SMART BRINES FOR MINIMAL SURFACE ADSORPTION IN POLYMER ENHANCED OIL RECOVERY(EOR)

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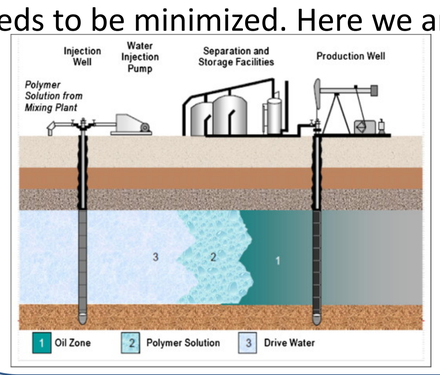
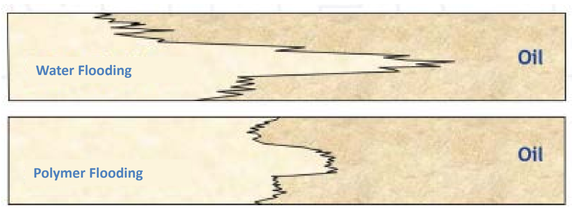
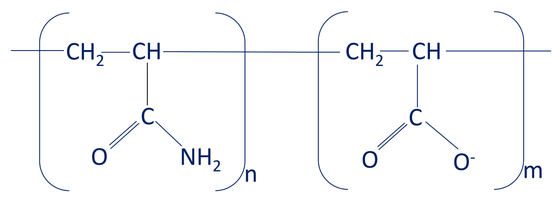
PROBLEM STATEMENT

The polymer EOR utilizes high molecular weight polymers to improve the viscosity of the displacing aqueous phase. This polymer-brine solution has a better sweep efficiency than the normal brine solution. But the polymers get adsorbed on the rock surface. Polymer adsorption on the pore surface has a negative impact and therefore needs to be minimized. Here we are investigating polymer adsorption fundamentally through QCM.







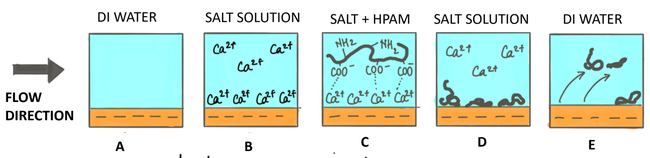
Chemical formula of Flopaam: Random copolymer of Polyacrylamide (70%) (the left,n) and polyacrylic acid (30%) (the right,m)

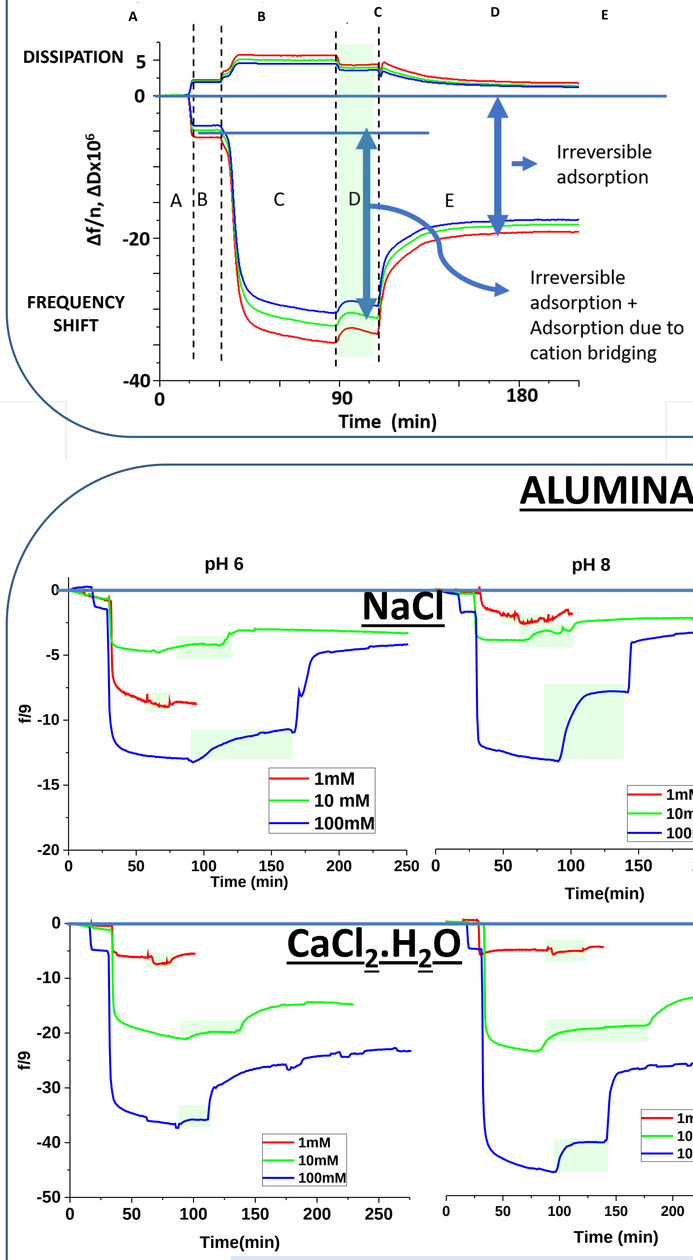
Some factors affecting adhesion:

- ✓ Charge on the polymer
- ✓ Surface charge (charge on the clays)
- ✓ Ions present in the brine
- ✓ pH of the solution

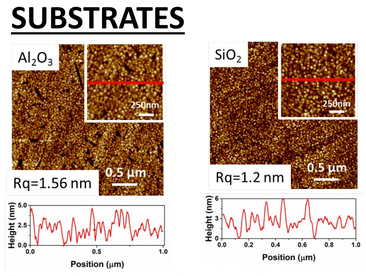
QCM-D

Upon passing the polymer solution, the sensor undergoes frequency shift (Δf) and Dissipation shift (ΔD) due to adsorption, density and viscosity effects.. Polymer studied: **Flopaam (40 kDa , 2000 ppm solution)**





SUBSTRATES



Topographical features of silica and alumina and their corresponding height profiles[1]

SALTS (1,10,100 mM)

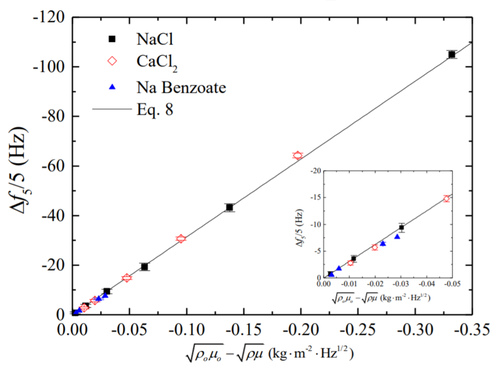
- ➢ NaCl
- ➢ $CaCl_2.2H_2O$

pH : 6 and 8

ANALYSIS

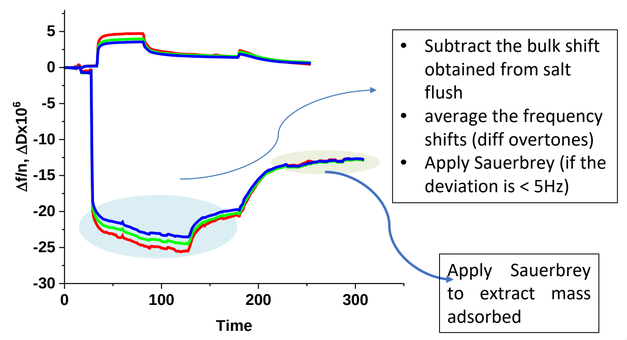
Assumptions:

- The system is very dilute ⟶ the bulk properties of polymer solution≈the bulk properties of salt solution
- Newtonian fluid
- The adsorbed film is rigid and uniform



$$\frac{\Delta f_n}{n} = \left(\frac{1}{C}\right)\hat{\Gamma} - \frac{\beta}{n^{1/2}}\left(\sqrt{\rho\eta} - \sqrt{\rho_o\eta_o}\right)$$

The frequency shift due to bulk can be calculated using modified Sauerbrey equation[2]



SAUERBREY EQUATION

$$\hat{\Gamma} = -C\frac{(f - f^*)}{n} = -C\frac{\Delta f}{n}$$, Where C= 17.7 ng/cm² Hz

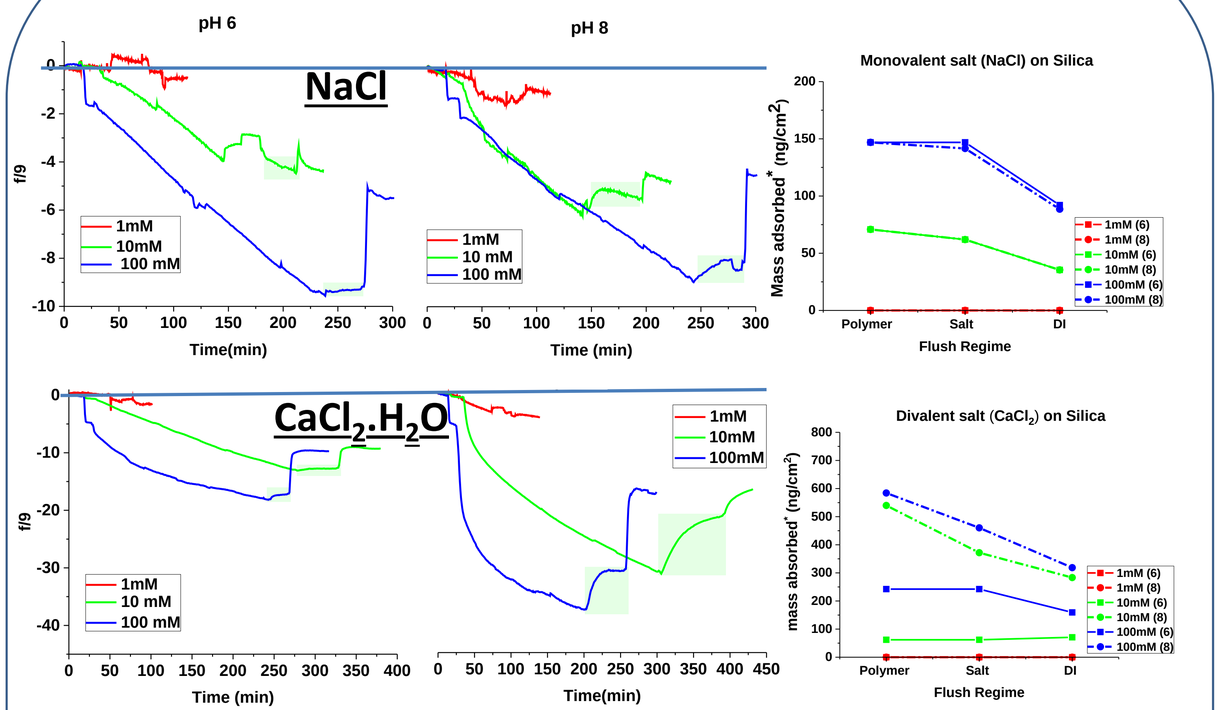
ALUMINA

- ➢ Immediate adsorption of polymers upon injection

More adsorption in the presence of Ca^{2+} ions and pH 8.

- ➢ Adsorption mechanism can be a combination of ligand exchange and cation bridging .

SILICA



- ➢ Adsorption has kinetics and needs to be probed*
- ➢ More adsorption in the presence of Ca^{2+} ions and pH 8.
- ➢ Adsorption mechanism is mainly via cation bridging .

CONCLUSIONS

- ➢ The adsorption mechanism differs on alumina and silica
- ➢ For alumina and silica in presence of monovalent salts, there is no pH dependence for adsorption.
- ➢ Ca^{2+} (divalent) ions and pH 8 combination lead to increased adsorption of Flopaam on both silica and alumina !!

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SNF

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