# Artificial Intelligence in Petroleum Engineering: Opportunities for Smarter and More Sustainable Energy Production

KEHINDE MICHAEL ODUWOGA, TAIWO SARAH ODUWOGA

*Journal of Secondary and Undergraduate Research*

*Published on September 3rd, 2026*

**Artificial intelligence (AI) and machine learning (ML) are increasingly being applied to petroleum engineering. Petroleum operations generate large amounts of geological, operational, and production data. AI can help engineers analyze this data, identify patterns, forecast production, support reservoir studies, improve drilling and maintenance decisions, and optimize operations. This student literature review examines selected applications of AI in petroleum engineering and considers its potential contribution to efficiency and sustainability. It also discusses important limitations, including data quality, model interpretability, validation, and the need for engineering judgment. The review suggests that future petroleum engineers will benefit from combining traditional engineering knowledge with data science and artificial intelligence skills.**

## 1 Introduction

Petroleum engineering combines mathematics, physical science, and engineering principles to support the exploration, development, and production of petroleum resources. Modern petroleum operations also generate large volumes of data from wells, reservoirs, drilling systems, production equipment, and surface facilities. The growth of data has created opportunities for computational methods to assist engineers in analyzing complex problems.

A systematic review by Tariq et al. (2021) describes applications of data science and machine learning across petroleum exploration, reservoir characterization, drilling, production, and well stimulation [5]. More recent reviews show that AI continues to expand into production forecasting, reservoir modelling, optimization, and sustainability-related applications [6, 2].

## 2 Methodology

This article is a student literature review rather than an original experimental study. Sources were identified from publicly accessible scholarly publisher and academic-index pages, including Springer Nature, Wiley Online Library, ScienceDirect, and PubMed, using combinations of the terms “artificial intelligence,” “machine learning,” “petroleum engineering,” “oil and gas,” “reservoir,” “production forecasting,” and “sustainability.” Sources were selected for direct relevance to AI applications in petroleum engineering and for clear bibliographic information. The selected literature was summarized and compared thematically across applications, benefits, limitations, and sustainability.

## 3 Applications of AI in Petroleum Engineering

One important application of AI is production forecasting. Machine-learning models can learn relationships between historical production and relevant geological, completion, and operational variables. Rahmanifard and Gates (2024) reviewed data-driven approaches for forecasting production from unconventional reservoirs and found that machine-learning methods can provide useful predictive performance, while also emphasizing the importance of validation and data quality [4].

AI is also being applied to reservoir characterization and property estimation. Reservoir properties such as porosity and permeability are important for understanding reservoir

behavior and planning development. Aljehani (2025) reviewed AI approaches for estimating subsurface properties and identified both the potential and the challenges of integrating machine learning with physical reservoir behavior [1].

Another area is proxy modeling and optimization. Motaei et al. (2026) reviewed machine-learning-driven proxy models used for petroleum engineering tasks such as asset optimization, production forecasting, and production optimization [3]. Their review highlights the usefulness of neural-network approaches while also noting the need for stronger validation before models are relied upon in real-time applications.

AI can also support drilling and predictive maintenance. Operational data can be analyzed to identify patterns associated with equipment performance or changing operating conditions. In principle, early identification of unusual patterns can help engineers investigate potential problems and improve operational planning.

# 4 AI, Efficiency, and Sustainability

The petroleum industry faces the continuing challenge of improving efficiency while reducing environmental impacts. AI is not a solution to these challenges by itself, but it can support monitoring, prediction, and optimization.

Waqar et al. (2023) reviewed applications of AI in oil and gas projects in relation to sustainable development [6]. Their review indicates that AI can contribute to areas such as optimization, monitoring, and improved decision-making. Khalili and Abbasi (2026) similarly describe applications in production forecasting, artificial-lift optimization, predictive maintenance, surface-facility optimization, and reservoir-production system integration, while discussing possible benefits for energy efficiency and emissions reduction [2].

These potential benefits depend on responsible implementation. A model that gives a technically accurate prediction is not automatically a safe or sustainable engineering solution. Engineers must consider the quality of the data, operating conditions, safety requirements, environmental effects, and the limitations of the model.

# 5 Challenges and the Importance of Human Expertise

AI systems depend strongly on the quality and representativeness of their training data. Petroleum reservoirs and operating environments can vary considerably, so a model that performs well in one field may not automatically perform equally well in another. Rahmanifard and Gates (2024) and Motaei et al. (2026) both emphasize issues involving validation and the reliability of data-driven models [4, 3].

Interpretability is another challenge. Some machine-learning models can produce useful predictions without making it easy for an engineer to understand why a particular prediction was produced. This matters when AI is used to support important operational decisions.

For these reasons, AI should complement rather than replace petroleum engineering expertise. Combining data-driven methods with physical understanding, engineering judgement, and appropriate validation can lead to more reliable applications.

# 6 Conclusion

Artificial intelligence has significant potential to support petroleum engineering through production forecasting, reservoir characterization, proxy modeling, drilling support, predictive maintenance, and operational optimization. Current literature shows promising applications, but also emphasizes the importance of data quality, validation, interpretability, and integration with engineering knowledge.

The future petroleum engineer is likely to work increasingly with digital tools and large datasets. Developing both engineering fundamentals and computational skills can therefore provide a useful foundation for addressing complex energy challenges. Continued research should focus on reliable, explainable, and environmentally responsible applications of AI in petroleum engineering.

# References

[1] A. S. Aljehani. Artificial intelligence for reservoir modeling and property estimation in petroleum engineering. *Physics and Chemistry of the Earth, Parts A/B/C*, 140:104015, 2025.

[2] Y. Khalili and S. Abbasi. Artificial intelligence in petroleum production engineering: Applications, optimization, and sustainability. *Discover Artificial Intelligence*, 2026.

[3] E. Motaei, T. Ganat, M. Tabatabai, M. Umer, and S. Krishna. Advancements in machine learning-driven proxy modelling techniques for reservoir engineering: A systematic review. *Journal of Petroleum Geology*, 49(2):516–540, 2026.

[4] H. Rahmanifard and I. Gates. A comprehensive review of data-driven approaches for forecasting production from unconventional reservoirs: Best practices and future directions. *Artificial Intelligence Review*, 57:213, 2024.

[5] Z. Tariq, M. S. Aljawad, A. Hasan, M. Murtaza, E. Mohammed, A. El-Husseiny, S. A. Alarifi, M. Mahmoud, and A. Abdulraheem. A systematic review of data science and machine learning applications to the oil and gas industry. *Journal of Petroleum Exploration and Production Technology*, 11:4339–4374, 2021.

[6] A. Waqar, I. Othman, N. Shafiq, and M. S. Mansoor. Applications of ai in oil and gas projects towards sustainable development: A systematic literature review. *Artificial Intelligence Review*, 2023.