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Continuous Distillation

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Abstract: *In the present study, a Distillation process separate two components namely Toluene and Benzene is being performed. The distillation experiments are carried out on the DWSIM software. Where we learn to create a material stream in DWSIM. The types of distillation performed on DWSIM include Shortcut distillation, Rigorous Distillation. Process equipment includes suction scrubber compressor discharge cooler mixture and value the major difference between the booster compression and sales as compression are the operating pressure temperature and chemical composition of gas production the flow sheet of sale gas compression and export in DWISM. We specifically focus on the simulation of chemical process using the modelling software to evaluate thermal and chemical behaviour of the system which uses the chemical processes related to offshore petroleum production facilities as an example to demonstrate the software capabilities of DWSIM.[1].*

Keywords: Distillation, DWSIM.

I. INTRODUCTION

Distillation is a process to separate a mixture of two or more components into high purity products based on the difference in their boiling points. It consists of boiling the mixture followed by rapid condensation of the pure vapors. Distillation dates back to 1200 BC where it was used in perfumery operations. [2] Generally, in a distillation column, the distillate is vapor or liquid or both, while, the bottoms product is liquid. Modern distillation units employed stages or trays thus, helping the industry to achieve far greater purity than traditional distillation setups. Moreover, the refining industry has utilized the staged distillation columns extensively, thus, being able to deliver fuels of higher purity and in turn enhancing the recovery of lighter fractions to a much greater extent than it could have been possible with earlier distillation setups. Distillation is an energy-intensive process and possess the capability to escalate and destroy the refinery's or distillery's profits. Plus, capital involved in setting up new columns and its operating costs can be manipulated to a great extent by the designer, designing the distillation column. With simulation of processes like distillation, designing, optimization and cost estimation of such processes has eliminated the human chances of human error and further, helped industries conserve capital and energy costs. Distillation differs from absorption and stripping in that the second fluid phase is usually created by thermal means rather than by the introduction of a second phase that may contain an additional component or components not present in the feed mixture. [3]. The study consisted on simulation of distillation column, but, in turn focused on the various pros and cons of open source software like DSWIM. Nowadays simulation plays a crucial part in various engineering-related problems. There are plenty of commercial software packages available. Some of them are free such as DWSIM, HYDROFLO and OpenModelica.[4]. Open-source research software is becoming increasingly common in the chemical process modeling community. Hence, it is possible to investigate the behaviour of pilot plants using a computer simulation without having to conduct experiments so that the experimental cost can be significantly reduced. DWSIM is an open-source chemical process simulation which was created by Daniel Medeiros. DWSIM allows user to better understand the behaviour of chemical systems with no cost as it is freely accessible.[5]

II. METHODOLOGY

The study initiated with an extensive literature review. Perform Shortcut distillation on DWSIM. Further, the Benzene and Toluene distillation was studied in two parts on the software.

2.1 Simulate a Shortcut Distillation Column.

The objective to perform the Simulation is to calculate Minimum number of stages, calculate Minimum reflux ratio,number of actual stages, distillate rate using Raoult's Law, calculate Condenser and Re-boiler dutyand finally calculate Optimal feed stage location. The model operates on assumptions of constant molar overflow and steady relative volatility. Further, a plot of reflux ratio v/s theoretical levels similarly proved the number of required levels and the reflux ratio required for the distillation column. The plot is used to determine areflux ratio for which the wide variety of levels do not go too high due to the fact that a high range of trays would add exorbitantly to thee capital price and a high reflux ratio will although reduce the number of trays required, however it would make the operations more expensive. Thus, greater the reflux ratio, greater vapour liquid contact will occur, greater will be the purity of distillate, slower will be the distillate series rate and thus, higher will be the operating expenses. The distillation is performed in DWSIM v5.8(Classic UI) Update 3 on windows 11. To run the simulation we need to initially know how to add components to a flow sheet, select thermodynamics packages and add materials and energy streams along with specifying their properties available on the software. We need to develop a flow sheet to determine outlet stream properties after Shortcut Distillation

2.2 Specification

Compounds	Benzene, Toluene	
Thermodynamics	Raoult's law	
Feed	Flow rate Pressure Mole- fractions	100kmol/h 1atm Benzene=0.4 Toluene=0.6
Method	Fenske-Underwood-Gilliland	

Followed by that we need to specify The Column Properties

Reflux ratio	1.4 times Minimum Reflux Ratio	
Compounds	Lightkey(LK) Heavy-key (HK)	Benzene Toluene
Product	Distillate Bottoms	X_D=0.99 X_B=0.01

After running the Simulation in Shortcut Distillation Column we get the following parameters:

Property	Valve
Minimum Reflux Ratio	1.655
Actual Reflux Ratio	2.317
Minimum no. of Stages	11
Actual no. of Stages	20
Optimal Feed Stage	9
Condenser Duty	1129.67kW
Reboiler Duty	1050.86kW

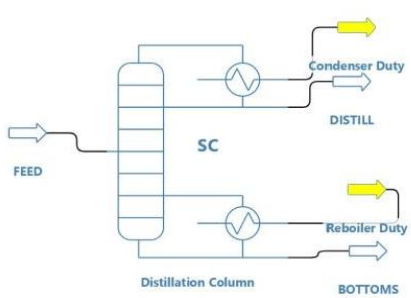


Fig. 1. Shortcut Column

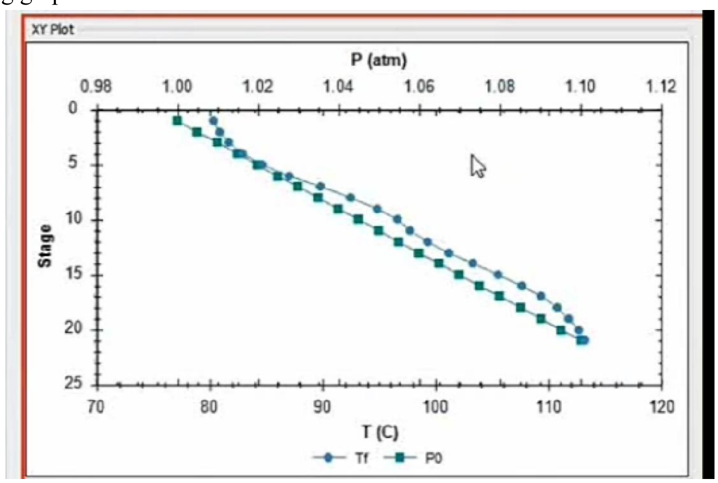
2.3 Rigorous Distillation

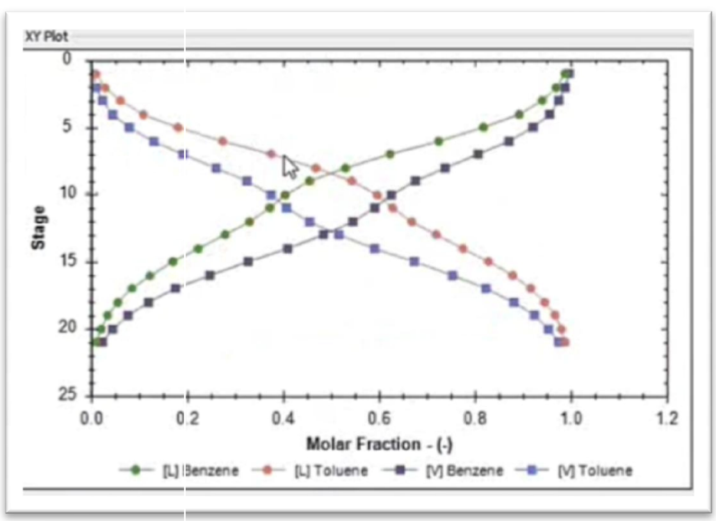
Rigorous model is further used to obtain more accurate Parameters using the values obtained from the shortcut distillation. After the simulation of the rigorous model. From the parameters, the reflux ratio of 1.655 was used for rigorous model. Also, the number of stages used was 20. Feed stage was taken as 9 and Bottom product rate was used 60.204 kmol/h.

After running the Simulation in Rigorous Distillation, we get following results:

Property	Value
Condenser Duty	1130.51kW
Re-boiler Duty	-1161.91kW
Internal loop iterations	69
External loop iterations	0

We also get the following graphs





This in turn helped to prove the validity of simulation results as the composition of methanol in liquid increased from bottoms i.e. stage 20 to the distillate i.e. stage 1 and the composition of Toluene in liquid increased from stage 3 where it was zero to 1.655 at stage 20. It is also clear from this plot that, the higher Benzene in liquid in the upper stages of the column is because of reflux which is extremely high in Benzene composition and the high Toluene composition in liquid on stage 20 may account for higher Toluene content of the bottoms product.

III. CONCLUSION

From the present study, it was concluded that the number of trays for the distillation column should be 20 and reflux ratio should be 1.655. Plus, optimum location for feed was stage 9. We may also conclude that by using Rigorous distillation we can obtain more accurate results as compared to Short cut Distillation..

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REFERENCES

[1]. M. Levey. "Chemistry and Chemical Technology in Ancient Mesopotamia". Elsevier, 1959, pp. 36.
[2]. J.D. Seader, J.H. Ernest, Separation Process Principles, 2nd ed., John Wiley and Sons, Inc. New York, USA, 2001.
[3]. C. Lyon, "Methanol Recovery Optimization Via Distillation", Final Project Report, ChE 460 G.G. Brown Industries Inc. 2012.
[4]. A. K. Jana, Process Simulation and Control using ASPENTM, Ist ed, PHI Learning Private Limited, New Delhi, India, 2009.
[5]. C.D. Holland, Fundamentals of Multi Component Distillation, Ist edition, McGraw-Hill Book Company