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Suppressing turbulence and enhancing the liquid suspension flows in pipelines with electrorheology[1]

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Flows through pipes, such as crude oil through pipeline, are the most common and important transportation of fluids. To enhance the flow output along the pipeline requires reducing viscosity and suppressing turbulence simultaneously and effectively. Unfortunately, no method is currently available to accomplish both goals simultaneously. The talk will show that electrorheology (ER) provides an efficient solution. When a strong electric field is applied along the flow direction in a small section of pipeline, the field polarizes and aggregates the particles suspended inside the base liquid into short chains along the flow direction. Such aggregation breaks the rotational symmetry and makes the fluid viscosity anisotropic. Along the flow direction, the viscosity is significantly reduced; thus the flow along the pipeline is enhanced. In the directions perpendicular to the flow, the viscosity is substantially increased, effectively suppressing the turbulence. Recent field tests with crude oil pipeline have confirmed that this new technology works very well. For untreated crude oil, the flow inside the pipeline is turbulent as the Reynolds number exceeds 2300. However, for ER treated oil, the flow remains laminar even when the Reynolds number reaches 6000. The combination of the viscosity reduction along the flow direction and the turbulence suppression greatly saves the energy required to transport crude oil. In addition, both effects have found lasting more than 11 hours inside the pipeline after one ER treatment. No additive is needed. The process is repeatable. As turbulence is classified as one of the most important unsolved classical physics, this development is not only important for technology applications, but significant for basic physics as well.

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