The Products of Thermal Decomposition in Intermediate Scale Testing

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Previous experimentation, Brockway et al(1994), indicate a point of "diminishing returns" in both the extinguishment time and acid gas levels produced for intermediate scale(1.28 m^3) tests employing a single Class B fuel(n-heptane). It was concluded that concentrations on the order of 140% of the cup burner extinguishing concentrations were necessary for optimum extinguishment performance (shortest extinguishment time and lowest hydrofluoric acid(HF) levels) and that concentration up to 160% of the cup burner extinguishing concentration resulted in no significant reduction to extinguishment time or peak HF levels. Discharge times were maintained at "approximately" ten seconds for all discharge scenarios. Phase I experimentation was performed, for a single Class B fuel(n-heptane) and single fire scenario(3.7 kW), to investigate the effects of increased agent concentration to 200% of the cup burner value. FC-3-1-10(CEA-410) was the only agent included for this study. Data was used to verify if in fact there is a point of "diminishing returns" and/or an optimum design concentration. Discharge times, extinguishment times, and HF levels were utilized to illustrate that similar performance was attainable at 120% of the cup burner extinguishing concentration as that gained at 200% of the cup burner value.

The second phase of this study investigated the effects of extinguishment time on HF levels for intermediate scale(1.28 m^3) testing employing a single Class B fuel(heptane) and multiple fire scenarios(0.1, 0.6, 1.7, and 3.7 kw). Two discharge scenarios, 9.50 and 3.25 seconds, at a single agent design concentration, were utilized to illustrate that reductions in peak HF levels ranging from 50 to 83% were possible for the various fire scenarios.

Phase III of this study incorporated data from two previous studies, Ferreira et al(1992) and Brockway et al(1994), to illustrate trends concerning peak HF levels vs.

extinguishment time and peak HF levels vs. energy density(kW/m^3). A correlation for "anticipated" HF levels was extrapolated as a possible tool for designers in evaluating the feasibility of CEA-410 for the protection of Class B commodity. The validity of this correlation was investigated for three previous studies; small scale(0.20 m^3), intermediate scale(56.0 m^3), and full scale(526 m^3), respectively.

All experimentation(Phase I, Phase II, and Phase III) was performed in a 1.28 m^3(45 ft^3) enclosure, referred to as the "box". The box was constructed of polycarbonate sheeting and reinforced with angle iron and has two ports which provided access to its interior. The enclosure was fitted with a ventilation system, to provide preburn and post burn purging of the volume, and discharge system consisting of an agent cylinder, piping, and interchangeable discharge nozzles. The weight of agent required to achieve a given enclosure concentration was calculated employing equation (1) of NFPA 2001 "Standard on Clean Agent Fire Extinguishing Systems -1996 ed." Cylinders were super pressurized with nitrogen to 360 psig to ensure complete agent discharge and homogeneity within the enclosure. A data acquisition system was included to monitor nozzle pressure, agent cylinder pressure, and enclosure pressure. Four stainless steel pans of dimensions 1.9 cm x 1.9 cm (0.75" x 0.75"), 4.5 cm x 4.5 cm(1.75" x 1.75"), 7.0 cm x 7.0 cm(2.75" x 2.75"), and 9.5 cm x 9.5 cm(3.75" x 3.75"), were used for the four test fires. Pans were calibrated with n-heptane and a cone calorimeter and found to have heat release rates of 0.1 kW, 0.6 kW, 1.7 kW, and 3.7 kW, respectively, following a one minute preburn. Pans were given a one minute preburn prior to discharge of the agent. All experiments were documented with a video camera and used to determine pan extinguishment times to within one tenth of a second. Products of decomposition were gained at flame extinguishment, following a thirty second mix period, with the use of "grab" gas sampling tubes. Previously employed "wet chemistry" techniques, found to be within $\pm$10% accuracy, were then followed to determine the actual acid gas(HF) concentrations of the test enclosure in parts per million(PPM) by volume. This method provided a single HF data point per experiment, considered to be the peak level. A 0.20 m x 0.31 m x 0.31 m(8" x 12" x 12") steel baffle was employed to shield the pans and mitigate against "flame blow off" during agent discharge.