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Comparison of the shape and dynamics of various splash forms in liquid single-phase systems

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The course of the direct contact between a single drop and soil, i.e. so-called splash is the object of numerous investigations. It is possible to investigate various aspects of the splash phenomenon in different model systems. In practice, this means that part of the research carried out in systems ensuring a drop impact on a dry or wet (e.g. glass) surface, on the surface of glass beads, or the surface of a liquid. This facilitates more precise definition of the system parameters and, hence, better understanding of the course of the phenomenon. The rationale for this type of research is the complexity of the raindrop impact on the soil surface (saturated or unsaturated). However, a vast majority of research is focused on water drop splash and soil transferred with water.

The splash phenomenon in the soil environment can involve not only water. It seems important to undertake research on splash that can spread petroleum contaminants present on the soil surface during environmental disasters or slight fuel leakage from agricultural machinery tanks. Although the problem of development of a model of the spread of petroleum substances in soil is timely, there are not many publications on this issue; hence the need for investigations in model systems.

The aim of this study was to compare the shape and dynamics of formation of various splash forms as a result of the impact of a liquid drop on the surface of the same liquid in three systems: water, petrol, and diesel fuel.

In the experiment, the height at which the liquid drop was formed as well as its velocity and kinetic energy changed. The drop size was similar in all cases, i.e. 3.3 mm (SD – 0.02 mm). Additionally, 5 dimensionless numbers widely used in fluid mechanics (We, Re, Fr, Oh, K) were established for each of the analysed variants.

The splash phenomenon was recorded using a set of high-speed cameras with the speed 3260 fps. The shape and dynamics of different forms, i.e. wave, crown, semi-closed dome, and dome were analysed. The analysis of the images obtained facilitated determination of the static and dynamic parameters, such as the maximum height of the form, the width of the form at its maximum height, and the time of expanding of each splash form.

The experiments allowed formulation of three major conclusions: i) 4 splash forms, i.e. waves, crowns, semi-closed domes, and domes, were observed in all the analysed systems and the sequence of their formation was maintained in all the systems and depended on the kinetic energy of the falling drop; ii) the parameters and shapes of the forms were highly similar in the case of water and petrol and different for diesel fuel; iii) in all the systems, the changes of the recorded time interval required for achievement of the maximum form height, depending on the height of the drop fall, was monotonic for each form.

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