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## Study on mechanism of removal of residual DNAPL by co-injection of ethanol and CO<sub>2</sub> into 2D porous micromodel

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Groundwater contaminated with dense non-aqueous phase liquids (DNAPLs) such as chlorinated hydrocarbons is difficult to remediate, and the effectiveness of conventional pump treatment techniques is very limited due to its low contaminant solubility. Enhanced in-situ flushing has attracted widespread attention as an alternative to the use of flushing fluid such as cosolvent and gas co-injection. It is very important to understand the recovery mechanism of cosolvent and gas co-injection into polluted aquifers to improve the recovery efficiency of polluted aquifers. In this study, the removal process of residual PCE in a two-dimensional (2D) micromodel that is used to represent the porous media with different concentrations of ethanol + CO<sub>2</sub> and different flushing rates was observed by using a camera at room temperature and pressure, and the removal mechanism of DNAPLs under cosolvent + gas co-injection was preliminarily understood. Firstly, it was verified that increasing the concentration of ethanol solution could increase the dissolution rate of ethanol to PCE and promote the dissolution of residual PCE. Secondly, when the ethanol solution and CO<sub>2</sub> were co-injected into the micromodel, the residual PCE in the injected CO<sub>2</sub> flow channel migrated out of the micromodel, which also changed the distribution of PCE, but did not reduce the interface area between PCE and flushing solution in the pore channel. It is well known that the interfacial area is proportional to the dissolution rate, which means that the injected gas does not inhibit the dissolution of the ethanol to the PCE, so the remediation efficiency of the contaminated aquifer can be significantly improved. In addition, a small fraction of PCE remains in contaminated aquifers that are troubles to remove in the small pore channels or the dead end channels, and are hard to completely repair with only cosolvent flushing. In the case of co-injection of ethanol solution with CO<sub>2</sub>, CO<sub>2</sub> cannot enter these channels, but the ethanol solution can be sent into these channels to contact with PCE, promote the dissolution of PCE, and thus improve the removal rate of PCE in the aquifer. Finally, different experiments were compared, and it was found that when the injection flushing rate ratio of 60wt% ethanol to CO<sub>2</sub> was 1:2, the removal rate of DNAPLs could be improved in a short time, and the amount of cosolvent could be saved, so as to obtain the best remediation scheme, which is of great significance for rapid repair and cost saving in the actual field.

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## **References**

## **Conference Proceedings**

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