The Summer Undergraduate Research Fellowship (SURF) Symposium
7 August 2014
Purdue University, West Lafayette, Indiana, USA

Preliminary Testing of Plasma-Induced Combustion

A. T. Razi, C. Slabaugh, and R. Lucht
Department of Mechanical Engineering, Purdue University

ABSTRACT

Plasma-induced combustion (PIC) has been shown to improve the reliability, efficiency, and delay time of ignition in flight systems like augmentors and scramjets. These high-velocity systems are mostly used in military applications, and improvement may help commercial viability. To understand this chemical process, the concentration of radicals, particularly H radicals, must be tracked through the flame using laser diagnostics. This requires a steady source of plasma-assisted combustion to be secured and well-understood. A plasma torch flowing partially premixed air and methane was installed and successfully operated, and preliminary testing was carried out. Primarily it was observed that PIC created stable flames at equivalence ratios as low as 0.3, though under the same conditions the flame would not light without PIC even at an equivalence ratio of roughly 0.7. In addition, photos of the flame demonstrate the presence of CH radicals. A jump in current was observed at certain electrode voltages, at which the current would spike and heat transfer would increase. Turning off the plasma extinguished the flame immediately. These observations and others point to the potential of plasma to assist combustion. In addition, future laser experiments will benefit from the recorded procedure and documentation of the plasma torch installation and operation.

KEYWORDS
plasma-induced combustion, plasma torch, laser diagnostics, H atom imaging

REFERENCES

Combustion Science and Engineering, Inc. “Non-Equilibrium Plasma-Assisted Combustion-Efficiency Control in Vitiated Air.” *Small Business Technology Transfer (STTR) Program*, Phase I Proposal #F13A-T04-0134.

I. B. Matveev, Y. D. Korolev, O. B. Frants, N. V. Landl, “Glow-to-Spark Transitions in a Plasma System for Ignition and Combustion Control,” *IEEE Trans. Plasma Sci.*, vol. 39, no. 12, December 2011.

Harry, J. E. (2010) *Plasma, an Overview, in Introduction to Plasma Technology: Science, Engineering and Applications*, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. doi: 10.1002/9783527632169.ch1

Jacobsen, L., Carter, C., Jackson, T., Williams, S., Barnett, J., Tam, C., Baurle, R., Bivolaru, D., and Kuo, S., “Plasma-Assisted Ignition in Scramjets,” *Journal of Propulsion and Power*, Vol. 24, No. 4, July–August 2008.