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Where The Heat Goes - Thermal Analysis of Internal Combustion Engines

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The last decades of automotive development have become a race driven by emission regulations, fuel efficiency and customer requirements. To meet future rrequirments, more and more virtual development is required to further accelerate the proces. One of the most significant trends in engine development is downsizing, which leads to smaller engines with higher power output and therefore much higher thermal loading. To reach a high levels of reliability and engine life an optimized and very effective cooling system is needed.

3D CFD has become a valuable and efficient tool to guide the IC engine design engineer to optimize the cooling system. Next to pure coolant flow field investigations, detailed studies of the engine-internal heat transfer have become possible, such that resulting structural temperatures can now be assessed with reasonable accuracy. However, in order to achieve reliable results every individual process along the heat transport path from gas side to coolant side needs to be analyzed in detail and the corresponding sub-models adjusted and verified.

This paper describes the developed methodology together with individual sub-model verification steps. The whole process is performed entirely using CD-adpaco simulation software. Beginning at the gas-side the combustion process is modeled with es-ice and STAR-CD. The complete engine structure and coolant regions are meshed and solved as a CHT model in STAR-CCM+ with model-sizes up to 20 million cells.

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