

15th International Flow Measurement Conference 2010

(FLOMEKO 2010)

**Taipei, Taiwan
13-15 October 2010**

Volume 1 of 2

ISBN: 978-1-61782-472-2

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2010) by the International Measurement Federation (IMEKO)
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact the International Measurement Federation (IMEKO)
at the address below.

IMEKO-International Measurement Federation Secretariat
P.O. Box 457
H-1371 Budapest
Hungary

Phone/Fax: +36 1 353 1562

imeko@t-online.hu

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

Volume 1

KEYNOTE SPEECH

Flow Measurement and Energy	1
<i>Michael Reader-Harris</i>	

ORAL SESSION: A

Bilateral Comparison Confirms NIM's and NIST's Gas Flow Capabilities	50
<i>Chunhui Li, Aaron Johnson</i>	
Assessment of Reproducibility and Linearity of the NMIA Bell Prover Using a High Flowrate Sonic Nozzle Array	66
<i>Khaled Chahine, Mark Ballico</i>	
Bell Prover – Calibration and Monitoring of Time Stability	74
<i>Miroslava Benkova, Stefan Makovnik, Ivan Mikulecky, Vlastimil Zamecnik</i>	
A Kind of New Calibration Method for the Volume of Bell Prover	82
<i>Lishui Cui, Lixu</i>	
Modeling Laminar Flow Meters for Process Gases	87
<i>Thiago Cobu, Robert F. Berg, John D. Wright, Michael R. Moldover</i>	
Improvements in the Implementation of Laminar and Sonic Based Gas Flow Meters in the Range of 2 X 10-5 G•S-1 (1 Ncc Min-1) to 100 G•S-1 (5000 NL•Min-1)	103
<i>Michael Bair, Casey Rombouts</i>	
Performance of a Gas Flow Meter Calibration System Utilizing Critical Flow Venturi Standards	115
<i>Michael Carter, William Johansen, Charles Britton</i>	
Performance Evaluation of Critical Flow Venturi Nozzle with Primary Standard Calibration Facilities at FCRI and Validation with ISO Standards	125
<i>P. N. Unnikrishnan, K. G. Sivaprakash, S. Saseendran</i>	
Laminar Flow Element Type Flow Meter with Straight Glass Capillary	134
<i>Chih-Cheng Feng, Win-Ti Lin, Cheng-Tsair Yang</i>	
Development of Large Air Flow Calibration System	141
<i>Kyung-Am Park, Saeng-Hee Lee</i>	
Experiment Research on Detecting the Small Throat Diameter Flowmeter for Critical Flow by Using a Bell-type Facility	148
<i>Xiao-Ming Sang, Li-Fen Wan, Dong-Jun Li, Hu Ji</i>	
Transient Response of Turbine Flow Meters During the Application at a High Pressure Piston Prover	156
<i>Bodo Mickan, Rainer Kramer, Volker Strunck, Toralf Dietz</i>	
Establishment of Air Flow Test Bench with Interact-Check Standards	171
<i>Chuanjing Li, Yunqi Chen, Aihua Guo, Jizhong Wang, Jian Yue, Shunfeng Gu</i>	
Ultrasonic Flowmeter Calibration Intervals	179
<i>Bryan Trostel, Joel Clancy, Thomas Kegel</i>	
The Development of Ultrasonic Meter Performance Diagnostic Methods Velocity Profile Ratios	189
<i>William Johansen, Thomas Kegel</i>	
Ultrasonic Flow Meter Diagnostics and the Impact of Fouling	204
<i>Jan G. Drenthen, Marcel Vermeulen, Martin Kurth, Hilko Den Hollander</i>	
The Production of Swirl in Oil and Method of Compensation in Multi-Path Ultrasonic Flowmeters	220
<i>T. Cousins, B. Griffith</i>	
Ultrasonic Flowmeter for Accurately Measuring Flare Gas over a Wide Velocity Range	235
<i>Lei Sui, Toan H. Nguyen, James E. Matson, Peter Espina, Ivan Tew</i>	
Implementation of Quadruple-Timing Pulse Interpolation Applied to Compact Piston Provers	251
<i>Carlos Eduardo Jeronymo, Valter Yoshihiko Aibe</i>	
Low-Pressure Gap Discharge Ultrasonic Gas Flowmeter	259
<i>Jerker Delsing, Kristoffer Karlsson</i>	
New Primary Low-Pressure Gas Flow Standard at NIMT	267
<i>Sutham Masri, Win-Ti Lin, Chun-Min Su</i>	

Bilateral Comparison of Primary Low-Pressure Gas Flow Standards Between NIMT and CMS	274
<i>Chun-Min Su, Win-Ti Lin, Sutham Masri</i>	
Dynamic Traceability of a Sonic Nozzle Prover System (SNPS) to Other Cal Benches at Same Company, to an Outlander One, and to the National Standard	286
<i>Alex S. Kun, László Juhász, Katalin Gadl-Nyeste</i>	
Reducing Calibration Uncertainty by Expanding the Use of Critical Flow Venturi Standards	293
<i>T. M. Kegel</i>	
The Application of Critical Nozzles in Series for the Determination of Small Flow Rates and the Generation of Gas Mixtures.....	302
<i>Rainer Kramer, Bodo Mickan, Roland Schmidt</i>	
Dependence of the Flow Velocity Field in Critical Nozzles on the Pressure Ratio	313
<i>Masahiro Ishibashi, Toshihiro Morioka</i>	
Discharge Characteristics of Small Sonic Nozzles in the Shape of Pyramidal Convergent and Conical Divergent	324
<i>Chih-Chung Hu, Win-Ti Lin, Chun-Min Su, Wen-Jay Liu</i>	
Experimental and Theoretical Investigation of Thermoacoustic Oscillations in Natural Gas Metering Stations	332
<i>Andreas Brümmer, Roland Edlerherr, Johann Lenz</i>	
Research on the Two-Phase Flow Measurement of Condensate Natural Gas	345
<i>Ying Xu, Qiang Zhang, Tao Zhang, Tao Li, Yu-Han Duan, Zhen-Lin Li</i>	
A Design of Capacitance Sensor System for Void Fraction Measurement in Liquid-Gas Flow	354
<i>Jin-Ming Zhang, Yi-Ping Liu</i>	
Identification of Vertical Upward Oil-Gas-Water Three-Phase Flow Pattern Based on Nonlinear Analysis Method	362
<i>Zhen-Ya Wang, Ning-De Jin, Zhong-Ke Gao, Rong-Hua Xie, Xing-Bin Liu</i>	
Calibration and Verification of MEMS Mass Flow Meters for Custody Transfer	368
<i>Wenhong Deng, Sugang Jiang, Rui Liu, Liji Huang, Pujun Zhao, Li Lei, Kaiyou Jin</i>	
All Electronic MEMS Flow Meters for City Gas Applications	376
<i>Liji Huang, Chihchang Chen, Yahong Yao, Gaofeng Wang, Yong Feng, Kaiping Wei, Wenhong Deng, Changming Jiang, Jiliang Ruan, Sugang Jiang</i>	
MEMS Thermal Time-of-Flight Flow Meter	384
<i>Yahong Yao, Chihchang Chen, Xiaozhong Wu, Liji Huang</i>	
Gas Flow Measurment and Controller	392
<i>Changhua Mou, Maolin Wang, Lihui Peng</i>	
Measurement of Helium Micro Flowrates with High Accuracy for Gas Chromatography	397
<i>J. Barbe, F. Dijoux, C. Yardin, T. Macé</i>	
Experimental Investigation on Zero Drift Effect in Coriolis Mass Flowmeters	405
<i>Li-Jun Wang, Liang Hu, Xin Fu, Peng Ye</i>	
Fluid-Structure Interaction (FSI) Simulations on the Sensitivity of Coriolis Flow Meter Under Low Reynolds Number Flows	412
<i>Vivek Kumar, Martin Anklin, Benjamin Schwenter</i>	
Inter-Laboratory Comparison Results for Coriolis Mass Flow Meter Calibration Facilities	422
<i>Dean M. Standiford, Mark Lee</i>	
Extending Flow Measurement Capacity with the Straight-tube Coriolis Technology	430
<i>Tao Wang, Yousif Hussain</i>	
Compensation Method Applied to Coriolis Mass Flow Metering	440
<i>F. Koschmieder, H. Röck</i>	
Numerical Approach to Estimate the Accuracy of Ultrasonic Flowmeter Under Disturbed Flow Condition	447
<i>He-Ming Hu, Chi Wang, Tao Meng</i>	
Installation Effects of Ultrasonic Flowmeter in Single Bend Pipe	455
<i>Dan-Dan Zheng, Tao Zhang, Li-Jun Sun, Tao Meng, He-Ming Hu, Chi Wang</i>	
Traceable Calibrations from Primary Standard to On-Site Ultrasonic Flowmeter	464
<i>Fong-Ruey Yang, Yi-Lin Ho, Wen-Bin Wang, Jiunn-Haur Shaw</i>	
Research on Accuracy Evaluation Method of Ultrasonic Flowmeter Used in Large Conduits	471
<i>Chi Wang, He-Ming Hu, Tao Meng</i>	

ORAL SESSION: B

European Comparison of National Water Flow Laboratories.....	479
<i>Jan Gersl, Libor Lojek, Petra Milota</i>	

Measuring Flowrates in Partially-filled Pipes in Siphonic Roof Drainage Systems	487
<i>Ying Yan Qu, Terry Lucke, Simon Beecham</i>	
Fluid Dynamics Model for Liquid Flow Calibration Facility	495
<i>Yu-Ming Shen</i>	
Novel Water Flow Facility in France - Range Extension to Low Flow Rates (10 000 ml/h Down to 1 ml/h)	501
<i>Christopher David, Pierre Claudel</i>	
Novel Modification of Large Water Calibration Facility	508
<i>Chun-Lin Chiang, Yi-Lin Ho, Jian-Yuan Chen</i>	
Extended Measurement Range of Vortex Flow Meter in High Turbulent Range	517
<i>M. Akresh, L. Reindl, M. Vasic</i>	
Development of a Vortex Flowmeter with Good Performance at Low-Flowrate	524
<i>Hui-Min Shen, Xin Fu, Jiao-Dan Chen, Peng Ye</i>	
Effects of Upstream Butterfly Valve on the Accuracy of a Vortex Flow Meter	531
<i>E. Von Lavante, A. Gedikli, A. Thibaut, S. Tournillon, H. Krisch</i>	

Volume 2

Performance of Vortex Shedding from a Circular Cylinder with a Slit	538
<i>B. H. Peng, J. J. Miau, F. Bao, L. D. Weng, C. C. Chao, C. C. Hsu</i>	
Numerical Simulation on the Flow Field of a Vortex Flowmeter with Various Upstream Conditions	550
<i>Jiann-Lin Chen, Jhih-Wei Lin, Peng Chen, Chin-Yi Wei, Yu-Chung Huang</i>	
Water Density Determination in High-Accuracy Flowmeter Calibration - Measurement Uncertainties and Practical Aspects	559
<i>Rainer Engel, Hans-Joachim Baade</i>	
“Prover-by-Prover”: Calibration of Provers Using Compact Prover as Master Meter	590
<i>Valmir Ruiz, Marcos Tadeu Pereira, Nilson Massami Taira, José Fintelmann, Danieli Guimarães</i>	
Treatment of the Time Dependent Residual Layer and its Effects on the Calibration Procedures of Liquids and Gases Inside a Volume Prover	598
<i>Anderson Ilha, Mauro M. Doria, Valter Yoshihiko Aibe</i>	
Analysis of Flow Field Characteristics in the Hydroturbine Intake Penstock of Three Gorges Power Station by Model Experiment	606
<i>Tao Meng, Chi Wang, He-Ming Hu, Hai-Bin Chen, Tao Zhuang</i>	
Measurement of Metallic Weight of The Pulp By The Electromagnetic Method	614
<i>Ju. V. Mikhailova, S. I. Kuznetsov, I. D. Velt</i>	
New Differential Producing Meters – Ideas, Implementation, and Issues	621
<i>Casey Hodges</i>	
Cone DP Meter Calibration Issues	639
<i>Casey Hodges, Charles Britton, William Johansen, Richard Steven</i>	
Metrological Comparison of Metering Characteristics of Differential Pressure Meters	667
<i>R. Mascomani, S. Saseendran, B. V. S. S. Prasad</i>	
4", 0.63 Beta Ratio Cone DP Meter Wet Gas Performance	679
<i>Richard Steven, Charlie Britton, Joshua Kinney</i>	
The Effect of Contaminated Orifice Plates on the Discharge Coefficient	697
<i>Michael Reader-Harris, Neil Barton, David Hodges</i>	
A New Laboratory for Calibration and Testing of Oil Meters and Measurement Systems Components	710
<i>Kazuto Kawakita, Marcos Tadeu Pereira</i>	
A New Calibration Facility for Small Flow of Hydrocarbon Liquid	717
<i>Kar-Hooi Cheong, Takashi Shimada, Ryouji Doihara, Yoshiya Terao, Masaki Takamoto</i>	
Establishment of Traceability System for Hydrocarbon Flow in Japan	723
<i>Takashi Shimada, Ryouji Doihara, Yoshiya Terao, Masaki Takamoto</i>	
Uncertainty Analysis of NIST's 20 Liter Hydrocarbon Liquid Flow Standard	729
<i>Aaron N. Johnson, Chris J. Crowley, T. T. Yeh</i>	
Comparison of Calibration Curves: An Application Example	748
<i>Pier Giorgio Spazzini, Luca Callegaro, Francesca Pennecchi, Bodo Mickan</i>	
Re-design of a Wind Tunnel Outflow Section	756
<i>Pier Giorgio Spazzini, Riccardo Malvano, Aline Piccato</i>	
Blockage Effects in the Calibration of Anemometer in a Wind Tunnel	764
<i>Wu Jian, Chua Hock Ann</i>	
Study on the Tests of Large-bore Flow Measurement Using FJPE-type Gauging Pipes	774
<i>Guo-Xiang Zhou, Jing-An Wang, Chunhui Li</i>	

On the Design of a Circulating Water Channel for the Brazilian National Institute of Metrology – INMETRO.....	782
<i>Alexandre T. P. Alho, Maria H. Farias, José L. S. Neto</i>	
A Novel Thermal Sensor for Gas Flowmeter Measuring.....	790
<i>Changhua Mou, Maolin Wang, Lihui Peng</i>	
Implementation and Application of SOPC-Based Pulse Interpolation Technology.....	796
<i>Wei Wang, Yuming Shen</i>	
Mass Flow Meter Concept with Diagnostic Capabilities.....	801
<i>Jim Storer, Richard Steven</i>	
The "RCT": Two Functions Integrated in One for Pressure Regulation and Gas Flow Metering	822
<i>J.-P. Vallet, P. Kervevan, A. Ouerdani, E. Mann, M. Schladerer, J. Guerin</i>	
The Effect of Using Real Gas Absolute Viscosity and Isentropic Exponent on Orifice Flow Measurement: Proposed Adoption of REFPROP 8.0 as a Standard for the Natural Gas Industry	836
<i>William R. Johansen</i>	
Properties for Accurate Gas Flow Measurements	850
<i>John D. Wright</i>	
The Foundation of Release System and Investigation on the Calculation Method on Energy Determination of Natural Gas	862
<i>Chi Wang, Chunhui Li, Jingen Wang, Tao Li</i>	
Development of a Flame Calorimeter	871
<i>Ki Won Lim, Jin Yong Jun, Byeong-Jun Lee</i>	
On the Dead Volume of a Standard Small Volume Prover	881
<i>Maria H. Farias, Marcos V. B. Ramos, Sandro R. Santoro</i>	
A Computational Investigation of FlowMeters	888
<i>Iryna Gryshanova</i>	
Optimization of Geometric Parameters of the Rotor in the Turbine Flowmeter	896
<i>Zhen Wang, Tao Zhang</i>	
Structural Optimization of Orifice Rotameter Based on CFD.....	907
<i>Li-Hua Piao, Tao Zhang, Tong Guo, Xiao-Zhong Li, Xing Chen</i>	
Numerical Investigation of Turbulent Swirling Flows In Flow Metering Configurations	915
<i>E. Von Lavante, J. Yao</i>	
The CFD Simulation and Experimental Research of the V Type Elbow Flowmeter	923
<i>Xian-Ju Meng, Shao-Feng Li, Zhi Li</i>	
Practical Application of Simulation of Electromagnetic Flowmeters.....	930
<i>I. D. Velt, L. M. Khavin, N. V. Terekhina</i>	
Numerical Simulation and Experiment on Averaging Pitot Tube with Flow Conditioning Wing.....	936
<i>Li-Jun Sun, Li-Xiao Qi, Tao Zhang</i>	
The ISO 5167 Compliant Design Venturi – A Further Summary of Calibration Experience.....	946
<i>T. M. Kegel</i>	
Diagnostic System for Venturi Meters	955
<i>Richard Steven</i>	
Wet Gas Flowrates Metering Based on Double Differential Pressures of Venturi Meter	973
<i>Qiang Zhang, Ying Xu, Tao Zhang</i>	

POSTER SESSION

Numerical Simulation of Electromagnetic Flowmeter on GPU	980
<i>Julia Michailova, Pavel Frolov</i>	
Electromagnetic Flowmeters With the Governing Boundary Conditions on The Channel Wall	986
<i>I. D. Velt, Ju. V. Mikhailova, Yu. A. Tyurin</i>	
The Specification, Selection and Use of Liquid Flow Rate Measuring Devices	992
<i>Richard Fertell</i>	
Physical Bases of Simulation of the Electromagnetic Flowmeters.....	998
<i>I. D. Velt, S. I. Kuznetsov, N. V. Terekhina</i>	
Recognition of Flow Readings for Float Flowmeters Based on Digital Image Technique	1004
<i>Xiao-Xuan Cao, Yu-Ming Shen</i>	
MEMS Mass Flow Technology: Striving for 30 Years	1010
<i>Liji Huang</i>	
Design of Miniature Disposable Flow Sensors for Medical Applications.....	1016
<i>Jian Luo, Yenan Liu, Xiaoping Liao, Jiliang Ruan, Chihchang Chen, Liji Huang</i>	

Cost Effective MEMS Mass Flow Meters	1022
<i>Kai Peng, Changming Jiang, Yongyu Liu, Wenhong Deng, Xiang Lan, Sugang Jiang, Jack Xuan, Liji Huang</i>	
On The Online Detection Method for Gas Flow Meter by Using Mobile Standard.....	1028
<i>Chen Huiyu, Xie Yu</i>	
Influence Factors Upon Verification of the Ultrasonic Heat Meter.....	1036
<i>Zhendong Shi, Huiming Duan, Xu Li</i>	
Numerical Simulation of Flow in Rotor-Casing Gap of an Rotary Piston Flow Meter	1040
<i>E. Von Lavante, S. Poggel, H. Kaya, M. Franz</i>	
Frauds in the Measurement of Natural Gas.....	1047
<i>Kazuto Kawakita, Rui Gomez Teixeira De Almeida</i>	
Development of a Self-Powered Pipe Flow Metering System.....	1054
<i>Song Hao Wang, Ronald Garcia, Xinyin He, Jiacheng Chen</i>	
Research on Tank Volume Metrology for Petroleum and Liquid Petroleum Products Based on 3D Laser Scanning Method	1060
<i>Jin-Tao Wang, Zi-Yong Liu, Long Zhang, Li-Gong Guo, Xue-Song Bao, Lin Tong</i>	

ADDITIONAL PAPERS

Present Status of Water Flow Calibration Facility at National Physical Laboratory, India.....	1068
<i>Shiv Kumar Jaiswal, I. S. Taak, Dalip Sharma, Chatar Singh, A. K. Bandyopadhyay</i>	
Reconstruction of Chengdu Natural Gas Calibration Facility in China	1076
<i>Jia Ren, Chunyuan Shi, Min He, Gang Xu, Mingliang Duan, Wenchuan Yang</i>	
Standards System for Downstream Natural Gas Flow Measurement in China	1082
<i>Min He, Jia Ren, Jiqin Duan</i>	
The Research of Correlation Between Flow Coefficient and Diameter Error of Upstream and Downstream Pipe for Elbow Flowmeter	1089
<i>Shao-Feng Li, Xian-Ju Meng, Zhi Li</i>	
Discussion on the Trend of Natural Gas Primary Standard in China Mainland	1094
<i>Jiqin Duan, Jia Ren, Huiyu Chen, Liguo Peng</i>	
In-situ Impurity Concentration and Density Monitoring of CO₂ Fluid by UV Absorption Method	1100
<i>Shau-Wei Hsu, Bao-Jen Pong, Zong-Ying Chung, Cheng-Hsien Chen</i>	
Views on In-service Inspection of Ultrasonic Flow Meter	1110
<i>Min Wei, Liwanjun, Zhoufang</i>	
Author Index	