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Book of Abstracts
November 2-5, 1998

Kellie Ann Beall, Editor

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Gaithersburg, Maryland 20899

United States Department of Commerce
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U.S. Department of Commerce
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Clean Agent Performance on Fires Exposed to an External Energy Source

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ABSTRACT

Work carried out over the last several years has shown that there can be a significant increase in the amount of agent required to extinguish and to prevent re-ignition of fires that are exposed to a continuous, external, energy source. This has implications regarding the NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems, which currently recommends that in the event of a Class C fire (i.e., fire involving electrical equipment) the power supply should be discontinued before or during agent discharge. In certain critical applications (e.g., remote telecommunications switching stations) disconnecting power, however, is neither an option nor desirable. The current work is aimed at developing a standard test device and method that will provide data necessary to address this situation.

Design concentrations for total flooding agents in NFPA 2001 are based on results from the cup burner testing device [1]. Briefly, a 24 to 29 mm diameter burning liquid pool is located within an 85 ± 2 mm diameter glass tube through which air flows from bottom to top at a rate ranging from 10 to as high as 60 L/min. Agent is added to the airstream in increasing increments until the fire is extinguished, and the agent concentration is calculated from the measured air and agent flow rates.

The approach taken in the current work has been to develop a variant of the cup burner that allows the test to be conducted with the fuel exposed to a source of external energy. In the case of a Class C fire, the Joule heating of the fuel by electrical energy constitutes the external energy source. In our first-generation, modified, cup burner [2], this Joule heating is approximated with radiant heating from an electric heater of the type used in the cone calorimeter. The cone heater was chosen because it is a highly stable, uniform, measurable, and repeatable energy source. A concentric outer glass tube is used to channel a nitrogen flow to protect the cone heater from products of combustion.

Previous work done at NIST with this burner examined the extinguishment of 25 mm diameter polymethylmethacrylate (PMMA) rods at external heat flux exposures of 0 to 40 kW/m^2 in increments of 10 kW/m^2. Six agents were evaluated: N_2; IG-541 (52% N_2, 40% AR, 8% CO_2); FC-3-1-10; FC-2-1-8; HFC-23 and HFC-227ea. At 10 kW/m^2 the average minimum extinguishing concentrations increased by a factor of 2 to 2.5 over that needed at zero radiant flux. As the imposed heat flux level was increased the amount of agent required for extinguishment increased asymptotically (Fig.1 is a typical result). At 40 kW/m^2 re-ignition occurred for all agents, except N_2, when the agent flow was terminated. In each case, however, re-establishing the flow and increasing the agent's concentration eventually produced inertion.

A second burner of the type used in the NIST study was built and was put into operation recently at 3M Company. Experiments to duplicate the PMMA results obtained with the NIST apparatus are underway. Polyethylene (PE) and Polyvinyl chloride (PVC) fuels also will be tested. These results and comparisons will be included in the presentation.

A second-generation, modified, cup burner (Fig. 2) was designed and is being fabricated at NIST. The inner tube has been extended 50 mm above the top face of the specimen to better conform to the original cup burner geometry and improve experimental control. The diameter of the inner tube is 85 mm, which is the diameter of the original cup burner. PE, PVC, and a phenolic laminate will be evaluated in the new unit using N_2, FC-2-1-8, and HFC-227ea. Results will be included in the presentation.

References

[1] ISO/DIS 14520, Part 1, General Requirements, Annex B (normative) - Gaseous Media Fire Extinguishing Systems "Determination of flame extinguishing concentration of gaseous extinguishants by the cupburner method", 30 March 1998.

[2] Smith, D.M., Kelly, A., Rivers, P.E., Braun, E., and Grosshandler, W.L., Energized Fire Performance of Clean Agents: Recent Developments, International Conference on Ozone Protection Technologies, Baltimore MD, November 13, 1997.

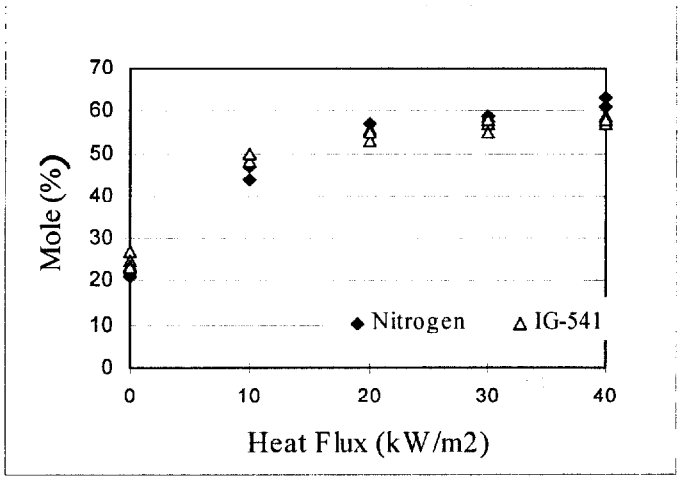

Fig. 1. Extinguishing Concentrations of Nitrogen and IG-541

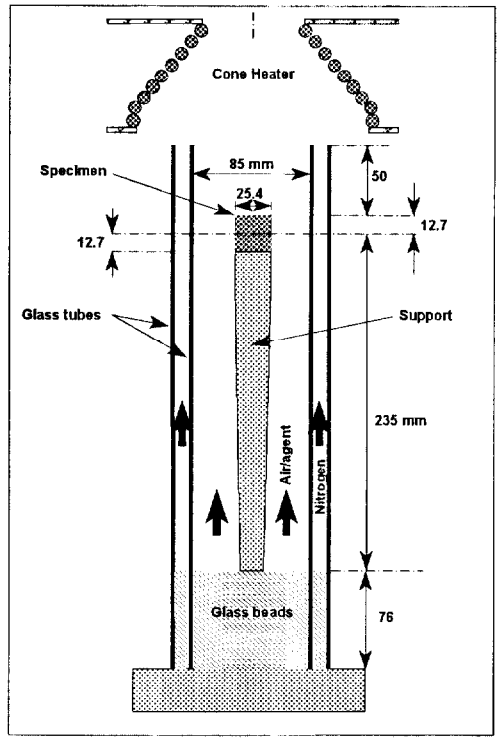

Fig. 2. Sketch of NIST second-generation, modified, cup burner.