Recent Advances in
Petrochemical Science
ISSN: 2575-8578

Juniper Publishers
key to the Researchers

Opinion
Volume 2 Issue 4 - July 2017
DOI: 10.19080/RAPSCI.2017.02.555591

Recent Adv Petrochem Sci

The Application of Supercritical Carbon Dioxide for the Recovery of Residual Hydrocarbon Reserves at the Late Stage of Reservoir Engineering

Filenko DG[1], Dadashev MN[1*], Grigoryev EB[2] and Vinokurov VA[1]

[1]*Gubkin Russian State University of Oil and Gas, Russia*

[2]*State Scientific Research Institute of the Breving and Wine Industries, Russia*

Submission: July 18, 2017; **Published:** July 20, 2017

***Corresponding author:** Dadashev MN, Gubkin Russian State University of Oil and Gas, Moscow, Russia, Email: denfile@yandex.ru

Abstract

The unique experimental base which allows to investigation and model the processes of extraction, wipe hard-to-recover hydrocarbon resources from a variety of solid porous media in a wide range of state parameters including critical area, using a variety of solvents, including carbon dioxide, is created. The experiments on the displacement of various hydrocarbons from the reservoir model carbon dioxide in the temperature range 20-200 °C and pressures of 5 to 45 MPa, as well as qualitative experiments on the extraction of hydrocarbons from core samples are conducted. The experimental results obtained prove high efficiency of the supercritical carbon dioxide for the displacement and extraction of hard to recovery hydrocarbon deposits.

Keywords: Oil; Hydrocarbons; Carbon dioxide; Supercritical parameters; Thermodynamics; Reservoir engineering; Hard to recovery deposits

Opinion

Today in connection with a reduction in the volume of proven and recoverable oil reserves, the problem of the research and development of new, environmentally friendly, energy-saving technologies of extraction of unconventional hydrocarbons from a variety of porous media for oil companies is becoming increasingly important. This is due to the fact that in the overall structure of the resource base the role of this type of stocks is constantly increasing. The analysis of the state of the raw material base of Russia shows that solving the problem of reproduction only through the engineering of new reservoir in remote areas is almost impossible. However, in Russia about 60% of proven oil reserves are confined to collectors with hard to recover reserves, the engineering efficiency where by traditional methods is low.

Recently, in a number of countries are actively conducted research and development work on the use of supercritical fluid technology in the processes of oil production and refining.

The analysis of new technologies of improving oil recovery allows to select the method of carbon dioxide in the supercritical state injection into the reservoir as the most promising, which combines the advantages of other known technologies. Supercritical fluid technology is a new technological process based on unique properties of solvents, which they have in the supercritical state. At the critical point and above it there are sharp anomalies both thermodynamic and transport properties in the system of the solvent. Having high density characterizing liquids and low surface tension and viscosity characterize gases, supercritical fluids are able to penetrate deeply into a solid porous structure and to extract the soluble components.

The advantages of the proposed technology over conventional ones are: high process speed, high depth of extraction and the high yield of the target product, the possibility of fractional product release due to the variation of thermodynamic parameters (temperature and pressure), the possibility of regeneration of the solvent due to its high volatility and possibility of its reuse in the process cycle, the lack of harmful and environmentally hazardous reagents in the technological cycle, the relative simplicity of the process, more opportunities for diversification process. The disadvantages of this technology include the relatively high cost of equipment and high working pressures.

On the Department of physical and colloidal chemistry of Gubkin University is created the unique experimental base which allows to investigation and models the processes of extraction, wipe hard-to-recover hydrocarbon resources from a variety of solid porous media in a wide range of state parameters including critical area, using a variety of solvents, including carbon dioxide.

The experiments conducted on the displacement of various hydrocarbons from the reservoir model carbon dioxide in the temperature range 20-200 °C and pressures of 5 to 45 MPa, as well as qualitative experiments on the extraction of hydrocarbons from core samples. The experimental results obtained prove high efficiency of the supercritical carbon dioxide for the displacement and extraction of hard to recovery hydrocarbon deposits.

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How to cite this article: Filenko D, Dadashev M, Grigoryev E, Vinokurov V. The Application of Supercritical Carbon Dioxide for the Recovery of Residual Hydrocarbon Reserves at the Late Stage of Reservoir Engineering. Recent Adv Petrochem Sci. 2017; 2(4): 555591. DOI: 10.19080/RAPSCI.2017.02.555591