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State of Wisconsin
Public Hearing
A.B. 701

February 17, 1998

U.S. Oil Co., Inc.
Testimony
Support Documents

State of Wisconsin
Public Hearing - A.B. 701
U.S. Oil Co. Inc. - Comments
Support Documents

1. *Analysis of Environmental Impacts of Used Oil and Oil Filters in Wisconsin Landfills*
   Kimberly Ann Free, University of Wisconsin - Green Bay, Spring, 1997

2. *Used Oil Filter Recycling Surveys - Determining Development for Needed Recycling Infrastructure*
   Stephanie Johnson, University of Wisconsin - Green Bay, May, 1997

3. *Motor Vehicle Oil Filter Recycling Demonstration Project*
   John L. Konefes, Iowa Waste Reduction Center, University of Northern Iowa, 1992

4. *Motor Vehicle Oil Filter Recycling - Revisited*
   James A. Olson, Iowa Waste Reduction Center, University of Northern Iowa, 1992

5. *Used Oil Filter Impact Brochure and Recycling Fact Sheet*
   U.S. Oil Company, Inc., 1998

6. *Fact Sheet #3: Oil and Oil Filter Management* (Online)
   Environment Canada
   Available: http://www.cciw.ca/glimr/data/federal-programs-division
   /environmental-products/factsheet3-pub.html

7. *National Used Oil Collection Study*
   American Petroleum Institute, May, 1996

8. *Priority Substance List Assessment Report - Waste Crankcase Oils*
   Environment Canada, 1994

9. *Used Oil Management Standards*
   Wisconsin Administrative Code, Chapter NR590

10. *Improve Groundwater Protection by Sharing Information, 1995 Continuing Education Program*
    Wisconsin Water Well Association and Wisconsin Department of Natural Resources

11. *No Hazardous Waste Listing for Used Oil that is Being Disposed*
    Environmental Protection Agency, Environmental Fact Sheet, May, 1992

12. *Summary of Superfund Sites with Used Oil Damages*
    Science Applications International Corporation, August 3, 1992

Analysis of Environmental Impacts of Used Oil and Oil Filters in Wisconsin Landfills

Kimberly Ann Free

Spring 1997

INTRODUCTION

In the United States, an estimated one billion oil filters are disposed of in U.S. landfills, a waste with components, oil and steel, which may be recycled. Along with the potential to reuse valuable resources, used oil filters create a threat of undesired contamination into ground and surface waters and consume precious space within the landfill.

Environment Canada stated in a fact sheet regarding oil and oil filter management that after an oil filter has been drained and crushed, to reclaim the oil for recylcing, 12% of the oil remains in the filter. An oil filter which is only drained may retain up to 44% of the oil. They claim that this quanity of oil will likely leach out into a landfill where it is dumped. The used oil contains traces of metals and other contaminants not normally found in unused oil. According to Environment Canada, collecting and recycling oil will help preserve the quality of the soil and water supply and give collection companies the oppurtunity to reuse a non-renewable resource.

Assumptions stated by Environment Canada are shared by U.S. Oil, the city of Combined Locks, and the Solid and Hazardous Waste Education Center (SHWEC). U.S. Oil has demonstrated a commitment to recycling by creating the Oil Filter Recycling Task Force in order to evaluate the possible environmental damages associated with landfill disposal of used oil filters and to determine the most appropriate collection and processing infrastructure for used oil filters. SHWEC has received numerous requests from businesses to facilitate the growth of an infrastructure in the recycling industry because of the increased number of filters and fear of environmental degradation. Any information providing adverse impacts on landfills and surface and ground water could assist in the promotion of recycling used oil filters instead of disposing them into precious landfill space.

Using the U.S. Oil Filter Recycling Task Force and SHWEC's charge and assuming that research beyond the Iowa University Study had not been conducted, I investigated the environmental impacts of used oil and oil filters in Wisconsin landfills. My research included gathering information on past studies, contacting states which had banned oil filters from landfills, contacting Wisconsin landfills, testing leachate from selected landfills, analyzing lab results of polycyclic aromatic hydrocarbon (PAH) tests run on leachate from Wisconsin landfills, comparing leachate data to components of filter oil for PAHs, and investigating characteristics and other sources of potential PAHs in landfills. I then determined the effects of used oil filters in Wisconsin landfills.

RELATED RESEARCH

Federal hazardous waste regulations by both Congress and the Environmental Protection Agency (EPA) classify a waste as hazardous only if it exhibits one or more hazardous characteristics, or if it contains certain toxic constituents in amounts that exceed defined regulatory levels. Three different studies were conducted to determine if used oil filters should be treated as a hazardous waste. The Filter Manufacturers Council (FMC), the Convenient Automotive Services Institute (CASI) and the University of Illinois Center for Solid Waste Management and Research developed and implemented individual studies to determine if used oil filters exhibit the characteristics of a hazardous waste. All three studies concluded that the used automotive filter does not exhibit the hazardous characteristics of ignitability, reactivity or corrosivity. The CASI study stated that the classification of used automotive oil filters as non-hazardous would allow their continued management under the current federal solid waste management system but recommended that efforts in pursuit of an economically viable recycling alternative for the future management of this waste should continue in a timely manner.

METHOD OF RESEARCH

Four states, Rhode Island, Texas, Minnesota, and Florida, have implemented bans on the disposal of used oil filters in landfills. Rhode Island has banned all oil filters from landfills. The filters are treated as a hazardous waste if they are not recycled. No used oil nor used oil filter components may be landfilled in the state of Texas. All handlers of the used oil filters must register with the Texas regulatory agency and follow cradle to grave regulations. The state of Minnesota has a Do-It-Yourselfer and commerical used oil filter landfill ban. No hazardous waste testing is required if the filter is recyled. If they are not recycled, the fiters must be managed as a hazardous waste. In Florida the landfill ban is for commerical generators only. The filter generators and processors must register with the state or contract with a registered processor to manage their used filters. After speaking with three of the four states, I learned that the ban on used oil filters predominantly occured because of the lack of space in the state's landfills and the potential to recylce the steel and oil from the filter. The threat of contamination to groundwater was mentioned, however the states did not test beyond EPA hazardous waste standards in order to put a ban in place.

The state of California considers used oil fiters to be a hazardous waste unless they are recylced. California promotes the recylcing of the oil filters becuase under the state scrap metal exemption language found in California Code of Regulations used oil filters are not exempt. The CA Department of Health Services adopted used oil fiter regulations in order to allow drained used oil filters that are generated in California to be managed as nonhazardous waste when recycled for their metal value.

As stated above, information regarding a federal ban of used oil filters concluded that the oil filters do not exhibit the toxicity characteristic when drained properly. However, I decided

to investigate the PAH concentrations in leachate. Polycyclic aromatic hydrocarbons (PAHs) were tested in samples of leachate from six different landfills in Wisconsin. The landfills used were the south tank of the Brown County east, Sauk County, Green County, Outgamie County, Rodefeld (in Dane Co.), and Winnebago County.

Originally I desired to sample numerous Wisconsin landfills, however my budget allowed for six PAH testings of leachate. I selected the six landfills because they expressed interest in my research and worked with labs which would contract out single assignments. I hired five different labs to run the PAH tests. Each of the labs and dates were selected because of convenience. The landfills sampled have their leachate tested on a monthly or quarterly basis by specific labs. My samples were taken on the scheduled days by the landfill's lab in order to eliminate the additional costs of extraction on a non-scheduled day. Robert E. Lee & Associates sampled Brown County on March 20, 1997. Commonwealth Technology, Inc. sampled Sauk County on March 24, 1997 and Rodefeld Landfill on March 21, 1997. Green County was sampled on March 11, 1997 by En Chem, Inc. Sample was taken on March 7, 1997 at Outgamie County and tested by U.S. Oil Co, Inc. National Environmental Testing, Inc. sampled Winnebago County on March 17, 1997. Landfills and labs which hire out sampling companies did not charge for the actual extraction of the leachate from the landfill. I only paid for the testing of the PAH analysis. The cost of the test ranged from $80.00 to $112.50. The following parameters were tested for in the PAH analysis: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h) anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene. All labs tested for the same 18 parameters using SW-846 Method 8310 or 8270.

I had the oppurunity to visit and experience leachate extraction at the Outgamie County Landfill. After receiving a tour of the landfill I was invovled in the leachate sample retrival. The method of obtaining my sample included the use of a bucket and a long rope. After removing the manhole cover, the sampler dropped the bucket into the hole. The leachate was then poured into a one liter amber bottle which would be sent to the lab. Outgamie County landfill also had two leachate collection tanks. Once the sample had been extracted, I was responsible for it and had to sign a chain of custody once I arrived at U.S. Oil, the labortory which tests Outgamie County's leachate.

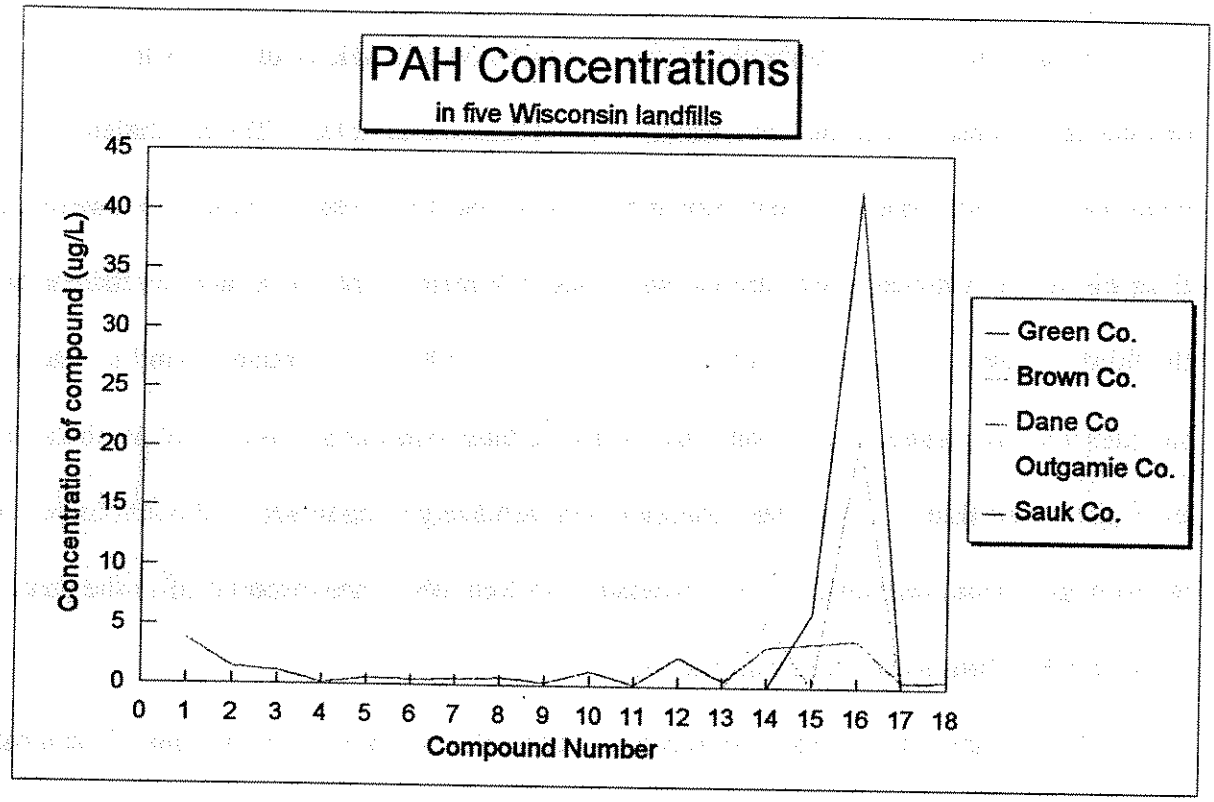
A sample of filter oil and filter paper from U.S. Oil were also tested. U.S. Oil collects and recyles used oil from their customers. An estimated 25 random customer samples were taken in order to create a cross section of different sources for the filter oil sample. The filter oil was tested for PAHs and Volatile Organic Compounds (VOC). The filter paper was tested for flash point, total halogens, ICP metals.

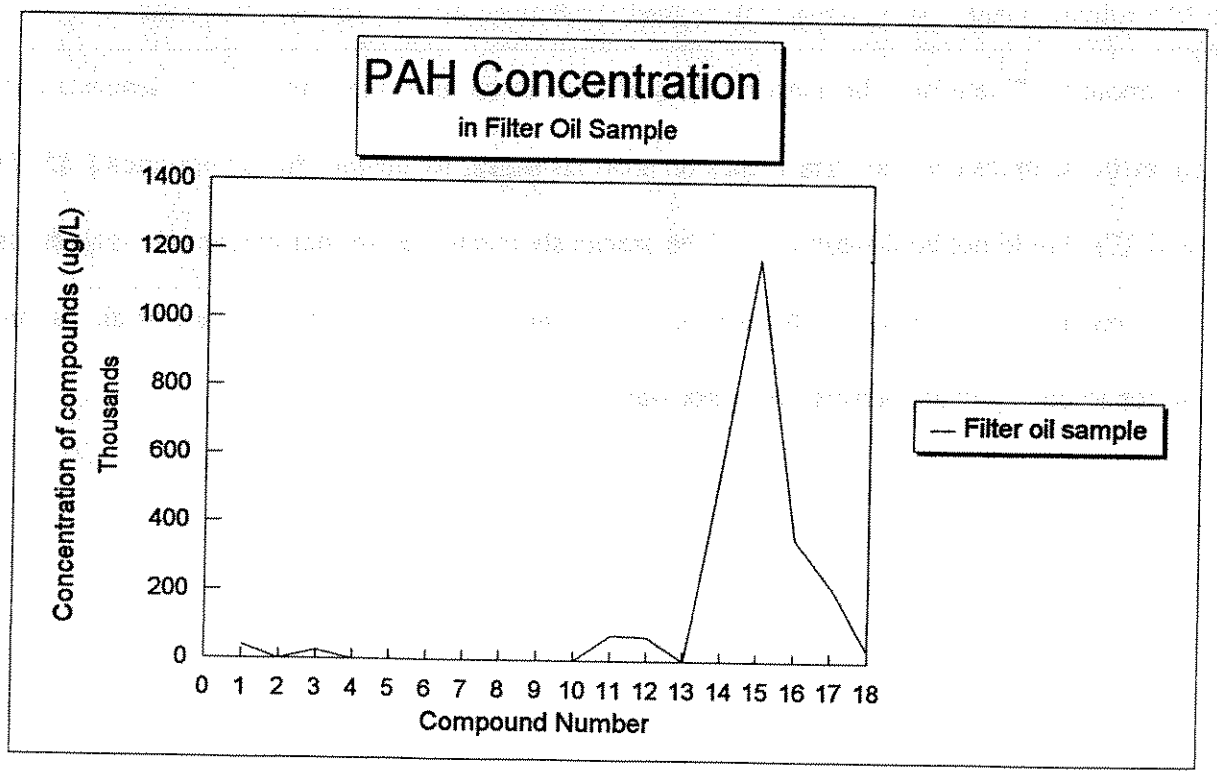
RESULTS

The spreadsheet below lists the concentrations for the PAHs in each landfill. The first graph visually displays the concentrations of the compounds in five of the leachate samples. Winnebago County landfill's values are not included in the graph becuase none of the tested compounds were detected. The second graph displays the concentration of the compounds in the filter oil sample. Both graphs are measured in units of ug/L, however the filter oil graph is in thousands ug/L.

	PAH Compound	Brown Co. East South Tank (ug/L)	Dane Co. (Rodefeld) (ug/L)	Green Co. (ug/L)	Outgamie Co. (ug/L)	Sauk Co. (ug/L)
1	Acenapthene	ND	3.8	18	0.9	ND
2	Acenaphthylene	ND	1.4	ND	ND	ND
3	Anthracene	ND	1.1	ND	0.5	ND
4	Benzo (a) anthracene	ND	0.12	ND	ND	ND
5	Benzo (b) fluoranthene	ND	0.51	ND	ND	ND
6	Benzo (k) fluoranthene	ND	0.42	ND	0.1	ND
7	Benzo (a) pyrene	ND	0.46	ND	ND	ND
8	Benzo (ghi) perylene	ND	0.62	ND	ND	ND
9	Chrysene	ND	0.23	ND	ND	ND
10	Dibenzo (a,h) anthracene	ND	1.2	ND	ND	ND
11	Fluoranthene	ND	0.15	ND	ND	ND
12	Fluorene	ND	2.5	ND	ND	ND
13	Indeno (1,2,3-cd) pyrene	ND	0.45	ND	ND	ND
14	1 - Methylnapthalene	5.5	3.4	2.6	1.3	ND
15	2 - Methylnapthalene	ND	3.7	3.4	2.4	6.2
16	Naphthalene	21	4	ND	14	42
17	Phenanthrene	ND	0.52	ND	0.6	ND
18	Pyrene	ND	0.62	ND	0.25	ND

	PAH Compound	Winnebago Co. (ug/L)	Filter Oil Sample (ug/L)
1	Acenapthene	ND	39000
2	Acenaphthylene	ND	ND
3	Anthracene	ND	23600
4	Benzo (a) anthracene	ND	ND
5	Benzo (b) fluoranthene	ND	ND
6	Benzo (k) fluoranthene	ND	ND
7	Benzo (a) pyrene	ND	ND
8	Benzo (ghi) perylene	ND	ND
9	Chrysene	ND	ND
10	Dibenzo (a,h) anthracene	ND	ND
11	Fluoranthene	ND	75000
12	Fluorene	ND	72000
13	Indeno (1,2,3-cd) pyrene	ND	ND
14	1 - Methylnapthalene	ND	570000
15	2 - Methylnapthalene	ND	1180000
16	Naphthalene	ND	360000
17	Phenanthrene	ND	221000
18	Pyrene	ND	36000


PAH Concentrations
in five Wisconsin landfills
Concentration of compound (ug/L)
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Compound Number
Green Co.
Brown Co.
Dane Co
Outgamie Co.
Sauk Co.


PAH Concentration
in Filter Oil Sample
Concentration of compounds (ug/L)
Thousands
1400
1200
1000
800
600
400
200
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Compound Number
Filter oil sample

DISCUSSION

As seen in the two graphs above, the concentration of PAHs in oil filters is expontentially greater than the concentrations in the leachate samples. The napthalene compound had the highest concentration in four out of the six leachate samples. However, the filter oil sample's highest concentration was found in 2-methylnapthalene, and napthalene was the third highest concentration. Additionally, some of the PAH compounds found in leachate samples were not detected in the oil filter, therefore those concentrations are not attributable to used oil and oil filters. Napthalene concentrations are likely to be linked to the amount of coal tar from petroleum refining and coal processing products which are disposed of in the landfill. All of the landfills accept industrial wastes.

Table 1 gives the physical properties of polycyclic aromatic hydrocarbons. The most critical property sited for this research is the water solubility of the compounds. 1-Methylnapthalene, 2-Methylnapthalene, and Napthalene were the most water soluble compounds. Therefore, the concentrations of these three compounds in both the leachate and filter oil samples (see data and graphs on previous pages, particulary for compounds # 15, 16, and 17) should not be disregarded. The previously mentioned studies performed analysis on the toxicity characterisitics of the used oil in oil filters, however the PAH concentrations and water solubility characteristics were not sited.

Table 1: Physical Properties of Polycyclic Aromatic Hydrocarbons

Compound	Molecular Weight	Melting Point (Celcius)	Boiling Point (Celcius)	Water Solubility @ 25 C (mg/L)
Acenapthene	154.21	95	279	3.42
Anthracene	178.24	216	340	0.045
Acenapthlylene	152.2	80-83	280	3.93
Benz (a) anthracene	228	84	-----	0.0057
Benz (a) pyrene	252.32	176.5	311	0.0038
Benz (b) fluoranthene	252.32	168	-----	0.014
Benz (k) fluoranthene	252.32	217	-----	0.0043
Benz (g,h,i) perylene	276.34	-----	-----	0.00026
Chrysene	228.2	254	488	0.006
Dibenz (a,h) anthracene	278.35	266-267	524	-----
Fluoranthene	202.26	107.8	384	0.265
Fluorene	166.22	114.8	295	1.98
Indeno (1,2,3-cd) pyrene	276	164	536	0.00053
1-Methyl napthalene	142.19	-22	240-243	**26-28**
2-Methyl napthalene	142.19	34	241-242	**26-28**
Napthalene	128.16	80.5	217.9	**31.7**
Phenanthrene	178.22	100	340	1.277
Pyrene	202.26	149-151	404	0.135

CONCLUSION

The Environmental Protection Agency and the federal government have presently not considered used oil filters as a harzardous waste. Used oil filters do not demonstrate toxicity characteristics nor high concentrations of polycyclic aromatic hydrocarbons. However, the threat of contamination from used oil and oil filters into our ground and surface waters and the lack of landfill space should push the state of Wisconsin towards the promotion of recylcing the steel and oil found in the filters.

The water solubility properties and greater concentrations of 1-Methlynapthalene, 2-Methlynapthalene, and Napthalene in landfill leachate and filter oil samples should warrant the state of Wisconsin to conduct further investigation on the impacts of the polycyclic aromatic hydrocarbons in leachate. Given more time and resources, my research would have included impacts on soil, reduction of adhering materials, and a time factor on the landfills. I would research soil samples of the landfills in a similar manner to the leachate sample testing. The state of Wisconsin is pulling materials, such as plastic and paper out of the waste stream. Therefore, I believe the impact of less materials in the landfill for the oil to adhere to should be analyzed. Lastly, the impact of time on breakdown of the PAHs in the landfills should be followed.

Regardless of the contamination impact of used oil filters in landfills and ground and surface water, the state should push for increased recycling efforts of used oil filters. First, landfill space is precious for all states, therefore materials which may be recycled should be eliminated from the landfill disposal waste stream. Secondly, oil and steel are both valuable resources. Recycling efforts could reduce the use of virgin oil and open a larger market for used oil products. Lastly, my research, along with studies around the country, do not

conclude that used oil has a negative impact on the environment. However, I am not confident that this research alone is the foundation to overlook future impacts of used oil filters in landfills.

Works Cited

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Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. 2nd edition.

USED OIL FILTER RECYCLING SURVEYS

Determining development for needed recycling infrastructure
and markets to facilitate used oil filter recycling.

By: Stephanie Johnson
University of Wisconsin - Green Bay
Intern - Solid & Hazardous Waste Education Center
May 23, 1997

I have conducted this research as an internship project for the University of Wisconsin - Green Bay. All results presented are based on the number of respondents that were received. Your facility has requested a copy of the research results which are enclosed. If your facility would like any more information in regards to this project, telephone the Solid and Hazardous Waste Education Center - UW Extension at (414)465-2327. Thank your for your interest.

RESULTS OF RESEARCH PROJECT:
Three surveys were conducted from January - April 1997. Each set of surveys had a target group and goals to achieve. They are defined as follows:

Survey 1: Targeted at Wisconsin area foundries.
Goal: To determine foundries currently using recycled filters and what requirements are necessary for use. To determine what barriers prevented the use of recycled filters at those foundries not using recycled filters.

Survey 2: Targeted at Used oil filter Processors and Collectors.
Goal: To determine how used oil filters are processed and the most common end product. Also, to locate processors and collectors and to identify each facilitie's functions for a final database.

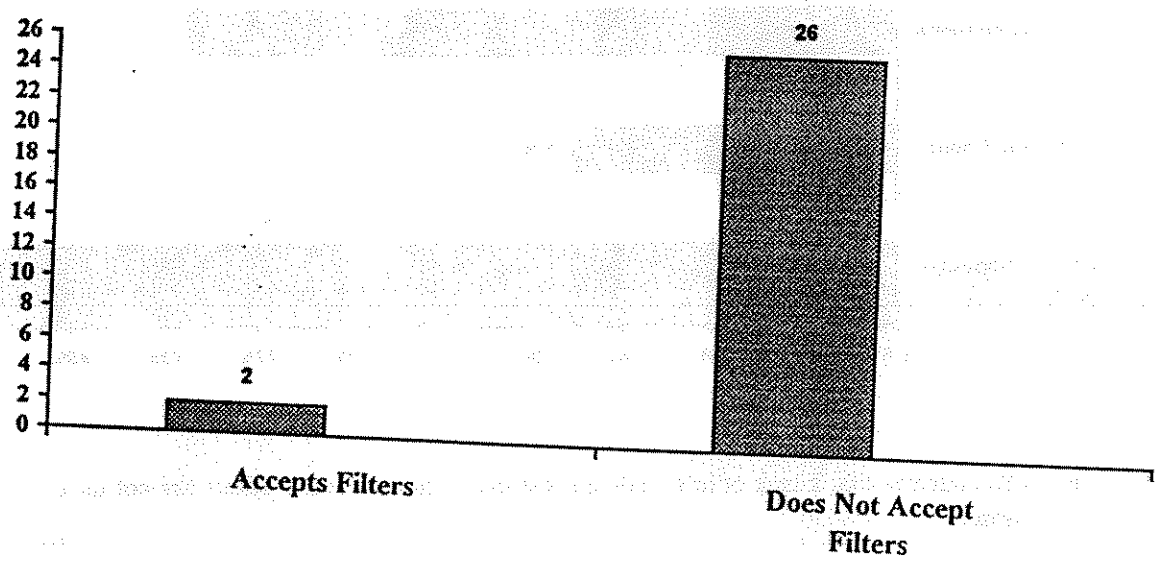
Survey 3: Targeted at Wisconsin area used oil filter generators including car dealerships, manufacturing companies and oil changing service shops.
Goal: To determine how used oil filter generators are commonly disposing of used oil filters and why. Also, to determine what barriers exist preventing generators from recycling and if recycling would be more feasible if it was mandated.

The results of each survey are summarized in the following report.

SURVEY #1

The first survey was directed at Wisconsin area foundries. The goal of the survey was to determine how many foundries are currently using recycled oil filters at their facility. The survey was not comprehensive of all Wisconsin foundries. In Wisconsin alone, there are hundreds of foundries, only seventy of these foundries were surveyed. The foundries which were targeted were those already known to accept recycled filters or those who manufacture products commonly manufactured with processed filters. There were 28 respondents which represent a 40% response rate. All graphs are representative of that 40% that responded.

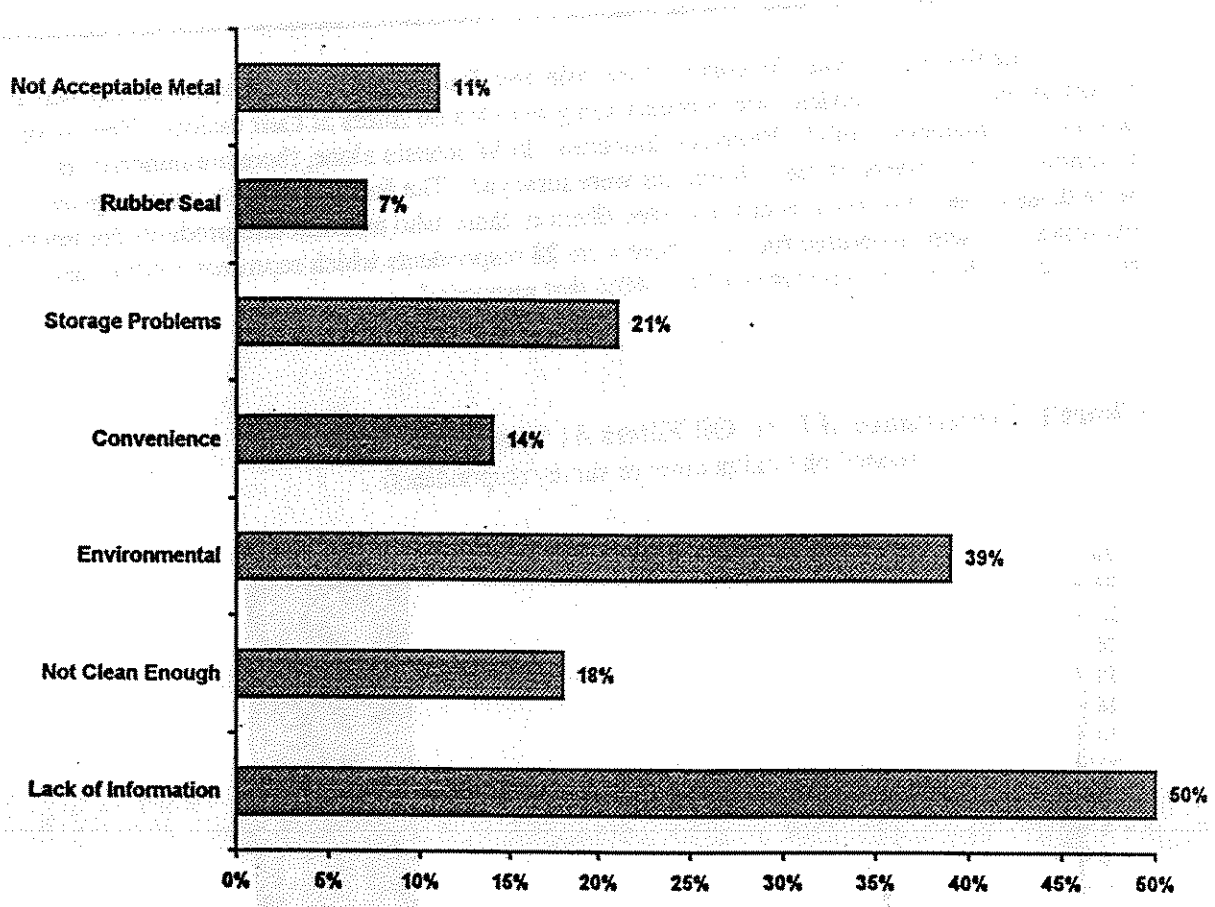
Chart 1: Acceptance of Used Oil Filters At Wisconsin Foundries
(Based on total number or survey respondents)



- It was determined that the majority of Wisconsin area foundries surveyed do not use recycled filters at their facility.

- Therefore, the survey results were useful in identifiying the barriers causing foundries not to purchase recycled filters.

Chart 2: Barriers Preventing the Use of Recycled Filters at Wisconsin Foundries (Based on Total Number of Survey Respondents)



* The graph indicates that a lack of information is the main reason used oil filters are not used by end-users.

* It is important that a connection be made between the used oil filter processors and end-users in order for the market to further develop.

* Other factors such as convenient collection and distribution of used filters and a cleaner processing technique need to be developed.

* Two foundries were identified that have used or currently are using recycled filters at their facility. Purchasing amounts of used oil filters are very large (approximately 20 tons on an as needed basis). Below is a table defining their responses to survey questions.

Table 1: Survey Responses of Foundries Utilizing Recycled Oil Filters
(Based on total number of respondents)

Survey Question:	Foundry #1	Foundry #2
What type of processed filters are accepted at this facility?	Briquettes	Briquettes & Shredded
What uses are the recycled filters serving at the facility?	Drainage Product	Regular Scrap Steel
Problems that have been encountered while using processed oil filters.	They pose a fire hazard	Environmental problems - the end product has too much oil residue.
What changes would you recommend to better meet your acceptance requirements?	Decrease filter residue	Somehow process filter to remove oil and filter media.

- The table shows the most commonly accepted form of recycled filters are briquettes.
- No foundry was identified as using the filters as a fuel source, most likely because of the air pollutants released when burning filters with large amounts of oil residue.

SURVEY #2

The second survey was targeted at Wisconsin and Northern Illinois used oil filer processors. The information accumulated through the research of the first survey was used to help design the questions in this survey. Questions were designed to determine what procedures processors are using to recycle filters and what the ultimate end product is. Forty-two processors, collectors and transporters throughout Wisconsin were surveyed and eleven responses were received. This is a 26% response rate. All information presented in the results are based on the total number of respondents.

- Because state law does not yet require that oil filters be recycled, the business of recycling oil filers is still customer service focused. It is important for processors and collectors to understand what end-user needs they must meet in order to maintain an operating business.
- Survey results showed that many facilities provide collection, transportation and processing services. Still some only provide one or two of these services.

State law considers used oil filters a solid waste as long as they are not mixed with any listed hazardous wastes. However, law requires that the used filters are hot drained of used oil for at least 12 hours after removal. All processors and collectors must, therefore require the same. This survey determined, not all processors or collectors require hot draining of the used filters.

There are various standards that must be met for certain processors and collectors to accept used oil filers from a generator. These may be specific amounts of waste filters, conditions of filter (crushed vs. uncrushed), or certain types of filters. In addition, various facilities that responded have various end products.

Table 2: Wisconsin Processors, Collectors, and Transporters

(Based on those who responded to the survey)

Company Name	Address	City	State	Zip	Telephone	Operations	Quantities of Collection	Price of Collection	Requirements of Collection	End Product
A & W Iron and Metal, Inc	7588 Otten Dr.	Keuaskum	WI	53040	(414)338-8487	Collector/ Transporter	55 gal. drum	Varies	Crushed & uncrushed filters	Shredded pieces & separated media/steel
Arcadia/ Alma Recycling	1420 E. Wanek Ave.	Arcadia	WI	54612	(608)323-3385	Collector	Any amount/ drop off collection	$0.50/per each filter	Only uncrushed drained filters	Do not process
Como Lube & Supplies, Inc.	2728 W. Superior St.	Duluth	MN	55816	(218)722-2926	Processor/ Collector/ Transporter	30,55,110 gal. drums	Varies per drum size	Accepts all filters	Briquettes
Jacobus Envronmental Services	3715 Lexington Ave.	Madison	WI	53714	(608)241-3883	Collector/ Transporter	55 gal. drum	$75.00/ drum	Accepts all filters	Do not process
OSI Environmental Service	3443 W. Mill Rd.	Milwaukee	WI	53209	(800)732-5667	Processor/ Collector/ Transporter	30,55 gal drums	$40/$55 per drum	Accepts all filters in drums	Briquettes
Rock Oil Refining, Inc.	PO Box 105	Stratford	WI	54484	(715)687-4198	Processor/ Collector/ Transporter	55 gal drums	$75.00/ drum	Accepts all filters in drums	Separated media & steel
Safety Kleen - Kauakuna	2201 Badger Rd.	Kaukauna	WI	54130	(800)669-5882	Collector/ Transporter	Various drums sizes - 16 gal & up	Varies depending on drum size	Accepts all filters in drums	
Safety Kleen - Madison	2325 Daniels St.	Madison	WI	53704	(608)221-0714	Processor/ Collector/ Transporter	30,55 gal drum	$109/drum and up	Accepts all filters in drums	Separated steel, media, oil
Sal Services, Inc.	1642 Raymond Ave.	Raymond	WI	53126	(414)895-3737	Processor/ Collector/ Transporter	55 gal drum	Varies	Accepts all filters in drums	Briquettes
WRR Environmental Services	5200 State Rd. 93	Eau Claire	WI	54701	(715)836-8764	Processor/ Collector/ Transporter	55 gal drum	Varies	Crushed & uncrushed filters	Shredded pieces & separated media/steel
People's Fuel, Inc.	2021 36th St. N	Wis. Rapids	WI	54494	(715)423-6280	Collector	Drop off collection only	$0.50/ filter	Accepts all filters	Do not process

All of the information in Table 3 is important to generators so they may determine what requirements they must meet to have their used filters recycled. The information accumulated through this research may also be helpful to end-users and has been supplied to those end-users who indicated they were interested in assistance locating a collector or processor. Waste management specialists may also use the information from Table 3 to help identify the best processing and collection facilities for interested end-markets.

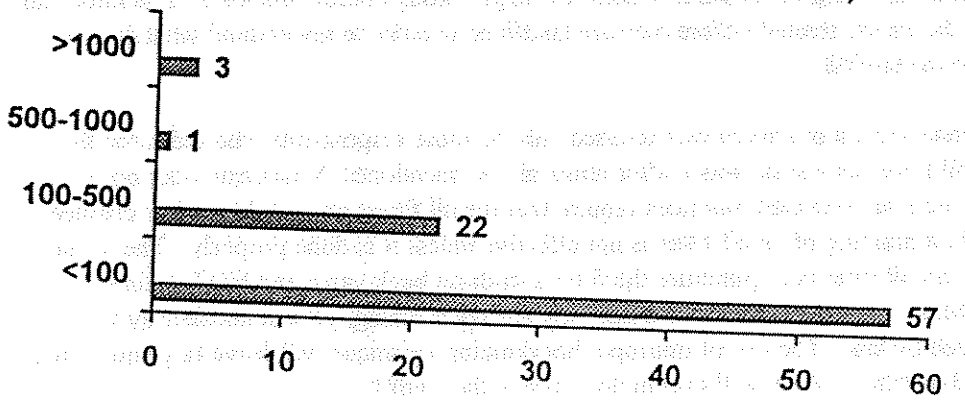
Survey one determined that only 14 % of the respondents (foundries) felt that convenience is a barrier preventing the use of processed filters at their facility. Information in Table 2 shows that not all processors collect used oil filters or transport the filters to the end users. Because convenience is not a major reason filters are not used by foundries, the services offered by processors and collectors are appropriate. However, end users said that lack of information, and environmental hazards posed by the remaining oil residue were primary reasons the processed filters are not accepted. The processors must, therefore, reevaluate the processes in which the used oil filters are recycled or modify the end product to better satisfy the demands of the end users for a cleaner processed end product.

SURVEY #3

The last survey conducted was targeted at Wisconsin Generators including car dealerships and quick lube shops. A total of 446 generators were surveyed in Wisconsin and 83 responses were received at the time this report was prepared. This represents an 18.6% response rate.

Out of the 83 generators which responded, over 12,500 oil filters are generated weekly, or over 650,000 annually. 84% of those who responded claimed they are currently landfilling the oil filters at their facility, which represents 10,500 used oil filters entering the landfill on a consistent weekly basis. However, each generator disposes of anywhere from 1 to 5000 oil filters weekly, per the survey questions. The chart below categorized the amount of oil filters disposed of at generating facilities.

Chart 4: Number of Used Oil Filters Generated At Oil Changing Facilities (Based on total number of Respondents)



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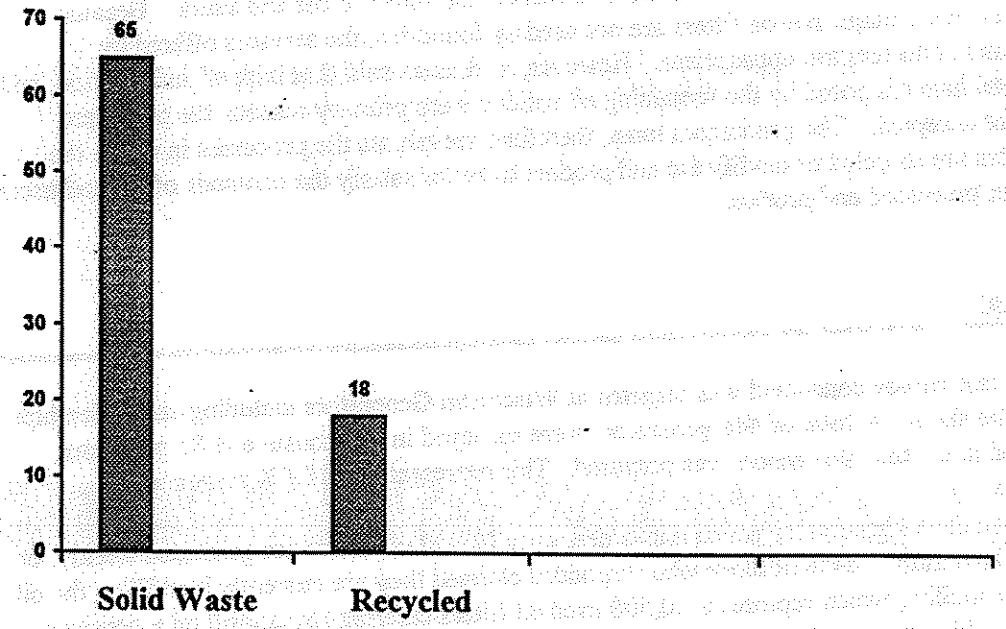
- The chart shows that most generators are disposing of less then 500 oil filters weekly.

- The large quantity generators (over 500) are not recycling.

The objective of this survey was to determine what procedures generators follow when disposing of used oil filters. The first section of the survey focused on evaluating whether oil filters are typically recycled or treated as a solid waste after removal at a generator's facility.

Chart 5: Methods of Disposal For Used Oil Filters

(Based on total number of survey respondents)

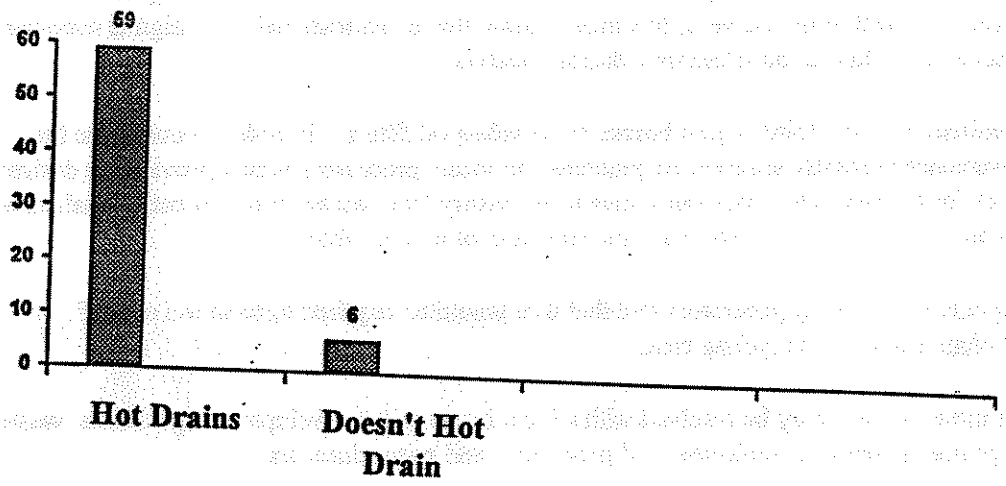


- The graph shows that 77% of the respondents do not recycle oil filters generated at their facilities.

In order to develop convenient collection processes, the survey evaluated the processes generators currently handling oil filters as a solid waste go through before disposal. It is important to know how oil filters are treated before they are landfilled in order to understand what dangers they may pose to the landfill.

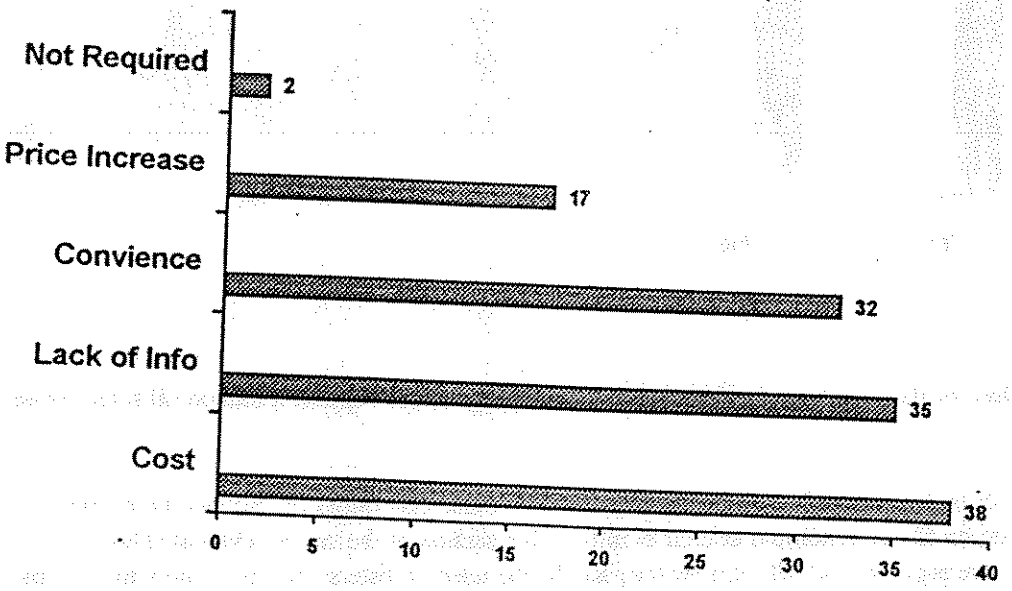
The second section of survey was focused only on those respondents who indicated that they treat used oil filters as a solid waste after removal. As mentioned, Wisconsin does not yet require that oil filters are recycled, but does require that the oil filters are hot drained or crushed after removal. Hot draining of an oil filter is not effective unless it is done properly. The proper way to hot drain an oil filter is to puncture the filter anti-drain back valve and HOT drain for at least 12 hours. Many respondents indicated that they are hot draining, yet not necessarily for 12 hours as mandated by law. The use of improper hot draining technique will leave large quantities of oil in the used oil filters which will eventually settle in the landfill

Chart 6: Number of Generators That Hot Drain Used Oil Filters Before Disposal as Solid Waste (Based on total number of respondents)



Since over 77% of the generators surveyed indicated that they do not recycle oil filters generated at their facility, it is necessary to determine why. By discovering what barriers exist preventing generators from recycling, the barriers may be resolved. Chart 7 describes what generators indicated as the primary reasons for not recycling used oil filters generated at their facility.

Chart 7: Barriers Preventing Generators From Recycling Used Oil Filters (Based on total number of respondents).



- Most respondents indicated that cost is a barrier. In order to decrease costs to generators, a more profitable market must be developed to cover the cost of collection and processing.

- Lack of information was also listed as one of the top reasons generators do not currently recycle used oil filters. Many generators stated that they were unaware that recycling was even an option. As with other surveys, this may indicate that an educational campaign is necessary to promote recycling as an alternative disposal method.

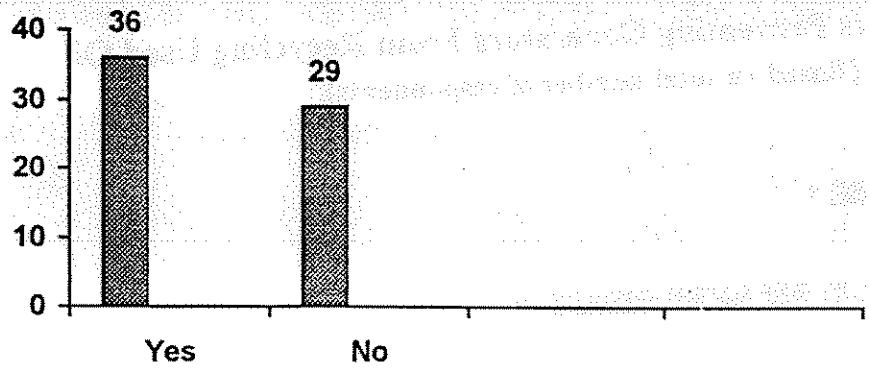
- Convenience was the third largest barrier to recycling oil filters. In order to overcome the inconvenience currently imposed on generators to locate processors which provide the desired services for the generator, assistance may be necessary from waste management specialists or others interested in further promoting the recycling of used oil filters.

- Along with costs, many generators feel that they would be required to raise the cost of an oil change to cover recycling costs.

- All of these barriers may be resolved with efforts from market development specialists, waste management specialists, collectors and processors and state educators.

Those generators surveyed who indicated that they don't recycle oil filters were asked if they would support the recycling of oil filters if it was mandated. The results are presented in Chart 8.

Chart 8: Would Generators Support a Mandated Recycling Program For Used Oil Filters? (Based on total number of respondents).

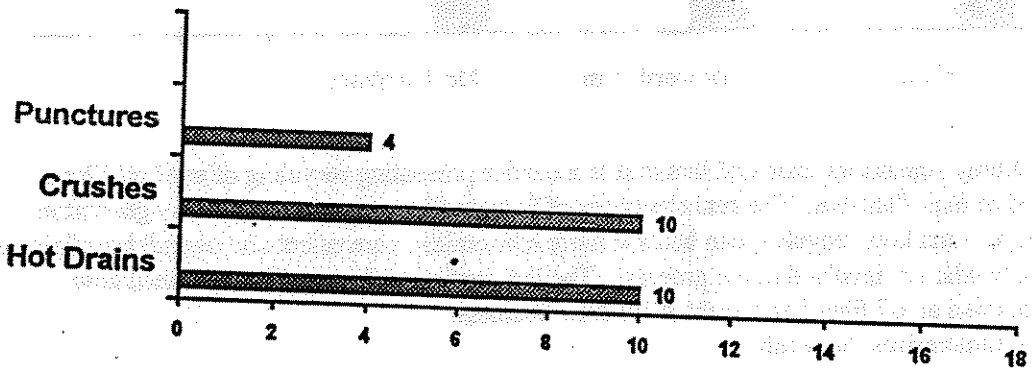


- Over half of those surveyed (55%) indicated that they would support a ban on oil filters from a landfill.

Section two of the last survey was focused on those generators (22%) who do currently recycle used oil filters generated at their facility. This section of the survey evaluated how generators are recycling oil filters, how they handle the used oil filters and lastly, how they recover the costs incurred for paying collection and processing fees.

The same state laws apply to those generators that recycle oil filters as do to those generators who do not recycle oil filters. The filters still must be hot drained or hot drained and crushed. Chart 9 characterizes the disposal practices of used oil filter generators which recycle used oil filters.

Chart 9: Disposal Practices of Generators Which Recycle Oil Filters
(Based on total number of respondents)



- There were 18 respondents stating that they recycle oil filters, 56% of those respondents hot drain and crush the oil filters.
- 44% of the generators now recycling are not hot draining or crushing the oil filters leaving the oil residue to be removed by processors.
- Of the 56% hot draining generated oil filters, only 3 of the respondents are allowing draining to occur for the appropriate 12 hours or more.

Cost of recycling used oil filters was listed as a barrier to those that do not yet recycle generated filters. In addition, many generators fear a price increase would be necessary in order to recover the costs of recycling.

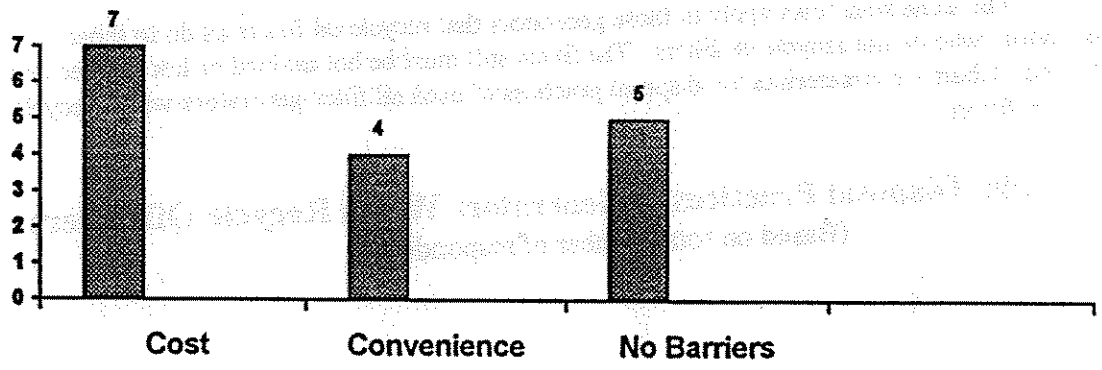
- 6 generators declared that they do increase prices anywhere from $0.50 to $2 for each filter that is disposed of.

- 3 generators stated that they do not, at this time, recover the costs of recycling.

As with those generators who do not recycle, convenience and cost are the two largest obstacles to recycling. Chart 10 describes the barriers faced by those generators who do recycle used oil filters.

Chart 10: Barriers Generators Encounter While Recycling Oil Filters

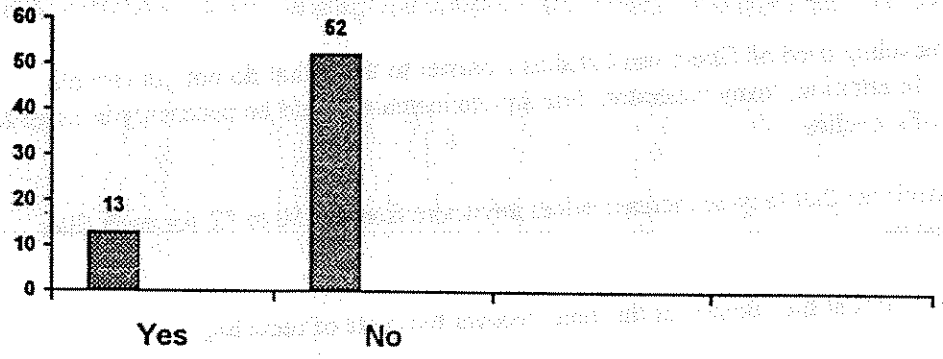
(Based on total number of respondents)



Many generators indicated that cost is a barrier preventing recycling of used oil filters generated at their facilities. The real objectives of Survey #3 were to determine why generators don't recycle and how recycling can become more economical, convenient and overall beneficial to all of those who are involved in the process. The last section of Survey #3 determined how generators feel an oil filter ban would effect their business.
Chart 11 summarizes the results.

Chart 11: Would Participating In An Oil Filter Recycling Program Have Less Impact On Your Business If It Was Mandated?

(Based on total number of respondents)



An overwhelming number (77%) felt that a mandatory filter ban would not decrease economic impact of recycling on their business. If oil filter recycling was mandated, all oil changing facilities would be required to recycle and pay collection and processing costs. Because each facility would be paying this extra fee, it is assumed that each facility would, in turn, increase prices to recover the cost. It is possible that generators did not make that correlation while responding to the question, or generators simply do not feel a filter ban would help decrease the economic impact of recycling. Yet, it is still important to recognize that 55% of those surveyed would support a ban of oil filters from a landifill (Chart 8).

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Used Oil Filter Recycling Surveys: Determining Development for Needed Recycling Infrastructure and Markets to Facilitate Used Oil Filter Recycling

Report Correction/Addendum

Issued February 4, 1998
Mary Kohrell, Recycling Markets Specialist

Chart 6 on page 13 of the report indicates that 59 respondents hot drain oil filters, while 6 do not hot drain. Upon re-examination of survey results, it appears that 61 respondents said they hot drain filters; 6 do not hot drain. The amount of time the filters are hot drained varied in survey responses as follows:

- 12 hours or less - 28%, or 17 respondents
- between 12 and 24 hours - 47.5% or 29 respondents
- over 24 hours - 24.5% or 15 respondents

It should be noted that responses to this particular survey were limited. It is possible that survey results are skewed in favor of those generators with good filter handling practices.

MOTOR VEHICLE OIL FILTER RECYCLING DEMONSTRATION PROJECT

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ABSTRACT: It is estimated that 6.6 million used motor vehicle oil filters are discarded annually in the State of Iowa, primarily through municipal landfill disposal. These filters leach as much as 400,000 gallons of used oil into the landfills and potentially threaten ground and surface water quality. Reduction or elimination of this environmental threat was evaluated in three phases: (1) waste management procedures to reduce residual oil in waste oil filters at the point of generation; (2) mechanical processing (hydraulic compaction) of waste oil filters to extract additional quantities of residual oil; and (3) recyclability potentials for the by-products created through mechanical processing of the filters. Report data show 88% of the residual oil contained in waste motor vehicle filters is extractable through proper management. Of this, approximately half may be recovered through simple filter inversion and draining. The remaining oil contained in the "drained" filter canister may be recovered by compaction in a hydraulic press. The oil remaining in the filters (12%) appears to be oil that has been absorbed into the actual filtration media and is not available for recovery as a free liquid. Recovered oil and filter canister metal were tested for a variety of environmental parameters and can be recycled through existing oil and scrap metal reclamation markets. Recycling of the oil saturated filtration media may be possible through incineration for energy recovery.

INTRODUCTION

U.S. motor oil sales were estimated at 1.2 billion gallons during 1983. Of this 1.2 billion gallons, approximately half of the oil was released into the environment through vehicle leakage, combustion, and disposal of oil saturated motor vehicle oil filters (Swanson, 1989). Each type of release results in less oil available for reclamation and poses increased potential for contamination of our air, soil, and water. Oil released due to vehicle leakage and combustion can be minimized through proper vehicle maintenance (i.e. servicing seals, piston rings, and valves in accordance with manufacturer specifications). Waste generated by motor oil changes and filter replacement is a direct result of scheduled vehicle maintenance activities and a requirement of all vehicle manufacturers.

Studies have shown used motor oil contains varying concentrations of lead, cadmium, chromium, arsenic, and barium (Salvesen Associates, 1988) all of which have been defined as toxic, hazardous waste components by the Resource Conversation and Recovery Act (RCRA). Other components such as benzene, a listed carcinogen, are known to be present in used oils as well. As a result of the potential health and environmental concerns, used oil is regulated under RCRA for commercial waste generators and has been banned from landfill disposal by most states. Compliance with the used motor oil regulations is easily accomplished due to availability of an existing and cost effective used oil recycling industry. However, the used oil recycling industry does not, at the present time, lend itself to collection and recycling of used oil filters/ With few exceptions, federal and state regulations do not address the hazardous/non-hazardous nature of used oil filters, nor do they mandate specific management and disposal practices. Due to lack of regulatory direction and the unavailability of cost effective recycling options, most used oil filters are disposed of in municipal landfills. The residual oil

contained in the filters may potentially leach from the landfill and into ground and surface water sources. This study offers alternative waste management techniques which will reduce or eliminate harmful oil introduction into landfills due to common used oil filter disposal practices. Specific areas addressed in the report include:

(1) Used oil recovery from oil filters by simple inversion and draining.
(2) Used oil recovery from oil filters by compaction using a commercial, hydraulic oil filter press (a partial list of filter press manufacturers is enclosed a Appendix 1).
(3) Potential means to recycle the by-products generated from the oil filter compaction process, namely the recovered oil, metal canister, and oil saturated filter media.

MATERIALS AND METHODS

The oil filter drainage phase of the project utilized used oil filters collected from two automobile service centers. The filters were carefully collected to maintain the quantity of oil present in the filters at the time they were removed from the vehicle. Initial weights were recorded for each filter. The filters were then inverted, placed on a wire grate platform and allowed to drain. Each filter was removed from the drainage platform and reweighed at 4 hour intervals. The difference in filter mass over time was converted into volume measurements and used as the basis for performance evaluation. The filters were then compacted in the oil filter press as a means to determine the quantity of recoverable oil remaining in the filters after simple drainage.

Mechanical processing (hydraulic compaction) was accomplished using a Model P200, Oberg Oil Filter Press (Specifications are included as Appendix 2). Approximately 1200 used oil filters were collected from 8 automobile, truck, and agricultural equipment service centers. In an effort to collect filters that were representative of those that would be discarded through landfill disposal, no collection criteria were given to the collection sites. Each filter was weighed and measured for initial dimensions. All data were recorded on field data sheets and entered into a data base for calculation and data manipulation. In addition, the manufacturer and part number for each filter were recorded. The filters were placed in the filter press and compacted. Compacted filters were weighed and measured again to establish performance data. The recovered oil and compacted filter canisters were collected for subsequent processing and/or recycling.

Three separate containers of recovered oil were collected during the course of the project. Each container was sampled for laboratory analysis. Based upon review of the laboratory data, the oil was collected by a permitted oil reclamation company for recycling as an alternative fuel or for re-refinement. Compacted filter canisters were transported to a scrap metal yard where they were shredded to separate the metal and filter media components. The separated metal was combined with other scrap metal sources for smelting. Filter media (oil saturated paper) was sampled and tested for RCRA hazardous waste characteristic and state landfill acceptance parameters. These data were evaluated in an effort to suggest possible recycling options or appropriate disposal means.

REGULATORY REVIEW

Generators of solid waste are required to determine the hazardous/non-hazardous nature of each waste material in compliance with Resource Recovery and Conservation Act (RCRA) regulations. (Note: solid wastes are defined as solids, liquids and contained gases). The hazardous/non-hazardous determination may be conducted through laboratory analysis or thorough knowledge of the waste material. Wastes are defined as hazardous through specific EPA listing or if they exhibit one or more of the following characteristics:

- Ignitability
- Corrosivity
- Toxicity
- Reactivity

Specific laboratory protocols have been established to test waste materials for these characteristics. Toxicity is evaluated using the Toxicity Characteristic Leaching Procedure (TCLP) laboratory method. The TCLP is an indirect measure of the contaminant levels contained in a waste and designed to simulate the effect leaching (water percolation) has on the waste after it is landfilled. TCLP testing is basically a three step process. Waste samples are first filtered through a 0.45 micrometer membrane to separate the liquid and solid phases. Materials that will not pass through the filter (solids and viscous liquids) are placed in a tumbling device (extractor) along with a pH controlled water and allowed to mix for 24 hours. At the end of the mixing period, the extractor liquid is separated from extractor solids and is combined with the liquid obtained during the initial filtration step (if any). This mixture is then tested for the 40 TCLP test parameters listed in Appendix 3. If test results show any of the 40 parameters in excess of the corresponding regulatory limits, then the waste is hazardous due to toxicity.

Used oil destined for recycling is regulated under a separate set of RCRA regulations. These regulations divide the used oil into two different types; off-specification used oil and oil that meets the specifications. Oil is considered off-specification if it exceeds any of the following levels:

Arsenic	5 ppm	maximum
Cadmium	2 ppm	maximum
Chromium	10 ppm	maximum
Lead	100 ppm	maximum
Flash Point	100°F	minimum
Total Halogens	4000 ppm	maximum

If the used oil <u>does</u> meet the specifications, it can be recycled without further regulatory restriction. If the used oil <u>does not</u> meet the specifications, the facility recycling the oil must do so under EPA approval and regulation.

Specification testing for used oil is accomplished using methods that provide the actual <u>total</u> concentration of the contaminant in the used oil sample. It is important to note, a comparison or conversion of <u>total</u> concentration laboratory data and TCLP data is not possible due to the variation in testing procedures. TCLP data are indirect measures of contaminant levels. Total concentration data are, as the name implies, direct measurements of the total quantity of contaminant present in the sample.

The hazardous/non-hazardous determination based on the TCLP is a relatively straightforward process for most waste types. However, TCLP testing of oil samples is problematic. As will be discussed later, TCLP data obtained from analysis of the oil filter filtration media reported laboratory detection levels in excess of the corresponding TCLP regulatory limits (eg. 2,4-dinitrotoluene laboratory result was reported as <0.50 milligrams/liter and the regulatory limit has been established at 0.13 milligrams/liter). Since the laboratory data cannot verify that the sample does contain less than the regulatory limit, the data may not be used to document that the media is non-hazardous. In this event, the media must be assumed as hazardous by default. The EPA recognizes this type of occurrence and has responded with the following policy statement as documented in a letter from A. McBride to R. Leonard dated August 1, 1990:

"There are situations when the laboratory is asked to perform an inappropriate test. The TCLP was not intended to be applied to oil or solvent matrices. The matrix itself is probably

hazardous and can cause a flammability or explosivity characteristic test failure. Your client will be better served in this case by assuming his wastes to be hazardous, since the laboratory can not demonstrate non-hazardousness with the TCLP for these materials. Possibly, if the treatment your client intended were incineration, you would apply TCLP to the ash".

Although the EPA states that the TCLP is inappropriate for oil and solvent based wasted, it is the only method available at the present time for use in determining the hazardous/non-hazardous characteristic for toxicity. A memo from S. Lowrance to R. L. Duprey (dated October 30, 1990 and enclosed as Appendix 4) addresses the regulatory determination on used oil filters. In summary the memo states:

"If the (used oil filter) generator recycles both the used oil and metal, you do not need to test (for the toxicity characteristic) because recycling of both types of materials are exempted from hazardous waste regulation as discussed below."

"Assuming a used oil filter exhibits the TC (toxicity characteristic as determined by TCLP testing), you had inquired whether the act of crushing filters is regulated (hazardous waste) treatment or exempt recycling. Generally, the types of used oil filter crushers you described would not be regulated if the used oil was being recycled (see 40 CFR 261.6 (a) (2) (iii) and (a) (3) (iii)). That is, since the purpose of the crushing is to remove the used oil for recycling, we view the crushing to fall within the used oil recycling exemption. The crushing may be performed on- or off-site, for profit or not. The determining factor is whether the used oil will be recycled. The filter may be shipped off-site for crushing under the used oil exemption, providing the oil is collected for recycling."

"However, as described next, a drained or crushed filter is considered scrap metal, and scrap metal is exempt from regulation when recycled."

"The scrap metal recycling exemption in 40 CFR 261.6(a) (3) (iv) is applicable to used oil filters (scrap metal) that are going to be recycled. However, an undrained or uncrushed oil filter would contain too much oil to qualify for the scrap metal exemption."

"To increase the probability that the used oil filter (hazardous scrap metal) will qualify for the scrap metal recycling exemption, the generator or recycling facility should drain (gravity) the filter for an amount of time sufficient to ensure that all free-flowing oil is removed. The amount of drain time will vary based on a number of variables, including the size of the filter and temperature (both ambient and that of the filter). Alternatively, the generator or recycling facility could crush the oil filter using the most appropriate crushing method that will force excess residual oil from the filter..... As a best operating practice, the Agency recommends that the generator or recycling facility both drain and crush used oil filters to be certain that the used oil filters would qualify for the hazardous scrap metal recycling exemption" (underlining emphasis added).

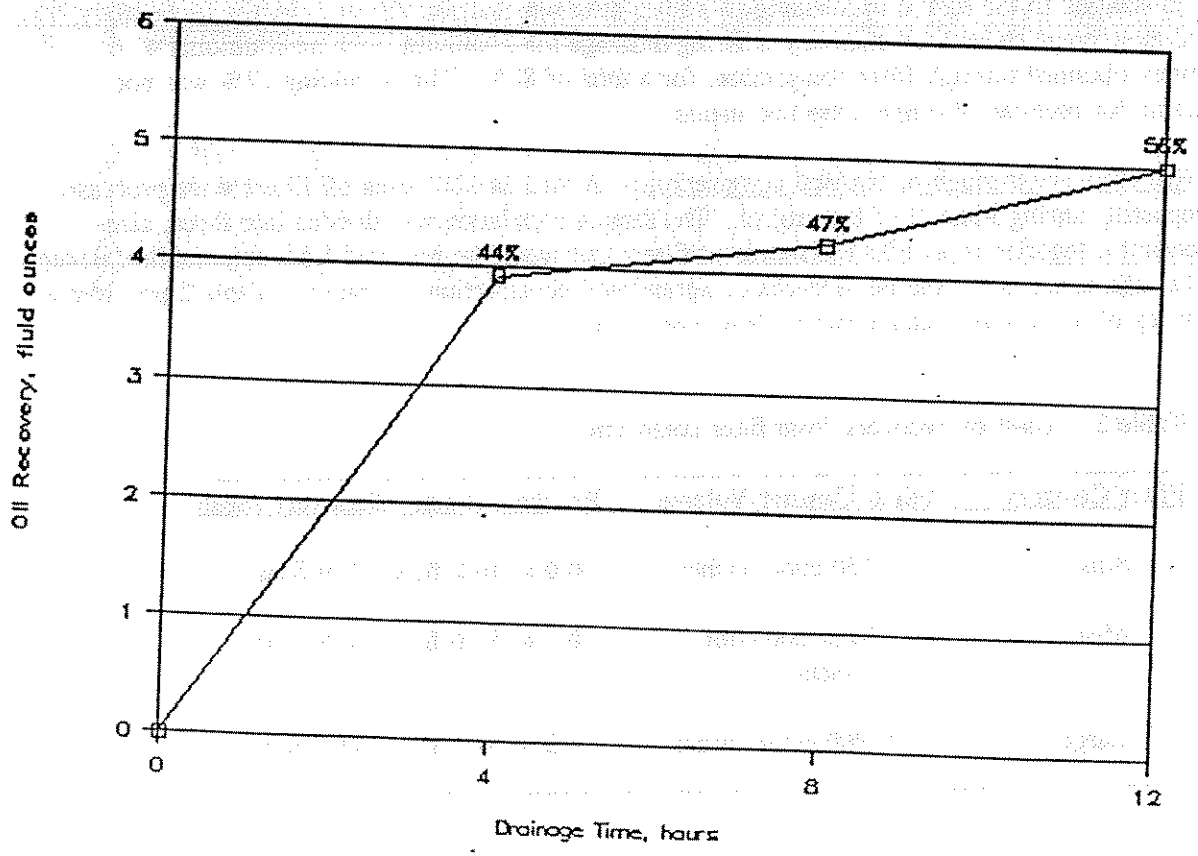
"If the crushed or drained filter will be recycled, it is unnecessary to determine whether it exhibits the TC (toxicity characteristic) because the scrap metal exemption is applicable." (underlining emphasis added) "It would also be unnecessary to manifest these used oil filters if they will be recycled. However, if the filter will be disposed of, the generator must determine if it is hazardous under the TC..... Non-hazardous waste filters may be disposed in a Subtitle D facility (municipal landfill)."

RESULTS

Oil recovery through simple drainage. - Phase 1 of the project demonstrated the oil recovery potential from used oil filters by merely inverting the filters and allowing them to drain over a collection container. The test utilized 24 used automotive filters collected from two separate vehicle service facilities. The filters were weighed as they were received, inverted and allowed to drain, and then reweighed at intervals of four hours for a total of 12 hours. The mass unit obtained when weighing the filters was converted to volumetric units (eg. fluid ounces) based on the density of the recovered oil. The drained filters were then compacted (as discussed in the following section of the report) and weighed a final time to establish the volume of recoverable oil remaining in the filters after drainage. The volume of oil recovered, through both drainage and compaction, totaled approximately 9 fluid ounces of oil per filter (mean value).

Figure 1 is a graphical representation of average oil recovery volumes versus time for oil filter inversion and drainage. The values posted above each data point show the volume of oil recovered as a percentage of the total, recoverable volume of oil initially present in the filters. As may be seen, an average of 4 fluid ounces or 44% of the recoverable oil was recovered by inverting and draining the used oil filters for a minimum of 4 hours. Collection of oil from 4 hours to the 12 hour ending point of the test was much less significant, averaging approximately 1 fluid ounce or an additional 11% of the total.

Figure 1. - Oil filter drainage vs. time



A similar study using 12 automotive filters and a 5 minute drainage time was conducted by the Minnesota Technical Assistance Program (Liebl, 1990). A data summary is shown in Table 1.

Table 1. - Used oil recovery from filter drainage and compaction

Parameter	Range(oz.)	% Removal(mean)
Volume of oil contained in the filter when removed from the vehicle	1.5 - 21 (mean = 11 oz.)	-
Volume of oil recovered by draining for 5 minutes*	0.0 - 16	39%
Volume of oil removed by draining and compaction	1.2 - 18	88%
Volume of oil remaining in filters after being drained and compacted	0.0 - 3 (mean = 1 oz. or 12% of the total)	

* The filters seemed to drain more completely when they were tipped at an angle rather than inverted upright.

In relation to the total oil remaining in a filter after removal from a vehicle, the Liebl study found an average of 39% oil recovery utilizing drainage for 5 minutes, with an additional 49% recovery obtained through filter compaction, for a total of 88%. The remaining 12% was not available for recovery through these two means.

Oil recovery through mechanical compaction. - A total of 1181 used oil filters were processed (compacted) during Phase 2 of the project. The sample population was divided into three, size-dependent categories in an effort to represent filters that would be removed from automobiles/pickup trucks, mid-size trucks, and large trucks or agricultural/construction equipment. Table 2 provides a summary of oil recovery data resulting from compaction.

Table 2. - Used oil recovery from filter compaction

Filter Category	Initial Canister Volume	Recovery Range	Recovery Mean
Small	< 50 cubic inches	0.0 to 16.2 fl.oz.	2.9 fl.oz.
Medium	50 to 200 cubic inches	0.0 to 52.6 fl.oz.	6.5 fl.oz.
Large	> 200 cubic inches	4.3 to 34.7 fl.oz.	21.7 fl.oz.

Table 3 illustrates the estimated number of used oil filters generated in the state of Iowa and the quantity of oil that enters state landfills due to non-processed filters. As shown, approximately 6.6 million used oil filters are generated per year from the servicing of registered vehicles and farm tractors in the state of Iowa. These filters contain an estimated 399,000 gallons of used oil which are capable of leaching from the oil filters and into ground and surface water supplies. Using filter drainage and compaction, 88%, or 351,000 gallons of used could be recovered in Iowa.

Table 3. - Estimated amount of used oil entering Iowa landfills

Motor vehicle	Ave. mileage[1] (mi/yr)	Registered in 1989[1] (millions)	Total miles (millions)	Miles per filter change[2]	No. of filters (millions)	Volume of oil[3] (gallons)
Cars	10,000	1.845	18,450.00	5,000	3.690	135,625
Buses	8,800	0.009	81.05	5,000	0.016	824
Light trucks	11,800	0.565	6,672.16	5,000	1.334	67,807
Heavy trucks	12,900	0.103	1,321.55	5,000	0.264	13,430
Semi-trucks	61,000	0.007	447.20	10,000	0.045	7,575
Subtotal					5.350	225,260

Farm tractors	Number[4]	Ave. run[4] hrs/yr	Total run hrs (millions)	Run hrs. per filter change[5]	No. of filter changes (millions)	Volume of oil[6] (gallons)
Less than 40 H.P.	79,062	400	31.62	100	0.316	16,070
Greater than 40 H.P.	232,330	400	92.93	100	0.929	157,405
Subtotal					1.246	173,475
TOTAL					6.595	398,735

[1] Source of data - Vehicle Fleet Summary, 1989, Iowa Department of Transportation

[2] Estimated

[3] Volumes were calculated using small and medium filter oil recovery mean values for cars, the medium filter recovery mean for buses and trucks, and the large filter recovery mean for semi-trucks

[4] Source of data - U.S. Census of Agriculture, 1987
[5] Source of data - John Deere Marketing Division
[6] Volumes were calculated using the medium filter recovery mean for tractors less than 40 H.P. and the large filter recovery mean for tractors greater than 40 H.P.

In addition to beneficial oil extraction and recovery, spacial volume reduction was also accomplished through compaction. As shown in Table 4, an average 73% volume reduction was obtained through compaction.

Table 4. - Oil filter volume reduction

Total volume of filters before processing	= 56,347 cubic inches
Total volume of filters after processing	= 14,974 cubic inches
Individual filter volume reduction range	= 54 to 95 %
Percent reduction in the total volume of filters	= 73%

This mean volume reduction would result in an estimated 4900 cubic yards of landfill or storage space savings per year in the state of Iowa.

By-product recyclability. - The final project phase evaluated recycling options for recovered oil and the compacted filter canisters. Oil recovered during compaction of the used oil filters was collected in three containers. A separate sample from each container was submitted for "used oil specification" laboratory analysis. A list of the test parameters and the laboratory results are shown in Table 5.

Table 5. - Recovered oil test results

Parameter	Range	Mean	RCRA Regulatory Limits*	Units
Arsenic	0.030 - 0.450	0.181	5	ppm
Cadmium	0.20 - 0.70	<0.50	2	ppm
Chromium (total)	<0.50 - <1.2	<0.73	10	ppm
Lead	12 - 60	31	100	ppm
Flashpoint	>200	>200	100(minimum)	°F
Total Halogens	483 - 926	666	4,000	ppm
Benzene	20.8 - 880	310	NA	ppm

* As defined for specification oil

The compacted canisters were processed through a scrap metal shredder which resulted in the separation of canister metal from the filter media. The recovered metal was essentially "oil free" and acceptable for incorporation into the existing scrap metal smelting market. A sample of the filter media was collected for laboratory analysis. A list of test parameters, laboratory results, and RCRA hazardous waste limits are provided in Table 6.

Table 6. - Test results for shredded oil filter canister filtration media

Parameter	Lab. Results	Regulatory Limit	Units
TCLP-Arsenic	0.02	5.0	mg/l
TCLP-Barium	<2.0	100.0	mg/l
TCLP-Cadmium	0.09	1.0	mg/l
TCLP-Chromium	<0.10	5.0	mg/l
TCLP-Lead	1.2	5.0	mg/l
TCLP-Mercury	<0.005	0.2	mg/l
TCLP-Selenium	<0.01	1.0	mg/l
TCLP-Silver	<0.02	5.0	mg/l
TCLP-Benzene	<0.01	0.5	mg/l
TCLP-Carbon Tetrachloride	<0.01	0.5	mg/l
TCLP-Chlorobenzene	<0.01	100.0	mg/l
TCLP-Chloroform	<0.01	6.0	mg/l
TCLP-1,2-Dichloroethane	<0.01	0.5	mg/l
TCLP-Tetrachloroethylene	<0.01	0.7	mg/l
TCLP-Trichloroethylene	<0.01	0.5	mg/l
TCLP-Vinyl Chloride	<0.10	0.2	mg/l
TCLP-Methyl Ethyl Ketone	<0.01	200.0	mg/l
TCLP-Pyridine	<0.50	5.0	mg/l
TCLP-1,4-Dichlorobenzene	<0.50	7.5	mg/l
TCLP-2,4-Dinitrotoluene	<0.50	0.13	mg/l
TCLP-Hexachlorobenzene	<0.50	0.13	mg/l
TCLP-Hexachloroethane	<0.50	3.0	mg/l
TCLP-Nitrobenzene	<0.50	2.0	mg/l
TCLP-Cresols, Total	<0.50	200.0	mg/l
TCLP-Pentachlorophenol	<2.50	100.0	mg/l
TCLP-2,4,5-Trichlorophenol	<0.50	400.0	mg/l
TCLP-2,4,6-Trichlorophenol	<0.50	2.0	mg/l
TCLP-1,1-Dichloroethylene	<0.01	0.7	mg/l
TCLP-Hexachlorobutadiene	<0.50	0.5	mg/l
Oil/Grease, Solid	49.0	-	%
Solids, Total	71.2	-	%
Paint Filter Test	pass	No free liquid	-

DISCUSSION

Project results indicate an estimated 400,000 gallons of used oil enters Iowa landfills each year due to used motor vehicle oil filter disposal. Due to the adverse health and environmental effects attributed to improper disposal of used oil and its contaminants, alternative disposal and/or implementation of oil filter recycling opportunities appear warranted. The first step is to reduce the quantity of oil remaining in the filter at the time of disposal. Project results indicate that as much as 55% of the free liquid oil contained in filters may be recovered through simple drainage at the service center, 44% of which is recoverable within a 4 hour drainage period. Research (Liebl, 1990) shows 44% free liquid oil (39% total) is recoverable after a 5 minute drainage period provided the filters are tipped at an angle. Although similar oil recovery quantities were observed in both studies, the MnTAP study yielded a significantly greater recovery rate (e.g. volume of oil recovered per unit time). The MnTAP study was conducted at the vehicle service center. Filters collected in the Iowa Waste Reduction Center study were transported to a processing site whereby several days may have elapsed between vehicle removal and testing.

Oil viscosity, defined as the property of a fluid to resist flow, is a function of temperature. It is hypothesized that the increased rate experienced in the MnTAP study was due, in part, to decreased oil viscosity in the filter resulting from higher oil temperatures. Liebl stated improved drainage was accomplished by placing the filter at an angle while draining rather than setting it vertically. This is also a practical consideration because it allows the oil to drain with minimal vacuum break or "gurgle".

Filter compaction provides a means to extract nearly all free liquid oil contained in the used oil filters. Data show compaction provides removal of the final 45% of the recoverable oil (free liquid) remaining in a "drained" filter. Total oil recovery using compaction (or drainage followed by compaction) equalled 88%. The remaining 12% appears to have saturated the filter media and is not available for recovery through physical means. Oil filter compaction showed an average of 73% spacial volume reduction based on before and after filter dimensions resulting in significant landfill or storage container space savings.

Laboratory analysis of oil recovered from used oil filters suggests the oil will meet current RCRA parameters for specification oil. This designation provides for reduced regulatory constraints and greatly enhances the cost/benefit ratio for recycling used oil. In addition, the canister shredding demonstration provided an acceptable metal for reclamation through commercial smelting.

Laboratory data generated from analysis of the shredded oil filtration media showed non-hazardous levels of the major parameters of concern, namely arsenic, cadmium, chromium, lead, and benzene. This data does not however, provide adequate documentation to define the media as non-hazardous due to the reported detection levels for 2,4-dinitrotoluene, hexachlorobenzene, and hexachlorobutadiene being equal to or greater than EPA's TCLP regulatory levels. Additional testing and/or more sensitive testing techniques must be implemented to make a valid hazardous/non-hazardous determination for the filtration media.

Acknowledgements. - We would like to thank the following participants who made this project possible: Mark Steinberg, Sujit Dhar, and Laura Dunson, Iowa Valley Community College District and Ellsworth Community College; Larry and Nancy McDowell, Waste Resource and Recycling Company; Ron Rosenberg, Oberg Sales Representative; Ramona Wallis and Mike Oberg, United Marketing International, Inc.; and the staff of the Iowa Waste Reduction Center, University of Northern Iowa.

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Salvesen, R. H., Associates, 1988, Guide to Oil Waste Management Alternatives for Used Oil, Oil Wastewater, Oily Sludge, and Other Wastes Resulting from the Use of Oil Products, Final Report Prepared for Alternative Technology Section, Toxic Substances Control Division, California Department of Health Services.

Liebl, D. S., 1990, MnTAP Memo on Vehicle Oil Filter Disposal (Draft).

Appendix 1

Listing of Oil Filter Compaction Equipment Manufacturers

Oil Filter Press Manufacturers

United Marketing International, Inc.
P.O. Box 989
Everett, WA 98206-0989
(800)848-8228

Morris Enterprises
2393 Teller Rd., Suite 108
Newbury Park, CA 91320
(800)833-3409

Ecosolve Corporation
425 Conestoga Road
Waterloo, Ontario, Canada N2L 4C9
(519)725-3222
(800)927-8749

CRUSH-A-MATIC
2805 Urbandale Lane N.
Minneapolis, MN 55447
(612)476-4944
(800)477-7617

Appendix 2

Oberg Oil Filter Press Specifications