Scale Inhibitor Retention and Release on Carbonate Substrates

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Applications

- Water management in Carbonate systems
- CO_2 EOR in Carbonate
- Brine production in CO_2 injection systems

BACKGROUND

Mineral scales:

$$Ca^{2+}_{(aq)} + CO^{2-}_{3(aq)} \leftrightarrows CaCO_{3(s)}$$

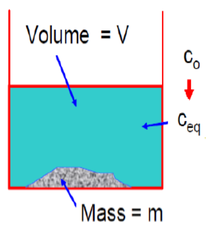
- Reduced production
- Increased costs
- Equipment damage

Scale inhibitors are chemicals that prevent the formation of scale.

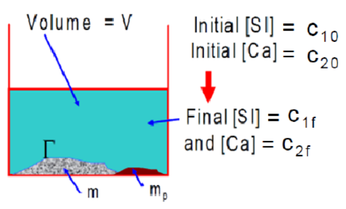
Retention mechanisms of SI:

- **Pure adsorption (Γ)**

$$SI + n{\cdot}Ca \rightleftharpoons SI_Ca_n$$



- **Coupled Adsorption/ Precipitation (Γ/Π):**



WHY / PURPOSE

The main purpose of this study is to extend the current knowledge and understanding of

SI ↔ Carbonate ↔ Brine

interactions relating to SI squeeze treatments.

Our goal for this part of the study is to see:

- The adsorption/precipitation behaviour of DETPMP in carbonate systems.
- Monitor pH Trends at Room Temperature and 95ºC.
- Study Co-precipitation of DETPMP with Ca^{2+} at various temperatures.
- Determine the Stoichiometry (N) of Ca_N_SI complexes.

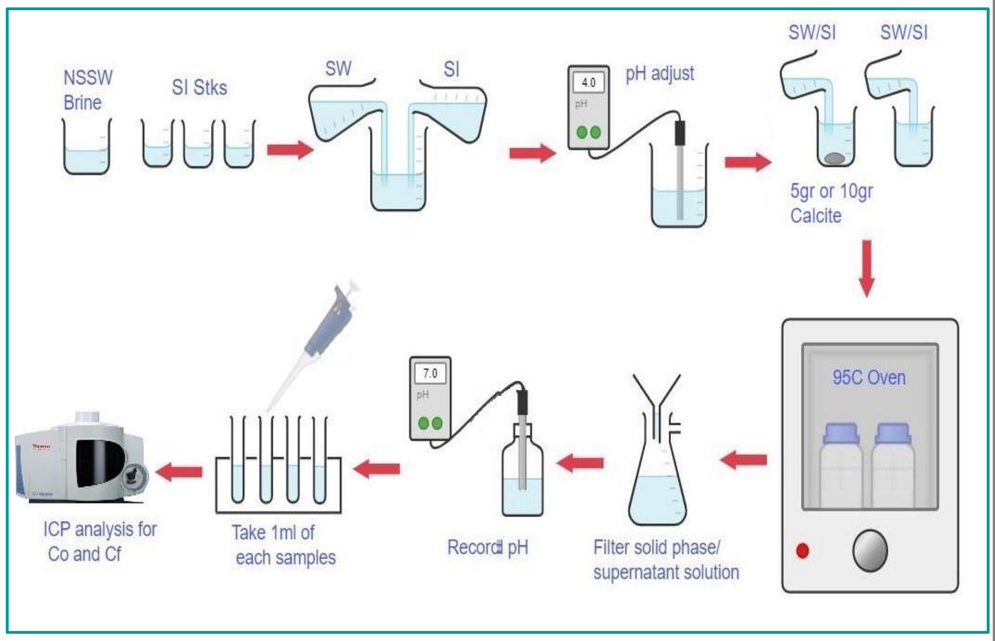
Future aims:

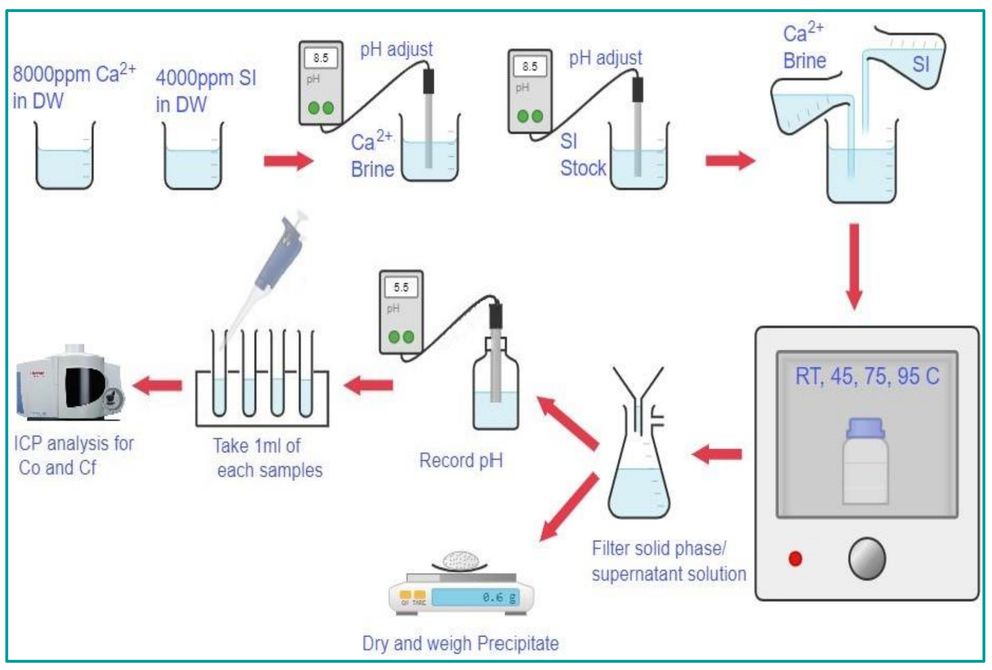
- Analyse results with Core Flood systems and also provide inputs for modelling work that is running by other FAST group members.

METHODOLOGY

Apparent adsorption/compatibility experiments (Γapp)

- Room Temperature and 95C
- pH_0 =4
- Different Mass/Volume ratios
- Analyse the ion concentrations: P, , Ca^{2+} , Mg^{2+}, Li^{+} before and after the experiment, i.e. initial and final concentrations.





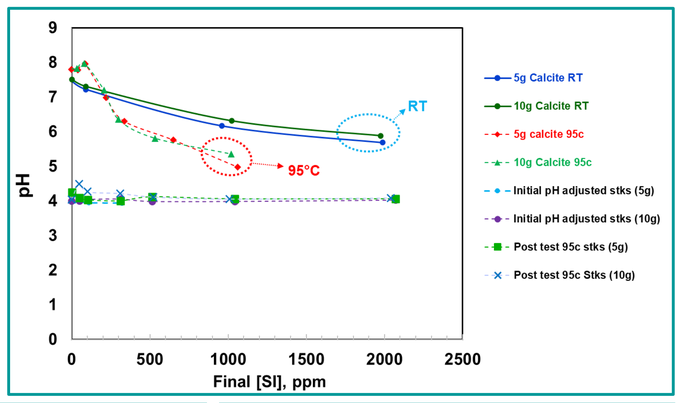
Static precipitation experiment was carried out for the purpose of purification or eliminating the unwanted phosphorus-containing compounds.

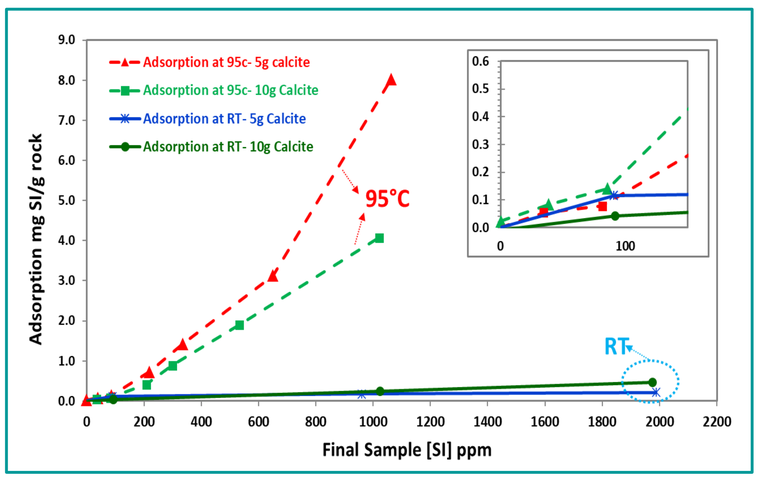
- RT, 45ºC, 75ºC and 95ºC
- pH_0 = 8.5
- $[Ca^{2+}]$= 4000 ppm, [SI]= 2000 ppm
- SI_Ca_n complexes, P, Ca^{2+} concentrations assayed with ICP.

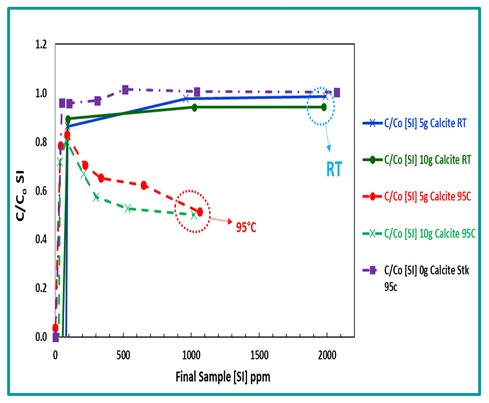
RESULTS

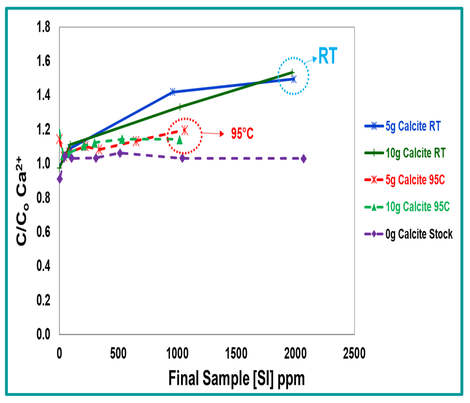
Apparent adsorption/compatibility experiments (Γapp)

The apparent adsorption, Γ_{app}, vs. C_f, the final scale inhibitor concentration is plotted. These plots identify whether the retention mechanism was pure adsorption or coupled adsorption/precipitation using two mass/volume (m/V) ratios of substrate/test volume.



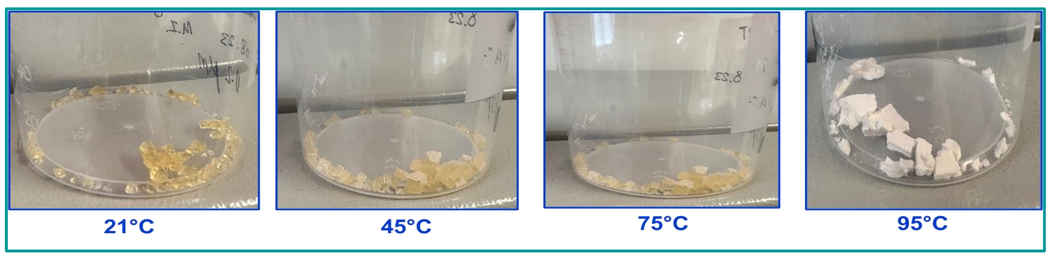


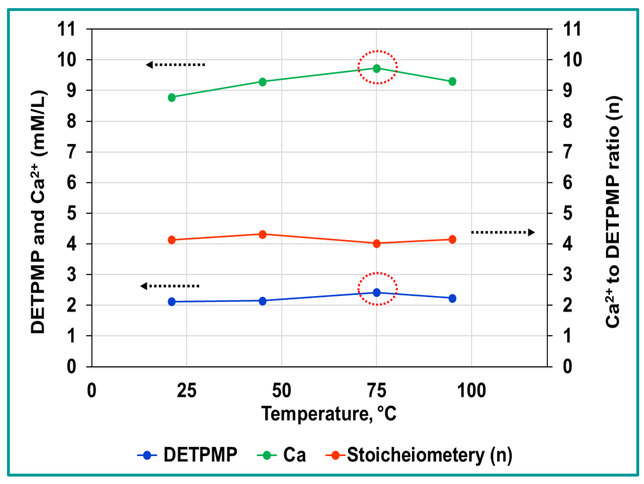




Static precipitation and redissolution experiment

The amounts of precipitate in all test temperatures are very similar but each temperature precipitate has different colours.





(Jarrahian, K., K. Sorbie, M. Singleton, L. Boak and A. Graham (2020). "Building a fundamental understanding of scale-inhibitor retention in carbonate formations." SPE Production & Operations **35**(01): 085-097.)