A NEW HYBRID SLURRY CFD MODEL COMPARED WITH EXPERIMENTAL RESULTS

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Keywords: *hybrid model, experimental, slurry, multiphase, jet-impingement*

Abstract

Erosion is a large problem in many industries. CFD modelling is used to model the process in order to enable the engineer to design better equipment. This paper discusses a novel solution to reduce computational effort, using OpenFOAM to combine two exiting solvers. The two phases of the bulk flow are modelled partially in the Eulerian-Eulerian reference frame, and partially in the Eulerian-Lagrangian frame. The method aims to reduce computational time, but still keep the necessary particle impact data at the wall required for erosion modelling.

This paper is a continuation of a previous paper which was concentrated on the development of the new hybrid solver [1]. The new solver was applied to different geometries and test cases, and was validated against experimental data. A submerged jet impingement test with different shaped impingement samples was used to generate experimental data of the fluid phase. The results show a promising outlook for the new solver to be used for more efficient erosion prediction.

Introduction

Mining and oil and gas companies spend large amounts of money on preventing their parts from eroding. One way of doing this is to model the erosion process by using CFD. Eulerian-Lagrangian (liquid-particle) solvers are used to model particle impacts at the wall which are used for erosion models. The downside of using Euler-Lagrangian solvers is that they are computationally expensive. The solution proposed in the new solver is to model the bulk flow in Euler-Euler, and the near wall flow in Euler-Lagrange.

The new hybrid multiphase slurry model was developed in a previous paper [1]. In this paper the model was compared against existing OpenFOAM models and was validated against experimental data from the submerged jet impingement test. The model combines two solvers: the Euler-Euler 'reactingTwoPhaseEulerFoam' and the Euler-Lagrange 'DPMFoam' (a detailed tutorial can be found online [2]).

Method

Experimental tests were carried out on a built for purpose submerged jet impingement test rig. The rig was designed for particle image velocimetry (PIV) to be carried out for data acquisition. Three different impingement geometries were compared: a cylinder, a cone, and a hemisphere (see Figure 1a). The geometries were all tested experimentally and data gathered by using PIV. Geometries were then replicated by CFD meshes and the hybrid solver was run on them. Figure 2 shows velocity contours of the fluid phase on each of the geometries. These were compared with the data acquired by PIV, as seen in Figure 1b. This was done for all of the geometries.

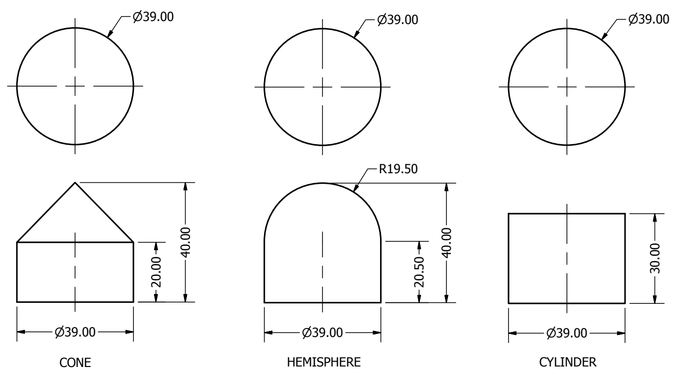
Further to this, the hybrid model was also compared to DPMFoam to asses the particle impact data. DPMFoam was run in each of the domains, with similar boundary conditions as the hybrid model. Particle impact locations and velocities were compared between each model. The viability of the hybrid model relies upon the data between the two solvers to be similar.

Conclusion

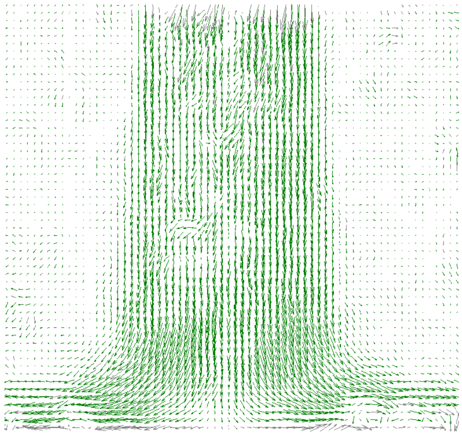
The results show that the hybrid model can reduce computational solving time whilst keeping particle data at the wall required for erosion modelling.

Acknowledgments

The authors thank all those involved in the organisation of OFW12 and to all the contributors that will enrich this event.



(a) Impingement geometries



(b) Velocity vectors on cylinder from PIV

Figure 1: Impingement geometries and experimental data

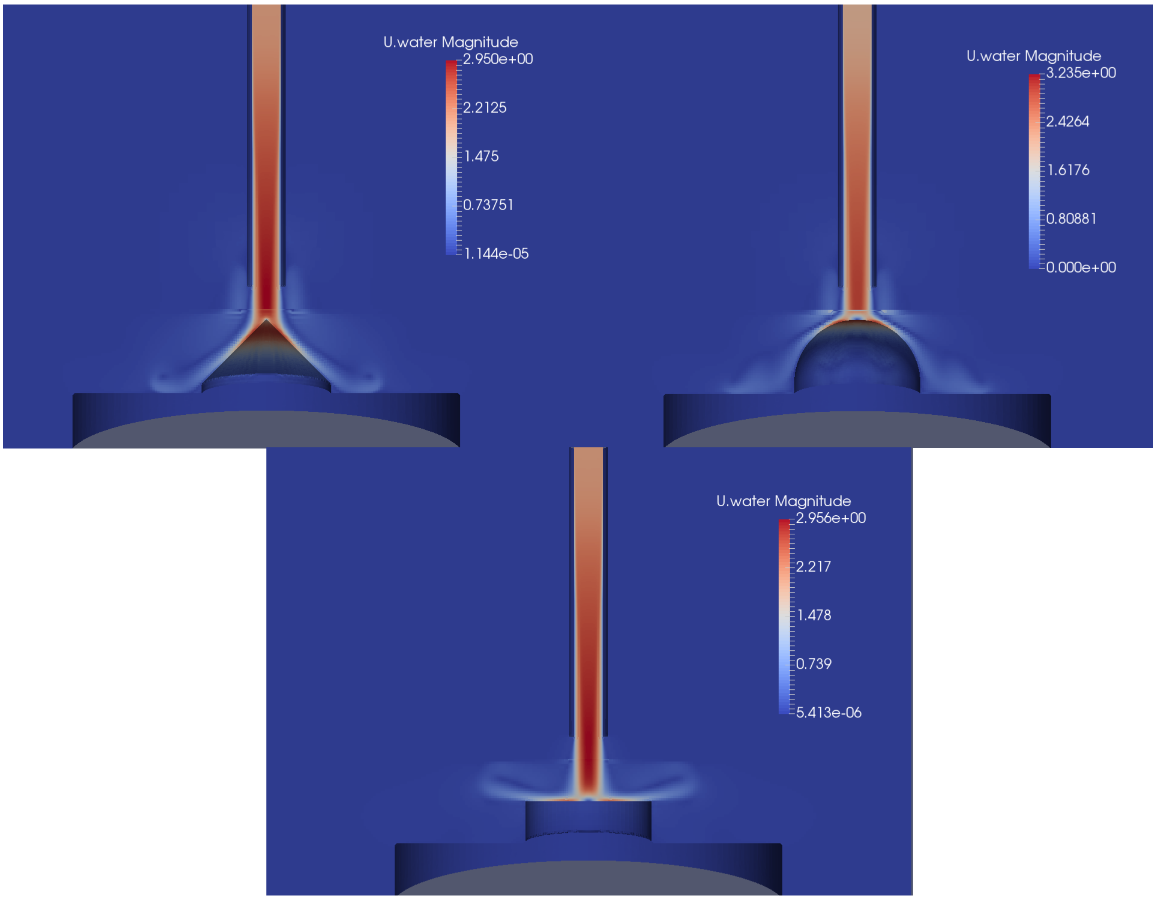


Figure 2: First phase velocity contours. Clockwise from top: cone, hemisphere and cylinder

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