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A New Screening Methodology for Improved Oil Recovery Processes Using Soft-Computing Techniques

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The first stage of production of any oil reservoir involves oil displacement by natural drive mechanisms such as solution gas drive, gas cap drive and gravity drainage. Typically, improved oil recovery (IOR) methods are applied to oil reservoirs that have been depleted naturally. In more recent years, IOR techniques are applied to reservoirs even before their natural energy drive is exhausted by primary depletion. Descriptive screening criteria for IOR methods are used to select the appropriate recovery technique according to the fluid and rock properties. This methodology helps in assessing the most suitable recovery process for field deployment of a candidate reservoir. However, the already published screening guidelines neither provide information about the expected reservoir performance nor suggest a set of project design parameters, which can be used towards the optimization of the process.

In this study, artificial neural networks (ANN) are used to build a high-performance neuro-simulation tool for screening different improved oil recovery techniques: miscible injection (CO2 and N2), waterflooding and steam injection processes. The simulation tool consists of proxy models that implement a multilayer cascade feedforward back propagation network algorithm. The tool is intended to narrow the ranges of possible scenarios to be modeled using conventional simulation, reducing the extensive time and energy spent in dynamic reservoir modeling.

A commercial reservoir simulator is used to generate the data to train and validate the artificial neural networks. The proxy models are built considering four different well patterns with different well operating conditions as the field design parameters. Different expert systems are developed for each well pattern. The screening networks predict oil production rate and cumulative oil production profiles for a given set of rock and fluid properties, and design parameters.

The results of this study show that the networks are able to recognize the strong correlation between the displacement mechanism and the reservoir characteristics as they effectively forecast hydrocarbon production for different types of reservoir undergoing diverse recovery processes. The artificial neuron networks are able to capture the similarities between different displacement mechanisms as same network architecture is successfully applied in both CO2 and N2 injection. The neuro-simulation application tool is built within a graphical user interface to facilitate the display of the results.

The developed soft-computing tool offers an innovative approach to design a variety of efficient and feasible IOR processes by using artificial intelligence. The tool provides appropriate guidelines to the reservoir engineer, it facilitates the appraisal of diverse field development strategies for oil reservoirs, and it helps to reduce the number of scenarios evaluated with conventional reservoir simulation.