

Evaluation of inhibitors performance for calcium carbonate scale in high ionic strength medium based on pH continuous measurements

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Introduction

The oil and gas industry uses inhibitors to control the formation of scale onto its facilities, such as pipelines and valves. The action of the inhibitor depends on the characteristics (ionic concentration, temperature, pH, pressure, etc.) of the scaling medium to which they are applied. Therefore it is very important to develop rapid methods to assess the suitability of an inhibitor to a particular fouling environment.

If the resulting scale is primarily due to deposits of calcium carbonate, measurements of pH variation when two solutions are slowly mixed producing potentially scaling brines has been object of some studies [1,2].

In this work the brine pH was continuously measured before and after sudden addition (jar test) of calcium carbonate solution to a solution containing calcium chloride in high ionic strength (≈ 4.0 M), in the absence and presence of two scale inhibitors, diethylenetriamine pentamethylene phosphonic acid (DETPMP) and phosphino polycarboxylic acid (PPCA), to evaluate their inhibiting performance.

Results and Discussion

The curves of pH versus time can be seen in Figure 1. Each curve represents the average of three experiments, which presented good reproducibility. The results clearly show the effect of the presence of each inhibitor in the formation of CaCO_3 and also allow the differentiation between them. With both inhibitors there is a slowing of the initial decrease in pH, which points the start of precipitation that is much more abrupt in the experiment without inhibitor (see insert). The equilibrium pH (Table 1) is much lower in the situation without inhibitor, indicating a higher consumption of carbonate and therefore more precipitation of CaCO_3 . When the inhibitor PPCA was added, which mainly acts inhibiting nucleation, it is observed that the beginning of the decrease in pH is slower than when using DETPMP that acts more as a growth inhibitor for CaCO_3 . The equilibrium pH in the presence of PPCA is lower because although this inhibitor decreases nucleation, once nuclei are formed they will grow more than in the presence of a growth inhibitor.

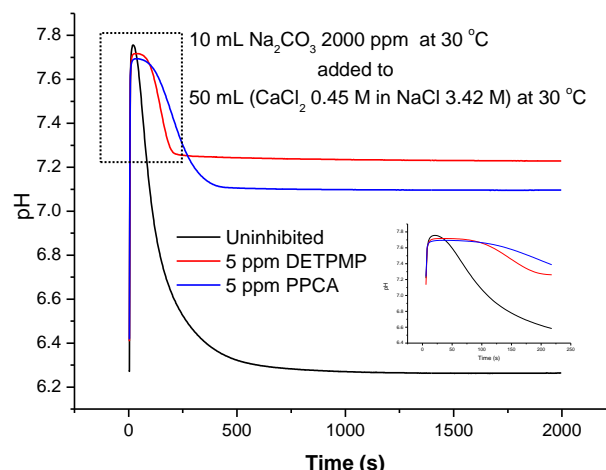


Figure 1. PH variation curves obtained in jar tests with and without addition of inhibitors.

Table 1. Average values of equilibrium pH.

Condition	pH
Uninhibited	6,26 ± 0,02
PPCA (5 ppm)	7,10 ± 0,02
DETPMP (5 ppm)	7,23 ± 0,03

Conclusions

This study demonstrates the viability of using continuous measurements of pH change in jar tests to evaluate the effect of inhibitors in scaling environments. The pH versus time curves are very reproducible and allow even differentiate the main form of action of the inhibitor: nucleation or growth inhibition. This methodology is a fast, efficient and low-cost way to assess inhibitors for in bulk CaCO_3 formation.

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¹Zhang, X.; Wu W.; Li, D.; G. Zhao, G. *Adv. Mater. Res.* **2012**, 356-360, 356-360, 2146.

²Sousa, M. F.B.; Bertran, C. A. J. *Colloid Interface Sci.* **2014**, 420, 57.