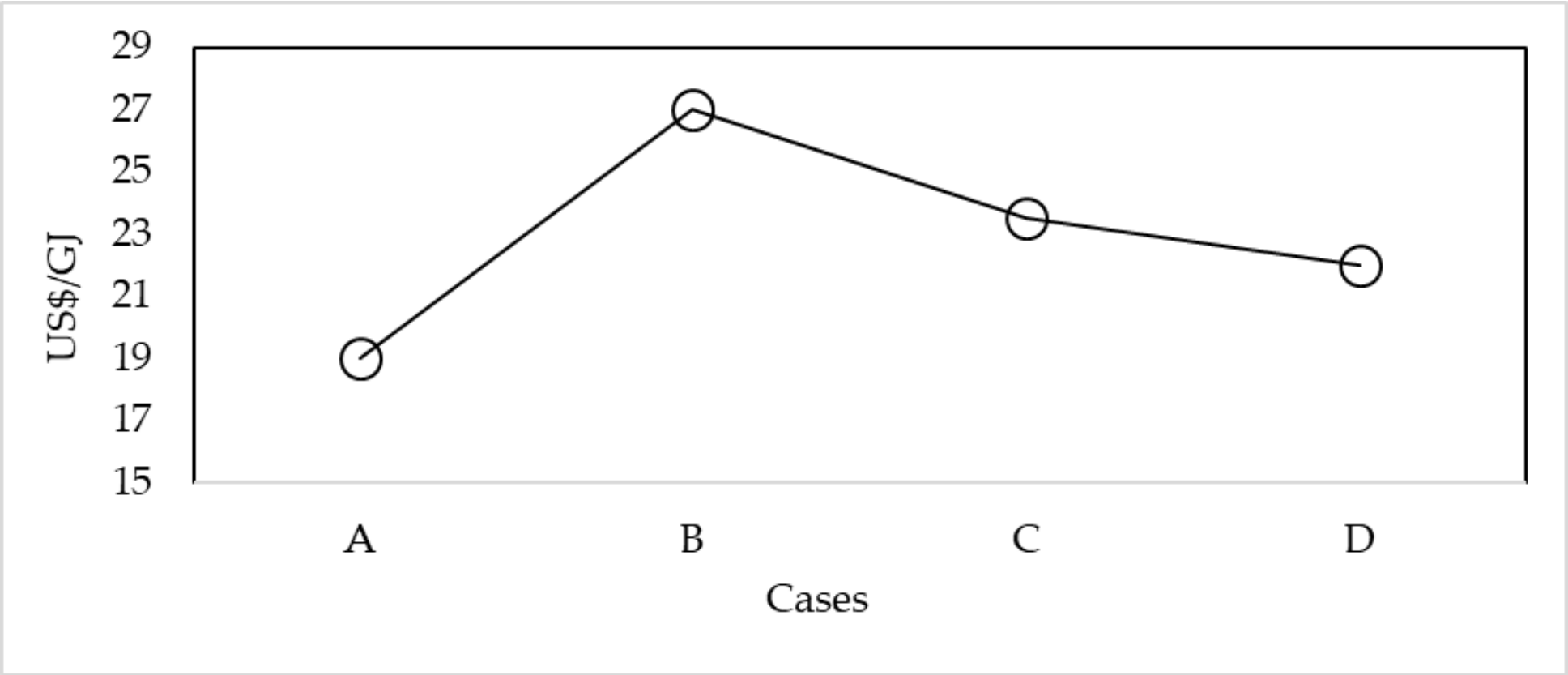


Fig 8. Minimum Fuel Energy Prices (MFEP) for the cases (production of ethanol [case A] and butanol [case B] and thermocatalytic pathway for the production of HCs [case C] and butanol [case D].

Conclusions and recommendations

- Fig. 8 shows that the utilisation of triticale as a bioethanol feedstock (case A) constitutes the most favourable economic pathway as illustrated by the lowest MFEP of US$19 per GJ.

- Correspondingly, producing butanol biochemically from triticale was the least economically favourable with the highest MFEP of 27.3 US$/GJ.

- Other feedstock i.e, sugarcane bagasse, invasive alien plants (IAPs), woodchips etc are currently being investigated as feedstocks for biofuel production.

- The production of jetfuels does have present substantial potential to become the most favourable pathway overall due to the possibility of carbon taxes which create premium prices for biofuels.

UNIVERSITEIT
iYUNIVESITHI
STELLENBOSCH
UNIVERSITY

100
1918 · 2018

Thank you