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Enhancement of Monte Carlo Technique in Absorbing/Emitting Radiating Media for CFD Applications

The main objective of the thesis was to develop Monte Carlo Ray Tracing method able of solving conjugate heat transfer problems in domains of arbitrary shapes, the presence of non-gray gases and solid particles. The model uses coarse hierarchical ortho-Cartesian mesh with NURBS surfaces for boundary description, which is created based on CFD mesh. The results are interpolated onto CFD mesh. The code of the model is written in C++, uses multi-threading for parallelization and is designed to be an add-on to open-source CFD package OpenFoam.

The model has been successfully verified for a number of test cases including non-participating and participating medium with gray and non-gray gas properties.

Subsequently, the model was employed for simulations of the pit furnace, non-isothermal chamber filled with gray gas and pulverized coal combustion in air and oxygen-enriched atmospheres. In the last case, the simulation results were confronted with rig tests and with results generated by Ansys Fluent showing very good agreement.

The thesis proven the ray tracing time can be shorten 100 times using ortho-Cartesian mesh with NURBS surfaces instead of dense CFD mesh. Moreover, the usefulness of mesh hierarchy was shown, by means of which the local refinement of the solution is possible. It has been proven that MCRT model developed within the thesis is fully capable of solving conjugate heat transfer problems in transparent, gray and non-gray media with the presence of particles.