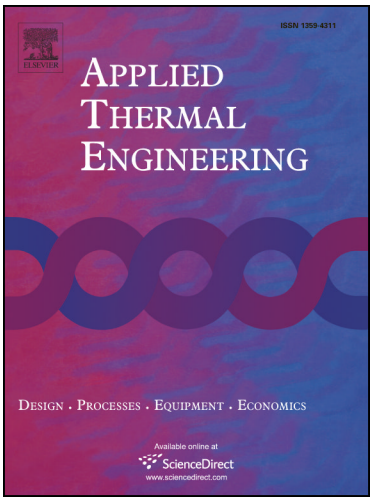

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Numerical simulation of oil-water non-Newtonian two-phase stratified wavy pipe flow coupled with heat transfer

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Abstract:

Oil-water two phase stratified wavy pipe flow widely exits in the petroleum and chemical industries. When the temperature of the oil is below abnormal point, the oil phase acts as non-Newtonian behavior and the flow process becomes more complex. A coupling mathematical model of oil-water non-Newtonian stratified wavy pipe flow under non-isothermal condition is established in bipolar coordinate system with the consideration of the fluctuation at the oil-water interface. The pressure gradient calculated is validated by the data from literature and the relative errors are within 6%. Then the oil-water non-Newtonian two-phase stratified wavy pipe flow process is simulated in this paper. The bulk temperature and pressure drop along the pipeline can be predicted by the models. Temperature and velocity distribution at the different length pipe section are simulated and analyzed in detail. The non-Newtonian behavior of oil phase and the effective roughness of oil-water interface can also be obtained from the model. Moreover, the non-dimensional parameter analysis is made to research the mechanisms of flow and heat transfer. Thus, the numerical model can be widely applied to calculate the global fluid properties and other operating parameters which are useful for the management of oil-water mixing transport pipeline.

Keywords: Non-Newtonian flow, Oil-water stratified wavy pipe flow, Heat transfer, Numerical simulation

Highlights:

- A quasi-3D non-isothermal oil-water two-phase stratified wavy pipe flow is investigated.
- The effective shift distance is exploited to describe the fluctuation of wavy interface.
- Water and oil phase have different effective roughness of interface.
- Effects of non-Newtonian behavior on oil-water flow and heat transfer are analyzed.