DIRECT NUMERICAL SIMULATION OF TWO PHASE TURBULENT FLOWS

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This work lies within the scope of MuTEch, which is an IWT-SBO funded project dealing with the simulation of transport phenomena in electrochemical processes. It involves research on a large range of scales as well as multi-phase flow, turbulence and heat transfer. In electrochemical processes, reactions between the electrodes and the electrolyte may produce gas bubbles, which interact with the turbulent carrier flow.

To simulate dispersed turbulent two-phase flows, T. Nierhaus (AR PhD candidate) is developing the parallel software library PLaS, which allows to track the trajectories of bubbles, droplets and particles inside a turbulent carrier fluid with an Eulerian-Lagrangian method. PLaS is coupled with the DNS code SFELES, which solves the Navier-Stokes equations of the carrier fluid using a hybrid spectral/finite-element solver. In this way, we couple the dispersed two phase flow with a continuous turbulent carrier flow in a numerical simulation.

The aim of this project is to \textbf{validate and enhance PLaS} for two phase turbulent flows. Two testcases are envisaged, the particulate channel-flow and the bubbly Taylor-Couette flow. From the particle-laden turbulent channel flow test case, we could reproduce the experimentally and numerically validated behavior of wall accumulation of particles. This phenomenon has been linked to the mechanisms of wall bounded turbulence, i.e. sweep and ejection events, see figure 1. This segregation was observed to depend on the Stokes number. The higher the Stokes number is raised, the more particles accumulate at the wall.

The second testcase is the bubbly rotating cylinder reactor, for which the PLaS library has been improved to handle cylindrical coordinates. This is the first testcase for PLaS in cylindrical coordinates. The results show an accumulation of the bubbles in the center of Taylor vortices, see figure 2. This behavior present a qualitative agreement with experimental results published.

Additionally, in the scope of MuTEch, a collaboration between AR and EA departments lead to a comparison between DNS calculations and PIV measurements on a rotating cylinder reactor. The results give a good starting point and show that further investigation is needed to obtain good agreement.

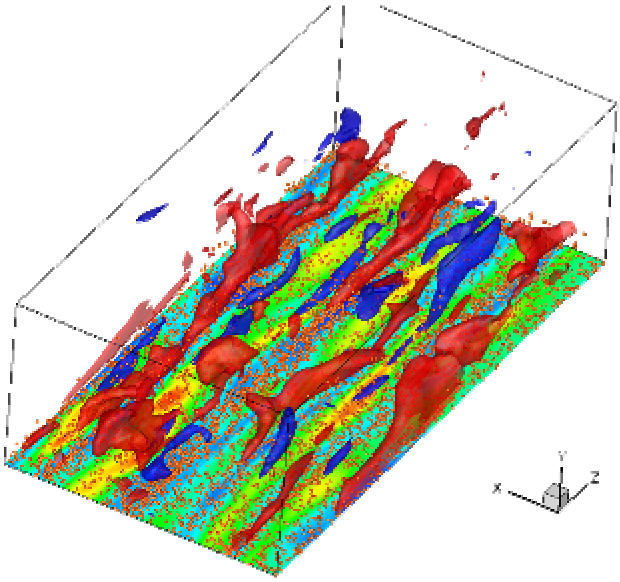

Figure 1: Particle positions in the boundary layer together with Sweep and Ejection events

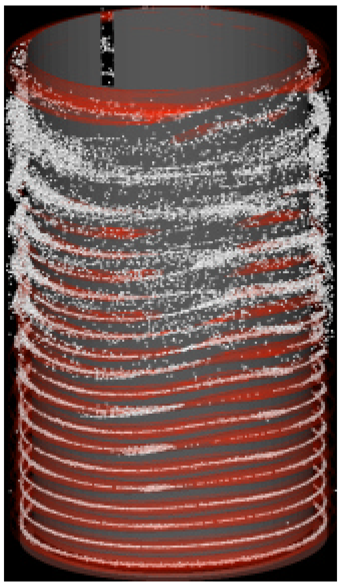

Figure 2: Bubble positons in the rotating cylinder reactor