DENSE GAS-PARTICLE SUSPENSION UPWARD FLOW USED AS HEAT TRANSFER FLUID IN SOLAR RECEIVER: PEPT EXPERIMENTS AND 3D NUMERICAL SIMULATIONS

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Dense particle suspension, also called an Upflow Bubbling Fluidized Bed (UBFB), is an innovative alternative to the heat transfer fluids classically used in concentrated solar power (CSP) plants. Indeed, such fluids have several limitations: restricted range of operating temperatures, significant safety issues, corrosion problems and high maintenance costs. The CSP2 (Concentrated Solar Power in Particles) FP7 European project (http://www.csp2-project.eu/) has the ultimate goal of developing commercially-viable CSP plants based on granular media as the heat transfer fluid, where power is transmitted to the particles by the receiver walls (metal or ceramic), which are themselves subject to solar radiation. An additional advantage of this technology is that it allows for direct thermal storage due to the large heat capacity of the particle suspension (Flamant et al. (1)). The key to the proposed process is the effective heat transfer from the solar heated surfaces to the heat transfer fluid, i.e. the circulating solid suspension. In order to better understand the process in order to optimise the design of the solar receiver, it is of paramount importance to know how particles behave inside the bundle of small tubes within it. Indeed, the radial movement of particles controls the suspension effective thermal conductivity, thus the heat transfer from the wall to the flow. To access to the particle motion in the solar receiver, two different techniques are carried out: experimental using Positron Emission Particle Tracking (PEPT) (Garcia-Triñanes et al. (2)) and 3D numerical simulation via an Eulerian n-fluid approach with NEPTUNE_CFD code (Fotovat et al. (3)).

Both numerical predictions and PEPT measurements describe an upward flow at the centre of the transport tube with a backmixing flow near the wall which amplifies the solar to particles heat transfer mechanism. Comparisons between experiment and computation were carried out for the radial profiles of the solid volume fraction, and vertical and radial time-averaged and variance velocities, demonstrating satisfactory agreement and the capability of NEPTUNE_CFD software to simulate this singular upflow bubbling fluidized bed.

REFERENCES
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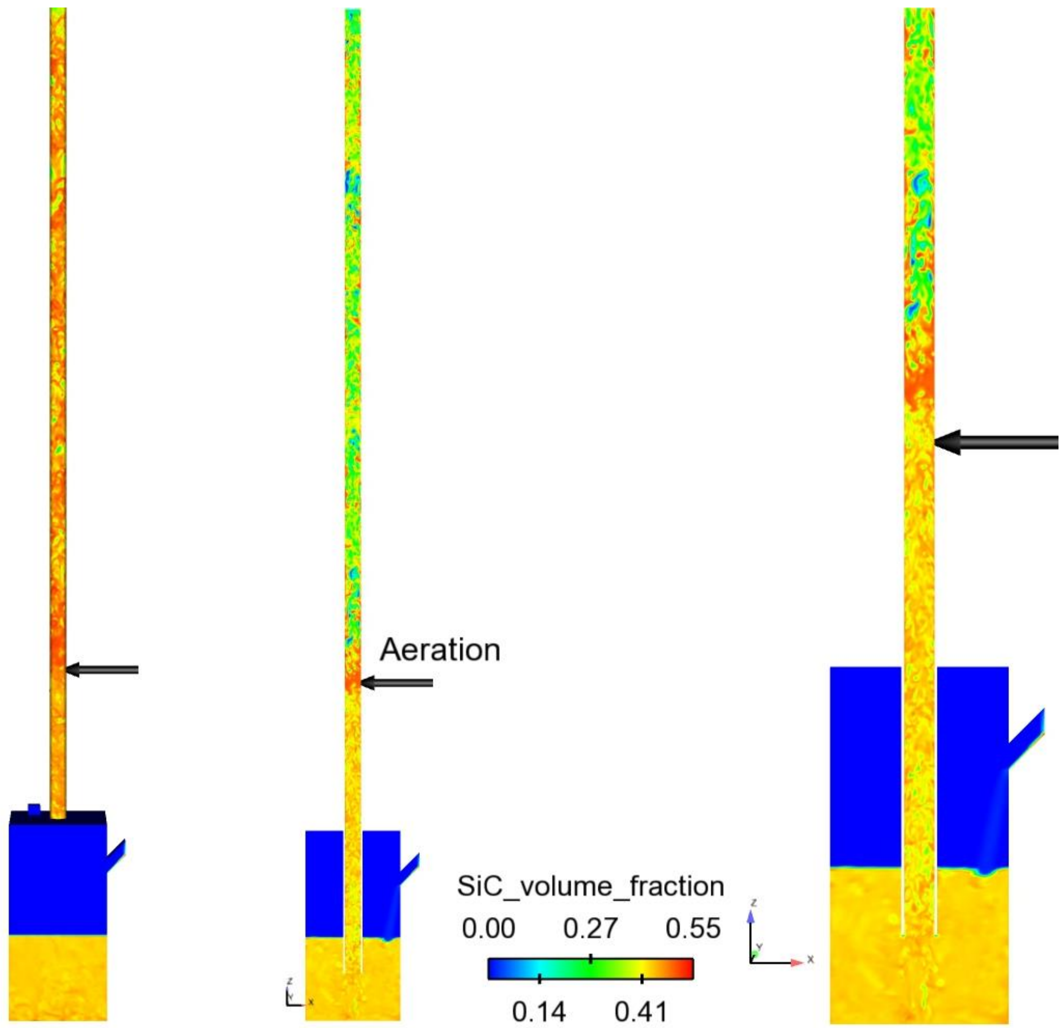

Figure 1: Instantaneous solid volume fraction field from 3D numerical simulation, .