Effervescent Atomization of Diesel Fuel Containing Dissolved CO_2

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Abstract

The effect of adding CO2 to diesel fuel has been previously studied by several groups that used tailored made injection systems. The downstream part of the injector consisted of an inlet orifice, an expansion chamber, a swirl duct, and a discharge orifice. When the mixture entered the expansion chamber, a part of the dissolved gas was transformed into tiny bubbles that grew inside the expansion chamber. When the mixture was driven out through the discharge orifice, these bubbles have undergone a rapid flashing process that resulted a rapid disintegration of the liquid bulk into small droplets. The effect of the CO2 content was clearly demonstrated and remarkable low SMD's were archived. In the present study we use a real commercial fuel injection system that is typical for medium diesel engine (2,500cc) and studied the effect of the amount of dissolved CO2 on the resulted spray characteristics. In this case, when the mixture enters the injector and flows downstream through the variable cross-sections duct, partial nucleation is expected to occur at different locations along the duct and a part of the dissolved gas is transformed into tiny bubbles that grow fast downstream. As for the case of the special designed injection system, when the mixture is driven out through the discharge orifice, these bubbles undergo a rapid flashing process resulting a rapid disintegration of the liquid bulk into small droplets. In the present study, an experimental study of steady-state atomization process of diesel fuel containing dissolved CO2, is presented. An extensive study was performed to map the effect of the CO2 content on the spray SMD and droplet distribution at different locations downstream the discharge orifice, and on the spray angle. The spray characteristics (SMD and D90) were measured with a laser particle size analyzer (Malvern XMastersizer), and a digital camera was employed to record the spray angle. An overall analysis has been performed to evaluate the advantage of the proposed method over its counterparts, in terms of the total energy required to produce a desired spray. It is concluded that the atomization of diesel fuel containing dissolved CO2, is significantly promoted by the flash-boiling phenomenon to result low SMD and D90 sprays. It was also found that the spray structure of a fuel/dissolved gas mixture is essentially different from that of a single-component fuel.

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