Unexpected Effects of Polymer Flow on the Permeability of Porous Media

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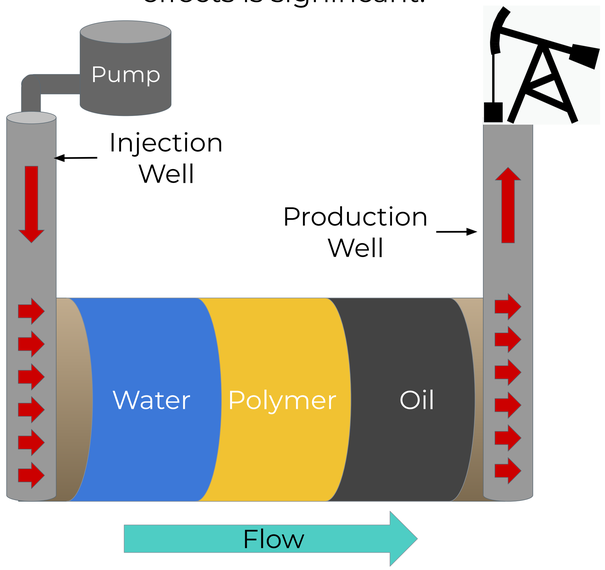
Introduction

Motivation

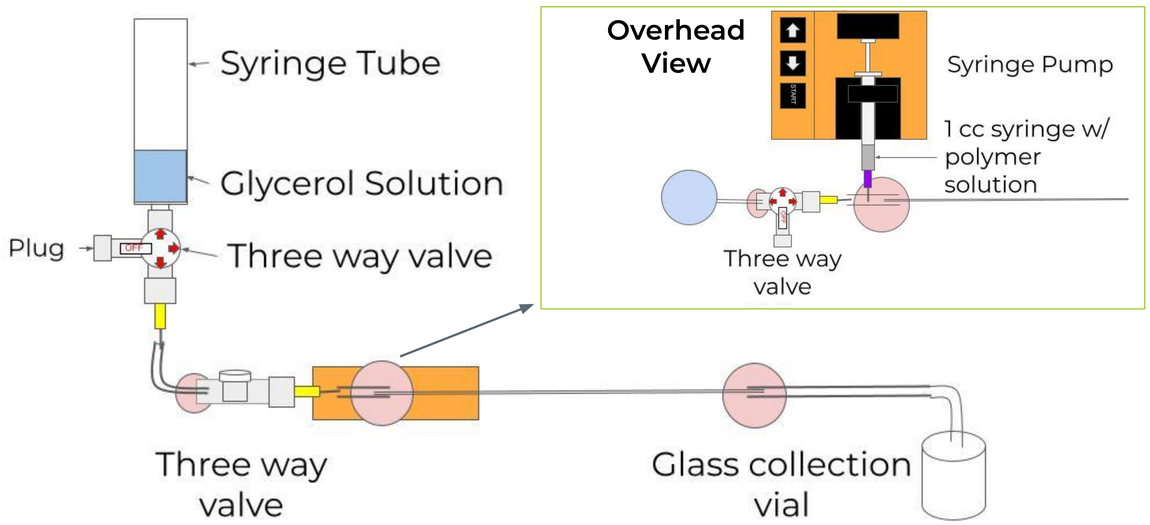
Understanding the effects polymers have on the permeability of different porous media is vital to various industries, specifically the oil recovery industry. Polymers, such as hydrolyzed polyacrylamide, have the tendency to retain to surfaces that it comes in contact with and are used in various applications and understanding its effects is significant.

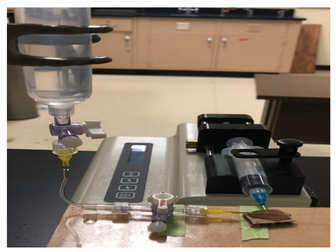


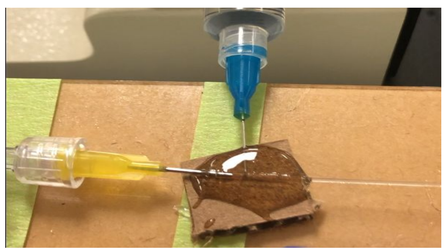
Problem

Polymer flooding is expected to be efficient in removing low viscosity oils but it has been effective in removing extremely high viscosity oils. This effect is attributed to polymer retention and changes in pore structure and is investigated by measuring the permeability. It is difficult to understand as a simple model cannot be used to explain the phenomenon.

Methodology



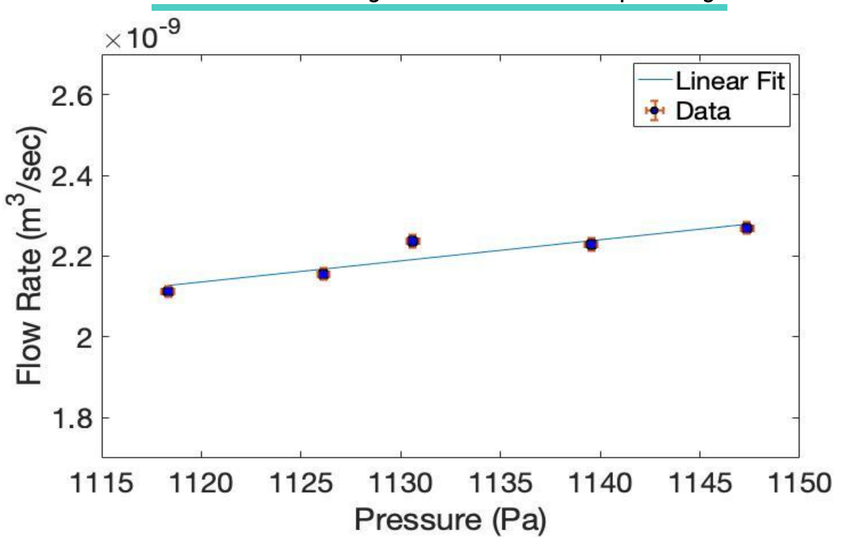




Measurement

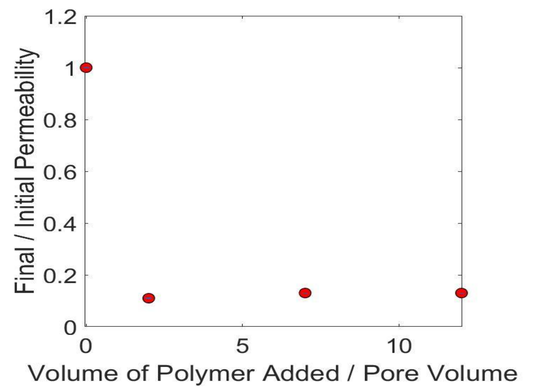
$$Q = \frac{kA}{\mu L}\Delta p$$

Permeability of a Glass Capillary

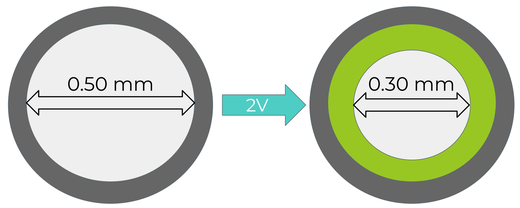


Results

Permeability Reduction Due To Polymer Retention



Diameter Reduction of Capillary Due To Polymer Retention

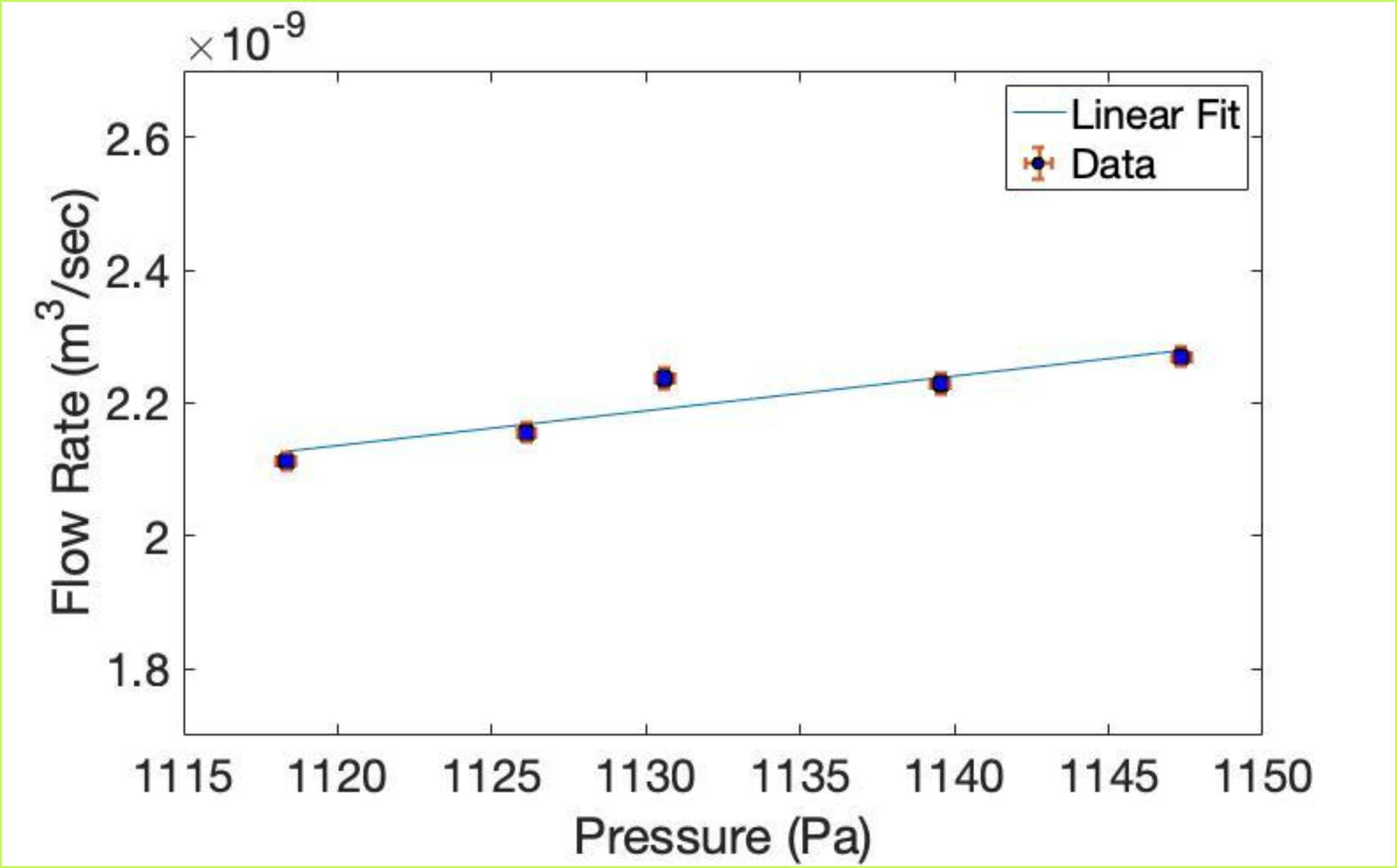


$k = \pi d^4/128l^2$ 40% Reduction

Conclusion

Utilizing bulk permeability measurements and Darcy's Law, we observe that the permeability of a glass square capillary tube decreases by an order of magnitude after polymer flow. The majority of reduction in permeability occurs in the first few volumes of polymer flow and additional polymer only decreases the permeability slightly. This explains the unexpectedly large reduction in permeability which provides a deep understanding of the role of polymer flow in oil recovery.

Permeability of a Glass Capillary



Permeability Reduction Due To Polymer Retention