Pressure Swing Distillation of Toluene - Ethanol

MehulKumar Sutariya
Sardar Vallabhbhai National Institute of Technology, Surat
Email: mehulsutariya09@gmail.com

Unit System: Pressure-atm; Temperature-°C; Mass Flow-kg/hr

Background

Due to their excellent dissolution ability; Ethanol and Toluene are widely used in pharmaceutical and other chemical industries. In the production of steroid drugs, there is often a problem of separating mixed solvents. It is great challenge to effectively separate toluene and ethanol mixture because their highly nonideal vapor–liquid equilibrium produces a minimum-boiling azeotrope.[1]
When the azeotrope is pressure sensitive, pressure swing distillation are widely use in industries for separating azeotrope.

Azeotrope of the Ethanol-Toluene at different pressure

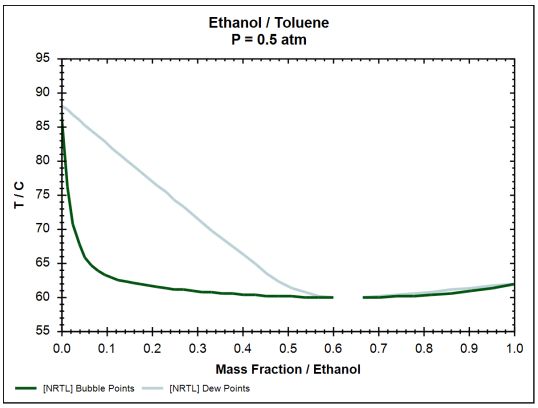

Figure 1: at 0.5 atm

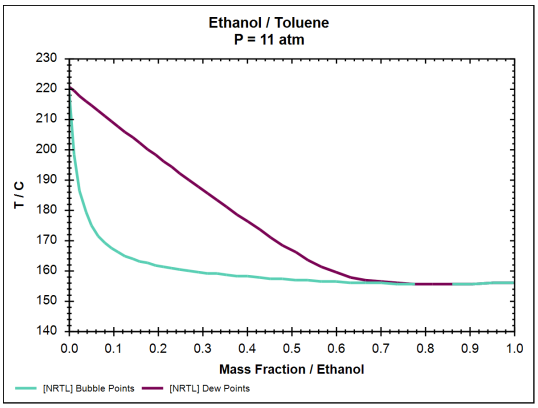

Figure 2: at 11 atm

From figure 1 and 2 [1] it is clear that the azeotrope are vary with the pressure.[1]

Description of Flow-Sheet

Here we use the two columns with the different pressure of 0.5 atm and 11 atm. These both columns try to achieve their respective azeotropic composition at their column pressure at a distillate stream; And due to that we get pure compound at the bottom stream.

[1] Images are produced by the DWSIM Utility function

Feed are enter at the low pressure column are diluted to 0.648 wt% Ethanol at Distillate from 0.72 wt% Ethanol in Feed , which gives a pure Ethanol from bottom. Distillate of low pressure column are feed to the second column which are concentrated to 0.849 wt% Ethanol at Distillate from 0.648 wt% Ethanol and gives a pure Toluene at bottom(Here dilution occur for Toluene). The distillate of high pressure column are again recycled at low pressure column.
Here we use ChemSep with NRTL property method for columns design.

Table 1: Columns Data

Name	**Low Pressure**	**High Pressure**
Total Stage	35	22
Pressure (atm)	0.5	11
Feed Stage	6 from top	16 from top
Feed (kg/hr) (%wt/wt) (%wt/wt)	3500 Ethanol(0.72%) Toluene(0.28%)	4127.36 Ethanol(0.648%) Toluene(0.352%)
2nd Feed Stage	16 from top	-
2nd Feed(kg/hr) (%wt/wt) (%wt/wt)	3148.87 Ethanol(0.849%) Toluene(0.151%)	- - -

Result

Table 2: Result

Name	**Low Pressure**	**High Pressure**
Top(kg/hr) (%wt/wt) (%wt/wt)	4127.36 Ethanol(0.648%) Toluene(0.352%)	3148.87 Ethanol(0.849%) Toluene(0.151%)
Bottom(kg/hr) (%wt/wt) (%wt/wt)	2521.72 **Ethanol(0.999%)** Toluene(0.001%)	978.49 Ethanol(0.001%) **Toluene(0.999%)**

References

[1] Zhaoyou Zhu, Lili Wang, Yixin Ma, Wanling Wang, Yinglong Wang;"Separating an azeotropic mixture of toluene and ethanol via heat integration pressure swing distillation",Computers and Chemical Engineering 76 (2015) 137–149.

compiled in LaTeX