The CAMERE Process

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Introduction

The CAMERE process[1] (carbon dioxide hydrogenation to form methanol via a reverse-water gas-shift reaction) is developed with the help of DWSIM. Here, Reverse water gas shift reactor and Methanol synthesis reactor are serially aligned to from methanol from CO_2 hydrogenation.

Flowsheet

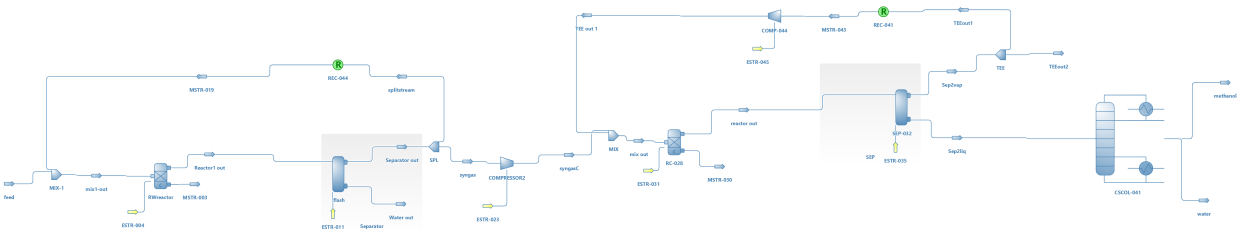

Figure 1: The CAMERE Process

Development of flowsheet in DWSIM

Thermodynamics

Here we use NRTL packages for Fluid behavior but other thermodynamics packages like UNIFAC and Peng-Robinson also provide satisfactory result. Due to the light gas, the flowsheet also gives satisfactory result with Raoult's Law, but it introduces some error in flash column.

Description of flowsheet

Stream containing 22.8 mol% CO_2 and other H_2 at flowrate of 10.06 mol/s at 10 atm pressure are feed to the Reverse water gas shift reactor; where CO_2 converted to CO by

$$CO_2 + H_2 \longrightarrow CO + H_2O$$

This reaction has total 48.54% conversion of CO_2. Reactor effluent are feed to the separator flash where water are removed by condensation by reducing temperature and pressure.

Optimum condition for this flash is obtained from the Sensitivity analysis tool of DWSIM for given specification in selected literature. 40% of gaseous stream coming out from separator are compressed up to 10 atm and recycled back to reactor and 60% stream or compressed to 30 atm pressure and feed to the methanol synthesis reactor. Where methanol produced from CO_2 and CO by

$$CO_2 + 3H_2 \longrightarrow CH_3OH + H_2O$$

$$CO + 2H_2 \longrightarrow CH_3OH$$

In this reactor 27.82% CO and 33% CO_2 are converted into the methanol. Reactor effluent are now feed to Flash column for removal of unreacted gas; Optimum condition for this flash is derived same as separator flash. Gaseous feed are now compressed up to 30 atm and recycle back to the methanol synthesis reactor. Liquid stream are feed to the compound separator to separate methanol with light gas impurity and water.

Result

Object	**Molar FLow**	**Methanol**	**CO_2**	**CO**	**H_2**	**H_2O**
feed	10.063	0	0.2286	0	0.77139	0
methanol	1.31	0.9766	0.017	0.00002	0.00012	0.00585
water	0.53	0.0014	0	0	0	0.9985
water out	1.42	0	0.0217	0.000023	0.000097	0.978
unit	mol/s	mol/mol	mol/mol	mol/mol	mol/mol	mol/mol

Table 1: Data of input and output streams

References

[1] O. S. Joo, K. D. Jung, I. Moon, A. Y. Rozovskii, G. I. Lin, S. H. Han and S. J. Uhm, "Carbon Dioxide Hydrogenation To Form Methanol via a Reverse-Water-Gas-Shift Reaction (the CAMERE Process)," Ind. Eng. Chem. Res., vol. 38, pp. 1808-1812, 1999.