Methanol synthesis from crude glycerine-derived syngas

PhD. Student : ir. J.G. van Bennekom
Thesis advisors : prof. dr. ir. H.J. Heeres
: dr. ir. R.H. Venderbosch
Research group : Chemical Reaction Engineering
OSPT theme : Sustainable feedstock

Phone : +31 50 363 4484
Fax : +31 50 363 4479
Email : j.g.van.bennekom@rug.nl

Period : November 2008 – October 2012

Introduction

Crude glycerine is a major by-product of bio-diesel production by trans-esterification of a vegetable oil with methanol. Due to increased bio-diesel production levels, large amounts of crude glycerine are produced for which alternative outlets are sought. The conversion of crude glycerine to methanol is a very attractive option as it allows re-use of a by-product and leads to green methanol [1].

An attractive process option to convert glycerol to methanol consists of reforming crude glycerine in supercritical water to syngas, followed by methanol synthesis. This concept is explored in detail in the EU-FP7 'Supermethanol' project [2]. Both the pressure and the composition of the syngas produced by supercritical water gasification differ considerably from that used in conventional low pressure methanol synthesis processes.

Approach

In this project we will perform in-depth reactor engineering studies and investigate important parameters on the methanol yield like the composition of the syngas, the syngas pressure, temperature, catalyst type and reactor geometry. In addition, equilibrium calculation will be performed and validated with experiments. With this information available, the optimum reactor configuration for methanol synthesis from syngas obtained from glycerine gasification in super critical water will be determined and modeled.

Current Results

Three equilibrium reactions are involved in the synthesis of methanol from syngas:

$$CO + 2\,H_2 \rightleftarrows CH_3OH \quad (1)$$
$$CO_2 + 3\,H_2 \rightleftarrows CH_3OH + H_2O \quad (2)$$
$$CO + H_2O \rightleftarrows CO_2 + H_2 \quad (3)$$

Methanol is produced in reactions 1 and 2. Reaction 3 is the water-gas shift reaction. All reactions are exothermic.

To gain insights in the methanol equilibrium yields as a function of process conditions, the Soave-Redlich-Kwong equation of state was applied. Figure 1 shows the pressure-temperature dependency of the conversion of H_2. Validation with experimental data is in progress. If necessary the model will be modified/extended to give a better description of the equilibrium conversion for the process under study.

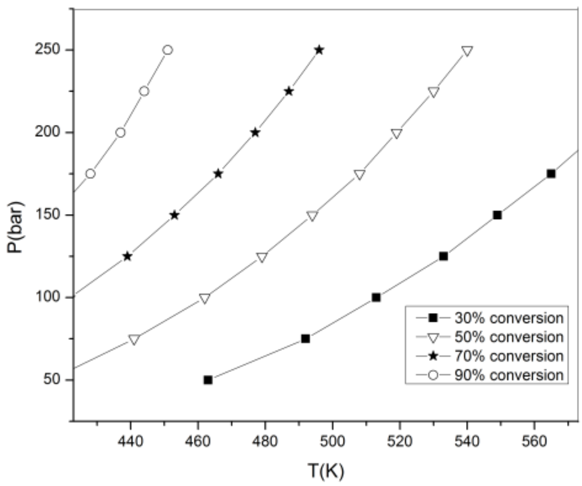

Figure 1. Effect of pressure and temperature on the hydrogen equilibrium conversion for methanol synthesis

References

[1] D. Goetsch, I.S. Machay, L.R. White, United States Patent 7388034, 2008

[2] www.supermethanol.eu