Prediction and numerical simulation of droplet impact erosion on metallic structure

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Abstract

The aim of this work is to understand the erosion mechanism caused by repeated water droplets impingement on a metallic structure, and then perform numerical simulations of the damage. When a high velocity water droplet with small diameter impacts a rigid surface, interaction is driven by inertial effects. Upon impact, the "water-hammer" pressure appears by inertial effect at the center of the contact though the maximum pressure occurs on the envelope of the contact area. Lateral jetting occurs by compression when the wave front travelling inside droplet overtakes the contact area. Concerning the structure, erosion is due to fatigue cracking. First, material grains are weakened during an "incubation" phase. After a large number of impacts, micro-cracks emerge and lead to ejection or fracture of grains, what is called "amplification" phase. A 2-way coupling computation with fluid-structure interaction at macroscopic scale allows to confirm the fatigue-based mechanism by observing the hydrostatic stress. Finally, erosion program developed with two criteria : a general one and Dang Van criterion. It provides the location of the most eroded zones of the structure during a loading cycle. They locate at the edge of jetting zone, which shows the influence of microjets in the erosion mechanism.

Keywords : impact / coupling / droplet / erosion / fatigue