Stabilizing multilayer flows may improve transportation of heavy oils

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During the past 20 years, the oil industry has begun a gradual transition away from light oils, which are being consumed progressively, toward heavier oils. transporting heavy oils cost-effectively is a big challenge because heavy oils are viscous -- essentially a thick, sticky and semifluid mess.

Stabilizing the interface of multilayer flows for transportation is no easy task. While several potential solutions have been proposed, no one-size-fits-all ap| currently exists that works for all applications.

One way to outmaneuver this problem, as University of British Columbia researchers report in Physics of Fluids, from AIP Publishing, is a viscoplastic lubric technique. It can complement existing methods to stabilize interfaces within multilayer flows.

Viscoplasticity describes the characteristic(s) in which a mass acts as a solid below a critical value of stress but flows like a viscous liquid as stress increases.

The researchers' work focuses on multilayer flows, specifically lubricated pipeline flow. In lubricated pipeline flow, a thin fluid, such as water, is used to lubr pipeline via core-annular flows. But this method suffers from interfacial instabilities, which means the oil and water may mix and make it more difficult to separ downstream.

"In multilayer flows, the interfaces between two fluids are highly unstable because of the differences between fluid properties," said Ian Frigaard, a profess mechanical engineering and applied mathematics.

Previous work on yield stress fluids by the researchers suggested a new configuration might prevent instabilities from growing. Their VPL technique places yield stress fluid between the heavy oil and the lubricant to form a flow stabilizing skin.

"Yield stress fluids -- think toothpaste or hair gels -- act as a solid if the applied stress is less than its yield stress (point at which a material begins to defor Parisa Sarmadi, a doctoral candidate working with Frigaard. "Our idea is to maintain this layer completely unyielded, so the interfacial layer of the fluid acts as eliminates interfacial instabilities."

Another key concept involved in this work is interface shaping. "We can control the inlet flow rates in a way to shape the interface as we desire," said Sarm shaped interface generates pressure within the outer layer, and these pressures act to counterbalance the core buoyancy to center the core fluid. Typically, the oil is less dense than the lubricating water."

For this work and previous studies, the researchers showed the VPL technique can be optimized to meet a system's specific requirements. They also discov yield stress required for these applications is easily attainable with available fluids.

This means that for any operational inputs, flow rates, geometries and fluid properties, the VPL technique can be optimized based on pump power, genera required yield stress. "The ability to shape the yield stress fluid came as a big surprise to us," said Frigaard. "But effectively any shape can be imposed on the in flow rates are properly controlled and there's enough yield stress."

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