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Revamping of Crude Distillation Unit for enhancement of Processing Capacity & LPG extraction through Steady State Simulation Modeling

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Abstract

The scope of this work covers the debottlenecking of operational constraints for increasing the processing capacity of crude distillation units and LPG extraction from crude oil. Simulation modeling on Aspen HYSY V7.1 is used for thoroughly investigating and evaluation of retrofit alternatives. Design and operations data of a crude distillation unit at Attock Refinery Limited is used as a case study. Capacity expansion through the addition or rearranging of circulating reflux/Pump-around is selected among the various available revamp alternates like addition of Pre-flash columns, tray geometry and hydraulics, etc. Then crude distillation unit is revamped for maximum possible expansion in processing capacity by re-arranging Pump-around circuits. Pump-around balances re-arrangement based on specific crude oil operating blend. Distillation column circulating reflux re-arrangement with different overhead configurations carefully modeled on Aspen HYSYS for evaluation. Some modifications are also incorporated in stabilizer column of the simulation model of crude unit to start On Spec. LPG extraction from stabilizer section. The results of Simulation Modeling validate propose modifications for revamping of processing capacity and LPG extraction.

Keywords: Steady State, Simulation Modeling, Revamping, Crude Distillation Unit, LPG Extraction

1. Introduction:

Revamping means complete re-organization or revision. For chemical process plants, this term is used for improving the infrastructure or product features or overall production capacity through modifications or re-structuring of a process. Almost every chemical process equipment has additional design margins [6]. There is also a difference exist between the specification of the equipment designed or sized and finally procured equipment. These margins and differences are widely used to revamp a process plant for increased throughput.

1.1 Revamping of a Crude Distillation Unit:

Some of the distillation units in Pakistan, especially which are designed to process local crude oils, are designed with minimum processing capacity because of the fewer opportunities available at that time. But now the scenario has changed. In recent years, the new reserves of crude oil found within the boundaries of KPK and Punjab provinces and also in some other areas (like Khevra and Ziarat) have made it possible to revamp these distillation units for maximum possible processing capacity.

Some distillation units are also operating on feed blends that are significantly different from their

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designed feed specifications. This difference in feed composition not only affects the crude unit distillation performance but also affects the reliability of the crude distillation unit's equipment. Because of the economic pressure, it had become essential to re-optimize the design and operation of such crude distillation units according to the present feed conditions or tune the crude distillation units according to the current feedstocks.

There are several ways to revamp crude distillation columns for higher processing capacities. Some of them are discussed below.

1.1.1. *Tray geometry and hydraulics:*

If the capacity of an existing column is increased by 40%, this will also increase the vapour-liquid traffic by 40% almost. This increased vapour-liquid traffic would result in an increased pressure drop across each section exceeding the allowable limit of pressure drop [2]. To bring it within allowable limits or to reduce the pressure drop across each section, the number of valves on each tray can be increased. Special valve trays can also be used which are very expensive but can give very low-pressure drops [12]. A detailed and careful study is needed so that columns could perform properly with the new internals. It is a time-consuming activity and requires proper planning and resources.

1.1.2. Circulating reflux or pump-around:

In case of no circulating reflux, excess heat of the distillation column will only be removed from the column top. This will increase the vapour load at the top of the tower therefore higher reflux ratio will be required to maintain the top temperature of the column. According to modern research, between every two product draws of the column, circulating reflux should be provided for achieving better product quality control and higher processing capacity without changing the column layout [3]. This is a simple and easy approach as it requires less time and capital but only a limited increase in processing capacity can be achieved.

1.1.3. Addition of Pre-flash Column

In this revamp strategy, a pre-flash column is installed just before the distillation column furnace [9]. The pre-flash column fractionates the lighter components of the feedstock before entering the furnace and distillation column. This technique reduces the overall heat duty of the furnace and vapour load in the rectifying section of the distillation column and thus a 50 to 60% increase in processing capacity. This is an excellent approach for revamping a crude unit without changing the main column layout.

This type of revamping project requires huge capital investment and space availability because of the addition of new equipment [3] but it is highly reliable with absolutely minimal chances of failure. An increase in plant processing capacity by up to 60% can be achieved by pre-flash implementation.

1.2. LPG Extraction:

The crude distillation units with small processing capacity, are not initially designed for LPG extraction because huge reserves of natural gas were available in the country initially, and also expected small LPG yield was not justifying the capital investment required. Light crudes contain less than 1 volume percent LPG [14].

As the natural gas reserves are depleting constantly and the country is facing an acute gas shortage. The demand and price of LPG have increased 10-fold times. Now the refiners are trying to maximize their production of LPG to grab this opportunity and to meet the market demand. There is a need to operate these distillation units, which are initially designed with no LPG facility, with the conditions to ensure the maximum possible LPG extraction.

2. Experimental Work:

For the purpose of the case study, a distillation unit is selected at ARL Rawalpindi, Pakistan. The design and operations data of this distillation unit are used in this case study. This unit is designed by Howe-Baker Engineers, Inc. and it is commissioned in 1970. It has a design processing capacity of 5000 bbl. /day with no LPG facility. This distillation unit is designed to process Meyal sweet or Meyal sour local crude oils to produce Off gases, stabilized Naphtha, Kerosene, Diesel, LDO and residue.

2.1. Simulation of Crude Distillation Unit:

The distillation unit taken as a case study was designed to process Meyal sweet or Meyal sour local crude oils. Due to the depletion of reserves from these oilfields, this distillation unit is operated with a blend consisting of different local crude oils. Crude oil blending is done for economic incentives and crude stock management. Composition and TBP (True Boiling Point) reports of all the constituents of the operating blend have been used for the calculation of the operating blend in Aspen HYSYS.

A steady state simulation model of the crude distillation unit is created by selecting the thermodynamic package and components in the Basis Environment [4] and by calculating the blend assay from the individual crude assays in the Oil Environment. The other input parameters for this simulation modeling case are:

Operating parameters (P, V, and T) are those used in normal plant operation.

The mechanical data of fractionating column is taken from the design manual of the Unit.

Finally, the process flow diagram of the model is created in the simulation environment of Aspen HYSYS. Figure 3.1 represents the Process Flow Diagram of the simulated model of a crude distillation unit. This process flow diagram represents all the equipment, their connections, and different product streams of the distillation column.

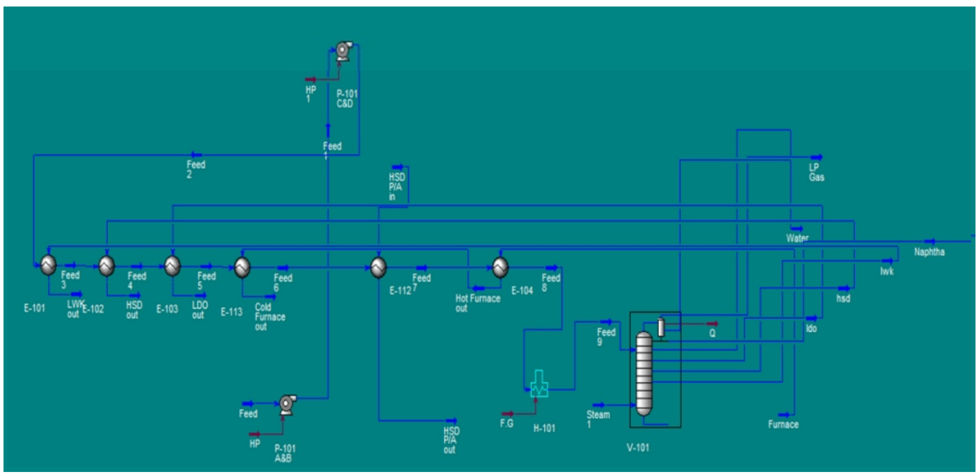


Figure 3.1: Process Flow Diagram of the CDU Simulation Model

The simulation model is solved by monitoring the desired and important parameters of the crude distillation unit. During monitoring, only the critical and desired parameters are monitored because the monitoring of all parameters is not possible. The monitoring window of the solved model is shown in figure 3.2.

Specifications

	Specified Value	Current Value	Wt. Error	Active	Estimate	Current
Reflux Ratio	<empty>	1.44	<empty>	☐	☑	☐
Distillate Rate	1344 barrel/day	1.34e+003	0.0000	☑	☑	☑
Reflux Rate	8152 barrel/day	1.94e+003	-0.7615	☐	☑	☐
Vap Prod Rate	1811 barrel/day	5.16	-0.9972	☐	☑	☐
Btms Prod Rate	1811 barrel/day	741	-0.5909	☐	☑	☐
Furnace PP	18.00 C	32.0	0.0028	☐	☑	☐
Top Temperature	110.0 C	110	0.0000	☑	☑	☑
LWK Draw T	168.0 C	166	-0.0038	☐	☑	☐
HSD Draw T	238.0 C	241	0.0059	☐	☑	☐
DFO Draw T	287.0 C	285	-0.0033	☐	☑	☐
lwk Rate	1132 barrel/day	1.13e+003	-0.0000	☑	☑	☑
hsd Rate	935.9 barrel/day	936	-0.0000	☑	☑	☑
ldo Rate	60.38 barrel/day	60.4	-0.0000	☑	☑	☑

View... | Add Spec... | Group Active | Update Inactive | Degrees of Freedom 0

Figure 3.2: Monitoring of CDU Simulation Model Parameters

3.2. Revamping of Crude Distillation Unit through Simulation Modeling

The crude distillation column is the heart of the crude distillation unit. Debottlenecking of the crude distillation column is the first step for achieving the maximum possible capacity enhancement of the crude distillation unit. The scope of this work covers the debottlenecking of operational constraints and increasing the processing capacity of crude units. All retrofit options were thoroughly investigated and capacity expansion through the addition of Pump-around circuits has been selected because it requires less capital investment, no further space requirement, and can be accomplished in the smallest period of time as compared to other revamp techniques. In this case study, a crude distillation column is provided with a single Pump-around circuit. This Pump-around circuit is providing heat recovery between Diesel and Kerosene sections.

One Pump-around circuit is recommended between the two adjacent product draws. So, in our case options are further limited. Now, only the two Pump-around circuits can be added. One Pump-around circuit can be added between Kerosene and Naphtha product draws and the second one can be added between Diesel and LDO product draws. This crude distillation unit is designed for Light crude and operating blend specific gravity is also low with a small portion of heavy LDO product. Therefore pump-around circuit between Diesel and LDO section will not contribute much to distillation performance. The only option left is the top Pump-around circuit between Kerosene and Naphtha sections.

This crude unit was originally designed to process crude oils with high Diesel and low Kerosene cuts. That is why the only Pump-around circuit is located in the Diesel section and no Pump-around circuit is included in the Naphtha - Kerosene section. Operating crude blend contains a higher percentage of Kerosene and Naphtha boiling range cuts opposite to design crude composition. Therefore, it is mandatory to relocate the Pump-around circuit from Diesel-Kerosene section to Naphtha-Kerosene section to accommodate higher loads of vapour-liquid traffic in this section and to tune up the crude distillation column according to the present feedstock conditions.

Simulation modeling is used for the evaluation of retrofit alternatives as it is widely used to design and analyze distillation column performance. Process design firms rely heavily on simulation modeling and it is a very powerful tool in process engineering.

Now, this crude distillation unit is again simulated on Aspen HYSYS with the same input parameters but with a changed location of the pump-around circuit from Diesel-Kerosene section to Naphtha-Kerosene section. The crude distillation unit is simulated with several different overhead configurations of the pump-around circuit to find out the best suitable configuration giving optimum processing capacity:

3.2.1. Overhead configuration case (a)

The top Pump-around circuit is added to the crude distillation column which is already validated on Aspen HYSYS 7.1. Top Pump-around or Naphtha Pump-around is drawn from 27^{th} no. stage and is returned to the crude distillation column as hot reflux at 29^{th} no. tray. Cold reflux or top reflux is provided to the crude distillation column at 32^{th} tray. Figure 3.3 represents overhead configuration case (A).

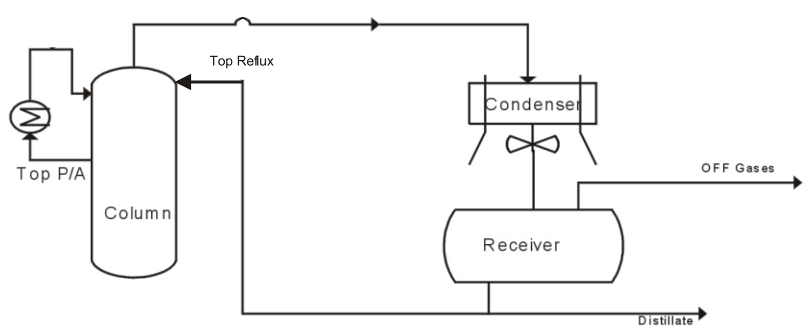


Figure 3.3 Overhead Configuration Case (A)

The crude distillation column is modeled on Aspen HYSY with an increased processing capacity of up to 7000 bbl./day. The increase in processing capacity after 7000 bbl./day un-converge the model. Temperature and pressure conditions of the column, Pump-around balances are adjusted and rearranged but the crude distillation column does not solve beyond this point. Figure 3.4 shows the liquid pump-around summary for overhead configuration case (A).

Liquid Pump Around Summary

	Draw Stage	Return Stage	Flow [barrel/day]	Duty [Btu/hr]	Draw T [C]	Return T [C]	Export
HSD PA	15__Main TS	18__Main TS	8499	1.519e+012	235.9	<empty>	
Naphtha P/A	27__Main TS	29__Main TS	5489	-1.506e+012	179.4	<empty>	

Figure 3.4: Liquid Pump-around Summaries for Overhead Configuration Case (A)

3.2.2. Overhead configuration case (B)

The top Pump-around circuit is added to the crude distillation column which is already validated on Aspen HYSYS 7.1. In this scheme, the top Pump-around or Naphtha Pump-around is drawn from 30th no. stage and is mixed with the cold reflux of the column before returning to the column at 32th tray. Figure 3.5 is the model representation of overhead configuration case (B).

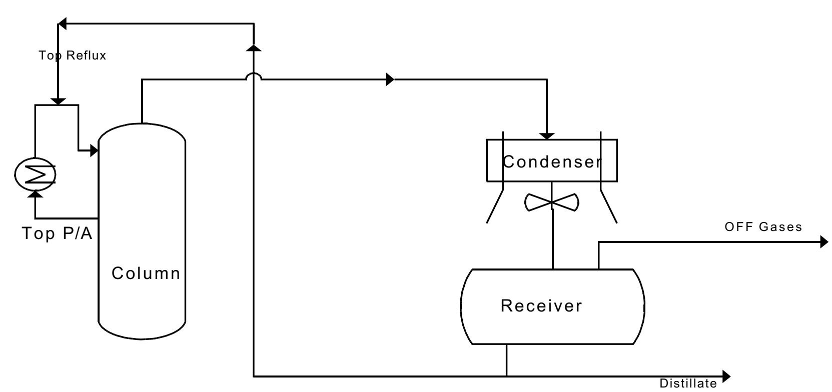


Figure 3.5 Overhead Configuration Case (B)

The crude distillation column is modeled on Aspen HYSY with an increased processing capacity of up to 7100 bbl./day. The increase in processing capacity after 7100 bbl./day un-converge the model. Temperature and pressure conditions of the column, Pump-around balances are adjusted and rearranged but the crude distillation column does not solve beyond this point. Figure 3.6 is the liquid pump-around summary for overhead configuration case (B).

Liquid Pump Around Summary

	Draw Stage	Return Stage	Flow [barrel/day]	Duty [Btu/hr]	Draw T [C]	Return T [C]	Export
HSD PA	15__Main TS	18__Main TS	8643	-1.370e+007	218.6	<empty>	☐
Naphtha P/A	30__Main TS	32__Main TS	5296	2.071e+007	127.5	<empty>	☐

Figure 3.6 Liquid Pump-around Summaries for Overhead Configuration Case (B)

3.2.3. Overhead configuration case (C)

The top Pump-around circuit is added to the crude distillation column which is already validated on Aspen HYSYS 7.1. Top Pump-around or Naphtha Pump-around is drawn from (24^{th} stage) the Kerosene draws stage and is returned to the crude distillation column as hot reflux at 28^{th} no. tray. Cold reflux or top reflux is provided to the crude distillation column at 32^{th} tray. Figure 3.7(A) shows the overhead configuration case (C).

Crude distillation column processing capacity is steadily increased up to 7500 bbl./day. By adjusting the mole balances, temperature, and pressure conditions of the column, the CDC converged on 7500 bbl./day throughput. Figure 3.7(B) represents the liquid pump-around summary for the solved simulation model of overhead configuration (C).

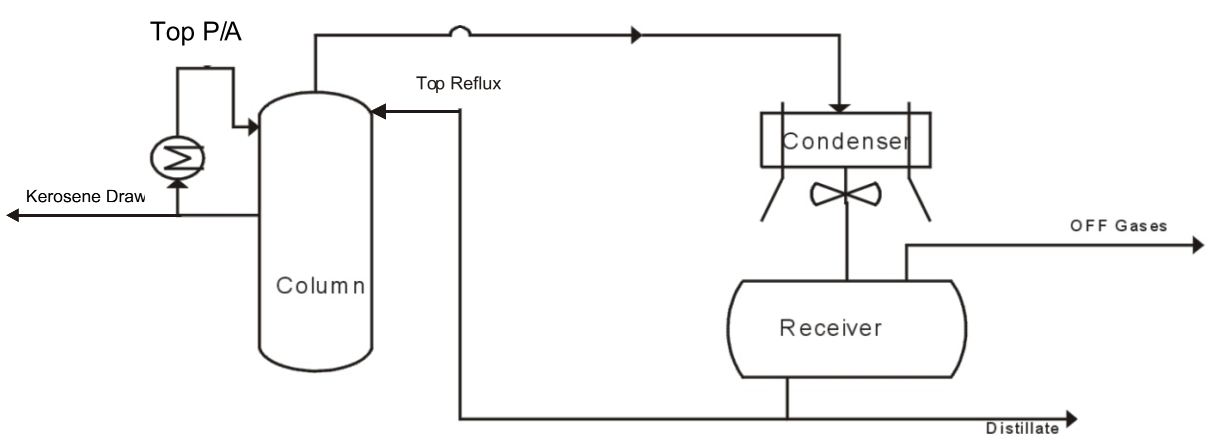


Figure 3.7: (A) Overhead Configuration Case ©

Liquid Pump Around Summary

	Draw Stage	Return Stage	Flow [barrel/day]	Duty [Btu/hr]	Draw T [C]	Return T [C]	Export
HSD PA	15__Main TS	18__Main TS	8514	1.997e+006	235.4	246.2	☐
Naphtha P/A	24__Main TS	28__Main TS	6250	2.121e+006	180.8	188.4	☐

Figure 3.7 (B): Liquid Pump-around Summaries for Overhead Configuration Case ©

3.3 LPG Extraction:

According to the case study crude unit simulation model, naphtha at the rate of 15.6 m^3/hr. is drawn from the distillation column and routed to the stabilizer column. In this case, the stabilizer feed is too small to justify the stabilizer column conditions for on spec. LPG extraction. To enhance the lighter content of the stabilizer feed and LPG yield, it is proposed to take the same amount of Pre-flash Naphtha, mix it with the crude distillation column naphtha, and fed it to the stabilizer column. This combined feed contains enough lighter ends to maintain normal temp.-pressure profile in stabilizer column for On Spec. LPG extraction. According to the proposed strategy, Pre-flash Naphtha stream and crude distillation column naphtha streams are mixed before Stabilizer preheat exchangers.

Now, this Naphtha feed is run at the Stabilizer column to check the feasibility of LPG production. First of all, a distillation column is selected from the list and all stream data including design and operating data is inserted. This data includes the condenser pressure, reboiler pressure, condenser and reboiler pressure drop, fixing the number of theoretical stages and all the input and output streams data. After that, the process flow diagram of the proposed strategy appeared in the simulation environment. The final step of the simulation is monitoring. The simulated values like distillate rate, reflux rate, reflux ratio and others are monitored and compared to the operational ones. Figure 3.8 is the Process flow diagram of the proposed strategy in Aspen HYSYS for LPG extraction.

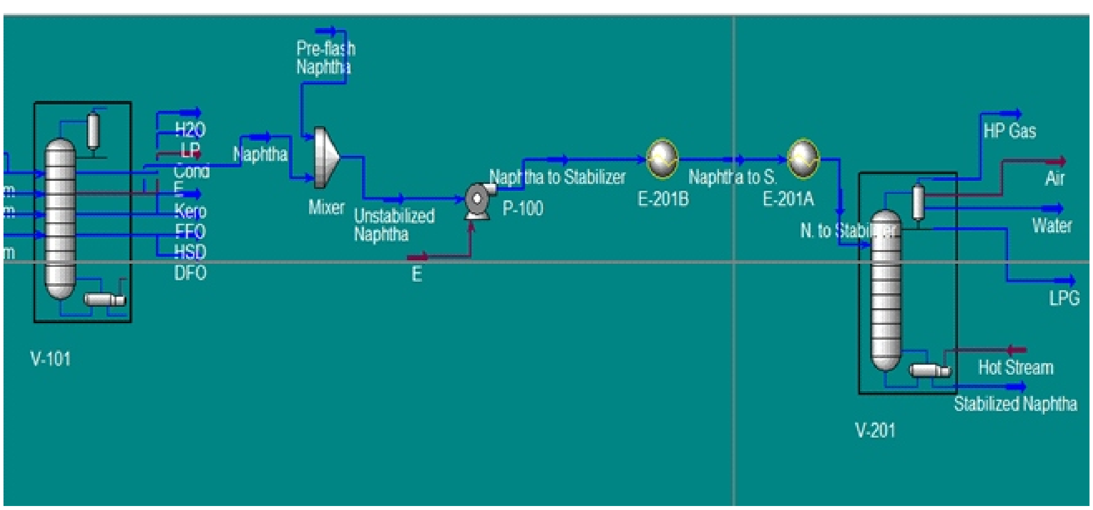


Figure 3.8: PFD of the Proposed Strategy of Stabilizer Simulated Model

The total length of this stabilizer column is 52 ft. and this column is divided into two sections. The bottom section with a total length of 32 feet and an internal diameter of 30 inches consisted of valve trays. The top section of the tower contains a packed bed of Raschig rings. The total length of the top section is 15 feet and the height of the packed bed is 10 feet. The diameter of the trays in the bottom tray section is 30 inches with tray spacing of 18 inches.

In order to validate the results of this simulation, this data and other specific data of the column are added to this simulation through the column sizing utility. After feeding column-specific data to this simulation model, the column sizing utility shows the following warnings and does not solve the column. Figure 3.9 shows the warnings displayed in the column sizing utility.

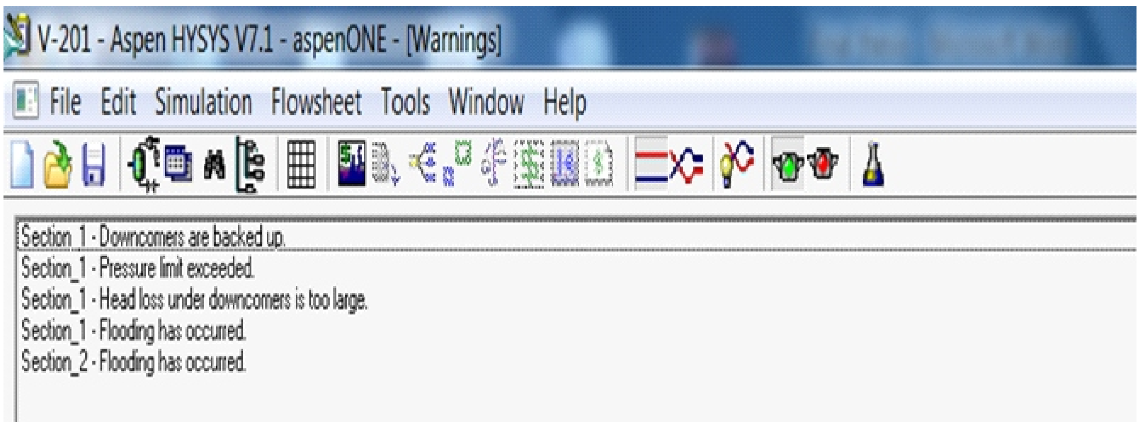
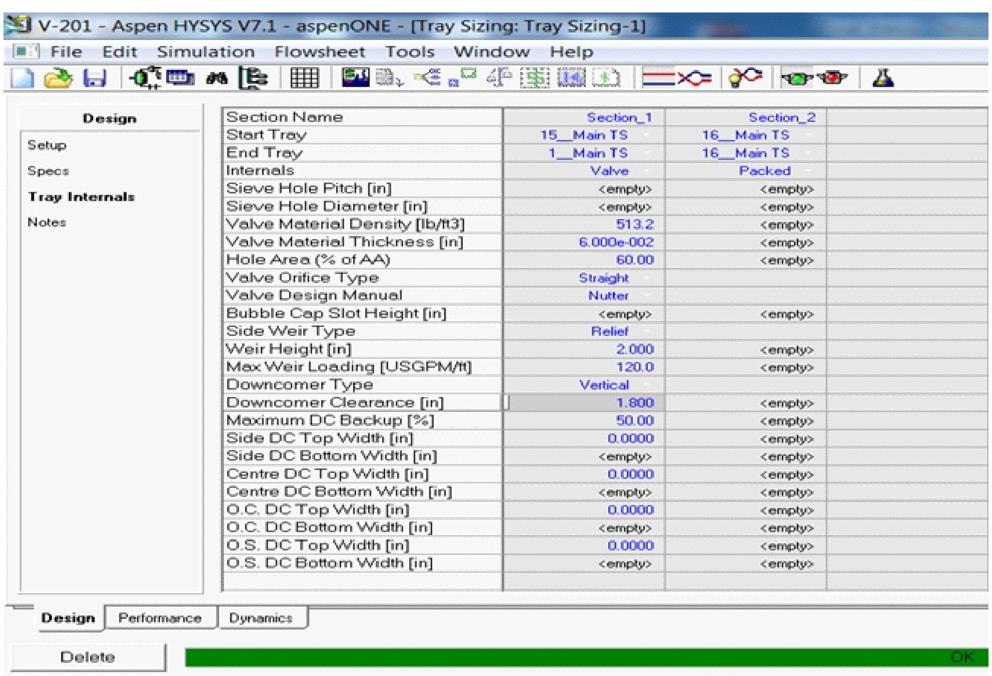


Figure 3.9 Column Sizing Utility Warnings

By increasing the down-comer clearance from 1.5 inches to 1.8 inches in the bottom section of the column and by increasing the diameter of the top section from 1.33 feet to 2 feet, the column sizing utility validates and fully solved the simulation model. Figures 3.10 and 3.11 shows the results of column sizing utility of the solved simulation model of CDU with incorporated modifications in the stabilizer section.



Section Name	Section_1	Section_2
Start Tray	15__Main TS	16__Main TS
End Tray	1__Main TS	16__Main TS
Internals	Valve	Packed
Sieve Hole Pitch [in]	<empty>	<empty>
Sieve Hole Diameter [in]	<empty>	<empty>
Valve Material Density [lb/ft3]	513.2	<empty>
Valve Material Thickness [in]	6.000e-002	<empty>
Hole Area (% of AA)	60.00	<empty>
Valve Orifice Type	Straight	
Valve Design Manual	Nutter	
Bubble Cap Slot Height [in]	<empty>	<empty>
Side Weir Type	Relief	
Weir Height [in]	2.000	<empty>
Max Weir Loading [USGPM/ft]	120.0	<empty>
Downcomer Type	Vertical	
Downcomer Clearance [in]	1.800	<empty>
Maximum DC Backup [%]	50.00	<empty>
Side DC Top Width [in]	0.0000	<empty>
Side DC Bottom Width [in]	<empty>	<empty>
Centre DC Top Width [in]	0.0000	<empty>
Centre DC Bottom Width [in]	<empty>	<empty>
O.C. DC Top Width [in]	0.0000	<empty>
O.C. DC Bottom Width [in]	<empty>	<empty>
O.S. DC Top Width [in]	0.0000	<empty>
O.S. DC Bottom Width [in]	<empty>	<empty>

Figure 3.10 Column or Tray Sizing Utility Simulation Results

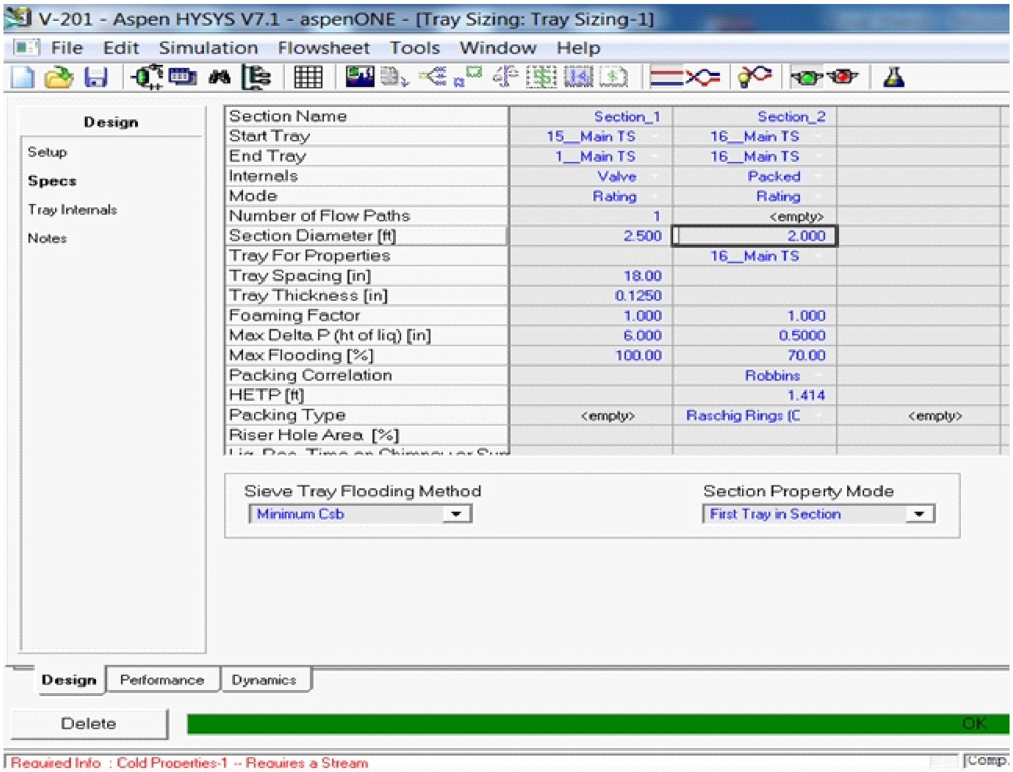


Figure 3.11: Column or Tray Sizing Utility Simulation Results

4. Results and Discussions:

4.1. Simulation of Crude Distillation Unit:

First of all, the crude distillation unit is simulated with operating conditions and operating blend on Aspen HYSYS 7.1. HYSYS does the property calculations for the model based on the fluid package selected in the Basis environment. Simulated values of critical parameters of the model can be monitored in the simulation environment. To obtain the desired results, monitoring parameters can be changed and also values for some parameters can be fixed as per degree of freedom of the process. Monitoring of the simulated values can be carried out even after the model is solved to fine-tune the results of the simulation.

The simulation model will only solve when the number of variables will be equal to the number of independent equations. It means that the degree of freedom should always be zero. Once the model is solved, HYSYS generates the heat and material balance across each stage and the whole system. The monitoring of results and adjustment of key parameters is done for achieving desired solution of the model. Table 4.1 shows the crude charge flow and product yields from the crude distillation unit when it is simulated with operating conditions and operating blend.

Table 4.1 Crude Charge flow and Product Yields with Normal Operating Conditions

Stream	Total flow/Total Yield
Crude Charge	4,218 Barrels/day
Naphtha	8.9 m^3/hr.
Kerosene	7.5 m^3/hr.
Diesel	6.2 m^3/hr.
LDO	0.4 m^3/hr.
Furnace	5 m^3/hr.
LPG	Nil

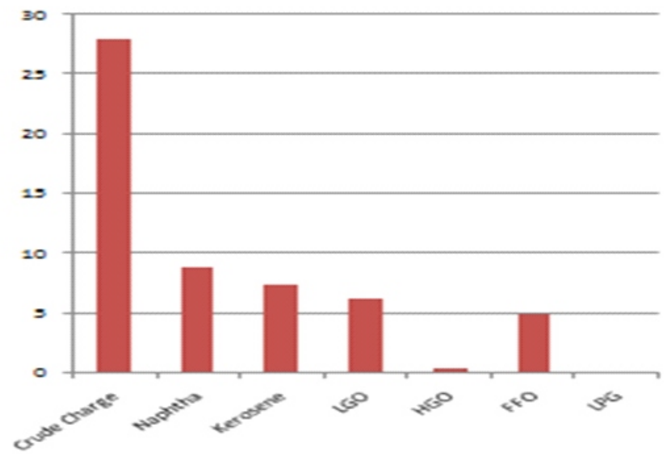


Figure 4.1 Graphical Representation of Crude Charge flow and Product Yields

4.2 Revamping of Crude Distillation Unit:

Single top reflux is responsible for providing condensation to all liquid product draws and also the over flash. Because of this arrangement, high variations in vapour-liquid traffic exist from the flash zone to the column top. The maximum amount of reflux is available at the top of the column and the lower sections of the columns are receiving only a small portion of it. As the vapour-liquid traffic is not uniform throughout the column, the column is more prone to disturbances.

To make the vapour-liquid traffic more uniform and to revamp the column for maximum possible capacity, pump-around circuits can be configured in the column as inter-condensers. By using Pump-around reflux, the liquid balancing will be more uniform and smoother in the column. Because of this uniform liquid balancing, the column can be made to operate for higher throughputs with the same column diameter. The Pump-around reflux method enhances heat recovery and lowers energy consumption.

Revamping of the crude distillation unit by relocating the pump-around circuit from the Diesel-Kerosene section to the Kerosene-Naphtha section with different overhead configurations is studied on Aspen HSYSY. Pump-around location significantly affects the internal vapour-liquid traffic. Crude feed composition, product draw patterns, distillation required, overhead condenser size and some other factors determine the number and location of the Pump-around circuits.

After studying various retrofit alternatives of overhead configuration, it is proposed that relocation of Pump-around to the Naphtha-Kerosene section can significantly enhance the capacity of this crude distillation unit with the overhead configuration (C). Here top Pump-around section is consisted of 04 trays to achieve a better heat transfer performance of hot reflux. Better heat transfer is also achieved when hot reflux is mixed with cold reflux before returning to the column. But in this case, hot reflux loses its maximum heat before entering the column and it does not remain effective.

The crude distillation column is again simulated on Aspen HYSYS 7.1 with a Pump-around relocated to the Naphtha-Kerosene section and with a new Pump-around balance and overhead configuration (C) but with the same operating blend. Table 4.2 shows the crude charge flow and product yields for the revamped case.

Table 4.2 Crude Charge flow and Product Yields with Revamped Case

Stream	**Total Flow/Total Yield**
Crude Charge	7,500 Barrels/day
Naphtha	14.50 m^3/hr.
Kerosene	4.938 m^3/hr.
Diesel	10.68 m^3/hr.
LDO	3.509 m^3/hr.
Furnace	10.6 m^3/hr.
LPG	Nil

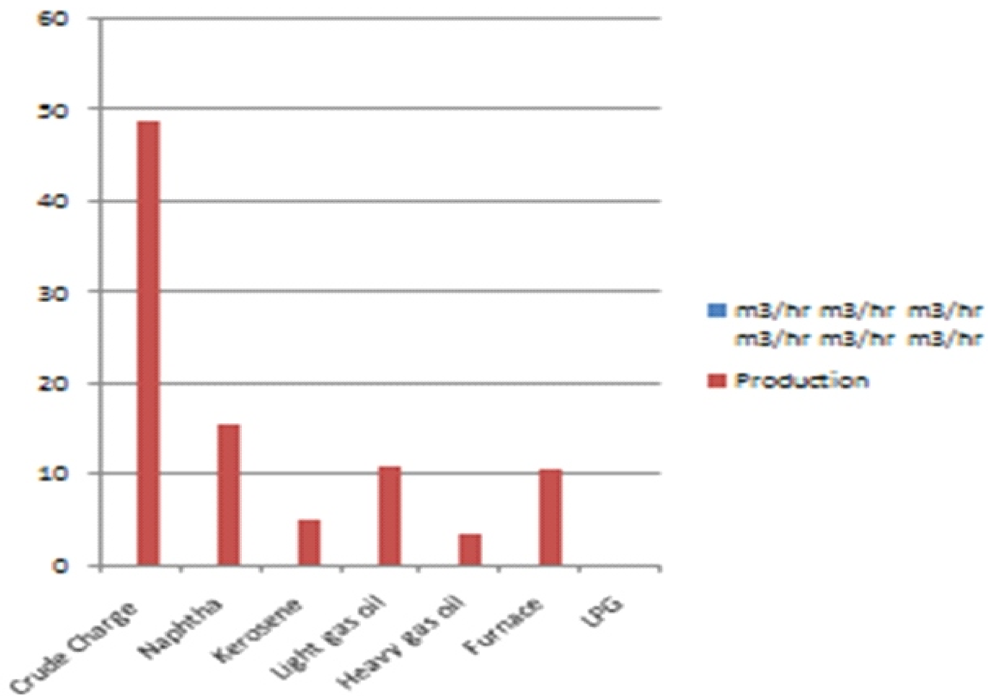


Figure 4.2: Graphical Representation of Crude Charge flow and Product Yields

Table 4.3 compare the results of both cases. "Case 1" represents the crude distillation unit operation with normal operating conditions and operating blend. "Case 2" represents simulation model results of crude distillation unit operation with revamped modifications. From the results shown in Table 4.3, it can be inferred that a significant increase in processing capacity is possible after some re-arrangement of the pump-around circuit in the distillation column loop. More than 70% enhancement in plant throughput justifies the capital investment and time requirement for this revamping project.

Table 4.3 Comparison of Overall Results

Stream	**Case 1**	**Case 2**
Crude Charge	4,218 Barrels/day	7,500 Barrels/day
Naphtha	8.9 m^3/hr.	14.50 m^3/hr.
Kerosene	7.5 m^3/hr.	4.938 m^3/hr.
Diesel	6.2 m^3/hr.	10.68 m^3/hr.
LDO	0.4 m^3/hr.	3.509 m^3/hr.
Furnace	5 m^3/hr.	10.6 m^3/hr.
LPG	Nil	Nil

4.3 LPG Extraction

During normal operating conditions with an operating blend, there is no production of LPG from this crude distillation unit due to the small processing capacity and low naphtha feed flow rate to the stabilizer section. The strict control of stabilizer operating conditions is necessary for on-spec LPG production. Stabilizer tower top temperature and pressure should not allow pentanes or heavier hydrocarbons to escape from the system. Pentanes and other heavier hydrocarbons make LPG heavy and off-spec. Sufficient stabilizer top pressure is necessary to resist the heavier hydrocarbons. This top pressure is developed with the lighter content of the stabilizer feed. Therefore, stabilizer feed should always contain sufficient lighter content to develop enough pressure which justifies the on-grade LPG production.

Now, this crude distillation unit has been revamped from 5,000 to 7,500 BPSD with proposed modification in the crude distillation column, and also depletion of Natural gas reserves made LPG more valuable creating an opportunity for on-spec. LPG production.

Table 4.4 shows the specifications and different operational parameters of the stabilizer column of the case study crude distillation unit.

Table 4.4: Specification Sheet of Stabilizer Column

Specification	Value
Distillate rate or LPG	Nil
Reflux ratio	0.529
Reflux rate	148 Barrels/day
Overhead Vapour rate	243 Barrels/day
Top Temperature	108^0C
Flash zone Temperature	123^0C

When the stabilizer section of this crude distillation unit is simulated with a revamped scenario and with a proposed strategy and modifications for the stabilizer column, the results obtained are shown in table 4.5.

Table 4.5: Specification Sheet of New Stabilizer Column Case

Specification	Value
Distillate rate or LPG	19 Barrels/day
Reflux rate	520 Barrels/day
Overhead vapour rate	$4.24e^{-008}$ Barrels/day
Top temperature	75^0C
Flash zone temperature	105 ^{0}C
Overhead accumulator temp.	36.95^0C

Table 4.6 shows the comparison of Stabilizer column specifications for the two cases. Here "Case 1" shows the normal conditions and normal operations and "Case 2" shows the revamped scenario and stabilizer column with the proposed strategy and modifications. Simulation results of both cases are shown in Table 4.6, it is evident that on spec. LPG production can be obtained from this crude unit after employing the proposed modifications in the stabilizer section. It shows that crude distillation units with low processing capacities can be made to produce On Spec. LPG.

Table 4.6: Comparison of Specification Sheets of Stabilizer Column

Specification	Case 1	Case 2
Distillate rate or LPG	Nil	19 Barrels/day
Reflux rate	148 Barrels/day	520 Barrels/day
Overhead Vapour rate	243 Barrels/day	$4.24e^{-008}$ Barrels/day
Top Temperature	108^0C	75^0C
Flash zone temperature	123^0C	105 ^{0}C
Overhead acc. Temp.	98^0C	36.95^0C
Top Pressure	4 kg/cm^2	7 kg/cm^2

5. Conclusions:

The conclusions drawn from the simulation results of the crude distillation unit case study are summarized below:

1. Feed Spec. is detrimental to the Distillation unit processing capacity and distillation performance. Feed specifications other than the design will have a negative impact on unit productivity. Therefore, it is recommended to operate the Crude unit with design feed specifications or tune the Crude unit with the operating feed blend specification for maximum performance.
2. Differences between operating crude blend specifications and designed feed specifications are responsible for capacity limitations and reduced distillation performance of this crude unit.
3. Designed crude feed was richer in HSD cut, therefore, a single Pump-around is given in the Kerosene-HSD section during the design phase of the unit.
4. Operating crude blend is richer in Light Weight Kerosene and Naphtha cuts and lacks HSD and other middle distillates.
5. Processing capacity of this crude distillation unit can be significantly enhanced by adding a Pump-around circuit in the Naphtha-Kerosene section.
6. Middle distillate yields can also be improved by employing a suitable crude blend to this crude distillation unit.
7. Addition of a single pump-around circuit on a specific location in the distillation column with a suitable configuration significantly enhanced the processing capacity from 5000 to 7500 bbl./day.
8. Naphtha yield is too small for the on-spec production of LPG from the stabilizer column.
9. Small amount of Pre-flash Naphtha can be charged to this stabilizer column along with the crude distillation unit Naphtha to have sufficient lighter ends to cope with the conditions for the extraction of on-spec LPG.
10. On-spec LPG extraction can be made possible through the following hardware changing:
    - By increasing the Stabilizer Column top section diameter
    - By increasing the down-comer clearance
11. After hardware modifications in Stabilizer column top Section and increasing stabilizer column throughput by pre-flash naphtha, 19 bbl./day on spec. LPG production is possible as evident from the simulation model of the unit on proposed modified conditions.

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