

Computational fluid dynamics simulations of oil-water mixture flowing through a sudden expansion

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Two-phase oil -water mixtures are frequently encountered in oil wells and pipelines of the chemical and petroleum industry.

We present the results of computational fluid dynamics simulations of oil-water dispersed flow through a sudden expansion. The transient numerical simulations are performed using a 3-D numerical domain coupled to three different turbulence models concerning the water phase ($k - \omega$ SST, Realizable $k - \varepsilon$ and Reynolds Stress Model) within the Eulerian multifluid framework. A sensitivity analysis is performed regarding the correlations for the momentum exchange between the phases. Different drag coefficients are considered as well as the non-drag forces. The simulation results indicate that only the drag force should be considered to obtain physical results.

Concerning the dispersed phase modelling a mono-dispersed approach is compared with a fixed poly-dispersed approach, where different droplets classes and velocity groups are implemented in the numerical model.

The superficial velocity evaluated downstream of the singularity, ranges between 0.29 m/s and 0.44 m/s concerning the oil phase and between 0.56 m/s and 0.84 m/s concerning the water phase. All the operating conditions considered result in a flow pattern of oil dispersion in continuous water.

The numerical model is validated comparing the numerical results with the experimental data of Dehkordi et al. (2017) [1]. They performed experiments on 11 m long pipe using optical methods, to obtain detailed representation of instantaneous velocity and in-situ phase fraction.

Time-averaged oil velocity profiles at different axial position after the sudden expansion ($L/D = 1$; $L/D = 2.5$; $L/D = 4$; $L/D = 5.5$), cross-sectional time-averaged oil holdup, and slip ratio are considered.

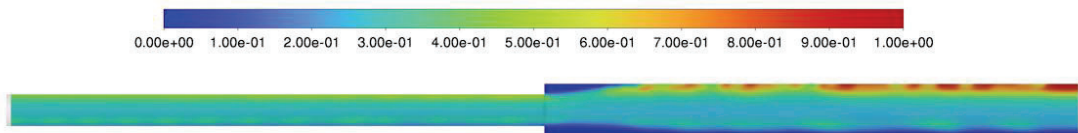


Figure 1: Instantaneous contour of oil volume fraction.

References

- [1] P. B. Dehkordi, L. P. Colombo, M. Guillizzoni, M. Sotgia, F. Cozzi, *Quantitative visualization of oil-water mixture behind sudden expansion by high speed camera*, Journal of Physics: Conference Series, **882**, p. 012009, 2017.

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