Heat Transfer in Two-Stroke Diesel Engines for Large Ship Propulsion

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Demands on reducing the fuel consumption and harmful emissions from the compression ignition engines (diesel engines) have been continuously increasing in recent years. To comply with this, better modeling tools for the diesel combustion process are desired from the engine developers. A very important aspect is determining the temperature distributions in and around the combustion chamber since they are important for determining the boundary conditions of the detailed computer models of the chemical and physical processes in the engine cylinder. Furthermore, the temperature information is very useful for validation of engine simulations. In this work, a special designed thermocouple is used to measure surface temperatures. The design and fabrication of the special thermocouple is described, along with response tests and uncertainty estimates. A series of experiments at part load conditions (25%, 30% and 50% load) was performed on a MAN Diesel & Turbo SE test engine, which shows very promising results for further investigations of dynamic temperature and heat flux in large bore engines. Instantaneous heat flux is derived using both an analytical and a numerical model and compared. More specifically, the analytical method is based on a one-dimensional assumption and utilizes Fourier series. A 1-D numerical model based on finite differences in a Crank Nicholson time scheme is also used. The magnitude of the perturbations of the temperature fields around the location of the thermocouples was investigated by computer simulations using a 3-D numerical finite volume model made in STAR-CD. General trends are observed from the temperature measurements in the limited part load range. These include among others: local increase in mean surface temperature and mean surface heat flux with increasing load, increase in peak surface heat flux with decreasing load and possible indication of an increase in wall deposit layer thickness with increasing load.

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