

GAS PHASE COMBUSTION STUDIES OF FLAME RETARDANT POLYMERS IN THE MICROSCALE COMBUSTION CALORIMETER

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A microscale combustion calorimeter (MCC) was modified to measure carbon monoxide and carbon dioxide in the exhaust gases in order to study gas phase combustion chemistry of flame retardant polymers. The temperature of the MCC combustor was systematically reduced from the ASTM D7309 value for complete oxidation of hydrocarbon fuel gases ($900\pm 100^{\circ}\text{C}$) in order to effect incomplete combustion of flame retardant polymers during the 9-second residence time. A two-step reaction model with carbon monoxide as an intermediate species was used to calculate the extent of reaction from the oxygen depletion as a function of combustor temperature. From these data, global kinetic parameters for thermal oxidation of the pyrolysis gases in excess oxygen were obtained and used to calculate the chemical reaction time in the diffusion flame of an over-ventilated cone calorimeter. These chemical reaction times increased by orders of magnitude when halogens were present in the polymer backbone or as additives. When the computed chemical reaction times at flame temperatures exceeded the computed residence time of the gases in the diffusion zone of the flame, low combustion efficiency was observed in the cone calorimeter, suggesting a possible method for screening flame retardants for gas phase activity.