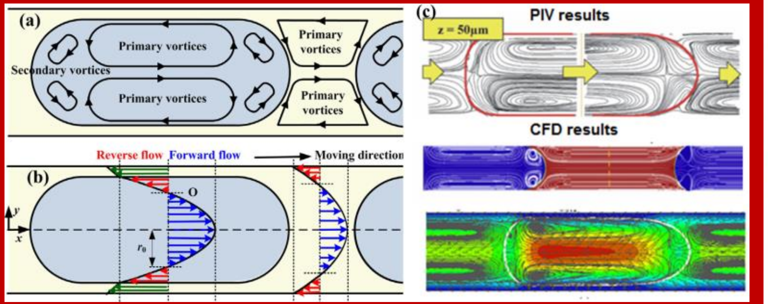
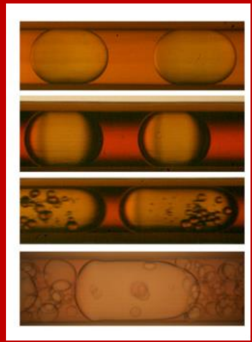




Prof. Rufat Abiev is a Full Professor of St. Petersburg State Institute of Technology (Technical University) and a Head of Department of Optimization of Chemical and Biotechnological Equipment (since 2008), Head of the Lab of Process Intensification at Silicate Chemistry Institute of the Russian Academy of Science. Dr. Abiev has written more than 350 publications, 6 books, 5 chapters in a "New Handbook of chemist and technologist" (in Russian), 4 chapters in books (2 of them are issued in Germany and USA), more than 100 papers in peer-reviewed journals and more than 90 patents. His research interests are: Process Intensification, Microreactors, Process Simulation, Multiphase Flows, Heat and Mass Transfer intensification. He had received meny international research grants: 2014 (DAAD) at Institut für Mikroverfahrenstechnik (KIT), 2006 (DAAD) at TU Dresden, 1998 at Swiss Academy of Technical Science. He has been working as invited Professor in France – Ecole des Mines d'Ales (2016) and Laboratoire de Génie Chimique de Toulouse of INP de Toulouse (2017). Dr. Abiev is a member of Working Party on Mixing and a guest member of Working Party on Process Intensification, European Federation of Chemical Engineering.

Dr. Ritunesh Kumar is an Associate Professor in the Department of Mechanical Engineering, Indian Institute of Technology Indore. He received his PhD from Indian Institute of Technology, Delhi in the area of Refrigeration and Air-Conditioning. Prior to joining IIT Indore he had worked with Tata Consulting Engineers Limited, Vikhroli, Mumbai.

GIAN

सत्यमेव जयते
Government of India
Ministry of Human Resource Development

Global Initiative on Academic Network

7th to 16th March 2022

Two-Phase Flows In Micro And Milli Channels: Theoretical Background, Experimental And Numerical Proofs Of Hydrodynamics, Heat And Mass Transfer

Indian Institute of Technology Indore, Dept. of Mechanical Engineering

Overview

The presented course represents a general view to the mathematical modeling of hydrodynamics, heat and mass transfer of Gas-Liquid (or Vapor-Liquid) and Liquid-Liquid Taylor flows in micro channels by means of theoretical approach using classical equations and modern formulae necessary to complete the model. The theoretical estimations is proven by own and available in the literature experimental and numerical data.

Objectives of the course:

- Exposing participants to the fundamentals of process intensification by means of miniaturisation in particular: the transition from macro to milli and micro levels, dominating forces, general theoretical approaches for hydrodynamics, heat & mass transfer modelling.
- Building in confidence & capability amongst participants in the application of two-phase micro reactors and extractors, two-phase micro mixers, two-phase micro heat exchangers. Mathematical modelling and experimental technique of hydrodynamics, heat and mass transfer in two-phase micro flows, design.
- Providing exposure to practical problems and their solutions, through case studies and live projects in two-phase micro reactors and extractors, two-phase micro mixers, two-phase micro heat exchangers,
- Enhancing the capability of the participants to identify, control and remove technical problems in micro heat exchangers like phases maldistribution, change in flow regime, the use of the enhanced method to generate two-phase flow, selection of optimal two-phase velocity for maximal performance.

Details of the course:

March 07 – Monday:

Lecture 1 : 16:00 to 17:00 PM

Introduction: Fundamentals of process intensification.

Fundamentals of process intensification in general and by means of miniaturisation in particular. Size effects by the transition from macro to milli and micro levels, dominating forces, general theoretical approaches for hydrodynamics, heat and mass transfer modelling.

Lecture 2 : 17:15 to 18:15 PM

Fundamentals of microreactors design and fabrication.

Fundamentals of microreactors design and fabrication. Topologies of two-phase micro reactors and extractors, two-phase micro mixers, two-phase micro heat exchangers. Microfabrication in Metals, Ceramics and Polymers.

Lecture 3 : 18:30 to 19:30 PM

Two phase flows in microreactors - 1.

Two phase flows in microreactors: Bubbly flow, Taylor flow, Annular flow, Churn flow, Transition flows. Experimental techniques to define flow regime.

March 08 – Tuesday:

Lecture 4 : 16:00 to 17:00 PM

Two phase flows in microreactors - 2.

Types of micro mixers used for Taylor flow. Coaxial-spherical micro mixer as a tool to better flow control.

Lecture 5 : 17:15 to 18:15 PM

Fundamentals of Taylor flow hydrodynamics – 1

Theoretical approach to the Hydrodynamics of Taylor flow: continuity and Navier-Stokes equations. Aussilous-Quere and Han-Shikazono models for liquid film thickness.

March 09 – Wednesday:

Lecture 6 : 16:00 to 17:00 PM

Fundamentals of Taylor flow hydrodynamics – 2

Calculation procedure for two-phase Taylor flow: Bubble velocity, film thickness, slug velocity. Dimensionless criteria used for two-phase flows.

Lecture 7 : 17:15 to 18:15 PM

Fundamentals of Taylor flow hydrodynamics – 3

Calculation procedure for two-phase Taylor flow: Pressure gradients, velocity profiles. The shape of the elongated bubbles. Impact of flow direction on bubble velocity. Stagnation of bubbles.

Lecture 8 : 18:30 to 19:30 PM

Fundamentals of Taylor flow hydrodynamics – 4

Calculation procedure for two-phase Taylor flow: Circulation and by-pass flow modes for Taylor flow. Criterion of transition between two modes.

March 10 – Thursday:

Lecture 9 : 16:00 to 17:00 PM

Fundamentals of Taylor flow hydrodynamics – 5

Maldistribution problems and available solutions. Computer tomography results for maldistribution measurements.

Lecture 10: 17:15 to 18:15 PM

Fundamentals of Taylor flow hydrodynamics – 6

Calculation procedure for two-phase Taylor flow: Relation between dynamic and real gas hold-up ratio and bubble velocity. Pressure drop: several origins of energy losses. Impact of wettability of microchannels. Experimental and numerical corroboration of theoretical approach.

Non-Newtonian Taylor flows in microchannels.

March 11 – Friday:

Tutorial 1 : 16:00 to 18:15 PM

Problem solving session with examples: Calculation of two-phase Taylor flow hydrodynamics for gas-liquid flow in circular micro channels. Bubble velocity, film thickness, slug velocity, pressure drop, velocity profiles, shear stresses.

March 12 – Saturday:

Lecture 11 : 16:00 to 17:00 PM

Fundamentals of heat transfer in two-phase flows in micro channels - 1.

Flows with and without phase change. Overview of state-of-the-art flow boiling and flow condensation calculations techniques.

Lecture 12 : 17:15 to 18:15 PM

Fundamentals of two-phase flow heat transfer in micro channels - 2.

Heat transfer in closed loop micro channel heat pipes (CLCHP). Oscillations in CLCHP. Comparison of oscillating and circulating modes in micro channel heat pipes.

Lecture 13 : 18:30 to 19:30 PM

Fundamentals of two-phase mass transfer in micro channels - 1.

The paths of mass transfer for Gas-liquid and Liquid-Liquid flows. Bercic-Pintar and Kreutzer et. al. mass transfer models. Improved mass transfer models for Taylor flow in micro channels.

March 14 – Monday:

Lecture 14 : 16:00 to 17:00 PM

Fundamentals of two-phase flow mass transfer in micro channels - 2.

Experimental techniques for mass transfer measurements: PLIFI, chemical indicator methods. Applications of three-layer mathematical model to analyse experimental data.

Lecture 15 : 17:15 to 18:15 PM

Heat and mass transfer intensification in micro channels.

Heat and mass transfer intensification by means of Taylor flow: numerical and experimental results. Three-layer mathematical model of mass transfer of Taylor flow: geometry of Taylor vortices, application of three-layer to process optimisation.

March 15 – Tuesday:

Lecture 16 : 16:00 to 17:00 PM

Conjugated hydrodynamics and mass transfer problem for two-phase flow in microchannels.

Use of three-layer mathematical model for mass transfer parameters calculation of two-phase Taylor flow in micro channels. Assessment of mass transfer coefficient. Frequency of circulations in two-phase flow.

Tutorial 2 : 17:15 to 18:15 PM

Problem solving session with examples: Calculations of three-layer mathematical model parameters of two-phase Taylor flow in micro channels.

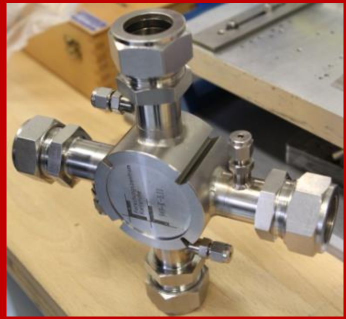
Tutorial 3 : 18:30 to 19:30 PM

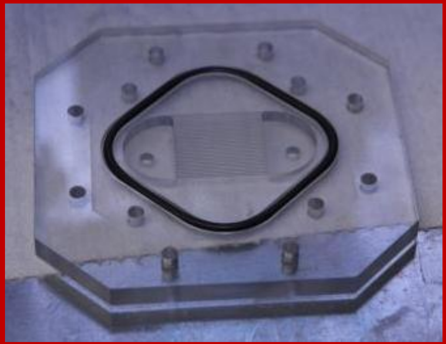
Problem solving session with examples: Comparison of three-layer mathematical model parameters with available experimental data.

March 16 – Wednesday

16:00 to 18:15 PM

Course Evaluation (Exams for students)





Step 2: The payment can be made through NEFT Transfer to the following account details: Name of the Beneficiary: Registrar, Indian Institute of Technology Indore; Name of Bank: Canara Bank; Branch Code: IIT Indore Campus; Branch Beneficiary Account No.: 1476101027440; Bank IFS Code: CNRB0006223. Payment can be made through demand draft also.

Contact Details

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