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Assessment of Pulsed Gasoline Fuel Sprays by Means of Qualitative and Quantitative Laser-based Diagnostic Methods

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ABSTRACT

The combination of qualitative measuring techniques such as imaging, with quantitative drop sizing techniques like Laser Diffraction and Phase Doppler Anemometry (PDA), has been applied for assessing the sprays formed by injectors for gasoline direct injection (DI) engines.

Both, the sizing instruments as well as the imaging, are offering temporal resolution in order to investigate the important features of pulsed DI sprays. Using a combination of the spatially integrating Laser Diffraction instrument with strobe illuminated dual view 2D-imaging, the overall spray properties have been assessed. Having the 2D information of the global spray shape in two perpendicular directions allows to immediately correlate the concentration and drop size measurement results of the Laser Diffraction instrument with the global spray appearance. Thus, the changes of the spray pattern can be related with the sizing information as the spray propagates away from the injector.

For injector design improvements, however, it is required to achieve a higher spatial resolution and especially to measure closer to the injector exit orifice than the Laser Diffraction allows. By using a Phase Doppler Anemometer, the different phases of the injection event, i.e. opening of the injector, main spray and closing phase of the injector, can be distinguished from each other. However, in sprays, where the spray geometry is changing with time, the Phase Doppler instrument can suffer from its high spatial resolution, yielding to results, which are difficult to interpret.

Assisting the PDA with a simultaneous imaging technique of similar spatial resolution creates a very robust experimental approach. By visualizing the plane perpendicular to the PDA probe volume, i. e. the crossing of the PDA laser beams on the spray image itself, a very precise adjustment of the PDA probe volume in regard to the spray rather than the nozzle can be achieved. This becomes critical when getting to the near orifice area at distances closer than 10mm. The synchronized images also bring additional information to the point measurement provided by the PDA. It becomes easier to choose which particular phase of the spray formation the user wants to characterize. Finally, more confidence into the interpretation of PDA data from locations close to the injector tip is reached.