

# **International Energy Conversion Engineering Conference 2018**

Held at the AIAA Propulsion and Energy Forum 2018

Cincinnati, Ohio, USA  
9 - 11 July 2018

ISBN: 978-1-5108-6899-1

**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.**

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 34922 Uwytkug'Xcmg{'Ftkxg.'Uwky'422, Reston, VA 20191, USA.

# TABLE OF CONTENTS

## **ECD-01: SOLAR, MHD, AND PIEZOELECTRIC ENERGY CONVERSION**

<b>Direct Power Extraction with MHD: Status of Numeric Models and Experimental Validation (AIAA 2018-4403)</b> .....	1
<i>George A. Richards, Rigel Woodside, Clinton Bedick, David Huckaby, Danylo Oryshchyn, Nate Weiland, Jason Hissam, Hyoungkeun Kim, Darren Mollot</i>	
<b>Numerical Study on Influences of Radiative De-excitation on Seed-Free Magnetohydrodynamic Generator (AIAA 2018-4404)</b> .....	13
<i>Takayasu Fujino, Soshi Ito, Yoshihiro Okuno</i>	
<b>On the Thermal Cyclic Precipitation of Aqueous Solutions for Heat Powered Cycles in Space (AIAA 2018-4406)</b> .....	29
<i>Francisco J. Arias</i>	

## **EERE-01: ADVANCEMENTS IN PYROLYSIS AND COMBUSTION FOR ENERGY**

<b>In-situ Characterization of Surface Components During Cellulose Pyrolysis (AIAA 2018-4412)</b> .....	32
<i>Kiran Raj Goud Burra, Ashwani K. Gupta</i>	
<b>Alumina Reduction by Laser Ablation Using a Continuous-Wave CO<sub>2</sub> Laser Toward Aluminum Energy Cycle (AIAA 2018-4413)</b> .....	40
<i>Seiya Tanaka, Shin Yamada, Kimiya Komurasaki, Makoto Matsui, Hiroyuki Koizumi, Rei Kawashima</i>	
<b>A Data-driven Situational Awareness Approach to Monitoring Campus-wide Power Consumption (AIAA 2018-4414)</b> .....	50
<i>Haoyun Fu, Styliani Kampezidou, WoongJe Sung, Scott Duncan, Dimitri N. Mavris</i>	
<b>Energy Performance of Smart Built Environment: Holistic Approach (AIAA 2018-4415)</b> .....	61
<i>Essam E. Khalil, Emil S. Bendas</i>	

## **TM-01: THERMAL SYSTEM APPLICATIONS AND UNIQUE ENVIRONMENT I**

<b>A Cryogenic Palletized High Energy Pulse System (AIAA 2018-4487)</b> .....	67
<i>Nathan J. Butt, Mitch Wolff, Rory A. Roberts, Scott Thomas</i>	
<b>A Method of Attaining High Pressurized Vessels in Space, the Moon and With Particular Reference to Mars (AIAA 2018-4488)</b> .....	79
<i>Francisco J. Arias</i>	
<b>Transient Temperature Effects on a High Energy Pulse System Model (AIAA 2018-4489)</b> .....	85
<i>Nathan J. Butt, Mitch Wolff, Rory A. Roberts, Soumya Patnaik</i>	
<b>Thermal Assessment of Paraffin Phase Change Material Mini-Packs on IceCube 3U CubeSat in Flight (AIAA 2018-4490)</b> .....	96
<i>Michael K. Choi</i>	

## **APS-01: SOLAR ARRAYS, LITHIUM-ION BATTERIES AND NUCLEAR TECHNOLOGY APPLICATIONS IN SPACE POWER SYSTEMS**

<b>Spacecraft Li-Ion Battery Power System State-of-Practice: A Critical Review (AIAA 2018-4495)</b> .....	108
<i>Thomas P. Barrera, Margot L. Wasz</i>	
<b>Preliminary Design of the Solar Propulsive Interplanetary Re-supplier (SPrIntR) (AIAA 2018-4496)</b> .....	118
<i>Daniel B. White, Tyler J. Lanes, Paul W. Joiner, Drake A. Noel, Sarah L. Smallwood, Zachary D. Wood</i>	
<b>The Van Allen Probes Lithium Ion Battery Performance (AIAA 2018-4497)</b> .....	163
<i>Michael H. Butler</i>	

## **ECD-02: STIRLING ENERGY CONVERSION SYSTEMS**

<b>Dynamic Power Convertor Development for Radioisotope Power Systems at NASA Glenn Research Center (AIAA 2018-4498)</b> .....	176
<i>Salvatore M. Oriti, Scott D. Wilson</i>	
<b>NASA Low Power Stirling Convertor for Small Landers, Probes, and Rovers Operating in Darkness (AIAA 2018-4499)</b> .....	195
<i>Scott D. Wilson, Nicholas A. Schifer, Steve M. Geng, Lawrence B. Penswick, Michael R. Casciani, Terry V. Reid</i>	
<b>Design and Development of Test Rigs for Experimental Investigation of Flow Loss and Heat Transfer in a Stirling Engine Heater Head (AIAA 2018-4500)</b> .....	203
<i>Pawan K. Yadav, Songgang Qiu, Koji Yanaga</i>	
<b>Experimental Study of Stirling Engine Regenerator Efficiency and Pressure Loss (AIAA 2018-4501)</b> .....	217
<i>Koji Yanaga, Songgang Qiu, Pawan K. Yadav, Laura Solomon</i>	
<b>Theoretical Simulation, Design and Manufacture, and Experimental Evaluation of a Free Piston Stirling Engine (FPSE) Electric Generator (AIAA 2018-4502)</b> .....	228
<i>Jean Gerard de la Bat, Robert Dobson</i>	

## **TM-02: THERMAL SYSTEM APPLICATIONS AND UNIQUE ENVIRONMENT II**

<b>Evaporator Wick Structure to Improve Thermal Performance of Loop Thermosyphon (AIAA 2018-4579)</b> .....	248
<i>Minwoo Lee, Chanwoo Park</i>	
<b>Thermal-Fluid Transients in a High-Power Loop Heat Pipe with Attached Mass (AIAA 2018-4580)</b> .....	258
<i>Timothy Holman, Robert Baldauff, Dmitry Khrustalev</i>	
<b>Titanium-Water Heat Pipe Radiators for Kilowatt System Cooling Applications (AIAA 2018-4581)</b> .....	269
<i>Kuan-Lin Lee, William G. Anderson, Calin Tarau</i>	
<b>Analytical Modeling of Thermal-Fluid Oscillatory Behaviors in Loop Heat Pipe Operations (AIAA 2018-4582)</b> .....	280
<i>Triem T. Hoang, Robert Baldauff</i>	

## **APS-02: SPACE SYSTEMS POWER MANAGEMENT AND CONTROL**

<b>An Intelligent Autonomous Power Controller for the NASA Human Deep Space Gateway (AIAA 2018-4634)</b> .....	292
<i>Jeffrey Csank, James Soeder, Jeffrey Follo, Matthew Muscatello, Yu Hin Hau, Marc Carbone</i>	
<b>The SPACE Computer Code for Analyzing the International Space Station Electrical Power System: Past, Present, and Future (AIAA 2018-4635)</b> .....	303
<i>Sara Miller, Brandon T. Klefman, Steven Korn, Terrian Nowden, Ann M. Delleur, David McKissock</i>	
<b>Magnetic Traveling Waves Induced by Mini-Coils for Sweeping Dust of Mars Solar Arrays. (AIAA 2018-4636)</b> .....	323
<i>Francisco J. Arias, Salvador de las Heras</i>	

## **TM-03: THERMAL SYSTEM APPLICATIONS AND UNIQUE ENVIRONMENT III**

<b>Ultra-High-Temperature Ceramic Matrix Composites in Hybrid Rocket Propulsion Environment (AIAA 2018-4694)</b> .....	327
<i>Stefano Mungiguerra, Giuseppe D. Di Martino, Raffaele Savino, Luca Zoli, Diletta Sciti, Miguel A. Lagos</i>	
<b>Thermal Management Challenges in Turbo-Electric and Hybrid Electric Propulsion (AIAA 2018-4695)</b> .....	344
<i>Patrick McCluskey, Yonatan Saadon, Zhaoxi Yao, Jash Shah, John Kizito</i>	
<b>Transpiration Cooling Experiments on a CMC Wall Segment in a Supersonic Hot Gas Channel (AIAA 2018-4696)</b> .....	364
<i>Daniel Prokein, Christian Dittert, Hannah Böhrk, Jens von Wolfersdorf</i>	
<b>Investigation of Water Jet Break Up by Supersonic Rocket Exhaust (AIAA 2018-4697)</b> .....	381
<i>Hansen J. Jones, Vaibhav Rajora, Shyam K. Menon</i>	

<b>Experimental Investigation of LN<sub>2</sub> Convection and Boiling in Traditionally and Additively Manufactured Rocket Engine Cooling Channels (AIAA 2018-4698)</b> .....	397
<i>Armando Sandoval, Enrique Gutierrez, Javier Chaparro, Luz Bugarin, Jason Adams, Ahsan R. Choudhuri, John Melcher</i>	

## **EERE-02: WIND AND SOLAR ENERGY GENERATION**

<b>Numerical Study on Turbine Wakes in Wind Farms (AIAA 2018-4713)</b> .....	408
<i>Mahmoud F. Nofal, Samir S. Ayad, Wagih Elaskary, Ali Abelsalam, Osama Abdelatif</i>	
<b>Shaving Peak Demand Using Photovoltaics – Economic Analysis (AIAA 2018-4714)</b> .....	422
<i>Mohammad H. Naraghi, Vishal Shah</i>	
<b>Why the AIAA Should Advocate for GEO Space Solar Power (AIAA 2018-4715)</b> .....	436
<i>James M. Snead</i>	
<b>Maximum Power Tracking among Different Groups of Distributed Power Sources with Uniform Time/Voltage Distribution Control (AIAA 2018-4717)</b> .....	478
<i>Kasemsan Siri</i>	

## **TM-04: THERMAL SYSTEM APPLICATIONS AND UNIQUE ENVIRONMENT IV**

<b>Design of a Thermal Wind Tunnel for Impingement and Film Cooling Research (AIAA 2018-4792)</b> .....	491
<i>Sean C. Underwood, Ray Taghavi, Saeed Farokhi</i>	
<b>Optimization for the Mass Flow Rate Entering the Aircraft Cabin through Gasper Nozzles (AIAA 2018-4793)</b> .....	505
<i>Essam E. Khalil, Eslam AbdelGhany, Taher E. Mohamed, Alaa E. Mohamed</i>	
<b>Planning and Directing Thermal Vacuum (TVAC) Chamber Testing (AIAA 2018-4794)</b> .....	515
<i>Deborah Zakar, Robert Baldauff</i>	
<b>Experimental and Numerical Investigation of an Airfoil using Impingement and Film Cooling in a Thermal Wind Tunnel (AIAA 2018-4795)</b> .....	521
<i>Sean C. Underwood, Ray Taghavi, Saeed Farokhi</i>	

## **ECD-03: VARIOUS TOPICS IN ENERGY CONVERSION TECHNOLOGY**

<b>Organic Acid–Promoted Hydrolysis of Ammonia Borane under Strained Conditions (AIAA 2018-4800)</b> .....	538
<i>Taylor B. Groom, Michael P. Drolet, Jason Gabl, Timothee L. Pourpoint</i>	
<b>The Next Generation Controller for Dynamic Power Convertors in Support of the Radioisotope Power Systems Program at NASA Glenn Research Center (AIAA 2018-4801)</b> .....	549
<i>Gina M. Dugala</i>	
<b>Stability Limits of Methane/Oxygen Mixtures Diluted by N<sub>2</sub> and CO<sub>2</sub> Under Various Oxygen Contents (AIAA 2018-4802)</b> .....	563
<i>Xiaoyao Zhao, Baolu Shi, Guixing Wang, Wei Gao, Kang Ma, Junwei Li</i>	
<b>A Comparison of Energy Conversion Technologies for Space Nuclear Power Systems (AIAA 2018-4977)</b> .....	574
<i>Lee S. Mason</i>	

## **TM-05: HEAT TRANSFER AND TRANSPORT MODELING AND ANALYSIS**

<b>Validation of Heat Transfer Correlations in Line Chill-down Tests of Cryogenic Fluid in SINDA/FLUINT (AIAA 2018-4884)</b> .....	584
<i>Barbara A. Sakowski, Daniel M. Hauser, Jason W. Hartwig, M. Kassemi</i>	
<b>Elements of an Advanced and Smart HEX Software Tool (AIAA 2018-4885)</b> .....	628
<i>Foluso Ladeinde, Ken Alabi, Wenhai Li</i>	
<b>Effects of Exit Fan Angle on the Heat Transfer Performance of Sweeping Jet Impingement (AIAA 2018-4886)</b> .....	651
<i>Mohammad Arif Hossain, Lucas Agricola, Ali Ameri, James W. Gregory, Jeffrey P. Bons</i>	
<b>Numerical Simulation of Transient Air Flow in a Large Scale High Density Data Centers (AIAA 2018-4887)</b> .....	670
<i>Essam E. Khalil, Yousri E. AbdelRahman, Waleed Abdelmaksoud, Esmail E. ElBialy</i>	

**SNPS-01: SPACE NUCLEAR POWER SYSTEMS**

**The Kilopower Reactor Using Stirling Technology (KRUSTY) Nuclear Ground Test Results and Lessons Learned (AIAA 2018-4973)**..... 681  
*Marc A. Gibson, David I. Poston, Patrick McClure, Thomas Godfroy, James Sanzi, Maxwell H. Briggs*

**Space Nuclear Power Systems - Direct Fusion Drive (AIAA 2018-4974)**..... 693  
*Michael Paluszek, Stephanie J. Thomas, Samuel A. Cohen, Eric Hinterman, Yukino Nagai, Lisa Peng, Audrey Walsh, Eric Ham, Gabriel Gaitan*

**Super-critical Carbon Dioxide Power Generation Systems for Space Exploration Applications (AIAA 2018-4975)** ..... 711  
*Margaret Mueller, Elliott Bryner, Daniel Dannelley*

**Author Index**