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Dynamics of the Film produced by Spray Impact under Various Gravity Levels

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Abstract

The present experimental study is devoted to the investigation of spray impact onto a rigid wall under various gravity levels. A large diversity of phenomena is associated with the flow in the liquid film layer initiated by single drop impacts onto a target and their interactions, which is an element of spray impact. Due to the complexity of the problem, the hydrodynamics of the films created by sprays is not entirely understood and no reliable model describing exclusively the behavior of the liquid film or depicting spray cooling is present until now.

The main aim of the present study is to better understand the hydrodynamics under terrestrial, reduced gravity and hypergravity conditions. By focusing on the dynamics of the thin liquid film produced by spray impact in the wall region it is expected to provide a sound basis for a reliable modeling of spray cooling.

This phenomenon has been investigated under terrestrial conditions and compared with observations gained under zero gravity and hypergravity conditions. The experiments at zero gravity conditions have been performed during Parabolic Flight Campaigns and on board of the ballistic rocket TEXUS 45 with microgravity duration of 360 s. The hypergravity and reduced gravity experiments have been performed in a centrifuge.

Spray propagation and wall impact at various gravity levels have been observed using a high-speed video system. Spray parameters have been determined with the help of image processing. Moreover, image analysis and the statistical methods of analysis have been applied to estimate the typical thickness of the liquid layer created by spray impact.

It has been shown that the thickness of the thin liquid film decreases when the gravity component normal to the wall increases. The spray cooling efficiency generally increases when the liquid film is thinner.

Key words: spray impact, film dynamics, spray cooling

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