

Proceedings of the ASME

**TURBO EXPO 2020: TURBOMACHINERY TECHNICAL
CONFERENCE AND EXPOSITION
- 2020 -**

VOLUME 4B

COMBUSTION, FUELS, AND EMISSIONS

presented at

ASME TURBO EXPO 2020: TURBOMACHINERY TECHNICAL

CONFERENCE AND EXPOSITION

SEPTEMBER 21-25, 2020

ONLINE

sponsored by

INTERNATIONAL GAS TURBINE INSTITUTE, ASME

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Two Park Avenue * New York, NY. 10016

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.

Statement from By-Laws: The Society shall not be responsible for statements or opinions
Advanced in papers. . .or printed in its publications (7.1.3)

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY ASME FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

For authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, Tel: 978-750-8400

Requests for special permission or bulk reproduction should be addressed to permissions@asme.org.

ISBN NO. 978-0-7918-8413-3

© 2020 ASME

All rights reserved.

Printed in U.S.A with permission by Curran Associates, Inc. (2021)

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

CONTENTS

GT 2020

COMBUSTION, FUELS, AND EMISSIONS

GT2020-15230	V04BT04A001
Significance of the Direct Excitation Mechanism for High-Frequency Response of Premixed Flames to Flow Oscillations <i>Vishal Acharya, Tim Lieuwen</i>	
GT2020-15231	V04BT04A002
Investigation of Spray Formation and Turbulent Droplet Transport in High Momentum Jet Stabilized Combustor Injection Systems <i>Dominik Schafer, Fabian Hampp, Oliver Lammel, Manfred Aigner</i>	
GT2020-15244	V04BT04A003
Experimental and Numerical Comparison of Non-Reacting Flow Formation From a 7-Point Lean Direct Injector Array <i>Tyler Capil, Francisco Guzman, Kathleen Tacina, Yolanda Hicks</i>	
GT2020-15274	V04BT04A004
Generating Laminar Flame Speed Libraries for Autoignition Conditions <i>Karthik V. Puduppakkam, Abhijit U. Modak, Cheng Wang, Devin Hodgson, Chitralkumar V. Naik, Ellen Meeks</i>	
GT2020-15294	V04BT04A005
Hydrogen Enrichment Impact on Gas Turbine Combustion Characteristics <i>Bassam S. Mohammad, Keith McManus, Anthony Brand, Ahmed M. Elkady, Daniel Cuppoletti</i>	
GT2020-15302	V04BT04A006
Investigating Boundary Layer Flashback of a High Turbulence Intensity Jet Flame at Gas Turbine Conditions <i>Nicolas Auwajjan, Vincent McDonell</i>	
GT2020-15304	V04BT04A007
Impact of Secondary Air Flow on Combustor Emissions <i>Bassam S. Mohammad, Brian Volk, Keith McManus</i>	
GT2020-15354	V04BT04A008
Protection and Identification of Thermoacoustic Azimuthal Modes <i>G. Ghirardo, F. Gant, F. Boudy, M. R. Bothien</i>	

GT2020-15356	V04BT04A009
Intermittency, Secondary Bifurcation and Mixed-Mode Oscillations in a Swirl-Stabilized Annular Combustor: Experiments and Modeling	
<i>Samarjeet Singh, Amitesh Roy, K. V. Reeja, Asalatha Nair, Swetaprovo Chaudhuri, R. I. Sujith</i>	
GT2020-15360	V04BT04A010
Aerodynamic Investigation of Guide Vane Configurations Downstream a Rotating Detonation Combustor	
<i>Majid Asli, Panagiotis Stathopoulos, Christian Oliver Paschereit</i>	
GT2020-15432	V04BT04A011
Numerical Modelling of NOx Emissions and Flame Stabilization Mechanisms in Gas Turbine Burners Operating With Hydrogen and Hydrogen-Methane Blends	
<i>Roberto Meloni, Matteo Cerutti, Alessandro Zucca, Maurizio Mazzoni</i>	
GT2020-15434	V04BT04A012
Ignition Probability and Lean Ignition Behaviour of a Swirled Premixed Bluff Body Stabilised Annular Combustor	
<i>Roberto Ciardiello, Rohit S. Pathania, Patton M. Allison, Pedro M. de Oliveira, Epaminondas Mastorakos</i>	
GT2020-15460	V04BT04A013
Soot Emission Simulations of a Single Sector Model Combustor Using Incompletely Stirred Reactor Network Modeling	
<i>Savvas Gkantonas, Jenna M. Foale, Andrea Giusti, Epaminondas Mastorakos</i>	
GT2020-15496	V04BT04A014
The Impact of Exceptional Points on the Reliability of Thermoacoustic Stability Analysis	
<i>Felicitas Schafer, Shuai Guo, Wolfgang Polifke</i>	
GT2020-15527	V04BT04A015
Laminar Flame Speed Measurements of Kerosene-Based Fuels Accounting for Uncertainties in Mixture Average Molecular Weight	
<i>Charles L. Keesee, Bing Guo, Eric L. Petersen</i>	
GT2020-15556	V04BT04A016
Experimental Investigation of the Impact of Biogas on a 3 kW Micro Gas Turbine FLOX(R)-Based Combustor	
<i>Hannah Seliger-Ost, Peter Kutne, Jan Zanger, Manfred Aigner</i>	
GT2020-15559	V04BT04A017
Impact of Soot Radiative Properties, Pressure and Soot Volume Fraction on Radiative Heat Transfer in Turbulent Sooty Flames	
<i>Kevin Torres Monclard, Olivier Gicquel, Ronan Vicquelin</i>	

GT2020-15612	V04BT04A018
Evaluation and Validation of Two-Phase Flow Numerical Simulations Applied to an Aeronautical Injector Using a Lagrangian Approach <i>Julien Tillou, Julien Leparoux, Jerome Dombard, Eleonore Riber, Benedicte Cuenot</i>	
GT2020-15618	V04BT04A019
Optimisation of CO Turndown for an Axially Staged Gas Turbine Combustor <i>Jacob E. Rivera, Robert L. Gordon, Mohsen Talei, Gilles Bourque</i>	
GT2020-15676	V04BT04A020
Application of a Convolutional Neural Network for Wave Mode Identification in a Rotating Detonation Combustor Using High-Speed Imaging <i>Kristyn B. Johnson, Donald H. Ferguson, Robert S. Tempke, Andrew C. Nix</i>	
GT2020-15681	V04BT04A021
CO and OH Imaging in Flames Using a Single Broadband Femtosecond Laser Pulse <i>Pradeep Parajuli, Ayush Jain, Waruna D. Kulatilaka</i>	
GT2020-15691	V04BT04A022
Atomization of High Viscosity Liquids Using a Two-Fluid Counterflow Nozzle: Experiments and Modeling <i>Roshan Rangarajan, Hongyuan Zhang, Paul J. Strykowski, Alison Hoxie, Suo Yang, Vinod Srinivasan</i>	
GT2020-15697	V04BT04A023
Analysis of Autoignition Chemistry in Aero-derivative Premixers at Engine Conditions <i>Sandeep Jella, Gilles Bourque, Pierre Gauthier, Philippe Versailles, Jeffrey Bergthorson, Ji-Woong Park, Tianfeng Lu, Snehashish Panigrahy, Henry Curran</i>	
GT2020-15760	V04BT04A024
Partial Premixing Effects on the Reacting Jet of a High Pressure Axially Staged Combustor <i>Tommy Genova Jr., Michelle Otero, Jonathan Reyes, Kareem Ahmed, Scott Martin</i>	
GT2020-15777	V04BT04A025
The Role of the Centerbody Wake on the Precessing Vortex Core Dynamics of a Swirl Nozzle <i>Arnab Mukherjee, Nishanth Muthichur, Chaitali More, Saarthak Gupta, Santosh Hemchandra</i>	
GT2020-15814	V04BT04A026
A Fully Non-Adiabatic Flamelet Generated Manifold Model for High Fidelity Modeling of Turbulent Combustion in Gas Turbine Like Conditions <i>Rakesh Yadav, Ishan Verma, Abhijit Modak, Shaoping Li</i>	
GT2020-15826	V04BT04A027
Ignition Studies of C1-C7 Natural Gas Blends at Gas-Turbine Relevant Conditions <i>Amrit Bikram Sahu, A. Abd El-Sabor Mohamed, Snehashish Panigrahy, Gilles Bourque, Henry Curran</i>	

GT2020-15863	V04BT04A028
A Novel Sensor for Improving Flame Stability of Gas Fired Gas Turbine by Continuously Monitoring Fuel Gas Quality <i>Patrice Flot, Alexis Duval, Mathias Digneton</i>	
GT2020-15939	V04BT04A029
Dynamics of Effusion Cooling Fluid in a Pressurized Swirl Combustor Flow <i>Aravind Chandh, Askar Kazbekov, Angie Zhang, Subodh Adhikari, David Wu, Ben Emerson, Reza Rezvani, William Proscia, Tim Lieuwen, Adam Steinberg</i>	
GT2020-15982	V04BT04A030
Numerical Investigation of Dump Diffuser Combustor Performance at Uniform and Non-Uniform Inlet Conditions <i>Heyu Wang, Kai Hong Luo</i>	
GT2020-15985	V04BT04A031
Low-Order Modeling to Investigate Clusters of ITA Modes in Annular Combustors <i>Guillaume J. J. Fournier, Matthias Haeringer, Camilo F. Silva, Wolfgang Polifke</i>	
GT2020-16013	V04BT04A032
High Firing Temperature GT36 H-Class Low NO _x Combustor Engine Validation and Performance <i>V. Granet, P. Sierra Sanchez, A. Cuquel, P. Gunster, A. Wickstrom, D. Pennell, G. Singla, G. Fruchtel</i>	
GT2020-16037	V04BT04A033
Experimental Investigations of Superheated and Supercritical Injections of Liquid Fuels <i>Zhiyao Yin, Peter Kutne, Jochen Eichhorn, Wolfgang Meier</i>	
GT2020-16041	V04BT04A034
Effect of Hydrogen on Steady-State and Transient Combustion Instability Characteristics <i>John Strollo, Stephen Peluso, Jacqueline O'Connor</i>	
GT2020-16042	V04BT04A035
Quantification of Variation in Combustion Instability Amplitude in a Multi-Nozzle Can Combustor <i>Seth Westfall, Olivia Sekulich, Wyatt Culler, Stephen Peluso, Jacqueline O'Connor</i>	
GT2020-16044	V04BT04A036
Towards a Detailed Liquid Fuel Injection Model for Gas Turbine Combustor CFD <i>L. Wang, H. Ozogul, T. Kaushik, A. Bhat, S. Rida</i>	
GT2020-16051	V04BT04A037
Elimination of Numerical Damping in the Stability Analysis of Non-Compact Thermoacoustic Systems With Linearized Euler Equations <i>Thomas Hofmeister, Tobias Hummel, Frederik Berger, Noah Klarmann, Thomas Sattelmayer</i>	

GT2020-16061	V04BT04A038
Simulation of Premixed and Partially Premixed Jet-in-Crossflow Flames at High-Pressure <i>Bernhard Stiehl, Michelle Otero, Tommy Genova, Tyler Worthington, Jonathan Reyes, Kareem Ahmed, Scott Martin, Carlos Velez</i>	
GT2020-16066	V04BT04A039
Low DP FlameSheet(TM) Extended Validation of a Flexible, Low Emissions, Higher Output and Efficiency F-Class Turbine Upgrade <i>Hany Rizkalla, Timothy Hui, Fred Hernandez, Matthew Yaquinto, Ramesh KeshavaBhattu</i>	
GT2020-16073	V04BT04A040
Smart Passive Control of Thermoacoustic Instability in a Bluff-Body Stabilized Combustor: A Lagrangian Analysis of Critical Structures <i>C. P. Premchand, Manikandan Raghunathan, Midhun Raghunath, K. V. Reeja, R. I. Sujith, Vineeth Nair</i>	
GT2020-16078	V04BT04A041
A Strategy to Tune Acoustic Terminations of Single-Can Test-Rigs to Mimic Thermoacoustic Behavior of a Full Engine <i>Matthias Haeringer, Guillaume J. J. Fournier, Max Meindl, Wolfgang Polifke</i>	
GT2020-16081	V04BT04A042
Numerical Studies of Novel Aero Engine Secondary Combustors for Low-NOx Emissions <i>Andrew Rolt, Victor Martinez Bueno, Mirko Romanelli, Xiaoxiao Sun, Pierre Gauthier, Vishal Sethi, Cesar Celis</i>	
GT2020-16083	V04BT04A043
Experimental and Kinetic Evaluation of Pressurized Lean Premixed Hydrogen-Air Flame Stability With Carbon Dioxide and Steam Dilution <i>Jon Runyon, Daniel Pugh, Anthony Giles, Burak Goktepe, Philip Bowen, Richard Marsh, Steven Morris</i>	
GT2020-16086	V04BT04A044
Advanced Automated GT26 Combustion Tuning for Increased Operational Flexibility and Performance <i>G. Singla, B. Delatti, A. Scarpato, J. Barracas, W. Wang, N. Demougeot</i>	
GT2020-16091	V04BT04A045
Effect of an Azimuthal Mean Flow on the Structure and Stability of Thermoacoustic Modes in an Annular Combustor Model With Electroacoustic Feedback <i>Sylvain C. Humbert, Jonas P. Moeck, Alessandro Orchini, Christian Oliver Paschereit</i>	
GT2020-16092	V04BT04A046
Effect of Different Fuels on Combustion Instabilities in an Annular Combustor <i>Preethi Rajendram Soundararajan, Guillaume Vignat, Daniel Durox, Antoine Renaud, Sebastien Candel</i>	

GT2020-16099	V04BT04A047
Development of a Multi-Phase Flamelet Generated Manifold for Spray Combustion Simulations <i>Xu Zhang, Ran Yi, C. P. Chen</i>	
GT2020-16100	V04BT04A048
Soot Emission Optimization of a Helicopter Engine: From Injector Design to Engine Tests Validation <i>Patrick Duchaine, Quentin Bouyssou, Stephane Pascaud, Gorka Exilard, Christophe Viguer</i>	
GT2020-16105	V04BT04A049
Experimental and Numerical Investigation of Ultra-Wet Methane Combustion Technique for Power Generation <i>Kai Zhang, Simeon Dybe, Yazhou Shen, Sebastian Schimek, Christian Oliver Paschereit, Christophe Duwig</i>	
GT2020-16107	V04BT04A050
4D Measurements and Analysis of Heat Release Rate in a Model Gas Turbine Combustor <i>Rongxiao Dong, Qingchun Lei, Yeqing Chi, Qun Zhang, Wei Fan</i>	
GT2020-16130	V04BT04A051
Identification of High-Frequency Transverse Acoustic Modes in Multi-Nozzle Can Combustors <i>J. Kim, W. Gillman, D. Wu, B. Emerson, V. Acharya, R. Mckinney, T. Lieuwen, M. Isono, T. Saitoh</i>	
GT2020-16132	V04BT04A052
An Optimized Correlation for Turbulent Flame Speed for C1-C3 Fuels at Engines-Relevant Conditions <i>Eoin M. Burke, Sajjad Yousefian, Felix Guthe, Rory F. D. Monaghan</i>	
GT2020-16158	V04BT04A053
Acoustic Energy Balance During the Onset, Growth and Saturation of Thermoacoustic Instabilities <i>R. Gaudron, D. Yang, A. S. Morgans</i>	
GT2020-16169	V04BT04A054
Lean Operation of a Pulse Detonation Combustor by Fuel Stratification <i>Fabian E. Habicht, Fatma C. Yucel, Niclas Hanraths, Neda Djordjevic, Christian Oliver Paschereit</i>	
GT2020-16172	V04BT04A055
Finding the Best Architecture of an Artificial Neural Network to Model Prefilming Airblast Atomization: Not So Deep Learning <i>G. Chaussonnet, S. Gepperth, S. Holz, R. Koch, H.-J. Bauer</i>	

GT2020-16192	V04BT04A056
The Effect of the Degree of Premixedness on Self-Excited Combustion Instability <i>Adam Howie, Daniel Doleiden, Stephen Peluso, Jacqueline O'Connor</i>	
GT2020-16197	V04BT04A057
Large-Eddy Simulation of Flame Dynamics During the Ignition of a Swirling Injector Unit and Comparison With Experiments <i>Karl Topperwien, Felix Collin-Bastiani, Eleonore Riber, Benedicte Cuenot, Guillaume Vignat, Kevin Prieur, Daniel Durox, Sebastien Candell, Ronan Vicquelin</i>	
GT2020-16210	V04BT04A058
Investigation of the Fuel Distribution in a Shockless Explosion Combustor <i>Fatma Cansu Yucel, Fabian Habicht, Alexander Jaeschke, Finn Luckoff, Kilian Oberleithner, Christian Oliver Paschereit</i>	
GT2020-16213	V04BT04A059
Wall Temperature Measurements in a Full Scale Gas Turbine Combustor Test Rig With Fiber Coupled Phosphor Thermometry <i>Patrick Nau, Simon Gors, Christoph Arndt, Benjamin Witzel, Torsten Endres</i>	
GT2020-16222	V04BT04A060
Novel Desulfurization Concept Using a Regenerable Adsorbent <i>Matthieu Vierling, Frederic Geiger, Jean-Francois Brillhac, Sophie Dorge, David Habermacher, Habiba Nouali, Jean-Louis Guichard, Eric Marchal, Joel Patarin, Michel Soulard, Michel Moliere</i>	
GT2020-16230	V04BT04A061
Boundary Layer Flashback Limits of Hydrogen-Methane-Air Flames in a Generic Swirl Burner at Gas Turbine Relevant Conditions <i>Dominik Ebi, Peter Jansohn</i>	
GT2020-16237	V04BT04A062
Experimental Investigation of a Radial Wave Engine Utilizing a Rotary Valved Pressure Gain Combustor <i>Pejman Akbari, Grant M. Brady, Brian C. Sell, Marc D. Polanka</i>	
GT2020-16238	V04BT04A063
Experimental and Numerical Characterization of a Novel Natural Gas Low NOx Burner in Gas Turbine Realistic Environment <i>Matteo Cerutti, Pier Carlo Nassini, Daniele Pampaloni, Antonio Andreini</i>	
GT2020-16243	V04BT04A064
Large Eddy Simulation of a Turbulent Spray Burner Using Thickened Flame Model and Adaptive Mesh Refinement <i>Aleksandra Rezchikova, Cedric Mehl, Scott Drennan, Olivier Colin</i>	

- GT2020-16257**..... **V04BT04A065**
A Stochastic Immersed Model of Breakup Characteristics in Dense Air Atomization
Flow Field
Tian Deng, Xingming Ren, Yaxuan Li
- GT2020-16282**..... **V04BT04A066**
Morphology and Dynamics of a Premixed Hydrogen-Methane-Air Jet Flame in Hot
Vitiated Turbulent Crossflow
R. Solana-Perez, L. Miniero, S. Shcherbanev, M. Bothien, N. Noiray
- GT2020-16302**..... **V04BT04A067**
Prompt Atomization Mechanism of the Tangentially Injected Prefilming (TIP) LDI
Injector
Yuwei Wang, Xiao Han, Yuzhen Lin
- GT2020-16305**..... **V04BT04A068**
Numerical Modeling of Gaseous Partially Premixed Low-Swirl Lifted Flame at
Elevated Pressure
*Leonardo Langone, Julia Sedlmaier, Pier Carlo Nassini, Lorenzo Mazzei, Stefan Harth,
Antonio Andreini*
- GT2020-16328**..... **V04BT04A069**
30 Years of Dry Low NO_x Micromix Combustor Research for Hydrogen-Rich Fuels:
An Overview of Past and Present Activities
Harald H.-W. Funke, Nils Beckman, Jan Keinz, Atsushi Horikawa