DIFFERENT TYPE GLOVEBOX FILTERS USED
FOR PLUTONIUM-238 WORK AT MOUND LABORATORY

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ABSTRACT

A review is presented of the different type glove box filters that have been used with plutonium-238 glove boxes at Mound Laboratory. Three filter installation types are discussed: (1) box-type filter mounted inside a small housing on top of glove box, (2) cylindrical filter with 2-in. diameter threaded pipe at one end designed to screw into exhaust line inside glove box, and (3) dual cylindrical filters with molded rubber gaskets designed to fit inside a stainless steel or fiber glass tube below glove box. Each type filter installation is discussed in terms of filtration adequacy, sources of leaks, ease of filter change, contamination control problems during filter change, and interference with glove box operations.

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INTRODUCTION

Mound Laboratory, Miamisburg, Ohio, has over 10 years' experience in large-scale glove-box operations with plutonium-238. The relatively high specific activity of this isotope, approximately 17 Ci/g, plus its high radiotoxicity have presented serious problems in containment and in the prevention of internal exposures to personnel.

One feature of glove-box design which is important, from the applied health physics point of view, is the primary glove-box filter installation at the exhaust of the glove box.

One of the early style primary filter installations used on plutonium-238 glove boxes at Mound Laboratory was a box-type housing mounted external to each glove box. An improved design for general use is a cylindrical filter housing mounted inside the glove box. A completely new design was placed into use when the Plutonium Processing Facility at Mound Laboratory went into operation in March, 1968. In this latest design two cylindrical filters in series are mounted in a stainless steel or fiber glass exhaust tube below the rear of the glove box.

In the following sections the different type primary filter installations used at Mound Laboratory are described and the major lessons learned by experience with each type are reviewed.

DESCRIPTION OF PRIMARY, GLOVE-BOX FILTER INSTALLATIONS

A. Box-Type Housing, External to Glove Box

An example of the box-type filter installation external to the glove box is shown in Figure 1. Four separate filter housings and part of a fifth may be seen in this photograph. Each filter housing serves the exhaust from one glove box. The housing has an upper and a lower chamber, each containing one absolute filter. This provides two filters in series at the exhaust of the glove box. There are four doors on each housing, two in the front and two in the rear. The rear doors are not visible in the photograph.

The absolute filter used in this installation is 8 in. x 8 in. x 5-7/8 in., gasketed on both faces. The filter is rated for 50 ft³/min. The gaskets are compressed by sliding the filter into the chamber. The doors on the housing are gasketed and held shut by latches.

Figure 1 - Box-type housing, external to glove box.

B. Cylindrical Housing, Mounted Inside Glove Box

An example of the cylindrical filter housing which is mounted inside the glove box is shown in Figure 2. The filter housing is a steel canister 6 5/8 in. in diameter and 9 1/2 in. long. The outlet end of the housing screws directly into the exhaust line of the glove box. The inlet end is fitted with a small holder containing a roughing filter.

Inside the canister are two absolute filters in series. Each internal filter is 6 1/2 in. in diameter and 2 13/16 in. long. The complete assembly is rated for 25 ft³/min.

There is no gasket associated with this type installation. The seal is dependent upon screwing the threaded pipe tightly into the exhaust line. Teflon tape is normally applied to the threads; however, care must be taken to minimize the amount of tape which will be in contact with high level contamination because (α , n) reactions with the fluorine in the Teflon can result in a significant neutron yield.

C. Dual Cylindrical Filters, Installed in Exhaust Tube

The newest type of primary glove box filter installation at Mound Laboratory is shown in Figures 3 and 4. Figure 3 is a photograph of the rear of a glove box in the new Plutonium Processing Facility, showing the access to the filter tube. Figure 4 shows a closeup of the top of the filter tube with the upper filter in position. The screen, coarse fiber material, and cap visible in this picture are placed over the top of the filter tube to serve as a roughing filter and to protect the face of the upper filter. Figure 5 shows one of the two absolute filters which are positioned in the tube, one behind the other. The filter itself is 5 1/4 in. in diameter and 6 in. long. The gasket around the top of the filter is a dual lip made of molded silicone rubber which is compressed when the filter is inserted into the exhaust tube. Three wooden spacers are attached near the bottom of the filter to keep the filter positioned straight inside the tube. The filter is rated at 30 ft³/min.

EXPERIENCE WITH DIFFERENT TYPE GLOVE BOX FILTER INSTALLATIONS

A. Box-Type Housing, External to Glove Box

1. Filtration This type filter installation has proven very satisfactory in filtering the air exhausted from a glove box. Although such installations have never been tested "in place" by the D.O.P. technique, air samples collected downstream from the filters

Figure 2 - Cylindrical housing, mounted inside glove box.

Figure 3 - New, primary filter installation. Rear of glove box showing access to filter tube.

Figure 4 - New, primary filter installation. Top of filter tube with upper filter in position.

Figure 5 - One of the two absolute filters which are positioned in the tube.

have confirmed that the installation does clean the airstream with a high degree of efficiency.

2. Source of Leaks If the exhaust air from the glove box contains acid fumes, corrosion of the metal filter housing may occur over a period of time. In some installations there may be enough damage sustained from acid corrosion that leaks develop around the gasket seal.
3. Ease of Filter Change As can be observed from Figure 1, access to these filter installations above the glove boxes for a filter change is awkward. Personnel changing filters must work on ladders and reach out to the filter housing. In some laboratories, the space above the glove boxes is even more cluttered with pipe lines and equipment than is evident in Figure 1. Some difficulty has been experienced in pushing the old filter out during the change procedure, but this is not normally the case.
4. Contamination Control During Filter Change Large plastic bags are sealed over the front and rear doors to permit bagging both the old filter out and the new filter in. Because of the awkward working conditions and the possibility of high level contamination being present on the lower filter, changing these filters can be a major contamination control problem. The fact that the filter housings are located out in the open laboratory could give some difficulties, since a large area is subject to contamination if anything goes wrong.

The contamination control problem during filter changes was the main reason that Mound Laboratory largely abandoned this type filter installation on plutonium-238 glove boxes.

5. Interference With Glove-Box Operations The external type filter housing takes up no valuable space inside the glove box. It must be recognized, however, that normal operations in a glove-box line equipped with this type installation are interrupted if any contamination results from the filter change. As indicated above, releases of activity may occur during filter changes with this type installation and this, of course, results in some shutdown of glove-box operations during decontamination.
6. Other Considerations The processing of large quantities of plutonium-238 dioxide does pose an external radiation

control problem. The (α ,n) yield of plutonium-238 dioxide is on the order of 4×10^4 n/sec/g. Some glove-box lines have to be shielded with several inches of a neutron shielding material. The accumulation of plutonium dioxide in the unshielded external filter housings along a box line raises the dose rate in the general work area.

B. Cylindrical Housing, Mounted Inside Glove Box

Because of the contamination control problems during filter changes with the box type filter housing, a cylindrical type housing mounted inside the glove box was adopted. A discussion of Mound's experience with this type filter installation is given below.

1. Filtration This type filter installation is very satisfactory, provided it is properly installed and does not leak. As in the case of the box-type housing, these cylindrical housings have never been tested "in place" using the D.O.P. technique, but air samples downstream from these installations have demonstrated that they can clean the air with great efficiency. Some trouble has been experienced with leaks in this type installation.
2. Source of Leaks With very few exceptions, the leak occurs at the pipe threads where the canister screws into the glove-box exhaust line. A leak at this point permits some of the glove-box atmosphere to be drawn directly into the exhaust line, bypassing the filters. The problem here is that the threaded fittings of the exhaust line become corroded and when the primary filters are changed, the new canister cannot be, or simply is not, screwed tightly enough into position to achieve a good seal. To correct this problem, the metal fitting of the exhaust line has been replaced in some cases with a PVC threaded fitting.

Another source of leaks may be the corrosion of the canister itself. A hole in the canister after the last filter will also allow air to bypass the filters. In a few installations where this has been a problem, the regular canister has been replaced with one having a stainless steel or PVC casing. This has prevented corrosion holes in the canister itself, but makes recovery of plutonium dioxide from these canisters more difficult.

3. Ease of Filter Change As indicated, corrosion in exhaust line threads may make the physical act of changing the filter difficult, and this increases the chance that the canister will not be screwed in properly.

It should be mentioned that since this type installation takes up space inside the box, it is normally located in the rear or off to one side so as to interfere as little as possible with the normal use of the box. Because of their location inside the box, these canisters cannot be changed by using the main gloves and the box must be equipped with a set of upper glove ports in the viewing window.

4. Contamination Control During Filter Change All filter changes take place inside a glove box.
5. Interference with Glove Box Operations This type filter installation uses up about one cubic foot of valuable glove box volume. The change of filters in one glove box does not interfere with other glove-box operations in the laboratory.
6. Other Considerations A buildup of material on the filters does increase the dose rate at the operator's position; however, as these boxes are shielded, this problem is not too serious.

C. Dual Cylindrical Filters, Installed in Exhaust Tube

In order to eliminate the problem of leaks associated with the threaded type fitting and to retain the advantage of changing the filter inside the glove box, a new dual cylindrical filter and housing installation was developed. Our experience with this new system is described below.

1. Filtration Before the Plutonium Processing Facility became operational in March 1968, approximately 30% of the glove-box exhaust filter installations were selected at random and D.O.P. tested. With two exceptions, no penetration could be detected. This, of course, was with two absolute filters in series, each of which is rated at least 99.95% efficient. The lower limit of detectability in this D.O.P. test was 0.001% penetration. The two exceptions which showed some leakage were found to have defects in the exhaust tubes. These exhaust tubes were out-of-round so that the gaskets on the filters did not seat properly.

Since the facility has become operational, air samples collected from the glove box exhaust system has confirmed that this type installation does provide excellent filtration.

2. Source of Leaks There have been a few instances where high level contamination has been noted in the chamber below the exhaust tube. In these cases, these glove boxes had been used for processes where a large quantity

of acid fumes were generated. The Plutonium Processing Facility does have a separate acid fume exhaust system which is designed to collect the fumes locally inside the box and prevent them from being carried into the main glove box exhaust. In these isolated cases, apparently large volumes of acid fumes were carried to the glove-box filter installation. It is not known how the material penetrated the filters: however, one possibility is that the fumes condensed above the filter gasket, and liquid migrated past the seals to the lower chamber.

3. Ease of Filter Change The changing of filters in this type installation is much easier than in either of the other two cases described earlier. Refer to Figure 3. As may be seen in this photograph, there is a cubical chamber directly below the exhaust tube. This chamber is opened by removing a bolted, gasketed plate. Once opened, a new filter is placed in and pushed upward into the exhaust tube. Normally, the filter is forced upward into the tube with the aid of a small jack. As the new filter is forced upward in the tube, the top filter is forced out into the box and the lower filter moves up to the top position.
4. Contamination Control During Filter Change The design of this installation lends itself to good contamination control. The filter change is made in a controlled access service corridor behind the glove-box line. The removal of the cover plate over the chamber below the exhaust tube is carefully monitored. If any contamination is detected, a small plastic enclosure with glove ports is used to complete the job. To date, over 90% of these filter changes have been made without any significant contamination being detected.
5. Interference With Glove-Box Operations The protrusion of the exhaust tube into the glove box and the need for room to push the dirty filter out during a change uses up perhaps one-half of a cubic foot of glove-box volume.
6. Other Considerations As in the case of the internal canister-type glove-box filter, accumulation of material on the filter does increase the dose rate at the operator's position, but the filters are inside the shielded box so that the problem is less serious than in the case of the external filters.