Influence of Crude Oil Type on Products Quality of the Atmospheric Distillation Unit by Applying Material Flow Cost Accounting Simulation: Part A

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ABSTRACT: *The oil refining industry, as one of the most important sources of supply for the people of the world needs to optimize energy .In the present study, the atmospheric distillation unit of a refinery has been selected as a case study. Using a new method of material flow cost, determining the positive and negative products and their actual valuation, the share of various costs in the unit has been demonstrated. Since about 99.3% of the total costs in this unit are related to the cost of purchasing crude oil as feedstock, the importance of purchasing crude oil in the event of crisis management and the conditions of alternatives are fully characterized. Three crude oils named Maroon, Dezful, and Mansouri were studied as alternatives for Ahwaz crude oil. The results of Maroon crude oil show that, in the same operating conditions, its substitution as the main feedstock obtains the same quality products as Ahvaz crude oil products. The products derived from Dezful crude oil shows a difference of approximately 7 to 8 degrees API. Products from Mansouri crude oil have a difference of between 20°C and 40°C at boiling point and a difference of 5° to 7°API, and with increasing temperature and feed pressure, there is no significant change in the quality of the products. The mixture of Mansouri and Dezful crude oil separately with Ahwaz crude oil does not achieve the desired quality. But proper quality can be obtained by applying changes of 10 °C to 30 °C at inlet temperature, and from 0.5 to 0.7 kg/cm^2 at the pressure. Due to the same price of Ahwaz and Maroon and Dezful, there is no change in the cost of purchasing and products of the same cost are obtained.*

KEYWORDS: *Refinery; Atmospheric Distillation Tower; Simulation; MFCA; Positive Products; Reduce Loss*

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1021-9986/2020/6/215-227 13/$/6.03

INTRODUCTION

The world's oil industry is one of the largest and most valuable industries that consists of refineries and processes that have a high share of energy and materials consumption. Petroleum refining is a huge industry and every day the industry which produces more than $8 billion of refined products [1-2]. The main purpose of refining is to maximize value added in turning crude oil into final products. Distillation is the most important separation and refining operation in the oil industry processes, and in the coming years, it will maintain its current importance [3]. In the manufacturing industry, the consumption of materials and energy, and the extent of the financial damages depend on how to design and optimize the production unit, and each unit requires to obtain the desired product at a high percentage by optimizing the raw material as feedstock into the process. In recent years, the simulation of various processes and the use of engineering techniques have been expanded to optimize and reduce waste and environmental problems. The optimization of the distillation column is one of the significant issues in refineries [4-5]. The optimization of distillation towers in oil industry can help engineers to design and operate petroleum refineries optimally [6]. As regards that direct changes cannot be made to optimize and reduce the cost of distillation columns, from the late 1940s, optimization techniques, such as simulation and modeling to address industrial problems, have been considered [5]. Different methods have been developed to optimize and improve the distillation process. Using Neural Network to optimize operating conditions using genetic algorithm [7], use of the ASPEN Plus simulation software to select the appropriate feed and consumes minimal energy for the efficient process [8], and decreasing energy consumption by pinch technology in oil refining industries and energy saving are the prominent processes [9]. With regard to environmental issues and the problems caused by excessive waste, the US Environmental Protection Agency (EPA) has been heavily involved in the implementation of various industrial projects and activities requiring accounting, environmental assessment life, identification and problem solving [4,10,11]. Material Flow Costing Accounting (MFCA) is one of the most important tools for managing Environmental Management Accounting (EMA) [12]. Due to the importance of reducing natural resources, material flow management and assessment of environmental issues are essential [13]. The emphasis of the MFCA is on the fact that all costs associated with waste production in the industry are considered and the true value of the products and generated waste are demonstrated. This kind of management system examines all relationships related to mass and energy balances and provides the type and amount of casualties, costs, and their actual cost and implementation strategies to reduce these environmental impacts [14]. Losses from the activities of various companies are recognized *via* the MFCA method, and they are characterized by comparison with the Transaction Processing System (TPS). Many companies do not have a clear understanding of their amount of waste and cost of materials and energy in their processes [15]. The underlying reason for the difference between the usual management system and MFCA is the value of the generated waste in the MFCA, as well as the transparency of all available costs. MFCA is also introduced as an economical and environmentally friendly management method [16]. Due to the influence of the production of industrial equipment on the environment, Implementation and replacing a unit requires an evaluation of the economic analysis and MFCA [17]. By establishment of MFCA in a production unit, and used appropriate modeling for energy resources, the MFCA domain can be expanded [18]. In order to strike a balance between industry and trade, it is necessary to identify all hidden costs and reduce environmental losses and make operational decisions [19]. For example, increasing the positive products from 58.92% to 90.76% and decreasing the negative products from 41.08% to 9.23% in a sewage treatment plant by implementing the proposed solutions from the MFCA calculations, which is a major change both in terms of the environment and in financial terms [20]. Via MFCA method was considered due to inefficiency in the process at a rubber production plant. Per one kg rubber are produced 77.89 kg of wastewater, 44 kg of dry rubber waste and 5.9 kg of ash. With the Implementation of MFCA, reduced 26 % of total cost of the process. MFCA approach is applied that decreased resource consumption via lessening waste [21]. The aim of the present study is to optimize of an atmospheric distillation column based on the feedstock by applying MFCA and simulation. For this purpose, by making MFCA calculations and identifying the positive and negative products and their actual valuation, the share of the various costs in the unit will be specified. As the high percentage of existing costs related to the feed of the distillation column, it is necessary to identify alternative feeds in critical situations. To this end, by simulating the atmospheric distillation column in Ahvaz's alternate oil supply with different types of crude oil, the properties of the products produced by the simulation are compared with the specifications of the existing status products. Furthermore, the most suitable alternative feed for the production of certain products is selected. Finally, the best option will be chosen by reviewing the price change of alternatives.

METHODOLOGY AND ANALYTICAL WORK

MFCA Concept

According to ISO 14051, MFCA is used as a tool for the actual identification and evaluation of materials, wastes and products in various processes. MFCA is used both in monetary and physical terms and known as a different method for allocating costs [22]. Due to the transparent construction of wastes and costs of losses and the calculation of actual efficiency by the deployment of MFCA, in many companies, the implementation of MFCA is known as a means of coping with the fake high-efficiency report by companies. The German Ministry of Environment defines MFCA as the sum of operating costs and materials for various processes [23]. The concept of MFCA appeared in the late 1980s and early 1990s with concepts about environmental issues in the German and English literature. Environmental management, production of environmentally friendly products, environmental accounting, environmental journalism, and environmental compatibility were among its basic concepts. In 1992, the Emo-Augsburg Research and Development Group released its first environmental report for textile company Kunert in southern Germany in connection with its activities [24]. The report prepared a balance sheet in which all inputs and outputs are physically identified and mismatching the input and output mass indicates the inefficiency of the system, the existence of unauthorized waste and leakage, and the excess production of waste. The determination of the real value of losses and final products leads to convert most inefficient resources to efficient resources and as a result all processes were fully optimized. Since 1996, efforts have been made to expand the MFCA deployment in Germany. In 1999, *Kokubu* and *Nakajima* began their efforts to import the MFCA in Germany for four Japanese companies, and they succeeded in 2001 [25]. MFCA emphasizes on increasing the efficiency of material and energy so that all products are classified as negative and positive products. Non-marketable products considered to be negative products and products that are marketable as positive products [26]. In the implementation of MFCA, the purpose of the flow assessment in both material and monetary dimensions and monitoring of other costs is to finalize the cost of products and to identify positive and negative products [27]. In order to deploy MFCA in an operational unit, it is necessary to specify the cost centers and carry out a balance of mass, energy and money to determine the number of casualties in each of these quantity centers. These centers are named as Quantity Centers (QCs). Quantity centers of operating units are spaces that are used to store, process or transfer materials, such as material storage, production units, maintenance of optimal outputs or system distances, and are in some way related to material flow [25]. MFCA introduce three Material Cost, Energy Cost and System Cost that considered for products and each of these costs entering the monetary equilibrium. MFCA calculations are based on the number of existing processes, major products, waste, and related products. Equations 1 to 3 show how the calculation is performed.

$$\mathrm{Cost}_i^{MAT} = \sum_{m=1}^{M} \mathrm{Cost}_{im} M_{i,m} \quad (1)$$

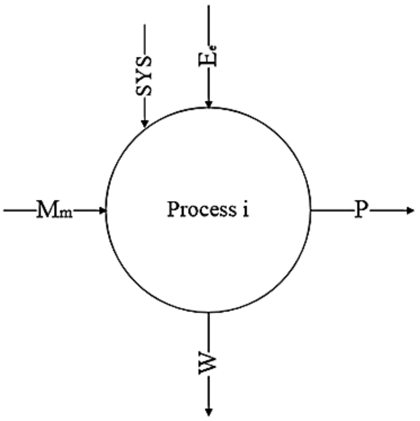
$$\mathrm{Cost}_i^{ENGY} = \sum_{e=1}^{E} \mathrm{Cost}_{i,e} E_{i,e} \quad (2)$$

$$\mathrm{Cost}_i^{SYS} = \sum_{L=1}^{L} \mathrm{Cost}_{i,l} L_{i,l} \quad (3)$$

Where i is the process number, $Cost^{MAT}$ is the raw material cost, M_m input material, $Cost^{ENGY}$ cost energy, E_e input energy and $Cost^{SYS}$ cost system and L_i manpower involved in the process [28].

The overall process of MFCA calculating and costs allocate are presented in Fig. 1.

All calculations performed in the MFCA are considered for all quantity centers, based on the provided equations.



$$M_P^C = \frac{Cost_i^{MAT}}{\sum_{m=1}^{M} M_{i,m}} * \sum_{i=1}^{i} P_i$$

$$E_P^C = \frac{Cost_i^{ENGY}}{\sum_{e=1}^{E} E_{i,e}} * \sum_{i=1}^{i} P_i$$

$$M_P^{SYS} = \frac{Cost_i^{SYS}}{\sum_{l=1}^{L} L_{i,l}} * \sum_{i=1}^{i} P_i$$

$$M_P^C = \frac{Cost_i^{MAT}}{\sum_{m=1}^{M} M_{i,m}} * \sum_{i=1}^{i} W_i$$

$$E_P^C = \frac{Cost_i^{ENGY}}{\sum_{e=1}^{E} E_{i,e}} * \sum_{i=1}^{i} W_i$$

$$M_P^{SYS} = \frac{Cost_i^{SYS}}{\sum_{l=1}^{L} L_{i,l}} * \sum_{i=1}^{i} W_i$$

Fig. 1: Allocation of costs in an operating unit [28].

Atmospheric Distillation Unit

The refineries consist of a large number of operational units that used to refine crude oil and produce products such as gasoline, jet fuel, diesel oil and heating fuel [6]. The atmospheric distillation unit is the first stage of refining and one of the most important units in every refinery complex. The general scheme of an atmospheric distillation unit is shown in Fig. 2.

The feedstock from the reservoirs was introduced into the tube shell heat exchangers and after preheating was introduced to the de-salter unit. In this unit sodium chloride, magnesium, calcium salts and impurities were removed from the stream. Then, crude oil crosses from a heat exchanger tube into the atmospheric distillation column and high value-added products will be removed from the distillation column. The main products of an atmospheric distillation column include gas oil, kerosene, column residue, overhead volatile gases and sour water, which are sent to different units for more processing. An overview of distillation column products is presented in Fig. 2 in order to distinguish between positive and negative products.

RESULT AND DISCUSSION

Establishment of MFCA in distillation unit

In order to establishment MFCA in an atmospheric distillation unit at the refinery, this section is considered as a quantity center. The calculation of the mass balance is presented in Table 1.

According to Table 1 data's, overhead gas to LPG, kerosene, gasoline and naphtha are positive products and bottom residue is the major negative product. The next step after the mass balance is finding a monetary balance for this unit. At this stage, the cost of materials, crude oil, chemicals, energy and water used is estimated. In terms of energy costs attributed to the cost of all energy carriers, including fuels, energy for steam production, and electricity consumption and the cost of the system means the cost of the existing staff as well as annual repairs and depreciation charges. Table 2 indicates the annual cost in the atmospheric distillation unit.

In the aftermath of the mass and financial balance, there is a need to estimate the cost of each product, which is calculated in accordance with equations1 to 3 and the results are presented in the results section.

Table 1: Annual Mass and Energy balance of Atmospheric Distillation Unit.

Stream Name	Input/ Output	Flow Rate (ton/y)	Percentage
CDU Feed	INPUT	5,303,690	94.6
Raw Water	INPUT	253,740	4.5
Caustic	INPUT	420	0.0
SUPER HEAT STEAM	INPUT	48,690	0.9
A.G.O[a] to Storage	OUTPUT	688,040	12.3
A.G.O. to U-400[b]	OUTPUT	248,830	4.4
Kerosene to Storage	OUTPUT	166,630	3.0
Kerosene to U-400	OUTPUT	3,130	0.1
AW[c]	OUTPUT	219,450	3.9
Overhead Gas to LPG	OUTPUT	35,620	0.6
LSRG	OUTPUT	156,680	2.8
HSRG	OUTPUT	271,940	4.9
Sour Water	OUTPUT	312,030	5.6
Wastewater	OUTPUT	220	0.0
Reduces Crude	OUTPUT	3,503,980	62.5

a) Atmospheric Gas Oil, *b) Un-refining Unit,* *c) Atmospheric Slops Wax*

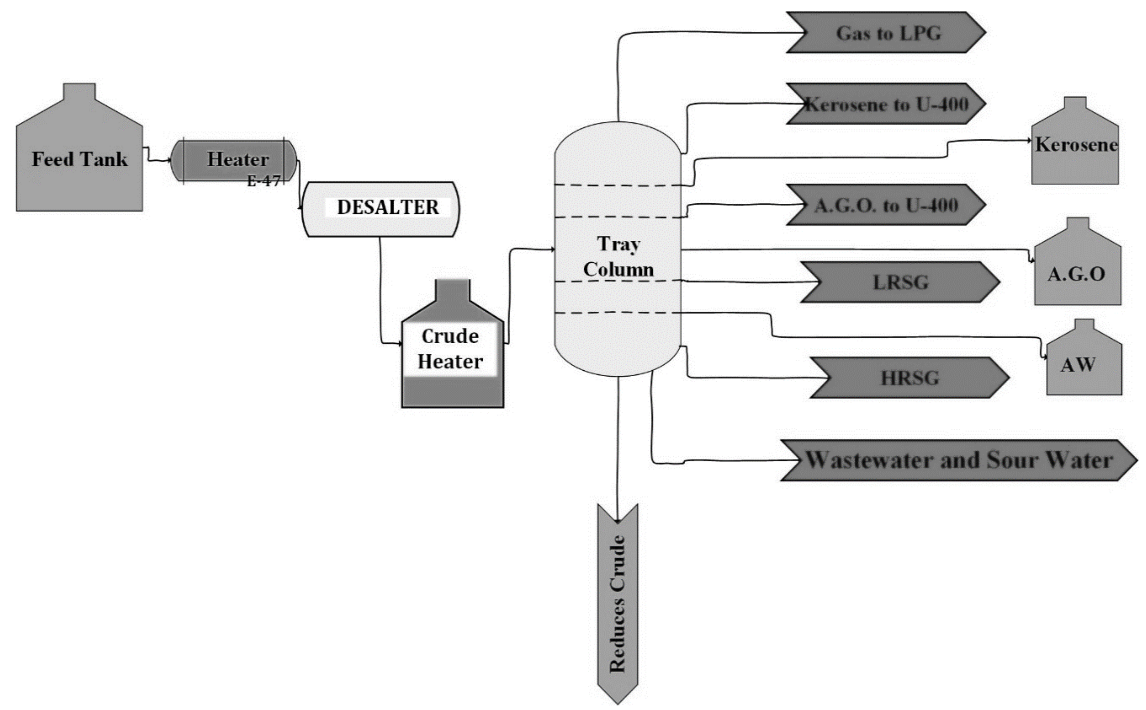


Fig. 1: A schematic of the Atmospheric Distillation Unit at the Refinery.

Table 2: Annual cost in the atmospheric distillation unit

Type of Cost	Million USD	%
Material Costs	1,809.41	99.3
Energy Costs	11.31	0.6
System Costs	2.26	0.1
Total Costs	1,822.98	

Table 3: Comparison of Ahvaz crude oil products and operating conditions.

Operational Situations	IT[a] (□C)	IP[b] (kg/cm²)	RPT[c] 1 (□C)	RPT 2 (□C)	RPT 3 (□C)	TCP[d] (kg/cm²)	BCP[e] (kg/cm²)
	353	2.9	73	44	65.5	1.9	1.9
Products Characteristics	Parameters	Actual/ Software	Blended Naphtha	Kerosene	Atm. Gasoil	Atm. Bottom	
	Mass Rate (kg/h)	Actual	26,500	20,122	83,087	423,135	
		Software	26,500	20,122	83,087	423,135	
	Std. API	Actual	50.4	44.1	35.4	19.5	
		Software	49.544	43.244	23.806	16.9	
	Std. Sp. Gr	Actual	0.7780	0.8057	0.8477	0.937	
		Software	0.781	0.814	0.861	0.953	

a) Input Feed Temperature, b) Input Feed Pressure, c) Return Pump Temperature, d) Top Column Pressure, e) Bottom Column Pressure

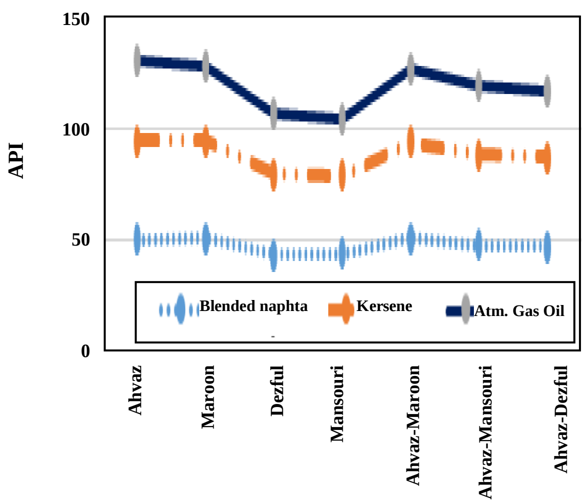


Fig 3: API comparison of Ahwaz crude oil and various types of crude oil.

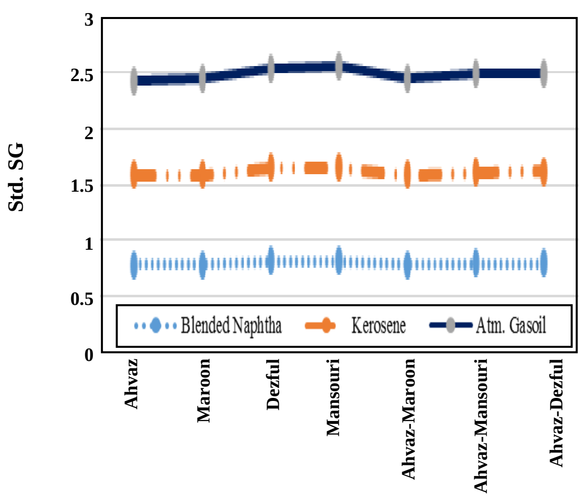


Fig 4: Std. SG comparison of Ahwaz crude oil and various types of crude oil.

Simulation of the atmospheric distillation unit

In this section, several different types of crude oil are used for simulation in an atmospheric distillation unit, which includes Ahvaz, Dezful, Maroon and Mansouri crude oil. At present, the refinery operates with Ahvaz crude oil. In order to study the simulation rate, the first step is to compare the existing feed stock, which is completely supplied from Ahvaz crude oil, with the simulation results, which are presented in Table 3.

The D86-IBP, D86-30 and D86-FBP are the distillation ranges that play a crucial role in the separation of crude oil. The D86-IBP, D86-30 and D86-FBP

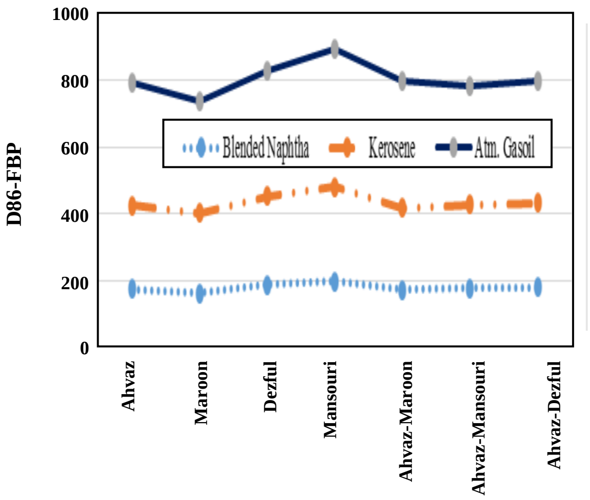


Fig 5: D86- FBP comparison of Ahwaz crude oil and various types of crude oil.

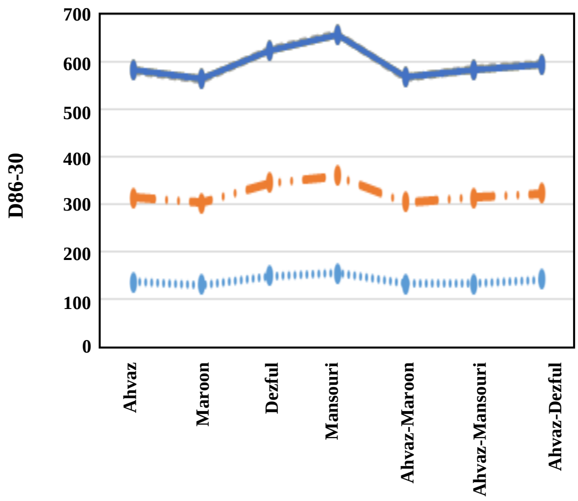


Fig 6: D86-30 comparison of Ahwaz crude oil and various types of crude oil.

are shown in Figs. 5 to 7 for various crude oil. As could see Maroon crude oil and blend of Maroon and Ahvaz have the most compatibility with basis crude oil. Mansouri crude oil has the worst results compared to Ahwaz crude oil.

Due to existing differences between Dezful and Ahwaz crude oil products, it is necessary to change operating conditions to the extent that the results are presented in Table 4.

Due to the fundamental difference in the characteristics of Mansouri's crude and Ahvaz's Crude products, there is a need for a change in the operating conditions of the distillation column. The results are presented in Table 5.

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Results of changing operating conditions in Ahvaz and Dezful mixture, because of difference products characteristics shown in Table 7.

Discussion

MFCA calculations

The results of the calculation of the cost and final value of the positive and negative products of the atmospheric distillation unit are given in Table 8.

Considering that the purchase of crude oil accounts for the main cost of the distillation unit (about 99.3% of total costs), the highest percentage of the existing costs is related to the cost of raw materials. Alternative feeds instead of the current feed have been investigated in order to manage the critical conditions of the refinery in the lack of Ahvaz crude oil to find the optimum alternative with the least properties.

Simulation results

By entering the initial specifications of Maroon crude oil in software under the same operating conditions as Ahvaz crude oil, the result shows that there is a slight difference between the quality of Maroon Crude oil products and desired products. This correspondence between the products data obtained is due to the API and SG of the Maroon and Ahvaz crude oils. The API difference between these two crude oils is about 0.5° API and the difference in SG is about 0.003. Also, the results from the software show that the characteristics of these two crude oils are almost the same, and they have a difference of 5% even at their initial and final boiling point. Thus, without changing the operating conditions, Maroon crude oil can be replaced by Ahvaz crude oil. Also, Maroon and Ahvaz crude oils' prices are very close, which is indicative of the unchanged cost of purchasing Maroon crude oil as the alternative to Ahvaz.

Dezful crude oil is another proposed alternative to Ahvaz crude oil. According to charts, due to a difference of about 8 ° API with the specifications of Ahvaz oil products, the change in the operating conditions of the

Table 2: The results of changes in the operating conditions of Dezful crude oil.

Operational Situations	IT (□C)	IP (kg/cm^2)	RPT 1 (□C)	RPT 2 (□C)	RPT 3 (□C)	TCP (kg/cm^2)	BCP (kg/cm^2)
	359.8	2.99	80	55	75	1.93	2.33
Products Characteristics	Parameters	Before/ After	Blended Naphtha	Kerosene	Atm. Gasoil	Atm. Bottom	
	Mass Rate (kg/h)	Before	26,500	20,122	83,087	423,135	
		After	26,500	20,122	83,087	423,135	
	Std. API	Before	43.41	35.56	27.13	12.59	
		After	44.05	36.55	27.48	12.59	
	Std. Sp. Gr	Before	0.809	0.847	0.892	0.982	
		After	0.806	0.842	0.89	0.982	
	D86-IBP	Before	112.77	153.303	218.306	285	
		After	109.549	150.602	214.172	281	
	D86-30	Before	147.930	195.073	280.850	439	
		After	144.267	191.360	277.452	420	
	D86- FBP	Before	188.01	265.725	277.751	544	
		After	183.506	263.238	365.060	535	

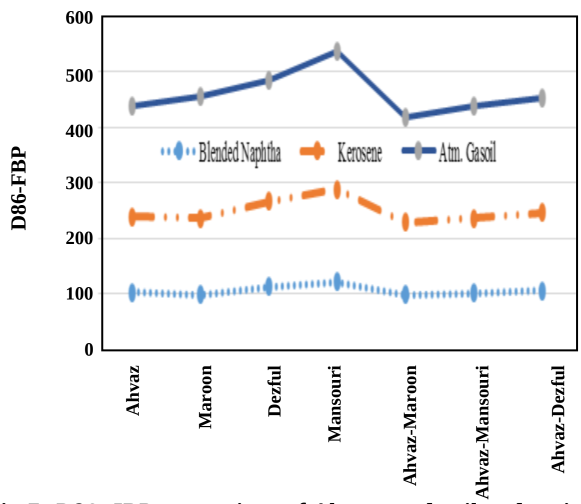

Fig 7: D86- IBP comparison of Ahwaz crude oil and various types of crude oil.

atmospheric distillation column is required in order to achieve the same specifications, which the results are given in Table 4. It demonstrates that by increasing the temperature and pressure of the feedstock stream to the column, changing the pressure of the top and bottom of the column, as well as changing the temperature of the returning pumps, some changes appear in the quality of the products. Also, excessive increase in temperature and pressure in these conditions causes a clogging phenomenon. Therefore, it can be concluded that Dezful oil is not suitable for these operating conditions of the atmospheric distillation column. The quality of the products from the refining of Dezful oil will be suitable if some changes take place in the column structure in addition of changes in the operating conditions of the atmospheric distillation column. These structural changes are the arrangement, type, material, and the number of trays.

Mansouri crude oil is another alternative that can be replaced instead of Ahvaz crude oil if their product's properties were almost identical. The results show that there is a significant difference between the specifications obtained from the simulation and the desired characteristics. Therefore, in order to resolve this difference in operating conditions, changes should be made which are listed in Table 6. By modifying the operating conditions of the atmospheric distillation column, there was a slight increase in the quality of the products, which are far from the desired quality. These results suggest that the refining of Mansouri crude oil for the atmospheric distillation unit would not only produce low-quality products, but also the bottom residue of the atmospheric distillation column would not be of great

Table 5: Results of Changes in Mansouri's Crude Oil Operating Conditions.

Operational Situations	IT (°C)	IP (kg/cm^2)	RPT 1 (°C)	RPT 2 (°C)	RPT 3 (°C)	TCP (kg/cm^2)	BCP (kg/cm^2)
	370	3	90.5	49	73	2	2.6
Products Characteristics	Parameters	Before/ After	Blended Naphtha	Kerosene	Atm. Gasoil	Atm. Bottom	
	Mass Rate (kg/h)	Before	26,500	20,122	83,087	423,135	
		After	26,500	20,122	83,087	423,135	
	Std. API	Before	43.62	35.16	25.72	12.59	
		After	45.15	36.15	26.24	13	
	Std. Sp. Gr	Before	0.808	0.849	0.9	0.982	
		After	0.801	0.844	0.897	0.979	
	D86-IBP	Before	122.210	166.238	248.060	302	
		After	109.602	155.577	240.938	291	
	D86-30	Before	152.186	206.53	298.735	454	
		After	142.14	198.216	289.76	453	
	D86- FBP	Before	198.013	283.729	413.982	585	
		After	188.599	278.575	404.018	570	

Table 3: Results of Changes in operating conditions of Ahvaz and Mansouri Crude Oil mixture.

Operational Situations	IT (°C)	IP (kg/cm^2)	RPT 1 (°C)	RPT 2 (°C)	RPT 3 (°C)	TCP (kg/cm^2)	BCP (kg/cm^2)
	365	3.4	90	54	50	1.8	2.4
Products Characteristics	Parameters	Before/ After	Blended Naphtha	Kerosene	Atm. Gasoil	Atm. Bottom	
	Mass Rate (kg/h)	Before	26,500	20,122	83,087	423,135	
		After	26,500	20,122	8,3087	423,135	
	Std. API	Before	47.76	40.53	30.23	16.29	
		After	49.44	41.07	31.7	17.1	
	Std. Sp. Gr	Before	0.789	0.823	0.875	0.957	
		After	0.782	0.815	0.867	0.952	
	D86-IBP	Before	101.48	135.039	201.244	268	
		After	92.912	123.770	193.686	260	
	D86-30	Before	131.251	180.527	271.312	414.3	
		After	128.659	168.845	262.261	401	
	D86- FBP	Before	177.620	250.463	356.237	570.7	
		After	168.583	243.589	376.448	571	

Table 7: Results of Changes in Operating Conditions of Ahvaz and Dezful crude oil mixture.

Operational Situations	IT (°C)	IP (kg/cm^2)	RPT 1 (°C)	RPT 2 (°C)	RPT 3 (°C)	TCP (kg/cm^2)	BCP (kg/cm^2)
	360	3.2	95	44	60	2	2.7
Products Characteristics	Parameters	Before/ After	Blended Naphtha	Kerosene	Atm. Gasoil	Atm. Bottom	
	Mass Rate (kg/h)	Before	26,500	20,122	83,087	423,135	
		After	26,500	20,122	83,087	423,135	
	Std. API	Before	46.89	39.97	29.54	15.5	
		After	48.03	40.71	30.21	16	
	Std. Sp. Gr	Before	0.793	0.827	0.879	0.962	
		After	0.788	0.822	0.875	0.959	
	D86-IBP	Before	105.813	140.023	207.738	272.8	
		After	98.978	128.144	195.218	264	
	D86-30	Before	139.296	182.455	272.915	418	
		After	131.892	174.18	263.656	409	
	D86- FBP	Before	179.678	252.752	367.402	562	
		After	174.127	249.16	379.26	565	

quality and would show its effect on the products of the vacuum distillation unit. An analysis of the results from Mansouri crude oil production data shows that changes of the operating conditions of the atmospheric distillation column cannot merely improve the quality of products and fundamental changes in structure of column are needed.

It can be concluded that products obtain from the mixture of Ahvaz oil and Maroon oil reach the desired quality, and in terms of productivity, the mixing of these two crude oils is affordable. The results show that the quality of the products of the atmospheric distillation unit feed by Maroon crude oil or its mixture with Ahvaz crude oil is consistent with the desired quality.

Besides, the mixture of Ahvaz and Mansouri crude oils achieves improper products which can be improved by changing the operating conditions of the atmospheric distillation column. For example, by increasing the inlet temperature from 353 ° C to 365 ° C and the pressure up to 3.4 kg/cm^2 as well as applying some changes to the return pumps, the quality of the products will be improved. The quality of the naphtha is approaching the reference quality, but the quality of the two other products of the atmospheric distillation unit has a difference of 3 degrees API with the reference product. This means that the place of the tray of the naphtha is suitable, but the trays of two other products are improper. So, with changes in the operating conditions of the atmospheric distillation column, there is no change in the quality of the products. But according to results of the simulation, Mansouri crude oil could be used in the absence of Ahvaz crude oil without changing the structure of column such as type and arrangement of trays. It should be noted that the price of Mansouri crude oil is approximately equal to Ahvaz crude oil, so there will be no fundamental change in the cost of the purchase.

The results of Ahvaz and Dezful crude oil mixing, clearly indicate that the quality of the products of this simulation is lower than the desirable quality. Therefore, with the change in operating conditions of the atmospheric distillation column, we have tried to approximate the quality of the product to its intended quality. By comparing the prepared data, Table 7 shows that by changing the operating conditions of the atmospheric distillation column, the quality of the mixed naphtha product is better than the quality of the other two products. But the quality of kerosene and gasoil was slightly different even by changing the operating conditions of column.

Table 8: Results of MFCA Calculations (Million USD).

Stream Name		Material Cost	Energy Cost	System Cost	Total Cost
Reduces Crude	Positive	1,130.8	7.1	1.4	1,139.3
Kerosene to Storage	Positive	53.8	0.3	0.1	54.2
AW	Positive	70.8	0.4	0.1	71.4
A.G.O. to Storage	Positive	222.1	1.4	0.3	223.7
Overhead Gas to LPG	Negative	100.7	0.6	0.1	101.5
LSRG	Negative	11.5	0.1	0.0	11.6
HSRG	Negative	50.6	0.3	0.1	50.9
A.G.O. to U-400	Negative	80.3	0.5	0.1	80.9
Kerosene to U-400	Negative	1.0	0.0	0.0	1.0
Wastewater	Negative	0.1	0.0	0.0	0.1
Sour Water	Negative	87.8	0.5	0.1	88.4

Due to the fact that the quality of the products obtained from the Dezful crude oil does not have the desired quality, then the products obtained from the mixing of Dezful oil with Ahvaz oil will not be of good quality either. But the quality of the products derived from the mixing of these two crude oils indicates that Dezful oil can be an alternative for crude oils that are purchased for the mixing with the Ahvaz crude oil for the refinery.

CONCLUSIONS

The analysis of Influence of Crude Oil Type on Products Quality of the Atmospheric Distillation led to the following results:

1- The concept of Material flow cost accounting was applied to establish the actual value of the existing products in an atmospheric distillation unit.

2- This process was simulated with the available feed (Ahvaz crude oil), also three different crude oil types were simulated and the optimal conditions were selected (350-355 °C, 2.9-3 kg/cm^2) via the method of MFCA.

3- The results of this study (simulation and MFCA method) show that the major cost for operating the atmospheric distillation unit is to buy crude oil (99.3 percent) and other costs such as energy (0.6 percent) and the system is negligible compared to feedstock price. Therefore, changing the current conditions of the refinery will not have much effect on the costs involved. Hence, we need to manage the crisis of buying and replacing existing crude oil, which is achieved by simulating the results.

4- Data from the simulation show that Maroon crude oil and the mixing of Maroon and Ahvaz crude oils leads to results similar to Ahvaz crude oil.

5- Applying Dezful and Mansouri crude oil results indicate low products and it is not a suitable alternative for Ahvaz crude oil. However, the mixing of Mansouri crude oil with Ahvaz oil as well as some changes in the operating conditions of the atmospheric distillation column has made the desired quality of the products.

Received : Jul. 12, 2019 ; Accepted : Aug. 5, 2019

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