Simulation analysis and Aspen Plus utilization of Barometrical crude array Hound

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ABSTRACT

Oil is separated into fractions such as gas, gasoline, kerosene, gas oil, air residue, oil fractions, and heavy residue during primary processing. The amount of each fraction is determined by the oil's composition. The barometrical and vacuum distillation preflash crude units are the most important aspects of this process. The goal of this project was to use the Aspen Plus simulator to create a computer simulation of atmospheric distillation. The feed is preheated in a heat exchanger system, and this step of the process was included in the simulation. The operational parameters were derived from the paperwork for the "Hound" project, which was designed for the Dangote oil refinery company. The simulation was carried out for a specific type of crude oil that is currently in use. The procedure was further tested to see if it could be conducted under varied feed conditions.

Keyword: *Aspen Plus; processing of oil; Hound*

INTRODUCTION

Oil is separated into fractions such as gas, gasoline, kerosene, gas oil, air residue, oil fractions, and heavy residue during primary processing (these are not final products, they need to pass several refinery processes). The composition of crude oil determines the amount of each portion. The atmospheric and vacuum distillation preflash crude units are the most important aspects of this process.

This research is based on information from the project paperwork for the Hound barometrical unit at the Dangote oil refinery [1]. This section of the refinery is crucial since it restores the key characteristics of the fractions obtained from this plant, such as viscosity, bubble point, and so on. Because of the additional adjustment possibilities and expenses, these parameters must be altered as much as feasible. The goal of this article was to create a simulation of the barometrical crude unit Hound using Aspen Technology Ltd's Aspen Plus 11.1 simulation engine. [2] to test the unit using a crude oil that is currently in use as well as another type of crude oil whose data was acquired from the Aspen Plus 11.1 Library as well as paperwork from the Dangote oil refinery plant.

Computer simulation

Thermodynamic property model

In the simulation, the thermodynamic model Chao-Seader with Lee-Kesler enthalpy [2] was utilized to create a broad correlation of the vapor–liquid equilibrium in hydrocarbon mixtures.

Barometrical crude unit Hound

Figure 1 depicts the barometrical crude unit schematically. A distillation column with two side stripers is the most important aspect of the operation. The stripers each have four stages, whereas the column has 22 stages. These two stripers are housed in a single column in the refinery.

Stripers are required to separate the desirable fraction from a lighter fraction. As a result, streams (6) and (7) introduce steam into the stripers (7). Using product streams, the crude is preheated in a series of heat exchangers (3, 5, 8, and 9). The feed stream (1) enters the column on stage 4, which is numbered from the bottom up, after leaving the furnace. The steam (2) enters the column on stage 1 and is used for elutriation of the heaviest fraction in the process. Reflux is represented by stream (4), which enters the column at stage 21. In the splitter, the reflux rate is adjusted.

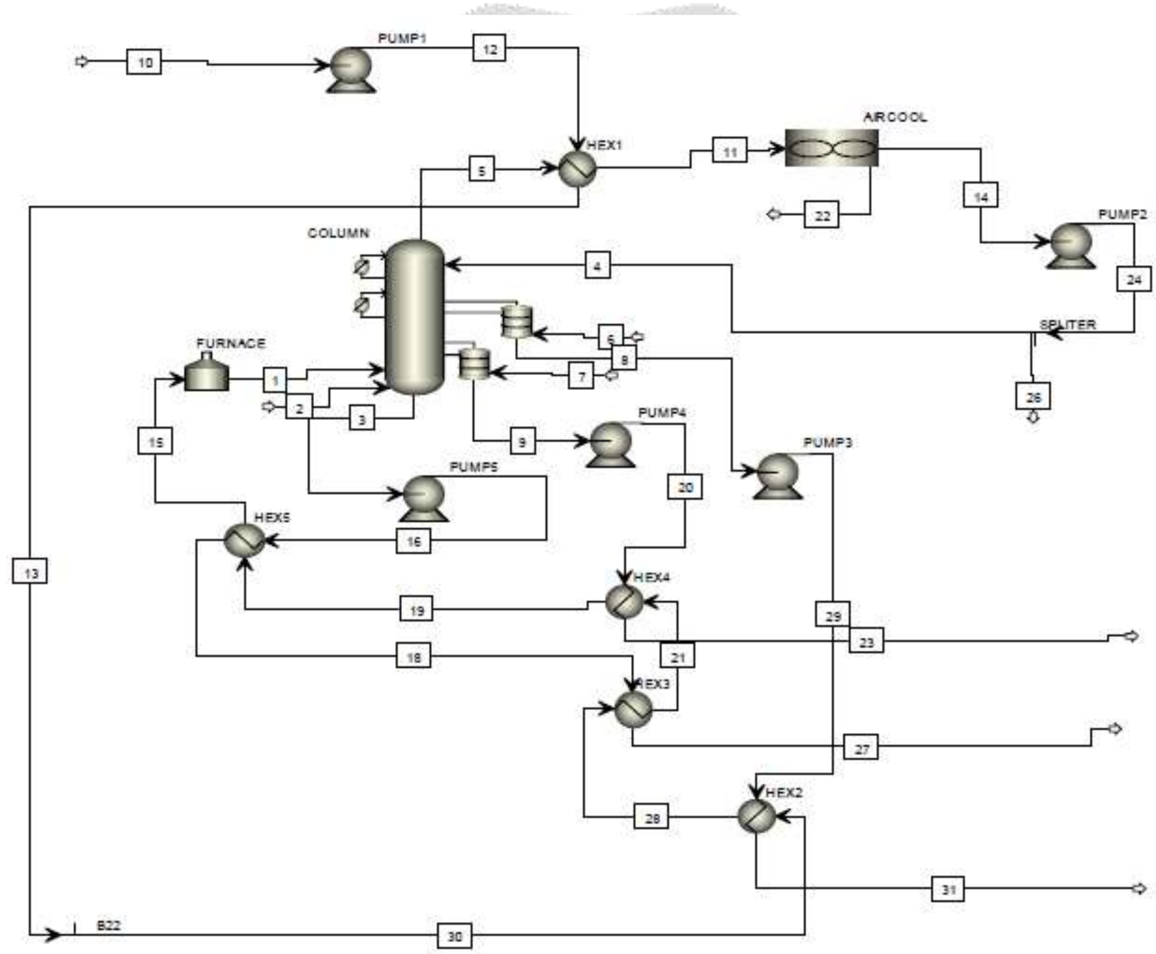

Figure 1: Schematic picture of the atmospheric crude unit.

Aside from this, data related to heat exchangers (such as cold or hot stream inlet or outlet temperature, or heat duty) must be entered before the simulation may begin. Other information required includes information on the type of crude oil processed in the Badger unit. These data came from the Novi Sad oil refinery for VELEBIT type [1], and the Aspen Assay Library for KIRKUK type [2]. KIRKUK is a lighter crude oil that is extracted from Iraqi lodes. KIRKUK is the crude oil for which the unit will be tested, and VELEBIT is a sort of crude oil that is currently in use. For each type of crude oil, data are shown in Table 1 as well as in Figs. 2 and 3.

Table 1. Data for VELEBIT and KIRKUK crude oil.

Type	Gasoline	Kerosene	Gas Oil	Long residue
VELEBIT	2.6%	10.7%	20.1%	66.6%
KIRKUK	20%	17%	20.5%	42.5%

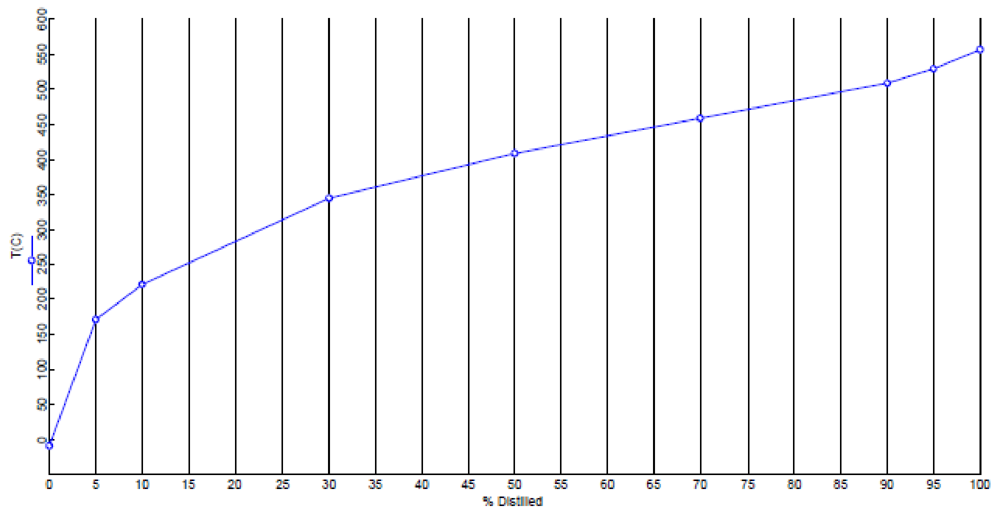

Figure 2: The distillation curve for VELEBIT type of the crude oil.

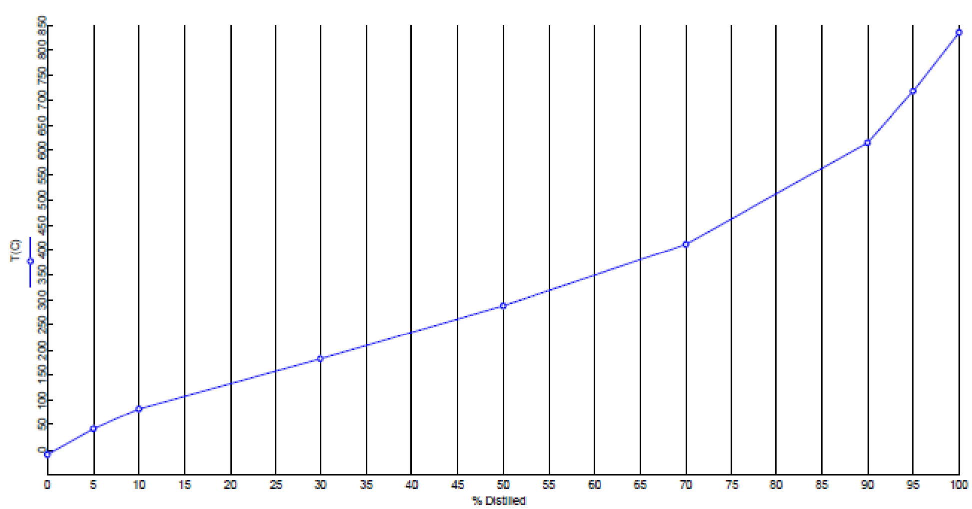

Figure 3: The distillation curve for KIRKUK type of the crude oil.

Because of its economic relevance, the most interesting fraction is a lighter one called gasoline.

As seen in Figures 2 and 3, KIRKUK will produce more light fractions, particularly the gasoline fraction. Furthermore, these results show that at the same temperature, the KIRKUK type of crude oil produces a greater amount of distilled liquid.

The most common fractions are set by TBP cuts [4]:

Light and heavy gasoline:	60-180^{0}C
Kerosene:	180-260^{0}C
Gas oil:	260- 3600C
Residue:	T > 360^{0}C

Column internals data together with the feed stream temperature and pressure are given in Table 2 [1].

Table 2: Column internals and feed stream data

Number of stages	22
Pressure (bar)	1,9- 1,55
Temperature (^{0}C)	350- 138
Feed stream temperature (^{0}C)	372
Feed stream pressure (bar)	17

PETRO FRAC unit operation model PETRO FRAC unit operation model from

Because the actual number of steps was previously known from the project documentation [1], the Aspen Plus model library was used. The column configurations for PETRO FRAC models consist of a main column with any number of pumparounds and side strippers.

Process limitations

The most critical limitation is the feed temperature, because at a certain temperature, the oil will start to fracture and coke will appear in the column, resulting in flooding and the process failing. Because of the same reason, the column pressure is also a constraint. Because the plant must be tested as is, the number of steps was included in the constraints.

However, because the stage from which liquid for stripers was drawn and the stage of return were not limited, it was tried in order to obtain higher amount and quality of light fraction in relation to the composition of gasoline fraction obtained from VELEBIT crude oil on this plant, HOUND. It was utilized in the case of crude oil of the KIRKUK type.

Results and discussions

VELEBIT crude oil was used in the first simulation. The simulation was completed successfully because the results were in good agreement with the project data. Table 3 shows the contrast between the project data and the data gained from simulation.

Table 3. The comparison between the project data and the data obtained by the simulation.

	Gasoline (kg/h)	Kerosene (kg/h)	Gas oil (kg/h)	Residue (kg/h)
Project documentation	21 460	4 585	8 380	27 690
1st Aspen simulation	22 506	4 585	8 380	27 037

Table 4. Results obtained from the second Aspen simulation.

	Gasoline (kg/h)	Kerosene (kg/h)	Gas oil (kg/h)	Residue (kg/h)

2nd Aspen simulation	48 717	3 754	10 010	18 438

Table 5. Results obtained from the fourth Aspen simulation.

	Gasoline (kg/h)	Kerosene (kg/h)	Gas oil (kg/h)	Residue (kg/h)
3rd Aspen simulation	49464	3650	9850	18564

These findings indicate that the simulation was successful and that it can be used to describe the process. As a result, if some process parameters are altered, the simulation may be used to forecast and adjust other parameters.

CONCLUSION

A different crude oil was used in the simulation this time. For the simulation, the KIRKUK kind of crude oil was employed, using attributes extracted from Assay Data Library in Aspen Plus [2]. Due to the aforementioned process restrictions, no additional pressure or temperature adjustments are possible or even necessary. Table 4 summarizes the findings of this study in terms of fraction flow rates. When these results are compared to those for VELEBIT crude oil, a substantial difference may be noted. This is clear since the crude oil compositions of the two types under consideration differ (Table 1). After the simulation successfully converged again, it was determined that the distillation unit could be used for this new form of crude oil.

However, as can be seen from the TBP gasoline cut, some of the light fraction was not distilled into gasoline. Because the temperature cannot be changed, the influence of the reflux rate was evaluated in the third simulation to increase the proportion of the light fraction. Because it had no bearing, another possible option - the striper's location – was investigated.

As a result, in the fourth simulation, both stripers' side stream withdrawal was changed one stage down. This reorganization resulted in an acceptable composition of the gasoline percentage, which is the most profitable. The fourth simulation's findings are shown in Table 5.

With the established project parameters for the crude oil VELEBIT, Aspen Plus can successfully simulate the atmospheric crude unit Hound. What's more important, this unit can be utilized with a different crude oil, such as KIRKUK crude oil, with just minor changes to the basic operational settings. These adjustments were made in accordance with the primary process constraints and unit capability.

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