Super-adiabatic combustion in porous media with catalytic enhancement for thermoelectric power conversion

The combustion of ultra-lean fuel to air mixtures provides an efficient way to convert the chemical energy of hydrocarbons into useful power. Conventional burning techniques of a mixture have defined flammability limits beyond which a flame cannot self-propagate due to heat losses. Matrix stabilized porous medium combustion is an advanced technique in which a solid porous matrix within the combustion chamber accumulates heat from the hot gaseous products and preheats incoming reactants. This heat recirculation extends the standard flammability limits and allows the burning of ultra-lean fuel mixtures, conserving energy resources, or the burning of gases of low calorific value, utilizing otherwise wasted resources. The heat generated by the porous burner can be harvested with thermoelectric devices for a reliable method of generating electricity for portable electronic devices by the burning of otherwise noncombustible mixtures.

The design of the porous media burner, its assembly and testing are presented. Highly porous (~80% porosity) alumina foam was used as the central media and alumina honeycomb structure was used as an inlet for fuel and an outlet for byproducts of the methane-air combustion. The upstream and downstream honeycomb structures were designed with pore sizes smaller than the flame quenching distance, preventing the flame from propagating outside of the central section. Experimental results include measurements from thermocouples distributed throughout the burner and on each side of the thermoelectric module along with associated current, voltage and power outputs. Measurements of the burner with catalytic coating were obtained for stoichiometric and lean mixtures and compared to the results obtained from the catalytically inert matrix, showing the increase in overall efficiency for the combustion of fuel-lean mixtures.

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The public is welcome to attend.