SPH-2PHASEFLOW

Simulation of two-phase flow patterns with a new approach based on Smoothed Particle Hydrodynamics

OBJECTIVES

The aim of SPH-2PHASEFLOW is to develop a new numerical approach, based on the Smoothed Particle Hydrodynamics (SPH) method, to simulate changes in two-phase flow patterns. Two-phase flows play a key role in several processes in NPPs and therefore capturing changes in regimes of a two-phase flow is a major challenge with strong safety and efficiency implications. E.g. this issue is involved in studies of re-floods of damaged reactor cores, spray cooling, steam-generator operating conditions, as well in several practical concerns such as cavitation in turbo-machineries. The new numerical approach represents a radical departure from traditional methods and relies on a meshless, particle-based, method that has the potential to capture rapidly-deforming interfaces in two-phase flows. Consequently, the project consortium gathers one industrial and two academic research centres in order to combine application-oriented objectives and state-of-the-art developments. The project also represents a first step towards the long-term objective of simulating rapid boiling phenomena and heat flux crisis.

DESCRIPTION OF WORK

The development of a two-phase SPH numerical approach is performed in three steps:

- **Step 1**: Development of general two-phase SPH formulation and adaption to water/vapour two-phase flows. The new formulation should cover the large density ratios between water and vapour and account precisely for surface-tension effects, which play a key role in the dynamics of the interface between the two phases.
- **Step 2**: Assessment of the two-phase SPH formulation towards capturing changes in two-phase flow patterns. This step is carried out for known patterns from experimental analysis in pipe or channel flows and also for the specific case, which is subject to Step 3.
- **Step 3**: Analysis of a specific case in which a dispersed two-phase flow, made of droplets carried by vapour, can create a liquid film on the boundary wall (through droplet deposition) and remove it (through vaporisation and/or droplet tearing-up at the interface and re-entrainment by the vapour flow) when flow rates are modified (see Figure 1).

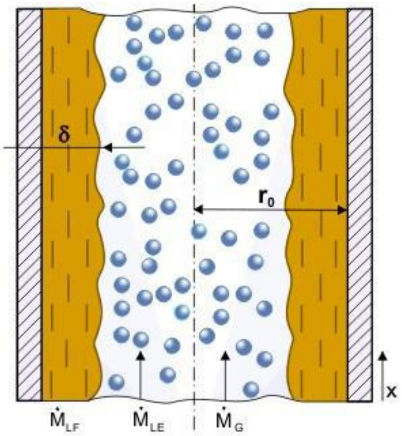

Fig. 1: Dispersed/separated two-phase flow

MAIN RESULTS / HIGHLIGHTS

- Report on definition of the benchmark case (dispersed/separated two-phase flow with film formation at the wall) (public)
- Report on formulation of the two-phase SPH method and its application to prediction of two-phase flow patterns (public)
- Report on comparative assessment of the two-phase SPH approach on the benchmark test-case (public)

DURATION

1 April 2015 – 30 September 2016
18 months

PARTNERS

EDF / IMP Gdansk / Univ. Udine

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This project has received funding from the Euratom Seventh Framework Programme under grant agreement No 604965.