Effect of Mineral-Scale Inhibitors on Particle Size Distribution of CaCO$_3$ and BaSO$_4$.

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Introduction

The oil industry applies chemical treatments using formulations known as inhibitors to control and mitigate inorganic deposits. Usually these formulations contain organic phosphates compounds or polyacrylate based polymers. Inhibitors can be continuously or periodically (squeeze process) injected into the reservoir matrix. They are able to control the processes of nucleation and/or crystal growth of precipitating salts by preventing adhesion on the walls and/or blocking the growing sites$^{1,2}$.

In this work was investigated the effect of some inhibitors on the particle size distribution of CaCO$_3$ and BaSO$_4$ formed by the addition of carbonate and sulfate ions to synthetic formation water (AF-W2), by monitoring the growth process of salt particles in real time. Particle size distributions were measured with the Mastersizer 2000 (Malvern) during 1 hour. Measurements started after the reagent solutions were gradually mixed at 1750 rpm in the tank of the wet dispersion unit “Hydro 2000S” and the laser obscuration reached the level of at least 10%, with or without the following commercial inhibitors: (Polyphosphonocarboxylic acid – PPCA), (Diethylenetriamine penta(methylene phosphonic acid) – DETPMP) and an organophosphonic acid (AOP).

Results and discussion

Addition of SO$_4^{2-}$ to AF-W2

For all the 3 inhibitors at the initial stages (Figure1) are not observed particles with $\Phi$ bigger than 10 $\mu$m but all the systems clearly indicate in Figure 2 a growing process (Ostwald ripening and dynamic coalescence), much more significant for DETPMP.

Addition of CO$_3^{2-}$ to AF-W2

Also with addition of carbonate, at the initial stages are not observed particles with $\Phi$ bigger than 10 $\mu$m, for all the 3 inhibitors. However all the systems clearly indicate in Figure 3 a multi-population growing process (Ostwald ripening and dynamic coalescence), less significant for DETPMP and more substantial for AOP.

Conclusions

This in situ light scattering technique is capable to determine the size and size distribution of scaling particles during the growth process. By following the evolution of the particle size distribution in real-time it is possible to better understand how an specific inhibitor works in scale controlling; if it acts in the processes of nucleation and/or crystal growth of the precipitating salt. It is also possible to observe which inhibitor is more efficient towards a particular salt: for BaSO$_4$ AOP and PPCA present similar effect while DETPMP is less effective; for CaCO$_3$, DETPMP presents the best efficiency and AOP shows the lowest performance.

Aknowledgment

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