

# **27th International North Sea Flow Measurement Workshop 2009**

**Tonsberg, Norway  
20-23 October 2009**

**ISBN: 978-1-61567-868-6**

**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© (2009) by the Energy Institute  
All rights reserved.

Printed by Curran Associates, Inc. (2010)

For permission requests, please contact the Energy Institute  
at the address below.

Energy Institute  
61 New Cavendish Street  
London W1G 7AR, UK

Phone: 44 (0) 20 7467 7100  
Fax: 44 (0) 20 7255 1472

[info@energyinst.org.uk](mailto:info@energyinst.org.uk)

**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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## **KEYNOTE**

<b>New Challenges in Oil &amp; Gas Measurement</b> .....	1
<i>Douglas Griffin</i>	

## **DP METERS**

<b>Significantly Increased Capabilities of DP Meter Diagnostic Methodologies</b> .....	13
<i>Richard Steven</i>	
<b>Cone DP Meter Calibration Issues</b> .....	42
<i>Casey Hodges, Charlie Britton, Bill Johansen, Richard Steven</i>	

## **MULTIPHASE MEASUREMENT**

<b>Recent Field Experiences Using Multiphase Meters for Fiscal Allocation</b> .....	67
<i>Eirik Åbro, Kaare Kleppe, Leif Jarle Vikshaland</i>	
<b>Fluid Characterization in a Subsea On-line Multiphase Fluid Sampling and Analysis System</b> .....	80
<i>Marie Bueie Holstad, Erik Magnus Bruvik, Bjørn Tore Hjertaker, Jarle Spilde, Kjell-Eivind Frøysa, S. H. Stavland, S. K. Meyer</i>	
<b>X-ray Based Densitometer for Multiphase Flow Measurement</b> .....	94
<i>Stein Arild Tjugum, Romulus Mihalca</i>	
<b>Successful Implementation and Use of Multiphase Meters</b> .....	107
<i>Gordon Stobie, Arnstein Wee, Oystein Fossa</i>	

## **WET GAS MEASUREMENT**

<b>An Improved Model for Venture Tube Over Reading Wet Gas</b> .....	131
<i>Michael Reader-Harris, Emmelyn Graham</i>	
<b>Measurement of Water in a Wet Gas</b> .....	154
<i>Arnstein Wee, Lex Scheers</i>	
<b>Operational Experience Roxar Wetgas Meters, Offshore Egypt</b> .....	180
<i>Mohamed Bydoun, Ingar Tyssen</i>	

## **GAS ULTRASONIC METERS**

<b>Reducing Installation Effects on Ultrasonic Flow Meters</b> .....	187
<i>Jan G Drenthen, Jeroen Van Klooster, Martin Kurth, Marcel Vermeulen</i>	
<b>Calibration Errors of Ultrasonic Meters in the Bernoulli Laboratory due to Non-isothermal Flow Conditions</b> .....	205
<i>Aernout Van Den Heuvel, Frans Doorman, Piet Van Den Herik, Arjan Stehouwer, Robert Kruithof</i>	
<b>Field Experience of Ultrasonic Flow Meter Use in CO<sub>2</sub>-rich Applications</b> .....	220
<i>Keith Harper, John Lansing, Toralf Diez</i>	
<b>OIML R 137-1, The First Ultrasonic Meter to Be Tested to Accuracy Class 0.5?</b> .....	235
<i>Skule E. Smørgrav, Atle K. Abrahamsen</i>	
<b>Ultrasonic Meter Condition Based Monitoring - A Fully Automated Maintenance Solution</b> .....	253
<i>Georg Kneisly, John Lansing, Toralf Diez</i>	

## **ENVIRONMENTAL MEASUREMENT**

<b>Three Columns Gas Chromatograph Analysis Using Correlation between Component's Molecular Weight and Its Response Factor</b> .....	275
<i>Anwar Sutan, Charles Johnson, Jason Laidlaw</i>	
<b>Validation of the CFD Method for Determining the Measurement Error in Flare Gas Ultrasonic Meter Installations</b> .....	292
<i>Jeff Gibson</i>	
<b>Nitrogen Subtraction on Reported CO<sub>2</sub> Emission Using Ultrasonic Flare Gas Meter</b> .....	309
<i>Kjell-Eivind Frøysa, Henning Ekerhovd, Atle A. Johannessen</i>	

## **LIQUID ULTRASONIC METERS**

<b>Comparison of Multipath Ultrasonic Meter Calibration Data from Two Liquid Hydrocarbon Facilities and One Water Facility</b> .....	325
<i>G J Brown, T Cousins, D R Augenstein, Bobby Griffith</i>	
<b>High Viscosity Hydrocarbon Flow Measurement, A Challenge for Ultrasonic Flow Meters?</b> .....	341
<i>Jankees Hogendoorn, Karsten Tawackolian, Peter Van Brakel, Jeroen Van Klooster, Jan Drenthen</i>	
<b>A Multipath Ultrasonic Meter with Reducing Nozzle For Improved Performance in the Laminar/Turbulent Transition Region</b> .....	361
<i>G J Brown, T Cousins, D R Augenstein, H Estrada</i>	

## **GENERAL MEASUREMENT TOPICS**

<b>Cost Benefit Analyses in the Design of Allocation Systems</b> .....	386
<i>Phillip Stockton</i>	
<b>Software for Evaluation of Uncertainty in Liquid Hydrocarbons Flow Measurement Systems</b> .....	N/A
<i>Verónica Mejía Gallardo, Diego Nelson Moncada Benavides</i>	
<b>Realistic Pipe Prover Volume Uncertainty</b> .....	412
<i>Paul Martin</i>	
<b>Inferential Chemometric Allocation</b> .....	438
<i>Phillip Stockton</i>	
<b>Metering Atlas - A Portal to Create Transparency in Production and Fiscal Measurement Data</b> .....	463
<i>Lex Scheers, Oi-Mee Voon, Tjidde Boers</i>	
<b>Author Index</b>	