Determination of Fluid Flow Mechanisms in Berea Using Mercury Porosimetry and A Stochastic Model to Relate These Mechanisms to Oil Recovery

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by

Dr. Robert W. Watson

The Pennsylvania State University

Fathi H. Boukadi

The Pennsylvania State University

ABSTRACT

This work is part of on-going research aimed at correlating rock skeletal properties to oil recovery from sandstone, limestone and dolomite cores and incorporating these properties into a stochastic model for predicting oil recovery. As such, this report is divided into the analyses and interpretation of experimental data collected from core floods and correlated against measurements of wettability, tortuosity, pore entry diameter, surface area and pore length and the presentation of a stochastic model based on data obtained from these laboratory experiments which relates rock skeletal properties to oil recovery.

Analyses suggest that capillary pressure curve shapes and mercury incremental intrusion volume plots are useful in describing pore-size distribution in porous media. Further analysis shows that snap-off and bypassing mechanisms are related to the pore aspect ratio(ratio of pore-body to pore-throat) and to pore connectivity. Mercury trapping is pronounced in Berea cores where cul-de-sac configurations are abundant. Cul-de-sacs with significant pore aspect ratios are characterized by a high degree of trapping. Moreover, limited pore connectivity enhances trapping and mercury isolation as discontinuous blobs of mercury are difficult to recover following the intrusion-extrusion cycle.

In a Berea core, a strongly water-wet rock, the mercury-air system is best suited to represent an oil-brine system. Extensive experiments using 524 core plugs revealed that mercury recovery efficiency is related to rock porosity, pore hydraulic diameter and surface area available to the non-wetting phase. Analyses show that under capillary force dominance, mercury recovery efficiency is high for the tighter cores which have a small pore-entry diameter and a large rock surface area.

The results of the core analyses have been incorporated into a stochastic model. This model, based on reservoir architecture, can be used to predict reservoir performance and consequently oil recovery. The skeletal properties contained in the model will include: hydraulic diameter, rock surface area, pore-size distribution, wettability, tortuosity and porosity.