14:12–Ballroom A

Investigation on particle-fluid energy transfer in turbulent channel flow

Lihao Zhao[*,†], *Helge I. Andersson*[*], *Jurriaan J. J. Gillissen*[**]
[*]*Department of Energy and Process Engineering, Norwegian University of Science and Technology, Trondheim, Norway*
[**]*Department of Multi-Scale Physics, TU Delft, Delft, The Netherlands*

Transfer of mechanical energy between particle additives and a carrier fluid has been explored by two-way coupled direct numerical simulation (DNS) in a turbulent channel flow. It was observed that the fluid transferred energy to the particles in the core region of the channel whereas the fluid received kinetic energy from the particles in the wall region. Locally a particle-induced energy dissipation was observed which represents a loss of mechanical energy from the fluid-particle suspension. The streamwise turbulence intensity was augmented in the buffer region due to work performed by the particles on the local fluid. The kinetic energy of the flow field in a cross-sectional plane was damped due to work done by the particles, and the energy was dissipated rather than recovered as particle kinetic energy. This explained the significant attenuation of the cross-plane velocity components. The observed modulations of the turbulence field could be thereby completely understood.

lihao.zhao@ntnu.no

14:15–Ballroom A

A moving mesh method for three-phase flows with triple junction points

Jie Li
Department of Engineering, University of Cambridge, Cambridge, UK

We present an ALE (arbitrary Lagrangian Eulerian) moving mesh method suitable for solving two-dimensional and axisymmetric three-phase flow problems, including the interaction of the three phases at triple junction points. This method employs a moving body-fitted unstructured mesh where the interfaces between phases are lines of the mesh, and the triple junction points are mesh nodes. Dynamic boundary conditions on the interfaces and the triple points are incorporated naturally and accurately in a finite-element formulation based on Taylor-Hood element. The resulting non-linear system of mass and momentum conservation is solved by an Uzawa method. Our method is used to investigate the rising of a liquid drop with an attached bubble in a lighter liquid.

jl305@hermes.cam.ac.uk

14:18–Ballroom A

Evaporating-freezing phenomena of water droplets during quick depressurization

Wangfang Du, Jianfu Zhao[†], *Kai Li*
Key Laboratory of Microgravity (National Microgravity Laboratory)/CAS; Institute of Mechanics, Chinese Academy of Sciences, Beijing, China

The evaporating-freezing process of single pensile water droplet during quick depressurization is studied experimentally. The typical characteristics of the thermal-dynamical behaviors of this process are obtained. Based on the experimental observations, the influences of non-condensable gases on the process are analyzed and discussed in detail. It is pointed out that the subcooling limit corresponding to the onset of freezing of the droplet is nearly a constant, and the freezing temperature is approximately equal to the solid-vapor equilibrium temperature determined by the vapor partial pressure at the terminal state. The present results are helpful for predicting correctly the evaporating-freezing processes of liquid droplets in high vacuum environment.

jfzhao@imech.ac.cn

14:21–Ballroom A

Turbulent particulate pipe flow at constant Reynolds number

Alexander I. Kartushinsky[*,†], *Efstathios E. Michaelides*[**], *Ylo A. Rudi*[*], *Sergei V. Tisler*[*]
[*]*Research Laboratory of Multiphase Media Physics, Faculty of Science, Tallinn Technical University, Tallinn, Estonia*
[**]*Department of Engineering, Texas Christian University, Fort Worth, USA*

Effect of the pipe diameter was numerically investigated in the particulate turbulent cylindrical pipe flows at constant Reynolds numbers. The method used is based on 2D Reynolds-averaged Navier–Stokes equations. This approach is supplied with closure equations allowing all pertinent forces and effects: particle-particle, particle-wall, particle-turbulence interactions, gravitation, viscous drag and lift forces and turbulence modulation. Finite volume technique was applied for numerical solution of governing equations. Results show the effect of the pipe diameter, flow mass loading and particles size on the radial distributions of the velocity lag, turbulence modulation and particles concentration. In particular, increase of the pipe diameter at constant Reynolds number results in decrease of the relative velocity lag and flattening of the radial distributions of particles velocity and mass concentration as well as decrease of a turbulence attenuation rate. The present model with applying of minimum number of assumptions represents a more contemporary computational approach in turbulent particulate flow.

aleksander.kartusinski@ttu.ee

14:24–Ballroom A

Visualization study on transient liquid film behavior and inner gas flow after rupture of a soap bubble

Dong Kim[†], *Chung Hyun Lee, Seung Jai Yi, Hyun Dong Kim, Kyung Chun Kim*
School of Mechanical Engineering, Pusan National University, Busan, Korea

The transient behavior of liquid film and flow of inner gas were investigated in this paper. The olive oil particles were supplied into the soap bubble through a Laskin nozzle for visualization and PIV