RESIDUE DRUM VENT FILTER MONITORING PROGRAM AT THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

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ABSTRACT

Several thousand 55-gallon drums of residue material from past plutonium processing operations are being stored at the Rocky Flats Environmental Technology Site (RFETS). This stored material awaits stabilization, packaging for shipment to the Waste Isolation Pilot Plant for disposal, or packaging for shipment to other DOE sites for processing. Each of these drums is fitted with a vent filter to prevent accumulation of hydrogen or other flammable gases. A filter-monitoring program was developed to assure that these vent filters continue to function properly. Nuclear Filter Technology Model 012 and 013 filters are being used to vent the drums. A simple filter test device has been developed at RFETS for monitoring these vent filters. This test device consists of a cup that sits over the filter and seals to the drum lid, a pressure gauge, a flow meter, and a hand pump. If the flow rate through the filter at 1-inch water column is less than 35 ml/min, the filter is considered plugged, and the filter is changed. During its first year, the vent-monitoring program has led to discovery of 14 plugged vent filters. These plugged filters were found on drums containing dry combustibles, wet combustibles, and Ful Flo filters. Calculations have shown that these drums could have contained hydrogen gas concentrations in excess of the Lower Flammability Limit of 4-volume %. In addition to the plugged filters, the testing also identified a number of filters with high flow rates, as well as numerous corroded filters. Most of these plugged, high-flow-rate, and corroded filters have been found on drums containing combustible residues generated from processes using chlorinated organic solvents. However, some plugged and corroded filters have been found on drums containing residues generated from processes that used nitric acid. All of the plugged filters have been changed, as well as many of the high-flow-rate and corroded filters. Some of these filters have been shipped to the Los Alamos National Laboratory for analysis and determination of the filter plugging mechanism. Gas samples are being taken from the drums to help determine the filter plugging mechanism.

INTRODUCTION

Several thousand drums of residue material are in storage at the RFETS. Most of the drums in the drum backlog were packaged assuming they would remain in storage for a few months to, at most, a few years. Some of these residues have been in storage for over 20 years, and none of the residues have been in storage for less than 10 years. A study conducted in 1993 identified a number of potential safety problems that might be present in the backlog residue drums (Reference1). One of the potential safety problems identified is generation and accumulation of hydrogen in residue drums. Headspace gas analysis of a number of non-vented residue drums showed that some of the drums did contain high concentrations of hydrogen gas. Following this confirmation that hydrogen could accumulate in residue drums, RFETS implemented a program to install drum vent filters in all residue drums.

As a result of the residue drum problems identified at Rocky Flats, and problems identified at other Department of Energy (DOE) sites, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 94-1. This recommendation addressed, among other things, safe storage of residue drums.

The DOE developed an Implementation Plan for DNFSB Recommendation 94-1, and an addendum to the implementation plan contains criteria for safe storage of residue containers (Reference 2). These criteria include the requirement that sealed containers must be capable of holding any gas generated during storage, or the container must be fitted with a filtered vent. If a filtered vent is used, a surveillance program is required to assure that the filtered vent functions properly.

To comply with the DOE interim safe storage criteria, a program for inspection and testing of drum vent filters was developed (Reference 3). This program is based upon testing a statistical sample of drum vent filters. Residue materials are divided into categories called Item Description Codes (IDC) based on processing history and material characteristics. The various IDCs present in the drum backlog were placed into Processing Groups, and the Processing Groups were evaluated based on the perceived level of risk associated with the IDCs in the Processing Groups. The number of drum vent filters requiring testing is highest for the IDCs in Processing Groups with the highest perceived risk.

The vent filter testing program was started in the fourth quarter of FY 97 and has continued through FY 98. During this period of time, a number of plugged, corroded and high flow rate filters have been found, and many of these filters have been changed. As RFETS developed this program, a number of improvements have been made to the filter test instrument and procedures. The program of filter testing will continue until the drums reach final disposition.

ESTABLISHMENT OF FILTER TEST PROGRAM

The program plan that established the filter test program recognized that other programs are already in place that require inspection of the residue drums. These programs are the Residue Characterization Program (RCP) and the Resource Conservation and Recovery Act (RCRA) Inspection Program. Implementation of the RCP requires that selected drums from the various residue IDCs be opened, packages removed, and samples taken from material in the packages. The vent filters are not inspected as part of the characterization program, but the condition of the drum and internal packaging is noted as part of the sampling operation. The vent filters on RCRA regulated drums are inspected during RCRA inspections. This is a visual inspection that is concerned primarily with the appearance of the filter. Corroded filters are noted during these RCRA inspections and some corroded filters have been changed as a result of these inspections. Recognition of the existence of these other programs resulted in a decrease in the number of drum vent filters requiring testing for the 94-1 program.

To implement the filter test program for 94-1, the residue Processing Groups were placed into one of four Monitoring Levels. The number of filter tests required for each Monitoring Level was based upon an assessment of the risk associated with the IDCs in each Monitoring Level. The risk assessment was based upon the expected rate of hydrogen generation in the drums and the expected rate of filter corrosion. The monitoring plan established confidence levels required for the four Monitoring Levels. A copy of the table from the monitoring plan is shown in Table I, which shows the initial information on number of drums in each Monitoring Level, the number of vents requiring inspection, and inspection frequency. The statistical sampling plan was developed to ensure X% confidence that not more than Y% of the total population fails (Table I defines X and Y for each Monitoring Level). The number of filter tests required for each Processing Group was developed using the information in Table I, along with information on the number of drums in each Processing Group. As the program has progressed, some of the requirements for number and frequency of filters requiring testing have changed based on observed failure rate.

Table I. Monitoring Level Information

Monitoring Level	Number of Drums	Number of Vents Inspected	Inspection Frequency	Confidence Level Achieved* (X/Y)
1	2220	523	Annually	95/2
2	608	137	Annually	95/5
3	1046	108	Annually	80/5
Special Case	43	43	Quarterly	95/2**

*X% confidence that no more than 7% fail

**Current failure rate exceeds desired confidence level

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To identify drums for testing, RFETS developed a computer program to select individual drums from each Processing Group. First, a sequence number is assigned to all of the drums within a Processing Group. The computer program then generates a list of random numbers, and a sequence number is assigned to the random numbers. The drum sequence numbers and the random sequence numbers are then listed from one to “X”, with “X” being the total number of drums in the population. If a sample size of 50 is required for the Processing Group, then the first 50 drums from the randomly ordered list are selected for testing. The exceptions to this process are the drums containing Ful Flo Filters that are contaminated with chlorinated organic solvents. Previously gathered data indicated that the filter failure rate for these drums already exceeded the desired 95/2 confidence level. All of the drums within this sub-population of Ful Flo Filter drums are tested every quarter.

The test program may be altered as data from the filter tests are generated. The number of filter tests required for a Processing Group must be reassessed if plugged filters are found on drums in the Processing Group. A Technical Review Team has also been established to review the data generated from the filter tests and recommend any required changes to the program

PROGRAM IMPROVEMENTS

Several improvements have been made to the filter test device and filter test procedure since the program was started. During the first six months of the program's existence, problems were encountered with obtaining a good seal between the filter test device and the lids on some residue drums. Improvements to the filter test device have solved this sealing problem. Changes to the filter test procedure have resulted in the generation of better quality data and improved safety during filter change operations. In addition to the improvement in the filter test device and procedure, a cold filter test facility was established during FY 98. This facility is used to retest failed filters to confirm the flow rates measured during the filter test, and provides a check on the accuracy of the filter test measurements.

FILTER TEST DEVICE

John Schierloh, RFETS, developed the filter test device. This device consists of an air source, a flow meter, a pressure gauge, and a cup or fitting that fits over the drum filter. A gasket is used to seal the fitting to the drum lid. A hand pump is used as the air source, and the operator pumps the hand pump several times to build up pressure in the system. A needle valve between the hand pump and flow meter is slowly opened until a pressure of 1-inch water column is obtained on the pressure gauge. The air flow rate is then read from the flow meter, which has a range equal to 0 to 450 cc/min. The flow rate through a new drum filter is approximately 200 cc/min at 1-inch water column. A reading of less than 35 cc/min on the filter test device indicates a plugged filter. The original filter test device developed by Schierloh was very accurate in identifying plugged filters. However, problems were encountered in sealing the fitting on some drum lids. Sealing the fitting on some older drum lids with surface corrosion or with a ridge running through the area where the filter is installed was very difficult and, in some cases, impossible. This sealing problem occasionally resulted in false high-flow readings (>450 cc/min) that exceed the range of the flow meter.

To correct the poor-sealing problem, several improvements were made to the filter test device during FY 98. The first improvement was to completely change the fitting hold-down mechanism. The old hold-down mechanism was a strap similar to a seat belt that held the test fitting down with force at two areas where the belt went over the test fitting. Two new mechanisms, a primary mechanism and an alternate mechanism, were developed. The primary hold-down mechanism is of a proprietary nature and is currently in a patent disclosure process. The alternate mechanism is used when the primary device cannot be attached to the drum lid. This alternate mechanism is a beam which is attached to the drum by applying force underneath the drum ring on both sides of the drum and applying force to the center of the drum lid. A screw, which can be positioned above the test fitting, is then used to apply a single point force down on the test fitting. Both of these mechanisms work well. However, the primary mechanism takes less time to set up and is easier to remove when the test is complete. These two new fitting hold-down devices have eliminated the problem of false high-flow readings.

Several other improvements were made to the filter test device. Additional neoprene gaskets were fabricated for the test fitting to ease problems associated with Tamper Indicating Devices (TIDs) interfering with a good seal. A new air pump was obtained to lessen the effort needed to obtain the proper pressure. A new mounting panel for the flow meter and pressure gauge was developed and this new panel is significantly stronger than the previous mounting panel. Tubing from the gauges to the test fitting was lengthened to allow greater flexibility in positioning the mounting panel during tests. The capacity of the air reservoir was increased to provide more time at the test pressure and this has resulted in more accurate flow meter readings. All of these improvements have resulted in a filter test device that is easier to use and provides more reliable test results.

FILTER TEST PROCEDURE

Improvements have also been made to the filter test procedure. Because of the potential for sealing problems between the test fitting and drum lid, the procedure was modified to require two successful tests on each drum. Additionally, the test fitting must be removed and reinstalled between tests. When the filter test team began finding plugged drum filters, a concern was raised about the possibility of hydrogen accumulation in the drum. To reduce the risk of personnel injury, the procedure was modified to require an evaluation of the potential for hydrogen accumulation in the drum before the filter is changed. The modified procedure also requires notification of the filter change team of possible hazards expected and the urgency for the filter change.

COLD FILTER TEST FACILITY

The Cold Filter Test Facility provides a location where filters removed from drums can be tested in a low radiation area. Established in Building 777, the facility provides a location for re-testing failed filters. The filters are installed in a cold 55-gallon drum, and the filter flow test is repeated. This re-testing of failed filters provides valuable information on the accuracy of the filter test device, as well as confirming that filters thought to be plugged really are plugged. All of the plugged filters tested to date in the Cold Filter Test Facility were verified to be plugged.

FILTER TEST RESULTS

The vent filters were tested on a total of 1206 drums during FY 98. Of those tests, 52 were performed on duplicate drums or were otherwise invalid. The remainder, 1154, represent the required number of tests for the year. A listing of the number of vent filters tested in each Processing Group is shown in Table II.

Table II. Drum Vent Filters Tested During FY98

Processing Group	Total Required	Total Completed	Extras or Duplicates	Number of Failures
1	9	9		
2	50	50		
3	54	57	3	
4	59	59		
5	29	29		
6	222	225	3	2
7a	88	89	1	7
7b	222	222		2
8	1	1		
10	138	165	27	
11	168	174	6	3
12	31	42	11	
13	34	35	1	
14	23	23		
15	26	26		
Totals	1154	1206	52	14

The extra or duplicate tests and the number of failures are also shown in Table II. A test failure resulted when a plugged filter was found. As a result of these filter tests, at total of 14-plugged drum-vent filters were identified.

A list of the drums that had plugged vent filters is given in Table III. The "G" suffix added to some of the IDC numbers in Table III indicate drums that contain chlorinated organic solvents. As the data in Table III show, three of the plugged filters were found in IDC 330 (Dry Combustible) drums, one was found in an IDC 331 (Ful Flo Filter) drum, two were found in IDC 331G drums, one was found in an IDC 336 (Wet Combustible) drum, and seven were found in IDC 336G drums.

Table III. Drums With Plugged Filters

Drum Number	IDC	Description	Test Date	Originating Material Balance Area	Building Where Filled
D63277	330	Dry Combustible	4/9/98	1476 07	707
D69615	330		8/3/98	1576 07	707
D69645	330		9/11/98	0389 50	776
D61908	331	Ful-Flo Filters	2/10/98	1371 31	771
D56800	331G		10/30/97	0389 19	776
D63417	331G		4/8/98	1576 07	707
D02064	336	Wet Combustible	4/9/98	1371 31	771
D22427	336G		4/15/98	1576 07	707
D53543	336G		9/11/98	1576 05	707
D59636	336G		8/26/98	1576 76	777
D63768	336G		6/10/98	0361 31	559
D70801	336G		6/4/98	1576 76	777
D71893	336G		2/10/98	1576 76	777
D71894	336G		6/4/98	1576 76	777

Finding the plugged filters in IDC 330 drums resulted in increases in the number of IDC 330 drums requiring testing. The plugged filters found on the IDC 331 and IDC 336 drums also resulted in an increase in filter test requirements.

In addition to the two plugged filters found on IDC 331G drums during normal filter test operations, three additional plugged filters were identified in the Cold Filter Test Facility. During an inspection of IDC 331G drums, the filters on 27 of these drums were identified as badly corroded. After these filters had been changed, they were tested in the Cold Filter Test Facility, and three filters were determined to be plugged. The filter on one of these drums tested okay before the filter was changed. The other two filters were showing signs of plugging before they were changed, but the flow rates were still above the 35-cc/min minimum. The filters were originally tested April 8, removed on April 15, and re-tested in May. Continued corrosion by residual hydrochloric acid in the filters after the filters were changed might account for plugging of these filters.

In addition to plugged filters, the filter test program identified a number of high-flow filters. A high-flow filter is a filter with a flow rate that exceeds the range (450 cc/min) of the flow meter in the filter test device. High flow test results were obtained on filters in 93 drums. High-flow test results were obtained on multiple drums in IDCs 330, 331, 331G, 336, 336G, 337 (Plastic), 338 (Filter Media), 409 (Pyrochemical Salt), 420 (Incinerator Ash), and 421 (Ash Heel). Some of the high-flow results obtained prior to January 1998 may have been due to test fitting sealing problems. However, this problem was solved by the end of January and all subsequent high-flow test results should be valid. As additional information was collected on high-flow filters, a decision was made to begin changing these filters as they are identified.

Another filter problem noted by the filter test team is corroded filters. If a filter showed signs of corrosion, from mild corrosion to severe corrosion, filter test team personnel noted this fact. The corroded filter notation occurred more than once for some of the drums. Most of the drums with the multiple corroded filter notations are IDC 331G drums, because filters on all of these drums were tested each quarter. However, multiple corroded filter notations appear for some drums in other IDC populations, because the filters on some of these drums were tested more than once. Multiple corroded filter notations appear for IDC 330, 331, 331G, 336, 336G, and 338 drums. The IDCs for which corroded filters were noted on more than one drum are 330, 331, 331G, 336, 336G, 337, 338, 405 (Pyrochemical Salt) and 420. Mild filter corrosion is not sufficient to cause changing of a filter, if the flow test results are acceptable. However, filters with severe corrosion are changed, even if the flow test results are acceptable.

FILTER ANALYSIS PROGRAM

Because of the large number of plugged, high-flow and corroded filters identified during the filter test program, a program was started to identify the mechanism causing plugged and high-flow filters. A total of six filters were shipped to Los Alamos National Laboratory (LANL) for analysis, and a listing of these filters is given in Table IV. Two of these filters were plugged filters from drums containing material contaminated with aqueous solvents (nitric acid), two filters were plugged filters from drums containing material contaminated with chlorinated organic solvents, and two filters were high-flow filters from drums containing material contaminated with chlorinated organic solvents. The two filters from drums contaminated with aqueous solvents are old style, carbon steel body filters (Nuclear Filter Technology [NFT] Model 012). The other four filters are new style, stainless steel body filters (NFT Model 013).

The analytical work at LANL has not been completed, but all of the filters have been sectioned. The Room Temperature Volcanized (RTV) adhesive used to hold the carbon filter element in the filter body is badly degraded in all four filters from drums containing chlorinated organic solvents.

The RTV is very brittle and some of the RTV fell out as the filters were being sectioned. The RTV in the filters from the drums contaminated with aqueous solvents is not as degraded as the RTV in the filters from drums contaminated with organic solvents. The RTV in the filter from drum D02064 (plugged filter, IDC 336) is degraded on one side only. The RTV in the filter from drum D61908 (plugged filter, IDC 331) is not degraded like the RTV in the other filters. Drum D02064 was packaged prior to 1983 and D61908 was packaged in 1988. Therefore, the filter from D61908 was exposed to the drum environment for a shorter period of time than the filter from D02064 and this might explain the difference in RTV degradation.

Table IV. Information on Filters Shipped to LANL

Filter Source	From Drum Number	IDC	Filter Type*	Failure Mode
Organic Contaminated	D71893	336G	NFT Model 013	Plugged
Organic Contaminated	D63417	331G	NFT Model 013	Plugged
Organic Contaminated	D67241	331G	NFT Model 013	High Flow/Corroded
Organic Contaminated	D68507	331G	NFT Model 013	High Flow/Corroded
Aqueous Contaminated	D61908	331	NFT Model 012	Plugged
Aqueous Contaminated	D02064	336	NFT Model 012	Plugged

*Model 013-New style filter, stainless steel body, lid over hole in top of filter.
Model 012-Old style filter, carbon steel body, single hole in top of filter.

Element mapping using micro X-ray fluorescence has been started on three of the filters. The X-ray maps for the filter from drum D71893 are shown in Figures 1 and 2. The maps in Figure 1 show chlorine throughout the carbon filter element and in the corrosion products around the element. The iron map shows iron in the corrosion products around the filter element in the same areas that contain chlorine. These two element maps are consistent with chloride corrosion of stainless steel. The silicon map shows that silicon is absent from areas where RTV should be present, and this map confirms the visual evidence for degradation of the RTV. Figure 2 shows element maps taken of the top left corner of a section of the filter from drum D71893. These maps show that chlorine and iron are filling the space between the top of the filter body and lid, indicating that the filter plugged because of an accumulation of corrosion products in the space between the filter body and lid.

X-ray element mapping has also been started on the two filters from drums contaminated with aqueous solvents. Analysis of the sectioned filter from drum D02064 shows that this filter is different from the filter from drum D71893. No large deposits of corrosion products are present in this filter. The element maps for the area around the

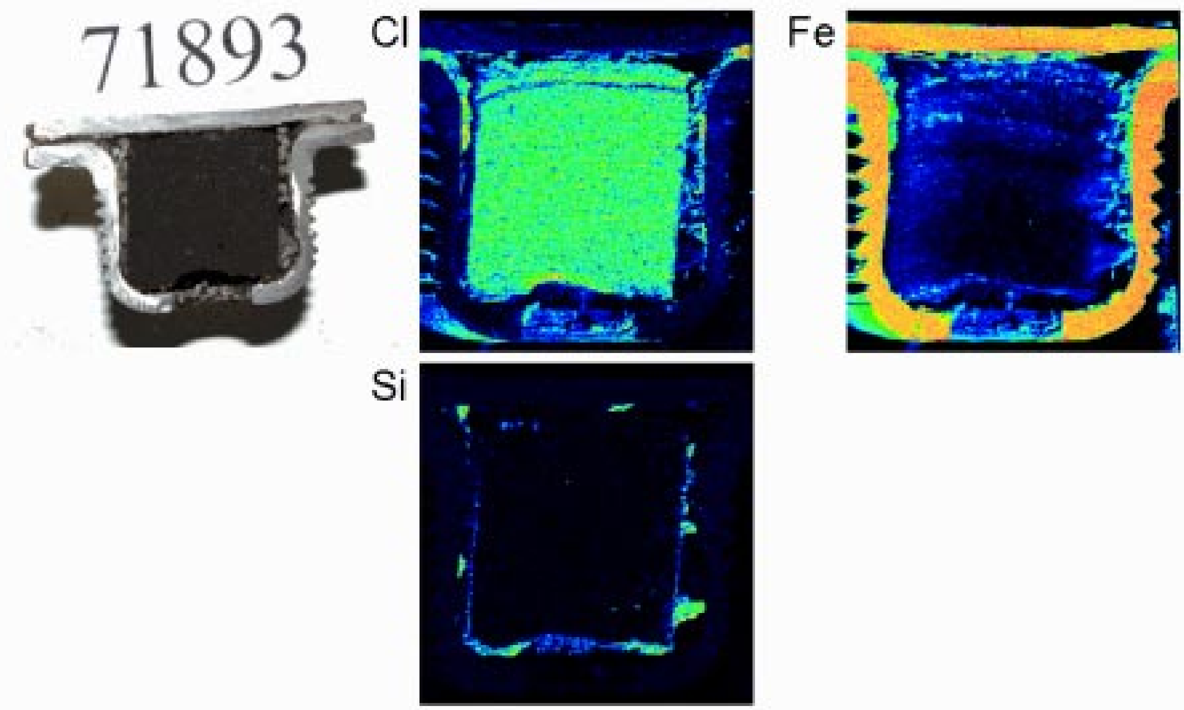

Figure 1. Cross Section: Elemental MXRF Maps

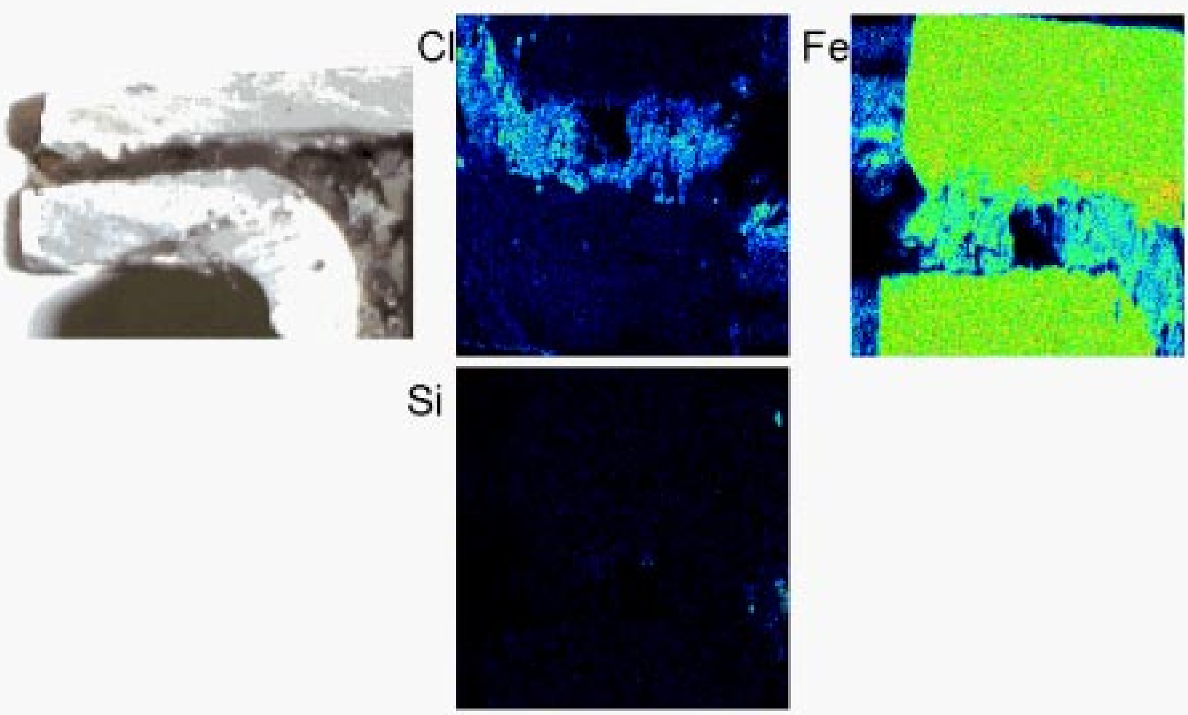

Figure 2. D71893 Cross Section of Annular Region

inlet hole of this filter are shown in Figure 3. These element maps show that some chlorine was detected on this filter, but not at the high concentrations seen on the filter from drum D71893. Some lead was also detected on the filter body around the bottom inlet hole, and the element maps for the lead and chlorine appear to overlap, indicating some type of lead chloride compound. A source for lead in drum D02064 is unknown at this time, but work is in progress at Rocky Flats to obtain samples of the contents of these two drums. The element map for silicon shows that the silicon extends across the inlet hole and a hole appears to have been torn through the RTV. The carbon filter element contains a channel above the inlet hole and the hole in the RTV. The importance of these findings will be explained in the next paragraph.

As with D02064, the initial results from analysis of the filter from the other aqueous solvent drum, D61908, show that some chlorine is present in this filter, but no lead was detected. The element maps for the area around the inlet hole on this filter are shown in Figure 4. The element map for silicon shows that the silicon extends across the inlet hole of this filter as it did with the filter from D02064. The carbon filter element also contains a channel, and this channel extends about ¾ of the way up from the inlet hole. A possible plugging mechanism for the filters from drums D02064 and D61908 has been proposed. Assume that RTV adhesive was smeared across the inlet hole during the manufacturing process, and a drill bit or other tool was used to remove the RTV. However, a hole was torn through the RTV so the filter functioned at specifications, but the RTV was not all removed. Prolonged exposure to the vapors in the drum caused the residual RTV to swell and plug the inlet hole. A representative of the filter manufacturer was contacted and he confirmed that the proposed filter plugging mechanism is possible (Reference 4).

As part of the filter analysis program, headspace gas samples will be taken from drums that had plugged, high-flow, or corroded filters changed. Limited headspace gas sampling of combustible drums has been conducted as part of the Residue Characterization Program. Carbon tetrachloride concentrations as high as 29,000 ppm have been measured in drums labeled as dry combustibles (IDC 330). High CCl_4 concentrations (up to 9,600 ppm) have been measured in drums of wet combustibles (IDC 336), and 1,1,1 Trichloroethane concentrations as high as 6,850 ppm have been measured in wet combustible drums. These headspace gas sample results tend to support the hypothesis that filter failure on some of the drums is caused by corrosion from hydrochloride acid produced from radiolysis of chlorinated organic solvents. Headspace gas samples for drums with known filter failure problems are required to confirm this hypothesis concerning the source of the corrosion.

DISCUSSION

All of the plugged filters found during FY 98 were on drums of combustible residues (Wet Combustibles, Dry Combustibles, and Ful Flo Filters). Most of the plugged filters were found on drums thought to contain material contaminated with chlorinated organic solvents. These drums either have RCRA "F" codes assigned to them (indicating the presence of volatile organic compounds), or they were generated from operations where chlorinated organic solvents were used. Only two of the 14 plugged filters were found on drums generated from operations using aqueous solvents.

As plugged filters were found during the year, possible safety problems associated with non-vented drums became a concern. A computer program was developed to calculate the rate of hydrogen accumulation in drums containing Wet Combustibles, Dry Combustibles, and Ful Flo Filters. This program was written assuming a sealed drum, and the program used hydrogen generation rates developed during previous experimental work at Rocky Flats. Since the date when a filter plugs is usually unknown, calculations are performed to generate a table of hydrogen concentration versus time. The results of these calculations are then evaluated to determine the hydrogen concentration that could be present in the drum. This information is transmitted to the appropriate building personnel so that proper safety precautions can be taken during filter change operations. Calculations on drums with filters that have plugged during FY 98 have shown that some of these drums could have contained hydrogen concentrations as high as 15-volume % before the filters were changed.

In addition to the low-flow filters, a number of high-flow filters were identified during the year. Filters with these high flow rates no longer provide the level of protection from release of contamination required for a HEPA filter. In addition, some evidence exists that indicates that filters with high flow rates will eventually plug. High-flow filters also require changing to prevent the release of contamination from drums with internal contamination, and eliminate the possibility that these filters will eventually plug. RFETS is re-testing all filters with high-flows to

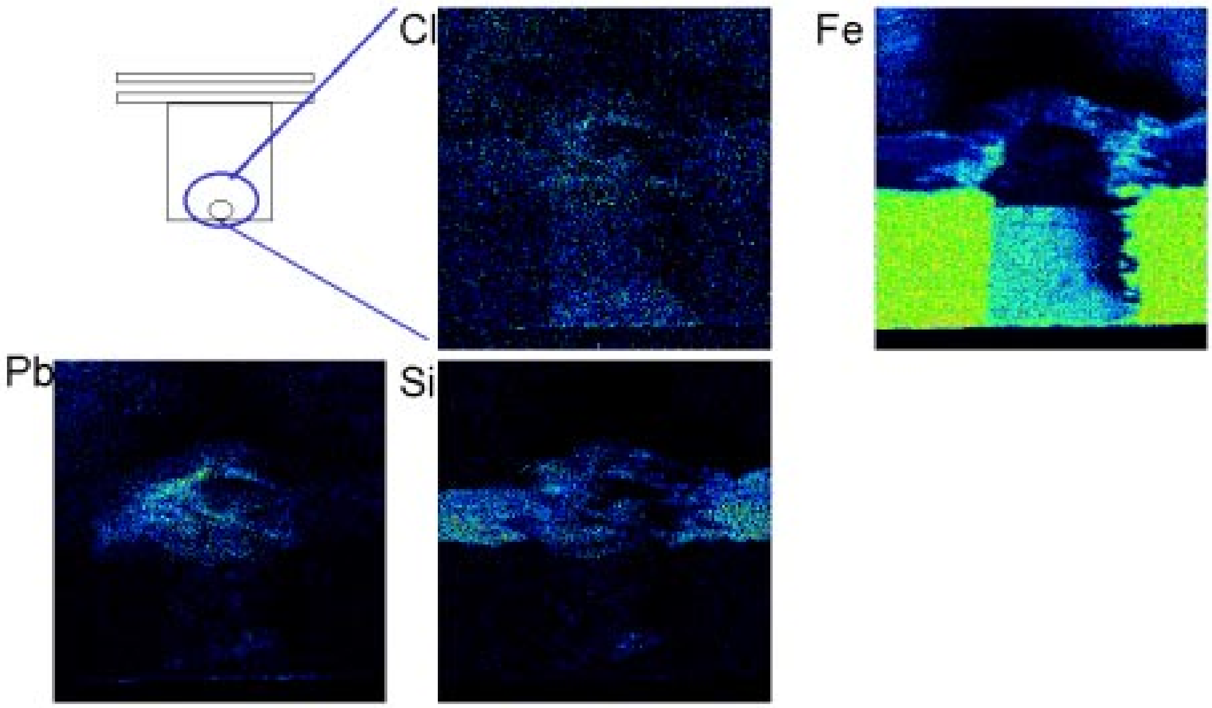

Figure 3. D02064 Cross Section: Elemental MXRF Maps of Inlet Hole

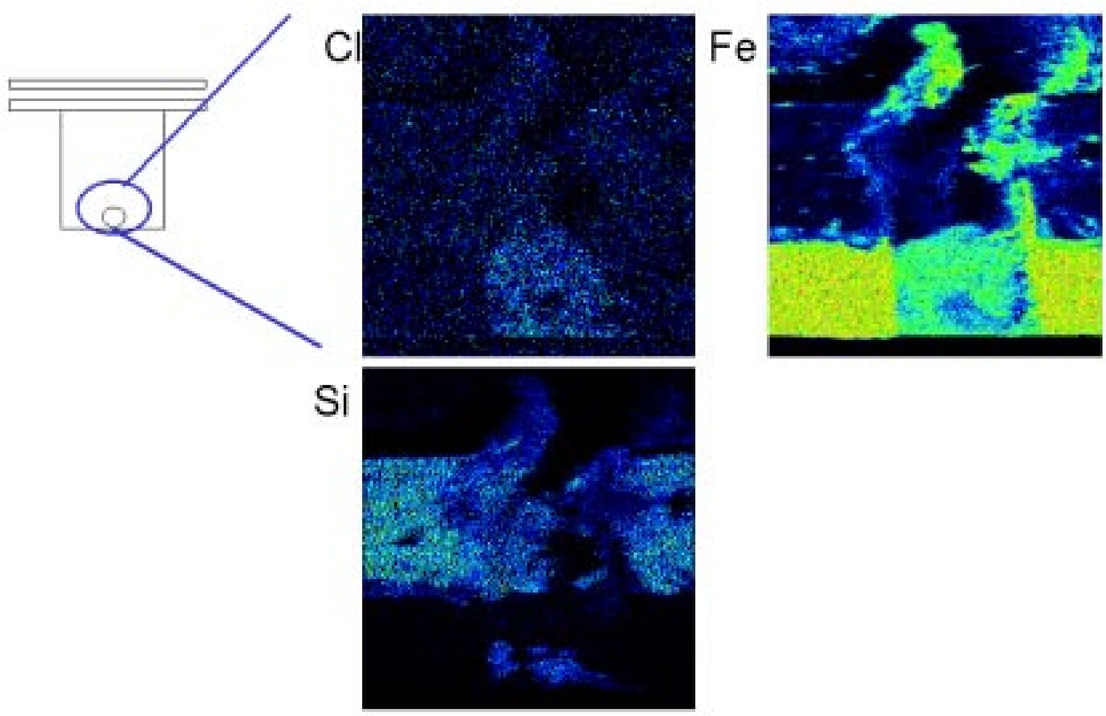

Figure 4. D61908 Cross Section: Elemental MXRF Maps of Inlet Hole

confirm the original test results. If the re-test confirms a high flow rate, the filter is changed. Over 20 high-flow filters have been changed to date.

The results of filter analysis work at LANL indicate that high-flow filters result from acid attack on the RTV used to hold the carbon filter element in the filter body. This work also indicates that filter-plugging results from corrosion of the filter body or, in the case of old style filters, swelling of RTV around the inlet hole caused by exposure to solvents in the drums. Results from LANL and the RFETS filter test program indicate that high-flow filters will eventually plug if the filters are not changed.

FUTURE PLANS

The filter analysis results obtained to date from LANL point to chlorinated organic solvents and inorganic acids as the cause for filter plugging. A program has been started to determine if addition of Granulated Activated Carbon (GAC) to drums with known filter corrosion problems will decrease or eliminate the drum vent filter corrosion. The concept is to place bags containing GAC coated with a substance specifically engineered to absorb and chemically bond hydrochloric acid (HCl) in problem drums to absorb carbon tetrachloride and absorb and neutralize HCl. Test and control drums have been selected for GAC testing. The filters on the control drums and drums with the bags of GAC will be monitored quarterly as part of the filter test program to determine if the bag of GAC is decreasing the rate of filter corrosion. Monitoring of these drums will continue for four quarters. Headspace gas samples will be obtained from the control and bag of GAC drums before addition of the bag of GAC and at the end of the four-quarter filter observation period.

Information that would be very useful in managing drum vent filters would be the time required for a new filter to begin showing signs of degradation. If it were known that a filter on a given drum would degrade to a high flow condition in six months after the filter was installed, and fail in nine months after the filter was installed, then steps could be taken to replace the filter prior to failure. Some information is available on the rate of failure on IDC 331G filters, but little information is available for other IDCs. New filters on drums that have required filter changes will be monitored in subsequent years to build a database on filter failure rates.

The Residue Drum Vent Filter Monitoring Program has been very successful during its first year of operation, identifying plugged and open drum vent filters and replacing those filters to support safe operation. The program will continue monitoring, as well as working to understand the basis for the filter failures in order to identify long term mitigation actions.

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