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CHEMICAL EFFICIENCY OF A CATALYTIC COMBUSTOR IN A TERMOELECTRIC GENERATOR

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Abstract

The increasing interest in the miniaturization of electromechanical devices and the resulting need for micropower generation (in the range of milliwatts to watts) have driven the development of microscale combustor. Since hydrocarbon fuels have a very high specific energy, miniaturized power supply devices with low weight and long duration have received an increasing interest as suitable alternative to common batteries. However, as the size decreases, effects of flame-wall interaction and the related heat losses become more significant in micro and meso-scale combustor compared to traditional systems. Moreover, reducing the flow residence time is also responsible of a decrease in the chemical efficiency of the micropower generation device. The catalytic combustor is particularly appealing for combustion stability and safety. Considering a meso-scale thermoelectric generator, operating temperatures lower than those typical of traditional combustion make the catalytic combustion more suitable for coupling with conventional thermoelectric modules, preventing the modules degradation.

In this work, two meso-scale thermoelectric generator configurations are developed and characterized. The generators consist of a catalytic combustor coupled with conventional thermoelectric modules (TE). The combustors are fueled with propane/air mixture at stoichiometric conditions and are filled with commercially available catalytic pellets of Alumina-Platinum (1 wt%) catalysts. The TE modules are positioned in a thermal chain with the catalytic combustor and the water-cooled heat sinks. The system is electrically characterized in different ranges of fuel flow rates at constant power and temperature conditions. The energetic characterization is performed considering the balance between power input (combustion) and power output (electrical power produced and dissipated power). Measuring water and gas flow rate and input/output temperature, ambient and wall temperature, the dissipated power components (water cooling, wall heat losses, exhaust gas) are evaluated. In order to obtain chemical efficiency, the exhaust gas composition is measured with FT-IR spectroscopy. The values of the chemical efficiency obtained in different experimental conditions are discussed in relation to the overall efficiency of the thermoelectric generators under study.