

An Organized Session in ICFD2009
November 4 in Sendai

Hybrid Rocket Propulsion and Related Fluid Dynamics

Organized by

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Overview:

In this session broad area of topics related to hybrid rocket propulsion and its internal fluid dynamics will be discussed. Hybrid rocket propulsion has received much attention as a propulsion system suitable for safe manned space transportation, but there are still several technical challenges in order for it to become fully operative. These technical challenges are 1) improvement of fuel regression rate, 2) better understanding of boundary-layer combustion, and 3) system optimization, etc. Among them, the first viewpoint is directly related to improvement of fuel contents and configuration of combustion chambers and covers topics such as WAX fuel, GAP fuel, oxidizer swirling injection, CAMUI (Cascaded Multistage Impinging-jet), gas-generator-type (gas hybrid), and so on. Fuels with higher regression rate and higher energy density are sought and so is configuration with higher energy feedback to fuel and with higher combustion efficiency for a combustion chamber. It should be underlined that the first viewpoint is closely related to the second viewpoint, which covers understanding of diffusion processes of oxidizer and fuel gas species in laminar or turbulent boundary layer, heat transfer to fuel surfaces, and fuel gasification determined from the surface thermal balance. The methodology of understanding these highly-coupled nonlinear phenomena itself is also a major research target. Scaling characteristics are also important field of research. The third viewpoint is technology area for optimizing systems and/or missions dealing with hybrid rocket characteristics such as fuel generation as a function of oxidizer mass flux, missions with throttling and shutdown-restart of the engine.

Keynote Lectures

13:00-13:40

KL-1) "Development of Throtttable Hybrid Rockets" by Daniele Barbagallo (ESA-ESRIN Frascati, Italy), Nicola Ierardo (AVIO SpA, Italy)

13:40-14:20

KL-2) "Roll Torque Prediction in SRM: a Numerical Approach" by F. Stella, M. Giangi (University of Rome "La Sapienza", Italy), D. Barbagallo, A. Scaccia (ESA-ESRIN Frascati, Italy)

(Break)

Regression Rate and Ablation

14:30-14:50

1) "Effect of Local O/F on Regression Rate of Solid Fuels in CAMUI Hybrid Rocket Motor" by Harunori Nagata, Kenta Uejima, Shunsuke Hagiwara, Masashi Wakita, Tsuyoshi Totani (Hokkaido University,

Japan), and Tsutomu Uematsu (Camuispaceworks Co., Ltd., Japan)

14:50-15:10

- 2) “Study on the Regression Rate of Some Hybrid Rocket Fuels” by Ichiro Nakagawa and Satoshi Hikone (Tokai University, Japan)

15:10-15:30

- 3) “Application of Temperature-Sensitive Paint to Heat Flux Measurement in High Temperature Gas flow” by Seungwon Ha, Ryosuke Sawamura, Hiroaki Sakamoto, Daiju Numata, Hiroki Nagai, and Keisuke Asai (Tohoku University, Japan)

15:30-15:50

- 4) “Charring Behavior within Thermal Protection Materials” by Masami Tomita, Mitsunobu Kuribayashi (Nagoya University, Japan), Keiichi Okuyama (Aichi University of Technology, Japan), Toshiyuki Suzuki, Kazuhisa Fujita (IAT/JAXA, Japan), Sumio Kato (University of the Ryukyus, Japan), Kazutaka Kitagawa (Aichi Institute of Technology, Japan), Kenichi Hirai (IHI Aerospace, Co., Ltd., Japan) and Takeharu Sakai (Nagoya University, Japan)

(Break)

Simulation I

16:00-16:20

- 5) “Element Free Galerkin Modeling of Unsteady Convection Flow and Heat Transfer Past a Semi-Infinite Vertical Porous Moving Plate with Viscous Heating” by Prof. R. Bhargava (Department of Mathematics, IIT- Roorkee, India), Rajesh K. Sharma (Department of Mathematics, IIT- Roorkee, India), and I.V., Singh (Department of Mechanical Engineering, IIT-Roorkee, India)

16:20-16:40

- 6) “Numerical Study of VEGA Third Stage Re-Entry Phase” by F. Stella, M. Giangi (University of Rome “La Sapienza”, Italy), D. Barbagallo, A. Scaccia (ESA-ESRIN Frascati, Italy)

16:40-17:00

- 7) “Numerical Simulation on Unsteady Compressible Low-Speed Flow Using Preconditioning Method: Re Effects on Drag for 2D Cylinder” by Nobuyuki Tsuboi (Kyushu Institute of Technology, Japan), Katsuyoshi Fukiba (Muroran Institute of Technology, Japan), Toru Shimada (ISAS/JAXA, Japan)

17:00-17:20

- 8) “A Numerical Simulation Using Hyperbolic Tangent Approximation Model for Diffusion Combustion in a Laminar Boundary Layer on a Flat Plate” by Keiichi Ishiko, Vasily Novozhilov, and Toru Shimada (ISAS/JAXA, Japan).

(Break)

Simulation II

17:30-17:50

- 9) “Higher-Order Accurate Numerical Simulation of Swirling Flowfield in Combustion Chamber for Hybrid Rocket Engine” by Kazuki Yoshimura (Graduate student of Tohoku University, Japan) and Keisuke Sawada (Tohoku University, Japan)

17:50-18:10

- 10) “Reynolds Averaged Numerical Simulation for Swirling-Oxidizer-Type Hybrid Rocket Engine” Mikiro Motoe (Graduate student of Tokai University, Japan), Toru Shimada (ISAS/JAXA, Japan), Saburo Yuasa (Tokyo Metropolitan University, Japan), and Katumi Hiraoka (Tokai University, Japan)

18:10-18:30

- 11) “Quasi-1D Simulation of Hybrid Rocket Flow with a Fast Chemistry Non-premixed Flame Model” by Yuki Funami (Graduate student of The University of Tokyo, Japan) and Vasily Novozhilov, and Toru Shimada (ISAS/JAXA, Japan)