Spray-Spray and Spray-Wall Interactions in Diesel Sprays from Micro-Hole Nozzles under Ultra-High Injection Pressures

W. Zhang[1*], K. Nishida[1] and J.-P. Tian[2]
[1]Department of Mechanical System Engineering, University of Hiroshima
Higashi-Hiroshima 739-8527, Japan
[2]Institute of Internal Combustion Engine, Dalian University of Technology
Dalian 116023, China

Abstract

In direct injection (D.I.) Diesel engines, injection parameters have a significant influence on the spray evolution, mixture preparation, combustion, and emission formation processes. It has been approved that decreasing nozzle hole diameter and increasing injection pressure are the two effective approaches to improve the spray and combustion characteristics. In the past research, the spray from a micro-hole nozzle (d = 0.08 mm) under an ultra-high injection pressure (P_{inj} = 300 MPa) has been comprehensively studied. To correlate the results of the single-hole nozzle to the multi-hole one and to clarify the effects of spray-spray and spray-wall interactions on the entrainment and vaporization processes, the present work focuses on the mixture formation process of a two-hole nozzle with a hole diameter of 0.08 mm under different wall-impinging conditions. The laser absorption-scattering (LAS) technique was employed to obtain the qualitative and quantitative information under various conditions. The evolution of both the liquid and vapor phases fuel was recorded. An asymmetric image processing method was used to acquire the data on the fuel vaporization and the projected vapor mass distribution. The experiments were carried out in a quiescent constant-volume vessel. The test ambient conditions were the same as those at the start of injection in the real engine. Firstly, the free spray and the flat-wall-impinging spray were investigated. Then, to simulate the engine-like wall-impinging spray process, two kinds of two-dimensional (2-D) piston cavity shape walls, the shallow dish type and the reentrant type, were designed according to the shape of the combustion chamber in the prototype engine. The interactions between the spray and the flat wall, between the spray and the curved wall, and between the sprays were discussed respectively. The results provide useful information for understanding the detailed evolution of Diesel sprays and for implementing the micro-hole nozzle and the ultra-high injection pressure in D.I. Diesel engines.

Key words: diesel sprays, fuel vaporization, micro-hole nozzle, ultra-high injection pressure, wall impingement

[*]Corresponding author, zhangwu-scl@hiroshima-u.ac.jp