Process Development for the Production of 30 TPD of Mono Propylene Glycol from Propylene Oxide

G. Jayaram and P. R. Naren*

School of Chemical and Biotechnology, SASTRA University

E-mail: gjjayaram23@gmail.com, prnaren@scbt.sastra.edu*

A. Background

Mono Propylene Glycol (MPG) is an industrially important chemical widely used in manufacture of unsaturated polyester resin, food, drug, cosmetics and personal care products. It is also known as 1, 2-Propanediol. It is a colorless organic liquid of molecular formula $C_3H_8O_2$. MPG has a huge demand globally, especially in the field of pharmaceuticals and food industry. The worldwide consumption of MPG was about 2.8 million tonnes in 2013. Dow, Lyondell Chemical Company and Shell Eastern Petroleum are the major players in the market. The present work is focused on production of MPG by hydrolysis of Propylene Oxide (PO).

B. Description of Flow Sheet

The process water and Propylene oxide from storage are pumped into a buffer drum. The mixture is pre heated to 200^{o}C and then fed to the conversion reactor, in which the vapor phase hydrolysis of Propylene oxide to Mono-propylene glycol (MPG) takes place. The exit stream from the reactor is fed to distillation column, where PO, water and traces of MPG are recovered at the top stream and the rest is obtained as bottoms. Thus 99% product is recovered in the bottoms of the distillation column. The product streams are cooled to room temperature and sent to storage vessel.

C. Results

The process flow sheet was simulated for a typical capacity of 30 TPD of MPG at the reactor temperature of 200^{o}C at 1 bar pressure. As the kinetics of the by-products formation was not known, in the present simulation side reaction for the formation of Di Propylene Glycol (DPG) and Tri Propylene Glycol (TPG) was not accounted. Conversion of 90% of Propylene Oxide was assumed in the “conversion reactor” in DWSIM. A shortcut distillation column was simulated to obtain actual number of stages and minimum reflux ratio for the given light key and heavy key compositions. PO was taken as light key and MPG was taken as heavy key. The light key composition was fixed as 0.001 at the bottom stream (Bottoms-A) and heavy key composition was fixed as 0.345 for the distillate stream (Distillate-A), Reflux ratio was assumed to be 4.3 for the shortcut column. Simulation of shortcut column gave minimum reflux ratio as 4.27 and actual no. of stages as 10. The results from shortcut column were used to specify the parameters for the rigorous column simulation. It was then simulated to obtain stage wise concentration and temperature profiles along the distillation column. Thus the desired product flow rate 16.42 kmol/h was obtained which corresponds to 30 TPD of MPG.

D. Conclusion and Recommendation

This work illustrates that open source simulator serves as a good platform for carrying out process development flowsheeting with ease. In the present work, as DPG and TPG components are not available in the DWSIM component database, production of MPG is simulated without accounting for the formation of DPG and TPG. In future, these components can be defined using user defined library and attempts can be made to simulate the flowsheet with the side reactions.

Unit System: (Custom 5 in the DWSIM)

Molar flow rate – kmol/h

Mass flow rate – kg/h

Volumetric flow rate – m^3/h

Density – kg/m^3

Temperature - ^oC

Pressure – bar

Molecular weight – kg/kmol