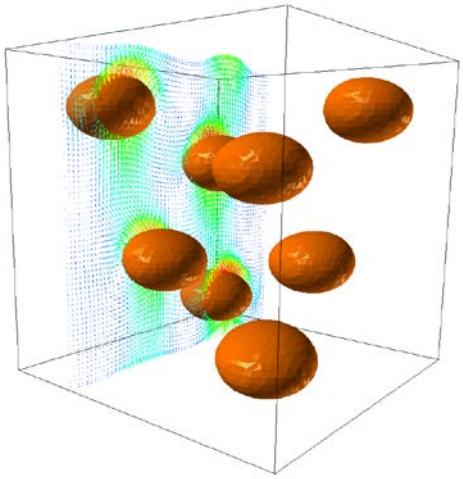
Turbulence modeling of bubbly two-phase flows

Background: This research is associated to the project "Increasing of Energy Efficiency and Reduction of Greenhouse Gas Emissions by Multi-scale Modeling of Multiphase Reactors" which is funded by the Federal Ministry of Education and Research (BMBF). The purpose of this BMBF project is the optimization of multiphase reactors utilizing the development of reliable overall scaling models, measurement techniques and -apparatus. This optimization will lead to a significant decrease in CO2 emissions in the chemical industry. The project consortium combines the skills of partners in fundamental research as well as the experience of different small and medium-sized companies in the field of measurement in apparatus techniques with the requirements of industrial applications. Within this BMBF project, KIT is subcontractor of the Technical University Hamburg-Harburg, Institute of Multiphase Flows.



Visualization of DNS results for a rising bubble swarm

Project: The goal of the KIT project is the development and validation of improved statistical models for bubble-induced turbulence. Such models are required for computation of chemical multiphase reactors (such as bubble columns) with engineering CFD codes that are based on the Euler-Euler approach (two-fluid model). The model development is based on extensive direct numerical simulations (DNS) of bubble swarm flows where all details of the interface topologies and the flow field are spatially and temporarily resolved. The DNS runs are performed by the KIT in-house computer code TURBIT-VOF. In the development of improved models, particular emphasis is put on the closure terms in the transport equation for the liquid phase turbulence kinetic energy, which is a cornerstone of many statistical turbulence models. The DNS data are used to evaluate existing models, to identify model deficiencies and to develop improved models. The improved models shall be implemented in the open source CFD code OpenFOAM and validated by comparing results obtained with the extended Euler-Euler model with experimental data of project partners for lab scale, pilot scale and industrial scale bubble columns.

Co-workers: Sercan Erdogan, Martin Wörner

Collaboration: M. Bothe, M. Schlüter, TU Hamburg Harburg/Germany; H. Marschall, D. Bothe, TU Darmstadt/Germany; M. Becker, G. Skillas, Evonik Industries/Germany

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Selected publications: The project started in February 2012 and there exist yet no publications. Former publications on which the present research project builds on are: M. Ilić. Statistical Analysis of Liquid Phase Turbulence Based on Direct Numerical Simulations of Bubbly Flows. PhD thesis University Karlsruhe (2006); M. Ilić, M. Wörner, D.G. Cacuci. Balance of Liquid-phase Turbulence Kinetic Energy Equation for Bubble-train Flow. Journal of Nuclear Science and Technology 41 (2004) 331; M. Ilić, M. Wörner, D.G. Cacuci. Investigations of Liquid Phase Turbulence based on Direct Numerical Simulations of Bubbly Flows. Proc. 11th Int. Topical Meeting on Nuclear Reactor Thermal-Hydraulics (NURETH-11), Avignon, France, October 2-6, 2005