Stabilized finite element method for solving heat transfer and turbulent flow inside industrial furnaces

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A mathematical and numerical model to design an industrial software solution able to handle real complex furnaces configurations in terms of geometries, atmospheres, parts positioning, heat generators and physical thermal phenomena has been developed. A three dimensional algorithm based on stabilized finite element methods (SFEM) for solving the momentum [1], energy, turbulence and radiation equations is presented. An immersed volume method for thermal coupling of fluids and solids is introduced [2]. It consists in considering a single 3D grid of the furnace and solving one set of equations for both fluid and solid with different thermal properties which can reduce the computational costs. A level set function enables to define precisely the position and the interface of any objects inside the furnace and to provide homogeneous physical and thermodynamic properties for each subdomain. Furthermore, in order to ensure an accurate capture of the discontinuities that characterize the strongly heterogeneous domain, we resort to an anisotropic mesh adaptation algorithm based on the variations of the level set function. The proposed method demonstrates the capability of the model to simulate an unsteady three dimensional heat transfers and turbulent flows in an industrial furnace with the presence of conducting solids [3].

Références

[1] E. Hachem, T. Kloczko, B. Rivaux, H. Digonnet and T. Coupez, *Stable-Mixed finite element method for incompressible flows with high Reynolds number*, submitted to Journal of Computational Physics (December 2009).

[2] E. Hachem, T. Kloczko, H. Digonnet and T. Coupez, *Immersed Volume Method for solving natural convection, conduction and radiation of a solid body inside a 3D enclosure*, submitted to Journal of Computational Physics (January 2010).

[3] E. Hachem, *Stabilized Finite Element Method for Heat Transfer and Turbulent Flows inside Industrial Furnaces*, Ph.D. thesis, MINES ParisTech, 2009.

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