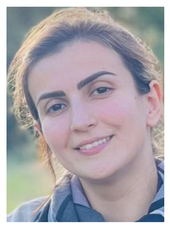


Scale Prediction and Prevention during Geothermal Brine Production

Sh. Mohammadi, K.S. Sorbie, L.S. Boak, Kh. Jarrahian, E.J. Mackay sm2219@hw.ac.uk
Heriot-Watt University

energi SIMULATION

BACKGROUND

- **Scale Problem in Geothermal Power Plants**
  - Exploitation of geothermal resources, upon flashing and cooling of brines, is frequently accompanied by significant scale deposition and a decrease in the amount of obtained energy from the power plant.
- **Common Scales**
  - Amorphous Silica
  - Metal Hydroxides/ Silicates
  - Carbonates (e.g. $CaCO_3$)/ Sulphates (e.g. $CaSO_4$)
- **Scale Inhibition Approaches**
  - Scale Inhibitors
  - Acidification/ alkalinization of the disposal brine
  - Aging silica over-saturated waters
  - Treating the brine with various metal cations
  - Reinjecting the disposal brine at higher temperature

Objective/ Why

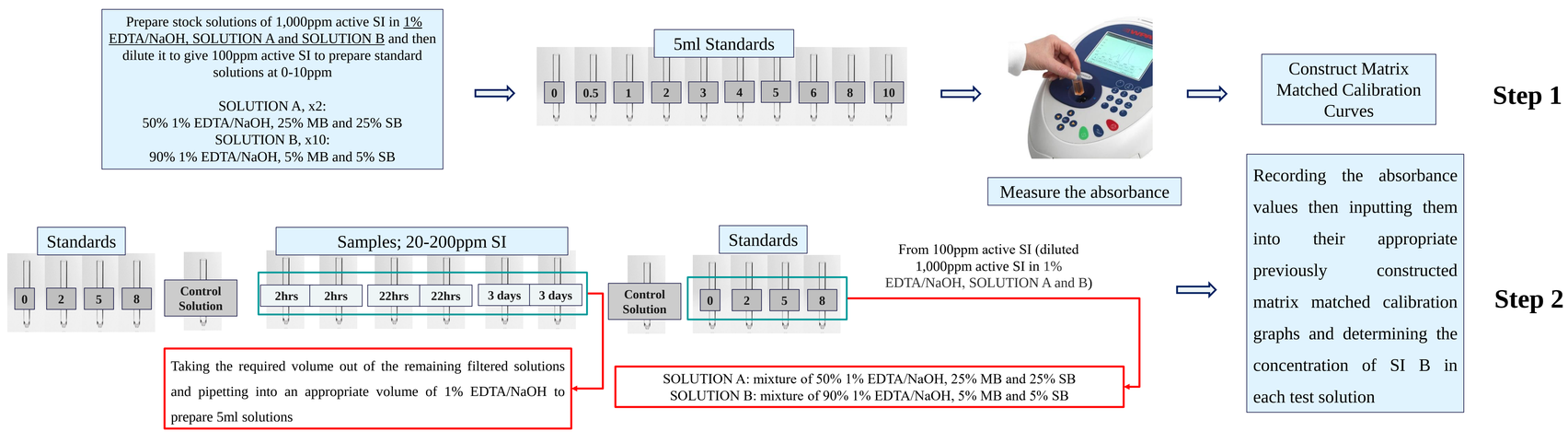
- **Objective**
  - Developing a static bottle test methodology to assist in identifying efficient silicate inhibitors/dispersants with high inhibition performance (80-90%), applicable for low enthalpy geothermal heat recovery systems to prevent silicate scale from occurring.
- **Why?**
  - In geothermal power plants, silica scaling is recognized as a potential limiting factor in the amount of extracted energy.
- **Context of Study**
  - Investigating inhibition efficiency and mechanism of two polymer-based scale inhibitors/dispersants, denoted A5 and SI B through determining the concentration of sulphur, contained within their structure, alongside the scaling ion consumption of magnesium and silicate by ICP-OES and measuring their polymer concentration by a matrix matched Hyamine technique.

METHODOLOGY

TEST CONDITIONS	
Mg:Si Mix Concentrations (ppm)	Worst Silicate Case 60ppm:940ppm
Mg:Si Mix Ratio	50:50
pH	8.5
T	60° C and 95° C
Overall Test Volume	100ml
Quench Solution	1% EDTA/NaOH

INHIBITION EFFICIENCY TEST PROCEDURE

MATRIX MATCHED HYAMINE TEST

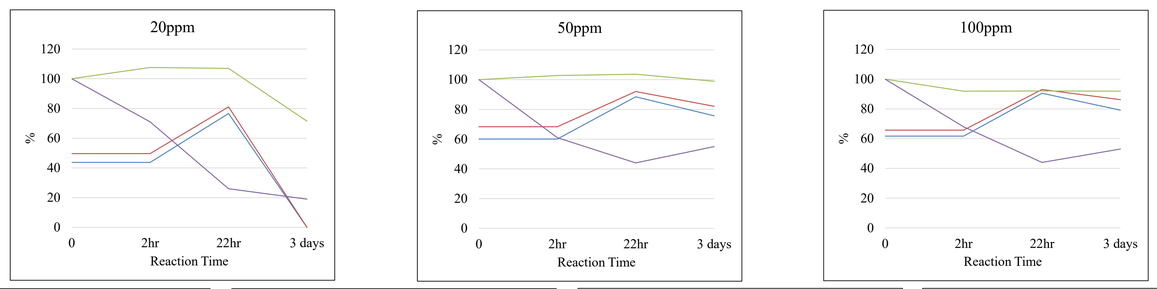


RESULTS

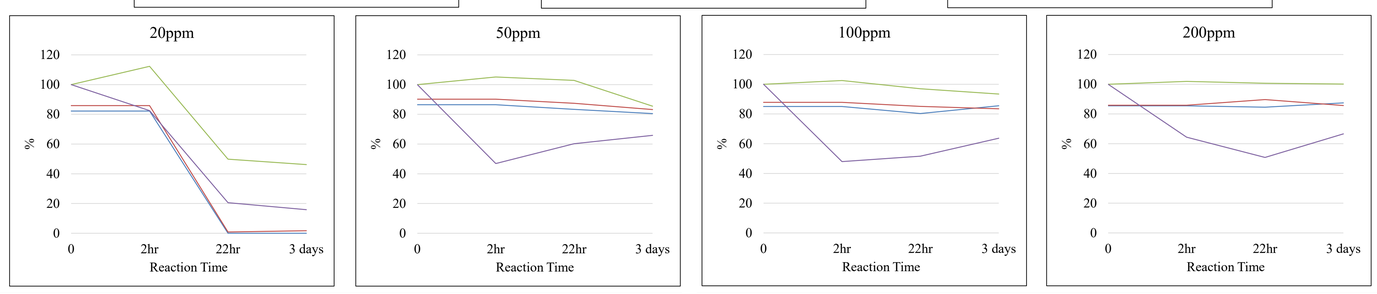
IE, Sulphur and Polymer in Solution (%)

SI B

60°C



95°C

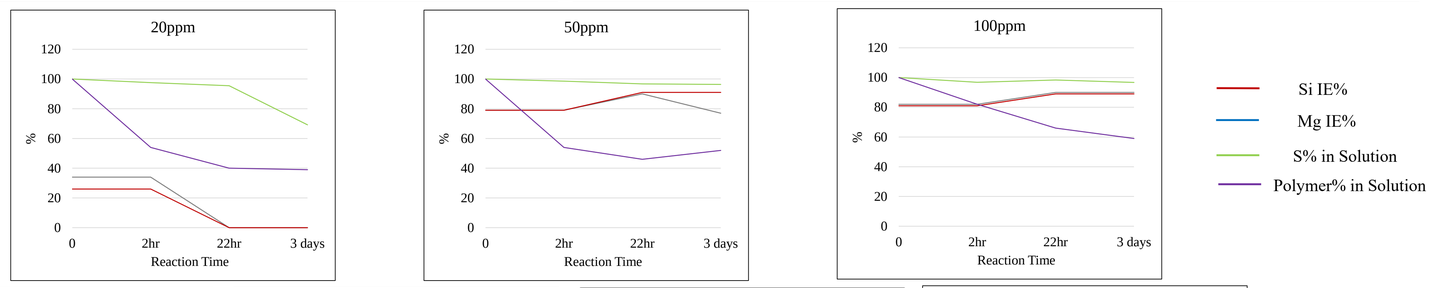


SI B 60°C
- At 50ppm and above, SI B shows ~90% IE at 22hrs & 3 days
- SI B is less effective at short 2hrs residence times
- Highest SI B sulphur and polymer consumption is at 20ppm at 30% and 80%, respectively
- However, less polymer (~ 50%) and no sulphur consumption is observed at 50-100ppm

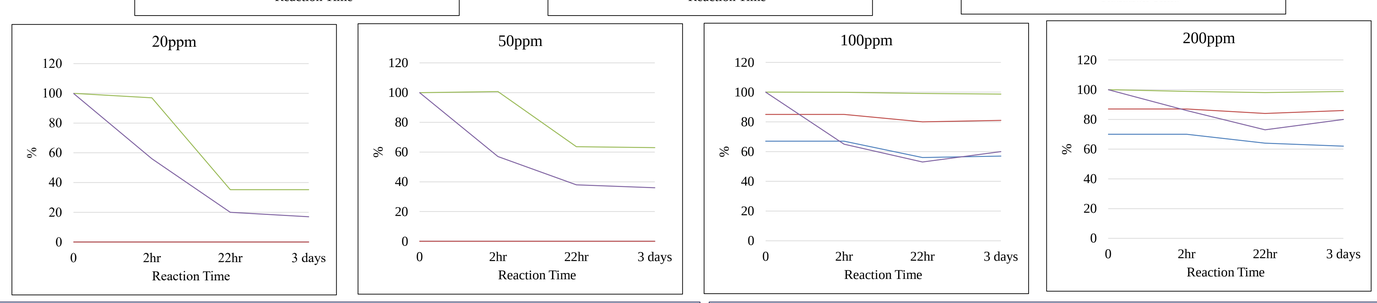
SI B 95°C
- 50ppm SI B is required to effectively control silicate scale formation
- At concentrations ≥ 50ppm, SI B is effective to a similar level at all sampling times
- Where 20ppm SI B is unable to protect against silicate scaling, sulphur and polymer consumption are highest, at 55% and 85%, respectively.

A5

60°C



95°C



A5 60°C
- ≥ 50ppm A5 inhibits silicate scale with best IE performance at 22hrs & 3days
- No IE % for 20ppm A5/22hrs onwards, significant sulphur and polymer decline observed
- For 50 and 100ppm A5, little sulphur (less than 5%) and 50 - 40% polymer consumption respectively observed. This allowed Si and Mg IE% of between 80 - 90%.

A5 95°C
- ≥100ppm A5 is required to control scale
- The greatest polymer and sulphur consumption is at 20ppm and 50ppm.
- For higher A5 concentrations with 60-90% inhibition efficiency performance, negligible sulphur consumption is noted with polymer consumption of 30-40% observed

Conclusions

- The Hyamine technique was selected as the more robust method for determining the consumption of SI, as it quantifies the whole polymer product.
- At 60ºC, ≥ 50ppm SI B is required to achieve an IE of 60-90% over 3days with 40-60% polymer remaining in solution. While, at 95ºC, ≥ 50ppm SI B is needed to effectively control scale formation at 80-90% with 40-60% polymer left in solution, hence SI B performs better at higher temperature.
- For A5 at 60ºC, ≥ 50ppm records 80-90% IE with 50-60% polymer remaining in solution over 3 days. However, at 95ºC, ≥ 100ppm A5 gives 70-90% IE with 50-70% polymer left in solution.
- SI B is the more effective SI under the tested conditions.