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Contents

Special Issue: Low Liquid Flows in Medical Technology

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Editorial

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Low liquid flows – an important aspect in medical technology

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The flow of liquids inside or outside the human body plays a key role in medical technology. Safety and reliability of many medical devices or their components, e.g. dialysis machines, infusion devices, or liquid-handling systems for *in-vitro* diagnostics, require safe and reliable dosing of liquids. For that reason all aspects of dosing, handling, and measuring of low liquid flows are current topics of many research activities. The results of this efforts are presented and discussed at conferences like, e.g. the International Conference on MicroFluidic Handling Systems (the 2nd conference took place in 2014) [11], the European Conference on Microfluidics (the 4th took place in 2014) [5], or the International Flow Measurement Conference (the 16th took place in 2013) [4]. Many other examples can be found in this issue.

This special issue focuses on low liquid flows in medical technology, mainly with regard drug delivery and infusion systems. Most of the contributions are based on results from the joint EURAMET – Metrology for Drug Delivery (MeDD) research project [10]. The project was carried out by the national metrology institutes VSL (NL, coordinator), CETIAT (F), CMI (CZ), DTI (DK), METAS (CH), IPQ (PT), and UME (TK) as well as UMC (University Medical Centre, Utrecht) (NL) and Luebeck University of Applied Sciences (GE). Although the project funding ended in the summer of 2015 the work will partly be continued by some of the partners. This special issue has therefore the character of a status report of ongoing research and discusses the major findings.

The contributions of this special issue are categorized as follows. The first two contributions introduce the subject. They explain the background of metrology for drug delivery [8] and offer an overview of studies related to flow variability [16].

The third to fifth articles deal with measurement technologies and assessment. Because the gravimetric method is a common method for a great deal of the relevant flow range, this method has been given specific attention in the project. Several calibration facilities have been developed, validated and accredited during the project [3]. So this paper gives quite a good overview of the European activities. Another research project aiming at realizing calibration services for low liquid flow rates is, for example, carried out by NIST [12]. Also flow standards are needed to measure and calibrate fluidic devices. In this special issue how this method has been used to assess several drug delivery systems is discussed [2]. In addition to the common gravimetric method, new methods are also discussed that could be adopted for extremely low flows for which the gravimetric method is not suitable. This includes an optical front tracking method [1] and a flow source based on volume expansion [9].

This is followed by a transition to papers focusing more on application. The first describes the development of a new restrictor to adjust drug flows in gas-driven implantable infusion pumps [7].

Finally there are three papers dealing with the application of low flows in infusion technology in a clinical environment. The influence of components and their properties (e.g. compliance) on multi-infusion systems and their behavior (e.g. interference) is studied in [13]. The influence of two different methods to change syringes is investigated in [6]. Finally, how safety guidelines can be deduced from current best practices and the research conducted in the MeDD project is discussed in [15].

Two workshops were organized by the "Metrology for Drug Delivery" group, one in Luebeck, Germany at Luebeck University of Applied Sciences in September 2014 and one in Utrecht, The Netherlands at University Medical Center in the summer of 2015. While the first one focused mainly on the results of the MeDD project, the second one was more directed to safety aspects in infusion technology and tried to work out possible future work. All presentations can be downloaded at the corresponding websites [14, 17].

The Guest Editors would like to thank all those involved in this special issue, especially the authors for their contributions and the patience needed during the several stages of the review process. We also thank the reviewers for their valuable hints to improve the quality of this issue. We also thank the Editor in Chief and the publisher for their

willingness to publish this edition and for their support and for their help in coordinating this issue. We hope the readers will find hints and inspiration for their own work.

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