MATERIAL BALANCE

The beginning of any design problem is to quantify the different streams involved in the process. This is done by formulating a material balance for the different units of the plant. The basis for the material balance is the product requirement of 100 TPD of ethylene glycol at a purity of 99 mol%. The mass flow rates of the different streams and their compositions are given below. The process is as described in fig. 3.3 of Chapter 3.

Material balance around the Hold Tank

Inputs:

Ethylene oxide (100% pure) = 1.0148 kg/s

Make-up Water = 0.4000 kg/s

Recycle Water = 7.9034 kg/s

Total = 9.3182 kg/s

Output:

Mixture stream = 9.3182 kg/s

Material balance around the reactor

Inputs:

Ethylene oxide = 1.0148 kg/s

Water = 8.3134 kg/s

Total = 9.3182 kg/s

Outputs:

Monoethylene Glycol (MEG) = 1.1574 kg/s

Diethylene Glycol (DEG) = 0.1982 kg/s

Triethylene Glycol (TEG) = 0.0312 kg/s

Water (Un-reacted) = 7.9314 kg/s

Total = 9.3182 kg/s

Material balance around the evaporator

Inputs:

Monoethylene Glycol (MEG) = 1.1574 kg/s

Diethylene Glycol (DEG) = 0.1982 kg/s

Triethylene Glycol (TEG) = 0.0312 kg/s

Water = 7.9314 kg/s

Total = 9.3182 kg/s

Outputs:

MEG + DEG + TEG = 1.3868 kg/s

(MEG = 1.1574 kg/s, DEG = 0.1982 kg/s, TEG = 0.0312 kg/s)

Water (as condensate) = 6.5314 kg/s

Water (as steam) = 1.3720 kg/s

Water losses = 0.0280 kg/s

Total = 9.3182 kg/s

Material balance around the MEG column

Assumption:

The impurities like water, chlorides, iron etc. Which cannot be quantified or estimated are assumed to be in minute amounts (as given in the product specification) and are assumed to play no role in the distillation operation.

Inputs:

Feed : MEG + DEG + TEG = 1.3868 kg/s

(MEG = 1.1574 kg/s, DEG = 0.1982 kg/s, TEG = 0.0312 kg/s)

Outputs:

(A)Distillate:

MEG + DEG = 1.1563 kg/s

(MEG = 1.1554 kg/s, DEG = 0.0009 kg/s)

(B) Residue:

MEG + DEG + TEG = 0.2305 kg/s

(MEG = 0.0020 kg/s, DEG = 0.1973 kg/s, TEG = 0.0312 kg/s)

Total = 1.3868 kg/s

Final product = 1.1554 + 0.0009 = 1.1563 kg/s

$= 1.1563 \times 24 \times 3600/1000$

= 99.9 TPD

(NOTE: The impurities that are not considered are assumed to constitute the remaining i.e. 0.1 TPD).

The subsequent section concerning the energy balance and design of equipment are based on the above material balance. The material balance is an ideal balance, neglecting losses, except in the evaporator.