abstract

Micro/meso combustion has several advantages over regular combustion in terms of scale, efficiency, enhanced heat and mass transfer, quick startup and shutdown, fuel utilization and carbon footprint. This study aims to analyze the effect of temperature on critical sooting equivalence ratio and precursor formation in a micro-flow reactor. The effect of temperature on the critical sooting equivalence ratio of propane/air mixture at atmospheric pressure with temperatures ranging from 750-1250°C was investigated using a micro-flow reactor with a controlled temperature profile of diameter 2.3mm, equivalence ratios of 1-13 and inlet flow rates of 10 and 100sccm. The effect of inert gas dilution was studied by adding 90sccm of nitrogen to 10sccm of propane/air to make a total flow rate of 100sccm. The gas species were collected at the end of the reactor using a gas chromatograph for further analysis. Soot was indicated by visually examining the reactor before and after combustion for traces of soot particles on the inside of the reactor. At 1000-1250°C carbon deposition/soot formation was observed inside the reactor at critical sooting equivalence ratios. At 750-950°C, no soot formation was observed despite operating at much higher equivalence ratio, i.e., up to 100. Adding nitrogen resulted in an increase in the critical sooting equivalence ratio. The wall temperature profiles were obtained with the help of a K-type thermocouple, to get an idea of the difference between the wall temperature provided with the resistive heater and the wall temperature with combustion inside the reactor. The temperature profiles were very similar in the case of 10sccm but markedly different in the other two cases for all the temperatures. These results indicate a trend that is not well-known or understood for sooting flames, i.e., decreasing temperature decreases soot formation. The reactor’s capability to examine the effect of temperature on the critical sooting equivalence ratio at different flow rates was successfully demonstrated.