Master's thesis Industrial Sciences Chemistry

The etherification of glycerol with tert. Butyl ether to produce mono-glycerol tert. Butyl ether

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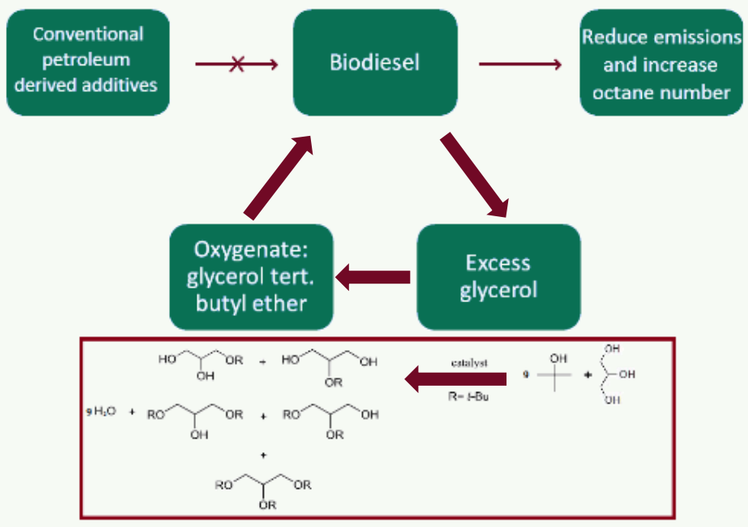
INTRODUCTION

The etherification of glycerol into oxygen rich compounds that can serve as octane enhancers for fuel is an interesting way to make biodiesel viable.



Etherification of glycerol:

- With isobutene or tert. butyl alcohol (TBA),
- In presence of an acid catalyst (Amberlyst, Beta Zeolite) ,
- Mixture of m-, d- and t-GTBE.

m-GTBE is not investigated as gasoline additive yet, despite its high octane number

EXPERIMENTAL

Step 1

Aim: optimization of etherification of glycerol with tert. butyl alcohol

Parameters:

- Reaction time (2 - 6h)
- Temperature (80 - 110°C)
- Catalyst ratio relative to glycerol mass (5 - 10%)

Step 2

Aim: isolation of m-GTBE from GTBE-mixture

Methods:

-Normal distillation

-Vacuum distillation

Step 3

Aim: effect of blending of m-GTBE with pure gasoline (mogas 92)

Percentages:

- 2,5 %
- 5 %
- 7,5 %

Step 4

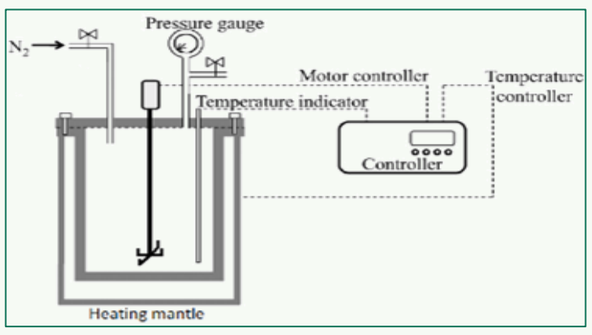
Aim: determination of characteristics gasoline with m-GTBE as additive

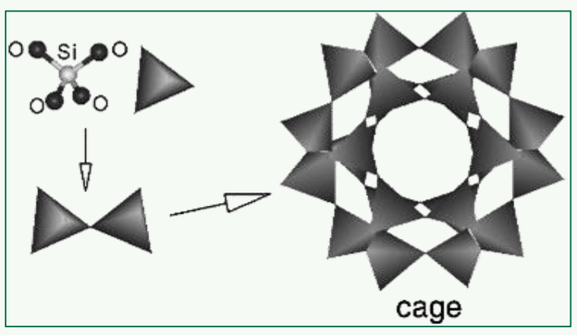
Characteristics:

- Octane number (ASTM D2699)
- Oxygen content (ASTM D4815)
- Vapor pressure (ASTM 3945)
- Density (ASTM D1298)
- Boiling range (ASTM D86)

The etherification was carried out in a batch reactor under 10 atm. N2.

Beta Zeolite was used as a catalyst.

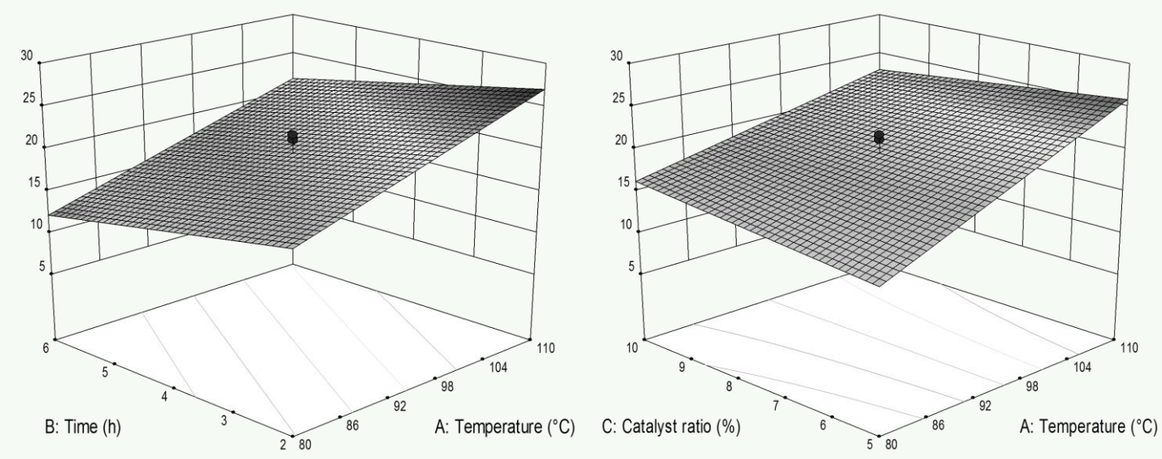




RESULTS

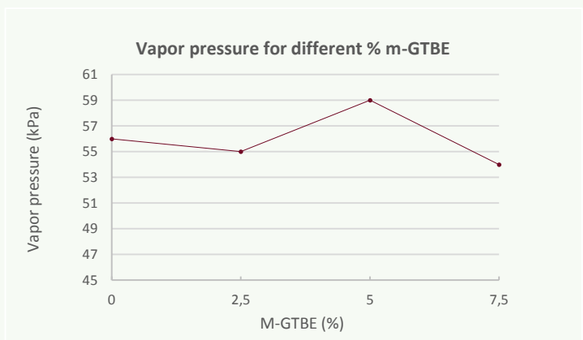
Optimization

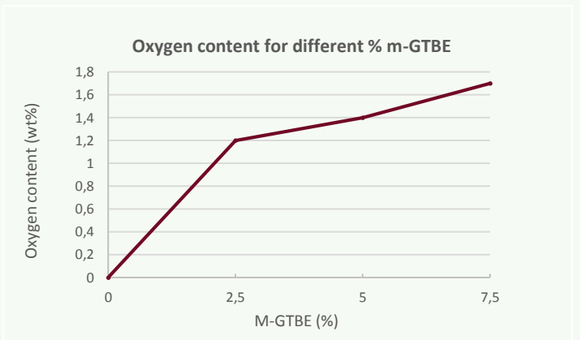
$$Yield = 19.63 + 4.79 \cdot Temperature - 2.61 \cdot Time + 1.08 \cdot Catalyst\ loading - 1.45 \cdot Temperature \cdot Catalyst\ loading\ (Coded\ values\ only)$$

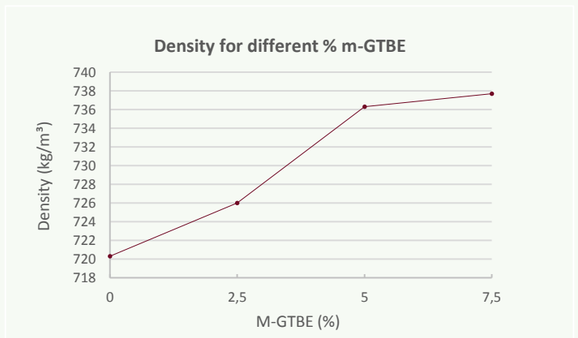


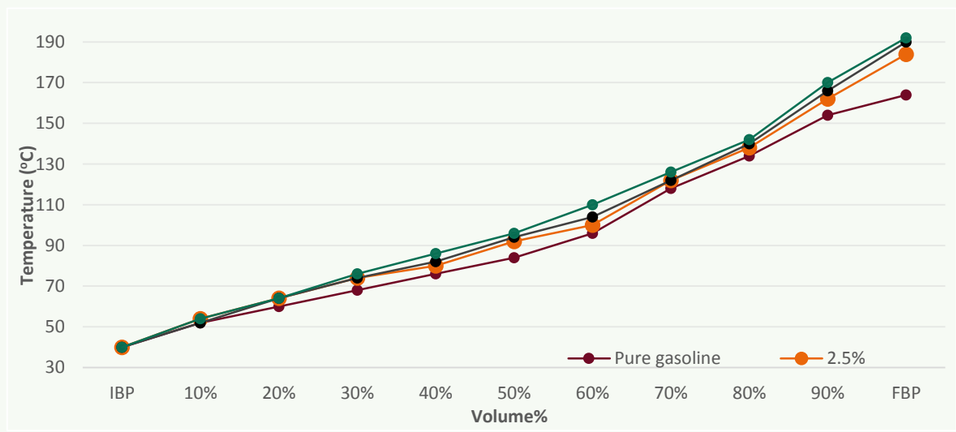
Yield of m-GTBE in function of time and temperature (left) and in function of catalyst ratio and temperature (right)

Characteristics









DISCUSSION AND CONCLUSIONS

- Optimal yield of m-GTBE: high temperature (110°C)
  low reaction time (2h)
  low catalyst content (5%)
  Temperatures higher than 110°C: more side reactions and lower conversion
- Commercial gasoline + m-GTBE: positive effect on ignition characteristics
  reduction of CO and hydrocarbon emissions

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