



Best Practice Guidance Seminar
CFD for Dispersed Multi-Phase Flows 2022
With Problem Shooting Session
10th and 11th October 2022

ERCOFTAC Henri Bénard Pilot Centre

SkyLab Centrale Lyon, Ecole Centrale de Lyon
36 Av. Guy de Collongue, 69130 Écully, France

Main lecturers:

- **Prof. Dr.-Ing. Martin Sommerfeld, Multiphase Flow Systems, Otto-von-Guericke University Magdeburg, Germany**
- **Prof. Dr. Olivier Simonin, Institut de Mécanique des Fluides de Toulouse (IMFT) Toulouse, France**
- **Dr.-Ing. Martin Wörner, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany**

Local lecturers:

- Prof. Dr. Mikhael Gorokhovski, LMFA, Ecole Centrale de Lyon, France
- Prof. Dr. Lionel Soulhac, LMFA, INSA de Lyon, France

Local Organiser:

- Prof. Dr. Mikhael Gorokhovski, LMFA, Ecole Centrale de Lyon
- ERCOFTAC Henri Bénard Pilot Centre, <http://chb.ec-lyon.fr/>, France

Monday, 10. October 2022

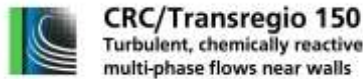
- 8:30 Registration and Coffee
- 8:45 Introduction to the course; Characterisation of multiphase flows (45 min); Martin Sommerfeld (OvGU)
- 9:30 Numerical methods for multi-phase flow (60 min) - Martin Wörner (KIT)
- 10:30 Refreshments (30 min)
- 11:00 Industrial challenges and needs for the application of CFD to industrial dispersed multiphase flows (60 min) - Olivier Simonin (IMFT)
- 12:00 Lunch (60 min)
- 13:00 Forces on spherical and non-spherical particles (60 min) - Martin Sommerfeld (OvGU)
- 14:00 Point-particle Euler/Lagrange method, fundamentals, implementation and coupling, turbulent dispersion (60 min) - Martin Sommerfeld (OvGU)
- 15:00 Refreshments (30 min)

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- 15:30 LES subgrid modelling in particle laden flows with Euler-Lagrange and Euler-Euler approaches (60 min) - Olivier Simonin (IMFT)
- 16:30 Bubble modelling in the point-particle Lagrangian approach (30 min)
Martin Sommerfeld (OvGU)
- 17:00 Q & A (30 min)
- 20:00 Joint dinner at a restaurant to be announced

Tuesday, 11. October 2022

- 8:30 Continuum Multi-Fluid approach, different modelling levels, *particle-laden flows* (60 min)
Olivier Simonin (IMFT)
- 9:30 Multi-Fluid (Euler/Euler) approach, *liquid-gas, bubbly flows* (60 min) - Martin Wörner (KIT)
- 10:30 Refreshments (30 min)
- 11:00 Turbulent transport of particles in atmospheric flows (45 min) - Lionel Soulhac (LMFA)
- 11:45 Resolved numerical simulations for small-scale processes and model development (45 min)
Martin Wörner (KIT)
- 12:30 Lunch (60 min)
- 13:30 Modelling elementary processes in dispersed multi-phase flows (60 min) (solid particles, spray droplets and bubbles) - Martin Sommerfeld (OvGU)
- 14:30 Coupling of flow and discrete particle method; CFD/DEM Simulations (60 min)
Olivier Simonin (IMFT)
- 15:30 Refreshments (30 min)
- 16:00 Test case calculations and examples of application (30 min); Summary of available test cases, channels, jets, sprays, fluidised beds - Martin Sommerfeld (OvGU)
- 16:30 Problem shooting session, presentations from participants (90 min);
(Registration required, please submit your proposal, we will try our best to help solving your problem) - ALL
- 18:00 Closure



Multiphase Flows Rationale

The simultaneous presence of several different phases in external or internal flows such as gas, liquid and solid is found in daily life, environment and numerous industrial processes. These types of flows are termed multiphase flows, which may exist in different forms depending on the phase distribution, such as separated and dispersed systems. Examples are gas-liquid transportation, crude oil recovery, circulating fluidized beds, sediment transport in rivers, pollutant transport in the environment and atmosphere, fine particle separation, cloud formation, fuel injection in engines, bubble column reactors and sprays for food processing, to name only a few. As a result of the interaction between the different phases such flows are rather complicated and very difficult to describe theoretically.

Consequently, the numerical calculation of multiphase flow systems based on CFD methods also comprises a multitude of different numerical methods each applicable to certain types of multiphase flows and resolving different length and time scales of the problem. The present course focusses on numerical simulations of dispersed multiphase flows and the required modelling of particle-scale phenomena. The hierarchy of available numerical techniques for the different scales in multiphase flows (i.e. particle-scale and industrial-scale simulations) is presented. Both the well-known Euler/Euler and Euler/Lagrange approach, suitable for large-scale simulations of industrial processes, are introduced in detail. Required modelling for particle-scale transport phenomena is presented and the use of particle-resolved direct numerical simulations for their development is emphasised. Examples of a number of advanced models are presented and their effects on large-scale processes are highlighted.

This course is rather unique as it is one of few in the community that is specifically designed to deliver, a) best practice guidance and b) the latest trends in CFD for dispersed multi-phase flows and c) many application examples.

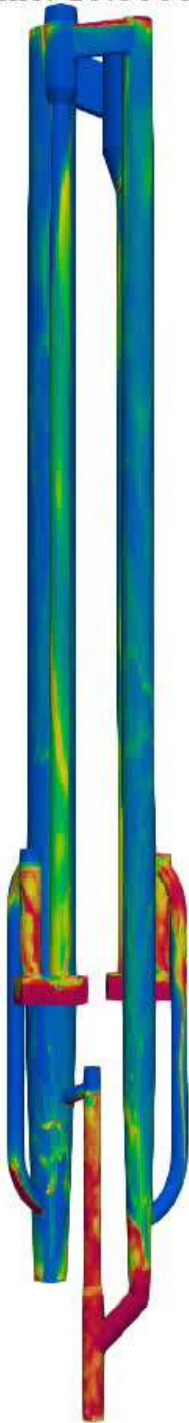
The course appeals to researchers and engineers involved in projects requiring CFD for turbulent dispersed multi-phase flows with bubbles, drops or particles.

Moreover, delegates are offered the opportunity to present their work via 10 minute presentations (problem-shooting session), thereafter, the lecturers can offer prospective solutions. Registration is required: martin.sommerfeld@ovgu.de.

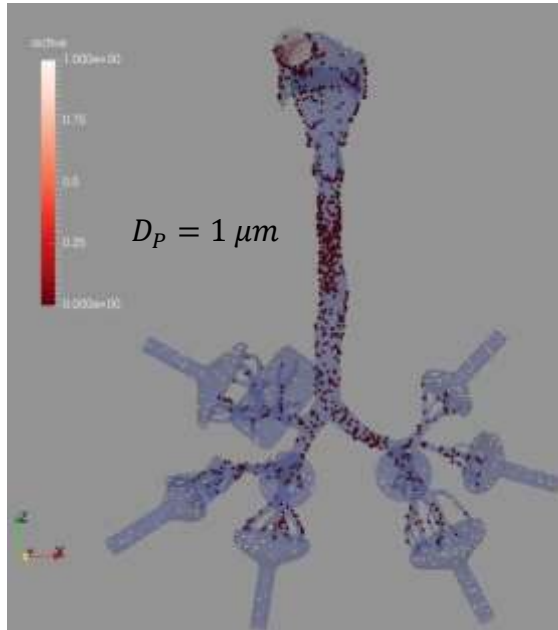
Each delegate will receive a free copy of the book BPG CFD for Dispersed Multiphase Flows, lunches and coffee breaks are included.

Example of Multiphase Flow Simulations

Time: 10.000000

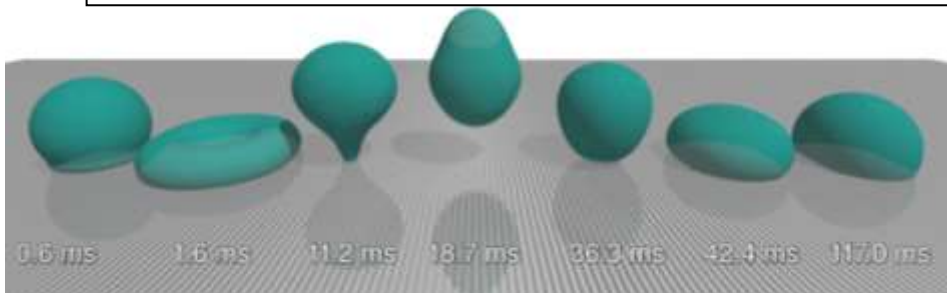


Instantaneous wall solids concentration from a 3D Euler-Euler unsteady simulation of a chemical looping combustion pilot built at SINTEF Energy Research and consisting of two fluidized beds interconnected with a lifter (IMFT, Toulouse, 2020).



Euler/Lagrange results for particle deposition in a lung model (dark particles: deposited; grey particles: still active particles, MPS-OvGU 2020)

Interface-resolving simulation of the impact/rebound of a drop on/from a surface with micro-grooves (KIT, Karlsruhe, 2018).



All attendees of the course are also invited to participate at the 2022 ERCOFTAC Autumn Festival with the da Vinci Award Competition on 6th October 2022.

All locally valid contact restrictions as a consequence of the Corona Virus have to be respected during the course. The requirements on the size of the lecture room are respected. We appreciate your understanding and your support.

<http://www.ercoftac.org/>

Address of the Event:

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