# Study on Spray Propagation under Pressurized Flow Field in Circuit Wind Tunnel

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## Abstract

Interaction between a spray and its surrounding air is a key factor for engine CFD codes since spray penetration and droplet breakup have their source from the relative velocity between the droplets and the ambient flow. It applies especially to the sprays in large marine diesels which often propagate nearly parallel to a swirl flow to promote their penetration and distribution inside the large combustion chamber. Various sub-models in spray simulations, however, have been developed for smaller engines where the sprays are injected orthogonally into swirling in-cylinder gas. This may lead to obscurity in the spray prediction in large diesels. Practical and well-founded spray models are definitely needed in the field, but a lack of experimental information keeps it difficult to derive and validate such models. In this study, a diesel nozzle of a single injection hole was inserted into a channel of a closed-circuit wind tunnel (Fig.1), which has a cross-section of 50 mm×50 mm and realizes maximum free stream velocity of 22 m/s under air pressure of 1.1 MPa. The spray was injected parallel to the tunnel stream windward or leeward, and its propagation was recorded by a high-speed camera. The measurement results (Fig.2A) showed the free stream velocity has significant effects both on the spray penetration and on the spray cone angle (Fig.3). Although the breakup process near the nozzle exit showed less dependency on the ambient flow, child droplets detached from an outer edge of the everted spray tip were observed to impinge on the liquid column of the spray body (Fig.2B). The observed spray propagation inside the ambient flow was successfully reproduced via a KIVA-3V code based on the unique modification in the collision length treatment (Fig.4).

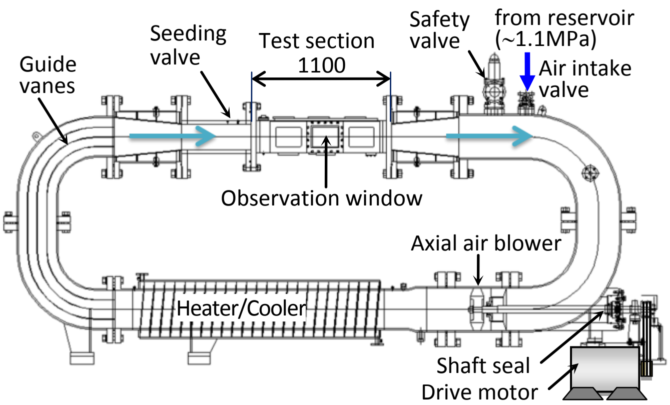


Fig.1. Overview of Closed-circuit Wind Tunnel (CWT)

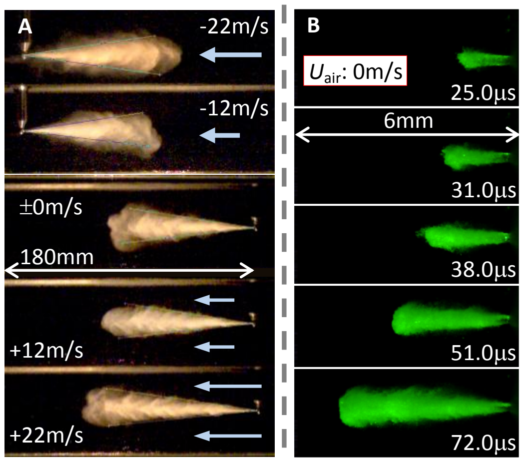


Fig.2. Spray penetrations under different wind velocities (A, left) and macro-graphic spray images near nozzle exit (B, right)

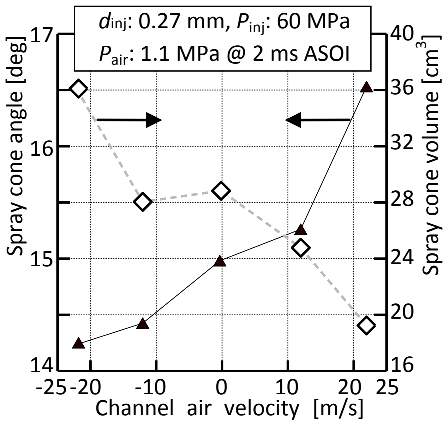


Fig.3. Effect of wind velocity on spray cone angle and estimated spray volume

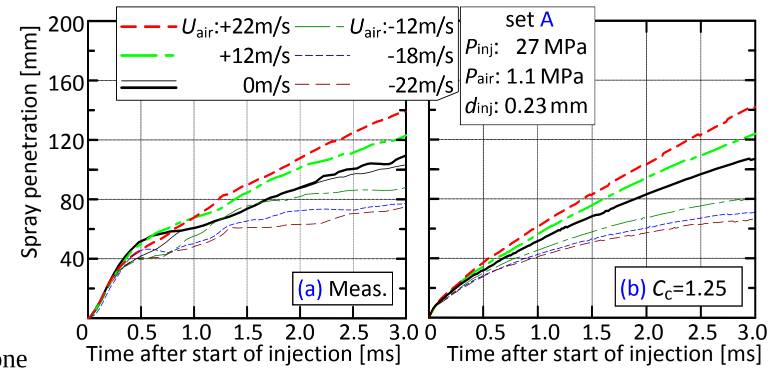


Fig.4. Comparison of measured spray penetration with simulated ones of different collision lengths

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