Biodiesel Production in Fixed-Bed Catalytic Reactors
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Introduction to biodiesel

Biodiesel is a potentially renewable fuel made by the transesterification of vegetable oils or animal fats with a primary alcohol; in this case methanol is used to make fatty acid methyl esters, or FAME. This can be performed with an acid or base catalyst. As a fuel, biodiesel can be interchanged directly with conventional diesel, and so can be used with the existing infrastructure. Environmental advantages include biodegradability and reduced emissions of volatile organics, carbon monoxide, and particulates. This project aims to develop a continuous reactor with a catalyst supported on a monolith structure.

Monoliths

Monoliths are catalyst support structures forming a continuous series of regular channels. These may be coated with additional support material, such as alumina, along with a catalyst. The monoliths used in this project are thin walled cordierite with parallel channels.

Why heterogeneous catalysis?

Ideally, a robust and impurity tolerant heterogeneous catalyst can be found, this will reduce:
- Plant equipment and footprint
- Feedstocks (catalysts, neutralising agents)
- Waste water and salts

Converting vegetable oil to FAME after 24 hours. SrO powder shows a similar rate to KOH.

Testing the catalysts

Monolithic catalysts are tested at 120°C in a stainless steel autoclave, with a 6:1 molar ratio of methanol-oil. Samples are taken regularly and analysed by gas chromatography. The results from the most promising candidate are shown in the chart to the left.

Solubility: Is it single-phase?

If the oil and methanol are miscible this will improve mass transfer and simplify reactor design. Methanol and oil were mixed in a glass pressure vessel at a range of temperatures, and after the phases were separated samples were taken from the oil phase. While the stoichiometry requires a 3:1 methanol-oil ratio, reactions are generally carried out between 6:1 and 9:1 to push the reaction to completion.

Continuous reactor for testing monolithic catalysts, capable of pressures up to 20 bar

Conclusions and future work

- Strontium oxide is a promising heterogeneous catalyst
- A coating method has been developed to deposit SrO on a monolithic support
- Catalyst candidates have been tested in a batch reactor
- The methanol-oil mixture is single phase at reaction conditions

Future work:
- Catalysts will be tested in a continuous reactor
- Continuous reaction data will be used to test a set of reaction modelling equations that have been developed

References:

2 Melko, J. A. et al., Green Chem. 2009; 22; 1285-1308.