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Cooperative mobilization of emulsion droplets in porous media[1]

LUKE NEARHOOD, DANIEL MATOS, SHIMA PARSA, Rochester Institute of Technology — Immiscible displacement in porous media is a fascinating problem encountered daily in oil recovery and soil remediation. Droplets of oil stabilized by a surfactant, naturally present in crude oil, resist merging while trapped in porous media, which results in unexpected dynamics. We study the cooperative dynamics of monodisperse droplets in 2D porous media, both experimentally using confocal microscopy and computationally using COMSOL. By probing the dynamics of the carrier fluid at pore level and tracking the mobilization of droplets, we find that upon arrival or mobilization of one droplet, large pressure fluctuations emerge across neighboring pores. The pressure fluctuations result in cooperative mobilization of droplets. Moreover, a pile up of droplets in one area results in reduction of viscous pressure across all droplets by diverting the flow in unoccupied pores. However, the pile up is extremely unstable and droplets easily slide out of the pile with small fluctuations in velocities of the neighboring pores. The correlation length of the mobilized single droplets remain of the order of a few pores while a pile of droplets result in an increased correlation length.

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