**Micromodel Study on Pore-Scale Mechanisms Associated with Permeability Impairment in Porous Media**

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**BACKGROUND AND MOTIVATION**

- Methane Hydrate bearing sediments are potential energy resource reserving 500-1000 Gt of carbon world wide.
- Dissociation of hydrate into gas and water is the preliminary process in gas production.
- Mobilization and migration of fines during gas production reduce the permeability of the formation.
- Laboratory column studies reveal the reduction in permeability during single and two-phase flow.
- Clogging of pore throats by fines significantly decrease the permeability.
- The fines mobilized by the gas-water interface might impact the permeability.
- The different pore-scale mechanisms need to be conducted to understand the mechanisms responsible for permeability reduction during two-phase flow.

**OBJECTIVES**

The objective of this study was to investigate the pore-scale mechanisms associated with fines mobilization on permeability reduction during two-phase flow using a micromodel.

**EXPERIMENTAL STUDY**

**MATERIALS**

- Glass Micromodel fabricated by Micronet Microfluidics
- Fines: Carboxylate modified Polystyrene latex particles of 5 μm diameter
- Fluids: Wetting phase (brine solution 1 mM of NaCl and pH 4) and Non-wetting phase (CO2 gas)

**METHODS**

- Determination of the following before and after fine injection
  1. Absolute Water permeability
     - Saturate micromodel with water (with or without fines)
     - Measure pressure drop across the micromodel at different flow rates
  2. Effective CO2 permeability
     - Saturate micromodel with water (with or without fines)
     - Inject CO2 at 0.5, 1 & 2 mL/min
     - Measure pressure drop across the micromodel
  3. CO2 breakthrough pressure
     - Measure the pressure drop during CO2 breakthrough in the micromodel
  4. Capture images at various locations

**RESULTS**

**CONCLUSIONS**

The important findings from the experimental investigation are summarized below:

- There is a decrease in permeability of the porous media due to the presence of fine particles.
- The reduction in permeability during single-phase flow is due to the pore clogging or decreased pore dimensions by the presence of fines.
- Comparatively higher percentage reduction in effective permeability during two-phase flow with CO2.
- The resistance to invade the pores by the gas-water interface increased by the presence of fines in the pore space.
- Fine particles attached on solid surface are mobilized with the moving gas-water interface and retained on the interface.
- The capillary retention of fines on gas-water interface pin the interface on grain surface causing higher hydraulic resistance to flow.
- The coalescence of two moving interfaces require higher capillary pressure due to the presence of fines on the interface.
- The different pore scale mechanisms (i.e., interface pinning, deformation and coalescence) are responsible for increased reduction in permeability during two-phase flow.
- The permeability can be affected by the percentage and type of fines and fluid chemistry in the porous medium.

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