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Contribution ID: **506** Type: **Oral Presentation**

Assessment of the role of densification on the displacement of DNAPL in high permeable porous media using a polymer solution

Thursday, 3 June 2021 10:45 (15 minutes)

The remediation of sites contaminated with Dense Non-Aqueous Phase Liquids (DNAPL) has gained great prominence due to the extreme difficulty of their remediation (Colombano et al., 2021). These DNAPLs, subjected to gravity forces, penetrate downwards through the aquifer and form a discontinuous insoluble trapping phase below the groundwater level. On the one hand, owing to their high density, high interfacial tension and high viscosity, the direct pump-and-treat method is not efficient enough to extract DNAPLs from the pore spaces. On the other hand, because of dissolution and stability issues, some other conventional remediation techniques such as surfactant or foam injection are not applicable (Maire et al., 2018; Omirbekov et al., 2020). Although using polymers can improve DNAPLs displacement by increasing the viscose pressure, in the case of high-density DNAPLs the gravity forces can overcome the viscose forces (Miller et al., 2000). Furthermore, because of the high permeability of the porous media, the capillary forces cannot prohibit the upward movement of polymer solution due to density contrast between the polymer and DNAPLs.
Here, we evaluated the rheological behavior of various polymer solutions (guar gum, xanthan gum, and carboxymethyl cellulose (CMC)) to find the most appropriate one to be able to suspend barite($BaSO_4$)-polymer solution. We employed a new formulation of densified CMC polymer solution to displace DNAPLs from the porous media. To examine the role of densification of the polymer solution we used barite in different concentrations equivalent to various ranges of densities (from 0.6 up to 1.15 times the density of DNAPL). In this regard, using a decimetric-scale 2D-sandbox, we designed an experimental procedure with similar permeability and fluids configuration as in the real site. To evaluate the efficiency of the displacement of the DNAPL by the densified polymer solution, the solution was injected through the DNAPL at the bottom middle of 2D-sandbox, for different solution densities but at a fixed injection rate. The injection was monitored using an advanced imaging technique and mass balance interpretation.
The results showed that the denser the polymer solution, the more significant is the lateral movement of DNAPL. In contrast, when polymer solutions with a lower density are used, the gravity forces cause more vertical displacement. The analysis of displacement efficiency depicts that when the density of polymer-barite solution is close to the density of DNAPL, the mobilization of trapped DNAPL is improved up to 150% in comparison to using only polymer or other solution densities. To model the displacement of two-phase flow, generalized Darcy's law and continuity equations were employed. The developed model predicts well the experimental fluid-fluid interface (image analyzing) as well as the displacement efficiency.
Our new formulation of the polymer solution can result in a great improvement in remediation processes of soils contaminated with DNAPL as it is presumably a safe and stable mobilization technique. We anticipate that our model can be considered as a good cornerstone for more complicated cases where the role of non-Newtonian behavior of polymer solution and the polymer retention inside the porous media can be involved.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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