Introduction

Barite (BaSO₄) scale formation is a problem in many industrial processes, especially in oilfields where mixing sea water with reservoir water can result in solid layers of barite scale that can completely block pipes. Organic compounds (e.g. organophosphonates) have been used as inhibitors for barite precipitation. The effectiveness of these compounds is pH-dependent, usually more effective at high pH where they are highly deprotonated.

Thus we need to determine the influence of pH on barite nucleation and growth before the performance of organic additives as barite scale inhibitors can be assessed.

Experimental procedure

Growth experiments. In situ AFM growth experiments were performed at room temperature in a fluid cell of a Digital Instruments (Veeco Instruments, Gmbh) Multimode AFM, working in contact mode.

Optically clear barite single crystals were cleaved immediately before each experiment to expose an (001) surface. The precipitates formed were studied using AFM, working in contact mode.

Conductivity experiments: A fluid cell of a Digital Instruments (Veeco Instruments, Gmbh) Multimode AFM, working in contact mode. Conductivity and pH were continuously monitored.

Nucleation experiments. Barite nucleation was studied from the evolution of turbidity and conductivity of supersaturated BaSO₄ solutions obtained by mixing BaCl₂ and Na₂SO₄ solutions at various pH. Turbidimetry experiments: UV-Vis Spectrophotometry was used to determine the onset of nucleation. The precipitates formed were studied using FESEM.

Conclusions

The higher concentration of strongly hydrated OH⁻ ions in high pH solutions could reduce Ba²⁺ hydration in solution and help desolvation of barite surfaces. Thus, this would eventually facilitate barite scale formation as suggested by our results. The reduction in interfacial tension and particle size found at high pH 10 is also consistent with the observed nucleation enhancement in those solutions.

References