Development of a tubular-flame combustor for thermophotovoltaic power systems

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Abstract

A novel tubular combustor with a metal-oxide-deposited quartz emitter and a reversed tube is developed for application in a small thermophotovoltaic (TPV) power generation system. The tubular combustor employs asymmetrical injections of fuel and swirling air to enhance the fuel/air mixing in a short distance, and the resultant tubular flame provides an optimal thermal energy for the emitter. The tubular flame structures can be categorized into three modes: the double-layer flame, attached-wall flame, and strip flame. Only the attached-wall flame is preferable for application in a small scale TPV system. Experimental results indicate that the laboratory-made metal-oxide-deposited quartz tube has better performance than the conventional silicon carbide emitter. In addition, a reversed tube is implemented with the tubular combustor to redirect the hot product gas for reheating the tube wall. Therefore, the swirling flame is pushed back into the combustion chamber and leads to uniform illumination of the emitter. Consequently, the CO and NOx emissions are significantly reduced and the radiant intensity is increased as compared to that of the emitter without a reversed tube.

Keyword：Mesoscale combustor; metal oxide; porous medium; thermophotovoltaic (TPV); tubular flame