Journal Pre-proof

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PII: S0997-7546(19)30573-4
DOI: https://doi.org/10.1016/j.euromechflu.2019.11.010
Reference: EJMFLU 103573

To appear in: *European Journal of Mechanics / B Fluids*

Received date : 7 October 2019
Revised date : 24 November 2019
Accepted date : 28 November 2019

Please cite this article as: C. Wang, C. Wang, B. Chen et al., Comparative study of water droplet interactions with molten lead and tin, *European Journal of Mechanics / B Fluids* (2019), doi: https://doi.org/10.1016/j.euromechflu.2019.11.010.

Comparative study of water droplet interactions with molten lead and tin

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Abstract:

Research on stream explosion between coolant and molten metal has a great significance for accident prevention in industry safety. A series of experiments and corresponding comparative study were carried out on the water droplet interactions with molten lead and tin using a high-speed camera. The typical factors including the water droplet dropping height and thickness of molten metal were focused. The results show that three phenomena of Droplet breakup, Bubble and Crown can be observed in the water droplet interactions with both molten lead and tin. The crown height increases with an increase in the water droplet dropping height. However, it firstly decreases and then becomes relatively stable as the thickness of the molten metal increases. Especially, due to the different density, viscosity and surface tension between molten lead and tin, some significant differences can be found in phenomenon evolution and regimes, evaporation time of water droplet, crown height etc. A smaller bubble and an additional liquid column appear on the lead surface. The evaporation time of water droplet on molten lead is slightly shorter than that on molten tin. The maximum crown height in the water droplet interaction with molten lead is much lower than that in the water droplet interaction with molten tin.

Keywords: water droplet; molten lead; molten tin; stream explosion; maximum crown height

Introduction

Study on the water interaction with molten metal is imperative for the accidental analysis and prevention in nuclear power plants. According to the relevant survey, about 2.5 million people were injured and direct economic losses amounted to more than 10 billion dollars in Chernobyl Disaster, which also caused serious pollution to the surrounding environment. In this accident, metal fuel rods are melted at a high temperature and come into direct contact with coolant, therefore a large-scale stream explosion occurs. The heat transfer involving the direct contact between coolant and molten metal is extremely intense, leading to a rapid evaporation of the coolant [1]. Meanwhile, the heat transfer area between coolant and molten metal increases dramatically due to the fragmentation of molten metal after the direct contact, which causes a large-scale stream explosion. The explosion