Analysis of Sensitivity of Vertical Corner Flame Spread Dynamics to Uncertainties in the Model Input

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A semi-empirical model combining a first-principal pyrolysis sub-model with an empirical representation of flame heat feedback was developed to simulate flame spread in a vertical corner scenario similar to that of the standard Single Burning Item test. This model was applied to a range of materials including poly (methyl methacrylate) (PMMA), polyisocyanurate (PIR) foam, and oriented strand board (OSB). Overall, the model captured the flame spread dynamics with a reasonable degree of success, but it also had some notable deviations from the experimental data. The sensitivity of the semi-empirical model predictions to various input parameters was further examined in this work by quantifying a sensitivity coefficient for each input parameter. Based on the sensitivity analysis results, flame heat flux parameter uncertainty was estimated to have the largest impact on model predictions. The average HRR error for PMMA reduced from 33% to 11% after decreasing flame heat flux by its uncertainty (10%). For OSB, the simulations with increased flame heat flux, a consequence of a more radiative flame for OSB than PMMA, still underpredicted peak HRR. The discrepancy in OSB predictions were attributed to limitation of using the flame heat feedback model which was calibrated on PMMA data. This limitation can be overcome by calibrating the empirical heat feedback model for materials with different radiative fractions. A CFD model will be developed using the Fire Dynamics Simulator (FDS) to understand how FDS predictions compare with those provided by the semi-empirical flame spread model. Potentially, the CFD model will be used to obtain surrogate flame heat flux data from fires having different radiative fractions.