

Syngas Conversion to Higher alcohols over K-promoted Co-Mo-alumina-Rh/C catalyst

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Introduction

Higher alcohols are attractive as fuel additives and substitutes. Ethanol is currently blended into gasoline in many US cities. Most of this ethanol comes from fermentation of sugars obtained from corn. This has led to increase in corn prices and hence higher food prices. One of the ways to substitute this biochemically derived ethanol is to convert biomass-derived syngas obtained from gasification to higher alcohols over solid catalysts. Commercialization of higher alcohol synthesis from syngas has been impeded by the lack of suitable catalyst having good conversion/selectivity and high space-time yield (STY) [1]. Rhodium based catalysts have been shown to be promising higher alcohol synthesis catalysts with high STY of C₂+ oxygenates [2].

We have studied the modified Fischer-Tropsch catalyst- K-promoted Co-Mo-alumina-Rh/C for higher alcohol synthesis. Various process parameters like temperature, pressure and space velocities were varied to find the ideal condition for higher alcohol synthesis. The results were also compared with K-promoted Co-Mo-alumina-Rh/alumina catalyst.

Materials and Methods

The catalysts were prepared by physical mixing Co-Mo-alumina, Rh/C (or Rh/alumina) and potassium carbonate in a planetary mono mill. Each of catalysts were calcined in 10% O₂ in helium at 500°C and then reduced in pure H₂ at 400°C. The reactor used for testing of the catalysts was a continuous flow packed bed BTRS-Jr Laboratory Reactor System from Autoclave Engineers. The syngas composition was 47% CO, 47% H₂ and 6% N₂. The product stream, after reacting with the catalyst, was passed through a condenser so as to collect the liquid products. The unconverted reactants and gaseous products were then sent to an online GC for gas analysis. The liquid product was phase separated (if 2 phases were present) and each of the phases was analyzed using the GC-MS.

Results and Discussion

Figure 1 shows the effect of space velocity on the STY of oxygenates and hydrocarbons. As can be seen there seems to be an optimum space velocity where maximum liquid yields are obtained. Figure 2 shows the effect of temperature on reactant conversions and product selectivities. With increasing temperature the selectivity towards liquid decreases while the selectivity towards light alkanes increases. A comparison with K-promoted Co-Mo-alumina-Rh/alumina catalyst reveals that the Rh/C has higher selectivity towards higher alcohols while the Rh/alumina catalyst has a tendency to form higher hydrocarbons.

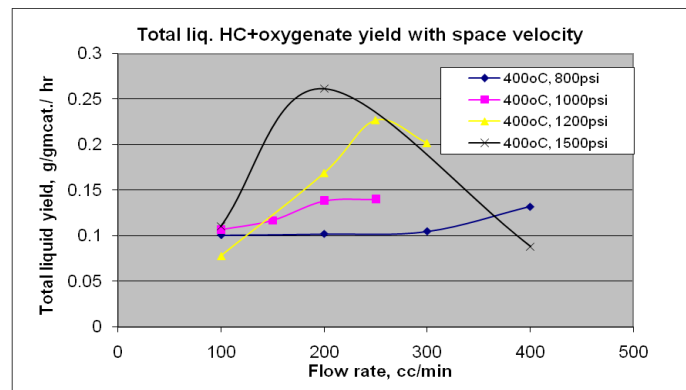


Figure 1. Space time yield comparison with varying syngas flow rates.

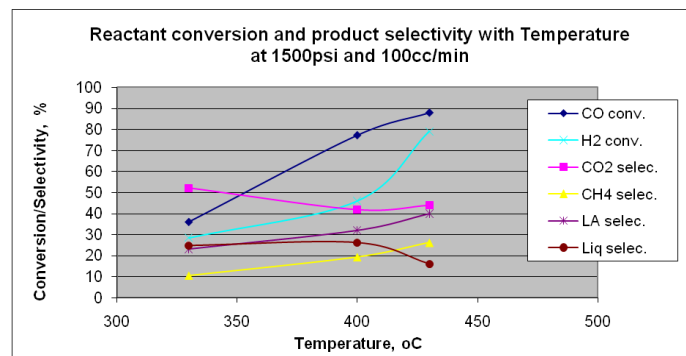


Figure 2. Reactant conversion and product selectivities over various temperatures.

Significance

The current work is of significance for conversion of biomass derived syngas to higher alcohols. We have shown that K-promoted Co-Mo-alumina-Rh/C catalyst is a promising higher alcohol synthesis catalyst. We have shown the effect of varying process conditions on the alcohol STY and product selectivities.

References

- Gerber, M.A., White, J.F. and Stevens, D.J. "Mixed alcohol synthesis catalyst screening" PNNL-16763, Pacific Northwest National Laboratory, Richland, WA, 2007.
- Gerber, M.A., White, J.F., Gray, M.J. and Stevens, D.J. "Mixed alcohol synthesis catalyst screening 2007 progress report" PNNL-17074, Pacific Northwest National Laboratory, Richland, WA, 2007.