



Optimization of C7/C8 splitter section of buali petrochemicals aromatic distillation unit with aspen plus software

Mohsen Darabi ^{1*}, Hamid Mohammadiun ², Mohammad Mohammadiun ²

¹ Department of Chemical Engineering, Azad University of Shahrood Branch, Shahrood, Iran

² Assistant Professor, Department of Mechanical Engineering, Shahrood Branch, Islamic Azad University, Shahrood, Iran

*Corresponding author E-mail: mohsendarabi313@yahoo.com

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Abstract

In order to separating benzene and toluene (BT), in the aromatic distillation unit of BuAli petrochemical are used of a distillation column containing 55 trays. For condensing steam in the upper part of air cooler and down, a natural gas furnace, which the fuel is sharply 1 million cubic foot (MMscfd) is applied. It was equipped with two ultra-high energy consumption so that energy costs has been estimated 93384 \$ in the year. In this study, according to the need of reduce energy consumption in consumer industries, especially oil, gas and petrochemical, we decided to investigate the energy recovery for aromatic distillation unit of BuAli petrochemical and with using of specialized software AspenPlus we provided a method for this purpose. In this regard, according to information taken from BuAli complex, several simulations were performed, and finally, the least investments expensive model with reducing energy consumption has been selected. The results of the selected model can be cited to remove completely power consumption of the air conditioner, 45% reduction in fuel consumption in furnaces and heat exchangers, and ultimately 58% reduction in the production of pollutant emissions that play important role in damaging the environment.

Keywords: Distillation; Energy Recycling; Aspen Plus Software; Furnace; Air Cooler.

1. Introduction

The starting point of heat integration aiming to reduce energy consumption is 1980. Since 1990 on, some methods have been developed to industrials it such as the total of annual costs, application in a unit and unit flexibility. In the level of heat integration, the processing integration can determine optimization level of heat recovery that is compatible with exchangers' network with regard to the least equipments. In the level of heat and Tolen, processing integration can determine the amount of loading optimization, consumption level, and or vapor production, and also the situations of combination of thermal and power systems. By using graphical diagrams and systematic methods in the processing integration, one can choose a suitable thermal pump in economic and thermo dynamical optimization. With regard to the increase in Unit's production, the processing integration can be used to increase production capacity among bottlenecks [4-2].

The crisis in Energy and the increase in price of oil in the world markets in 1970s made the west industrial countries, being the significant importers of raw oil and other natural gas and oil productions, have done wide researches to access new technology with the ability of reducing energy consumption in a chemical process and by doing so, it might decrease the current production costs and also decrease dependence to oil exporting countries. These researches led to the appearance of Pinch technology as a tool to optimized design of thermal exchangers [5].

Nowadays, Pinch technology is of vast application, but what is considered as limitation in this technology is that Pinch analysis only analyzes systems analysis and is not able to peruse power or pivot work. In the other words, this technology is not solely applied to threshold issues and also systems like cooling cycles and steam turbines which are dealing with pivotal work in addition to thermal energy, but Exergy Analysis as another tool is used to peruse power or pivotal work. By proper combination of Pinch Analysis and Exergy Analysis, one can find a practical and proper

solution to simultaneous investigation of thermal energy and pivotal work of these kinds of systems. This technique is called Pinch & Exergy combinational Analysis. In the late seventies, Linnhof studied a thermo dynamical method to decrease energy consumption in the network of thermal exchangers, and he introduced concepts like combinational curve as a significant tool in recycling thermal energy. Over time, Pinch technology has a salient improvement, as it is used to optimize energy consumption in distillation tower, furnaces, evaporators, turbines and reactors in addition to the network of thermal exchangers. But this technology faced problems like limitation of pressure-dropping in repair of the current systems, complication of Unit, piping costs, safety problems and etc. At the beginning of the nineties, limitation of pressure- dropping was solved by presenting proper solutions; and in the middle of the nineties, the issues making this technology inapplicable and showing it uneconomic were resolved by using regional analytical theory. The tools of Pinch Analysis and combinational curve are comprehensive [9-6].

2. Research significance

The main problem is the method with capability of limiting electricity energy consumption in the in the air coolers which consume a significant amount of energy. Moreover, thermal exchanger should be removed from the process before the distillation tower and finally the consuming fuel should be decreased in re-boiler.

3. Discussion of the process of section c7, c8 splitter

The input feed of this distillation Unit is flow 7023 (figure 1) that enters the exchanger tube in the exchanger A/B 6009 as a result of heat exchanging with the flow 6038. It also changes from 140 ° C to 153 ° C and then enters to distillation tower T- 6002 (separating Benzene and Toluene from the heavier aromatics) with the pressure Bara 5/4 [1].

This distillation tower includes more than 55 trays from the type of valve which is based the twenty forth trays according to processing plan of input feed place (flaw 6038). The tower 6002 condenser is of the type of full and includes air cooler AE-6002 and a three phase separator D-6002. The overhead steam of tower 6002 with temperature of 174° C at first divided to two parts (flows 6025, 6027) and approximately 11percent of it enters air cooler 6002 (6025). In this air cooler, the temperature of the aforementioned flow decreases from 174 ° C to 150 ° C in a stable pressure and this flow totally condensed. This tower is the aim of separating the light Aromatics from the heavy ones. The overhead steam is rich with light compounds like Benzene, Toluene with the combination of certain percentage, and includes few amounts of heavy Aromatics like Xylene and Astryln and etc. This assertion can be perceived from density profile of compounds on the trays of tower (figures 2 &3). The output flow from the condenser (6026 flow) is sent to three phase separator 6002. By consideration of the design, pressure-dropping equals Bara .17 in these equipments. The possible vapors from the above of this separator are sent to flare and are burnt. The flow of the output liquid from this equipment enters the pump A/B 6005 to compensate the lost pressure and enters a divider with the pressure of Bara 5.1. In this divider, approximately 3 percent molar of this flaw, named BT production, is sent and saved to tank D-6004, and the remained part is returned to tower 6002 (on tray 55) as reflux [1].

At the bottom of the tower, the conditions are reversed and the output saturated liquid from the lower tray (the first tray) enters pump A/B – 6012 and then enters re-boiler of tower 6001 with pressure 7/3 Bara that was originally furnace of H-6001. The pressure dropping in this furnace was determined as 1.8 Bara based on design. The production of the bellow of the tower which is flow 6019 is finally obtained from that bellow tray. This flow enters pump A/B-6004 and is sent to exchanger A/B 6002 with pressure of 20.6 Bara and temperature of 29 c [1].

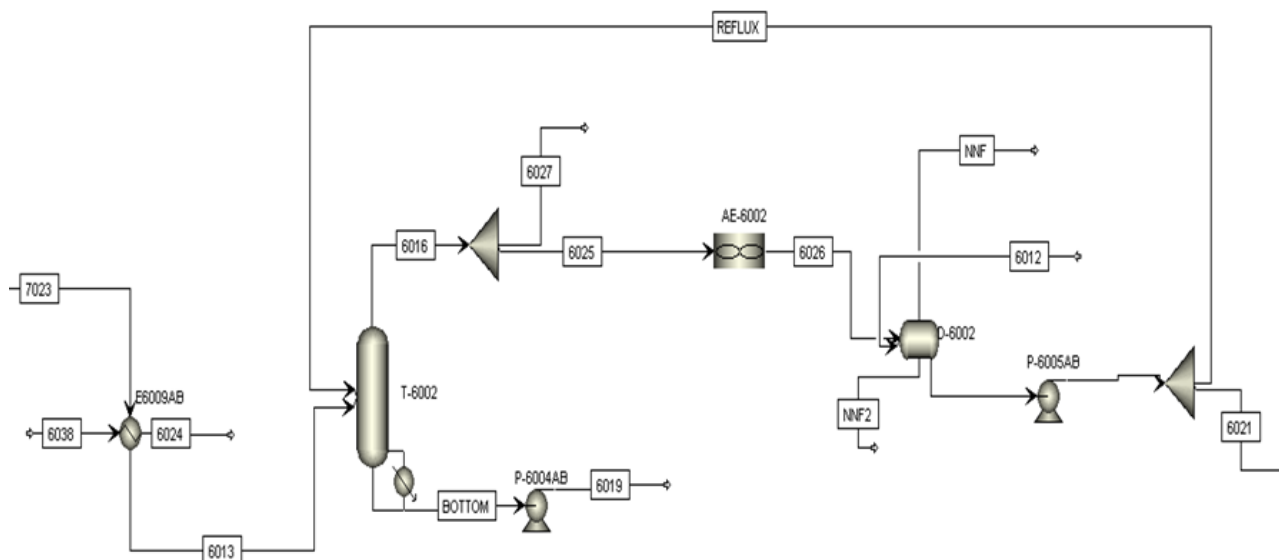


Fig. 1: Schematic Designing with Aspen plus (The Current Process)

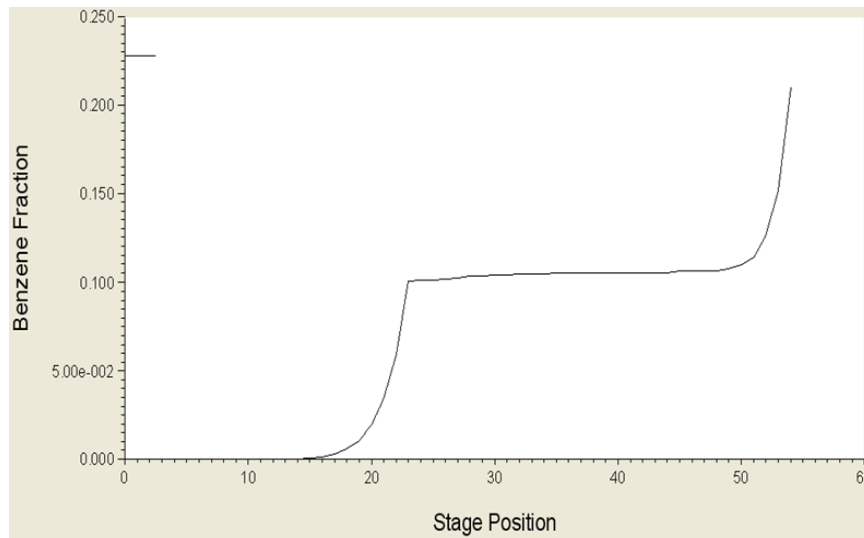


Fig. 2: Benzene Condense Profile in Trays of Tower 6002

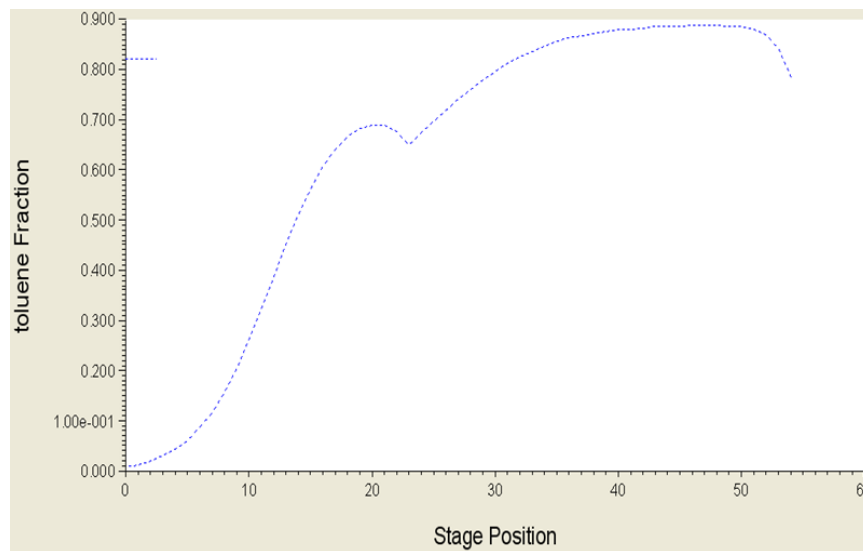


Fig. 3: Toluene Condense Profile in Trays of Tower 6002

4. Optimization

In Aromatic distillation Unit of Buali petrochemical complex, Air cooler (tower condenser) and re-boiler consume a very much amount of energy while we can decrease this amount of consuming energy by using feed flow. In so doing, the capital return is considerable. According to energy recycling, feed flow can be a suitable factor to integrate Aromatic distillation tower that the result of simulation prove it. Based on the result of simulation (figure 4), using feed to condense vapor of tower leads to following results:

- 1) Omitting air cooler (condenser) and saving 2 megawatt electricity power; moreover, the operational costs deduce from this processes
- 2) Feed pre-heating, that in this case there is no need to use heat exchanger E-6009 A/B
- 3) As a result of increase in feed temperature entering distillation tower, heating load. (Consumption of gas fuel), re-boiler will decrease in 45percent

5. Conclusion

In this research, optimization of Benzene and Toluene separation Unit from heavier Aromatic from c8 by using economic software Apsen Plus has been this unit was simulated in stable state and by using thermodynamic package peng-Robinson, this target function (simultaneous integration of condenser and re-boiler of distillation tower) was defined an a scenario was presented to come to an economic optimization.

Methodology was follows

- 1) Operational unit simulation in an advance form with software

- 2) Recognizing the equipment and the processing needs based on energy integration
- 3) Presenting a scenario for simultaneous optimization of condenser and boiler
- 4) Investigating the possibility of defining scenario based on contracts of energy analysis
- 5) In case of positivity of case 4, the operating Unit will be simulated again

Based on heat integration, our processing needs above the condensing tower is overhead vapor and below the tower is supplying, heat for separation. However, the feed are pre heated before entering the distillation tower. Thus we can say the more pre heating of feed the less consumption of re-boiler fuel. Therefore the process possibility can be regarded as power of feed flow entering Unit. By exchanging flow of middling feed with temperature f 14c and overhead vapor with temperature of 174c, the operation of feed pre heating will improve to 166c in addition to supplying vapor condensing without any need to air cooler. Thus, by increasing feed temperature, we will see an increase in temperature of distillation tower and a decrease in heating load of re-boiler. Among the result of this study, we can mention the complete mission of electricity consumption in the air cooler, a decrease of 45 percent in fuel consumption in furnace a decrease in heat exchangers and finally a decrease of 58 percent in production of polluting gasses that have a significant role in destruction of environment.

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