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Effect of underestimation/overestimation of falling drop parameters on the result of splash simulation in an immiscible liquid system

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The phenomenon of multiphase splash can be a mechanism for transporting various types of pollution (e.g. petroleum substances), which makes it especially interesting in the context of environmental protection.

In this paper, the water splash phenomenon caused by the impact of a petrol drop on the water surface was simulated using the multiphaseInterFoam solver, i.e. a part of the OpenFOAM computational fluid dynamics software implementing the finite volume method (FVM) for space discretization. The simulations were experimentally validated based on splash images obtained with the use of a high-speed camera (2800 fps). Several variants of simulations with a varying drop size (in 0.10-mm steps) or drop velocity (in 0.025-m/s steps) were conducted.

Our experiments showed the importance of even a slight underestimation/overestimation of the properties of a falling drop on the simulation of the size and dynamics of splash in an immiscible liquid system. On the other hand, correct simulation made it possible to analyse aspects of the phenomenon that were difficult or even impossible to achieve experimentally due to the limitations of the image analysis method. This concerned the determination of the cavity width, the moment of cavity disappearance, the moment of jet formation (still below the water level), and the height of the jet. In addition, based on the validated simulation of splash in immiscible liquids, the scale of the spread of petroleum contamination as a result of the impact of a single droplet was determined.

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