# 13th International Conference on Pressure Surges 2018

Bordeaux, France 14 - 16 November 2018

Volume 1 of 2

ISBN: 978-1-5108-7524-1

#### 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© (2018) by BHR Group All rights reserved.

Printed by Curran Associates, Inc. (2019)

For permission requests, please contact BHR Group at the address below.

BHR Group The Fluid Engineering Centre Cranfield, Bedfordshire MK43 0AJ United Kingdom

Phone: +44 1234 750422 Fax: +44 1234 750074

info@bhrgroup.com

#### Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400 Fax: 845-758-2633 Email: curran@proceedings.com Web: www.proceedings.com 13<sup>th</sup> International Conference on

## **PRESSURE SURGES**

Bordeaux, France: 14<sup>th</sup> – 16<sup>th</sup> November 2018

# CONTENTS

FOREWORD	1
ACCIDENTS AND INCIDENTS	
Owning up to our misbehaving systems: the complex and multifaceted assessment of failure <i>B W Karney, University of Toronto, Canada</i>	5
Pump start-ups ignite nuclear power plants: history, law, and risk <i>R A Leishear, Leishear Engineering, LLC, USA</i>	13
AIR VESSELS AND CURTAINS	
Control of dynamic peak loads with air bubble curtain I Szeredi, Candidate of Technical Sciences, MVM senior strategy expert (retired), Hungary	31
Transient thermodynamic processes in air chambers with a gas cushion for surge protection <i>F Haakh, Zweckverband Landeswasserversorgung, Germany</i>	47
Comparison of the extended rational heat transfer model with 3D simulations S van der Zwan, S L Kooreman, Deltares hydraulics for industry and infrastructure, The Netherlands	65
CFD and 1D simulation of transient flow effect on air vessel M Besharat, H M Ramos, University of Lisbon, Portugal; O E Coronado-Hernández, Universidad Tecnológica de Bolívar, Colombia; V S Fuertes-Miquel, Universitat Politècnica de València, Spain; M T Viseu, Laboratório Nacional de Engenharia Civil (LNEC), Portugal	73
ENTRAPPED AIR	
The influence of air pressurization in stormwater systems flows: experimental and numerical assessment <i>J Kaiber da Silva, R D Maestri, A L O Borges, Federal University of</i>	89

Rio Grande do Sul, Brazil; J G Vasconcelos, Auburn University, USA

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

Pressure wave behaviour due to entrapped air in hydraulic transient events	105
J P Ferreira, D I C Covas, Universidade de Lisboa, Portugal; E Ghezzi,	
M Ferrante, University of Perugia, Italy	

Modeling complex boundary conditions during transient two-phase mixed flow117in storm water systems (SWS)M Fuamba, M Daynou, S Bousso, A Rokhzadi, Polytechnique Montreal,<br/>Canada

### FAULT DETECTION

Reliable pipeline leak detection J C P Liou, University of Idaho, USA	131
Characterization of transient pressure traces due to the effects of different anomalies and features in water pipelines J Bohorquez, A Simpson, M Lambert, The University of Adelaide, Australia	151
Explanation for the frequency shift pattern of non-uniform blocked pipeline systems from an energy perspective <i>T C Che, H F Duan, B Pan, The Hong Kong Polytechnic University, Hong</i> <i>Kong SAR, PR China; P J Lee, The University of Canterbury, New Zealand;</i> <i>M S Ghidaoui, The Hong Kong University of Science and Technology,</i> <i>Hong Kong SAR, PR China</i>	171
Leak detection in a long pipe system H Alharbi, S B M Beck, R P Collins, University of Sheffield, UK	187
Correlation of post-burst hydraulic transient noise for pipe burst/leak localisation in water distributions systems J Gong, S T N Nguyen, M F Lambert, A Marchi, A R Simpson, A C Zecchin, The University of Adelaide, Australia; M L Stephens, South Australian Water Corporation, Australia	201
Multiple defects detection and characterization in pipes F Zouari, M Louati, E Blåsten, M S Ghidaoui, Hong Kong University of Science and Technology, Hong Kong	217
Wave-defects interaction in a simple pipe system M Louati, M S Ghidaoui, Hong Kong University of Science and Technology, Hong Kong; M M Tekitek, University of Tunis-Manar, Tunisia	233
Numerical investigation of high-frequency wave-leak interaction in water-filled pipes Z Lai, Zhejiang University of Technology, China; M Louati, M Ghidaoui, Hong Kong University of Science and Technology, Hong Kong, China	251

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

## FLUID AND STRUCTURAL DAMPING

Acceleration-dependent unsteady friction revisited A E Vardy, University of Dundee, UK	265
Comparing analytical solutions for unsteady laminar pipe flow K Urbanowicz, M Firkowski, West Pomeranian University of Technology, Poland; A Bergant, Litostroj Power d.o.o., Slovenia	283
Effect of creep compliance derivative in modeling water hammer in viscoelastic pipes K Urbanowicz, M Firkowski, West Pomeranian University of Technology, Poland	305
A frequency-domain transient-based method for the analysis of viscoelastic parameters of plastic pipes B Pan, H F Duan, T C Che, The Hong Kong Polytechnic University, Hong Kong SAR, PR China; S Meniconi, B Brunone, The University of Perugia, Italy	325
Field measurements and theoretical modeling of hydraulic transients in HDPE pipeline with PRV interaction H C Yan, M Y Lam, J H W Lee, Hong Kong University of Science and Technology, Hong Kong, China	339
FLUID STRUCTURE INTERACTION	
The influence of pipe support stiffness on pressure transients in pipe coils: An experimental investigation <i>L-D Nguyen, University of Science and Technology (UST), Republic of</i> <i>Korea; M Kim, T Kim, K Do, B Choi, University of Science and Technology</i> <i>(UST) and Korea Institute of Machinery and Materials (KIMM), Republic of</i> <i>Korea</i>	351
Effect of structural vibration in the propagation of high-frequency waves through a fluid-filled elastic pipe G Grigoropoulos, M Louati, M S Ghidaoui, E G Dimitrakopoulos, Hong Kong University of Science and Technology, Hong Kong	365
Structural response under transient load combination M Simão, H M Ramos, Universidade de Lisboa, Portugal	381
Fluid-structure interaction in pipelines with anchor blocks against longitudinal movement D Ferras, IHE Delft Institute for Water Education, The Netherlands; P A Manso, A J Schleiss, École Polytechnique Fédérale de Lausanne.	393

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

### FUNDAMENTALS

Influence of static pressure on the damping of pressure waves in rocket engine feed lines <i>S Klein, T Traudt, C Bombardieri, M Oschwald, German Aerospace Center,</i> <i>Germany</i>	411
Analysis of pulsating flow in a large-scale pipeline close to resonance conditions A Bergant, Litostroj Power d.o.o. and University of Ljubljana, Slovenia; J Gregorc, University of Ljubljana, Slovenia; T Wahl, ETH Zurich, Switzerland; K Urbanowicz, West Pomeranian University of Technology, Poland	423
A modal-based analysis of pipeline networks with applications to time-domain simulation A C Zecchin, The University of Adelaide, Australia; S H Kim, Pusan National University, Korea; M Ferrante, The University of Perugia, Italy	439
Reflections on the acoustic wave propagation speed in homogeneous two-phase flow A Malekpour, Innovative Hydraulic Group Inc., Canada; B W Karney, University of Toronto, Canada; D McPherson, HDR Inc., USA	455
Comparing CFD and 1-D solvers for the classic laminar water-hammer event in a pipe-reservoir system, perspectives on energy transformations and wave reflection <i>S Mandair, B W Karney, University of Toronto, Canada; R Magnan,</i> <i>J-F Morissette, Institut de recherche d'Hydro-Québec, Canada</i>	471
Applicability of the Lattice Boltzmann Method to the simulation of pressure surges of liquid nitrogen <i>T Traudt, S Schlechtriem, German Aerospace Centre (DLR), Germany</i>	487

## AUTHOR INDEX

The following sessions are included in Volume II of these Proceedings:

HYDRO POWER INDUSTRIAL CASE STUDIES PUMPS, TURBINES AND VALVES SIGNAL ANALYSIS, FAULT DETECTION, BIG DATA SURGE MITIGATION TRANSIENT MULTIPHASE FLOW

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

# 13th International Conference on Pressure Surges 2018

Bordeaux, France 14 - 16 November 2018

Volume 2 of 2

ISBN: 978-1-5108-7524-1

13<sup>th</sup> International Conference on

## **PRESSURE SURGES**

Bordeaux, France: 14<sup>th</sup> – 16<sup>th</sup> November 2018

## CONTENTS

The following sessions are included in Volume I of these Proceedings: ACCIDENTS AND INCIDENTS AIR VESSELS AND CURTAINS ENTRAPPED AIR FAULT DETECTION FLUID AND STRUCTURAL DAMPING FLUID STRUCTURE INTERACTION FUNDAMENTALS

### HYDRO POWER

A selective literature review of vortex rope in turbine draft tubes and the associated induced pressure pulsations in the conveyance system Y Chen, J Zhou, Hohai University, China; B Karney, University of Toronto, Canada	503
The effect of brook intakes, downstream surge tanks and reservoir levels on surge tank stability <i>L Pitorac, D Bardini, L Lia, Norwegian University of Science and</i> <i>Technology, Norway; K Vereide, Norwegian University of Science and</i> <i>Technology and Sira-Kvina Power Company, Norway</i>	521
Hydraulic transients in pipe networks caused by micro-turbines D Ferras, IHE Delft Institute for Water Education, The Netherlands; A McNabola, Trinity College Dublin, Ireland	535
First principles approach linear model for hydraulic turbines suitable for use in available simulation platforms B Svingen, NTNU and Hymatek Controls, Norway; T K Nielsen, NTNU, Norway	549

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

An investigation of air inflow into hydropower conduits during emergency closure	565
F Sadeque, University of British Columbia and BC Hydro, Canada; H Charrette, EPFL, Switzerland; Z Shawwash, University of British Columbia, Canada	
Mitigation of pressure pulsations of a small hydro pit turbine M Bruns, Voith Hydro Holding GmbH & Co. KG, Germany; L Cosmai, Voith Hydro S.r.I., Italy	581
INDUSTRIAL CASE STUDIES	

Slower valves closures cause larger pressures! I T Telci, Bechtel Oil Gas & Chemicals, USA; S R Koirala, City of Austin, USA; F A Locher, Bechtel NS&E, USA	591
Rejected take-off engine generated pressure surges and the prediction of surge propagation along an aircraft wing fuel system <i>D Morrison, M Sandford, Airbus Operations Ltd, UK</i>	603
Case study: Hydraulic modelling and field verification on bulk transfer schemes in Southern Africa <i>K Prinsloo, C2D Consulting (Pty) Ltd, South Africa</i>	613
Surge transients due to check valve closure in a municipal water pumping station D Lozano Solé, R Bosch Segarra, Aquatec Proyectos para el Sector del Agua SAU (SUEZ Group), Spain; T W Walters, Applied Flow Technology, USA	627
Modeling of transient pneumatic events in a combined sewer overflow storage tunnel system <i>P Klaver, LimnoTech, USA; K Robinson, City of Portland, Oregon Bureau of Environmental Services, USA; D Collins, David J. Collins Engineering, USA</i>	645
Numerical investigation of reciprocating valve characteristics on pressure pulsations W Schoemakers, F Bos, E J Lingen, Dynaflow Research Group, The Netherlands	659
Surge mitigation in a marine fuel oil terminal D Witte, Purple Mountain Technology Group, USA; D Jackson, Sealaska, USA; T Walters, Applied Flow Technology, USA	677
A case study of hydraulic design of an undulating sewage pumping main A Alidai, D J Mitchell, S Stanford, Atkins - Member of the SNC Lavalin Group, UK	691
Case analysis on surge problems and further updating design of a throttled surge tank <i>J Zhou, Y Chen, F Cai, Hohai University, China</i>	701

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

Smart use of topography in surge mitigation	715
M O Al Dajani, P H Leruth, M Al Ali, Abu Dhabi Transmission and Despatch	
Company (TRANSCO), UAE	

## PUMPS, TURBINES AND VALVES

Modelling valve behaviour in unsteady conditions J P Ferreira, N M C Martins, D I C Covas, Universidade de Lisboa, Portugal	729
Unappreciated challenges in applying four quadrant pump data to waterhammer simulation part 1: fundamentals	741
T W Walters, S A Lang, D O Miller, Applied Flow Technology, USA	
Unappreciated challenges in applying four quadrant pump data to waterhammer simulation part 2: application examples	755
T W Walters, S A Lang, D O Miller, Applied Flow Technology, USA	
Pump-turbine four-quadrant characteristics model for analysis of transient operation	771
I Szeredi, Candidate of Technical Sciences, MVM (Hungarian Power Companies), senior strategy expert (retired), Hungary	

## SIGNAL ANALYSIS, FAULT DETECTION, BIG DATA

Inverse transient analysis using the head-based method of characteristics with a flexible grid: a laboratory verification	785
C Zhang, J Gong, A R Simpson, M F Lambert, A C Zecchin, The University of Adelaide, Australia	
Regularization for pipeline impulse response extraction with least square deconvolution	795
X Wang, M S Ghidaoui, Hong Kong University of Science and Technology, Hong Kong, China; P J Lee, University of Canterbury, New Zealand	
Comparison of probabilistic modelling techniques for transients in water distribution networks	805
E Kazemi, R Collins, University of Sheffield, UK	

### SURGE MITIGATION

Exploring surge protection strategies: system modification, operational	821
considerations, surge protection devices, emergency control procedures and	
inter-systems protection	
B S Jung, Tebodin Middle East, UAE; B W Karney, University of Toronto,	
Canada	

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.

Transient analysis of sewer rising mains J Amorim, A Shimmin, M Toscano, Mott McDonald Limited, UK	833
Smaller air chambers through consideration of transient heat transfer in the pressure surge calculation? Results from comparison calculations <i>F Haakh, M Veit, Zweckverband Landeswasserversorgung, Germany</i>	851
Using water hammer software to model extended period simulation and surge analysis in a water supply network <i>M Toscano, L Henriques, D Steel, Mott MacDonald Limited, UK</i>	865
Experimental assessment of pressure pulsations and transient characteristics of a 1400 m pipe line <i>I K Vilberg, Flow Design Bureau AS and Norwegian University of Science</i> <i>and Technology, Norway; M Kjeldsen, Flow Design Bureau AS, Norway;</i> <i>B Svingen, T K Nielsen, Norwegian University of Science and Technology,</i> <i>Norway</i>	881

### TRANSIENT MULTIPHASE FLOW

Multiphase fluid hammer during priming operation: comparative analysis893between water and liquid nitrogenJ-B Gouriet, Z Petro, J-M Buchlin, von Karman Institute for Fluid Dynamics,Belgium; J Steelant, ESTEC-ESA, The Netherlands

A Finite-Volume approach for water-hammer events with column-separation 909 F Daude, EDF Lab Paris-Saclay and Université Paris-Saclay, France; P Galon, Université Paris-Saclay, France

Experimental measurements of momentum changes at hydraulic jump in a 925 transparent horizontal pipe *K Kaur, I Annus, J Laanearu, Tallinn University of Technology, Estonia* 

Two-phase CFD modelling of air-water flow transition in a horizontal circular937pipe and comparisons with experimental resultsJ Laanearu, K Kaur, Tallinn University of Technology, Estonia

A parametric sensitivity analysis of numerically modelled piston-type filling and 949 emptying of an inclined pipeline with an air valve
O E Coronado-Hernández, Universidad Tecnológica de Bolívar, Colombia;
V S Fuertes-Miquel, Universitat Politècnica de València, Spain;
M Besharat, H M Ramos, University of Lisbon, Portugal

Making the world a safer and better place – a plea for more data, validation961cases and guidelines for waterhammer simulation7T W Walters, Applied Flow Technology, USA; G G Orieux, Q Li,<br/>L Thomson, Enbridge Pipelines Inc, Canada4

### AUTHOR INDEX

The Proceedings for this event have been produced in 2 volumes. Pages 1–500 are included in Volume I. Pages 501–974 are included in Volume II.