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GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Project Multiscale Modelling of Multiphase Reactors (Multi-Phase)

Direct Numerical Simulation of Pseudo-Turbulence in a Sub-region of a Flat Bubble Column

1. Objectives

Goal: Development and validation of improved turbulence models for bubbly flows based on direct numerical simulations

- **Investigation of pseudo - turbulence in bubble swarm flows by direct numerical simulations (DNS)**
- Evaluation of all terms in the transport equation for liquid phase turbulent kinetic energy from DNS data
- Analysis, assessment and improvement of engineering models for pseudo turbulence in two-fluid model
- Implementation of improved models in OpenFOAM, validation by experiments in various scale bubble columns

2. Preliminary studies for "single" bubbles

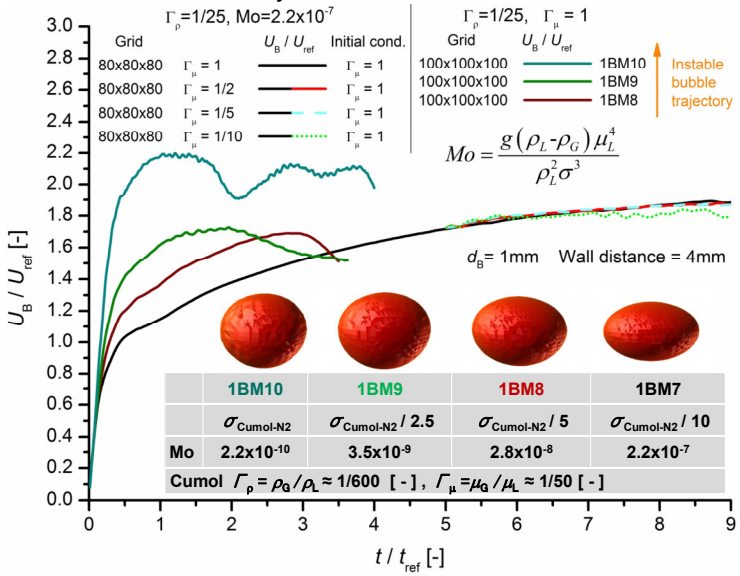
- Computational setup for simulations

Domain	1 x 1 x 1		
Grid	64x64x64	80x80x80	100x100x100
Mesh cells/bubble	16	20	25

Bubble diameter: 0.5 mm and 1mm
No. of bubbles: 1B, 4B, 8B
Gas holdup (ε): 0.8%, 3.2%, 6.4%

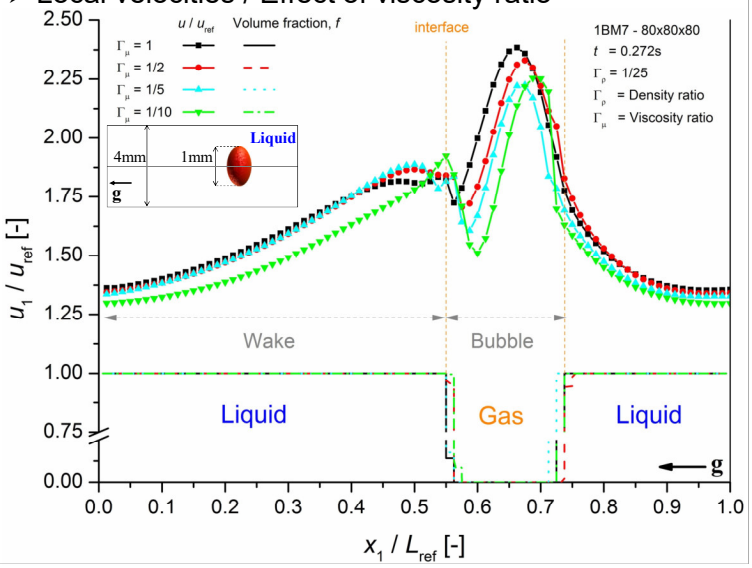
- Bubble rise velocities

Effect of the Viscosity Ratio and the Morton Number

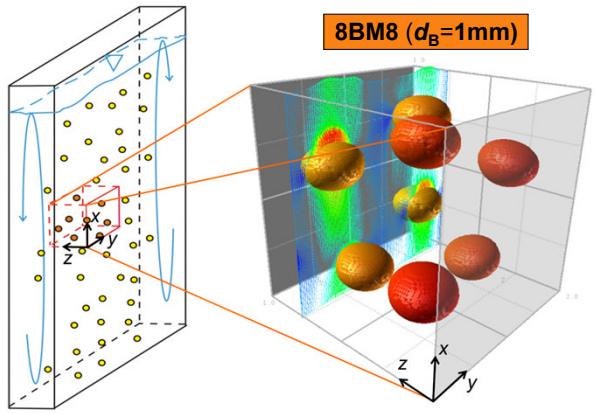


	1BM10	1BM9	1BM8	1BM7
	$\sigma_{Cumol\text{-}N2}$	$\sigma_{Cumol\text{-}N2}$ / 2.5	$\sigma_{Cumol\text{-}N2}$ / 5	$\sigma_{Cumol\text{-}N2}$ / 10
Mo	2.2×10^{-10}	3.5×10^{-9}	2.8×10^{-8}	2.2×10^{-7}
Cumol	$\Gamma_\rho = \rho_G/\rho_L \approx 1/600$ [-], $\Gamma_\mu = \mu_G/\mu_L \approx 1/50$ [-]			

- Local velocities / Effect of viscosity ratio

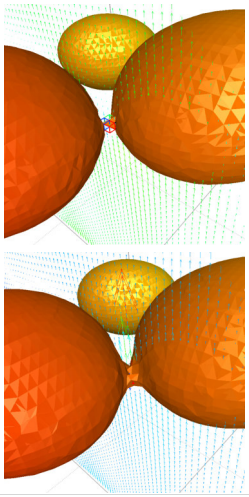


3. Simulations for bubble swarms

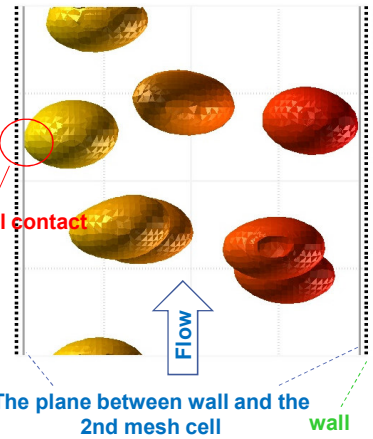


- **Coalescence**

At values of the Mo $<10^{-7}$



- **Artificial Wall Contact**



Non-equidistant grid:
Finer mesh near the wall

4. Conclusions and Outlook

- The swarm characteristics is highly dependent on *Mo*
- A decrease of *Mo* means instable bubble trajectory
- The viscosity ratio has:
  - Almost no influence on the bubble rise velocity
  - Significant influence on the intensity of the recirculation in the bubble and on the velocity profile in the wake

Outlook

- Comparison of numerical results for single bubbles with experiments by TU Hamburg-Harburg
- The evaluation of statistical data of the bubble flow