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Effect of Oil Viscosity and Brine Salinity/Viscosity on Water/Oil Relative Permeability and Residual Saturations

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Abstract : Oil recovery in petroleum reservoirs is greatly affected by fluid-rock and fluid-fluid interactions. These interactions directly control rock wettability, capillary pressure and relative permeability curves. Laboratory core-floods and centrifuge experiments were conducted on sandstone and carbonate cores to study the effect of low and high brine salinity and viscosity and oil viscosity on residual saturations and relative permeability. Drainage and imbibition relative permeability in two phase system were measured, refined lab oils with different viscosities, heavy and light, and several brine salinities were used. Sensitivity analysis with different values for the salinity and viscosity of the fluids,, oil and water, were done to investigate the effect of these properties on water/oil relative permeability, residual oil saturation and oil recovery. Experiments were conducted on core material from viscous/heavy and light oil fields. History matching core flood simulator was used to study how the relative permeability curves and end point saturations were affected by different fluid properties using several correlations. Results were compared with field data and literature data. The results indicate that there is a correlation between the oil viscosity and/or brine salinity and residual oil saturation and water relative permeability end point. Increasing oil viscosity reduces the Krw@Sor and increases Sor. The remaining oil saturation from laboratory measurements might be too high due to experimental procedures, capillary end effect and early termination of the experiment, especially when using heavy/viscous oil. Similarly the Krw@Sor may be too low. The effect of wettability on the observed results is also discussed. A consistent relationship has been drawn between the fluid parameters, water/oil relative permeability and residual saturations, and a descriptor may be derived to define different flow behaviors. The results of this work will have application to producing fields and the methodologies developed could have wider application to sandstone and carbonate reservoirs worldwide.

Keywords : history matching core flood simulator, oil recovery, relative permeability, residual saturations
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