Chemical control of miscible viscous fingering

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ABSTRACT

In many applications involving fluid displacements in porous media maximization of the displacement efficiency is an important issue. This efficiency can be impaired because of viscous fingering [1], i.e. instability that develops at the interface between two fluids when the less mobile one is displaced by the more mobile one [2,3].

We present here an experimental study on control of miscible viscous fingering thanks to a chemical reaction. This control is obtained via the build up of a global minimum in viscosity in the reaction zone between the less viscous pushing fluid and the more viscous displaced one, thanks to a A+B → C reaction changing the viscosity. This high-mobility region between the fluids acts as a buffer boundary that leads to a better control and efficient displacement. Fig.1b shows the fingering suppression by the reaction, when the control strategy is applied, compared to the non-reactive case of Fig.1a.

The experimental results can be explained in terms of a simple physical model that gives insight into the best control strategy via chemical reactions, that depends on the Peclet number (*Pe*) and the reactants initial concentration.

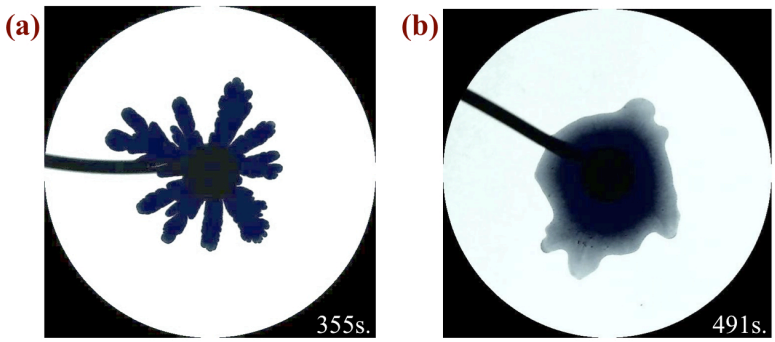

Figure 1: Miscible viscous fingering observed when a polymer solution is displaced by a dyed less viscous (a) non-reactive and (b) reactive aqueous solution. The displacing fluid viscosity is the same in both cases, but in case (b) the reactive control strategy is applied. The injection flow rate q = 0.05ml/min. The displacement radius, reached by the displacing fluid, is in both cases 30mm and the total radius of the field of view is 46mm. The corresponding injection time is shown in the lower right corner of each image.

References

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