Investigation on the cavitating flow of biodiesel fuel within the nozzle passage according to the nozzle geometry

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Abstract

The high pressure fuel injection and complicated nozzle geometry caused an unstable flow field and the occurrence of cavitation by the dropping of the dynamic pressure at an inlet orifice. This cavitation inside nozzle orifice and the vortex flow in the sac volume affect the spray behavior and characteristics including the spray cone angle at nozzle exit. The purpose of this work is to investigate the internal flow characteristics using biodiesel fuel derived from soybean oil and the enlarged 2-dimensional nozzle, experimentally and numerically. In addition, it was studied the effect of the nozzle geometry such as a rectangular inlet shape, a tapered inlet shape, and another rectangular inlet orifice with different L/W (length / width) ratio on the cavitating flow characteristics of biodiesel fuel. A velocity distribution in a nozzle and a volume fraction of liquid / gas phase were calculated from the method of two-fluid model in FIRE code.

It was revealed that the length of cavitation get longer as increasing of the injection pressure after the occurrence of cavitation, and the cavitation grew along the nozzle orifice wall. Numerical results showed almost similar an inception point of caviation compared with experimental results. When the cavitation grew to near the nozzle exit, the flow velocity at the center of fuel flow increased. In addition, the spray cone angle of the injected fuel increased due to the increase of the relative velocity between the center and edge of the nozzle. In the case of the tapered inlet nozzle and the rectangular inlet nozzle with large L/W ratio, it needs a higher injection pressure to occur the nozzle cavitation compared to the rectangular inlet nozzle. At the tapered inlet nozzle, the volume fraction of liquid is smaller, and the flow velocity at the nozzle exit is higher than that of the rectangular inlet nozzle. The calculated cavitating flow from FIRE code was well agreed with the experimental cavitating flow.

Key words: Biodiesel, Discharge coefficient, Nozzle cavitation, Reynolds number, Weber number

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