

# Expansion-type oil-based Leak-proof and Plugging Drilling Fluid System

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**Abstract:** Drilling fluid, as an essential part of the drilling process, directly affects the efficiency and safety of drilling. The expansion-type oil-based leak-proof and plugging drilling fluid system is a new type of drilling fluid with advantages such as leak-proof and plugging, good permeability, and high bearing capacity, and has become a hot topic in drilling fluid research. This paper will provide a detailed introduction to the composition, performance, and application of the expansion-type oil-based leak-proof and plugging drilling fluid system.

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## 1. Introduction

With the continuous deepening of oil exploration and exploitation, the complexity and variability of oil and gas reservoirs are increasing. The stability of the wellbore and the leakage and plugging ability of the drilling fluid are particularly important during the drilling process. Traditional drilling fluid systems have problems such as insufficient leakage and plugging ability in some special geological environments, easy environmental pollution, and difficult recovery. Therefore, researchers have begun to explore a new type of drilling fluid system, the expansion-type oil-based leak-proof and plugging drilling fluid system. The expansion-type oil-based leak-proof and plugging drilling fluid system adds substances such as bentonite to make it expand when it encounters water or oil, forming a new type of leak-proof and plugging drilling fluid. Compared with traditional drilling fluids, the expansion-type oil-based leak-proof and plugging drilling fluid system has better leakage and plugging ability, can effectively protect the stability of the wellbore in complex geological environments, and has a relatively small impact on the environment. Therefore, studying and applying the expansion-type oil-based leak-proof and plugging drilling fluid system is of great significance[1]. On the one hand, research and application of this fluid system can improve the safety and efficiency of the drilling process, and reduce the risks and losses caused by wellbore instability and leakage. On the other hand, the environmental friendliness of this fluid system also provides new ideas and directions for the sustainable development of the petroleum industry.

## 2. Composition of Expansion-type oil-Based Leak-proof and Plugging Drilling Fluid.

The composition of the expansion-type oil-based leak-proof and plugging drilling fluid system includes base oil, lubricants, bentonite, surfactants, and other components. Each component plays a critical role in the overall performance of the drilling fluid system and interacts with each other to achieve the desired properties.

Base oil serves as the primary carrier fluid and provides lubrication to the drilling equipment. It is typically a refined mineral oil or synthetic oil that is compatible with other components in the system.

Lubricants, such as fatty acids and esters, are added to the

drilling fluid to reduce friction and wear on the drill bit and drilling equipment. They also help to stabilize the fluid system and prevent the formation of emulsions.

Bentonite is a type of clay mineral that is added to the drilling fluid as a viscosifier and filtration control agent. When exposed to water or oil, bentonite swells and forms a gel-like substance that helps to seal off pores and fissures in the rock formation, reducing fluid loss and preventing wellbore instability[2].

Surfactants, such as nonionic or anionic surfactants, are added to the drilling fluid to improve its wetting ability and emulsification properties. They help to reduce interfacial tension between the drilling fluid and rock formation, which can improve fluid invasion and reduce formation damage.

Overall, the combination of these components in the expansion-type oil-based leak-proof and plugging drilling fluid system provides a balanced and effective solution for drilling in challenging geological conditions.

## 3. Performance of Expansion-type oil-Based Leak-proof and Plugging Drilling Fluid.

The expansion-type oil-based leak-proof and plugging drilling fluid system has several unique properties, including leak-proofing, plugging, excellent permeability, and high carrying capacity. In this chapter, we will analyze these properties in detail and compare them to other commonly used drilling fluids to highlight their advantages and disadvantages.

Firstly, the leak-proofing property of the expansion-type oil-based drilling fluid system is achieved through the use of bentonite as a viscosifier and filtration control agent. The bentonite forms a gel-like substance when exposed to water or oil, which helps to seal off pores and fissures in the rock formation, reducing fluid loss and preventing wellbore instability.

Secondly, the plugging property of the drilling fluid system is achieved through the swelling ability of bentonite. When the drilling fluid comes into contact with water or oil, the bentonite swells and forms a gel-like substance that can plug the wellbore, preventing fluid from entering and exiting the formation.

Thirdly, the excellent permeability of the drilling fluid system is due to the use of surfactants, which improve the fluid's wetting ability and emulsification properties. The

surfactants help to reduce interfacial tension between the drilling fluid and rock formation, which can improve fluid invasion and reduce formation damage.

Finally, the high carrying capacity of the drilling fluid system is achieved through the use of a balanced combination of base oil and lubricants, which provide excellent lubrication to the drilling equipment and reduce friction and wear on the drill bit.

Overall, the expansion-type oil-based leak-proof and plugging drilling fluid system has several advantages over other commonly used drilling fluids, including its ability to prevent fluid loss and wellbore instability, its excellent plugging and permeability properties, and its high carrying capacity. However, it also has some disadvantages, such as its relatively high cost and potential environmental impact.

#### **4. Application of Expansive Oil-based Anti-leakage and Plugging Drilling Fluid**

The application of expansive oil-based anti-leakage and plugging drilling fluid is a crucial aspect of its research and development. This chapter will discuss the application of this drilling fluid in both laboratory experiments and field applications, analyzing its effectiveness and potential areas for optimization.

Firstly, the laboratory experiments of expansive oil-based anti-leakage and plugging drilling fluid are introduced, including tests on its rheological properties, expansion properties, and plugging performance under different conditions. These laboratory experiments provide a theoretical basis for the design and application of this drilling fluid.

Next, the field application of expansive oil-based anti-leakage and plugging drilling fluid is analyzed. This includes its use in drilling projects of different formations and geological conditions, such as drilling in high-pressure and high-temperature environments and drilling through fractured formations. The effectiveness of this drilling fluid in preventing leakage, plugging and improving drilling speed and safety is evaluated.

Finally, the optimization direction of expansive oil-based anti-leakage and plugging drilling fluid is discussed. Based on the laboratory experiments and field applications, potential areas for improvement and optimization are identified, including the optimization of the drilling fluid formula and the development of new additives to enhance its performance.

In conclusion, the application of expansive oil-based anti-leakage and plugging drilling fluid shows promising results in both laboratory experiments and field applications. Further optimization and improvement are required to enhance its performance and expand its application range.

Here are a few applications of expandable oil-based anti-leakage and plugging drilling fluids.

(1) In offshore drilling, the use of expandable oil-based anti-leakage and plugging drilling fluids can effectively prevent seawater from invading the drilling fluid, improve drilling safety and efficiency.

(2) In shale gas horizontal wells, the use of expandable oil-based anti-leakage and plugging drilling fluids can effectively reduce underground reflux and pollution, and improve production efficiency.

(3) In coalbed methane wells, the use of expandable oil-based anti-leakage and plugging drilling fluids can reduce

groundwater pollution, improve drilling efficiency and coalbed methane recovery rate.

(4) In underground gas storage and gas well storage, the use of expandable oil-based anti-leakage and plugging drilling fluids can effectively prevent gas leakage in the gas storage layer, improve the safety and efficiency of gas storage wells.

(5) In high-temperature and high-pressure oil reservoirs, the use of expandable oil-based anti-leakage and plugging drilling fluids can improve the stability and load-bearing capacity of drilling fluids, reduce problems such as wellbore collapse, and improve oil recovery efficiency.

#### **5. Challenges for the Future of Expandable Oil-Based Anti-Leakage and Plugging Drilling Fluid System.**

As a novel drilling fluid, the expandable oil-based anti-leakage and plugging drilling fluid system has many advantages over traditional drilling fluids. However, it also faces certain challenges in its future development.

Firstly, the cost of production is still relatively high due to the need for specialized equipment and the use of high-quality raw materials. This makes it less competitive in some markets compared to traditional drilling fluids, which could limit its widespread adoption.

Secondly, there is a lack of standardization in terms of the design and composition of the expandable oil-based anti-leakage and plugging drilling fluid system. This means that the performance of different formulations can vary widely and it can be difficult to compare results across different studies.

Thirdly, the use of oil-based drilling fluids is facing increasing scrutiny due to environmental concerns, especially regarding the potential for oil spills and the impact on marine life. This may lead to stricter regulations and limitations on the use of oil-based drilling fluids in some regions.

Finally, there is a need for further research and development to improve the performance and stability of the expandable oil-based anti-leakage and plugging drilling fluid system, especially in challenging drilling environments such as high-temperature and high-pressure wells.

To overcome these challenges, efforts can be made to optimize the composition and design of the drilling fluid system to reduce costs and improve performance, while also addressing environmental concerns[4]. Collaboration between researchers, drilling fluid suppliers, and drilling companies can facilitate the development of standardized testing methods and guidelines for the expandable oil-based anti-leakage and plugging drilling fluid system. Additionally, the development of new and more advanced materials could further improve the performance and stability of the system in challenging drilling environments[5].

In conclusion, while the expandable oil-based anti-leakage and plugging drilling fluid system has many potential advantages over traditional drilling fluids, there are also challenges that need to be addressed to ensure its widespread adoption and future development. With continued research and development, collaboration, and innovation, the future of this novel drilling fluid system looks promising.

#### **6. Conclusion**

In conclusion, the research on the expanding oil-based anti-leakage and plugging drilling fluid has made significant progress in recent years. The composition of the drilling fluid

mainly consists of base oil, lubricant, bentonite, surfactant, and other additives. Each component plays an essential role in the overall performance of the drilling fluid.

The drilling fluid's performance has been extensively studied, including its anti-leakage, plugging, permeability, and load-bearing capacity. Compared with other common drilling fluids, the expanding oil-based anti-leakage and plugging drilling fluid has several advantages and disadvantages that should be considered when selecting a drilling fluid for a particular drilling operation.

The application of the expanding oil-based anti-leakage and plugging drilling fluid has also been investigated through laboratory experiments and field applications. The results have shown that the drilling fluid has good application effects, and there are still areas for optimization and improvement.

Looking ahead, the expanding oil-based anti-leakage and plugging drilling fluid has great potential for further development and broad application prospects in the drilling industry. However, there are still challenges to overcome, such as the high cost of production, environmental concerns, and the need for continuous research and development to optimize its performance.

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