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Three dimensional remeshed smoothed particle hydrodynamics for the simulation of turbulent flow in complex geometries

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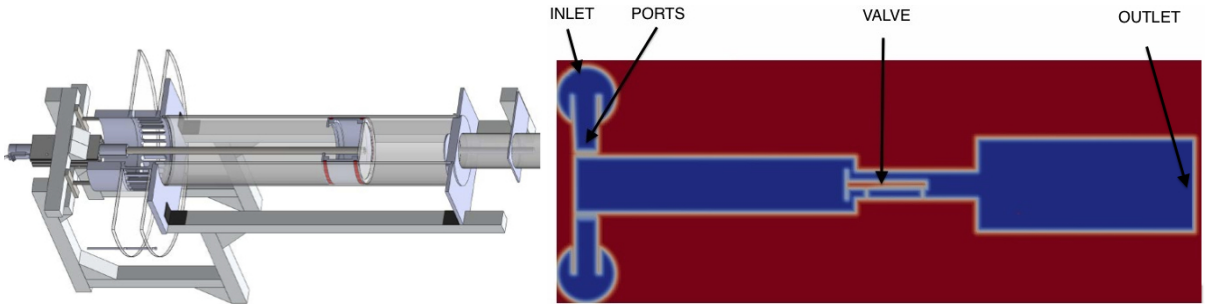
ABSTRACT

The current work is devoted to numerical modeling of the in-cylinder confined turbulent swirling flow in a simplified model of a large two-stroke marine diesel engine Fig. 1a. The compressible flow is governed by Navier-Stockes equations, and we model turbulence using large eddy simulations [1]. We use the remesh smoothed particle hydrodynamics (rSPH) method [2], where the particles locations are periodically reinitialized (remeshed) onto uniform grid, in which the conserved quantities are redistributed onto a new set of particles. The quantities are interpolated by the 3rd order M_4' kernel [7]; as result the accuracy of the original formulation is significantly enhanced, as we overcome the particle distortion, associated with all Lagrangian particle methods, often leads to large inaccuracies of the quantities. To simulate the compressible flow around solid obstacles of complex geometry, rSPH is coupled with



(a) (b)

Figure 1: (a) The simplified model of a large two-stroke marine diesel engine, (b) A cross-sectional plane of the engine showing the solid geometry as a porous media using Brinkman penalization method, where the blue represent the flow area and red represent the solid area

Brinkman penalization method [4], the main advantage is the efficient implementation for stationary and moving solid boundaries. The idea of the penalization is to consider the obstacles as a porous media with porosity, and viscous permeability approaching zero [3] Fig. 1b.

The method has been validated on standard benchmarks and results from simulations of the decay of three dimensional isotropic turbulenc Fig. 2 will be presented at the symposium.

All the simulations are done using the Parallel Particle Mesh (PPM) [6].

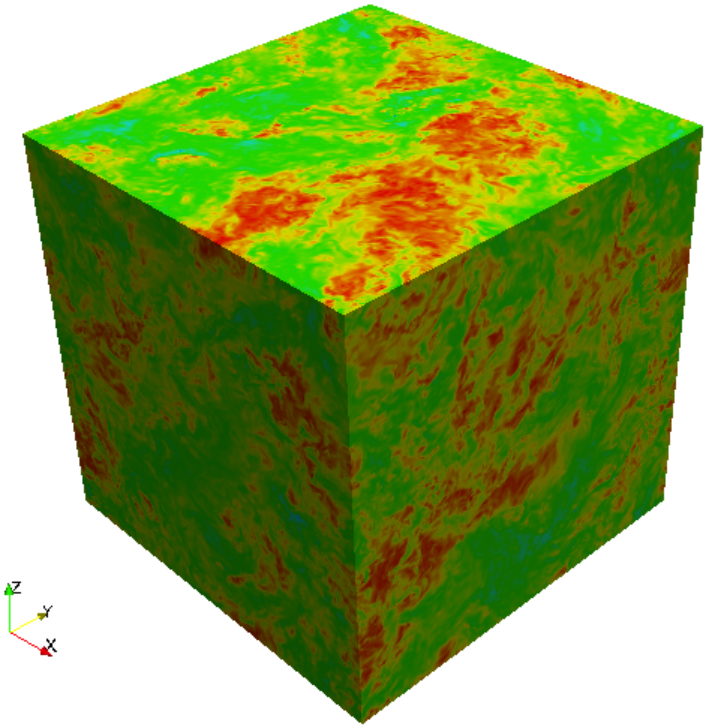


Figure 2: The present 3D remeshed smoothed particle hydrodynamic method is applied to decaying isotropic turbulence, here illustrated as contours of the initial flow speed [5].

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