Experimental and Numerical Analysis of Marine Diesel Engine Injection Sprays under Cold and Evaporative Conditions

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Abstract

Exhaust gas emissions of marine diesel engines are globally legislated by the IMO-TIER regulations. With the introduction of the next stages, a significant reduction of emission limits forces engine manufacturers to implement new, highly sophisticated technologies. However, considerably changing qualities, compositions and properties of the marine fuel oils do not allow the application of several well known techniques as for example exhaust gas recirculation and exhaust gas treatment systems. This is caused by corrosion problems brought about by a sulphur content of currently up to 4.5% in the fuel.

Against this background modern, flexible fuel injection systems proved to play a key role in order to efficiently reduce emissions. Though, as well engine manufacturers as injection system suppliers are about to develop and apply heavy fuel Common-Rail injection systems. Major task in this context is the systems capability to cope with heavy fuel oil and its abrasive acting components.

In cooperation with several partners a project funded by the German government was purchased in order to investigate the emission reduction potential of modern Common-Rail injectors using different marine fuels. This includes the experimental analysis of injection sprays in an optically accessible high pressure/high temperature research chamber. Different methods like scatter light, PDA and a combined Schlieren/Scatter light-bypass technique are applied in order to quantify the spray parameters penetration length, cone angle, droplet size and velocity. The data is mainly used for the validation and development of spray models for the simulation of diesel and heavy fuel injection sprays in a combustion chamber of a medium speed ship engine. In order to account for nozzle internal effects a coupling between the nozzle internal flow and the spray simulation is done. By means of a special polymer moulding technique, real nozzle geometries were derived and considered in the simulation of the nozzle internal flow pattern. The obtained flow conditions are then used as input data for the spray simulation. A good correlation of the experimental and simulation results is observed. After a short introduction to marine diesel engine demands, the experimental setup, simulation strategy and settings as well as the results are presented and discussed.

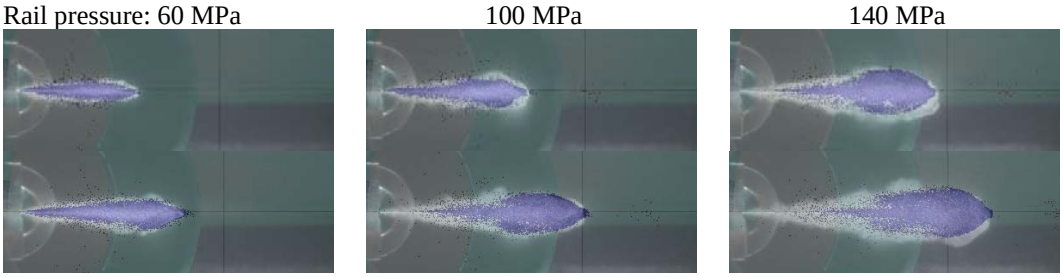

Figure: Calculated and measured spray 1.9 ms (top) and 2.2 ms (bottom) after start of current

Key words: diesel fuel injection, marine diesel engines, spray analyses, spray modeling

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