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 CaCO3 and BaSO4 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 Φ bigger than 10 μm but all the systems clearly indicate in Figure 2 a growing process (Ostwald ripening and dynamic coalescence), much more significant for DETPMP.

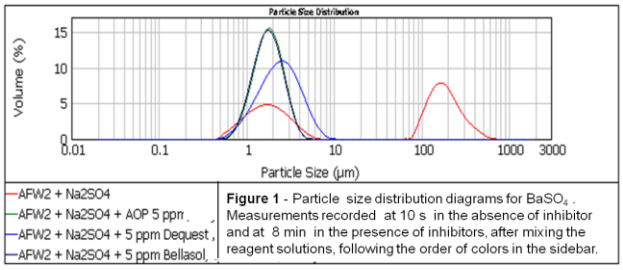

Figure 1 - Particle size distribution diagrams for $BaSO_4$. Measurements recorded at 10 s in the absence of inhibitor and at 8 min in the presence of inhibitors, after mixing the reagent solutions, following the order of colors in the sidebar.

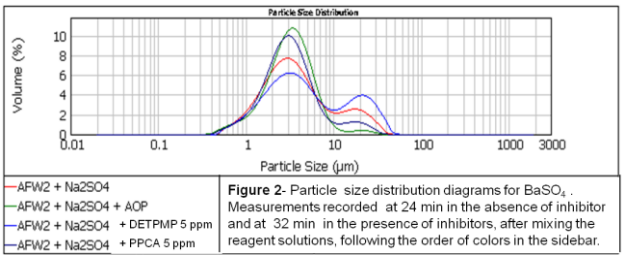

Figure 2- Particle size distribution diagrams for $BaSO_4$. Measurements recorded at 24 min in the absence of inhibitor and at 32 min in the presence of inhibitors, after mixing the reagent solutions, following the order of colors in the sidebar.

Addition of CO_3^{2-} to AF-W2

Also with addition of carbonate, at the initial stages are not observed particles with Φ bigger than 10 μm, 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.

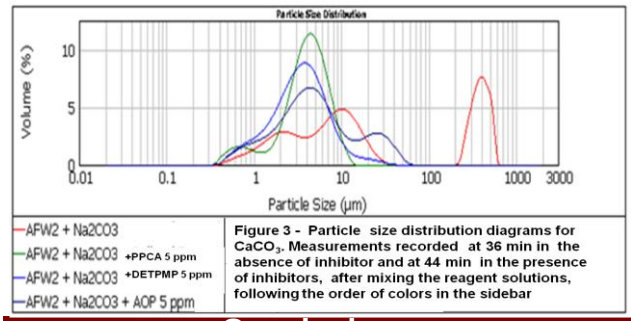

Figure 3 - Particle size distribution diagrams for $CaCO_3$. Measurements recorded at 36 min in the absence of inhibitor and at 44 min in the presence of inhibitors, after mixing the reagent solutions, following the order of colors in the sidebar

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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