Polymer Floods: A Case Study of Nonlinear Wave Analysis and of Instability Control in Tertiary Oil Recover

P. Daripa, J. Glimm, B. Lindquist, and O. McBryan
Courant Institute of Mathematical Science, New York University

Polymer flooding in oil reservoir simulation is considered in two space dimensions. The wave structures associated with such a process give rise to interesting phenomena in the nonlinear regime which have direct bearing on the efficiency of oil recovery. These waves influence and can prevent surface instabilities of the fingering mode. In this paper we resolve these waves by a front tracking method. We consider the fingering problem and the issue of oil recovery for the polymer flood. The details of these two phenomena depend on the separation between the waves and upon the viscosity contrast between the oil, water and polymer. We identify a nonlinear transfer of instability between adjacent waves and a nonlinear enhancement of recovery due to successive waves. The conclusions produced by this work are also pertinent to tracer flooding.

One interesting conclusion applies to polymer injection followed by pure water injection. In this case the instability is transferred to the polymer-water interface, and the pure water region can break through the polymer to achieve direct contact with the oil. The polymer is left in narrow ribbons parallel to the main flow field and is by-passed by pure water. The effect of narrow regions of by-passed polymer can be simulated by the front tracking method and is not equivalent to numerical or physical diffusion, which would distribute the polymer more uniformly and retard the breakthrough of water through the polymer layer.

Appeared: *SIAM J. Appl. Math.*, 48, pp. 353–373, 1988.