INSTABILITIES OF SUPERSONIC COMBUSTION AT PLASMA-BASED FLAMEHOLDING*

S. Elliott[1] and S. B. Leonov[2]

Abstract: Two types of supersonic combustion instabilities identified in a $M = 2$ reacting flow at direct injection of gaseous hydrocarbon fuel and quasi-direct-current (Q-DC) plasma assistance have been considered: a global instability triggered by a mechanism of flow–combustion–plasma coupling and a fast instability of a thermoacoustic nature. The experiments were performed at SBR-50 supersonic combustion facility at variable conditions: pressure $P_0 = 1–4$ bar, temperature $T_0 = 300–750$ K, and fuel mass flow rate $\dot{m} = 1–8.5$ g/s. Diagnostics included pressure measurements, filtered fast camera imaging, schlieren visualization, and spectroscopic observations. The global instability develops with a characteristic time of about 10 ms and is related to the interaction of the combustion-based separation zone with the reflected shock wave (SW) and electric discharge. It is shown that this instability could be effectively controlled by electrical discharge power. The thermoacoustic instability is developed with a characteristic time less than 1 ms. The analysis of pressure data reveals a resonant acoustic wave presence in the combustion zone between the fuel injection ports and the test section diffuser.

Keywords: supersonic combustion; instability; plasma assistance; flow separation

DOI: 10.30826/CE22150302 **EDN:** HBILOP

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*This paper is based on the work that was presented at the 13th International Colloquium on Pulsed and Continuous Detonations (ICPCD), April 18–21, 2022, St. Petersburg, Russia.

[1]Institute for Flow Physics and Control, Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN 46556, USA

[2]Institute for Flow Physics and Control, Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN 46556, USA; Leonov.1@nd.edu

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Received January 29, 2022

Contributors

Elliott Skye (b. 1994) — PhD in aerospace engineering, research engineer, Institute for Flow Physics and Control, Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN 46556, USA

Leonov Sergey B. (b. 1958) — Doctor of Science in physics and mathematics, research professor, Institute for Flow Physics and Control, Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN 46556, USA; Leonov.1@nd.edu