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Factors influencing shale wettability from nano to macro-scale

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Shale rocks remain the least understood sedimentary rocks. In particular, shale rocks depict a complex wetting behavior which is arguably due to complex microstructure of shales. This work investigates wettability of shale/decane/brine systems as a function of pressure, temperature and brine salinity. Moreover, nano-fluid aged shale surfaces are also investigated to examine the potential nanoparticles for shale wettability alteration. To elucidate the wetting behavior, advancing and receding contact angles are measured for pressures ranging from 0.1 MPa to 20 MPa and temperatures ranging up to 323 K. Three shale samples (Mancos, Eagle Ford and Wolf Camp) are investigated.

The results indicate that all shale surfaces demonstrate distinct wetting behavior at ambient and high pressure conditions. For instance, Mancos was water-wet while Eagle Ford and Wolf Camp depicted oil-wet state. Increase in pressure resulted in a slight increase in contact angle –which contradicts some previously published literature findings. Notably, the temperature effect was quite inconsistent i.e. for Mancos and Wolf camp increase in temperature led to more oil-wet surfaces while Eagle Ford turned more water-wet with increasing temperature. This discrepancy may be attributed to high quartz content of Eagle Ford samples. Moreover, with increasing concentration silica nanoparticle, shale surfaces turned much more water wet. This can have implications for the use of silica as an additive in hydraulic fracturing and potential chemical EOR options. The optimum concentration for maximal wetting alteration were 1 wt. % for Eagle Ford, and 5 wt. % for Wolf Camp and 2 wt. % for Mancos.

A high degree of heterogeneity was also evident from the obtained SEM images of all samples and nanoparticle adsorption was also observed in some of the samples at micro-scale. More interestingly, surface roughness of all shale samples were investigated via AFM (Atomic Force Microscopy) before and after exposure to nano-fluids and the results indicated an increase in nanoscale surface roughness after nano-fluid treatment. Lastly, Fourier Transfer Infrared Spectroscopy measurements were also conducted on all shale samples and an abundance of oxygen containing functional groups was observed for Mancos sample which explained its water-wet behavior.

The results of this study thus provide new insights into the factors affecting shale rock wettability from nano to macro-scale. The results have implications for understanding fluid flow in shale rocks.

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References

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

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