Asociación Argentina
de Mecánica Computacional

Mecánica Computacional Vol XXXVI, págs. 1327-1327 (resumen)
José G. Etse, Bibiana M. Luccioni, Martín A. Pucheta, Mario A. Storti (Eds.)
San Miguel de Tucumán, 6-9 Noviembre 2018

SIMULATION OF FOUR-STROKE INTERNAL COMBUSTION ENGINES USING A LAGRANGIAN-EULERIAN STRATEGY WITH THE FINITE VOLUME METHOD

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Keywords: Internal Combustion Engines, Finite Volume Method, OpenFOAM(R), Dynamic Meshes, Combustion.

Abstract. Internal combustion engines (ICE) suffer from a transformation process due to several regulations which limit their pollutant emissions. In this context, new operating strategies are investigated to increase the thermal efficiency and optimize the combustion process. To accomplish this, the computational fluid mechanics has a central role as a development and design tool for evaluating new design concepts. Particularly, the numerical simulations of ICE include the simultaneous resolution of compressible flows, fuel injection and combustion. Furthermore, all these tasks take place inside deforming domains which requires the application of moving mesh techniques. In order to solve this problem, this work presents an integral tool for the simulation of internal combustion engines. This is implemented inside a parallel computational framework with the aim of simulating several engine cycles in short computational times. The governing equations are discretized with the Finite Volume Method where non-conformal interfaces and a local remeshing technique are used to handle the deforming domains. Then, an Eulerian-Lagrangian strategy is applied to model the gaseous and liquid phases of air and fuel respectively. Finally, the combustion is solved using a Flame Surface Density approach using the "flamelets" assumption. The computational tools are validated through experimental data of a four-stroke Otto engine. Finally, the results showing the temporal evolution of the main variables are presented and the capacities, accuracy and computational efficiency of the developed tools are analyzed.