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March 28, 2016

Executive Summary

Text for report Abstract.

Contents

Introduction

1 Background

2 Objectives and Technical Plan

2.1 Objectives

2.2 Technical Plan

This study consisted of the following tasks:

- Item 1
- Item 2

2.3 Limitation and Scope

3 Project Technical Panel

A general discription of the technical panel and the make up.

Figure 3.1: Positive Pressure Attack Technical Panel Member Locations

The individuals below provided direction for the project, assisting in planing the experiments, witnessing the testing and developing tactical considerations. Their tireless support and effort make this project relevant to the fire service across the world.

Table 3.1: Fire Service Technical Panel

Name	**Fire Department**
Name 1	Department 1
Name 2	Department 2

4 Previous Literature

4.1 Fire Service Publications

4.2 Fire Service Training Manuals

4.3 Firefighter Line of Duty Deaths

4.4 Research Work

5 Instrumentation

Throughout this project measurements were taking of temperature, heat flux, pressure, gas velocity and heat release rate. The same instrumentation was utilized for all three sets of experiments. The following describes the instrumentation used and potential uncertainty.

Heat flux measurements were made using a 2.54 cm nominal diameter water-cooled Schmidt- Boelter heat flux gauge (Figure 5.1). The gauges measured the combined radiative and convective heat flux. For these experiments, the dominant form of heat flux is radiative due to the distance of the heat flux gauges from the flames. It should be noted that the convective contribution to the heat flux is dependent upon the surface temperature of the heat flux gauge. The manufacturer gives an uncertainty of 3% and results from a study on heat flux calibration found the typical expanded uncertainty to be 8% [3].

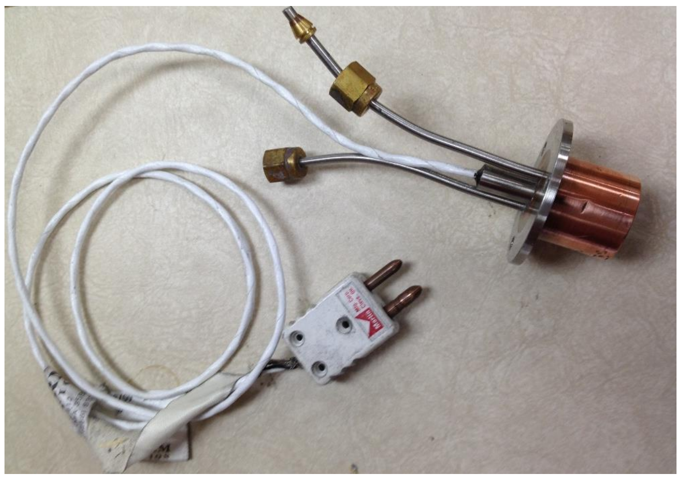

Figure 5.1: Water Cooled Schmidt-Boelter Heat Flux Gauge

Temperatures were recorded using a bare-bead, Chromel-Alumel (type K) thermocouple with a 0.5 mm nominal diameter (Figure 5.2). The uncertainty given by the manufacturer for the temperature measurements is 2.2 oC for temperatures below 293 oC and 0.75% for higher temperatures [4]. The thermocouple readings will be lower than the air temperature when the thermocouple is in the flame region, due to radiative losses to the surrounding cooler environment. When the thermocouples are farther from the flame region, the impact of radiation will result in temperature readings higher than the air temperature. Due to the effect of radiative heat transfer to the thermocouples, the expanded uncertainty is approximately 15%.

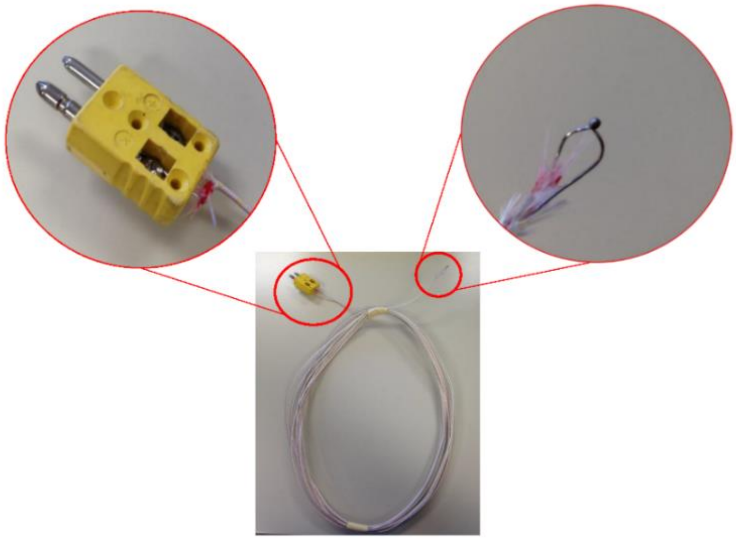

Figure 5.2: Chromel-Alumel (Type K) Thermocouple

Pressure was recorded through the use of a Setra Model 264 differential pressure transducer with a range of 0.5 Wc (124.5 Pa) (Figure 5.3). The transducer was used to evaluate the pressure difference from ambient pressure. The uncertainty given by the manufacture is 1% or 1.2 Pa [1].

Figure 5.3: Setra Model 264 Differential Pressure Transducer

Gas velocity was obtained through the use of a bi-directional probe in conjunction with a differential pressure transducer and iconel thermocouple. The probe was constructed of stainless steel. The iconel thermocouple was a 0.063in. diameter type KSL iconel 600 sheathed grounded junction with a type K, 24 gauge glass/glass insulation lead. The differential pressure transducer was a Setra Model 264 with a range of 1.0in. WC (248.8 Pa) CORRECT FOR ACTUAL RANGE. The configuration had a velocity range of 24.2 m/s (54 mph) CORRECT FOR ACTUAL RANGE. The pressure transducers were configured in groups of 6, contained in a single plastic box with connections for pressure, temperature and power

(Figure 5.4)b. Five probes were installed in openings where velocity measurements were taken, centered horizontally in the opening (Figure 5.4a). Velocity measurement with this configuration was determined to have an uncertainty of 5% [2].

(a) Pressure Transducer Box

(b) Bi-Directional Probe Array

Figure 5.4: Bi-Directional Probe

The heat release rate is measured through the use of oxygen consumption techniques. The oxygen consumption calorimeter is capable of accurately measuring the heat release rate up to 10 MW. Above 10 MW, larger inaccuracies are expected due to the combustion products overflowing the collection hood. Figure 5.5 shows the collection hood utilized for the calorimetry data.

Figure 5.5: Oxygen Consumption Calorimetry Hood

Stand video was obtained through the use of BoschVTC-206F03-4 video cameras (Figure 5.6). Thermal imaging of the front and rear of the structure was taken using ISG Infrasys Elite XR (Figure 5.7). The thermal imaging camera has a fixed emissivity value of 0.9 and was utilized for visual representation of relative conditions, no temperature measurements or analysis were derived using the camera. All cameras were recorded using a TriCaster 8200 video acquisition system.

Figure 5.6: Oxygen Consumption Calorimetry Hood

Figure 5.7: ISG Elite XR Fire Service Thermal Imaging Camera

Gas samples were analyzed through the use of OxyMat6 and UltraMat23 Siemens gas analyzers. Samples were pulled from the structure through the use of cole palmer model L-79200-30 vacuum/pressure diaphragm pump rated at 0.75CFM via a stainless steel tube. The sample is filtered through a course filter, solberg model 842, 2 micron paper filter before running through a condensing trap to remove moisture. The sample then runs through a drying tube dry fine filter, perma pure model FF-250-SG-2.5G with a 1micron filter FF-250-E-2.5G before splitting into two branches and entering the UltraMat and OxyMat analyzer. The analyzers are calibrated to measure CO from 0-50000PPM, CO2 from 0-20% and O_2 from 0-25%.

(a) Sample Line

(b) Vaccum Pump - Cole Palmber L-79200-30

(c) Course Filter - Solberg 842

(d) Condensing Tube

(e) Dririte Tube

(f) Fine Filter - Perma Pure FF-250-SG-2.5G

(g) Gas Analyzers

Figure 5.8: Gas Analyzer Configuration

All data was logged through the use of a national instruments data acquisition system incorporating a SCXI-1001 chassis with 8 SCXI-1102C 32-Channel modules (Figure 5.9). The system is configured for a total of 256 channels capable of reading values between 0-10 volts DC. Values are recorded once a second and translated to quantities of interest through the use of LabVIEW software specifically programmed for use with the system.

Figure 5.9: Data Acquisition System

6 Test Set Up

6.1 Structures

6.2 Measurement Locations

7 REMOVE IF NOT APPLICABLE - Heat Release Fuel Load Characterization

To characterize the foam furniture energy release rates, heat release rate burns were conducted under a cone calorimeter hood.

8 Task 1 Experiments

A discription of the experiments. Table 8.1 shows the experiments conducted.

Table 8.1: Table Caption

Item 1	Item 2	Item 3
Item 1	Item 2	Item 3

8.1 Experiment Task 1 Subsection 1

Experimetn Task 1 Subsection 1 Paragraph 1

9 Task 2 Experiments

A discription of the experiments. Table 9.1 shows the experiments conducted.

Table 9.1: Table Caption

Item 1	Item 2	Item 3
Item 1	Item 2	Item 3

Experiment 1

Experiment 1 Discription Figure 9.1 shows the configuration fo the structure, table 9.2 show at what times interventions were preformed and figures 9.2 shows images of the experiment at each of the intervention times. The results of experiment 1 can be found in Appendix A.

0_Images/FireExperiments/Single_Story/Experiment_1.jpg

Figure 9.1: Experiment 1 Ventilation Configuration

Table 9.2: Experiment 1 Interventions

Time	Intervention
Time 1	Event 1
Time 2	Event 2

(a) Event 1
(b) Event 2
(c) Event 3

Figure 9.2: Experiment 1 Images

(d) Event 4
(e) Event 5
(f) Event 6

Figure 9.1: Experiment 1 Images

10 Analysis

10.1 Analysis Subsection 1

Anaylsis Subsection 1 Paragraph 1

11 Future Research Needs

Discription of Future Reasearch Needed.

References

[1] *Installation Guide Setra Systems Model 265 Differential Pressure Transducer*. Boxboroguh, 2009. MA.

[2] L.A Lent and M.E. Schneider. "The Design and Application of Bi-Directional Velocity Probes for MEasurements in Large Pool Fires". In: *Instrument Society of America* 26.4 (1987), pp. 25–32.

[3] William M. Pitts et al. "Round Robbin Study of Total Heat Flux Gauge Calibration at Fire Laboratories." In: *Fire Safety Journal* 41.6 (2006), pp. 459–475.

[4] *The Temperature Handbook*. 7th ed. Omega Engineering, 2010.

Appendices

A Experimental Results

A Experiment 1 Results

Figure A.1: Experiment 1 - Chart Name

Figure A.2: Experiment 1 - Chart Name