Flame Spread on Black Poly(methyl methacrylate) in Corner Configuration

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Corner fires are much more hazardous than single wall fires because of radiative heat feedback between burning surfaces and longer flame heights associated with inhibited air entrainment. The Single Burning Item (SBI) test, a part of the Euroclass system, is a standardized test where the wall lining materials must be tested before commercialization; it uses a triangular 30 kW propane burner to expose the materials of interest mounted in a corner geometry. This study was focused on obtaining heat release rate (HRR), flame structure, and flame heat feedback to the solid surface in order to better understand the process of the flame spread in an SBI-like scenario.

The apparatus was constructed and multiple experiments were performed on black poly(methyl methacrylate) (PMMA), a material with well-known pyrolysis properties. Two 6×10^{-3} m thick sheets of PMMA with exposed surface of 50 cm x 146 cm were used. The identical panels were mounted at the right angle to create a plane of symmetry and thus facilitate collection and physical interpretation of the flame spread data. The HRR was measured using an advanced oxygen consumption calorimetry based on multipoint pressure differential and temperature measurements and taking into account moisture, and chemical makeup of the fuel. To study flame heat feedback, total incident heat flux was measured along one exposed wall using water-cooled Schmidt-Boelter heat flux gauges at seven different elevations and four different lateral positions from the corner at each elevation. A Digital Single-Lens Reflex (DSLR) camera with a modified sensor was used to collect high resolution images of the flame at 900 nm. Time-resolved soot emission and flame probability maps were obtained from these images.

This work provides a valuable dataset to understand buoyancy driven flame spread in corner configuration and will be used in the future for the development of an empirical flame heat feedback model. This model will be integrated with a pyrolysis solver, ThermaKin, to enable prediction of dynamics of fire growth in the corner fire scenario for an arbitrary polymeric solid.