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Effect of External Radiative Heat Flux on Combustion Characteristics of Rigid Polyurethane Foam under Piloted-Ignition and Radiative Auto-Ignition Modes

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Abstract : Rigid polyurethane foam (RPU) has been extensively applied in building insulation system, yet with high flammability for being easily ignited by high temperature spark or radiative heat flux from other flaming materials or surrounding building facade. Using a cone calorimeter by Fire Testing Technology and thermal couple tree, this study systematically investigated the effect of radiative heat flux on the ignition time and characteristic temperature distribution during RPU combustion under different heat fluxes gradient (12, 15, 20, 25, 30, 35, 40, 45, and 50 kW/m^2) with spark ignition/ignition by radiation. The ignition time decreases proportionally with increase of external heat flux, meanwhile increasing the external heat flux raises the peak heat release rate and impresses on the vertical temperature distribution greatly. The critical ignition heat flux is found to be 15 and 25 kW/m^2 for spark ignition and radiative ignition, respectively. Based on previous experienced ignition formula, a methodology to predict ignition times in both modes has been developed theoretically. By analyzing the heat transfer mechanism around the sample surroundings, both radiation from cone calorimeter and convection flow are considered and calculated theoretically. The experimental ignition times agree well with the theoretical ones in both radiative and convective conditions; however, the observed critical ignition heat flux is higher than the calculated one under piloted-ignition mode because the heat loss process, especially in lower heat flux radiation, is not considered in this developed methodology.

Keywords : rigid polyurethane foam, cone calorimeter, ignition time, external heat flux
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