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Hydrogen-Fueled Micro-Thermophotovoltaic Power Generator: Flame Regimes and Flame Stability

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Abstract : This work presents the optimum operational conditions for a hydrogen-based micro-scale power source, using a verified mathematical model including fluid dynamics and reaction kinetics. Thereafter the stable operational flame regime is pursued as a key factor in optimizing the design of micro-combustors. The results show that with increasing velocities, four H2 flame regimes develop in the micro-combustor, namely: 1) periodic ignition-extinction regime, 2) steady symmetric regime, 3) pulsating asymmetric regime, and 4) steady asymmetric regime. The first regime that appears in 0.8 m/s inlet velocity is a periodic ignition-extinction regime which is characterized by counter flows and tulip-shape flames. For flow velocity above 0.2 m/s, the flame shifts downstream, and the combustion regime switches to a steady symmetric flame where temperature increases considerably due to the increased rate of incoming energy. Further elevation in flow velocity up to 1 m/s leads to the pulsating asymmetric flame formation, which is associated with pulses in various flame properties such as temperature and species concentration. Further elevation in flow velocity up to 1 m/s leads to the pulsating asymmetric flame formation, which is associated with pulses in various flame properties such as temperature and species concentration. Ultimately, when the inlet velocity reached 1.2 m/s, the last regime was observed, and a steady asymmetric regime appeared.

Keywords : thermophotovoltaic generator, micro combustor, micro power generator, combustion regimes, flame dynamic
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