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NUMERICAL STUDY OF HORIZONTAL TWO-PHASE WATER-OIL FLOW USING COMPUTATIONAL FLUID DYNAMICS

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Abstract. The transport of very viscous oils requires a considerable amount of energy due to pressure losses by friction. This energy could be reduced by incorporating water in order to form a two-phase water-oil annular flow pattern, which would have a lower pressure loss by friction due to the formation of a core of viscous oil and an annulus of water. Similar to this is the case when an emulsion is formed and the emulsion has a higher viscosity than the separated phases. It is desirable to reduce the viscosity in order to minimize energy losses due to friction. In many cases, this can be done by adding a demulsifier to the mixture of water and oil. The objective of this study is to analyze the behavior of heavy oil with different contents of water and compare the reduction in pressure gradient achieved by obtaining a core-annular flow. In particular water-oil flows are considered, assuming these flows as incompressible and isothermal. Special care is taken to model the behavior of the water-oil interphase and the wall viscous stress in order to obtain a precise prediction of the pressure gradient. The computations are performed for two-dimensional (2D) channels and three-dimensional (3D) pipes. The Volume of Fluid (VOF) method is used to determine the phase boundaries and turbulence is treated with the SST (Shear-Stress Transport) k-omega model, as incorporated in the open-source toolkit OpenFOAM(R). Adaptive refinement is applied in order to sharpen the liquid-liquid interphase and to compute accurately the velocity gradient, with the aim to reduce the computational cost of the simulations, maintaining the total number of cells in a tractable amount. The results are compared with maps constructed from experimental results.