

International Topical Meeting on Advances in Thermal Hydraulics 2020 (ATH'20)

Palaiseau, France
20-23 October 2020

Volume 1 of 2

ISBN: 978-1-7138-6055-6

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© (2020) by American Nuclear Society
All rights reserved.

Printed with permission by Curran Associates, Inc. (2022)

For permission requests, please contact American Nuclear Society
at the address below.

American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526
USA

Phone: (800) 323-3044
(708) 352-6611
Fax: (708) 352-0499

www.ans.org

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

TABLE OF CONTENTS

International Topical Meeting on Advances in Thermal Hydraulics (ATH 2020)

Foreword	xiii
Organizing Committees	xiv
Invited Keynotes	xvii

Keynotes

Towards More Efficient Implementations of Multiscale Thermal-Hydraulics	3
<i>Antoine Gerschenfeld</i>	
Multi-Level CFD Modeling and Applications for Subchannel Thermal-Hydraulics, Experimental Designs, and Safety Analysis	17
<i>Bao-Wen Yang, Bin Han, Hisashi Ninokata, Aiguo Liu, Luona Yang, Xinyi Miao</i>	
Passive Systems and Nuclear Thermal-Hydraulics	52
<i>F. D'Auria</i>	
High Fidelity Simulations in Support to Assess and Improve RANS for Modeling Turbulent Heat Transfer in Liquid Metals: The Case of Forced Convection	64
<i>Yann Bartosiewicz</i>	

General Thermal Hydraulics

ATHLET Simulation of PKL IBLOCA I2.2 Benchmark Test and Quantitative Assessment	81
<i>Hong Xu, Aurelian Florin Badea, and Xu Cheng</i>	
Key Learnings of Full Scope Simulator's Nuclear Steam Supply System (NSSS) Model Re-Hosting Project at EDF	95
<i>Alexandre Bonne, Nicolas Bardiaux, David Pialla, Karine Vareille, Nicolas Delanghe</i>	
Research on the Significance of Small Scale TH Analysis for PWR Fuel Assemblies	110
<i>Guangliang Chen, Jijun Wang, Zhijian Zhang, Rui Ma, Yang Yu, Lei Li, Zhaofei Tian</i>	
Numerical Simulation and Validation of Passive Safety System of Generation III+ PWR with RELAP5	119
<i>Yao Yao, Deng Cheng-cheng, and Yang Jun</i>	
Experimental and Numerical Investigations on Micro-Sized Particle Wall Collision in Pebble-Bed High Temperature Gas Cooled Reactors	129
<i>Zhu Fang, Yiyang Zhang, Shumiao Zhao, Mingzhe Wei and Xinxin Wu</i>	
A Sensitivity Study of Sodium Heat Pipes for Microreactor Applications	143
<i>Clayton Turner and Donna Post Guillen</i>	
Making the Switch from Pipe to Vessel Components	157
<i>I. Clifford, O. Zerkak and H. Ferroukhi</i>	
Impact of Fuel Pellet-Clad Gap Characteristics on an Unprotected Loss of Flow Transient in a Sodium Fast Reactor	171
<i>S. Bajard, S. Li, V. Blanc and M. Lainet</i>	
The Sensitive Analysis of Thermal Hydraulics Phenomena of a Suppression Pool with the System Analysis Code	185
<i>Jin-guang Zang, Yu Du, Yan Zhang, Lin-kun Li, Xiao Yan</i>	

Pressure and Oscillatory Flow Effects on the Two-Phase Flow and Heat Transfer in a Rod Bundle	194
<i>Grant Garrett, Faith Beck, Douglas Miller, Brian Lowery, Fan-Bill Cheung, Stephen Bajorek, Chris Hoxie, and Kirk Tien</i>	

Experimental Methods and Instrumentation for Thermal Hydraulics

Noninvasive Interrogation of Local Flow Phenomena in Twisted Tape Swirled Flow via Positron Emission Particle Tracking (PEPT)	211
<i>Cody S. Wiggins, Lane B. Carasik, Arthur E. Ruggles</i>	
Experimental Analysis of the Start-Up of a Natural Circulation Loop in Single and Two-Phase Flow	223
<i>C. Bertani, A. Bersano, N. Falcone and M. De Salve</i>	
Beyond Time-Averaged Measurements Using Conductivities Probes	237
<i>Zhiew Jhia Ooi & Caleb S. Brooks</i>	
Experimental Study of Fluid Motion and Mass Transfer in a Cylindrical Bubble Column	248
<i>Jiaqi Chen and Caleb S. Brooks</i>	
CIGMA Experimental Investigation on Heat and Mass Transfer Phenomena Induced by Natural Convection with Density Stratification in the Enclosure Vessel	258
<i>Satoshi Abe, Ari Hamdani, Masahiro Ishigaki and Yasuteru Sibamoto</i>	
Acoustic Analysis of the Effects of Vapor-Liquid Interfacial Morphology on Pool-Boiling Heat Transfer	269
<i>Mustafa.H.Almadih, T.Almudhhi, S.Ebrahim, A.Howell, G.R.Garrett, S.M.Bajorek, and F.B.Cheung</i>	
PASI – A Test Facility for Research on Passive Heat Removal	280
<i>Virpi Kouhia, Vesa Riikonen, Otso-Pekka Kauppinen, Joonas Telkkä and Juhani Hyvärinen</i>	
Upgrading the PLINIUS Platform toward Smarter Prototypic-Corium Experimental R&D	294
<i>C. Journeau, V. Bouyer, F. Charollais, N. Chikhi, J. Delacroix, A. Denoix, C. Mattassoglio, D. Molina, P. Piluso, P. Sauvecane, S. Thilliez, B. Turquais, and C. Suteau</i>	
Study on Melting Process of Solid Salt Contained in Metal Vessel	308
<i>Tomio Okawa, Tatsuya Tokushima, Indarta Kuncoro Aji, and Mahammad Ilham</i>	

DNS and LES of Single-Phase and Two-Phase Flows

Towards Direct Numerical Simulation of a 5X5 Rod Bundle	323
<i>Adam Kraus, Elia Merzari, Thomas Norddine, Oana Marin, Sofiane Benhamadouche</i>	
High-Fidelity Simulation of Heat-Transfer in Turbulent Pipe Flow	337
<i>Rodrigo Vicente Cruz, Eric Lamballais, Gabriel Fernando Narváez Campo, and Rodolphe Perrin</i>	
Direct Numerical Simulation of Natural, Mixed and Forced Convection in Liquid Metals: Selected Results	349
<i>Andrea Fregni, Diego Angeli, Andrea Cimarelli, and Enrico Stalio</i>	
Validation of the Hydrodynamics in a Turbulent Un-Baffled Vortex-Reactor at Two Different Stirring Reynolds Numbers	363
<i>E. Saikali, M.G. Rodio, G. Bois, U. Bieder, N. Leterrier, and M. Bertrand</i>	
Detailed Analysis of the Effects of Spacer-Grid and Mixing Vanes on Turbulence in a PWR Sub-Channel under DFFB Conditions Based on DNS Data.....	377
<i>Nadish Saini and Igor A. Bolotnov</i>	

Turbulent Flow over a Confined Backward Facing Step: Measurements and Simulations	391
<i>Jure Oder, Boštjan Zajec, Marko Matkovič, Nejc Kosanič, Iztok Tiselj</i>	
Modal Decomposition of the Flow in a Randomly Packed Pebble Bed with Direct Numerical Simulation	402
<i>Mustafa Alper Yildiz, Elia Merzari, Thien Duy Nguyen, Yassin A. Hassan</i>	

Thermal Hydraulics for Generation IV Reactors

Sensitivity of SC-HTGR Conduction Cooldown to Reactor Cavity Cooling System Operation	415
<i>B. Mays, L. Lommers, S. Yoder, and F. Shahrokhi</i>	
Feasibility Studies in Support to the Update of Tabletop Facility	429
<i>V. Chorda, D. Rozzia, A. Marino, K. Van Tichelen</i>	
Molten Salt Modelling Capabilities in Spectra and Application to MSRE	443
<i>F. Roelofs, M.M. Stempniewicz</i>	
GeN-FOAM Model of Graphite Moderator of a Molten Salt Reactor	457
<i>Alexander Barzilov and Jeff Stewart</i>	

Thermal Hydraulics of Small Space Nuclear Reactors

Non-Nuclear Transient Simulation Experiment of a Heat Pipe Cooled Nuclear Reactor System	473
<i>Panhe Ge, WeiJian An, Jian Guo, Xiaobo Sun, Gu Hu, Ye Han, Jian Mou</i>	
Startup Transient Thermal-Hydraulic Analysis of a Lithium Heat Pipe Cooled Reactor Core	484
<i>Xiao Liu, Zhixing Tian, Chenglong Wang, Wenxi Tian, Suizheng Qiu, Guanghui Su</i>	
Steady State and Transient Analysis of Gas-Cooled Reactor Space Nuclear Power System	494
<i>Ran Zhang, Kailun Guo, Chenglong Wang, Suizheng Qiu, G. H. Su</i>	

Advanced Thermal Hydraulics Modeling of Heat Exchangers

Development of a Numerical Tool to Predict the Thermal and Hydraulic Behavior of a Heat Exchanger	507
<i>Youssef Alilou and Alan Jean-Marie</i>	
Time Domain Theoretical Study on Two-Phase Flow Instability	516
<i>Yang Su, Xiaowei Li, Qian Liang, and Xinxin Wu</i>	

Thermal Hydraulics for Nuclear Safety

Study on Automatic Depressurization System of SMR	531
<i>Shasha Yin, Yan Sun, Yi Li, Hongfa Yang</i>	
CFD Study of an Innovative Safety System for Pressurized Water Reactors	544
<i>Thierry Cadiou, Elisabetta Stratta, Loic Augier</i>	
Solving Thermal Hydraulic Safety Issues of PWRs through Experiments in the Integral Test Facility PKL	558
<i>Holger Schmidt, Simon Philipp Schollenberger, Lars Dennhardt, and Rafal Bryk</i>	

Simulations of Simplified LOCA Scenario with a Non-Equilibrium Homogeneous Model	572
<i>Olivier Hurisse and Lucie Quibel</i>	
Numerical Prediction of the Reactor Pressure Vessel Melting under IVR-ERVC Conditions	582
<i>Muritala A. Amidu, Yacine Addad</i>	

Thermal Hydraulics and Neutronics

Heat Transfer Correlations Effects on Fuel Temperature in SCWR with Fractional Neutron Point Kinetics	593
<i>Erick-G. Espinosa-Martínez., Juan-Luis François, Cecilia Martín-del-Campo, Gilberto Espinosa-Paredes, Nader Maleki Moghaddam, Sergio Quezada-García</i>	
Accurate Calculations “Neutronic-Thermal Hydraulic” by MCU/OpenFOAM Codes for Light Water and Liquid Metal Cooled Systems	606
<i>D. A. Koltashev, E. F. Mitenkova</i>	
Preliminary Neutronic/Thermal-Hydraulic and Safety Assessment of Pressurized Water Reactor Loaded with Fully Ceramic Microencapsulated Fuel	617
<i>Di Wu, Minyang Gui, Dalin Zhang, Chenglong Wang, Yingwei Wu, G.H. Su, Suizheng Qiu and Wenxi Tian</i>	

Thermal Hydraulics of CORIUM

MELCOR Study of Alkaline Carbonate Cooling to Mitigate Ex-Vessel Molten Corium Accidents	631
<i>David L.Y. Louie, Kyle W. Ross, and Yifeng Wang</i>	
Numerical Simulation of Droplet Formation by Rayleigh-Taylor Instability in Multiphase Corium	645
<i>R. Zanella, G. Tegze, M. Plapp, R. Le Tellier, and H. Henry</i>	

Code Development and Validation in Thermal Hydraulics

Some Progresses in System Code Modelling Validation and Application Including 3D Modelling	661
<i>D. Bestion, P. Fillion and R. Pr�ea</i>	
Advanced Benchmark of the Flow through a Mixing Vane Grid – Large Eddy Simulation Validation	675
<i>B. Farges, M-C. Gauffre, S. Benhamadouche, P. Badel, V. Faucher, G. Ricciardi</i>	
Validation of ATHLET 3.2 on an SBO Scenario Test at the PWR PACTEL Test Facility	691
<i>L. Guo, P. Sch�offel, T. Hollands</i>	
Theoretical Investigation on CHF Characteristics of Natural Circulation under Moving Condition	703
<i>Minyang Gui, Wenxi Tian, Di Wu, Ronghua Chen, Kui Zhang, G.H. Su, Suizheng Qiu</i>	
Multicomponent Diffusion Modelling for Light Gases Predictions in Water Cooled Nuclear Reactors	716
<i>Matilde Fiore, Andrea Attavino, Lilla Koloszar, and Delphine Laboureur</i>	
CATHARE-3 V2.1: The New Industrial Version of the CATHARE Code	730
<i>R. Pr�ea, P. Fillion, L. Matteo, G. Mauger, A. Mekkas</i>	
Hunting for the Correct Pressure Drop in a Scaled Reactor Pool: Effect of Geometry, Mesh Resolution, Turbulence Model and Mass Flow	743
<i>S. Lopes, L. Koloszar, P. Planquart, D. C. Visser, and K. Van Tichelen</i>	
Application of Immersed Boundary Method for Jet Flow in Grating Type Structure	757
<i>Yoshiyasu Hirose, Masahiro Ishigaki, Satoshi Abe, and Yasuteru Sibamoto</i>	

Validation of the ALTHAMC12 Subchannel Code	768
<i>Stepan Foral, Karel Katovsky, Ladislav Suk and Radek Polasek</i>	

Error and Uncertainty Quantifications in Thermal Hydraulics

Enhanced Tolerance Limit Evaluation Method to Determine Statistically Meaningful Minimum Sampling Size	785
<i>Jiafeng Guo, Zhongning Sun, Jianjun Wang</i>	
Quantification of Uncertainties in a SAS-SST Simulation Caused by the Unknown High-Wave Number Damping Factor Using Surrogate Modelling	799
<i>Yu Duan, Ji Soo Ahn, Matthew D. Eaton, Michael J. Bluck</i>	
Demonstration of a Data-Driven Physics-Based Approach for Computationally Efficient CFD Prediction of Two-Phase Bubbly Flow	813
<i>Han Bao, Jinyong Feng, Nam Dinh, Igor Bolotnov, Hongbin Zhang</i>	

Computational Fluid Dynamics in the Reactor Vessel

Blurring the Lines between CAD, Mesh and Solver in <i>Code_Saturne</i> to Improve Predictive Capabilities of Finite Volume CFD Modelling	829
<i>Nicolas Tonello, Yohann Eude, Sofiane Benhamadouche, Martin Ferrand, Yvan Fournier</i>	
Numerical Investigation on Complete Reactor Vessel Flow with <i>Code_Saturne</i>	841
<i>Lianfa Wang, Mingjun Wang, Suizheng Qiu, Guanghui Su, Wenxi Tian, Tingting Xu, Jiasheng Min</i>	

Computational Fluid Dynamics of Turbulent Single-Phase Flows

CFD Evaluation of Pressure Change along Coolant Passages in Sodium-Cooled Fast Reactor Using Nek5000	857
<i>J. Fang, Y. Yu, H. Yuan, D.R. Shaver, E. Merzari</i>	
Simulations of Heat Transfer Impairment in AGR Fuel Assemblies	870
<i>Juan Uribe, Charles Moulinec, Bing Xu, and David R. Emerson</i>	
RCS Flow Rate from Elbow Taps - Validation of Computational Fluid Dynamics Calculations	881
<i>Romain Camy, Yvan Fournier, and Erwan Le Coupanec</i>	
Thermal Stripping Analysis in T-Junctions with Different Entry Flow Profiles	895
<i>Lisa Lampunio, Yu Duan, Raad Issa, Matthew Eaton</i>	

Turbulence, Heat and Mass Transfer Modeling and Simulation

Turbulence Models Assessment for Ascending Mixed Convection Flows	909
<i>Jean-Francois Wald, Sofiane Benhamadouche, Tarik Hassi, Erwan Le Coupanec, Thomas Norddine, and Elodie Farina</i>	
Preliminary Discussion on the Equivalent Thermal Conductivity Affected by the Inner Heat Source	922
<i>Ziping Liu, Jun Sun</i>	
Mass Transfer Measurement in a Rectangular Channel for Heat Transfer Analogy	936
<i>V. Khayiguian, M. Cissé, N. Goreaud, C. Airiau, and D. Lo Jacono</i>	

Numerical Simulation of a Toroidal Single-Phase Natural Circulation Loop with κ - κ_L - ω Transitional Turbulence Model	950
<i>Yi-wa Geng, Xiong-bin Liu</i>	

Computational Fluid Dynamics of Two-Phase Flows

CFD Study of the Effect of Sliding Bubbles on Heat Transfer in Laminar Regime	965
<i>K.W. Wong, L. Bures, and K. Mikityuk</i>	
Numerical Simulation of a Compressible Air Bubble Rising in Water with Variable Thermophysical Properties	979
<i>Yuanwei Cao, Inés Mateos Canals, and Rafael Macián-Juan</i>	
Assessment of Wall Boiling Model to Predict Critical Heat Flux Using CFD	993
<i>K. Podila, C. Li, G. Waddington, Y. Rao</i>	

Multi-Phase Flows Modeling

Topology Based Multi-Phase Flow Model for Nuclear Safety Applications	1009
<i>Ido Silverman</i>	
Sockeye Heat Pipe Code Theory Development: Based on the 7-Equation, Two-Phase Flow Model of RELAP-7	1023
<i>R.A. Berry, J. Hansel, M. Kunick, D. Andrs, and R.C. Martineau</i>	
Investigation of the Effects of Surface Wettability and Surface Roughness on Nanoscale Boiling Process Using Molecular Dynamics Simulation	1037
<i>Huaqiang Liu, Jiyun Zhao</i>	
Multi-Dimensional Calculation of Reflood Behavior in a SCTF Experiment at Partial Blockage Condition	1050
<i>Young S. Bang, Joosuk-Lee, Andong Shin</i>	
Effects of the Bubble Size Distributions on the Decontamination Factors during Bubble Rise in the Pool Scrubbing.....	1060
<i>Yoonhee Lee, Yong Jin Cho, Inchul Ryu</i>	
A Modified Liquid Sublayer Dryout Model for Subcooled Flow Boiling Critical Heat Flux Prediction in IVR Condition	1074
<i>M. A. Rafiq Akand, T. Matsumoto, W. Liu and K. Morita</i>	
Progress of Recent Studies on Sloshing Motion in a Liquid Pool with Solid Particles	1088
<i>Ruicong. Xu, Songbai. Cheng, and Hui. Cheng</i>	

Multi-Scale and Multi-Dimensional Modeling and Simulation in Thermal Hydraulics

Some Progress Made in Multiscale Analysis, Multiscale Simulation and Multi-Scale Validation in Reactor Thermalhydraulics	1105
<i>D. Bestion, P. Fillion, C. Rabe, R. Pr�a, S. Mimouni, N. Merigoux</i>	
A Collocated Finite Volume Scheme with an Integral Formulation for Flows with Fluid Section Jumps	1117
<i>Cl�ment Colas, Martin Ferrand, Jean-Marc H�rard and Erwan Le Coupanec</i>	
Vapour Bubble Growth during Nucleate Boiling Accounting for Contact-Line Evaporation.....	1131
<i>Vinod Pandey, Guillaume Bois, and Vadim Nikolayev</i>	
Multidimensional SAM Equations with Volume Fraction Effects (Or Porosity) for Use in Pronghorn	1145
<i>Ray A. Berry</i>	

A CFD Investigation into the Dispersion of Radionuclides within the Street Canyon 1155
Junjie Cai and Jiyun Zhao

Toward an Innovative CFD-Based Upscaling Methodology to Elaborate Closures for the FLICA4 Subchannel Code 1166
Pierre-Emmanuel Angeli, Andr'e Bergeron, and Ulrich Bieder

Use of CFD Results to Model Heat Transfer in a Thin Metal Layer 1180
M. Peybernes, B. Bigot, and R. Le Tellier

Mechanical Evaluations to Define Possible Fuel Element Designs for the Conversion of FRM II 1194
Kaltrina Shehu, Julius Merz, Winfried Petry, Christian Reiter

Author Index

Subject Index