ABSTRACT

Flammability Properties and Radiant Fraction of FRT Wood Plastic Composites using Mass Loss Calorimeter under HRR Hood

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ABSTRACT

A special test arrangement was used to assess the flammability of 4 different wood plastic composites (WPC), most with fire retardants, all of which has a tendency to high smoke production leading to high radiant energy losses to the apparatus walls. The mass loss calorimeter (MLC) was modified to include a thermopile on the exhaust pipe stack to compensate for radiant energy losses to the wall (Figure 1) (Dietenberger, et. al.) A truncated conical electric heater provides a constant heat flux of up to 100 kW/m^2 onto the test specimen of up to 50 mm thick and a spark pilot igniter. Pure ethylene glycol and methanol for low flame radiant losses and the PMMA and solid polystyrene for high flame radiant losses supplanted the use of methane for calibrating the HRR using both thermopiles. Mass data was processed using a SG digital filter followed by an exponential filter so that the mass loss profile was synchronized the HRR in order to obtain an accurate effective heat of combustion (HOC) with time. Standard materials of methanol, ethylene glycol, PMMA and polystyrene have data listed by Tewarson for the radiant fraction of the chemical heat of combustion, whose values were used in calibration of the modified MLC for estimating radiant heat of combustion of unknown materials.

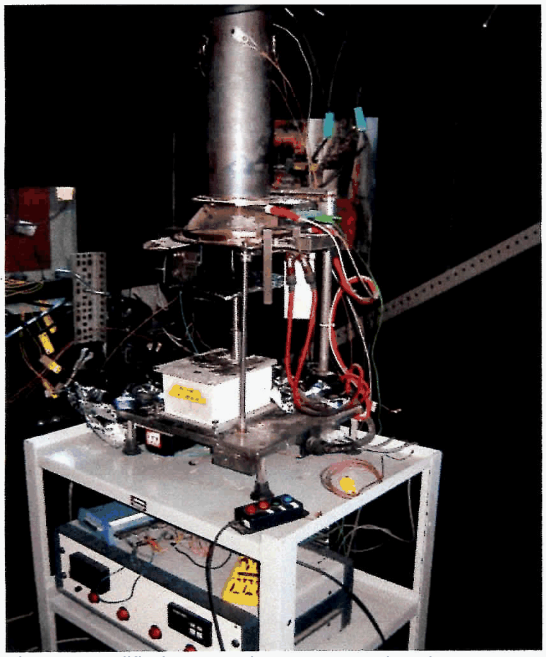

Figure 1 Modified MLC under FPL's HRR hood surrounded by radiant absorbing walls

The FPL HRR hood apparatus has been calibrated to provide the stoichiometric, chemical, radiant, and sensible heat of combustion as a function of time in which to provide indirect measures for radiant fraction associated with open flame as located under the HRR hood, The well-known properties of propane or methane pool fires and their simulation with FDS provided the verification of HRR hood apparatus calibration, particularly at lower HRR of that associated with MLC test specimen. A completely walled in hood, except for North side doorway, with high emissivity paint coating help achieved a higher accuracy to the radiant fraction measurements. This is in addition with the HRR hood's exhaust pipe instrumented with bidirectional velocity probe, pair of thermocouples, red laser smoke extinction, and extraction for gas analysis of O_2, CO_2, CO, and H_2O with time. Radiant fractions of HRR for methane, methanol, and propane open flames were comparable to the values listed by Tewarson.

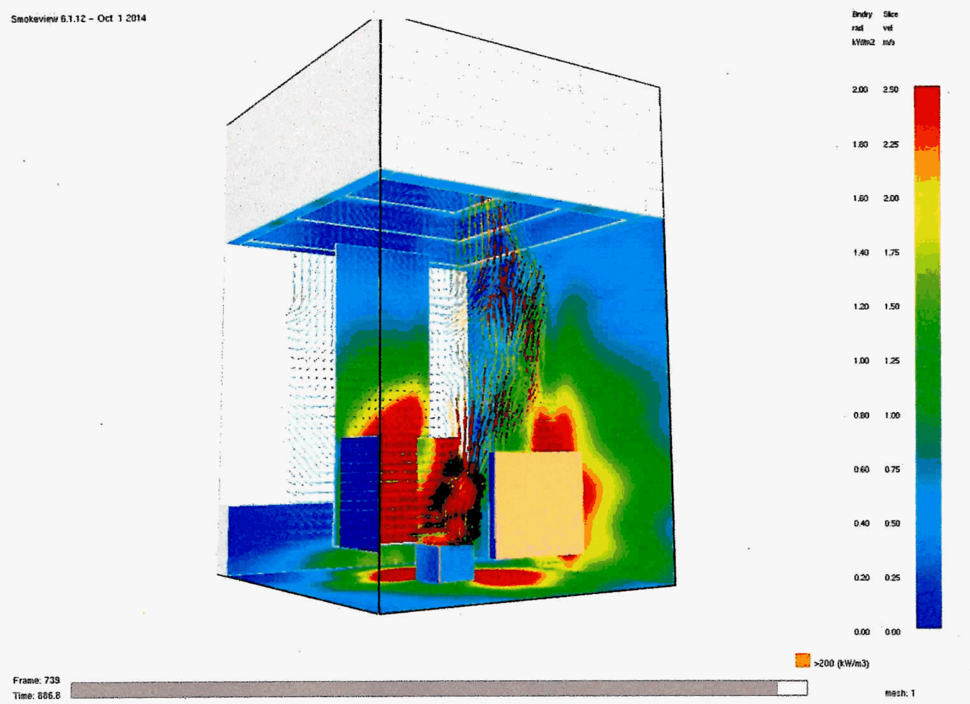

Figure 2 Propane pool fire under HRR hood with opened North wall with FDS rendition of flows and radiant heatfluxes from 30% radiant fraction of HRR measured with advanced O2 consumption method corrected for CO2, CO, H2O and soot measurements

Wood-plastic composite (WPC) boards were manufactured at the Forest Products Laboratory. The base WPCs investigated consisted primarily of high-density polyethylene (HDPE) and wood flour (WF). The HDPE had a 5 melt flow index and was purchased from ExxonMobil (HD 6605.70, Houston, TX). American Wood Fibers supplied 40 mesh, mixed pine WF (AWF 4020, Schofield, WI). To maintain good composite surface characteristics, a lubricant was added to each composite. Struktol Company of America supplied the lubricant (TPW 113, Stow, OH). In addition, two fire retardant systems typical for use in WPCs were investigated: 1) 3:1 ratio of decabromodiphenyl oxide (Saytex 102E, Albemarle Corporation, Baton Rouge, LA) and antimony trioxide (BrightSun HB, China Antimony Chemicals Co., Ltd., Guangxi, China); and 2) ammonium polyphosphate (Exolit AP 422, Clariant Corporation, Charlotte, NC). WPCs without fire retardants had either 50% or 60% by weight WF, 5% lubricant, and the remainder HDPE. Composites with fire retardants incorporated 50% WF, 10% of the fire retardant, 5% lubricant and the remainder HDPE.

Test results with the modified MLC under the HRR hood were comparable with our previous cone calorimeter test results of the same WPC specimen at irradiance of 50 kW/m^2 (Stark, et. al.). We confirm that the addition of WF into PE dramatically improves the fire performance of PE. For example, incorporating 60% wood into PE lowered the peak HRR of PE by 76%. The average HRR decreased, relative to this WF/PE composite, between 19 and 39% when fire retardants were added. Reductions to the estimated radiant HOC were also noted, especially when the wood component was increased.

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