

## **5th Workshop on Measurement Techniques for Steady and Transient Multiphase Flows in Rossendorf**

The Forschungszentrum Rossendorf (FZR) carries on a series of workshops on Measurement Techniques for Steady and Transient Multiphase Flows with the support of the following organisations: DECHEMA / Gesellschaft für Chemische Technik und Biotechnologie e.V., Kerntechnische Gesellschaft e. V. (KTG), Technical Group on Thermal and Fluidynamics and Local Section of Saxony, Institute of Process Technique, Process Automation, and Measuring Technique (IPM) at the University of Applied Sciences Zittau/Görlitz and the TELETRONIC GmbH in Rossendorf. The first workshop was held in 1997 and had the character of a national event. International participation started for the first time in the 2000 edition of the workshops series.

The main aim of this workshops series is to discuss recent developments and future tendencies in the field of high-resolution measuring techniques used to characterise two-phase or multi-phase flow fields. Examples are measurements of the gas-liquid interface, the characterisation of its structure and its evolution in the field of gas-liquid flows and measurements of size, shape and velocity of individual particles of the disperse phase (bubbles, droplets etc.) and their dynamics. The efforts in the measurements field correspond to the needs of the development of three-dimensional computational fluid-dynamics (CFD) models and computer codes. High-resolution data is necessary both for the development of geometry independent constitutive equations describing the interaction of the different phases taking part in the flow and for the validation of the CFD codes against experiments. Moreover, modern tendencies in instrumentation for industrial applications are discussed.

The fifth Workshop on Measurement Techniques for Steady and Transient Multiphase Flows took place in the period of September 18-20, 2002. The number of participants was about 30, among them guests from Japan, The Netherlands and the Russian Federation. 19 papers were presented including three key-note lectures from Prof. A. Tomiyama (Kobe University, Japan), Prof. H. Auracher (Technical University Berlin) and Dr. M. Misawa (AIST, Tsukuba, Japan).

Other measuring techniques discussed in the workshop include wire-mesh sensors, new type of ultrasonic mesh sensors, new liquid film probes, ultrasonic flow meters for oil-water-gas three-phase flows at oil wells and the use of Raman spectroscopy for condensation experiments. Advanced methods of data evaluation for optical probes and gamma-tomography for periodically changing void fields in pumps were presented, together with methods for the assessment of the accuracy of electrical wire-mesh sensors. Industrial applications considered, among others, test of a novel hydrostatic level measuring system and cavitation water hammers in pipelines.

The present proceedings volume contains full-length papers or, respectively, abstracts of the presentations. Those papers dealing with fluid-dynamic problems that are conform with the scope of the Journal KERntechnik were reviewed and selected for being published in this journal. Seven publications were found to be suitable in this sense. For these papers, abstracts are included in the proceedings volume. The papers not published in KERntechnik are included in full length, if authors supplied full-length versions.

A number of papers deals with instrumentation that is able to characterise the shape and the extension of the gas-liquid interface. This is necessary to replace one-dimensional thermal-hydraulic system codes by CFD models, which is a strong tendency in the field of nuclear safety. The ultra-fast X-ray tomograph presented by Dr. M. Misawa from the National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, is one of the leading non-intrusive devices in this field worldwide. New results were presented on the comparison of this method with a wire-mesh sensor developed at FZR Rossendorf. An ultrasonic mesh sensor for pressures and temperatures typical for the primary circuit of pressurised water reactors and its application at the PSB-VVER test facility in Elektrogorsk, Russian Federation, was presented by Prof. V. Melnikov. High time-resolution liquid film thickness measurements were performed by R. Belt from the TU Delft, who takes advantage of a high-speed conductivity measurement. M. Goldbrunner from the TU Munich referred to a combined temperature and concentration profile measurements of non-condensable gases in the condensation boundary layer using Raman spectroscopy. Important safety related issues of industrial interest are condensational water hammers as well as water level measurement methods. Dr. A. Dudlik from Fraunhofer UMSICHT, Oberhausen, reported about condensational water hammer experiments carried out at the Pilot Plant Pipework test facility. T. Gocht presented the results of a test of a novel hydrostatic level measuring method performed at close-to-reactor conditions.

The papers related to general questions of multi-phase flows and problems of chemical process engineering are published in the present proceedings volume. The keynote lecture of Prof. Tomiyama from Kobe University, Japan, deals with recent results in the study of the motion of single bubbles in stagnant liquids and simple shear flows, which are fundamental for the modelling of the forces at the gas-liquid interface. There is furthermore a summary of the keynote presentation of Prof. Auracher from the Technical University of Berlin about an ultra-fine optical needle probes and appropriate experimental techniques to study the effects of nucleation and the transition from nucleate to film boiling at heated surfaces. Other papers were related to ultrasonic three-phase flow rate measurements in an oil-water gas mixture (V. P. Drobkov, TU Nishny Novgorod, Russian Federation), bubble aspect ratio estimation using an optical probe (J. Rensen, TU Twente, The Netherlands), time series analysis of turbulent bubbly flow (S. Luther, TU Twente, The Netherlands), an optical method for studies on bubble behaviour in turbulent flows (D. Bröder, Martin-Luther-Universität Halle, Germany), the Intrusive Effect on Gas Liquid flow Measurement by Wire Mesh Tomography (W. Wangjiraniran, Tokyo Institute of Technology, Japan) and gamma-tomography in an axial pump delivering a two-phase flow (H.-M. Prasser).

The meeting included visits to the laboratories of Forschungszentrum Rossendorf. A. Schaffrath made a short introduction to and a guided tour through TOPFLOW, a new thermal fluid-dynamic test facility, which was meanwhile put into operation. Beside this, the test facilities ROCOM for coolant mixing studies in pressurized water reactors and the two-phase flow test MTLoop were visited.

In general, the workshop has become a good platform for discussing needs, ideas and solutions for novel multiphase instrumentation. These workshops will be continued to be held every two years.