Elliptical jet breakup related with the internal nozzle flow

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Abstract

An experimental study was conducted to investigate the atomization characteristics of a circular nozzle and elliptical nozzles of small diameter (0.5mm) under the high injection pressure (1MPa~9MPa). Furthermore, numerical simulations were attempted to investigate the internal flow structure in the circular and elliptical nozzles. This study showed that the disintegration characteristics of the liquid jet of elliptical nozzles were much different from those of the circular nozzle. In the case of the circular nozzle, the surface of liquid jet was much smooth near the nozzle exit under the injection pressures of this study. But, in the case of the elliptical nozzles, surface waves on liquid jet have been generated and grown with increase of the injection pressure. As a result, surface breakup was observed with the increase of injection pressure because a rough column surface caused by growth of surface wave is disintegrated to ligament as the relative velocity between the liquid jet and ambient air increases. Furthermore, the numerical simulations informed that the internal flow structure of elliptical nozzle was quite different from that of the circular nozzle. The internal flow structure of the elliptical nozzle in hydraulic flip was reattached to the orifice wall of the minor axis unlike the flow in the circular nozzle which is detached from orifice wall. It has been concluded that the internal flow structure of the elliptical nozzle has influence on the disintegration characteristics of the liquid jet issued from the elliptical nozzle.

Introduction

We carried out an experimental study on the atomization characteristics of an elliptical nozzle with a small hole diameter (0.5mm) and under relatively high injection pressure (1MPa~9MPa). From this study, it is thought that the atomization characteristics of an elliptical nozzle were related to the internal flow structure characteristics in the orifice.

Experimental setup and method

The experimental setup consists of an injection device, visualization system, pressure measurement and SMD measurement system. Working fluid was water at room temperature. The water pressurized by nitrogen in the surge tank was injected from the nozzle into ambient air. The nozzle was linked to the traverse for movement. Injection pressure was controlled by the pressure of the nitrogen gas, which was controlled by the gas regulator. Injection pressures were measured by a pressure transducer (KELLER, PA-21SR). The pressure signals were acquired by data acquisition board and monitored in real time. The spray image was obtained by the shadowgraph method using a CCD camera (Vieworks, VM-2M 35) and a xenon lamp (Drello, Drelloscope 3020) as the light source. The spray images were automatically stored by the image grabber, which was interlinked with the computer. The macroscopic characteristics of the liquid jet were analyzed from the spray images. The SMD for the variation conditions such as injection pressure, axial distance from the nozzle exit and radial distance of spray from the spray center was measured by using the laser diffraction method

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