Validation and Initial Application of a Novel Spray Combustion Chamber Representative of Large Two-Stroke Diesel Engine Combustion Systems

K. Herrmann*, A. Kyrtatos, R. Schulz and G. Weisser
Wärtsilä Switzerland Ltd
PO Box 414, CH-8401 Winterthur, Switzerland

B. von Rotz, B. Schneider and K. Boulouchos
ETH Zurich, Aerothermochemistry and Combustion Systems Laboratory
ETH Zurich, CH-8092 Zurich, Switzerland

Abstract

The application of state-of-the-art Computational Fluid Dynamics (CFD) tools to the simulation of combustion in large marine diesel engines continues revealing the need for further development of the models used for the description of the spray processes in particular. Such development is, however, suffering from the lack of relevant validation data, considering the physical dimensions and operational parameters involved, including flow characteristics of the process gas and fuel quality. Therefore, a novel experimental setup has been realized, allowing the study of spray and combustion processes at conditions typical of large two-stroke marine diesel engines. Its core element is a disk-shaped constant volume spray combustion chamber of diameter 500 mm with peripheral injection into a swirling flow and equipped with comprehensive options for granting optical access. In order to achieve realistic thermo- and fluid dynamic conditions at start of injection, the chamber is fed with pressurized and heated process gas provided by a pressure vessel/heat regenerating system, via inclined intake channels. The chamber design includes various injector arrangement options and the injection system is prepared for running on typical marine fuels. Following the completion of the setup, the first focus was its validation against the requirements and design specifications in terms of the pressure and temperature ranges envisioned as well as regarding the swirl pattern at start of injection. The initial application involved the visualization of the spray evolution of either single or multiple sprays from the injector tip by means of shadow imaging techniques, thereby varying temperature and pressure at start of injection and considering both non-reactive and reactive cases. These investigations have fully confirmed the potential of the setup for studying spray and combustion processes at conditions relevant to large marine diesel engine combustion and have provided valuable insight already into the spray characteristics at such conditions.

Key words: Diesel Sprays, Combustion Chamber, Marine Diesel

*Corresponding author, kai.herrmann@wartsila.com