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Effect of Temperature on Oil/Water Relative Permeability in Different Rock-Fluid Systems

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The effect of temperature on oil/water relative permeability is an important issue in reservoir simulation studies of thermal recovery techniques for heavy oil and bitumen. However, experimental data on changes of relative permeability with temperature are for candidate reservoirs are time consuming and expensive to obtain. For more than half a century, a large number of scholars have endeavoured to delineate the effects of temperature on two-phase relative permeability curves using different oils and porous media. However, we still cannot predict how the relative permeability will change with temperature in a specific rock-fluid system. In fact, even a cursory review of the literature on the effect of temperature on oil/water relative permeability will show that a bewildering array of conflicting results have been reported. These inconsistent results are partly due to the likelihood that the effect of temperature is different in different rock-fluid systems and partly due to differences in the measurements techniques that can introduce varying experimental artifacts. The objective of this study was to see whether some of the contradictions in the reported results would be resolved by examining the effects of temperature on relative permeability separately in different classes of rock-fluid systems. Another objective was to develop empirical correlations for estimating the effect of temperature on oil/water relative permeability in different classes of rock-fluid systems. Reported results from a large number of experimental studies of the effect of temperature on relative permeability were collected to generate a large dataset of oil/water relative permeability curves. This dataset was partitioned into four parts representing four different classes of rock-fluid systems, namely: 1) light oil in sandstone, 2) heavy oil in sandstone, 3) light oil in carbonates and 4) heavy oil in carbonates. The effects of temperature on irreducible water saturation, residual oil saturation, the endpoint relative permeability to oil and water and the generalized Corey saturation exponents of oil and water were analyzed separately for each rock-fluid system. It was found that, although the scatter in reported data is very large, some discernable differences are present in the effect of temperature in different rock fluid types. Separate correlations were developed for these relative permeability parameters in different systems. Correlations for the overall effect of temperature on oil/water relative permeability in different rock-fluid were developed in the form of generalized Corey correlation with temperature dependent parameters.

Biography:

Brij Maini is a Professor and NSERC/Nexen & CNOOC Industrial Research Chair in Advanced In-situ Recovery Processes for Oil Sands in the Department of Chemical and Petroleum Engineering at Schulich School of Engineering, University of Calgary. Prior to joining University of Calgary faculty, he was a Senior Staff Research Engineer and Group Leader for Heavy Oil Research at the Petroleum Recovery Institute. He is a specialist in heavy oil reservoir engineering with research interests in improved heavy oil recovery methods and multiphase flow in porous media. He has authored more than 100 peer-reviewed journal papers and many more conference papers. He holds a B. Tech. degree in chemical engineering from the Indian Institute of Technology, Kanpur, India and a Ph.D. in chemical engineering from the University of Washington, Seattle. He is a registered professional engineer in Alberta and is a member of Society of Petroleum Engineers.