Improvement of Atomization and Flow Characteristics of Atomization Enhancement Nozzle for Direct Injection Diesel Engine

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Abstract

The purpose of this study is to improve atomization characteristics of a direct injection Diesel nozzle, which spray with large spray angle, short liquid core length and small droplet diameter are obtained. In the previous study, the single hole atomization enhancement nozzle, which cavitation occurs in the nozzle hole and strong disturbance is given to the liquid flow in the nozzle hole, and excellent spray characteristics are obtained at relatively low injection pressure, was developed. Moreover, it is demanded improvement of flow characteristics under low injection pressure, that is, even though excellent spray characteristics are obtained at low injection pressure, volumetric flow rate, which is obtained at high-injection pressure, has to obtain under low injection pressure. In this study, it was investigated about atomization of spray of the multi-hole atomization enhancement nozzle, which the single hole nozzle was separated to four nozzle holes (Hole number: N=4) with the same sectional area of the single hole nozzle as one of the four nozzle holes, and aimed to improve atomization characteristics and to obtain excellent spray characteristics. Effects of geometric shapes and dimensions of the multi-hole atomization enhancement nozzle, such as sharp and rounded inlet shapes and combination of hole diameter, on atomization characteristics were investigated. It was investigated that the developed atomization enhancement nozzle with the best hole inlet shape and dimension of nozzle hole was installed at the direct injection Diesel injector, effects of the multi-hole atomization enhancement nozzle on atomization of intermittent spray under high-ambient pressure condition. As a result, it was cleared that in case of the multi-hole atomization enhancement nozzle with hole number of N=4 and rounded inlet shape, breakup length becomes short and spray angle becomes large about 50 percent compared with the actual single hole nozzle (Fig.1). Moreover, volumetric flow rate is increased about 60 percent, and flow characteristic was considerably improved (Fig.2). Atomization characteristics and flow characteristics were improved under low injection pressure. Atomization characteristics of intermittent spray were improved considerably by using the multi-hole atomization enhancement nozzle with hole number of N=4 and rounded inlet shape at high-ambient pressure conditions for the direct injection Diesel engine (Fig.3). Although spray tip penetration of the multi-hole atomization enhancement nozzle is short compared with the actual single hole nozzle, spread of spray becomes wide considerably and homogeneity of spray are obtained.

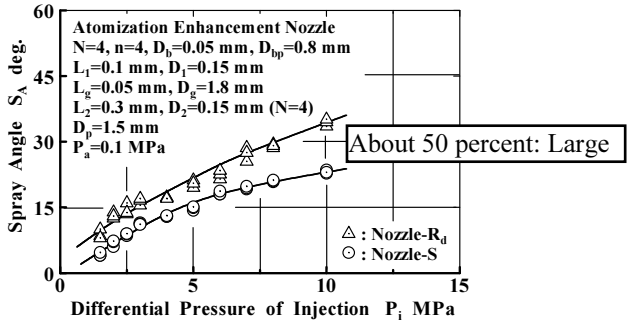


Figure 1 Effect of inlet shapes of nozzle hole on spray angle

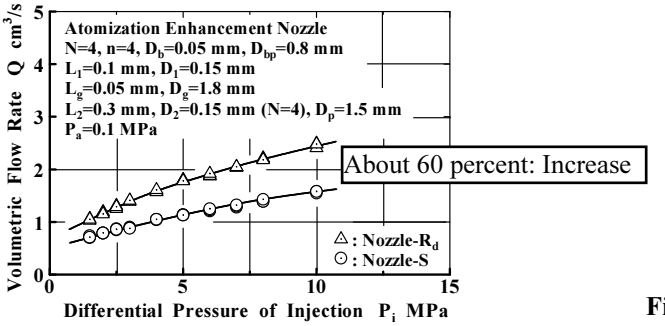
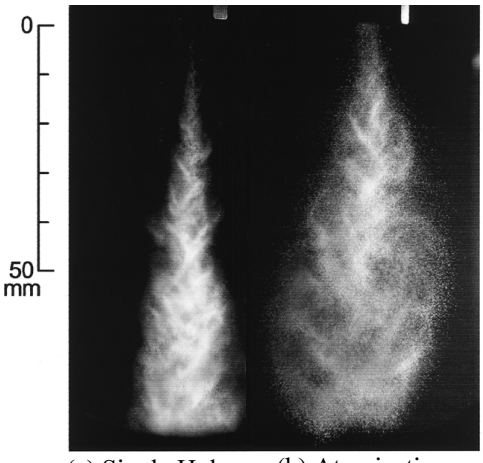


Figure 2 Effect of inlet shapes of nozzle hole on volumetric flow rate



(a) Single Hole Nozzle (b) Atomization Enhancement Nozzle

P_i=100 MPa, P_a=1.6 MPa, T_a=300 K, $T_{inj.}$=900 us, t=3.0 ms

Figure 3 Atomization of intermittent spray under high-ambient pressure condition