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Yield Stress Fluid Displacement by Newtonian Fluid in a Wavy Annular Geometry: Experimental Observations and Insights

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ABSTRACT

This experimental investigation explores the dynamic behavior associated with displacing a yield stress fluid by a Newtonian fluid within an annular configuration featuring sinusoidally varying gap widths to simulate the impact of borehole irregularities on displacement flow dynamics during the primary cementing process in oil and gas well operations. Such irregularities can hinder the removal of drilling mud, potentially leading to an unsuccessful cementing job. In our experiments, we utilize sugar solution as the displacing fluid and an elasto-visco-plastic Carbopol solution as the displaced fluid, mirroring the properties encountered in practical field scenarios. The experimental apparatus allows for adjustable inclination, ranging from vertical to horizontal, replicating various wellbore orientations. Through the utilization of high-speed camera imaging, we assess how factors like pumping rate, fluid density, and viscosity disparities influence interface velocity and displacement efficiency. The principal aim of this research is to enhance the industrial comprehension of the influence of geometric irregularities in annular structures on displacement flows. This knowledge can contribute to the optimization of cementing procedures crucial for the successful construction of oil and gas wells.