Global Journal of Engineering and Technology Advances

eISSN: 2582-5003

Cross Ref DOI: 10.30574/gjeta

Journal homepage: https://gjeta.com/

(Research Article)

Check for updates

Optimising the gas-oil ratio for enhanced production

Arinze JohnPaul Chukwu [1], Obumneme Okwonna [2] and Peter Muwarure [1, *]

[1] *Centre for Gas, Refining and Petrochemicals Engineering, University of Port Harcourt, Nigeria.*

[2] *Department of Chemical Engineering, University of Port Harcourt, Nigeria.*

Global Journal of Engineering and Technology Advances, 2025, 22(03), 131-142

Publication history: Received on 03 February 2025; revised on 12 March 20215 accepted on 14 March 2025

Article DOI: https://doi.org/10.30574/gjeta.2025.22.3.0052

Abstract

The Gas-Oil Ratio (GOR) in oil and gas production is the focus of this study. The objective of this research is to maximise the GOR in order to increase operational efficiency, reduce costs, and maximise resource utilisation. Under the conditions of the simulation, light crude oil was used, the API gravity was set to 17, the temperature was set to 66 °C, the pressure was set to 3447 kPa, and the feed flow rate was set to 37 kgmole/hr. Version 11 of Aspen HYSYS was used in order to carry out the simulation project. A three-phase separator was used for the goal of understanding how the GOR, flowrates, capital costs, and energy requirements are affected by the various High-Pressure (HP) gas pressures. The results suggested that there is a direct link between the pressure of the HP gas and the GOR, with a decrease in GOR being identified when the pressure of the HP gas that corresponded to it increased. The fact that there was a shift towards a production stream that was more liquid-rich was brought to light by this trend, which resulted in a decrease in both the amount of energy that was used and the amount of money that was spent on operational expenditures. After careful consideration, it was established that the best range for GOR is between 814.4 and 905.5. This range achieves a compromise between the efficiency of production and the management of costs. When it comes to the optimisation of manufacturing processes, the findings shed light on the usefulness of simulation tools such as Aspen HYSYS. The usual methods of GOR estimation are replaced by these technologies, which provide a reliable alternative.

Keywords: Gas-Oil Ratio (GOR); Oil and Gas Production; Aspen HYSYS; Optimum GOR; Cost management

1. Introduction

The oil and gas industry are usually divided into three major sectors based on functions and operations into: upstream, midstream, and downstream. In the upstream sector, the gas-oil ratio (GOR) is a key parameter used to evaluate reservoir performance and the composition of produced fluids. This showcases that the reservoir is an important consideration in gas-oil ratio optimization. Other associated facilities and activities that inform GOR optimization include drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, GOSP and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property [1].

Gas-Oil Ratio (GOR) is the ratio of the respective volumes of liberated gas and residual oil [2]. It is an important parameter for optimizing production efficiency and maximizing oil recovery in the quest to increase yield and revenue in the oil and gas industry. High Gas-Oil Ratio is an indication of the rise in gas output while a low Gas-Oil Ratio indicates a rise in oil output [3].

Simulators are particularly essential for modeling systems that are not yet in existence or would be expensive to “experiment” with, such as large-scale chemical processes [4]. Aspen HYSYS is the appropriate engineering tool because it has a wide spectrum of different applications [5]. Aspen HYSYS produces solutions much faster, making it possible to

* Corresponding author: Peter Muwarure.

deploy large, complex models in demanding situations such as online real-time optimization thus its application in this study so as to optimize gas-oil ratio for enhanced production in the oil and gas industry.

Over the last several years, there has been an increasing interest in the use of simulation tools, such as Aspen HYSYS, to maximize industrial processes in the oil and gas industry [5, 6, 7, 8]. According to Haydary [9], this may assist operators in making well-informed choices on the most effective ways to manage their production processes to optimize both efficiency and profitability. Aspen Plus (AP) is a software that will allow the user to build a process model and then simulate it using complex calculations (models, equations, math calculations, regressions, etc). Aspen HYSYS is more specialized for hydrocarbon systems and preferred in the oil and gas industry. Aspen Plus is considered to be a general -purpose tool thus applicable in chemical, polymer and other specialized chemical processes.

The purpose of this research is to investigate further on the use of Aspen HYSYS in optimizing GOR in the oil and gas industry. More specifically, the research will concentrate on a case study in which Aspen HYSYS was used to simulate and optimize GOR in a crude separation process (upstream operation). The findings of the study will provide significant insights into the advantages of using simulation tools for the purpose of improving GOR and will also contribute to the advancement of future research and practices within the industry.

2. Material and methods

2.1. Materials

The simulation software used in this study was Aspen HYSYS version 11, developed by Aspen Technology, Incorporation, Crosby Drive Bedford, Massachusetts, U.S.A. The data used for this study was obtained from the Usan FPSO terminal.

2.2. Research Method

In this section, we explored the sources and methods that aided in the completion of this research. First, data was generated using the Aspen inbuilt crude assay management tool. The crude oil used in the process has an API gravity of 17 (which signifies SG of 1.0337 and it is a light crude) The temperature of the feed stream is 66 ^{o}C, and the pressure is 3447 kPa. The feed streams' flow rate is 37 kgmole/h. Aspen HYSYS version 11 was used for the design simulation.

2.3. Model Development and Process Simulation Procedure

2.3.1. Process Simulation

In this experiment, a new case was started in the Aspen HYSYS simulation software. The petroleum assays folder in the navigation pane was clicked to access the assay management option. The assay management environment was preferred because it offered many advantages over the heritage oil manager approach. The crude information was manually specified in the assay management environment.

In the assay management environment, "assay components Celsius to 850 ^{O}C" was selected, which referred to the distillation range of the crude oil sample. The distillation process was carried out from the initial temperature of Celsius degrees up to 850^{o}C, which was the boiling point of the heaviest component in the sample. A new assay input window appeared, showing multi-cut, single-stream, and back-blending properties. The single-stream properties were selected, allowing the definition of the distillation percent and temperature of individual streams. The default name was retained, and the Peng Robinson fluid package was chosen automatically.

The distillation volume percentages and temperature were entered into the distillation table using the volumetric basis, as shown in Table 1. The "ok" button was clicked to proceed. At the input summary, the standard liquid density menu item was double-clicked, allowing for a change of units for the properties. API was selected as the unit, and the API of 17 for the whole crude was entered. In the next row, sulphur by wt of 2.1715% for the whole crude was also entered, and the cut yield volume was 100%.

To supply the Light ends data, the pure component tab was opened, and the information was entered as shown in Table 2. The "ok" button was clicked to proceed. Finally, the "Characterize Assay" button was clicked so that the assay could compute fully. This process resulted in the following: kinematic viscosity, paraffin, naphthene, olefins, aromatic, and vanadium content by volume (%) as shown in Table 3, pourpoint, freeze point, and cloud point.

The computed data from the assay characterization process provided essential information for designing and optimizing the process.

2.3.2. Modelling of HP separation of crude oil Process

Navigated to the petroleum assay folder and utilized the "Export" function to integrate the characterized fluid with a material stream within the simulation environment. Subsequently, a material stream labelled "Raw Crude" was created and the petroleum assay was attached to it by selecting the assay from the worksheet tab and clicking "attach existing." Then, the Raw Crude stream conditions were specified, including a temperature of 66.5°C, a pressure of 3447 kPa, and a flow rate of 37 kgmole/hr.

Another material stream was created to represent the gas portion of the production fluid, using the values provided in Table 2. This stream, named "Crude Gas," has a temperature of 66°C and a molar flow rate of 49.9 kgmole/hr, with methane, ethane, propane, i-butane, n-butane, and i-pentane as its constituent components.

A mixer component was selected to merge the crude oil and gas streams into a single stream, and the pressures of both streams were equalized. The resulting mixed stream was named "Well." Subsequently, this stream was directed through a valve into a three-phase separator (HP separator), yielding three separate streams: HP Gas, HP Liquid (oil), and HP Heavy (water).

The HP Gas stream underwent pressure adjustment to 2068 kPa at its inlet, leading to a pressure drop of 1379 kPa, which was observed up to the choke valve. The HP Gas stream then passed through a JT-Cooler with a pressure drop (deltaP) of 69 kPa, resulting in an outlet temperature of 26.67°C.

Following this, the HP Gas stream was subjected to another JT valve without a specified pressure drop, as it would be back calculated by downstream pressure. The outlet gas stream from this valve was set to 1724 kPa (250 Psia).

$$GOR = 1000000 \times (Gas\ flow\ )/(ideal\ liq.Vol\ flow) \qquad (1)$$

A logical operation spreadsheet was integrated into the flowsheet to compute the GOR of the production fluid. This spreadsheet utilized Equation (1), where the GOR was calculated as 1000000 times the gas flow divided by the ideal liquid volume flow. To ensure compatibility with the equation, the units were converted to English/imperial units (field units).

Table 1 Distillation volume percentage and temperature

Distillation (%)	**Temp. ^{o}C**
0	-12
4	32
9	74
14	116
20	154
30	224
40	273
50	327
60	393
70	450
78	490
80	516

Table 2 Hydrocarbon Components and Gas Portion Production Fluid

Light ends components in crude oil		**Gas portion of production fluid**	
Component	Volume (%)	Name	Crude Gas
Methane	0.007	Temperature	66°C
Ethane	0.023	Molar Flow	49.9kgmole.h
Propane	0.32	Component	Mole Fraction
i-Butane	0.24	Methane	0.8188
n-Butane	1.75	Ethane	0.0909
i-Pentane	1.65	Propane	0.0404
n-Pentane	2.25	i-Butane	0.0145
		n-Butane	0.0152
		i-Pentane	0.0202

2.3.3. Process Optimisation

One of the biggest challenges the production industry faces in terms of enhancing efficiency is the optimization of the GOR, as Sleiti et al [10] mentioned. According to Makinde [2] definition, GOR is the ratio between the amount of gas produced and the volume of oil generated in a reservoir. After the model of the crude oil stabilization had been simulated, the optimization was carried out with the optimizer tool of the same Aspen HYSYS version 11 used for the model development. The essence of the optimization was to determine the best production and cost-effectiveness of the process. The spreads According to Calderón and Pekney [3], a greater GOR may result in a rise in gas output, which can then be sold at a higher price on the market, while having a lower GOR, on the other hand, might lead to a larger output of oil, which is often more valuable than gas. This implies that GOR optimization is a process that depends on the specific objectives and conditions of the petroleum production operation since GOR optimization could be made to favour the production of gas or oil.

The formula used in the GOR (Equation 1) calculation requires using English/Imperial units. Ten points of varying HP Gas pressures (100, 150, 200, 250, 300, 350, 400, 450, 500, 550) psia were selected to determine the corresponding GOR, flowrate, cost (capital and utility), and energy requirement for the system. The original HP gas pressure for the system was 300psia. There was a need to check the effect of pressure below and after the specified value of 300psia.

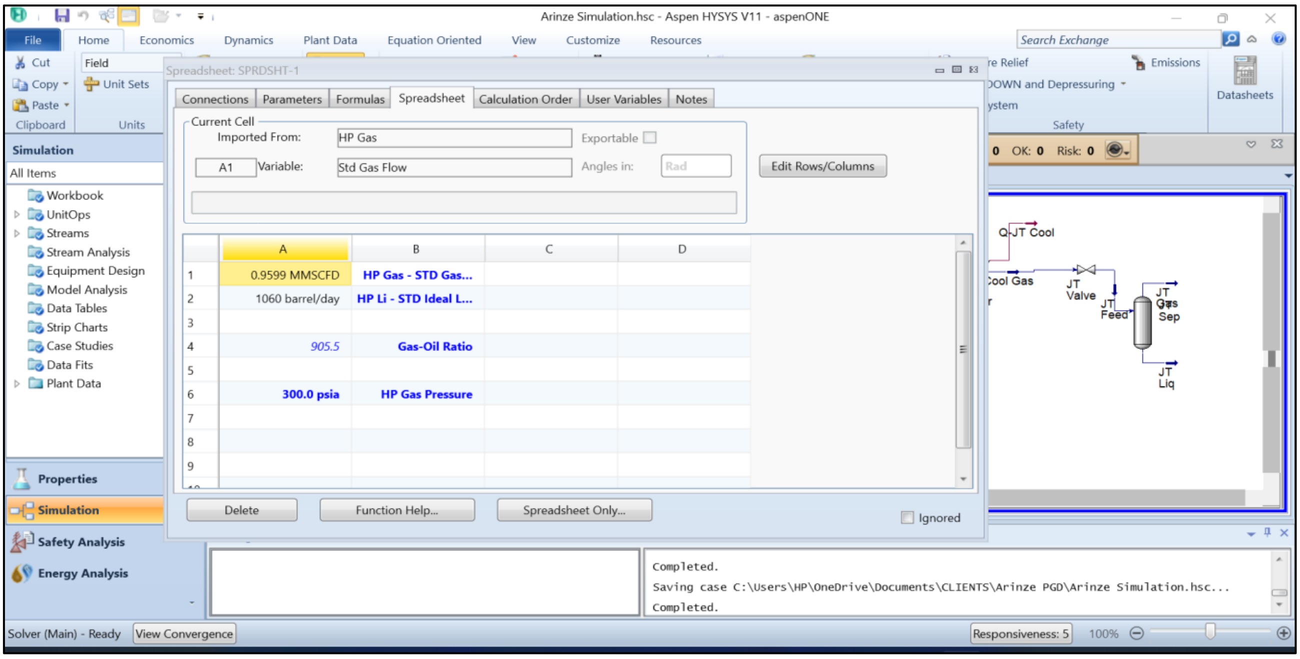

Figure 1 Aspen HYSYS Spreadsheet Analyser

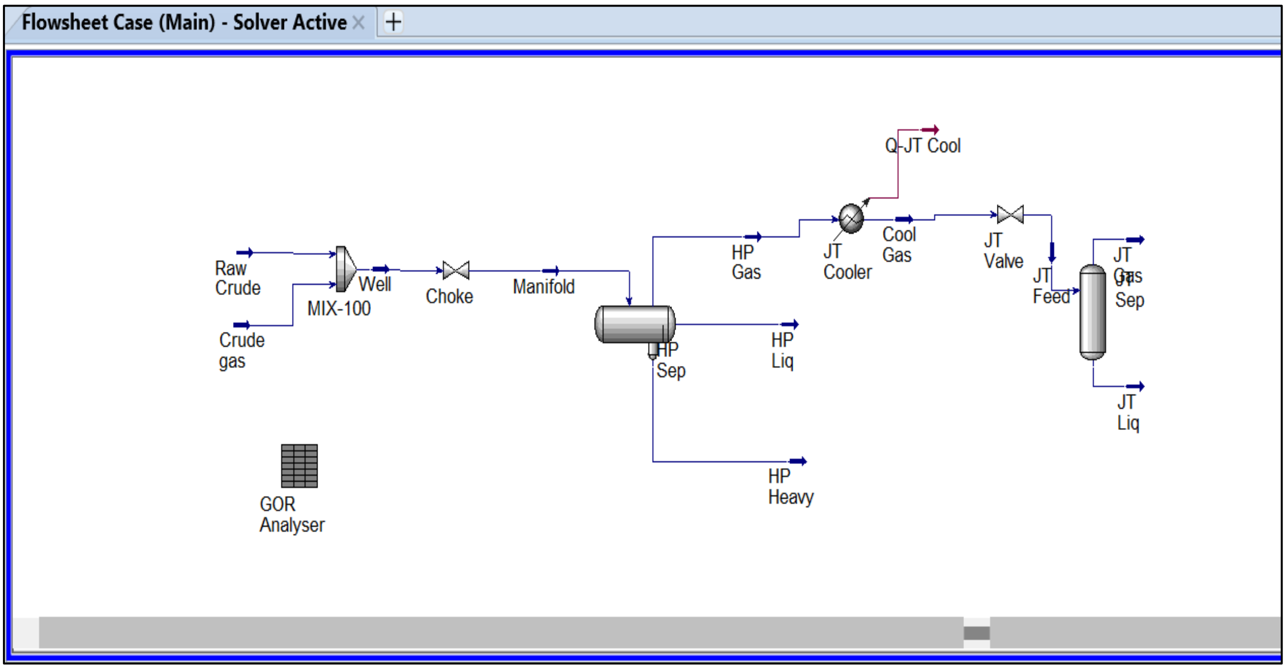

Figure 2 Complete process flow model for GOR determination and optimisation

3. Result and discussion

The following results were obtained from the basic model and the optimised model using the Aspen HYSYS software. All the analyses were done using the software in addition to Microsoft Excel.

3.1. Petroleum Product Characteristics Data

Table 3 presents a comprehensive dataset of essential oil characteristics crucial in determining the quality and behaviour of crude oil. The yield, with a cut yield by weight of 99.99999999%, reflects the efficiency of modern refining techniques. The crude oil's standard liquid density, measured at 16.99482086 API, indicates its relatively light nature, which is important for various downstream applications. The sulphur content, measured at 2.715%, falls within the expected range for crude oil sources, indicating its environmental impact and suitability for refining processes. The kinematic viscosity at 100.4°F, measured at 1.71299923 cSt, aligns with anticipated values for light to medium crude oils, with implications for flow behaviour and transportation. The compositional breakdown, which includes paraffins, naphthene, olefins, and aromatics, along with parameters such as pour point, freeze point, and cloud point, provides valuable insights into the crude oil's properties and suitability for various refining processes. Impurities, including nitrogen, vanadium, and Conradson carbon residue, fall within customary ranges for crude oil, (0.1% to 0.9%,) indicating potential refining challenges and downstream implications [11]. Lastly, the clear octane ratings, portraying 130.1510043 for RON and 111.6027616 for MON, adhere to industry standards, signifying the fuel's performance attributes and potential applications.

Table 3 Oil characteristics data

Parameter	Values
Std Liquid Density (API)	16.99482086
Sulphur ByWt (%)	2.715
kinematic viscosity (cSt)@ 100.4 (F)	1.71299923
Paraffins By Vol (%)	9.719354223
Naphthene ByVol (%)	9.161177903
Aromatic ByVol (%)	81.11946787
Pour Point (F)	260.4285044
Freeze Point (F)	-24.09764016
Cloud Point (F)	-24.66310625
Smoke Pt (ft)	4.98E-06
Conradson Carbon ByWt (%)	3.483427
RON Clear	130.1510043
MON Clear	111.6027616

3.2. Effect of the high-pressure (HP) gas stream on flowrate

Figure 3 provides a comprehensive dataset detailing the relationship between High Pressure (HP) gas pressure, HP gas flow rate, and HP liquid flow rate. As the HP gas pressure increases from 100 to 550 psig, the HP gas flowrate decreases steadily from 115.60 to 98.33 lbmole/hr, while the HP liquid flowrate exhibits a slight increase from 75.98 to 93.25 lbmole/hr. This trend reflects the dynamic interplay between gas and liquid phases within the reservoir and the production system, with variations in pressure impacting the relative quantities of gas and liquid produced [12]. The gradual decrease in gas flow rate underscores the diminishing availability of gas as reservoir pressure decreases, potentially necessitating adjustments in production strategies to maintain optimal production rates [13]. Overall, the findings insights into the dynamic behaviour of oil and gas production systems under varying pressure conditions, highlighting the importance of optimizing production strategies to maximize operational efficiency in the oil and gas industry.

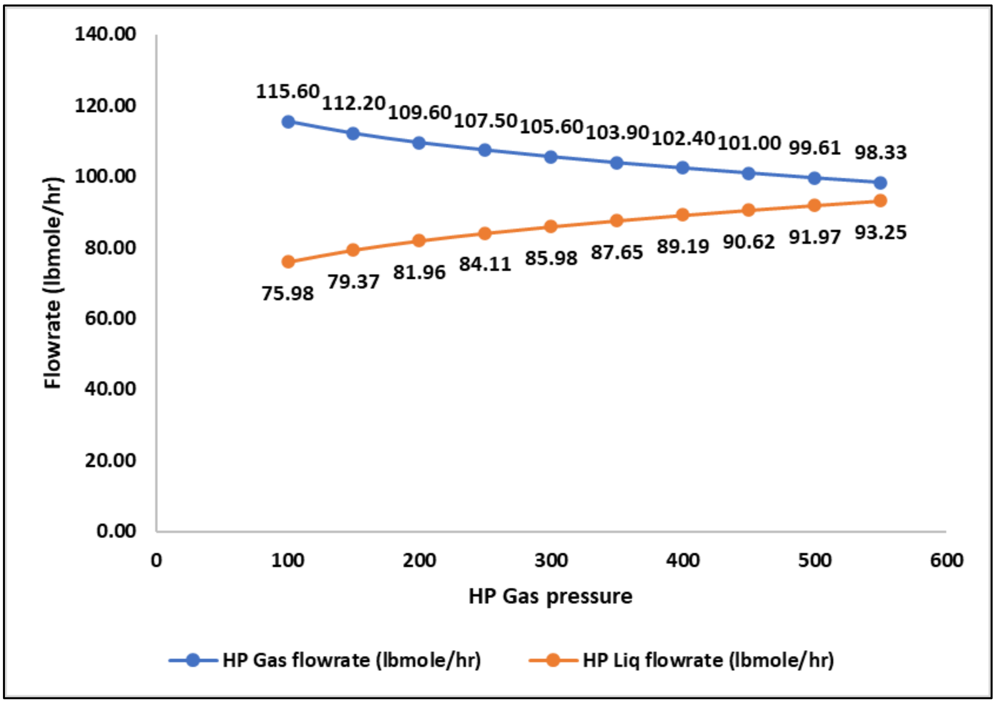

Figure 3 Effect of HP Gas pressure on the flowrates

3.3. Effect of HP gas stream on the GOR

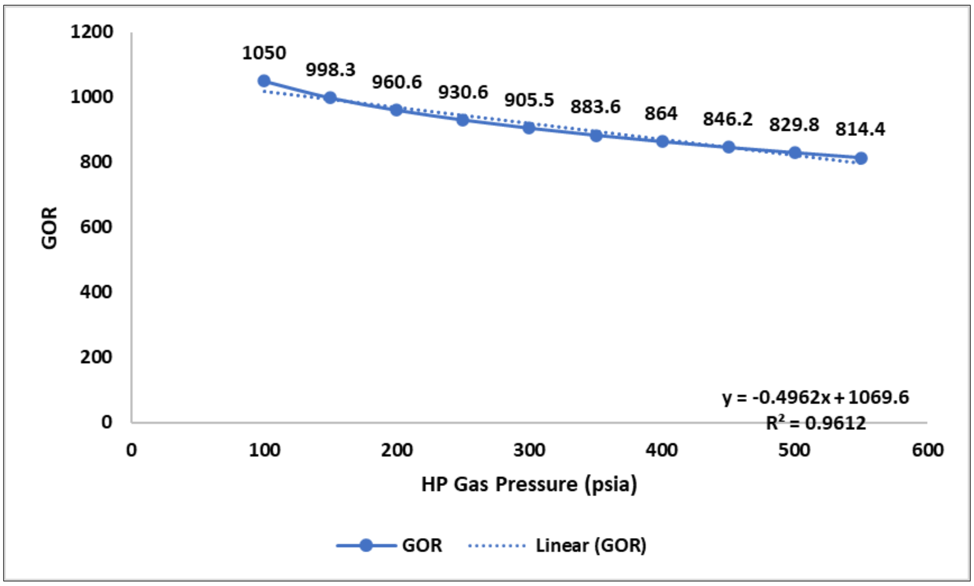

Figure 4 Effect of HP Gas pressure on the Gas Oil ratio

Figure 4 presents data on High Pressure (HP) gas pressure and the corresponding GOR. As the HP gas pressure increases from 100 to 550 psig, there is a noticeable decrease in the GOR, with values declining from 1050 to 814.4. This inverse relationship between gas pressure and GOR is consistent with typical observations in oil and gas reservoirs, where increasing pressure often results in lower gas-to-oil ratios [2]. The decreasing trend in GOR suggests a shift towards a more liquid-rich production stream as pressure increases, which may have implications for downstream processing and utilization strategies [13]. The data underscores the dynamic nature of oil and gas production systems, with variations in pressure influencing the relative quantities of gas and oil produced [12]. Additionally, the declining GOR highlights the diminishing availability of gas as reservoir pressure decreases, necessitating adjustments in production strategies to optimize resource recovery [14]. Overall, the findings from the Figure 4 provide valuable insights into the relationship between gas pressure and GOR, emphasizing the importance of optimizing production strategies to maximize operational efficiency and resource utilization in the oil and gas industry.

3.4. GOR and capital cost of the plant

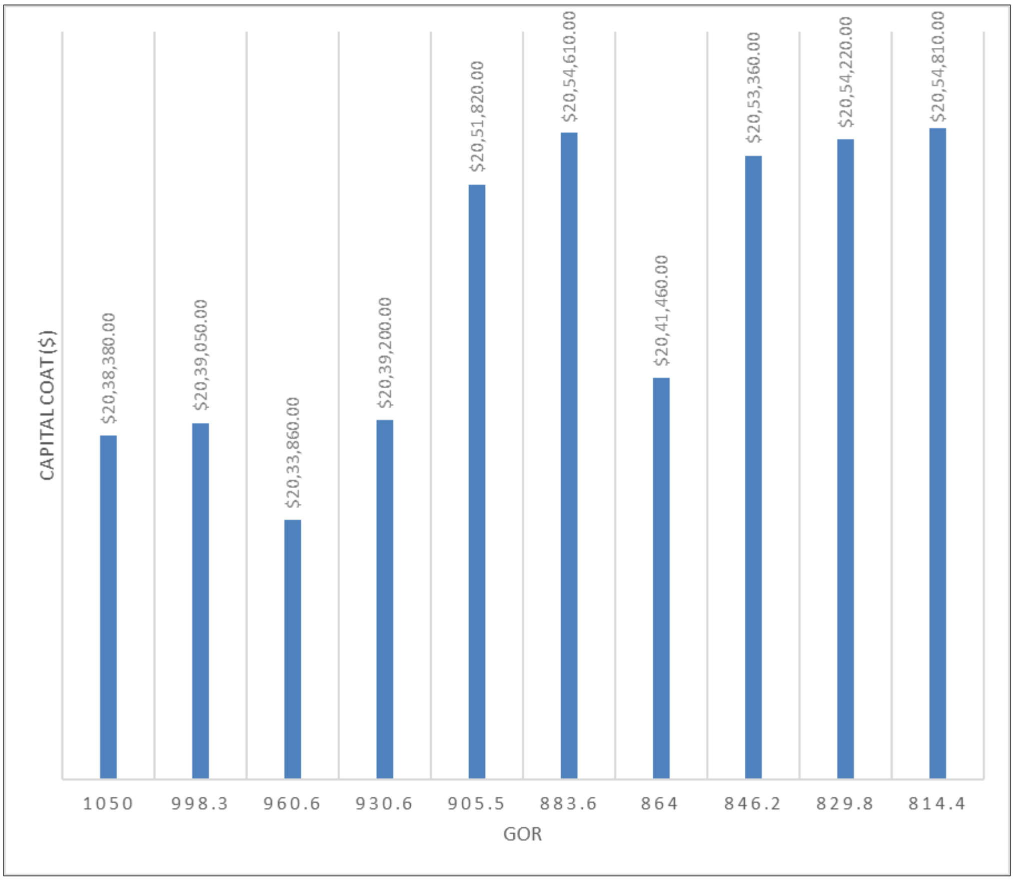

Figure 5 GOR and their corresponding capital costs

The provided data showcases the relationship between GOR and associated capital expenditures. As the GOR decreases from 1050 to 814.4, there is a trend of fluctuating capital expenditures. While the GOR declines, the capital expenditure values vary, indicating potential complexities in the relationship between GOR and investment requirements within the oil and gas industry. This observation aligns with the dynamic nature of oil and gas production systems, where factors such as reservoir characteristics, operational efficiency, and market conditions can influence capital investment decisions. The data underscores the importance of optimizing production strategies and resource utilization to achieve desired GOR targets while effectively managing capital expenditures. This holistic approach is essential for enhancing operational efficiency and maximizing returns in oil and gas production operations.

3.5. GOR and flowrates

The Figure 6 illustrates the impact of GOR on the rates of oil and gas streams. As GOR decreases from 1050 to 814.4, a consistent trend is observed in both the high-pressure (HP) gas flowrate and the HP liquid flowrate. Specifically, as GOR decreases, the HP gas flowrate gradually decreases from 115.60 lbmole/hr to 98.33 lbmole/hr, while the HP liquid flowrate increases slightly from 75.98 lbmole/hr to 93.25 lbmole/hr. Relating this data it is inferred that a clear relationship between GOR and the rates of oil and gas production occurs. As GOR decreases, indicating a higher proportion of liquid to gas in the production stream, we observe a decrease in the rate of gas production and a slight increase in the rate of liquid production.

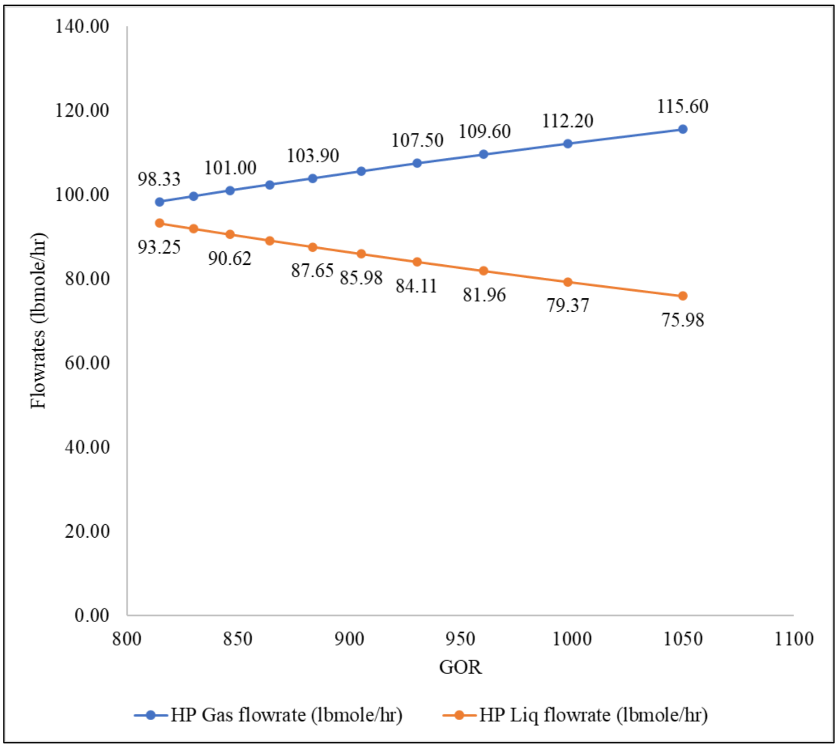

Figure 6 Effect of GOR on the rates of Oil and Gas streams

3.6. Energy requirement for various GOR, HP Gas and flowrates

Table 4 Energy Requirement for GOR, HP Gas and Oil flowrate and Capital Expenditure

HP Gas pressure (psia)	GOR	HP Gas flowrate (lbmole/hr)	HP Oil flowrate (lbmole/hr)	Capital	Energy (Btu/hr)
100	1050	115.60	75.98	$2,038,380.00	89,321.22
150	998.3	112.20	79.37	$2,039,050.00	92,254.02
200	960.6	109.60	81.96	$2,033,860.00	93,618.73
250	930.6	107.50	84.11	$2,039,200.00	94,311.35
300	905.5	105.60	85.98	$2,051,820.00	94,670.67
350	883.6	103.90	87.65	$2,054,610.00	94,853.31
400	864	102.40	89.19	$2,041,460.00	94,939.65
450	846.2	101.00	90.62	$2,053,360.00	94,973.49
500	829.8	99.61	91.97	$2,054,220.00	94,979.58
550	814.4	98.33	93.25	$2,054,810.00	94,972.14

Table 4 provides a comprehensive overview of the energy requirements associated with Gas-Oil Ratio (GOR), High-Pressure (HP) Gas and Oil flowrates, and capital expenditure across varying HP gas pressures. As the HP gas pressure increases from 100 to 550 psia, there is a corresponding decrease in GOR from 1050 to 814.4, indicative of a shift towards a more liquid-rich production stream. Concurrently, the HP gas flowrate shows a steady decline from 115.60 to 98.33 lbmole/hr, while the HP oil flowrate experiences a slight increase from 75.98 to 93.25 lbmole/hr. These changes in flowrates reflect the dynamic interplay between gas and liquid phases within the production system, influenced by variations in HP gas pressure. Moreover, the capital expenditure associated with each scenario ranges from $2,038,380.00 to $2,054,810.00, reflecting the investment required to maintain production efficiency at different pressure levels. The corresponding energy requirements, ranging from 89,321.22 to 94,979.58 Btu/hr, underscore the energy-intensive nature of oil and gas production operations. Overall, the data presented in Table 4 highlights the intricate relationship between GOR, HP gas and oil flowrates, capital expenditure, and energy requirements, providing valuable insights into the optimization of production strategies and resource utilization in the oil and gas industry.

3.7. Validation of findings

The findings presented in Table 3 regarding petroleum product characteristics align with the literature, reflecting typical properties of crude oil essential for understanding its behaviour and suitability for refining processes [5]. The observed trends in Figure 3 regarding the effect of high-pressure (HP) gas stream on flowrates are consistent with previous studies, indicating the dynamic interplay between gas pressure and the rates of gas and liquid production [12, 13]. Furthermore, the inverse relationship between HP gas pressure and Gas-Oil Ratio (GOR) presented in Figure 4 corresponds with established patterns in oil and gas reservoirs, emphasizing the importance of pressure management for optimizing production strategies [2, 12, 14]. The discussion on the capital cost of the plant and its relationship with GOR underscores the complexities inherent in oil and gas production systems, echoing the need for strategic investment decisions to maximize operational efficiency [15, 16]. Additionally, the insights from Figure 4 regarding GOR and flowrate trends corroborate previous research, highlighting the impact of GOR on oil and gas production rates [12, 13].

The findings in Table 4 align with insights from literature, confirming the complex dynamics of oil and gas production. The observed decrease in Gas-Oil Ratio (GOR) with increasing High-Pressure (HP) gas pressure corresponds to a shift towards a more liquid-rich production stream, validated by studies such as Olugbenga et al. [5], emphasizing the impact of gas pressure variations on separation processes. Additionally, the decline in HP gas flowrate and slight increase in HP oil flowrate with rising HP gas pressure mirror optimization efforts demonstrated in literature, as highlighted by AL-Dogail et al. [8] , suggesting that operational parameters like separator pressures can influence flow rates. The range of capital expenditures associated with different HP gas pressures underscores the financial implications of optimizing production strategies, supported by economic considerations in the literature, such as Giwa et al. [16]. Furthermore, the energy requirements in Table 4 emphasize the energy-intensive nature of oil and gas production operations, aligning with discussions on optimizing energy consumption to enhance operational efficiency, as discussed by KAMIŞLI & AHMED [15].

3.8. Optimum GOR

From the given dataset, we can observe variations in Gas-Oil Ratio (GOR) alongside changes in HP gas pressure, gas flow rate, liquid flow rate, capital expenditure, energy consumption, and utilities cost. The optimum GOR can be inferred from a combination of factors, including maximizing gas and liquid production while minimizing operational costs and energy consumption. The data shows that the GOR ranges from 814.4 to 1050 across different HP gas pressures. However, we notice that there are corresponding decreases in capital expenditure, energy consumption, and utility costs at specific HP gas pressures. For instance, at 300 psia, the GOR is 905.5, and the energy consumption is at a relatively lower value of 94,670.67 Btu/hr compared to adjacent data points, with a capital cost of $2,051,820. Similarly, at 550 psi, the GOR decreases to 814.4, accompanied by a decrease in utility cost, with a corresponding capital cost of $2,054,810. The trend suggests that as the GOR decreases within a specific range, there is a corresponding decrease in operational costs and energy consumption. This indicates that the system operates more efficiently with a lower GOR within this range. Therefore, based on the data provided, the optimum GOR appears to be within the range of 814.4 to 905.5, where the system achieves a balance between maximizing gas and liquid production while minimizing operational costs and energy consumption.

4. Conclusion

The optimization of GOR is pivotal in maximizing oil and gas production efficiency while minimizing operational costs. The results of this study show that adjusting HP gas pressure significantly impacts GOR, flowrates, capital expenditures, and energy requirements. A lower GOR was found to align with improved liquid production, reduced energy consumption, and optimized operational costs. The research established the reliability of simulation tools like Aspen HYSYS in providing accurate and efficient GOR estimations, eliminating the inaccuracies of traditional methods. Overall, the study demonstrates that the optimum GOR range of 814.4 to 905.5 enables enhanced operational performance, balancing production efficiency with cost and energy management.

Compliance with ethical standards

Acknowledgments

I would like to acknowledge the Department of Chemical Engineering and the Centre for Gas, Refining and Petrochemicals Engineering, University of Port Harcourt, Nigeria, for their support during the course of this research.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Saikia B, Gori S, Trapa MA, Torres MA. Regulatory regime in fixing risk accountability of inland oil and gas exploration and production industry in India. Proceedings of the International Academy of Ecology and Environmental Sciences. 2024; 14(1):1-1. Available from: http://www.iaees.org/publications/journals/piaees/articles/2024-14(1)/risk-accountability-of-inland-oil.pdf

[2] Makinde I. A Simulation Study of the Factors that Impact Gas-Oil Ratio (GOR) Behavior in Liquid-Rich Shale (LRS) Reservoirs. Global Journal of Researches in Engineering [Internet]. 2017 Sep 9; Available from: https://engineeringresearch.org/index.php/GJRE/article/download/1631/1562.

[3] Calderón AJ, Pekney NJ. Optimization of enhanced oil recovery operations in unconventional reservoirs. Applied Energy [Internet]. 2019 Nov 22; 258:114072. Available from: https://doi.org/10.1016/j.apenergy.2019.114072

[4] Eze HU, Otaraku IJ, Muwarure PO. Optimization of the ABB Randall process of NGL recovery. World Journal of Advanced Engineering Technology and Sciences [Internet]. 2023 Nov 25;10(2):051–7. Available from: https://doi.org/10.30574/wjaets.2023.10.2.0287

[5] Olugbenga AG, Al-Mhanna NM, Yahya MD, Afolabi EA, Ola MK. Validation of the molar flow rates of oil and gas in Three-Phase separators using Aspen HYSYS. Processes [Internet]. 2021 Feb 10; 9(2):327. Available from: https://doi.org/10.3390/pr9020327

[6] Al-Ali H. Process simulation for crude oil stabilization by using Aspen Hysys. Upstream Oil and Gas Technology [Internet]. 2021 Apr 15; 7:100039. Available from: https://doi.org/10.1016/j.upstre.2021.100039

[7] Nath SR. Separation Train Design and Optimaztion in Offshore Oil and Gas Production Facilities [Internet]. 2022; Available from: https://projekter.aau.dk/projekter/files/485887410/Simulation_Train_Design_and_Optimization_in_Offshore_Oil_and_Gas_Production_Facilities.pdf

[8] Al-Dogail A, Gajbhiye R, Al-Shammari H, Alnaser M, Kamerkar T. Maximization of Gas-Oil separation plant oil recovery by operation parameter optimization. SPE Production & Operations [Internet]. 2023 Jun 23; 38(04):666–77. Available from: https://doi.org/10.2118/215826-pa

[9] Haydary J. Chemical Process design and simulation: Aspen Plus and Aspen HySys applications [Internet]. 2019; Available from: https://openlibrary.org/books/OL29368081M/Chemical_Process_Design_and_Simulation

[10] Sleiti AK, Al-Ammari WA, Abdelrazeq M, El-Naas M, Rahman MA, Barooah A, et al. Comprehensive assessment and evaluation of correlations for gas-oil ratio, oil formation volume factor, gas viscosity, and gas density utilized in gas kick detection. Journal of Petroleum Science and Engineering [Internet]. 2021 Jun 24; 207:109135. Available from: https://doi.org/10.1016/j.petrol.2021.109135

[11] Choudhury SP, Haq I, Kalamdhad AS. Unleashing synergistic potential of microbially enhanced anaerobic co-digestion of petroleum refinery biosludge and yard waste: Impact of nutrient balance and microbial diversity. Journal of Hazardous Materials [Internet]. 2023 Aug 22; 460:132361. Available from: https://doi.org/10.1016/j.jhazmat.2023.132361

[12] Elfeel MA, Ali S, Giddins MA. Efficient Optimization of Field Management Strategies in Reservoir Simulation. In SPE Reservoir Characterisation and Simulation Conference and Exhibition [Internet]. 2019 Sep 10; Available from: https://doi.org/10.2118/196662-ms

[13] Maduabuchi IP, Chinedu M. EFFECT OF INITIAL GAS OIL RATIO, PRODUCED GAS RE-INJECTION AND FORMATION COMPRESSIBILITY ON PREDICTED PRODUCTION PERFORMANCE OF A DEPLETION DRIVE RESERVOIR. Petroleum & Coal. 2019 Jan 1; 61(1).

[14] Nguyen TV, Barbosa YM, Da Silva JAM, De Oliveira S Junior. A novel methodology for the design and optimisation of oil and gas offshore platforms. Energy [Internet]. 2019 Jun 29; 185:158–75. Available from: https://doi.org/10.1016/j.energy.2019.06.164

[15] Kamışlı F, Ahmed AA. Simulation and optimization of a crude oil distillation unit [Internet]. 2019; Available from: https://dergipark.org.tr/en/pub/tjst/issue/48762/539382

[16] Giwa A, Asiwaju OA, Olusojiowolabi J, Olateju II. Modelling and economic analysis of a crude oil distillation system using Aspen HYSYS. | EBSCOHost [Internet]. 2021; Available from: https://openurl.ebsco.com/EPDB%3Agcd%3A6%3A22094102/detailv2?sid=ebsco%3Aplink%3Ascholar&id=ebsco%3Agcd%3A160600874&crl=c&link_origin=scholar.google.com