SD Numerical Simulation Technique for Hydrodynamic Flow Gas-Solids Mixing

I. Mantilla[1], S. De Vicente[2]

[1]National University of Engineering, Lima, Perú
[2]Polytechnic University of Madrid, Madrid, Spain

Abstract

We formulate a new mathematical model of Gas-Solids Mixing hydrodynamic flow [1] in a combustion chamber with a fluid bed system used in the combustion of mineral coal waste. This model in study is called Model Gas-Solids Mixing and it is constructed by averaging the conservation equations (mass and momentum) for a two-phase flow, which takes into account the existence of a small parameter rho in the order of 10 ^ (-4). This parameter is related to the ratio of the mass densities of both phases and is a free boundary problem making an asymptotic adjustment in the model. We found the solution. This model is important in the production of thermal energy-based solid waste.

Introduction: In this model, a nonlinear term is added to the Navier-Stokes equations to take into account the effect of nonlinearity in the compressible flow. In this problem in particular during the process empty areas of particles called singularities appear, ie. when the volume fraction of the dispersed phase is zero caused for the gas velocity. This is why there are serious theoretical problems upon convergence in the solution. Because of difficulties encountered in the model, it there is not an exact solution. In this paper we have developed a weak solution based on the results found in the literature [2]. This contribution is complemented by the construction of a numerical scheme for the quantitative study of the problem. This includes the formulation of decoupling techniques. The solution of the variational problem in space-time we realized the discreta inestability in time during the process. To overcome this difficulty we have used the Galerkin method with a numerical technique to capture the discontinuities in the Stream Lines Difussion (SD) with nite elements of type P1 + P2. We have built a new numerical model evolutionary for hydrodynamic volume fraction of solids and speed-gas in the simulating of the reactor with COMSOL Multiphysics® [3] for the effective simulation of the evolutionary problem.

Results: The results shown are coal waste assumptions regarding the parameter in the order of 10 ^ (-4) (Figure1: In the XY plane the axial section of the fixed bed reactor is represented; in Figure 2: Gas velocity through a nozzle in the bed, Figure 3: Pressure stream lines in the bed, and Figure 4: speed and volume fraction in N-reactor nozzles.

Conclusion: This work contributes to the knowledge of numerical techniques that are very important in order to predict the optimal size for fluidizing solid particles in multiphase flow

models. The detailed information will be given at the conference [4].

Reference

[1] Drew,D.A,1983 Mathematical modelling of two-phase Flow. Ann.Rev.Fluid.Mech.Vol15.pp.261-291.
[2] Claes Johnson, Numerical solution of partial differential equations by the finite element, Cambridge University Press, 1994.
[3] COMSOL Multiphysics, User's guide. Version 4.0, COMSOL AB, 2010.
[4] http://www.comsol.com/conference2013.

Figures used in the abstract

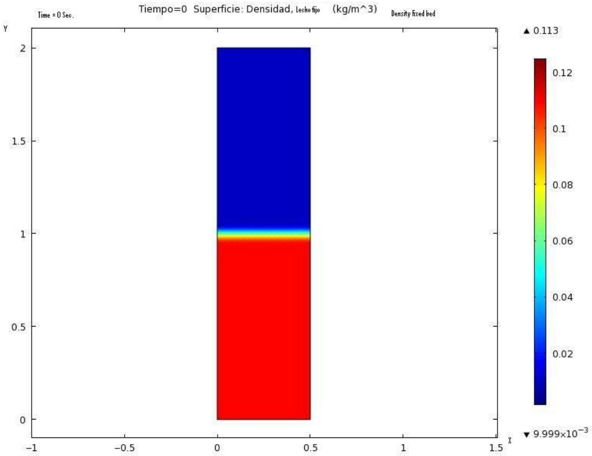

Figure 1: Fixed Bed

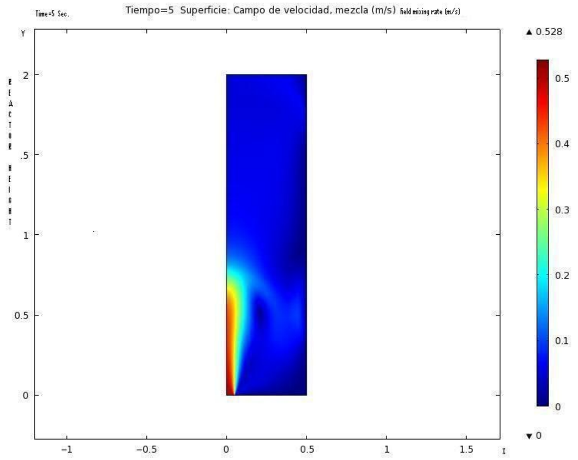

Figure 2: Gas velocity through a nozzle

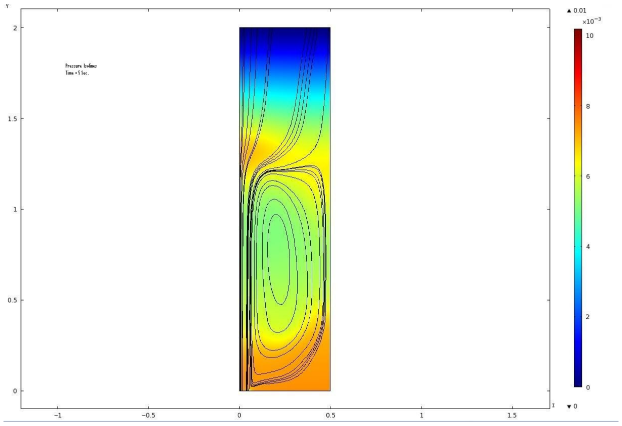

Figure 3: Pressure stream lines and gas velocity through a nozzle

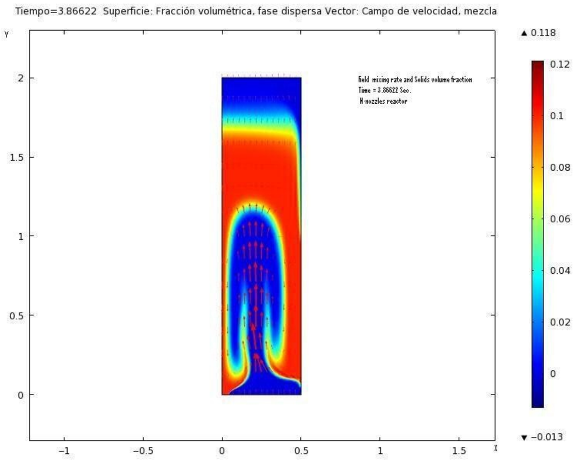

Figure 4: Solids and gas velocity through N-nozzle