EFFECT OF MOISTURE ON FIRE RESPONSE OF POLYMERS

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ABSTRACT

A previous study of poly(arlyether-ether-ketone) (PEEK) showed that the ignitability of this high temperature engineering plastic is sensitive to the presence of absorbed moisture. The present research extends this work to include five other engineering plastics: polycarbonate (PC), polyoxymethylene (POM), polymethylmethacrylate (PMMA), polyphenylsulfone (PPSU) and polyhexamethyleneadipamide (PA66). Separate batches of each polymer were equilibrated in hot (80°C) water, 50% relative humidity at 20°C, or vacuum dried at 100°C and tested in a cone calorimeter at heat fluxes between 10 and 75 kW/m^2. These hygrothermally-conditioned samples were also examined by differential scanning calorimetry, thermogravimetric analysis, and microscale combustion calorimetry to determine the effect of moisture on the thermal, decomposition, and combustion properties. It was found that absorbed moisture did not change the thermal decomposition or ignition temperatures significantly, but was released as steam that formed microscopic surface bubbles at or above the softening (glass transition or melting) temperature of the polymer. The phase change from bound water to steam entrained in the polymer melt (foam) significantly reduced the ignition time compared to dry samples. Attempts were made to account for the moisture-sensitive ignition delay in terms of thermal properties and chemical processes governing ignition, and a numerical thermokinetic pyrolysis model.