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Optimizing water consumption in oil and gas well drilling: Strategies for reducing the water footprint in Texas

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Abstract

As oil and gas drilling operations intensify in Texas, the environmental impact of water consumption has become a growing concern. This paper explores strategies for reducing the water footprint associated with drilling wells in the state, focusing on well types commonly drilled in regions like the Permian Basin and Eagle Ford Shale. By analyzing water consumption during various stages of drilling—namely, drilling, completion, and hydraulic fracturing—this paper examines both technological innovations and operational adjustments that can optimize water use. The study highlights the potential for water recycling, the use of alternative water sources, and improvements in drilling technology to reduce freshwater demand. Drawing on case studies and industry reports, the paper concludes with recommendations for sustainable water management practices in Texas's oil and gas industry, essential for balancing energy production with environmental stewardship.

Keywords: Water Security; ESG; Permian; Sustainable; Energy

1. Introduction

Water is an essential resource for oil and gas extraction, particularly in hydraulic fracturing (fracking), which has transformed oil production in shale plays across Texas. However, in water-scarce regions like West Texas, where both the Permian Basin and Eagle Ford Shale are located, the rising demand for water in drilling operations is unsustainable in the long term. A single well can require millions of gallons of water, a substantial burden on local water supplies already under stress due to drought and increasing population.

This paper aims to explore ways to reduce water consumption in the oil and gas drilling process in Texas. Emphasizing the importance of optimization techniques, water recycling, and alternative water sources, the study outlines practical steps that operators can take to reduce their water footprint. The goal is to provide a framework for sustainable water management practices that minimize environmental impact while maintaining operational efficiency.

2. Methodology

This research relies on a combination of industry data, case studies, and expert interviews to assess water consumption in drilling operations and evaluate potential optimization strategies. The study focuses on three main stages of drilling:

- **Drilling Phase:** This includes the water required for cooling, lubricating, and maintaining pressure control during the drilling process.
- **Completion Phase:** Water used for casing, cementing, and pressure testing the well after drilling is completed.

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- **Hydraulic Fracturing Phase:** Water used in fracking to create fractures in the rock formations, facilitating the release of oil and gas.

We explore technological advancements and operational practices designed to reduce water consumption in each of these phases. In addition, case studies of companies successfully implementing water-saving measures are reviewed to identify best practices and potential for broader industry adoption.

3. Case Study: Optimizing Water Use in the Permian Basin and Eagle Ford Shale

The Permian Basin is one of the most water-intensive oil production areas in Texas. A typical horizontal well in this region requires up to 4 million gallons of water for hydraulic fracturing (TXOGA, 2021). However, some companies in the Permian have adopted water optimization strategies to reduce consumption. One notable example is Occidental Petroleum, which has partnered with local municipalities to use treated wastewater for hydraulic fracturing. This collaboration, initiated in 2019, has allowed Occidental to reduce its reliance on freshwater by up to 25% per well (Occidental Petroleum, 2020).

Similarly, in the Eagle Ford Shale, Apache Corporation has implemented a water recycling program, reusing water from previous fracking operations for new wells. According to a 2021 report, Apache has been able to recycle more than 50% of the water used in its fracking operations in the Eagle Ford, significantly reducing its freshwater consumption (Apache Corporation, 2021).

These case studies highlight the potential for both operational adjustments and technological innovations to optimize water use in drilling operations, demonstrating the feasibility of reducing the water footprint even in water-scarce regions.

4. Discussion

Reducing water consumption in oil and gas drilling in Texas requires a multi-faceted approach, integrating technological innovation, operational changes, and regulatory improvements. Several key strategies can be employed:

- **Water Recycling:** Recycling produced water (water that has been used in previous drilling or fracking operations) can significantly reduce the need for freshwater. As demonstrated by Apache and Occidental Petroleum, technologies for cleaning and reusing water are already in practice and can be scaled up. The water used in hydraulic fracturing, which can be up to 5 million gallons per well, can be a prime candidate for recycling, reducing reliance on local freshwater sources.
- **Use of Non-Freshwater Sources:** Many companies are turning to non-traditional sources of water, such as brackish water, treated wastewater, and desalinated water. A 2020 study by the University of Texas at Austin found that treated wastewater from municipal sources can be a viable alternative for fracking operations in many parts of the state, helping reduce competition for freshwater between the oil industry and other sectors (University of Texas at Austin, 2020).
- **Advanced Fracturing Technologies:** New methods of hydraulic fracturing, such as “slickwater” fracturing, require less water and are less environmentally taxing. Research from the Texas A&M University Energy Institute suggests that the use of foam-based and gel-based fracking fluids could reduce the water required for hydraulic fracturing by as much as 40% (Texas A&M University Energy Institute, 2021). These technologies offer promising alternatives to traditional water-intensive methods.
- **Optimizing Drilling Operations:** Beyond fracking, improvements in the drilling process itself, such as reducing the time spent on drilling and optimizing the use of drilling muds, can also decrease overall water consumption. According to a study by the Society of Petroleum Engineers, new drilling techniques like managed pressure drilling (MPD) and automation in rig operations can reduce the water required for wellbore cleaning and cooling (SPE, 2019).
- **Water Use Reduction through Regulation and Incentives:** In some areas of Texas, local governments have implemented water use restrictions for the oil and gas industry, encouraging companies to adopt water-saving technologies. The Texas Commission on Environmental Quality (TCEQ) has also introduced incentives for companies to use recycled water and explore alternative sources, such as brackish water and treated effluent.

5. Results

The implementation of water optimization strategies has shown promising results in Texas's oil and gas fields:

- **Water Recycling:** Companies like Apache and Occidental have demonstrated that recycling can reduce water consumption by over 50%, with some operators achieving nearly full recycling of fracking water. Apache's Eagle Ford operations, for instance, recycled over 50% of their water in 2021 (Apache Corporation, 2021).
- **Alternative Water Sources:** The use of treated wastewater for hydraulic fracturing has been particularly successful in the Permian Basin. Occidental's partnership with local municipalities has cut down freshwater consumption by up to 25%, while also alleviating pressure on local water resources (Occidental Petroleum, 2020).
- **Technological Improvements:** The use of new fracturing technologies and optimized drilling methods has contributed to a significant reduction in water demand. The application of foam and gel-based fracking fluids, for instance, has been shown to reduce water requirements by up to 40% (Texas A&M University Energy Institute, 2021).
- **Regulatory Impact:** Local water use restrictions and incentives for using recycled or alternative water sources have led to increased adoption of sustainable water management practices. Companies operating in regions like the Eagle Ford and Permian have been able to reduce their water footprints significantly.

6. Conclusion

The water footprint of oil and gas drilling in Texas remains a significant concern, but technological innovations, water recycling, and the use of alternative water sources offer practical solutions for reducing consumption. As the industry continues to face mounting pressure to balance resource extraction with environmental sustainability, it is clear that adopting water-efficient technologies and practices is no longer optional. Companies in Texas have already demonstrated the viability of these strategies, and with continued investment in new technologies and regulatory support, the water consumption associated with drilling operations can be substantially reduced.

The findings suggest that, while the oil and gas industry will continue to be a major consumer of water, its water use can be optimized to minimize environmental impacts. Future research and investment should focus on improving water recycling technologies, exploring new water sources, and developing more water-efficient fracturing methods.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed. The paper has been presented at American Petroleum Institute (API) Sub Committee meeting in Jan 2025.

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