Catalytic Upgrading of Biodiesel
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Introduction & Motivation
The interest in renewable fuels as replacements for fossil fuels has rapidly increased over the past few years. Among the various fuel-from-biomass investigated, fatty acid methyl ester biofuels (FAME) obtained by trans-esterification of triglycerides from natural oils and fats with methanol have received considerable attentions. They exhibit high cetane number and are considered to burn cleanly; however, there is growing concern about the compatibility of these fuels with conventional petroleum-derived diesel due to the oxidative and thermal instability. Lowering oxygen content in the fuel would readily improve the stability of the fuels and therefore its utilization potential.

Objective
To investigate deoxygenation reaction on Cs- and NaX zeolite catalysts using methyl octanoate as model feed that may mimic some of the most relevant reactions involved in the refining of biodiesels.

To study the deoxygenation reaction on HZSM-5 zeolite catalyst (acid catalyst)

To understand the possible reaction pathways of deoxygenation of the methyl ester on both catalysts (CsNaX and HZSM-5)

Results & Discussion

Our Research Interest

Various processes including HYDROLYSIS, DECARBONYLATION, and DECARBOXYLATION have been proposed to transform biodiesel into the hydrocarbon base fuel. The decarbonylation and decarboxylation have advantages over hydrolysis, because while the hydrocarbons thus produced may contain less carbon than its fatty acid counterpart, the former reactions require much less hydrogen than the latter. Moreover, the properties of the fuel obtained from decarbonylation and decarboxylation are not significantly different from those obtained from the hydrogenolysis.

Activity Testing Apparatus and Testing Conditions

Activity Testing Apparatus: Gas Chromatography (GC)
Tested Catalysts: CsNaX and HZSM-5
Carrier gas: He and H2
Temperature: 425 and 500 °C
Pressure: Atmospheric

Tested Catalysts: CsNaX and HZSM-5

Results & Discussion

Reaction over CsNaX Catalysts

A rapid deactivation of the catalyst due to a strong adsorption of methyl octanoate on basic zeolite.

Methanol can be competitively adsorbed on basic sites, thus reducing deactivation.

Methyl Ester

Dioctanoic acid anhydride (Acid anhydride)
Decomposition
Hydrolysis
Condensation
Coupling Products
Cracking Products

Aromatics Distribution on HZSM-5

Decarbonylation on CsNaX does not require gas phase hydrogen when methanol is used as a solvent.

The CsNaX catalyst stability is greatly enhanced when methanol is co-fed.

Proposed Reaction Pathways for the reaction on HZSM-5

10 %wt of methyl octanoate in NONANE

The adsorbed methyl octanoate may react with each other (self condensation) forming high molecular weight oxygenates.

The presence of methanol would prevent the formation high molecular weight oxygenates by competitive adsorption.

Conclusions

• Decarbonylation / Decatetalation of methyl octanoate can occur at high rate for a long time on stream on CsNaX when co-feeding methanol.

• The CsNaX catalyst stability is greatly enhanced when methanol is co-fed due to the presence of decomposed fragments of methanol on the surface.

• The HZSM-5 catalyst is effective catalyst for aromatization of methyl octanoate.

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