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SIMULATION AND EXPERIMENTAL STUDY OF THE HEAT FLOW THROUGH THE WALLS OF AN INTERNAL COMBUSTION ENGINE

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Abstract. This work presents the first stage of a broader experimental and numerical study of the heat flux through the walls of an internal combustion engine running under low carbon footprint alternative fuels. Heat losses during engine operation have a significant impact on engine emissions, efficiency, and thermal stresses. As an initial validation step, the work at hand deals with the applicability of models for predicting the heat flux magnitude of the end gas flow in proximity to the combustion chamber walls. Measurements of pressure dynamics in the engine manifolds and cylinder, and of the heat flux in the cylinder walls, by means of a differential thermocouple-type heat flux sensor, are used for validating the computational model, in cold flow conditions. As heat flux is strongly affected by the complex flow structures induced by the different engine components, the complete fluid domain of the engine was included in the computational domain, making the atmospheric boundary conditions at the inlet and exhaust manifolds the overall system boundaries. Therefore, the in-cylinder flow dynamics are exclusively dependent on the valves and piston kinematics. The computational model combines a pseudo-supermesh approach with dynamic layering, coupled with a valve opening/closure model. This enables the model to be efficient, in terms of computational cost, robust and versatile for parallel computation. These are crucial features when dealing with complex simulations. The accuracy of the different models was evaluated comparing the heat flux evolution throughout the compression and expansion cycles of a closed piston-cylinder assembly and by computing a series of quantitative indicators. It was found that, while the in-cylinder pressure calculation converges rapidly, heat-flux convergence requires larger computational times.