Bachelor Integration Project IEM

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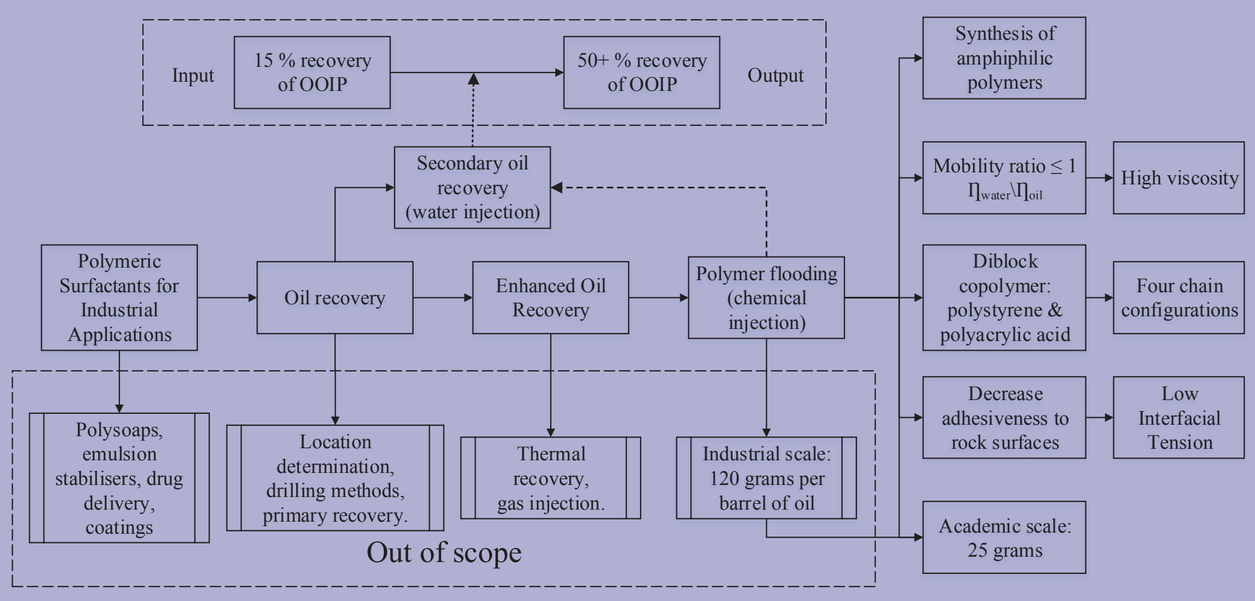
Enhancing oil recovery with polymers

Introduction

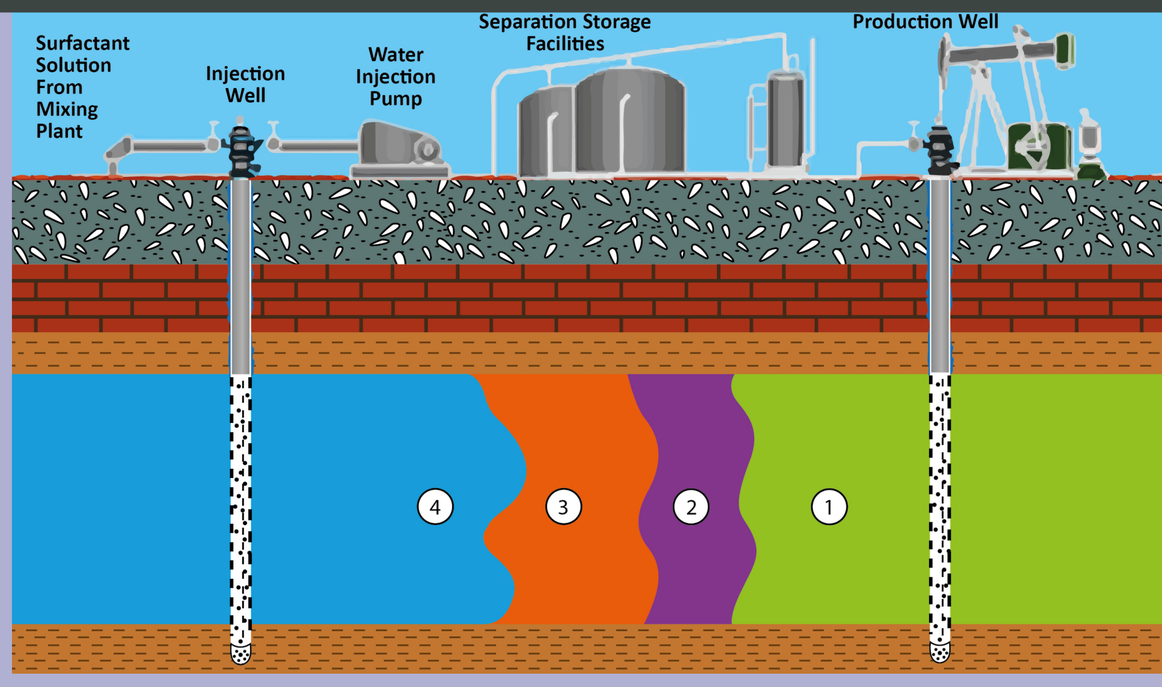
Oil recovery is not as straightforward as one might think, the power of a pumpjack alone can produce 10-15% of the original oil in place (OOIP). With artificial methods, known as enhanced oil recovery (EOR), the production can be increased to 60% of the OOIP[2]. One opportunity is to flush the well with water to form a driving force behind the oil. As water and oil are not miscible, this proposes problems. During this integration project, research was conducted on the properties of four polymeric surfactants when introduced in water. It was hypothesised that the viscosity and the interfacial tension of the solution would change. With this characteristic, oil can be produced more effectively as this polymer increases the driving force of the water.

System description

The system and its inputs, outputs and boundaries is depicted in the figure below. On the left, the subject of the integration project is stated. By determining the scope of this project, decisions were made in different stages. For example, only the application of polymeric surfactants in EOR was taken into account for this project. Moreover, oil recovery consists of a large amount of methods. Only surfactant-polymer flooding is considered.



Enhanced Oil Recovery[1]



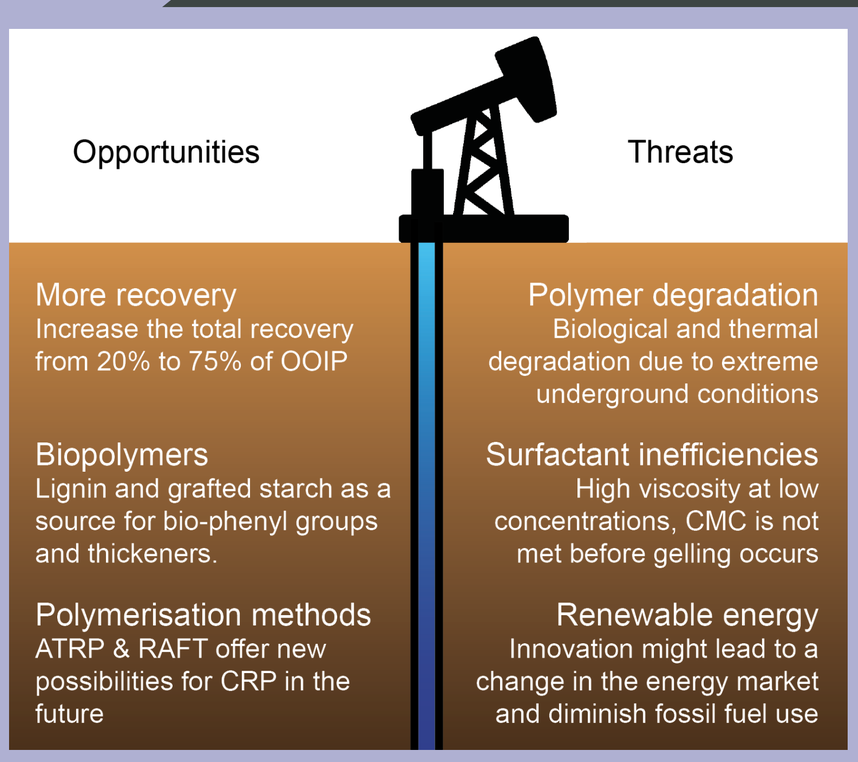
Polymeric Surfactants

Polymers and surfactants are common chemicals. Polymers can be long chains of small building blocks, some natural examples are proteins and the biopolymer lignin. and surfactants are molecules that influence the interfacial tension of a fluid. For example, compounds like soap and other emulsion stabilisers are surfactants. When one desires to achieve both properties in one chemical compound a diblock copolymer can provide a solution. To be surface active, the polymer should have a hydrophobic and a hydrophilic group. Respectively polystyrene and polyacrylic acid have been selected to polymerise in this Integration Project. ATRP, a renowned method for the controlled polymerisation was utilised to controllably determine the length of the blocks with a proportional addition of moles of monomer.

References

1: Shale Play Water Management Magazine (2018)
2 : Knight A. (2015). *Enhanced Oil Recovery: Methods, Economic Benefits and Impacts on the Environment.* Energy Policies, Politics and Prices. Nova Science Publishers, inc.

Summary and Conclusion



Multiple conclusions are drawn with respect to the experimental process, the applicability of these specific synthesised polymers and the use of polymeric surfactants in enhanced oil recovery. First of all, when using ATRP, it is discouraged to use a macroinitiator of polytert-butyl acrylate as it has been shown to be incapable of forming a diblock copolymer with polystyrene. Already from the results of NMR and GPC the conclusion could be drawn that the attachment of polystyrene was unsuccessful. This expectation of failure was confirmed by the measurements of the interfacial tension and viscosity. Instead of a PtBA macroinitiator, polystyrene should be used to initiate this block copolymerisation. That hypothesis was tested with the configuration of 18 : 150, this provided a promising polymeric surfactant that foamed at 1wt%. The IFT measurements however, were disappointing as they did not show the expected drop. Solutions with weight percentages of 2.5% and above could not be measured for IFT as the solutions were too viscous.

Surfactant-polymer flooding can be executed with a wide variety of polymeric surfactants. No chain configurations with feasible properties have been found in this research for the application in EOR for PAA-b-PS and PS-b-PAA. However, future research into different configurations of the synthesis of PS-b-PAA with ATRP could provide more surface active products. Preferably, the polystyrene is derived from lignin, a bio-degradable resource for aromatic molecules. When a polymer with beneficial characteristics is found, tests should turn out if the product is mechanically and thermally stable for its application in enhanced oil recovery. By using bio-polymers this unsustainable application is made as sustainable as possible.