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Solutions for Dioctyl Phthalate (DOP) Tested  
High Energy Particulate Air (HEPA) Filters Destined for  
Disposal at Hanford, Washington

by

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## Abstract

In January 1992, Argonne National Laboratory East, Environmental and Waste Management Program learned that a chemical material used for testing of all HEPA filters at the primary source, Flanders Filter, Inc. in Washington, NC, was considered a hazardous chemical by Washington State Dangerous Waste Regulations. These regulations are under the jurisdiction of the Washington Administration Code, Chapter 173-303, and therefore directly under impact the Hanford Site Solid Waste Acceptance Criteria. Dioctyl Phthalate, "DOP" as it is referred to in chemical abbreviation form, is added in small test quantities at the factory, at three Department of Energy (DOE) operated HEPA filter test facilities, and in the installed ductwork at various operating laboratories or production facilities. When small amounts of radioactivity are added to the filter media in operation, the result is a mixed waste. This definition would normally only develop in the state of Washington since their acceptance criteria is ten times more stringent than the US Environmental Protection Agency's (US EPA). Methods of Processing will be discussed, which will include detoxification, physical separation, heat and vacuum separation, and compaction. The economic impact of a mixed waste definition in the State of Washington, and an Low Level Waste (LLW) definition in other locations, may lend this product to be a prime candidate for commercial disposal in the future, or a possible de-listing by the State of Washington.

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# **Solutions for Dioctyl Phthalate (DOP) Tested High Efficiency Particulate Air (HEPA) Filters Destined For Disposal at Hanford, Washington**

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## **INTRODUCTION**

In January 1992, Argonne National Laboratory East, Environmental and Waste Management Program, learned that a chemical material used for testing of all HEPA filters at the primary source, Flanders Filter, Inc. in Washington, NC, was considered a hazardous chemical by Washington State Dangerous Waste Regulations. These regulations are under the jurisdiction of the Washington Administration Code, Chapter 173-303, and therefore directly under impact the Hanford Site Solid Waste Acceptance Criteria. DOP, as it is referred to in chemical abbreviation form, is added in small test quantities at the factory, at three Department of Energy (DOE) operated HEPA filter test facilities, and in the installed duct work at various operating laboratories or production facilities. When small amounts of radioactivity are added to the filter media in operation, the result is a mixed waste. This definition would normally only develop in the state of Washington since their acceptance criteria is ten times more stringent than the US Environmental Protection Agency's (US EPA). Methods of Processing will be discussed, which will include detoxification, physical separation, heat and vacuum separation, and compaction. The economic impact of a mixed waste definition in the State of Washington, and an Low Level Waste (LLW) definition in other locations, may lend this product to be a prime candidate for commercial disposal in the future, or a possible de-listing by the State of Washington.

## **WHAT IS A HEPA FILTER?**

A HEPA filter is a throw-away, extended media, dry type, filter with a rigid casing enclosing the full depth of the pleats. The filter is extremely efficient in its ability to stop 99.97 % of a testing or challenge aerosol that is 0.3 microns diameter when mono dispersed. The filter that is on display is 24 inches square, representing the filter area for a tested flow rate of 1000 cubic feet per minute. The filter media is about one foot deep, enclosed in a 3/4 inch plywood frame or rigid metal casing.

## WASTE MANAGEMENT PROBLEMS WITH HEPA FILTERS

The HEPA filter is a constant irritating problem in our Waste Management Operations because of its size and the difficulty of compaction within the normal rules of radiation and air borne particulate management. The filter itself varies in size, but the majority of filters that Argonne National Laboratory-East (ANL-E) has in the HEPA filter category are 24 inches on a side, but many filters, including pre-filters, are thinner and smaller. Some filters used in other locations have metal frames, making compaction and disposal far more difficult.

The HEPA filter is somewhat difficult to break down and compact because of the structural integrity and makeup of the wood frame. The fact is, the frame does not fit into a compactor designed for fifty-five gallon drums without a great deal of reconstruction labor. This includes, one, radiation exposure which is not as low as reasonably achievable (ALARA), as well as, two, being subjected to the dust exposure which is caused by cutting the filter media away from the plywood frame prior to compacting.

## GLASS FIBERS MAKE UP THE FILTER MEDIA

Some descriptions of the HEPA filter mention that it is a paper media. This is in total error. It is really made of glass fibers. The glass fibers may resemble paper due to its white color and appearance. The glass fibers are produced by passing molten glass through fine holes and drawing it into the desired diameter by steam. In this case the small glass fibers are approximately the diameter of the aerosols they are designed to catch. Because the filter is made out of glass fibers, it has the right composition and tolerance for handling corrosive air, as well as having the normal fireproof capabilities of glass, in the same way glass fiber insulation in the home is capable of operating in the environment of a fire. The glass is manufactured by heating it to about 2700 to 2750°F, and removed from a continuous open-hearth furnace in a plastic condition. This feature is very important for future disposal choices.

## DOP AND LABORATORY DOP TESTING

The material used to test the HEPA filter is called DOP (dioctyl phthalate). The DOP material is used for initial testing at the Flanders Filters, Inc. Factory in located in Washington, North Carolina. HEPA filters are DOP tested by Industrial Hygiene at Argonne National Laboratory while the filters are in place in the duct work. Prior to coming to the ANL-E, HEPA filters are again tested at a DOE operated testing facility located in Oak Ridge Tennessee, which then supplies the filters to our laboratory. It should be noted that there are two additional filter testing facilities within the DOE complex, namely Rocky Flats, CO, and the other in Hanford, Washington. I visited the testing site at Rocky Flats, and have talked extensively with the filter testing people at Hanford, which is operated by the Hanford Environmental Health Foundation.

DOP is manufactured by Eastman Chemical Products, Inc., which is part of the Eastman-Kodak Company, and is a plasticizer that rivals another plasticizer, Diisononyl Phthalate (DINP). Both are used in the manufacture of flexible polyvinyl chloride (PVC), in other commercial applications. The flexible PVC is then used for the manufacture of storage bags used by blood banks for storing whole blood, an application that has Food and Drug Administration (FDA) approval, and in many household and industrial items such as garden hose and garbage can liners. The material information that is supplied here comes from the Material Safety Data Sheet (MSDS), and from the medical officer of Eastman Chemical Products in Kingsport, Tennessee.

During a routine trip to Westinghouse Hanford Company in January of 1992, I learned through discussions with their personnel that DOP was looked at as a suspected carcinogen, by the state of Washington. The state of Washington, along with the Hanford Site Solid Waste Acceptance Criteria 0063-3 issued by Westinghouse Hanford Company produces rules that we have to live by to dispose of our waste in their disposal facility, or store it in their mixed waste facility. With the addition of DOP to the filters, plus any HEPA filter with a small amount of radioactivity on it, is classified as mixed waste. The economic significance of the addition of DOP is its redefinition from low-level waste to mixed waste. It in our estimation, this is a purely economical decision. The price increases from a rough estimate of \$75.00 to \$80.00 a cubic foot for disposal of LLW, to something like \$330 to \$340 for mixed waste storage. We looked at this extensively, and decided we need to find superior ways of handling HEPA filters both in volume reduction and in characterization, of the material, and review our thoughts with other waste generators at other national labs as well as Westinghouse Hanford, Inc.

Since Westinghouse Hanford Company is under the dictates of Washington Administrative Code, 173-303, which in reality is a law, not any Waste Acceptance Criteria, they have very little choice but to obey the law as they interpret it. Currently, there are several ways we are working with Westinghouse Hanford Company and other Laboratories to solve the problems that will be listed below.

Under Colorado Hazardous Waste Regulations, "...if DOP has been used for its intended purpose the resultant used commercial product (liquid) is not controlled as a RCRA-regulated hazardous waste. As long as the DOP was used for its intended purpose, the object receiving the DOP (filters wipes, machine parts) are not rendered hazardous waste when discarded."

## DE-LISTING OF DOP

A solution to the DOP problem would be a straightforward negotiation leading to de-listing of this product by the state of Washington. A meeting held in mid-October 1992, between DOE-Richland Operations, Westinghouse Hanford Company personnel and the writer, indicated that Westinghouse Hanford Company was going forward with the de-listing. How this fits within the general time frame is not well understood, the four calls that have been placed to get current information for this paper have not been returned as of this writing, so I have little more to

report. At least there is a position to review de-listing and have coordination with the commercial site at Hanford operated by the US Ecology Company. It appears that US Ecology is getting some of the problems generated by the DOP information being disseminated and they may not to accept HEPA filters from the commercial industry.

## DETOXIFICATION OF HEPA FILTERS

A second method for removing the DOP from the HEPA filters has been proposed by using a combination of high heat and high vacuum. Referring to the specifications of DOP, there is a boiling temperature of 723 F at atmospheric pressure, lending itself to very low vapor pressure at normal conditions. In reviewing the high temperature and acknowledging the plywood frame, any temperature that approached the boiling point of DOP would also cause auto ignition of the plywood frame and off-gassing of various adhesives that hold the HEPA filter media to the frame.

In order to reduce the temperature, Argonne National Laboratory has proposed a test where a HEPA filter and HEPA filter media be put into an oven evacuated to 5mm of Mercury absolute, at that reduced pressure the DOP would boil off at approximately 450 F degrees Fahrenheit. This would reduce the risk of fire problems since the process would introduce helium as a transfer medium device to pass through the HEPA filter and help purge the material towards an exit point where it could be analyzed and measured very easily.

## VOLUME REDUCTION FOR SEPARATION AND COMPACTION

Westinghouse Hanford Company, would allow us to put the filter media into a compactor with anti-snap-back disks inside, then compact each HEPA filter media sequentially. When the filter media has completely filled the compacted drum, the anti-snap back discs, which would have a testing hole in the center, could provide a convenient composite sample of all the compacted HEPA filter media. A Toxicity Characteristic Leaching Procedure (TCLP) of the entire drum using a circle saw or "cookie cutter" type device could draw the sample. Obviously, this still produces a mixed waste with accompanying additional costs of a mixed wastes and has the very complicated problems of ALARA as well as the cost of labor and associated dust and inhalation problems which are significant in our waste operation.

In addition to the above mentioned problems we still would have the large quantity of plywood which represents four sheets of 3/4 inch plywood, each two feet in length and one foot in width. The material is extremely difficult to compact, with the only possible advantage being that it could be surveyed under health physics requirements and possibly be considered a waste that could go into the sanitary landfill, this is still questionable.

## COMMERCIAL INCINERATION

Another method would require the use of commercial facilities, and would take the material off-site and allow it to be commercially incinerated with the understanding that we would receive the slag back from the molten glass fibers. The majority of other material, i.e. the plywood and the plastic mastic that glues them together would be incinerated, as well as the PVC bag that covers the filter.

## REMEDIAL TECHNOLOGY - WROUGHT IRON

The final method of disposal of HEPA filters, would require the use of a commercial facility which has metal melting capabilities. Argonne has a sufficient amount of contaminated steel that could be reclaimed in the shielding blocks. If ANL-E could access a system where HEPA filters could be added to the top of molten steel or iron while the metal is being processed, this would produce a drastically reduced volume of the HEPA filter, resulting in only a very small amount of slag produced from the molten form of glass fibers in the HEPA filters. The glass fiber contribution would probably represent the volume of a glass marble. This molten glass could either be incorporated in the steel melt, or skimmed off as slag, depending on how the process operates. In this way, a large number of HEPA filters could be incorporated in one melt of steel. The steel could either be taken back to Argonne National Laboratory-East for disposal or be available for other options, depending on how the system would operate in practice. I have no idea as of this writing, how we would have a TCLP performed in this case, but I feel the relative fact that glass and steel have approximately the same melting points, leads me to suggest that this may easily be a solution if the standards were set up, the procedures approved, and it was allowed to take place. If the slag representing the glass fibers were incorporated in the steel melt, this would result in wrought iron, which is the oldest iron known to man. I would consider this the very best in remedial technology.

## SHALLOW LAND DISPOSAL

An additional alternative to disposal of the HEPA filters would include shallow land burial, and disposal in states having a process for dealing with extremely low-level mixed waste. It is my understanding that Envirocare of Utah is opening up a site for mixed waste under DOE authority in the very near future. The DOE contract will be for the permanent disposal of mixed Resource Conservation and Recovery Act (RCRA) Hazardous/Toxic Substance Control (TSCA) and Radioactive Contaminated Waste.



## REPLACEMENT FOR DOP FOR TESTING OF HEPA FILTERS

Another method that could solve the problem of newly generated HEPA filter waste would be the substitution of the DOP material by other aerosol testing devices which have been reviewed. One that has some play in industry is corn oil, which has been used by the laboratory. It has the problem of smelling like food and of going downhill with bacteria action creating an offensive odor.

The other replacement being reviewed by the Hanford Environmental Health Foundation is Emery 3004 synthetic hydrocarbon 4 CST fluid. Another material that is used in some locations is called DOS. What the future of these materials will be is still questionable, but the problem that remains at Argonne National Lab is our historic waste that has been stored since 1988 when we were refused access to the Idaho Falls disposal. We have a significant backlog of filters, and consequently a very expensive problem to review and solve, with little process knowledge available for documentation.

It should be noted that our problem is not unique within the organization of National Laboratories operated by the Department of Energy.