15 Shell OMEGA only monoethylene glycol advanced process

15.1 Background information

The conventional Shell glycol process consists of an ethylene oxide (EO) section and a glycol (G) section. In the EO section, ethylene is partially oxidized to EO. The by-products, approximately 10%, are carbon dioxide and water. In the glycol section, EO reacts with water to form monoethylene glycol (MEG). The by-products are diethylene glycol (DEG), triethylene glycol (TEG), and heavy ends (HE), which together constitute 10% of the total reaction. This amount of by-products results from the thermal reaction system in which EO reacts with water to form MEG. EO, however, also reacts with MEG to form DEG and also with the DEG to form TEG. This by-product formation could only be limited to 10% by supplying a large surplus of water over EO at the ratio of 22 mol/mol such that the first reaction to MEG is faster than the other reactions. This large surplus of water has to be removed by evaporation from the product stream. Also, DEG and TEG have to be separated from MEG and from each other. This separation is carried out by distillation. As glycols are high-temperature boilers, high-pressure steam is needed for heating the bottom section of the distillation columns. This requires large amounts of energy while a large wastewater stream is also created [1].

This conventional process design is licensed by Shell to ethylene glycol manufacturers over 50 times and Shell is the market leader in licensing the ethylene glycol processes.

The new OMEGA process concerns the glycol section. The EO section remains the same. OMEGA is a two-step reaction process. In the first step, carbon dioxide (from the EO section) reacts with EO to form ethylene carbonate (EC). According to stoichiometry:

$$C_2H_4O + CO_2 \rightarrow C_3H_4O_3$$

This reaction is exothermic with a reaction enthalpy of −24 kcal/mol.

In the second step, EC reacts with water to form MEG and carbon dioxide. According to stoichiometry:

$$C_3H_4O_3 + H_2 \rightarrow HOC_2H_4OH + CO_2$$

This reaction is endothermic with a reaction enthalpy of 2 kcal/mol.

The reactions are homogeneously catalyzed by a set of catalysts. The by-product formation is less than 0.5%. The EC conversion rate is >99.9999% and hence EC is absent in the reactor outlet stream. A small quantity of water is needed for the reaction. The OMEGA process, therefore, requires a small separation section to remove carbon dioxide and trace amounts of water. The separation section is also

https://doi.org/10.1515/9783110657357-015