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Numerical Simulation of Drop Impact on Wetted and Dry Surfaces

M. GATTRINGER, H. STEINER

Institute of Fluid mechanics and Heat transfer, Graz University of Technology, Graz, Austria

E-mail: helfried.steiner@tugraz.at (H. Steiner)

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The impact of liquid drops on wetted and dry surfaces is a complex two-phase flow phenomenon with high technical relevance especially in surface coating. It is also of increasing interest in the development of novel drug dosage forms in pharmaceutical engineering. The complex physics after the impact, which is still not understood in full detail, has been investigated in numerous experimental and analytical studies. Based on dimensional analysis and/or simplifying assumptions various semi-empirical correlations and analytical solutions have been derived to describe the individual stages of the motion of the liquid (see, e. g. [1, 2]). The present work numerically investigates the whole process of the liquid spreading after the impact using the CFD software FLUENT. Impact velocities and surface wettabilities were varied in the considered cases. It is shown that the Volume of Fluid based approach, which has become a standard numerical method for two-phase flow simulations, generally captures the typical flow features, like splashing (see Fig. 1), qualitatively and quantitatively very well. As such the computational results agree very well with the experimental data and analytical asymptotic solutions obtained for the individual regimes in literature. Notable discrepancies were however observed at the late stages of the liquid spreading on dry surfaces, where the outer rim of the liquid lamella eventually starts to recede. This deficiency points at the great numerical challenge to capture accurately the dynamics at the contact line between the liquid, gas, and the solid surface. The strong sensitivity of the incipience of liquid receding to the contact physics becomes very evident here.

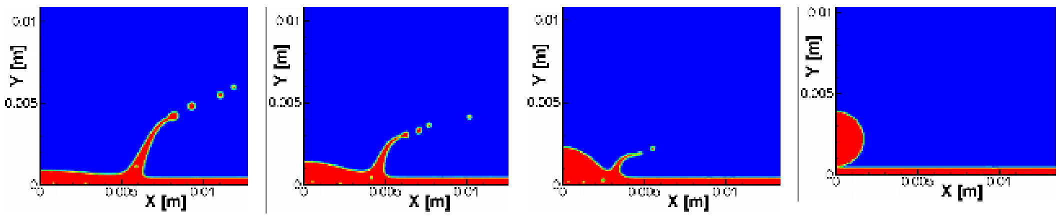

Fig. 1. Evolution of the liquid phase (denoted by red area) after drop impact on a wetted surface (We=203, Oh=0.005).

[1] Yarin AL, Weiss DA. Impact of drops on solid surfaces: self-similar capillary waves, and splashing as a new type of kinematic discontinuity. J Fluid Mech. 1995; 283: 141–273. doi:10.1017/S0022112095002266

[2] Rioboo R, Marengo M, Tropea C. Time evolution of liquid drop impact onto solid, dry surfaces. Exp Fluids. 2002; 33: 112–124. doi:10.1007/s00348-002-0431-x