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Improving The Efficiency of Developing Oil Fields with Hard - to - Recover Reserves Based on Refining Geological and Hydrodynamic Models

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Abstract

This article analyzes the issues of efficient use of hard-to-recover oil fields by refining the geological and hydrodynamic model. As a result of refining the geological model and hydrodynamic studies, the efficiency of mining technologies is increased. This approach allows for resource conservation, optimization of production processes, and ensuring the environmental safety of the oil industry.

Keywords: Geological model refinement, Hydrodynamic model, Oil recovery efficiency, Hard-to-extract reserves, Seismographic studies, Nuclear analysis, Geophysical methods, Layer porosity and permeability, Mathematical modeling, Real-time monitoring, Horizontal drilling, Hydraulic fracturing, Water and gas injection, Oil industry technologies, Energy saving, Environmental safety.

Introduction

In recent years, the effective exploitation of oil fields with hard-to-extract reserves has become a pressing issue on a global scale. These deposits typically have complex geological structures, leading to a number of technological and economic challenges during the extraction process. Therefore, the accuracy of geological and hydrodynamic models is crucial for optimizing extraction processes.

The geological model plays a crucial role in determining the geological structure of oil fields, the positioning of stratigraphic layers, reservoir properties, and the volume of reserves. A refined model is created based on the following methods:

- Seismographic studies are widely used to identify stratigraphic layers and structures.
- Core analysis - determination of the rock composition and porosity of oil reservoirs.
- Geophysical methods - Evaluating rock properties through the study of electrical and acoustic parameters.

Core analysis is crucial for determining the physical and chemical properties of rocks in reservoirs. This method is used for the following purposes:

- **Determination of mineralogical composition**: Assessment of rock strength and reactivity by analyzing the mineral content of core samples.
- **Measurement of porosity and permeability**: Determining the ability of reservoir rocks to store and transmit oil, gas, and water.
- **Studying chemical properties:** Obtaining information about the chemical composition of rocks and their interaction with oil.

This data is crucial for further refining the hydrodynamic model of reservoirs and developing an effective extraction strategy.

1. Geophysical methods

Geophysical methods are widely employed to determine reservoir properties. Geophysical studies are conducted based on the following technologies:

- **Electrical Intelligence:** The electrical conductivity and resistance of the rocks are analyzed, through which the structure and composition of the layers are determined.
- **Acoustic and ultrasonic methods:** The density and elastic moduli of layers are evaluated as a result of sound waves passing through them.
- **Magnetometric analyses**: Changes in the Earth's magnetic field are studied to determine the location of minerals and the composition of reservoirs.
- **Gravity exploration:** Gravitational changes are analyzed to determine the density and shape of the layers.

These methods create additional opportunities to enhance the accuracy of reservoir assessment and improve the efficiency of extraction.

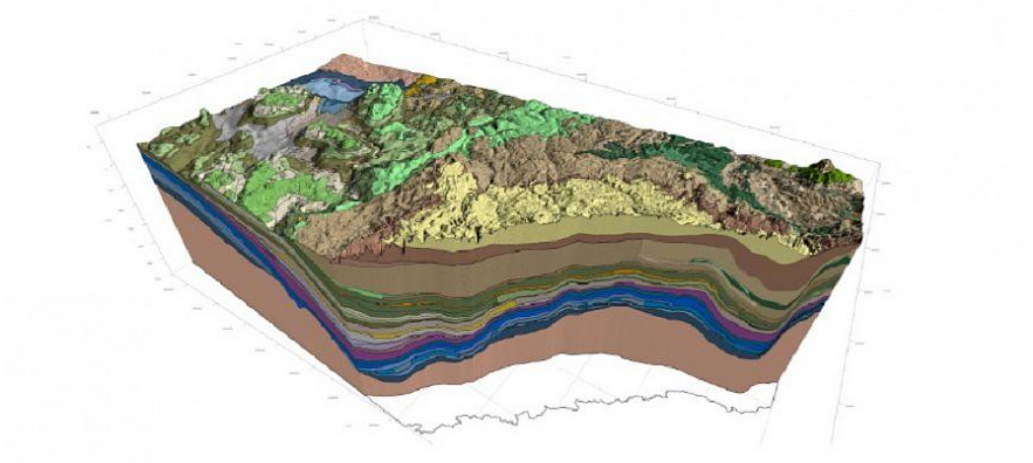

Figure 1. Geological model of the deposit – Mining

Creating an accurate model enables efficient management of oil field reserves and optimization of extraction processes.

Enhancing the hydrodynamic model: The hydrodynamic model is used to depict the movement of water, oil, and gas within the reservoir. This model encompasses the following stages:

- **Determining the properties of the layer** — The permeability, viscosity, and pressure distribution are analyzed.

- **Mathematical modeling** — Differential equations are applied to calculate the movement of fluids in a layer.
- **Model calibration** — Tuning and refining models for greater accuracy based on real data.

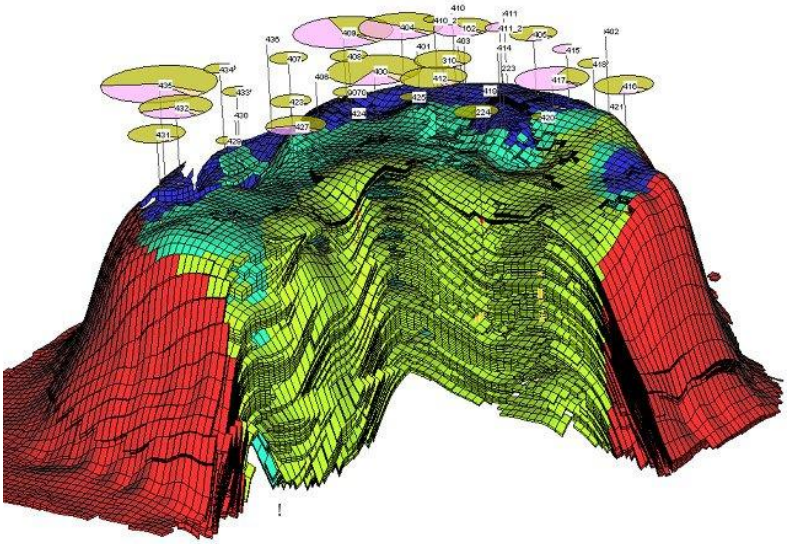

Figure 2. Hydrodynamic model (Perm)

The accuracy of geological and hydrodynamic models forms the foundation for enhancing extraction efficiency. This process encompasses the following methods:

Optimization of extraction technologies - The application of horizontal drilling and hydraulic fracturing creates opportunities for increased oil recovery in complex geological formations.

Consideration of external factors - Stabilizing pressure and increasing oil production by adapting water and gas injection to the properties of the reservoir layers.

Improving processing technologies - Application of thermal or chemical methods for extracting high-viscosity oil.

Real-time monitoring - Using modern sensors and software to monitor extraction processes. This allows for monitoring the reservoir condition and making effective decisions.

Resource conservation - Reducing extraction costs through the implementation of energy-saving and environmentally safe technologies.

Results: Studies indicate that the utilization of accurate geological and hydrodynamic models leads to the following outcomes:

Increased oil production indicators: As a result of optimizing extraction technologies based on geological and hydrodynamic modeling, oil production volume will increase by 15-20%.

Stabilization of reservoir pressure: Due to the adaptability of water and gas injection technologies, reservoir pressure is effectively managed, which maintains oil extraction processes stable for an extended period.

Reduced residual reserves: Due to the improvement of processing and extraction technologies, the number of residual reserves is significantly decreased.

Improvement of environmental safety: The use of energy-efficient and environmentally safe technologies in extraction processes reduces the risk of environmental damage.

Increased economic efficiency: As a result of reduced resource and energy consumption, extraction costs decrease, which improves the economic performance of projects.

By refining the geological and hydrodynamic model, it is possible to enhance the efficiency of developing oil fields with hard-to-recover reserves. This approach not only increases the effectiveness of oil extraction processes but also improves the economic and environmental performance of the industry. In the future, research in this area will enable the broader implementation of technological innovations.

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