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A Review of Nonlinearity and Solution Techniques in Reservoir Simulation

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Introduction

With high-order nonlinear equations, reservoir simulation is used to demonstrate the dynamic physical processes of rocks and fluid properties. Various types of simulation models are currently used in the petroleum industry. These models are solved numerically to obtain a solution while taking into account numerous inherent assumptions. This paper provides an extensive review of the current literature, with a focus on nonlinearity in partial differential equations related to petroleum reservoir simulation. The various techniques for solving nonlinear governing equations in a petroleum reservoir are critically examined. It also discusses the inherent assumptions and properties of nonlinear solvers, as well as their technical challenges [1].

Simulation models capture complex physical phenomena related to earth models' inherent geological complexity. The dynamic simulation and solution processes in a petroleum field remain a major challenge and an ongoing research topic due to the nonlinearity complexity in governing equations. The governing equations for fluid flow in porous media is based on mass, momentum, and energy conservation equations [2]. Based on standard black-oil reservoir simulation models, reservoir simulation models are divided into two groups.models as well as compositional models (Aziz and Settari, 1979). Individual components in compositional models had conservation equations written (Young and Stephenson, 1983).

To handle nonlinear problems, several analytical and numerical methods were used to solve the simulation models.However, the solutions are not exact due to linearization possibilities and various assumptions, and they failed to provide multiple solutions rather than a single solution for a set of governing equations. To predict the exact solution to a multivariable problem, an advanced numerical tool is required, and the solutions must be realistic rather than impractical [3].

Description

All current commercial computer simulators in the petroleum industry (e.g., Eclipse, CMG Suite, Tempest MORE, ExcSim, Nexus, FlowSim, etc.) solve the set of governing equations (including all algebraic, PDEs, and ODEs equations) by linearizing nonlinear governing equations and taking several assumptions into account. Because of the nonlinear behaviour of the equations, the solutions are not always ideal. According to Islam et al. (2010, 2016), these solutions vary with the realistic range of most petroleum parameters in a single-phase flow. Using advanced fuzzy logic, the researcher discovered significant errors in the prediction time of petroleum reservoir performance. When linearization occurs in the governing equations, the scenarios for multiphase flow deteriorate (Islam et al., 2016) [4].

Conclusion

The petroleum industry is the primary key to the global economy, and technological progress is based on it. Energy demand is rising, and crude oil production is currently around 90 million barrels per day. More oil and gas extraction from existing reservoirs is therefore critical if the industry is to meet future energy consumption growth. As a result, there is a need to improve reservoir performance and the hydrocarbon recovery mechanism, which is heavily influenced by appropriate reservoir simulation models. Crichton (1977) provided an overview of the simulation method for the petroleum industry [5].

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Conflict of Interest

There are no conflicts of interest by author.

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