
Production Enhancement of Heavy Oil Reservoirs in Oman:

The Promise and Potential of Hydraulic Fracturing

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EXECUTIVE SUMMARY

Heavy oil represents one of Oman's largest untapped resources, but extracting it efficiently remains a formidable challenge due to its poor flow characteristics. Oman is a prime example of this challenge: a [large portion](#) of the country's oil reserves comprises heavy crude, which is becoming increasingly important as its light-oil fields mature. Traditionally, Omani operators have relied on energy-intensive enhanced oil recovery (EOR) methods – such as steam flooding and polymer injection – to extract heavy oil successfully. While effective, these techniques are costly and complex.

Hydraulic fracturing has [emerged](#) as a more efficient way to extract heavy oil. Abraj Energy Services recognized its potential early and has led the application of fracturing in Oman's heavy oil fields, demonstrating its viability. The results have yielded significant production improvements: in one South Oman pilot, a fracturing treatment tripled an old well's oil production and restored it to continuous operation.



Abraj Energy Services' integrated approach – combining deep reservoir understanding, tailored frac fluid design, and high-quality execution – **offers a cost-effective alternative** for developing heavy oil. Fracturing can rapidly boost production from existing wells and is often implemented faster and more economically than drilling new wells. This paper examines the heavy oil challenge, reviews conventional solutions and their limitations, and highlights how Abraj Energy Services' hydraulic fracturing solution has delivered results. With hundreds of aging wells across Oman facing similar production declines, hydraulic fracturing could unlock millions of barrels of stranded oil, transforming an economic liability into a national asset.

Comparison of Oil Recovery Techniques

	Technique	Recovery Efficiency	Cost	Time to Deploy	Infrastructure Required	CO ₂ Emissions
	Steam Flooding	30-60%	High	Long	High	High
	Polymer Flooding	15-40%	Medium	Long	Medium	Medium
	Primary with Pumps	5-10%	Low	Fast	Low	Low
	Fracturing (Abraj)	~3x production increase in pilot	Medium	Short	Medium	Lower than steam

Data Sources: Heliyon 2024 (Seidy-Esfahlan et al.), Energy 2021 (Wang et al.)

Lifecycle of a Fracturing Job



INTRODUCTION

Oman's oil industry is at a turning point as it shifts from easily produced light oil to the heavier crudes that make up much of its remaining reserves. Heavy oil has historically been less attractive to develop due to the complexity of its extraction. However, as light reservoirs are depleted, Oman's remaining heavy oil resources are playing an increasingly important role in sustaining production. Maximizing output from these challenging resources is increasingly important for Oman's economy, which remains heavily reliant on oil revenue.

The fundamental problem is that heavy oil does not flow readily. Under normal conditions, heavy oil wells yield very low production. This raises a pressing question: **how can Oman economically extract more of its heavy oil?** The following sections explore this issue and a potential solution. We review Oman's heavy oil context and the limits of traditional recovery methods, then introduce hydraulic fracturing as an innovative approach that Abraj Energy Services has deployed to dramatically improve heavy oil well performance.



BACKGROUND & INDUSTRY CONTEXT

Oman's geology contains **substantial** heavy oil deposits. As a senior technical engineer at Abraj Energy Services emphasized:

“The better you know the geology, the better you can address any kind of question.”

This philosophy has guided the company's early investments in detailed reservoir studies, setting the foundation for successful heavy oil development. Indeed, by the 2010s, Oman had expanded its investment in EOR projects to tap these resources. Large-scale **efforts** such as polymer flooding at Marmul and steam flooding at fields like Mukhaizna and Qarn Alam added tens of thousands of barrels per day of production. However, these successes required significant investment and long lead times - commitments that are not feasible or economical for every reservoir.

Eager to improve heavy oil economics, Omani operators began exploring new approaches. Hydraulic fracturing, long used in Oman's gas fields, only started trials in oil wells recently. Before **2019**, oil wells made up less than 5% of Oman's fracturing jobs, but by 2021 that share **grew** to roughly 25% as operators observed the benefits. At the same time, Abraj Energy Services moved early to champion this innovation. By launching the Middle East's first integrated fracturing services for oil wells and successfully executing pilot campaigns, the company helped demonstrate that hydraulic fracturing could be the key to unlocking heavy oil reserves where traditional methods had fallen short.

THE PROBLEM

Heavy oil's high viscosity means a new well will often only produce a slow trickle of oil, unlike the strong flow that might come from a light-oil well. Without stimulation, heavy oil wells have very low natural productivity, and primary recovery typically extracts only a small fraction of the oil in place.

In Oman's mature fields, this issue is vividly illustrated by wells that once produced lighter oil but are now primarily producing heavy crude in the remaining zones. Operators have found that many heavy oil wells can not be maintained in continuous production. In some cases, these wells operate under cyclic production – running a pump for only a few hours per day, then shutting down – because the viscous oil (and often sand) would overwhelm the equipment if operated full-time. For example, one heavy oil well in South Oman, before intervention, could only pump about 8 hours per day before reaching its limits, making it barely economically viable to operate.

Leaving such wells underperforming has significant consequences. For operators, each under-producing heavy oil well means lost potential output and revenue. The typical response is to drill additional wells to compensate for low per-well output, but in heavy oil fields this is a costly and inefficient solution – especially in Oman's desert terrain, where drilling is expensive and adding wells multiplies maintenance requirements without solving the flow problem. Strategically, if heavy oil remains too difficult to extract, Oman could face declining overall production despite having ample oil in the ground. An additional challenge expressed by a fracturing engineer at Abraj Energy Services is the variability from one drill site to the next:

“Every new well is almost like a first-time challenge because of the complex geology; it's never the same from well to well...”

In summary, Oman needs a way to economically extract far more of its heavy oil resources, given these flow challenges, the limits of current methods, and the variable geology. Put simply, **what strategies can significantly enhance the productivity and economic viability of both new and existing heavy oil wells?**



EXISTING SOLUTIONS & THEIR LIMITATIONS



Thermal EOR (Steam Flooding)

Heating heavy oil in the reservoir (e.g., with injected steam) dramatically reduces its viscosity and can greatly improve flow. Oman has implemented large steam-flood projects (for example, at +Mukhaizna and Qarn Alam) that added tens of thousands of barrels per day of output. However, thermal EOR requires massive investment in steam generation facilities, fuel to produce steam, and large volumes of water. It can take years of continuous steaming to sweep a reservoir, and it works best in shallow, thick zones. Thermal projects also pose significant logistical and environmental burdens; steam generation alone can require over 3 barrels of water and substantial fuel per barrel of oil produced, raising costs and carbon emissions, particularly in Oman's arid climate.



Chemical EOR (Polymer or Gas Injection)

Another approach is injecting special fluids to help push or thin heavy oil. In Oman's Marmul field, polymer flooding has been used to help sweep out heavy oil more effectively compared to conventional waterflooding methods. Miscible gas injection (for example, injecting CO₂ or rich gas that dissolves in the oil) has been trialed in some fields to reduce oil viscosity and boost flow. These methods also have limitations: polymer flooding requires continuous supplies of expensive chemicals and a complex surface injection system, and polymers can degrade or plug the reservoir over time. Gas injection depends on having large volumes of suitable gas and maintaining high pressure; it's not practical for every field. Both polymer and miscible gas floods are typically full-field projects requiring significant upfront commitment – if heavy oil accumulation is small or the economics are marginal, these methods may not be viable.



Primary Recovery with Pumps

The simplest method is **artificial lift** – using pumps to extract heavy oil, since it won't flow naturally. This approach is common as a first phase in Oman's heavy fields. The problem is that primary recovery for heavy oil is extremely low – often only in the range of 5-10% of the oil in place – as even a strong pump can only draw oil from a limited area around the wellbore when the oil is thick. Moreover, heavy oil wells often suffer operational issues: the combination of viscous oil and unconsolidated sands leads to clogged pumps, sand production, and rapid wear.

In summary, Oman's heavy oil producers historically faced a choice between expensive, large-scale EOR projects and suboptimal primary production, with little in between. This is the gap that Abraj Energy Services identified: the need for a mid-cost, high-impact solution that could be applied more quickly and cost-effectively than a full-field EOR development yet deliver a meaningful increase in production. Hydraulic fracturing was evaluated in this context as that potential solution – a way to close the performance gap without the massive infrastructure of traditional EOR.



THE PROPOSED SOLUTION: HYDRAULIC FRACTURING

Abraj Energy Services proposes **hydraulic fracturing** as a game-changing solution to unlock Oman's heavy oil potential. In a hydraulic fracturing treatment, fluid is pumped at high pressure into the reservoir interval to crack the rock, and then sand (proppant) is injected to prop those cracks open. This creates artificial channels of highly conductive fractures through the oil-bearing formation. In essence, hydraulic fracturing turns a narrow, resistant pathway into a wide, free-flowing conduit for the oil. The well's contact area with the reservoir is dramatically increased, and the heavy oil can flow much more easily toward the wellbore. Importantly, hydraulic fracturing can be applied not only to new wells but also to existing ones, making it a flexible tool to restore production from declining heavy oil wells. As an Abraj Energy Services engineer explained:

“We are not changing the properties of the reservoir; we are simply creating the conductivity needed for the oil to flow.”

This distinction underscores hydraulic fracturing's role as an enabler, not a disruptor, of natural reservoir behavior.

Why Abraj Energy Services' Approach Excels in Oman: Abraj Energy Services [bridges](#) the gap between global best practices and local conditions with a fully integrated fracturing approach tailored to Oman's heavy oil reservoirs. Key features of the company's approach include:



Tailored Fluids & Proppants

Heavy oil reservoirs in Oman have unique characteristics that require customized frac fluids and proppants. Abraj Energy's engineers choose fluids with the right viscosity and additives to create an effective fracture without damaging the formation. The company also employs flowback-control additives to prevent proppant from flowing back out of the fracture. These fluid and proppant choices provide the needed fracture conductivity while protecting the integrity of the formation. Abraj Energy Services' fluid systems were further adapted to Oman's unique field conditions, including developing slickwater-based systems optimized for high-salinity water sources and employing proppant technologies that minimized solids flowback even under low reservoir pressure.



Data-Driven Design & Candidate Selection

A successful heavy oil frac starts with picking the right well and designing the right fracture. Abraj Energy Services works closely with the operator on detailed reservoir characterization and well selection. The team analyzes geological data, reservoir properties, and well performance to identify which wells have sufficient remaining oil and would benefit most from fracturing. Using advanced modeling and simulation tools, Abraj Energy Services then optimizes each fracture design for the specific reservoir conditions. The company leverages GOHFER, a leading 3D hydraulic fracturing simulator, to optimize fracture designs. GOHFER's reservoir modeling capabilities provide Abraj Energy Services with predictive accuracy comparable to international tools like StimPlan and FracCADE. Lab tests are conducted to ensure the frac fluid is compatible with the actual reservoir oil and rock, preventing issues like emulsions or clay swelling. By thoroughly understanding geology and tailoring each treatment, Abraj Energy Services increases the likelihood that each frac delivers a measurable improvement in production performance.



Operational Excellence & Cost Efficiency

Implementing a frac job in Oman's remote desert fields requires reliable equipment and skilled crews. Abraj Energy Services deploys high-quality frac spreads and an experienced team to ensure each job is pumped as designed. In the South Oman case study, the treatments were completed with no significant downtime or issues, demonstrating the company's operational capability on par with major international service providers. Post-job performance reviews by PDO benchmarked Abraj Energy's operational KPIs, including non-productive time and proppant placement rates, as comparable to those achieved by international majors such as Halliburton and Schlumberger. This level of execution not only ensures technical success but also helps keep **costs** in check. Indeed, fracturing has proven to be highly cost-effective: performing a frac on an existing well is far more cost-efficient and timely than drilling a new well.



Leveraging Global Best Practices

Rather than developing proprietary solutions from scratch, Abraj Energy Services became one of the **first** companies in the Middle East to offer an integrated oil well fracturing service, localizing a capability that previously had to be imported. This provides Oman with a domestically developed advantage, a local service provider able to execute complex fracs to international standards. This localization of high-performance hydraulic fracturing operations positions Abraj Energy Services as more than a conventional service provider, but as a strategic partner in Oman's energy transition.

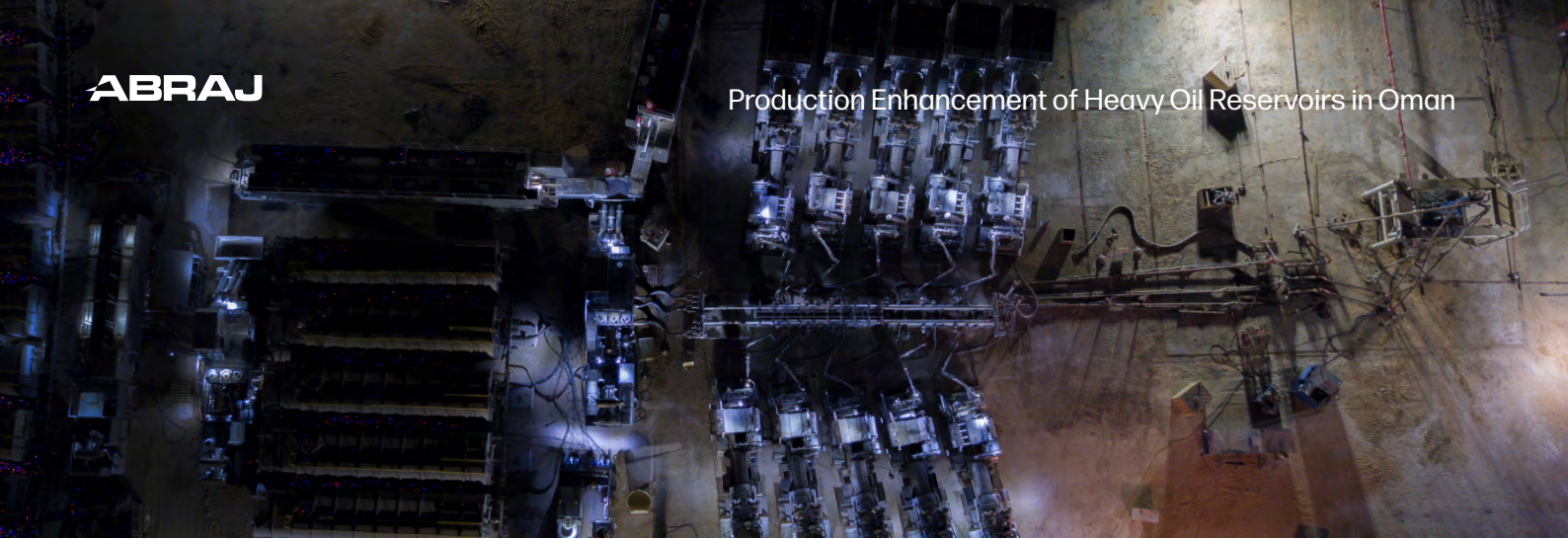
In summary, hydraulic fracturing – when customized and executed as Abraj Energy Services has done – directly addresses heavy oil's flow limitations by creating the needed pathways. It provides a means to rapidly and significantly boost heavy oil well performance without the massive infrastructure of traditional EOR. The following section outlines how our company implements this solution and the best practices that maximize its success.

IMPLEMENTATION & BEST PRACTICES

1. **Reservoir Characterization & Candidate Selection:** Before hydraulic fracturing, a thorough analysis of the reservoir is performed. Geological and reservoir data, and well production histories, are integrated to identify promising candidates – wells that have significant remaining oil but poor flow. Simulation models or analytical forecasts estimate the potential uplift from a frac, helping justify the treatment economically. It's also essential to ensure the well's construction can handle high-pressure pumping. Selecting the right wells and zones upfront maximizes the chances of a successful outcome.
2. **Fracture Design Optimization:** Each fracture treatment is custom designed for heavy oil conditions. The goal is to create a highly conductive channel for flow, rather than an extremely long fracture. Often, this means designing for fracture **width** (packing the fracture with ample proppant) so that thick oil can flow easily. A viscous gelled fluid is used to carry large sand volumes; it is formulated with appropriate breakers to ensure it will “clean up” in the reservoir after the job. If the reservoir pressure is very low, foamed or energized fluids may be used to help with cleanup. Abraj Energy Services also performs lab tests with actual reservoir oil and rock to ensure the chosen fluid is compatible and won't cause issues. Modern diagnostic tools help verify the fracture dimensions and guide any design tweaks for future treatments. Abraj Energy Services has also been compiling data from previous hydraulic fracturing operations into a comprehensive database, enabling frac engineers to compare current job designs with historical execution data.



3. **Execution & Quality Control:** On the day of the frac job, precise execution is critical. In the field, all necessary equipment is on site, and Abraj Energy Services' team closely monitors the operation. Pumping parameters are watched in real time and compared against the design. Any deviation is addressed through real-time adjustments. For example, slowing the pump rate or adding a fluid-loss additive if the formation exhibits excessive fluid intake. Maintaining an experienced crew and contingency plans is a best practice to handle unexpected events. Throughout the job, strict safety and environmental protocols are followed. Abraj Energy Services' workflows also account for the complex tectonic features common in Oman's subsurface, where unpredictable fracture networks require real-time adjustments to perforation strategies and proppant placement to avoid early screen-outs.



- 4. Post-Fracture Flowback & Cleanup:** Once the fracture is placed, the well is carefully brought back online. Rather than immediately opening the well fully, Abraj Energy Services implements a controlled flowback procedure. Initial steps may include swabbing or using nitrogen lift to initiate the removal of the injected fluid. Because heavy oil does not mix readily with water, it is important to remove as much of the water-based frac fluid as possible to enable the oil to flow. Special measures are used to ensure the proppant remains in the formation and does not flow back to the surface during this early flow. The well's flow is increased gradually while monitoring for any sand production, and the surface choke is adjusted to maintain a controlled rate. By systematically cleaning up the well and ramping up production, the new fracture is protected from damage, and the heavy oil is allowed sufficient time to flow through the propped channel as intended.
- 5. Performance Monitoring & Iteration:** After the frac, Abraj Energy Services and the operator monitor the well's performance against the pre-frac baseline. Key indicators include the oil production rate and the pump run-time or efficiency. In one pilot well, a pump that previously operated for only a few hours per day was able to run continuously for 24 hours after the frac, and the oil rate increased several-fold – clear evidence of success. Such results are documented and analyzed to calculate the incremental oil recovered and the economic payback period of the treatment. During recent campaigns, the company dynamically adapted its fracturing designs between stages. For example, after the first stage revealed unexpected geo-mechanical behavior, subsequent stages incorporated modified proppant schedules and treatment designs, leading to improved outcomes. This feedback loop is important for refining future designs and for building confidence to expand the program. Conducting a post-job review to capture lessons supports the continuous improvement of subsequent frac campaigns.
- 6. Integration with Field Development:** Fracturing should be integrated into the field's overall development plan so that it complements other recovery efforts. For example, if a waterflood or steam-flood project is planned for a later phase, fracturing certain wells can now accelerate early oil production and subsequently serve as enhanced injection channels for those processes. By coordinating fracturing with other methods (and with drilling or workover schedules), operators ensure that hydraulic fracturing works in synergy with the broader development strategy rather than as an isolated one-off operation.

By following these best practices at every step – from candidate selection and design to execution, cleanup, and evaluation – heavy oil fracturing operations can be conducted safely and effectively, with maximum benefit. The Omani experience shows that when these guidelines are followed, fracturing can overcome heavy oil challenges. The next section illustrates the real-world impact through a case study of a successful application.

CASE STUDY: REVITALIZING AN OLD HEAVY OIL WELL IN SOUTH OMAN

One of the most compelling examples of this approach in action is a **pilot** conducted on **Well X** – the oldest well in a mature heavy oil field in South Oman. This decades-old well had produced oil for many years, but by 2022 its output had plummeted. The reservoir is a sandstone containing heavy crude, and over time, the well's production declined to the point that it was only operating about 8 hours per day. The downhole pump could not run continuously due to viscous fluid and sand-related issues. The well was barely economic and headed for abandonment unless performance could be improved.

In mid-2023, the operator (PDO) and Abraj Energy Services carried out a hydraulic fracturing treatment on Well X as a pilot to revive production. Abraj Energy Services engineered a propped frac targeting the main pay zone that still held substantial oil. The design used a high-viscosity borate-crosslinked gel fluid and pumped a large volume of sand to create a wide, conductive fracture, with special additives to prevent proppant flowback. The frac job was executed as planned, placing tens of tons of proppant into the formation. After pumping, the well was carefully returned to production through a gradual, controlled flowback procedure.



Results: The effect on Well X was immediate and significant. Once the well was brought into production after the frac, it was able to pump 24 hours a day with no “pump off” incidents. The oil production rate jumped to approximately **three times** the pre-frac level. Equally important, this higher output was sustained. Even 18 months after the treatment, the well continued to produce at the improved rate with the pump operating continuously.

This single fracturing intervention transformed Well X from a marginal, dying asset into a valuable producer again, essentially extending the productive life of the well. The economic turnaround was significant: a well that was about to be written off was now generating healthy production and revenue. The success of this pilot provided proof that even the oldest, most depleted heavy oil wells could be rejuvenated through hydraulic fracturing. On the strength of this result, the operator moved forward with plans to frac a series of similar wells in the field and even to incorporate fracturing into the development of new infill wells. In effect, one successful frac de-risked the technology and led to broader adoption in that field.

CONCLUSION

Oman's experience **demonstrates** that hydraulic fracturing can be a cost-effective, high-impact solution for unlocking heavy oil. Abraj Energy Services demonstrated that applying a proven technology, hydraulic fracturing, to a new scenario, such as heavy oil, can deliver breakthrough results when supported by the right design and technical expertise.

Oil producers and field managers should consider hydraulic fracturing for heavy oil wells or reservoirs that were previously deemed uneconomical. The process should begin with screening mature heavy oil fields for suitable candidates (wells with high remaining oil but poor current flow) and studying successful cases like the South Oman pilot. Engage experienced experts in planning a pilot fracturing program. Start with one or a few wells, define clear success metrics, and execute a trial frac with an experienced team. If the pilot is successful, the program can be scaled up and integrated into the broader field development plan alongside other methods (waterfloods, thermal EOR) to maximize long-term recovery.

By embracing modern stimulation techniques like hydraulic fracturing, operators can transform heavy oil from a challenge into a strategic opportunity. With the right approach, heavy crude previously considered unproducible can become a critical component of Oman's future oil supply.

For more information, please visit **our website**.



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