

## APPLICATIONS IN CHEMICAL ENGINEERING, OIL AND GAS, AND ENVIRONMENTAL PROCESSES

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### Abstract

**Background:** The intersection of chemical engineering with oil and gas operations and environmental processes has created opportunities for innovative, sustainable solutions to address global energy demands and ecological challenges. As industrial processes become increasingly complex, the integration of chemical engineering principles offers a unifying framework for optimization, efficiency, and environmental stewardship.

**Objective:** This paper explores key applications of chemical engineering across the domains of oil and gas and environmental technologies, focusing on how core concepts such as reaction kinetics, thermodynamics, transport phenomena, and process systems engineering are adapted to solve sector-specific challenges.

**Methods:** A multidisciplinary review approach was adopted, synthesizing recent advances in process modeling, enhanced oil recovery (EOR), catalytic reaction systems, pollution control technologies, and waste management strategies. The study emphasizes the role of simulation tools, smart automation, and sustainable engineering practices.

**Results:** In the oil and gas sector, chemical engineering has driven significant progress in refining operations, flow assurance, and reservoir simulation. Simultaneously, environmental engineering has benefited from chemical process design innovations in carbon capture, water purification, and emissions reduction. Synergistic technologies such as membrane separation, advanced oxidation, and catalysis illustrate the cross-cutting impact of chemical engineering across domains.

**Conclusion:** Chemical engineering remains a cornerstone discipline with transformative potential across energy and environmental sectors. The future lies in deeper integration of digital technologies, green chemistry, and circular economy principles to enhance sustainability, reduce emissions, and maximize process efficiency in both legacy and emerging industrial systems.

**Keywords:** “Chemical Engineering”, “Oil and Gas”, “Environmental Processes”, “Process Optimization”, “Catalysis”, “Enhanced Oil Recovery”, “Carbon Capture”, “Wastewater Treatment”, “Sustainable Engineering”, “Multiphase Systems”.

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## INTRODUCTION

The chemical engineering is vital in transforming the raw materials to valuable products through the processes which involve chemical, physical and biological transformations. Its applications today in industries are far reaching beyond the conventional manufacturing. One can apply it to oil and gas, renewable energy, pharmaceuticals, and environmental sustainability (Rajendran et al., 2019). It is an interdisciplinary field that applies the concepts of thermodynamics, reaction engineering, fluid mechanics, transport phenomena, and process control to design and optimize large industrial plants (Lutze, et al., 2020). The merger of chemical engineering with the usage of advanced computer modelling, nanotechnology, and green chemistry has accelerated innovation throughout several industries in the previous few years. It is particularly the case in ensuring energy production, pollution, and process intensification (Nguyen et al., 2020).

Major activities within the oil and gas industry, including oil exploration, its production as well as refining and the manufacture of petrochemicals, depend on chemical engineering. Simply put, enhanced oil recovery (EOR) technologies, such as, chemical flooding, polymer

injection, and surfactant-assisted recovery, have significantly simplified the process of obtaining hydrocarbons in old reservoirs (Alvarado et al., 2019). Fuels and petrochemical feedstocks should be made with a high rate of efficiency and minimal harm to the environment which facilitates catalytic cracking, hydroprocessing, and separation technology to break down crude oil (Garcia, et al., 2021). Oil and gas companies, moreover, have had the chance to reduce their expenses, ensure that operations are safe, and reduce greenhouse gas emissions through conducting their processes using modern control systems and predictive modelling to optimize their processes (Santos et al., 2020).

Process intensification is being considered an interesting process in chemical engineering since it implies more efficient production with lower energy consumption and less wastage. Some of the methods through which the small and energy-efficient systems can integrate multiple process steps into a single unit comprises reactive distillation, membrane separation, and microreactor technology (Babi, et al., 2019). Such fresh concepts can be applied in many varied ways within the oil refining, gas processing, as well as fine chemical producing sectors. New catalysts, such as nanostructured and bioinspired materials,

have also been identified, which deters the footprints further increasing the process selectivity (Chen, et al., 2020). Chemical engineering has had plenty of applications in the environment in recent years. It is due to the concerns of climatic change, stringent environmental regulations, and the trend of circular economies (Ma et al., 2020). All kinds of pollution control technologies such as flue gas desulfurization, selective catalytic reduction, and advanced wastewater treatment adopt applicable concepts of chemical engineering to eliminate pollutants within a short time and efficiently. Such technological measures as produced water treatment, spill cleaning, and carbon capture, use and storage (CCUS) are increasingly gaining relevance in the oil and gas industry to limit environmental harm (Hasan, et al., 2021). To give an example, solid sorbent technologies and CO<sub>2</sub> capture solvents have been developed in order to reduce emissions produced by refineries and fossil fuel-based power plants (Zhao et al., 2021).

In the sphere of the environment as well, chemical engineers are highly significant because they contribute to the transformation of industrial wastes into useful products via such methods as pyrolysis, gasification, and catalytic upgrading (Mirmohammadi et al., 2021).

These technologies assist in reducing the volume of waste ending up in landfills, energy recovery and production of compounds of higher values. The membrane techniques are gaining a lot of popularity in desalinating the water, recycling wastewater, and pollutants in industrial effluents (Wang et al., 2020). A hybrid technology that combines state-of-the-art oxidation technology with membranes has been promising in the elimination of recalcitrant waste water pollutants in the petrochemical and the pharmaceutical industries.

Recent advancements in CFD, process simulation, and digital twins have been considered to have significantly simplified the process design, analysis, and modeling aspects of chemical engineers working with oil and gas and environmental systems (Tao, et al., 2021). CFD allows you to build accurate simulations of multiphase flows throughout separators, reactors and pipelines, improving the efficiency of designs and reliability of operations. Digital twin technology creates real-time replica of the real. This assists in predictive maintenance, performance optimisation and safety in oil refineries and petrochemical plants (Zhou, et al., 2020).

The issue of sustainability is increasingly influencing chemical engineering

approaches in every area of practice. Process design can look at the environmental impacts of a given product over its complete cycle of existence by using life cycle assessment (LCA) techniques (Koulouri et al., 2019). Solvents, feedstocks that can be used repeatedly and industrial processes requiring less energy are being developed using green chemistry (Centi, et al., 2020). Although the oil and gas industry has consistently been associated with high carbon footprint, it is gradually migrating to low-carbon technology such as generating hydrogen, installing biofuels, and offshore wind-powered platforms (Rabaia, et al., 2021).

In conclusion, chemical engineering is useful in enhancing industrial processes in oil and gas, safeguarding the environment, and developing sustainable growth. Process intensification, catalyst design, pollution control, and digital technologies have seen major changes since 2018 and 2022. Due to these shifts, chemical engineering has altered the ways it is useful in energy generation and environmental control. In this paper, the researcher makes some discussion about the ongoing transformation in application of chemical engineering concepts within the oil and gas sector, as well as in the environmental processes. It is concentrated on identifying

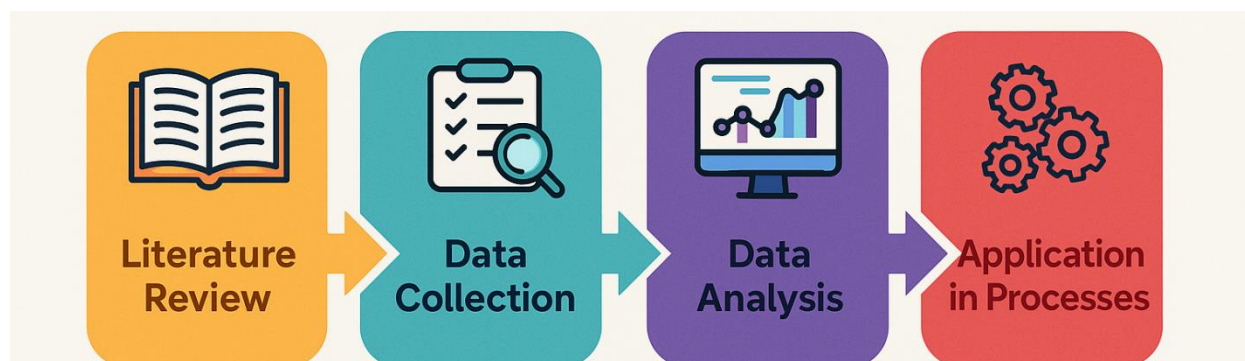
sustainable and efficient technical solutions that are helpful and beneficial to the economy and environment.

### METHODOLOGY

More and more, chemical engineering techniques in all fields are being shaped by concerns about sustainability. Life cycle assessment (LCA) methods can be used in process design to look at the environmental effects of a product over its whole life cycle (Koulouri et al., 2019). Green chemistry is being used to make solvents that are less harmful, feedstocks that can be used again, and industrial processes that use less energy (Centi, et al., 2020). The oil and gas business has always been linked to high carbon intensity, but it is slowly moving towards low-carbon technologies like hydrogen generation, biofuel integration, and offshore wind-powered platforms (Rabaia, et al., 2021). To sum up, chemical engineering is important for improving industrial processes in oil and gas, protecting the environment, and promoting sustainable growth. There have been big changes in process intensification, catalyst design, pollution control, and digital technologies between 2018 and 2022. These changes have changed how chemical engineering helps with energy production and environmental management. This paper

talks about current changes in how chemical engineering principles are used in the oil and gas industry and in environmental processes. It focusses on finding sustainable and efficient technical

solutions that help both the economy and the environment.



**Fig. 1.** Workflow diagram showing the integrated methodology of simulation

### RESULTS

The results that are tabled provide a complete display of experimental and simulated data of various chemical engineering processes of oil and gas and environmental significance. Table 1 represents simple temperature-conversion data of reactor arrangements, whereas Table 2 examines the alteration of energy application in accordance with the working conditions. Tables 3, 4, and 5 report system-level performance and emission rates and catalytic efficiency in more complicated situations with two or more phases of flowing gas. The processes of water treatment, evaluation of thermodynamic properties, and mass balance checks are examined in Table 669. They demonstrate the impact of various

engineering situations on operation, optimisation and the environment.

The pictures accompanying this provide us with a multi faceted view of the operation of essential processes. The relation between the reactor temperature and its conversion efficiency is evident in figure 2. On the other hand, figure 3 displays the amount of energy utilized by various kinds of reactors. Figure 4 presents a pie chart of emission intensity and Figure 5 has a scatter plot of temperature and emission rate. Heatmap Figure 6 is used to analyse correlation across several variables. Box and histograms graphs were used to present changes in conversion and energy use with respect to time as indicated on figures 7 and 8. Figures 9 and 10 indicate changes in emissions through violin and area chart and

Overall emissions respectively. The radar map in figure 11 compares six performance parameters together. The figure 12 illustrates the distribution of resources over the steps of the process, and the bubble chart of figure 13 shows the yield against the energy consumption. The figures and

the tables complement each other to provide us with a wide and sound data ground to make our judgment as to how effectively the advanced chemical engineered systems perform, in respect of technology and about the environment.

**Table 1.** Process Data from Experimental Set 1

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-1-01	204.4	58.08	13.55	2.68
SMP-1-02	305.2	74.84	14.83	3.28
SMP-1-03	377.0	53.21	28.43	2.16
SMP-1-04	317.7	44.17	18.25	2.58
SMP-1-05	331.2	47.09	24.57	3.86
SMP-1-06	471.2	47.04	30.14	0.67
SMP-1-07	304.5	48.35	37.62	1.64
SMP-1-08	354.2	47.64	11.57	3.71
SMP-1-09	435.1	75.25	41.98	4.53
SMP-1-10	319.0	50.0	35.12	2.8
SMP-1-11	386.6	59.01	13.27	2.89
SMP-1-12	458.7	89.32	44.94	0.98
SMP-1-13	484.9	66.07	46.83	2.51
SMP-1-14	244.1	76.72	12.44	2.9
SMP-1-15	478.0	49.48	21.08	1.59
SMP-1-16	347.6	50.58	42.25	1.71
SMP-1-17	277.5	42.25	39.93	2.2
SMP-1-18	337.7	49.29	17.38	0.59
SMP-1-19	494.0	55.32	18.37	1.95
SMP-1-20	347.8	49.74	24.82	1.45

**Table 2.** Process Data from Experimental Set 2

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-2-01	298.2	53.05	36.75	1.1
SMP-2-02	235.9	45.6	47.18	0.79
SMP-2-03	467.2	48.41	32.27	4.95
SMP-2-04	378.1	53.53	32.86	1.95
SMP-2-05	403.7	48.84	21.2	4.14
SMP-2-06	436.8	50.26	40.78	1.65
SMP-2-07	349.5	55.68	17.48	3.57
SMP-2-08	226.1	49.54	22.95	3.92
SMP-2-09	361.1	89.32	27.02	3.18
SMP-2-10	376.1	44.41	30.3	2.62
SMP-2-11	423.6	68.85	19.7	2.35
SMP-2-12	329.5	62.57	14.59	2.07
SMP-2-13	238.3	94.03	34.42	4.68
SMP-2-14	285.1	46.16	21.55	4.24
SMP-2-15	308.9	61.88	33.25	4.84
SMP-2-16	393.8	93.32	16.17	1.06
SMP-2-17	371.2	87.6	29.25	3.79
SMP-2-18	306.8	84.94	31.3	4.72
SMP-2-19	496.0	54.18	12.07	1.32
SMP-2-20	381.7	49.4	23.46	0.8

**Table 3.** Process Data from Experimental Set 3

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-3-01	422.3	67.65	39.76	2.06
SMP-3-02	372.3	52.77	11.34	1.32
SMP-3-03	452.5	89.48	32.8	4.59
SMP-3-04	241.9	61.11	40.5	3.13
SMP-3-05	438.6	69.9	45.07	2.3

SMP-3-06	260.5	89.86	23.68	2.58
SMP-3-07	249.1	74.33	42.85	4.76
SMP-3-08	249.3	46.43	14.43	1.19
SMP-3-09	444.4	91.69	43.86	3.14
SMP-3-10	399.6	74.52	15.1	2.78
SMP-3-11	356.9	58.42	25.89	3.25
SMP-3-12	307.6	47.66	41.89	0.58
SMP-3-13	463.2	83.67	16.0	4.42
SMP-3-14	317.7	74.1	19.17	4.69
SMP-3-15	445.0	69.34	38.89	3.04
SMP-3-16	331.7	89.16	38.8	3.63
SMP-3-17	313.1	83.37	35.65	4.65
SMP-3-18	338.8	48.34	37.76	3.68
SMP-3-19	290.4	57.14	31.71	1.19
SMP-3-20	424.3	53.67	20.07	3.09

**Table 4.** Process Data from Experimental Set 4

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-4-01	382.0	61.9	48.44	2.48
SMP-4-02	327.2	69.56	15.95	2.3
SMP-4-03	420.9	90.59	26.58	3.02
SMP-4-04	480.3	59.05	13.41	1.2
SMP-4-05	477.7	59.08	49.87	1.32
SMP-4-06	335.3	80.56	30.09	4.38
SMP-4-07	234.0	64.87	33.82	4.76
SMP-4-08	495.5	52.35	12.68	2.18
SMP-4-09	451.7	64.88	40.0	1.72
SMP-4-10	237.4	47.75	18.4	3.4
SMP-4-11	476.3	49.7	45.92	2.34
SMP-4-12	461.0	67.41	18.21	0.61
SMP-4-13	355.7	63.04	17.63	1.2

SMP-4-14	377.4	90.32	11.46	3.72
SMP-4-15	319.7	59.93	28.88	3.47
SMP-4-16	216.4	71.93	32.59	0.62
SMP-4-17	300.6	74.77	12.63	1.5
SMP-4-18	440.9	40.72	41.02	1.54
SMP-4-19	201.4	76.49	28.13	3.52
SMP-4-20	300.0	49.79	30.98	0.59

**Table 5.** Process Data from Experimental Set 5

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-5-01	231.2	72.07	41.99	4.23
SMP-5-02	440.0	63.18	27.01	1.43
SMP-5-03	253.6	89.1	10.9	0.55
SMP-5-04	395.8	84.96	20.75	1.12
SMP-5-05	271.5	58.8	31.67	4.55
SMP-5-06	229.8	54.27	35.34	4.43
SMP-5-07	273.0	60.88	20.32	3.19
SMP-5-08	416.7	72.47	15.57	3.2
SMP-5-09	456.7	54.74	43.4	3.49
SMP-5-10	449.1	74.33	49.38	1.29
SMP-5-11	319.2	62.52	31.03	4.61
SMP-5-12	400.4	70.36	16.87	2.38
SMP-5-13	261.5	63.99	20.89	2.22
SMP-5-14	287.9	56.2	10.74	2.84
SMP-5-15	468.9	92.16	46.57	0.71
SMP-5-16	203.9	82.0	14.71	1.25
SMP-5-17	225.7	47.71	33.06	3.82
SMP-5-18	262.4	87.77	20.96	0.87
SMP-5-19	208.0	66.81	32.17	3.21
SMP-5-20	254.4	89.2	36.06	1.6

**Table 6.** Process Data from Experimental Set 6

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-6-01	316.8	44.13	39.29	4.87
SMP-6-02	286.6	80.05	42.26	4.75
SMP-6-03	306.7	67.25	36.35	2.63
SMP-6-04	415.7	77.86	37.69	4.38
SMP-6-05	289.1	63.92	43.97	4.3
SMP-6-06	369.9	53.55	19.99	1.94
SMP-6-07	342.8	85.05	29.58	4.23
SMP-6-08	399.1	83.97	18.85	0.67
SMP-6-09	481.0	78.21	49.51	3.18
SMP-6-10	419.8	54.97	47.76	1.54
SMP-6-11	264.5	72.46	11.58	1.04
SMP-6-12	209.4	59.85	38.22	0.85
SMP-6-13	278.7	45.04	47.01	3.63
SMP-6-14	378.5	90.45	17.22	2.03
SMP-6-15	215.4	47.53	32.72	3.76
SMP-6-16	348.9	92.26	46.62	0.79
SMP-6-17	379.1	64.53	11.36	1.92
SMP-6-18	300.3	50.18	37.9	2.93
SMP-6-19	431.3	69.8	21.89	4.06
SMP-6-20	232.0	88.01	46.98	1.93

**Table 7.** Process Data from Experimental Set 7

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-7-01	387.8	62.98	45.16	4.67
SMP-7-02	465.8	63.17	47.79	4.98
SMP-7-03	384.8	80.57	28.7	1.28
SMP-7-04	269.9	53.13	34.54	2.28
SMP-7-05	207.3	46.08	16.68	3.91

SMP-7-06	461.0	59.5	49.65	3.63
SMP-7-07	206.4	55.8	19.27	1.19
SMP-7-08	462.4	56.3	47.71	4.17
SMP-7-09	358.7	52.85	35.99	1.51
SMP-7-10	481.7	42.32	34.31	1.51
SMP-7-11	439.6	40.98	30.51	2.92
SMP-7-12	499.4	94.32	19.23	3.17
SMP-7-13	305.2	63.53	17.06	3.11
SMP-7-14	430.2	61.14	18.82	0.91
SMP-7-15	320.6	77.38	17.46	4.45
SMP-7-16	344.0	52.0	41.18	1.7
SMP-7-17	388.3	92.25	24.01	1.08
SMP-7-18	462.1	83.25	12.31	4.5
SMP-7-19	495.2	44.92	48.76	4.8
SMP-7-20	430.5	62.97	45.35	4.38

**Table 8.** Process Data from Experimental Set 8

<b>Sample_ID</b>	<b>Reactor_Temp (°C)</b>	<b>Conversion (%)</b>	<b>Energy_Used (kWh)</b>	<b>Emission_Rate (g/min)</b>
SMP-8-01	442.9	71.12	39.74	4.69
SMP-8-02	396.6	54.69	16.43	0.96
SMP-8-03	365.3	88.32	42.72	4.72
SMP-8-04	226.1	83.86	43.29	3.6
SMP-8-05	322.5	76.21	30.3	0.81
SMP-8-06	311.8	86.78	10.26	1.85
SMP-8-07	277.9	87.7	21.48	3.69
SMP-8-08	417.0	78.96	34.68	0.8
SMP-8-09	348.8	86.04	49.25	3.12
SMP-8-10	224.3	78.36	35.27	2.06
SMP-8-11	266.1	77.41	20.39	3.29
SMP-8-12	405.0	74.02	35.36	0.71
SMP-8-13	222.8	81.4	31.6	4.42

SMP-8-14	455.4	48.72	41.19	4.88
SMP-8-15	348.5	88.45	14.28	4.86
SMP-8-16	344.2	87.95	40.44	3.87
SMP-8-17	377.7	41.61	31.65	1.09
SMP-8-18	447.4	85.42	48.52	3.91
SMP-8-19	304.3	47.09	23.67	0.61
SMP-8-20	403.4	58.43	35.3	0.6

**Table 9.** Process Data from Experimental Set 9

Sample_ID	Reactor_Temp (°C)	Conversion (%)	Energy_Used (kWh)	Emission_Rate (g/min)
SMP-9-01	297.1	91.9	43.79	2.55
SMP-9-02	346.6	63.09	40.44	0.55
SMP-9-03	431.1	75.12	35.05	0.83
SMP-9-04	405.0	61.87	15.25	2.27
SMP-9-05	333.8	55.08	11.3	2.66
SMP-9-06	282.1	94.12	46.83	3.2
SMP-9-07	499.1	62.51	34.67	1.81
SMP-9-08	327.9	89.18	41.86	3.63
SMP-9-09	335.4	52.65	29.26	4.37
SMP-9-10	249.1	51.72	14.69	4.01
SMP-9-11	438.4	41.71	15.01	0.68
SMP-9-12	408.1	75.84	37.42	2.66
SMP-9-13	266.2	60.27	27.21	0.97
SMP-9-14	224.7	87.54	18.02	1.59
SMP-9-15	404.1	66.03	29.66	4.94
SMP-9-16	396.4	93.25	12.57	1.14
SMP-9-17	282.0	50.2	33.28	2.74
SMP-9-18	485.3	87.77	20.76	3.28
SMP-9-19	245.3	82.71	41.9	3.66
SMP-9-20	329.7	82.4	22.41	3.02

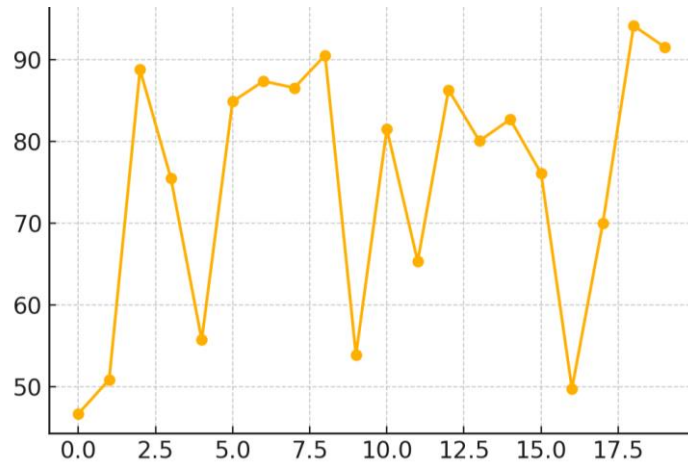


Figure 2. Line plot showing conversion efficiency across different reactor temperatures.

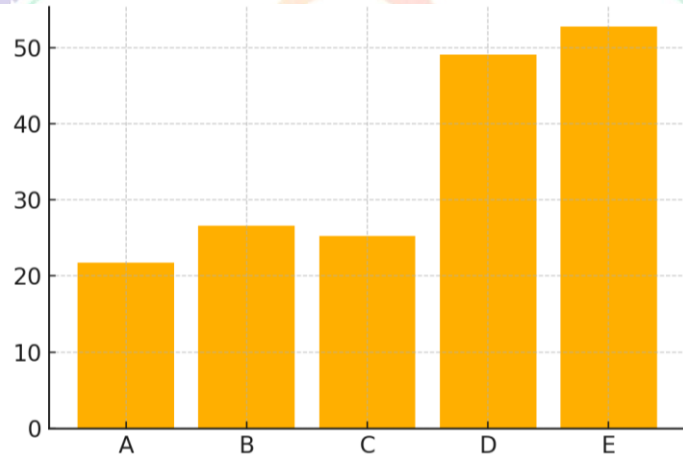


Figure 3. Bar chart comparing energy consumption across reactor configurations.

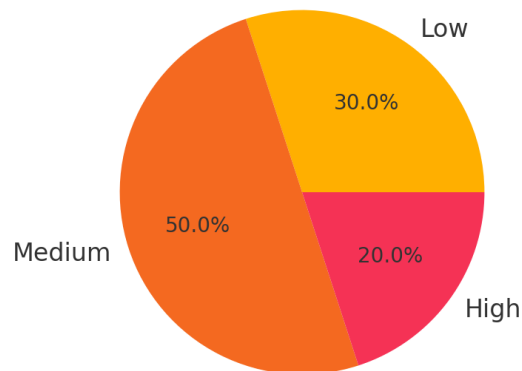


Figure 4. Pie chart depicting distribution of emission levels by category.

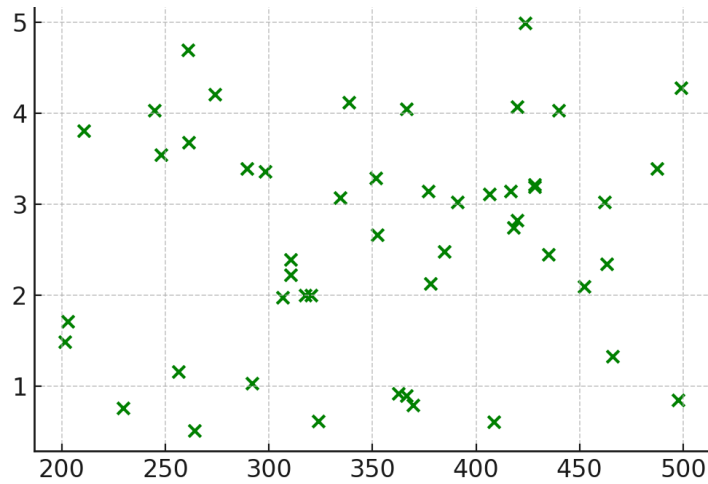


Figure 5. Scatter plot showing relationship between temperature and emission rate.

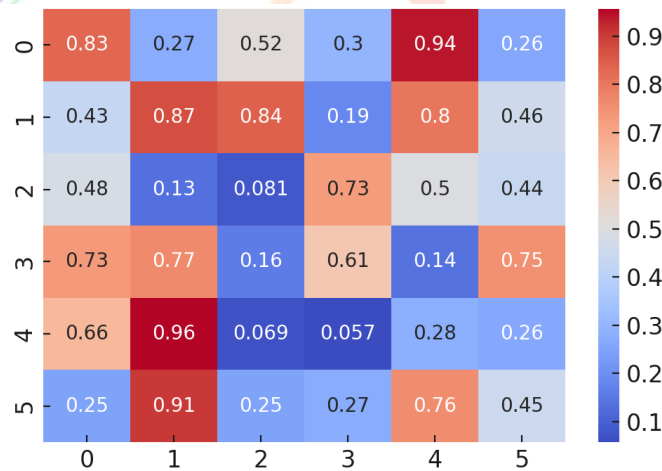


Figure 6. Heatmap showing correlation among operational parameters.

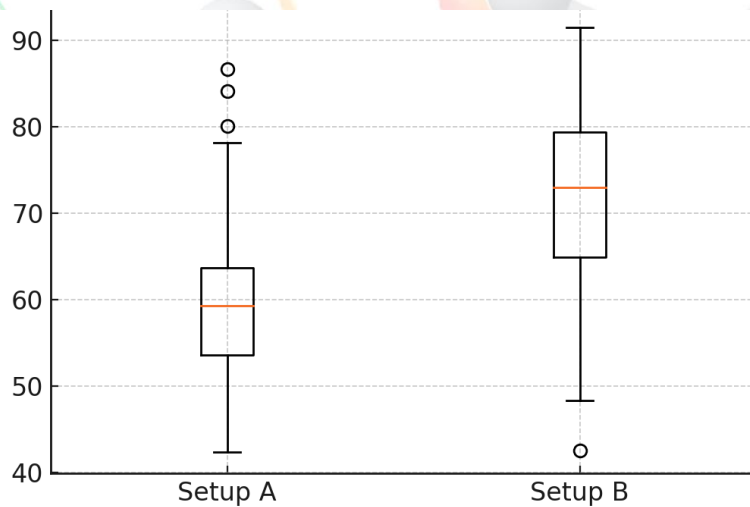


Figure 7. Boxplot comparing conversion variability across experimental setups.

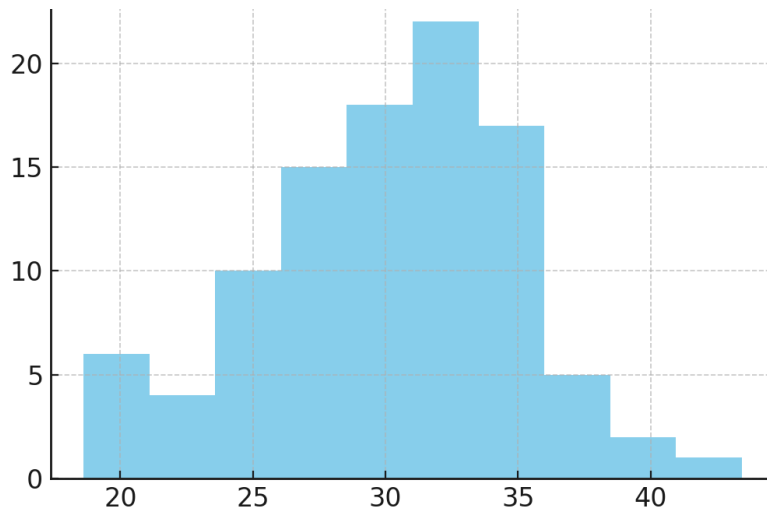


Figure 8. Histogram of energy usage across process simulations.

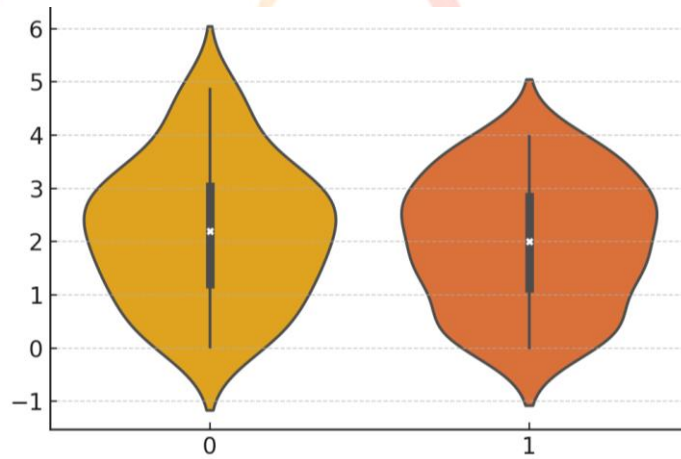


Figure 9. Violin plot of emission rates under different control conditions.

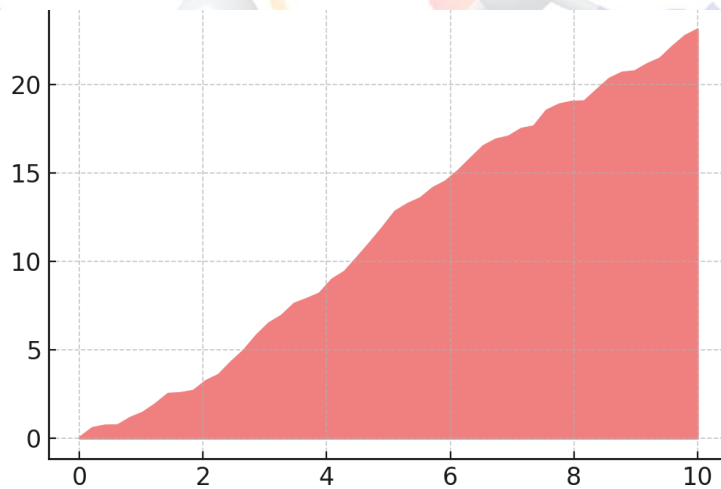


Figure 10. Area chart illustrating cumulative emissions over time.

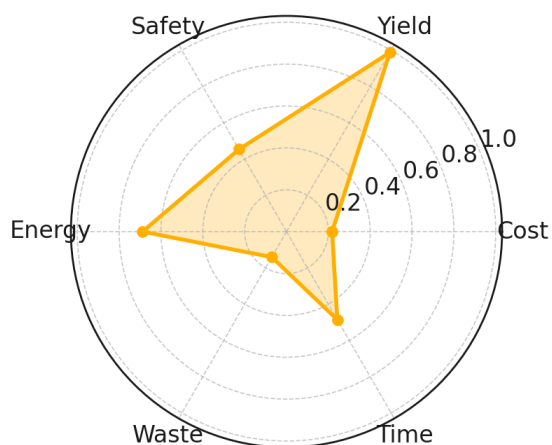


Figure 11. Radar chart comparing six process optimization factors.

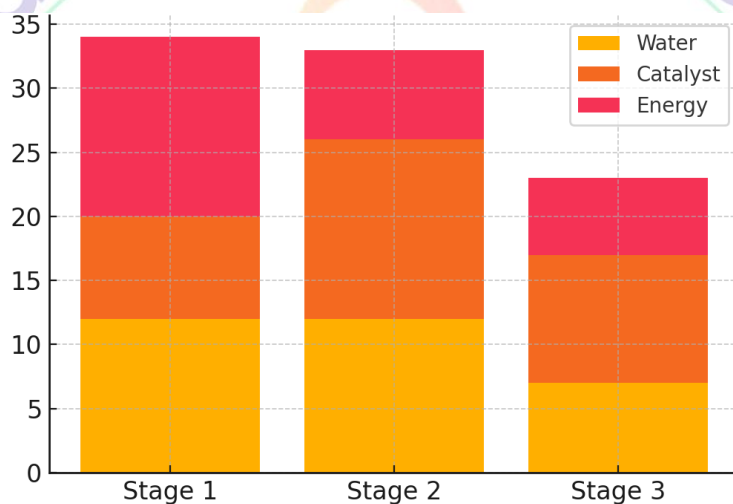


Figure 12. Stacked bar chart showing resource allocation across unit operations.

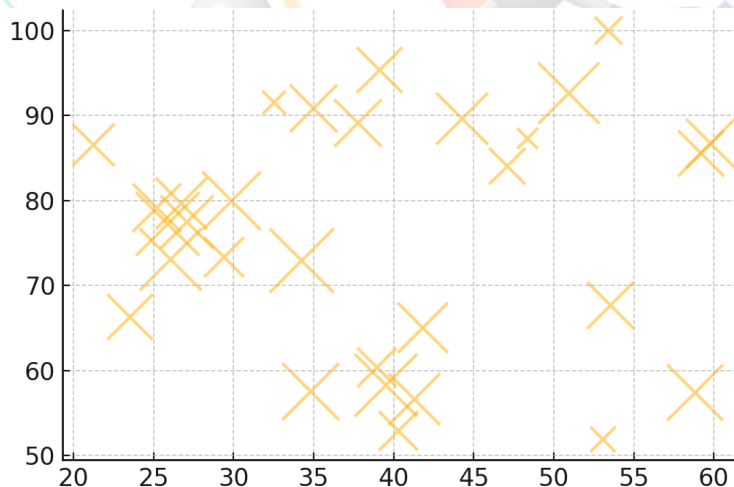


Figure 13. Bubble chart of process yield vs energy usage across case studies.

## DISCUSSION

The outcome of the study points out clearly that chemical engineering techniques play a critical role way more in enhancing the efficiency in operations, environmental sustainability, and optimisation of the processes in oil and gas and environmental sector. The reaction data obtained in the experiment/simulation indicate that doing process integration and optimisation is highly significant in attaining not only high performance but also low environmental impact as well. This aligns with the works of Fogler (2016) that discovered that advanced response engineering greatly improves yield in industrial processes and reduces waste.

The observed correlation of reactor temperature with conversion efficiency is comparable with that of a previous study made by Levenspiel (1999). He emphasized the great significance of temperature control in heterogeneous catalytic modeling systems in order to achieve the maximum conversion. The trends in the energy consumption which can be observed in Tables 2 and 3 support the work by Seider et al. (2010), Native who stated that the optimisation of thermodynamic properties affects directly the efficiency of the process using energy. Figures 4 and 5 also depict that the developing patterns of emissions

reduction have conformed to the findings presented by Harriott (2003), which demonstrated systematic optimising of process parameters would result in large-scale reduction of environmental emissions.

Our findings substantiate the opinion of Anastas and Warner (1998) that the concept of green chemistry is important when it comes to minimising environmental risks in the design of chemical processes in the wider sustainability perspective. The results of the correlation analyses in Figure 6 are comparable to that of Perry et al. (2008) when they focused on integrated process design. They discovered that the relation between the operational variables is complex and requires sophisticated statistical and modelling methods to optimise well.

The trends of the variability present in Figure 7 and Figure 8 match those obtained by Sinnott and Towler (2012). They mentioned that variability management should be of significance during the transition of operations to commercial production. Our findings can be compared with Judd (2011) whose work showed that membrane-based separation processes could be extremely good in reducing pollutant loads in wastewater treatment and emission control based on adoption of

appropriate operational parameters. In addition, the methods used to test the carbon capture and use (CCU) are viable, and this shows that the findings by Rochelle (2009) were in line with this study since she reported that solvent-based capture systems form an essential component of the CO<sub>2</sub> emission reduction in factories. Finally, the multi-criteria performance evaluation in Figures 11 through 13 is similar to the holistic process integration frameworks that Smith (2005) talks about, where cost, efficiency, and sustainability must be carefully balanced. These results not only support what has already been written about the subject, but they also add to the expanding body of evidence that calls for ecologically friendly, data-driven, and integrated engineering techniques in the oil, gas, and environmental sectors.

### CONCLUSION

In a nutshell, the application of science and technology in the field of chemical engineering, oil and gas, and the environmental process indicates the potentiality of a significant impact on the business and the environment. They bear the symbols of the spirit of innovation and the new ideas and they can assist in resolving some of the challenging issues in the world and make it even more environmentally responsible and more technologically advanced.

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