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Simulation and Optimization of A Crude Oil Distillation Unit

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Abstract: In the present study simulation and optimization of a crude oil distillation unit of a refinery by Aspen HYSYS simulation program has been carried out with the aim of increasing the efficiency of the unit. The effects of the temperature of the kerosene removal plate, the cap temperature of the distilling tower, the stripping steam flow and the top pressure of the tower on the distillation products were determined for the aim of increasing yields of some valuable products. The yield of kerosene increased to be 5.98 % by varying the temperature of the kerosene removal plate from 202 ˚C to 206 ˚C. It was observed that the decrease in the cap temperature and the increase in both the stripping steam flow and the tower feeding temperature increase flow rates of both the kerosene and the naphtha cuts. It was noted that the adjustment such as the reduction of the tower pressure from 1.7 kg/cm^2 to 1.5 kg/cm^2 generates the greatest impact on the yields of the products with the highest commercial value without generating additional costs. The optimum operation conditions determined by the simulation increased the efficiency of the plant in terms of higher yields of both kerosene and naphtha.

Keywords: HYSYS, Simulation, Optimization, Crude distillation unit.

Ham Petrol Damıtma Ünitesinin Simülasyonu ve Optimizasyonu

Öz: Bu çalışmada, damıtma ünitesinin verimini arttırmak amacıyla bir rafinerinin ham petrol damıtma ünitesinin simülasyonu ve optimizasyonu HYSYS simülasyon programı ile yapıldı. Gazyağı uzaklaştırma raf sıcaklığının, kule tepe sıcaklığının, sıyırıcı buhar debisinin ve kule tepe basıncının damıtma ürünleri üzerindeki etkisi, değerli bazı ürünlerin verimlerini artırmak amacıyla, belirlendi. Gazyağı uzaklaştırma rafının sıcaklığı 202 °C'den 206 °C'ye değişmesiyle gazyağı verimi % 5.98 arttı. Tepe sıcaklığında düşme, hem sıyırma buharının debisinde hem de kule besleme sıcaklığında artma; hem gazyağı hem de nafta debilerini arttırdığı gözlendi. Ayarlamaların, kule basıncının 1.7 kg/cm^2'den 1.5 kg/cm^2'ye düşürülmesi gibi, ilave masraf çıkarmadan en yüksek ticari değere sahip olan ürünlerin verimleri üzerinde en büyük etkiyi oluşturdukları not edildi. Simülasyonla saptanan optimum işletme şartları, hem gazyağı hem de naftanın daha yüksek verimleri açısından, işletmenin verimini arttırdığı gözlendi.

Anahtar kelimeler: HYSYS, Simülasyon, Optimizasyon, Distilasyon ünitesi.

1. Introduction

Nowadays the process simulation can be applied in almost all the disciplines of chemical engineering and engineering in general. It is the inevitable part of the different disciplines such as the design of the process, the investigation and the development, the planning of the production, the optimization, the training and the education and the decision-making for a process.

Process simulation could be a model-based illustration of chemical, physical, biological, and alternative technical processes or unit operations in software package. Basic conditions are a radical information of chemical and physical properties such as pure parts and mixtures and even reactions. Furthermore, mathematical models permit the calculation of chemical and physical properties used in the method given in simulation program [1]. One can find a detailed description and comprehensive summary for the process simulation by the software packages in the book by Roses [2].

The dynamic models allow the chemical engineers to execute continuously the unit with a strategy of definite optimization, transforming the knowledge of the process into the form of the mathematical model hidden within the control algorithm [3].

Atmospheric and vacuum distillation is one of the first steps in crude oil refining. Fractions in the atmospheric distillation process are done based on the differences in volatility since this distillation process is performed using different boiling points of the components of crude oil [4]. According to Gomez [5], the majority of the products obtained in the different stages of distillation column are susceptible of reprocess; either for obtaining other fractions by processes of conversion and separation or for improving their quality.

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Nuhu et al. [6] performed a technical investigation of crude oil distillation unit of N'djamena Refinery Company in Chad Republic. They performed the second law analysis and ascertained efficiency to be 35.8 %. The investigation incorporated in the elements quality changing alongside design variation was done by Rahman and Kirtania [7] by using Aspen HYSYS 7.1 and a retrofit plan technique and simulation structure used to incorporate unrefined petroleum were carried out by Gadalla et al. [8] using HYSYS to simulate refinement of crude oil. The increase of gasoline production in every one of the refineries is the main goal. When focusing on the crude oil distillation unit is primary objective, optimizing the yield of gasoline and its intermediates affect positively on total inventory gasoline production. Okeke & Osakwe-Akofe [9] utilized HYSYS software to develop a simulation of a process and a strategy for the improvement and management systems and operability. The some software packages allow engineers or scientists to use their experience to resolve challenges distinctive to the industries in a way that it is very safe and virtual atmosphere. Moreover the software packages assists them to urge inform with the present management systems and to know the basics of the plant operation [10].

According to Matar [11], the organic compound intermediates are created by subjecting crude oils to varied process schemes. These embrace a primary distillation step to separate the oil-complicated mixture into less complicated fractions. According to the optimization [12], one or additional fractionating columns are used in atmospheric distillation units. Distilling a crude oil starts by preheating the feed by exchange heat with the new product streams. According to Perry et al. [13], a distillation is outlined as an equilibrium-staged separation method within a liquid or vapor mixture or each containing two or a lot of components which are separated into its component fractions of desired purity by the applying and/or removal of warmth.

Aspen HYSYS manual process simulation can be employed for the planning, development, analysis, and improvement of technical processes such as chemical plants and complicated chemical processes, environmental systems, power plants, advanced producing operations, biological processes, and similar technical functions [14]. The goal of a process simulation is to search out optimum conditions for a process unit being examined. This can be primarily an improvement drawback, which should be solved in a repetitive process [15, 16].

According to Rodriguez et al. [17], process simulation relies on models. A model ought to mirror the fact at the degree of accuracy needed by application. Having a decent information of the modelling background is mandatory for obtaining reliable results and victimizing the software package effectively. Estrada [18] established the event of models for a more robust illustration of real processes that was the core of the additional development of the simulation software package. Walters [19] indicated that process flow diagrams are often generated by linking modeling software package to simulators and process simulation is additionally inspired the additional development of mathematical models within the fields and Hough simulators offer information about the resolution of complicated issues. Quimitec [20] mentioned that if somebody links a process simulator to a system, the system itself would see what is an expected calculation from engineering thermodynamic models and choose what is a practical expectation for the behavior of a process, which will tell you the way profitable you are at any given moment. Michel [21] indicated that the simulator model would recognize a dangerous situation before operator's intuition, which leads to faster reactions and spending less time off spec.

The model can help interpret the pilot plant data and allow investigating process alternatives. Once the decision has been made to build a new plant or to modernize an existing plant, the HYSYS models may be used to study trade-offs, to investigate off design operations and to evaluate the flexibility of the plant to handle different feedstocks. Moreover, simulation studies during process design could avoid costly mistakes before committing to plant hardware [22].

2. Material and Method

Since the purpose is to simulate the distillation column, with aim of increasing flow rate of kerosene, by using Aspen HYSYS, the present study is theoretical and evaluative. Therefore, the study is represented in a clear way to evaluate the simulation of crude oil distillation unit by applying specialized Aspen HYSYS software. In this study, the Aspen HYSYS (V8.8 (License. HYAC9322456)) simulation program was used to simulate distillation column and investigate various operating parameters. According Hernandez et al. [23], evaluative study should be conducted to collect the necessary fundamentals of data to use for improving the process being simulated. For this reason, the current research focuses as field research referred to improve the performance of crude oil distillation unit by simulation. Tamayo [24] defined the field research as "a plan or strategy designed to get the information you want, in the same place and time when this occurs". Segovia [25] also indicate that evaluation studies aim precise study for accomplishment of event determination at standard conditions.

3. Results and Discusion

In order to check whether Aspen HYSYS Process modeling software for present situation works accurately or not, the product yields obtained from both the program and the real refinery compared one another. It was observed that the product yields in both HYSYS and the refinery are quite close to one another for a crude oil having the same properties (API grade of 34). This comparison indicated that in the present research the HYSYS program can be safely used to simulate the process at the hand.

3.1 Simulation of Refinery Process Diagram (PFD)

The flow diagram used to simulate process in Aspen HYSYS is shown in Figure 1. The diagram consists of preheat exchanger train. Here, various process streams leaving from the distillation tower exchange heat with the incoming crude oil. Typically, the charge stream is heated from 90 °F to 653 °F (32-325 °C).

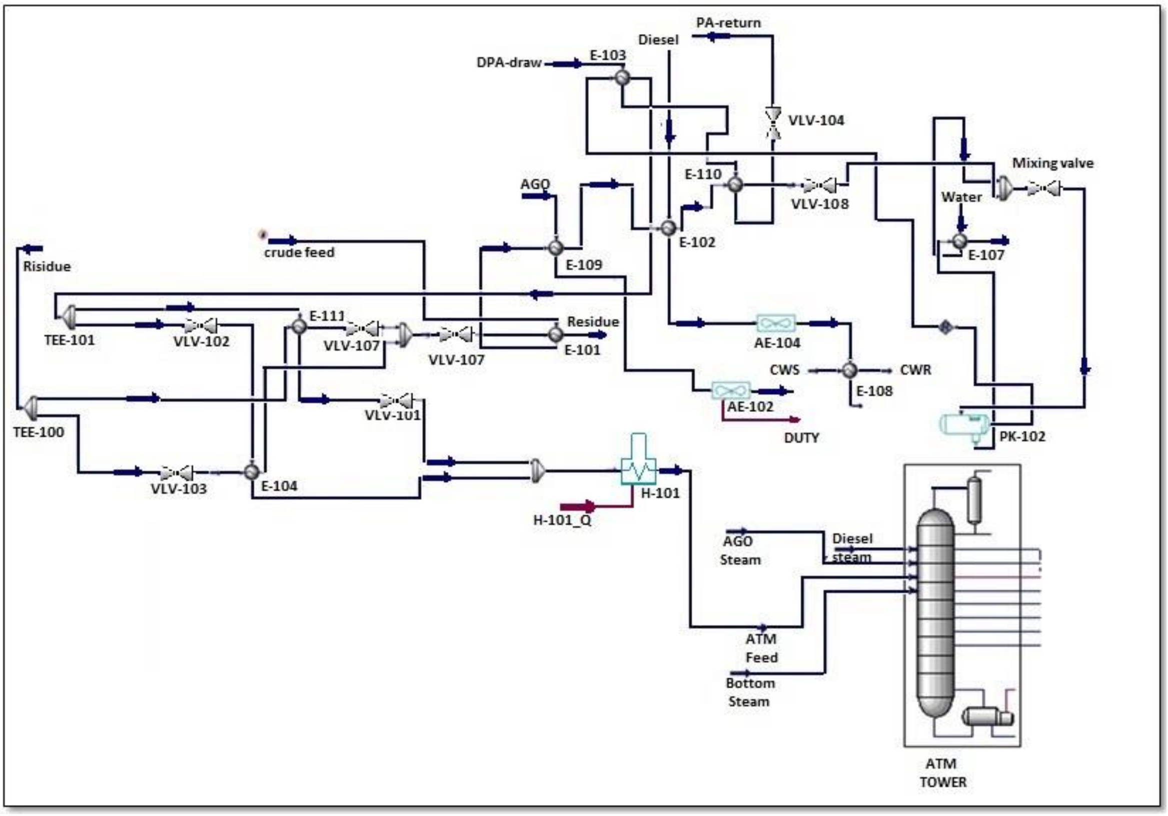

Figure 1. Process flow diagram for simulation in HYSYS.

After leaving the initial preheat exchangers (E-101A/B, -E-109, E-102 and E-110), the crude oil flows into desalters (PK-102). In the desalters, water and impurities that could cause corrosion in process piping and equipment are removed from crude oil. The crude oil leaves the desalters and passes through the heat exchangers (E-103 & E-104), then flows to the charge heaters (-H-101). After leaving the crude oil charge heaters, the streams enter the crude oil tower (T-101) at 653 °F (325 °C).

As shown in Figure 2 the column consists of 39 stages with a partial condenser, three side strippers and one pump around. The heated crude oil is sent into the tray 36. Side strippers comprising 3 stages have been utilized for kerosene, diesel and atmospheric gas oil (AGO).

3.2 Effect of Changing Parameters

3.2.1 Influence of increasing cut temperature of kerosene production

The effect of temperature on the optimization of the products from HYSYS Process modeling software that are of greater commercial value are is presented in Table 1. The results showed that an increase in temperature is proportional to a higher performance but sacrificing the performance of the heaviest product such as diesel. The optimum point has been defined by the ASTM D86 curve at different temperatures in each plate. It should be noted that the variables such as tower pressure, feed temperature, water vapor flow to the tower and load were kept constant while the cut temperature of kerosene changes.

Table 1 shows the results obtained for the different cases in which the behavior of some variables and qualities are orientated to produce the maximum product namely kerosene cut. When the crude oil distillation is done, the temperature is measured in the exit of the kerosene flow. The steams are rising across the trays where the contact is taken place between the vapor and liquid at about 202 °C that is the boiling point of the kerosene at atmospheric pressure. In this respect, the flow drawn from the distillation tower at this temperature possesses a chemical composition corresponding to the kerosene. The values of all the variables and qualities change as seen in Table 1 when the draw temperatures vary in ascending manner. Making an analysis of the behavior trends, it is possible to observe that as the draw temperature is increased, the flow of kerosene increases.

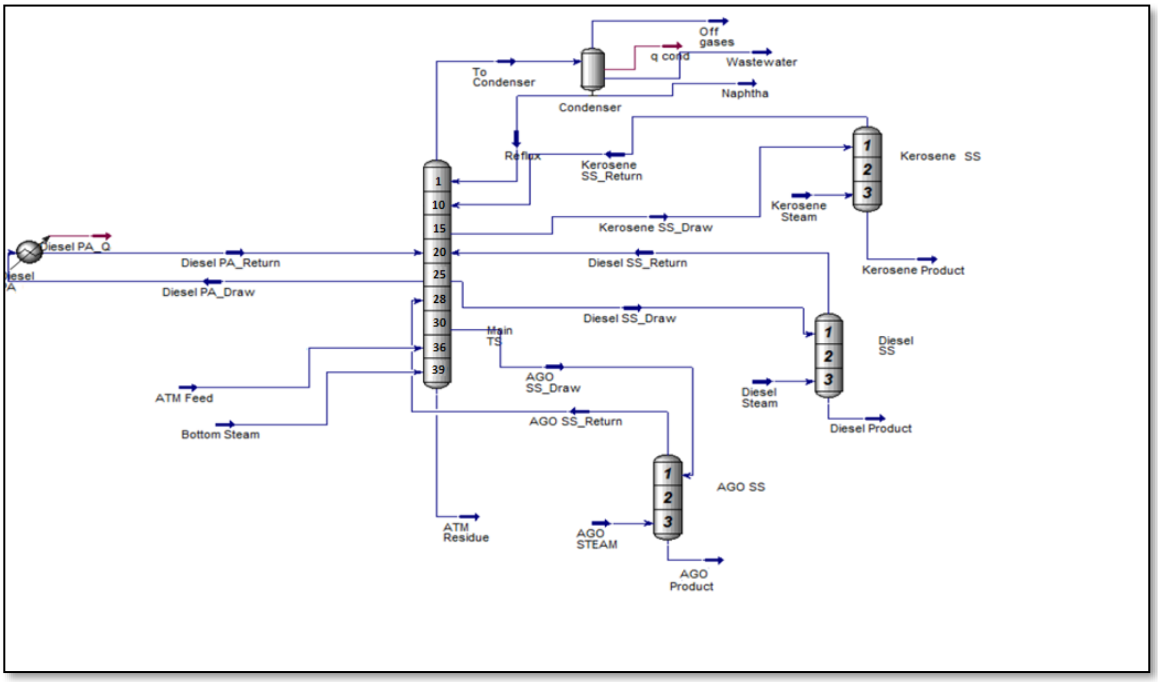

Figure 2. Flow diagram for the distillation tower in HYSYS.

It is obviously seen in Table 1 that the performance of the flow of diesel diminishes with the increase of the cut temperature of the kerosene. This is due to the fact that a part of this cut is dragged towards the tray of top retirement owing to lager vaporization of heavier components, which increases the flow rate of kerosene product and affects also the specific gravity of the kerosene due to the content of heavier components in this flow having

Table 1. The effect of increasing kerosene cut temperature on some variables**.**

Kerosene cut temperature ˚C	**Kerosene flow rate m^3/h**	**Sulfur content of kerosene wt %**	**Final boiling point of kerosene**	**Diesel sp.gr**	**Diesel flow rate m^3/h**
202	3.2	0.21	207	0.824	16.4
202.2	3.3	0.211	207.1	0.82395	16.35
202.4	3.4	0.212	207.2	0.8239	16.3
202.6	3.5	0.213	207.3	0.82385	16.25
202.8	3.6	0.214	207.4	0.8238	16.2
203	3.7	0.215	207.5	0.82375	16.15
203.2	3.8	0.216	207.6	0.8237	16.1
203.4	3.9	0.217	207.7	0.82365	16.05
203.6	4	0.218	207.8	0.8236	16
203.8	4.1	0.219	207.9	0.82355	15.95
204	4.2	0.22	208	0.8235	15.9
204.2	4.3	0.221	208.1	0.82345	15.85
204.4	4.4	0.222	208.2	0.8234	15.8
204.6	4.5	0.223	208.3	0.82335	15.75
204.8	4.6	0.224	208.4	0.8233	15.7
205	4.7	0.225	208.5	0.82325	15.65
205.2	4.8	0.226	208.6	0.8232	15.6
205.4	4.9	0.227	208.7	0.82315	15.55
205.6	5	0.228	208.8	0.8231	15.5
205.8	5.1	0.229	208.9	0.82305	15.45
206	5.2	0.23	209	0.823	15.4

increased the draw temperature, one notices that the content of sulfur increases due to heavier components dragged into kerosene cut. Drawing kerosene at higher temperature causes heavy components to depart from their tray to the tray of the kerosene. The variation of the sulfur content is directly proportional to increasing temperature of the kerosene plate. The flow rate of heavier components toward to lighter components increases with increasing tray temperature and then sulfur content in kerosene increase since some sulfur combined with heavier components will be carried with those components. It is necessary to keep the sulfur content under control in kerosene since it is one of the undesirable components and could cause the loss of quality due to being out of specification in terms of the standard or customer requirements. A high content of sulfur in the product will produce acidic gases and a high rate of corrosion in the equipment used.

By changing the withdrawal temperature of the tray, the final boiling point of the distillate (kerosene) changes by increasing the gap-overlap. When the tendency is to increase the gap, it can be said that the optimization of the product is good because it has a better separation (within 5% of the heavy product and 95% of the light cut); otherwise it will occur if the overlap increases. This is because a part of this cut is dragged towards the upper tray by virtue of the larger evaporation of heavier components, which increases the kerosene production flow and will affect the specific gravity of the kerosene owing to the content heavier components in the flow. This situation obeys the established mass and energy balance. An increase in sulfur content in kerosene indirectly affects flow of heavier products such as diesel since it is dragged with heavier components as expressed previously; therefore, the expenses of treatment to remove sulfur in diesel will be less since flow rate of diesel decreases from 16.4 m^3/h to 15.4 m^3/h. A certain amount of naphtha also changes into kerosene during the handling of the kerosene extraction at plate temperature, which increases flow rate of kerosene.

3.2.2 Influence of decreasing top tower temperature

Decreasing top temperature of the distillation tower, heavier naphtha products go towards the kerosene tray, which increases production of kerosene and decreases its distillation end point; therefore, kerosene product becomes lighter. The data about decreasing top temperature of the distillation tower were obtained in terms of volumetric flow rates of naphtha and kerosene and their properties. The results are illustrated in Table 2. As seen in the table, the kerosene flow rate increases as the uppercut temperature decreases since the naphtha becomes a part of the kerosene; therefore, the kerosene yield increases.

Table 2. The effect of decreasing top tower temperature on the some parameters.

Top Temperature ˚C	**Kerosene flow rate m^3/h**	**Sulfur content of kerosene wt %**	**Final boiling point kerosene**	**Naphtha flow rate m^3/h**	**Naphtha API**	**Naphtha RVP Psi**
153	3.2	0.21	207	32	64.8	7.2
152.8	3.3	0.209	206.8	31.9	64.82	7.3
152.6	3.4	0.208	206.6	31.8	64.84	7.4
152.4	3.5	0.207	206.4	31.7	64.86	7.5
152.2	3.6	0.206	206.2	31.6	64.88	7.6
152	3.7	0.205	206	31.5	64.9	7.7
151.8	3.8	0.204	205.8	31.4	64.92	7.8
151.6	3.9	0.203	205.6	31.3	64.94	7.9
151.4	4	0.202	205.4	31.2	64.96	8
151.2	4.1	0.201	205.2	31.1	64.98	8.1
151	4.2	0.2	205	31	65	8.2
150.8	4.3	0.199	204.8	30.9	65.02	8.3
150.6	4.4	0.198	204.6	30.8	65.04	8.4
150.4	4.5	0.197	204.4	30.7	65.06	8.5
150.2	4.6	0.196	204.2	30.6	65.08	8.6
150	4.7	0.195	204	30.5	65.1	8.7

It can be noted that the sulfur content in kerosene cut decreases with a decrease in the upper cutting temperature. This is because the lighter product returning to the kerosene has a very low sulfur content; the sulfur tends to remain in the heavier cuts such as light diesel and diesel.

The lowering of the temperature in the upper plate of the distillation tower causes a variation in the end point of the kerosene as part of the light product remains in the kerosene cut, which causes the final boiling point of the kerosene to decrease since it has a larger content of low molecular weight carbonate chains. On the other hand, it is observed that the flow rate of naphtha is directly proportional to the temperature variations of the upper cut. In present case, its decrease will produce a smaller withdraw of this cut, which decreases its yield and increases the yield of the kerosene production. Thus, having a lower molecular weight liquid current returning to the kerosene plate will generate a higher API.

When the temperature of the naphtha cut decreases, its heavier fractions remain in the lower tray. Therefore, the lighter product contents increase in the heavier cut such as the kerosene cut, producing an increase in the RVP in the naphtha.

3.2.3 Influence of increasing crude feed temperature

Increasing temperature of the crude oil fed to distillation tower increases the rate of process separation of the product and decreases time of process but increases the pressure of the tower. This causes high boiling points for components and thus, the heavier products that will go up in the distillation tower affect the quality of the products. This situation can be seen from data about increasing feed temperature of the crude oil. However, the data are not given here on account of limited pages.

The high temperature of feed increases the flow rate of elements with higher molecular weight from the flash or feed tray to upward in the distillation tower, mixing with the lighter fraction and increasing its final boiling point. Higher specific gravity corresponds to higher molecular weight components, which indicates that the increase in the specific gravity by virtue of higher feed temperature is results of the heavier components that flow to upper trays and thus, change the composition of light products. This condition generates a higher yield for products such as naphtha and kerosene with higher sulfur content and higher specific gravity and higher boiling point.

Higher temperature in the flash tray (feeding the tray) sends heavier components to the upper trays; therefore, a part of the sulfur content that should be deposited in the diesel tray is transferred to the upper cut, which causes an increase in sulfur content in the kerosene. The sulfur has to be removed to be in the specifications demanded by the client.

3.2.4 Influence of increasing steam flow rate

Increasing mass flow rate of steam to the distillation tower, partial pressures of products decrease; thus, heavier products will go up and also the percentages of sulfur in the cuts increases on account of the dragged sulfur with heavier compound. The data about variation of volumetric flow rates of cuts and their properties with increasing mass flow rate of stripping steam were obtained from the Aspen HYSYS. The variation of volumetric flow rate of kerosene and naphtha and sulfur content of kerosene with increasing flow rate of stripping steam are shown in Table 3. The stripping steam under conditions of 300˚C and 14 kg/m^2 in a range of 700 kg/h - 775 kg/h is supplied at the bottom of the distillation tower. The final boiling point of the cut/cuts increases as the steam flow at the bottom of the distillation tower increases. As can be seen in the table, the heavy components are dragged to the upper tray since the partial pressure of a component in the mixture decreases. Heavier components contain more sulfur because compounds with sulfur are usually heavier compounds; thereby, the sulfur content also increases. The rising volume of vapor carry light components to the upper trays in which they condense according to their partial pressure at the tray temperature. Thus, the performance of the naphtha will increase. The increase in the production of the different cuts such as naphtha and kerosene is due to the light components overlapped in the residue.

Table 3. The effect of increasing steam flow rate on some variables.

Steam kg/h	Final boiling point of kerosene	Sulfur content of kerosene wt%	Kerosene flow rate m^3/h	Final boiling point of naphtha	Naphtha flow rate m^3/h	Naphtha RVP Psi
700	207	0.21	3.2	189	32	7.2
705	207.15	0.2104	3.3	189.35	32.2	7.3
710	207.3	0.2108	3.4	189.7	32.4	7.4
715	207.45	0.2112	3.5	190.05	32.6	7.5
720	207.6	0.2116	3.6	190.4	32.8	7.6
725	207.75	0.212	3.7	190.75	33	7.7
730	207.9	0.2124	3.8	191.1	33.2	7.8
735	208.05	0.2128	3.9	191.45	33.4	7.9
740	208.2	0.2132	4	191.8	33.6	8
745	208.35	0.2136	4.1	192.15	33.8	8.1
750	208.5	0.214	4.2	192.5	34	8.2
755	208.65	0.2144	4.3	192.85	34.2	8.3
760	208.8	0.2148	4.4	193.2	34.4	8.4
765	208.95	0.2152	4.5	193.55	34.6	8.5
770	209.1	0.2156	4.6	193.9	34.8	8.6
775	209.25	0.216	4.7	194.25	35	8.7

3.2.5 Influence of decreasing tower pressure

A decrease in the partial pressures of products with decreasing pressure at the top of the distillation tower increases flow rates of cuts in upper trays; however, the quality of the products decreases since sulfur percentage in the upper cuts increases as evidenced in the obtained data that are given in Table 4. As the pressure in the distillation tower decreases, the separation of the products tends to improve and thus, the volumes of gases increases. Therefore, flow rates of the lighter cuts such as kerosene and naphtha tend to increase since the crude oil vaporizes more at the low pressure in the distillation column. The difficulty of separation decreases with increasing relative volatility. Thereby, the number of floors, reflux and consumption requirements in the condenser and the boiler decrease. The effect of the lowering of the tower pressure on the sulfur content in kerosene cut was examined by reducing tower pressure while other parameters were kept to be constant. The sulfur content in kerosene increases with decreasing tower pressure as the gas flow traffic increases and a part of the lower product (diesel) with its sulfur load flows into the upper product namely kerosene. As the upper pressure of the tower decreases, upper products increase due to the mobilization of heavy carbon chains to the upper plates, it is noted that a heavier cut has a higher final boiling point. The specific gravity of a raw cut depends on its components. The specific gravity of kerosene increases due to a part of diesel being in the kerosene since higher molecular weight causes the higher specific gravity in a mixture.

Table 4. The effect of decreasing tower pressure on some variables.

Column Pressure Bar	Kerosene flow rate m^3/h	Sulfur content of kerosene wt %	Final Boiling Point kerosene	Naphtha sp.gr	Naphtha flow rate m^3/h	Naphtha RVP Psi
1.7	3.2	0.21	207	0.7203	32	7.2
1.685	3.4	0.2111	207.24	0.7205	32.4	7.18
1.67	3.6	0.2122	207.48	0.7207	32.8	7.16
1.655	3.8	0.2133	207.72	0.7209	33.2	7.14
1.64	4	0.2144	207.96	0.7211	33.6	7.12
1.625	4.2	0.2155	208.2	0.7213	34	7.1
1.61	4.4	0.2166	208.44	0.7215	34.4	7.08
1.595	4.6	0.2177	208.68	0.7217	34.8	7.06
1.58	4.8	0.2188	208.92	0.7219	35.2	7.04
1.565	5	0.2199	209.16	0.7221	35.6	7.02
1.55	5.2	0.221	209.4	0.7223	36	7
1.535	5.4	0.2221	209.64	0.7225	36.4	6.98
1.52	5.6	0.2232	209.88	0.7227	36.8	6.96
1.505	5.8	0.2243	210.12	0.7229	37.2	6.94
1.49	6	0.2254	210.36	0.7231	37.6	6.92
1.475	6.2	0.2265	210.6	0.7233	38	6.9

The comparative data given in Table 5, it can be noted that the least favorable action for the process is to increase the temperature of feed. In order to increase temperature of feed, energy has to be given to heat up the crude oil fed to the distillation tower, which requires a higher operating cost in the use of fuel oil whose volumetric flow rate increases by 0.23 m^3/h for each additional burner that is required. On the other hand, the most recommended action is to lower the top pressure since it does not require an increase in operating expenses and maximizes the light products such as kerosene and naphtha. However, attention must be paid to the content of sulfur in kerosene that must not exceed the required specifications for the consumption/customers.

3.3 Optimum Operation Conditions Obtained by HYSYS

The summary of the present simulation are given in Table 6. The optimum results obtained from the simulation and the base values can be compared one another in the table. The optimized case showed improvements in naphtha and kerosene productions with volumetric flow rates of 35 m^3/h and 7 m^3/h over the base case, respectively.

Table 6. Summary of optimized cases and optimum results of the base case.

Parameters	Units	Base case	Optimized case
Crude Feed Flow rate	m^3/h	117	117
Heater temperature	˚C	325	325
Column top temperature	˚C	153	157
Column top pressure	bar	1.7	1.5
Steam Flow rate	Kg/h	700	750
Kerosene Cut of temperature	˚C	202	206
Diesel Cut of temperature	˚C	251	260

The effects of increasing top temperature, decreasing top pressure, increasing temperatures of the kerosene and diesel trays in the distillation column and increasing stripping steam flow rate fed at bottom of the column were examined previously. An increase in the temperature of the diesel tray cause an increase in flow rate of the lighter components from diesel tray to kerosene tray. Thus, the end point temperature of this stream rises, which means better stripping and results in greater flow rate of ascending vapors that will be condensed in the upper trays, are mostly in the kerosene and other namely in naphtha stream.

The optimum values for those parameters are shown in Table 6. Those values cause the flow rates of kerosene and naphtha to increase significantly almost without causing extra production cost in especially the case of decreasing top pressure in the distillation tower.

4. Conclusions

In this study, crude oil distillation unit was simulated and verified using Aspen HYSYS simulation program to analyze the influence of variation of some parameters on products. In other words, the optimum operation conditions were determined to obtain maximum kerosene. The results indicated that the product yields were not stable and often changed according to the variation of operation parameters.

The simulation results were compared with a real refinery results. It is found that there have been several variations in yields of products between Aspen HYSYS simulation and the refinery results. The steady state simulation of the naphtha and kerosene processing plant was performed based on the design and physical properties of those compounds.

All distillation columns ought to be rigorously operated to attain the specified production rates and products quality. Process variables like temperatures, pressures, flow rates, levels and compositions should be monitored and controlled altogether in distillation processes. These process variables in a distillation system have an effect on one another whereby a modification in one process variable can lead to changes in different process variables. Thus, in column management one ought to be watching the entire column and not that specialized in any specific sections solely.

Each column contains a system that consists of many management loops. The loops regulate process variables required to catch up on changes because of disturbances throughout plant operation. Each process variable has its own management loop, which usually consists of a detector and transmitter, controller and control valve. Each control loop keeps track of the associated process variable. An adjustment is made to a process variable by varying the opening of its control valve. The stream flow rate is, therefore, adjusted and a desirable variable is being controlled.

It is possible to find the optimum operating conditions that maximize the production of naphtha and kerosene for a certain crude oil. The simulation indicates that the flow rates of the naphtha and kerosene can be increased to be from 27.36% to 29.91% and from 2.74% to 5.98%, respectively. Both simulation and optimization were tested for different operating conditions and it was observed that program achieved a rapid convergence of the used models. This leads to the same models can be applied to other distillation towers with different designs.

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