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THE FIRE TEST FACILITY
AT ROCKY FLATS

-A STATUS REPORT-

W. E. Domning

CRDL 950371-6

April 8. 1970

Chemistry R & D

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CHEMISTRY RESEARCH AND DEVELOPMENT
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SUMMARY

A fire test facility has been constructed at Dow, Rocky Flats, consisting of a glovebox and a filter plenum containing 12 filters. The purpose of this facility is to study the effect of a fire originating within the glovebox and on entire glovebox system which includes the filter plenum.

The details of construction of the facility are shown and the results of several experiments are discussed to show the capability of the facility. Two of these experiments consisted of burning a full-scale glovebox. Air temperatures leaving the burning box were found to be between 1530 and 1620°F. A third experiment consisted of a test of a water spray-cooled baffle inserted in the filter plenum. This baffle was effective in cooling 1672°F incoming air to 125°F within one minute after actuation.

The objectives and brief outlines of future experiments to be done in the facility are also discussed.

INTRODUCTION

One of the conclusions drawn from the recent Dow, Rocky Flats fire was that sufficient data on fire suppression for glovebox-type facilities was not available. To fill this gap, a fire test facility has been constructed at Dow, Rocky Flats. This facility consists of a glovebox, testing building, filter plenum, and associated fan controls and instrumentation.

Considerable work has been conducted in the past on glovebox fires; however, the scope of the work has been limited to the glovebox and its contents, and the work can essentially be divided into two categories: evaluation of materials and evaluation of extinguishers. In previous work reported, the experiments considered neither the effects of air flow nor the effect of a fire on the protective filter system.

It is very important that the glovebox and filter be considered as a single system for fire protection. Figure 1 shows the interrelation of the components that make up a typical glovebox facility. A filter plenum and its filters should not be damaged as a result of fire fighting efforts, therefore the filters should not be exposed to either high temperature air or to water. It is apparent that plugging of the

Glovebox System

FIGURE 1

building exhaust filters from smoke would cause a loss of negative pressure within the building, and consequent spread of radioactive contamination. However, if the filters in the system serving the glovebox should plug, the results would not be serious since containment would still be effected by the surrounding building.

The fire test facility at Dow, Rocky Flats has been designed to study the interaction between the glovebox and the filter plenum as well as provide the designer and fire protection engineer with sufficient data to prove the fire safety of an installation.

DESCRIPTION OF FACILITY

Figure 2 shows a general view of the facility. A test glovebox, which can be shielded, is shown at the left of Figure 2, and Figures 3 and 4 illustrate the glovebox shielding configuration. The taller building is the burning test building and is constructed to simulate a "typical room" condition for a glovebox. The ceiling of the building is 12 feet high and the walls of the building, which act as heat reflectors, are approximately 4 feet from the exterior of the glovebox. The building on the right of Figure 2 is the test filter plenum. A fan, with a maximum capacity 10,500 CFM, is connected to the filter plenum.

To the rear of the burning building is a small instrument house. Three recorders provide 14 points of thermocouple readout. Pressure sensing instrumentation and electrical controls are also located nearby.

Figure 5 is a view of the filter plenum under construction. The inlet end of the plenum is a steel bulkhead to withstand the high temperature of the incoming air. The remainder of the plenum is covered with asbestos-cement board. All joints are battened and caulked to provide a leakproof

FIGURE 2

Fire Test Facility

FIGURE 3

Glovebox and Shielding
Arrangement - Straight Side

FIGURE 4

Glovebox and Shielding
Configuration - Sloped Side

FIGURE 5

Filter plenum under construction

structure. The floor of the plenum is made from road-mix gravel and is built-up about 1 foot from the ground-level to allow for water drainage.

A water spray-cooled baffle forms the inlet section of the plenum and two filter-holding frames divide the plenum into three additional sections.

A window and access door is installed in each section. High intensity flood lamps are mounted in the ceiling of the plenum to aid test viewing.

Figure 6 shows the partially completed water spray-cooled baffle. The baffle is made from 6-inch, 10.5 lb/ft channel iron members. The channels are staggered to form a tortuous path for the air. One of the two channel support members is movable and adjustment screws are provided to vary the distance between the toes of the channels. The present setting is such that the open area between the channels is equal to the filter face area. Figure 7, a close-up of the baffle construction, shows the adjustable space between the two portions of the baffle.

The channel members are easily removed so that an inlet pipe may be added to by-pass the baffle, and simulate existing plenum construction.

FIGURE 6

Partially finished baffle

FIGURE 7

Detail of baffle construction

Figure 8 shows the relationship between the upstream and downstream filter frames. Twelve 2' X 2' X 1' HEPA filters are installed in each frame.

The construction details of the filter-holding frame are shown in Figure 9. The upright members are made from 3-inch by 5-inch square structural tubing (CRS). The cross-members are made from 3-inch by 4-inch square structural tubing (CRS). Hold-down studs are fabricated from 5/8-inch 304 stainless steel rod. Filter supports are fabricated from 3-inch by 4-inch structural tee members. Hold-down bars, compressed by nuts on the stud furnish the pressure necessary to seal the filter to the frame.

A two-inch header pipe and valving is provided into each section for water supply. Additional branch piping is available for spray or sprinkler heads as desired. A water-flow meter and pressure gauges are available for calibration of nozzles.

FIGURE 8

Filter - holding frame

FIGURE 9

Detail of filter holding frame

DISCUSSION OF EXPERIMENTS PERFORMED

Two experiments have been performed relative to fire suppression in burning gloveboxes. Unfortunately, these experiments were performed before the filter plenum was constructed; therefore, experiments concerned with the interaction between the burning glovebox and filter system have not been carried out.

In each of the glovebox experiments performed, the air temperature inside the burning box was measured by thermocouples. A plot of the time-temperature relationship for the two glovebox experiments is shown in Figure 10. The importance of this data is that it shows the air temperature generated in a burning glovebox. These air temperatures set the conditions that must be countered for filter protection, since heat can cause loss of filter effectiveness.

A test has been made of the effectiveness of the water-sprayed baffle in reducing the incoming air temperature. In this particular test, 6000 CFM of incoming air was heated to 1672°F and contacted the baffle. The massive baffle structure acts as a heat sink as well as promoting turbulence in the upstream plenum section. Without the water spray on, an air film heat transfer coefficient of

FIGURE 10

$\frac{14.5 \text{ BTU}}{\text{Hr. ft}^2 \text{ } ^\circ\text{F}}$ was calculated. With the water spray on, at a rate of 80 GPM, the water-air heat transfer coefficient was calculated to be $31.3 \frac{\text{BTU}}{\text{Hr. ft}^2 \text{ } ^\circ\text{F}}$. Figure 11 shows air-temperature plotted as a function of time, with the spray actuated at time zero. The upstream temperature drops more rapidly because the thermocouples were in the spray field. The downstream air temperature dropped to 125°F in one minute; therefore, the water spray baffle appears to be a very effective method of filter protection.

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FIGURE 11

Performance of Water Spray-Cooled Baffle

FUTURE PLANS

A program for fire suppression within a glovebox system has been prepared and the objectives of the program are as follows:

1. Investigate the combustion characteristics of those materials normally found within a glovebox system.
2. Screen and test fire suppression agents and design systems for delivery of the agents.
3. Develop engineering recommendations for fire suppression systems which would be compatible with operations and materials occurring within glovebox systems.

The initial step in the program is to catalog the various combustible materials used for glovebox construction and those materials used within the glovebox system. Samples of the products of pyrolysis of these materials would be identified so that thermodynamic calculations might be used to indicate possible reactions during a fire. Also, from these data, appropriate fire suppression systems can be chosen. If small scale testing is successful, a final proof test using a full-scale glovebox and connected filter plenum would complete the evaluation for a suppression system. The results of the proof test would be used to

develop engineering recommendations for a specific suppression system.

Concurrent with the fire suppression program, a filter test program is proposed. The objectives of the filter test program are as follows:

1. Improve system design, fire protection, and testing methods.
2. Provide data for immediate modification to existing filter system.
3. Develop data for design of an "ideal" filtration system.

The major activities necessary to carry out this program are: Studies on fire intrusion and water damage to include further evaluation of the baffle and water spraying the filter face under fire conditions. A re-evaluation of the design of the components of the system to include number and location of stages, air flow distribution, and installation techniques for filters. Evaluation of in-place testing techniques for filter banks.

These tests will involve the conditions of air flow and particulate loading found to be "typical" at Dow, Rocky

Flats. This program would be readily adaptable to other air flows and particulate concentrations if desired.