DeNOx SCR: comparison of commercial Adblue injectors

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Introduction

The injection process of urea-water solution (AdBlue) determines initial conditions for reactions and catalysis and is fundamentally responsible for optimal operation of selective catalytic reduction (SCR) systems. The spray characteristics of four commercially available injectors (one air-assisted and three pressure-driven with different nozzle-hole configurations) are investigated by non-intrusive optical techniques, shadow imaging and Phase Doppler Anemometry (PDA).

Experimental setup

Injection occurs in the crossflow of a channel blowing preheated air. The gas flow through the measurement chamber can be regulated up to 450kg/h and 500°C, which allows the reproduction of engine exhaust-like conditions.

PDA measurements deliver droplet size distributions and droplet volume distributions. Measurements have been performed in several locations near the opposed channel wall area. Sauter mean diameters of the droplets from the pressure-driven injectors are between 60-80μm, while that of the air assisted is 20μm. The 3-Hole pressure-driven injector is characterized by the largest droplet sizes. Injectors P1-6H and P2-6H, the pressure-driven 6-Hole injectors, have similar average droplet sizes. The distribution of the latter is though narrower than the former. The largest part of the spray mass of the latter is contained in droplets being almost 30% smaller than of the former.

Conclusions

SCR spray characteristics differ drastically among available injectors. The air-assisted injector generates a fine spray which is highly susceptible to the exhaust gas flow. All sprays of the pressure-driven injectors hit the opposed wall at the same location, regardless the exhaust flow conditions. The 3-Hole pressure-driven injector is characterized by the largest droplet sizes. The injector location and the vicinity to further parts like the exhaust pipe walls and the catalysts are decisive for the selection of the most suitable injector.

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Figure 1: PDA measurement in the injection chamber under exhaust-like conditions

Figure 2 shows the stereomicroscopic photographs of the nozzle tip configuration of the four commercial SCR injectors investigated. A-A is a single-hole air-assisted injector. The others are pressure-driven injectors. P1-6H has larger nozzle diameter and smaller spacing diameter than P2-6H.

Figure 3: Shadow imaging contours at different flow conditions for the four commercial SCR injectors (gas flow conditions: 300°C, red: 100kg/h, green: 200kg/h, blue: 300kg/h)

Figure 4: Droplet size distribution and droplet volume distribution at exhaust gas flow conditions: 300°C, 100kg/h.

Results

The effect of several gas temperatures and flows on the spray propagation and entrainment has been studied by shadow imaging. Shadow images show that the spray of the pressure-driven injectors is only marginally affected by the gas crossflow. In contrast, the air assisted spray is strongly deflected by the gas, the effect increasing with increasing gas flow.

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