Recovery of Various Fractions of Crude Oil in Porous Media at the Pore Scale: Application of Synchrotron X-Ray Microtomography

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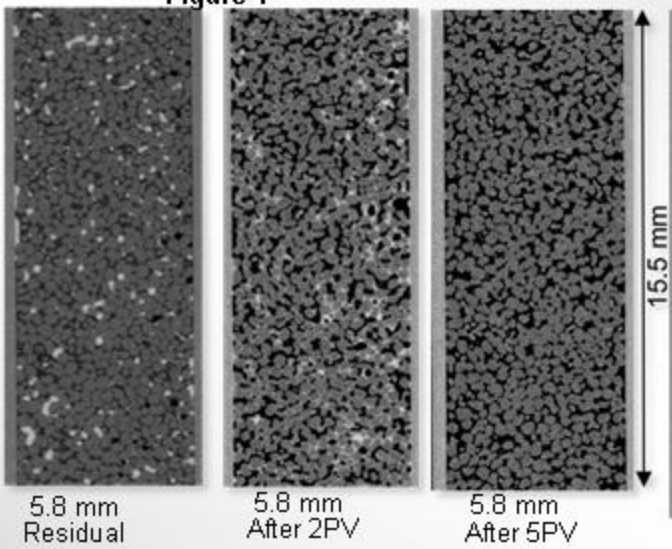
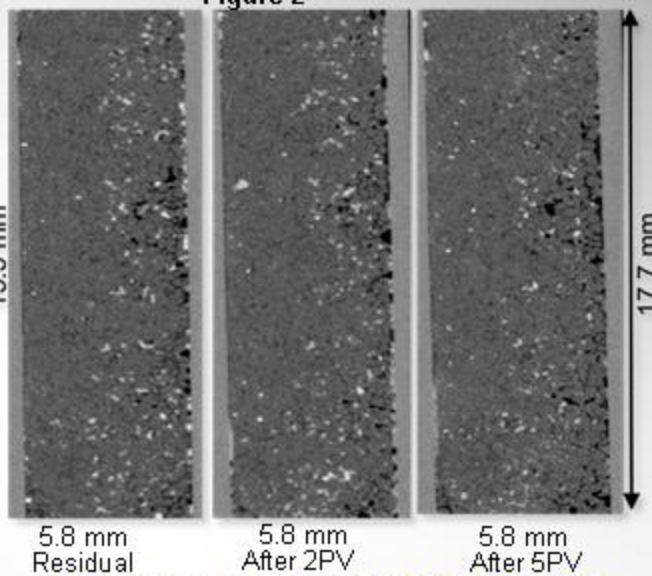
Figure 1



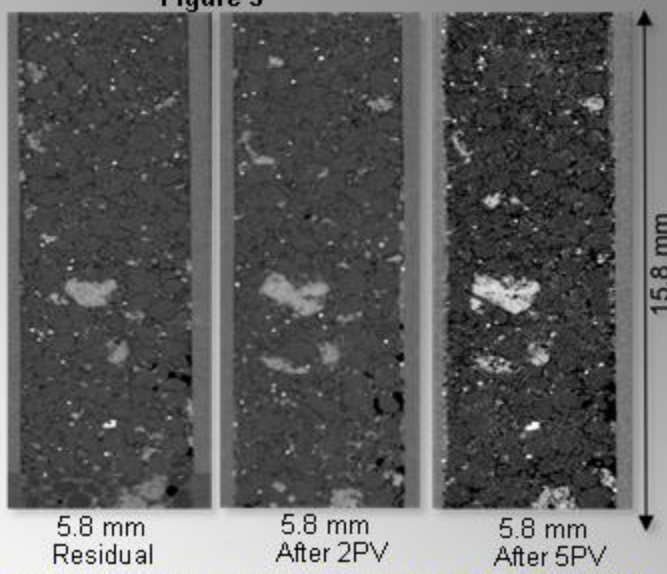
Homogeneous Porous Media (Cu = 1)

Figure 2



Heterogeneous Porous Media (Cu = 5.6)

Figure 3



Highly Heterogeneous Porous Media (Cu = 10.8)

Figures (1, 2, and 3) show oil recovery behavior of light (41.4° API) gravity crude oil in homogeneous, heterogeneous and highly heterogeneous media (Cu_{media} = 1, 5.6, &10.8 respectively) after sequential surfactant flushing for 2 pore volumes (PV) and 5 PV. Both light and medium oil show 100% recovery from homogeneous medium and 10-40% recovery from two heterogeneous media. Blob size distribution in various crude oil-media systems were characterized and compared as lognormal distribution (Figure 4, 5, and 6). Both light and medium oil residual saturation within homogenous and highly heterogeneous media show relatively homogeneous distribution (Cu_{blob} and Cv_{blob} ranges from 2-3) compared to more heterogeneous distribution (Cu_{blob} and Cv_{blob} ranges from 3-14) within the medium heterogeneity porous medium. For both oil fractions, the number of blobs increased after each surfactant flooding event by segregating into smaller particles and blob morphology deviated greater from spherical shape (Figure 7,8 and 9 show results for only light oil), thereby increasing the blob contact surface area with flushing time. These results reveal that oil distribution pattern and trapping mechanisms are controlled by the heterogeneity of the media, whereas the extraction potential for a particular reservoir is highly dependent upon the available surface area and the flow dynamics of the oil blobs controlled by the surfactant flooding event.

Figure 4

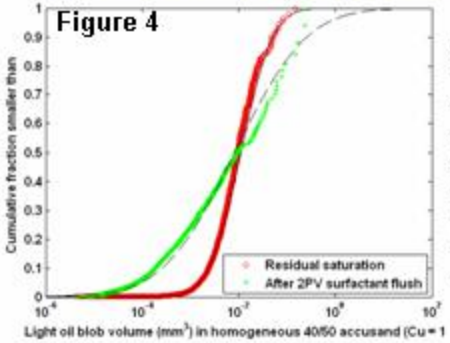


Figure 5

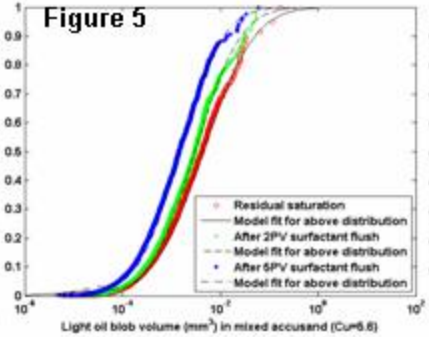


Figure 6

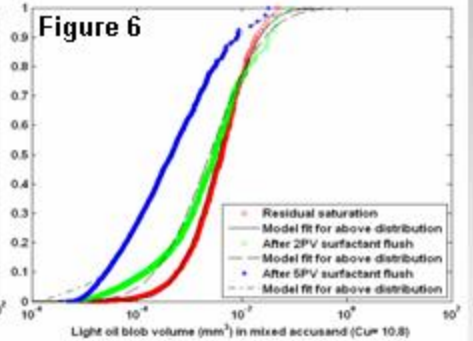


Figure 7

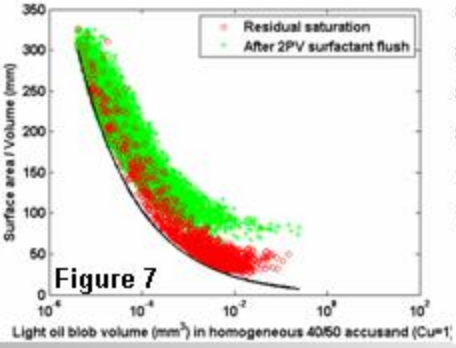


Figure 8

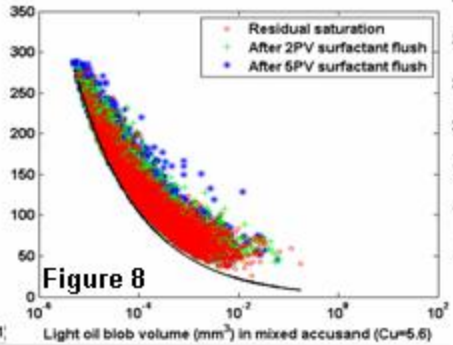


Figure 9