

Cracking of a rapeseed vegetable oil under realistic FCC conditions

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Introduction

The anticipated limited availability of fossil fuels has initiated the development of alternative, sustainable sources of energy. Transportation fuels derived from renewable sources are potentially good alternatives for conventional fossil-derived fuels. For example, bio-fuels can be obtained from biomass and agricultural sources (e.g. plant oils, methanol, and ethanol). An alternative option for the conversion of vegetable oils into transportation fuels may be through (catalytic) cracking. The co-feeding of vegetable oils with fossil feedstocks to Fluid Catalytic Cracking (FCC) units can be an interesting application. The FCC process is currently one of the most important processes in the refinery that aims for the production of Light Cycle Oil (LCO, an important diesel blending component), gasoline, and lower olefins (C₃= and C₄=) from fossil feedstocks. In contrast to 'conventional' feedstocks, the rapeseed oil is well defined. In this project the effect of type of catalyst, temperature, and residence time on the product distribution obtained by cracking a vegetable oil has been evaluated under realistic FCC conditions in a laboratory-scale once-through microriser reactor (figure 1).

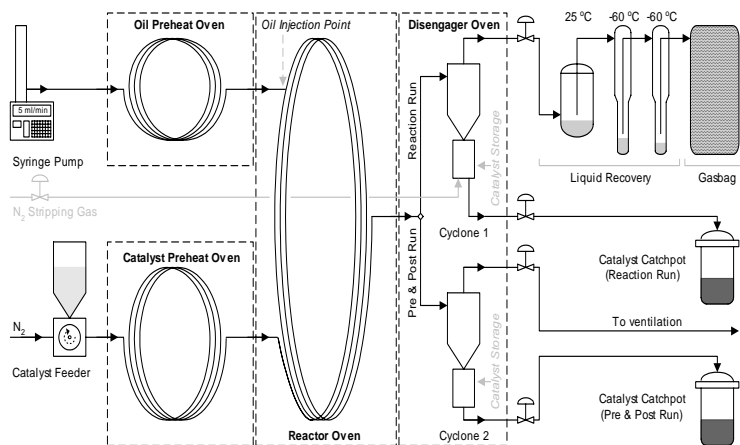
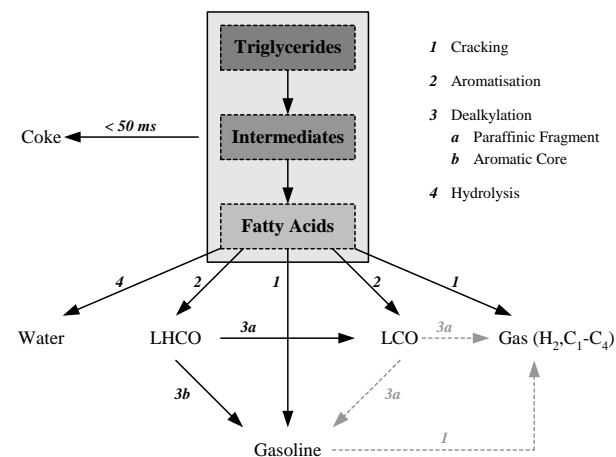


Figure 1. Schematic overview of the once-through microriser.

Results and Discussion

Under realistic FCC conditions vegetable oils can be cracked into products in the gasoline- and diesel boiling-range. During the first 50 ms the decomposition of triglycerides into fatty acids is governed by radical cracking reactions. The fatty acids are subsequently (after 50 ms) converted by the catalyst into products. The relatively high number of double bonds in the molecule enhances the formation of aromatics. This reaction competes heavily with catalytic cracking reactions and, as a consequence, high amounts of aromatics are formed in the gasoline and Light Cycle Oil (LCO) fractions. Most oxygen is removed as water. Only a small amount is present as oxygenates. Scheme 1 will give an illustration of the processes occurring.



Scheme 1: Overview of the cracking of rapeseed oil.

The catalytic cracking of the saturated stearic acid yields much higher gasoline and gas (H₂, C₁-C₄) fractions than rapeseed oil and oleic acid (fatty acid with a single unsaturated bond). In addition, the concentration of aromatics in the obtained gasoline from the stearic acid is significantly lower than that of the rapeseed oil and oleic acid.

The vegetable oil can be blended with the feed of an existing FCC unit, e.g. the rapeseed oil can be blended with the Hydrowax without any problems. No synergetic effects between both feeds appear to be present. Since the rapeseed oil is more selective to LCO (diesel), more of this product can be obtained, although it should be considered that it will be high in aromatic content.

Conclusion

The catalytic cracking of vegetable oil mixed with conventional FCC feedstock can be a potential alternative for increasing the share of renewable fuels in the market. This alternative should be evaluated further, i.e. technically, economically, and environmentally (as the products contain large amounts of aromatics).