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“ Enhancing liquefied petroleum gas production through debutanizer column optimization ”

Name : V SHIVAKUMAR

Roll No : 220107092

Authors of the Article : Abdulrazzaq S. Abdullah

Hassan Wathiq Ayoob Raad Z. Homod

Hayder I. Mohammed

01.Abstract

This research explores ways to improve the debutanizer column in natural gas processing to increase liquefied petroleum gas (LPG) production efficiency. Using Aspen HYSYS simulation software, the study examines how vary operating conditions such as temperature, pressure, feed flow, and reflux ratio affect butane separation, a critical component of LPG. Adjustments to these conditions showed promising results for enhancing LPG output, especially under hot conditions. This study provides strategies to increase production, conserve energy, and reduce environmental impact.

2. Novelty Statement

This study brings a new perspective to optimizing the debutanizer column by focusing on seasonal challenges, particularly high temperatures, which often lower column performance. Unlike conventional approaches, this research uses Aspen HYSYS modelling to fine-tune the column’s operation to handle summer heat efficiently. The study highlights condenser adjustments that help maintain butane recovery even in hot

conditions. By pinpointing which variables most impact performance, this work offers practical improvements for LPG facilities in similar climates.

03.Introduction

Liquefied Petroleum Gas (LPG) is a widely used, cleaner-burning fuel important in homes, businesses, and industries. In natural gas processing, debutanizer columns separate lighter hydrocarbons like butane and propane, essential for LPG production. However, this process is energy-intensive and affected by conditions such as temperature, pressure, and flow rates, making it crucial to optimize these settings for better production and efficiency.

This study aims to improve debutanizer column performance, particularly in hot weather, to support more reliable LPG production. Using Aspen HYSYS software, the research investigates how temperature, pressure, flow rate, and reflux ratio adjustments impact butane separation. By focusing on these key variables, this study offers valuable guidelines for optimizing LPG production, especially in hot climates where efficiency is more challenging to maintain.

04. Methodology

A) Flow chart Feed

Debutanizer column

Recycle Bottom product

Air cooler

Debutanizer Reflux drum 7.1 bar , 64.9 C at top , 120C at bottom

Debutanizer Column Reboiler Reflux drum debutanizer Optimize

Condensation Pressure Max **plane System**

Top product

B) Salient Components of the flow diagram and adopted Standard testing methods.

01)debutanizer column: It separately Lighter Hydro Carbons from heavier one and It operates of it's own optimal Conditions like Temp, pressure and the topper section is less hot than lower Section for vaporization.

02) Air cooler : It is Essential in the summer seasons where the temperature is rise. And The cooling is Controlled by fan speed in air cooler

03) Reflux drum: Non-Condensable gases are removed through Reflux

drum **04) Condenser:** It cools the vapour

05) Reboiler : It Vaporize the Heavier hydro Carbons.

Testing method : ASPEN HYSYS method it mean Hyprotech System" Chemical process modelling & optimization This Software for Higher Calculations.

SENSITIVITY

To Set (or) Control the parameters in a particular range to obtain optimal product yield & purity like :

- feed Temperature: Higher for Improve butane recovery.

-feed flow: Increase feed flow can impact on purity.

-Reflux ratio: Higher reflux ratio improve separation

(C) Validation of model built.

-Compare with Actual parameters.

The Varying parameters like feed flow, Temperature, Pressure, reflux ratio, Concentrations. These parameters are Conforming How our model is working with the industrial machines more accuracy.

"How our equations of energy balance in between process and air balanced. It also describes how our energy is Conservative in those models"

Here we observe the good performance of model with the fixing of Temperature & pressure at it's optimal range to get good & pure yield. if we increaser(or) decrease then may be distraction.

D) How methodology enabled the researcher to plan and achieve The results

of the case study.

01) Parameters Sensitivity: The feed flow and Reflux ratio is most important parameters to achieve the good & pure product. by changing the feed flow (or) Reflux ratio make a change in butane Concentration and getting low desired purity levels.
02) Seasonal adaption of air Coolers: In Summer The Researchers to optimize the Condenser air cooler's performance. and By adjusting far Speed we Control air flow, vapour loss.

03) Butane Concentration: The final range of butane Concentration (0-70-0.74 mol fraction) was achieved by feed rate , temperature, pressure. Controlling of parameters like

04) In Real-world: These like fan speed for Cooling, practical results of Simulation and Sensitive analyses of parameters are implementable in real debutaniser System.

05. Results & Discussion

(A) Report of the most important information and data of the result

To enhance the LPG production with summer Operational Challenge some of the fixed parameters are:

1) Butane yield:

- Concentration is in b/w (070-0-74) mol fraction in top distillation stream.

- Ideal feed temperature above 120 degree C resulting in yield and purity and higher feed rates may reduce butane recovery.

- change in reboiler Temp & Reflux ratio may show mor impact on Separation of butane from

Higher hydro Carbons,

2)Seasonal Impact

- In summer season high temperature may reduced Condenser efficiency. **(B)**

Supplement the findings (data) with discussion ang Related hypothesis.

-Butane Recovery Optimization is the Concentration of around (0.70-0.74) mol fractions and feed temperature cross 120 C, to getting more yield.

-Adjusting the Reflux ratio impact on by enhancing liquid - Vapour butane Recovery Interactions.

2) Parameters:

-feed flow may be negative impact on the butane Recovery → Reboiler Temperature mainly impact on the efficient Separation.

3) Seasonal challenge:

-In Summer Season like Başra region there is low yield of butane because of higher temperature for optimal yield we of Air cooler

4) Environmental benefits : It also Reduced the energy Consumption. And By using of Air Cooler we will sent gas out which is nm-Condensable.

(C) Compare with Literature trends and literature hypothesis?

1) Butane yield vs Reflux ratio

-Increasing in reflux ratio improves separation efficiency This study supports a strong relation in between increased Reflux and higher butane purity

2) feed temperature process efficiency : the higher feed temperature reduce reboiler energy and more separation efficiency.

-By Optimaization feed temperature give optimal butane Recovery without requiring excusive reboiler beating.

5) Seasonal Operational Variability:

-The Butane Columns need precise condensate Control. in This case Air Cooler maintain the Condenser efficiency.

-The temperature & pressure controls are critical for operation -al Stability and product yeild in high temp Conditions.

(D) other interesting information.

1) Energy Saving : Optimizing the Reboiler and Condensers to get significant energy savings, It occurs mainly in summer season.

2) Environmental benefits: by optimising the cooler fan speeds there is sent out of the non Condensable gases.

-this hay environmental benefits reducing green house gases white improving process Sustainability

06. Conclusions & Future Work

This study optimized the debutanizer column to improve LPG production efficiency by adjusting operational variables like temperature, pressure, feed flow rate, and reflux ratio. Using Aspen HYSYS for simulations helped validate the model, with results aligning well with actual operational data. Key findings highlight the significance of feed flow rate and adjustments during hotter months to maximize butane yield and maintain process efficiency.

Future research could apply AI-based control methods to enhance process optimization and

environmental sustainability in LPG production. Exploring new heat exchange techniques and adjusting for different feed compositions could also lead to better performance and energy efficiency.

7. References

Abdullah, A.S., Ayoob, H.W., Homod, R.Z., & Mohammed, H.I. (2024). Enhancing liquefied petroleum gas production through debutanizer column optimization. *Chemical Engineering Research and Design.*