Waste Analyses Project for Auto Dealerships

Waste Antifreeze Summary

Introduction

Virtually all automotive repair facilities, no matter the size, perform antifreeze service. Antifreeze is made of ethylene glycol, a poisonous substance that may also become a hazardous waste due to contaminants accumulated while circulating through the vehicle engine cooling system.

Because of the toxicity of contaminants that may be present, used antifreeze should never be dumped on the ground or discharged to a storm sewer or a septic system. When illegally discharged to a septic tank, antifreeze may destroy the bacteria and cause the tank to cease functioning and toxins may pass through the system to pollute groundwater. Improper disposal of used antifreeze may result in soil, groundwater or surface water contamination, and may also lead to expensive regulatory fines and cleanup costs.

The Iowa Waste Reduction Center (IWRC) recommends Toxicity Characteristic Leaching Procedure (TCLP) analysis for waste antifreeze. TCLP testing is required to determine whether the waste is hazardous or non-hazardous. Follow-up regarding this recommendation revealed that small businesses rarely characterize waste antifreeze, most likely due to costs associated with laboratory analysis. This lack of testing bases disposal decisions on incomplete data that does not often lead to regulatory compliance or implementation of pollution prevention (P2) alternatives.

The Waste Analyses Project for Auto Dealerships conducted TCLP analysis on waste antifreeze from Iowa automotive dealerships. The primary objective of the project was to improve the implementation rate of P2 practices by first making a hazardous waste determination to categorize the waste and then determine the proper P2 action and disposal method at volunteer facilities. The secondary goal of the project was to collect enough data to produce a study report that dealerships could use in lieu of an individual test from each shop on the waste, if the data supported such a statement. Like all other services the IWRC provides, the *Waste Analysis Project for Auto Dealerships* maintained client confidentiality.

The study did <u>not</u> support a generalized statement that automotive dealerships should no longer make a hazardous waste determination through TCLP analysis on waste antifreeze. The presence of toxins at any level may be construed as reason to continue TCLP testing at each facility.

Overall the study identified that shops that continue to use chlorinated brake cleaner have the potential to generate waste that is toxic due to the presence of Tetrachloroethene at levels above the 0.7 milligrams per Liter (mg/L) regulatory threshold in antifreeze.

The study also recognized that the most accurate TCLP testing methodology for the eight heavy metals, specifically Arsenic and Selenium, is the use of a graphite furnace over the generally used ICP SW6010 procedure.

Sampling & Testing

Using the EPA's Decision Error Feasibility Trials (DEFT) tool and published data from a test of metals in the wastes, a sample population of 49 facilities was derived as being statistically

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significant to draw a generalized conclusion from the data. Members of the Iowa Automotive Dealership Association (IADA) were approached and 56 facilities agreed to participate in the study. IWRC staff was trained and collected all samples used in the study to help eliminate sampling error. The study collected 74 samples of antifreeze (mostly waste samples, a few virgin antifreeze samples were tested as a control).

While the TCLP includes 40 test parameters, wastes need only be tested for the toxins likely to be present. In this study, TCLP testing parameters were limited to the heavy metals and volatile organic compounds (VOCs) likely to be present and listed in **Table 1**.

Table 1: TCLP Testing Parameters.
The eight heavy metals and ten VOCs tested for in the Waste Antifreeze Study.

TCLP Parameter	Regulatory Level*	EPA Number
Metals		
Arsenic	5.0 mg/L	D004
Barium	100.0 mg/L	D005
Cadmium	1.0 mg/L	D006
Chromium	5.0 mg/L	D007
Lead	5.0 mg/L	D008
Mercury	0.2 mg/L	D009
Selenium	1.0 mg/L	D010
Silver	5.0 mg/L	D011
VOCs		
Benzene	0.5 mg/L	D018
Carbon Tetrachloride	0.5 mg/L	D019
Chlorobenzene	100.mg/L	D021
Chloroform	6.0 mg/L	D022
1,2-Dichloroethane	0.5 mg/L	D028
1,1-Dichloroethene	0.7 mg/L	D029
Methyl Ethyl Ketone (MEK)	200.0 mg/L	D035
Tetrachloroethene	0.7 mg/L	D039
Trichloroethylene	0.5 mg/L	D040
Vinyl Chloride	0.2 mg/L	D043

* Samples exceeding these levels are hazardous

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Of the initial twenty-two (22) samples taken, fifteen (15) returned with hazardous waste results for Arsenic and/or Selenium, with the presence of the two toxins above the regulatory threshold level of 5.0 and 1.0 mg/L, respectively. The samples were taken from ten different dealership facilities.

The project staff embarked on research to determine the source of the contaminants. Web research showed a strong possibility that Arsenic and Selenium were present from the metal fabrication process that takes place in building automobiles. Some inquiry to the dealerships was conducted to determine if the antifreeze was being changed out in new vehicles upon arrival from the automaker (that was not the case).

Samples of virgin antifreeze were sent to the laboratory with the intent to eliminate the virgin product as the source of the toxins. Surprisingly, the samples came back with the presence of the two toxins, Arsenic and Selenium. The Selenium was above the regulatory threshold level of 1.0 mg/L in the virgin samples. With the virgin samples coming back hazardous the research on the manufacturing process was discontinued.

The TCLP results were presented and discussed with the National Oil Recycling Association (NORA) Antifreeze Work Group meeting in Scottsdale, AZ on February 1, 2006. All members present agreed that a testing problem was the cause of the results. The group overwhelmingly agreed that there was no possibility of Arsenic or Selenium at levels exceeding the regulatory limit was possible in virgin antifreeze. They also suggested that one or more of the additives in antifreeze was causing interference in the matrix of the tests.

At the laboratory the information was discussed. Experts in glycol were contacted but had very little experience with waste analysis so were unable to identify the potential inference. The lab diligently studied the test results looking for any anomalies. The lab explained that the standard TCLP analysis (protocol ICP SW 6010) determined the presence of heavy metals through a process of elimination in which graphs of the chemicals presence in the test material were compared to the known graphs of the eight heavy metals. When the peaks of the two graphs align then the toxin is reported to be present.

Upon scrutiny of the Arsenic and Selenium graphs it was determined that the two peaks were, in fact, slightly different than the known graphs. The lab then recognized two other tests that identified metals in other ways that could be used to verify or refute the presence of Arsenic or Selenium in antifreeze. Those tests use mass spectrometry or a graphite furnace known as SW6020 and SW7060, respectively.

Six new samples including duplicates were submitted to the laboratory for testing using all

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three methodologies. The new samples were taken from three of the sites that originally had received hazardous waste results. The standard SW6010 procedure once again showed the presence of Arsenic and Selenium above the regulatory threshold. The mass spectrometer and graphite furnace tests then refuted the presence of the heavy metals and the waste was determined to be non-hazardous without much additional expense for the testing procedures. The lab was unable to identify the interference by name.

Antifreeze sampling was resumed. The sites with previous hazardous results were re-sampled and found to be non-hazardous through the use of the mass spectrometer and graphite furnace but still erroneously indicated the presence of Arsenic and/or Selenium at levels above the regulatory limits when using the standard TCLP procedure (ICP SW6010).

It was interesting that samples from the same facilities were able to reproduce the erroneous Arsenic and Selenium results indicating some common denominator that we were not able to identify. This warrants additional investigation.

In the data set, sites determined to have hazardous waste antifreeze were those that tested positive for the presence of Tetrachloroethene above the regulatory limit. In all cases those shops were using chlorinated brake cleaner, often as a general cleaning agent, and the toxin was also often present in their sump sludge. In one case, the toxin Lead was present above the regulatory threshold for an undetermined reason.

Additionally, it is important to note that in the testing of both heavy metals and VOC's, several samples returned with inconclusive results. Specifically, the result was reported not as a specific quantity, but as 'less than' the lowest detectable level (i.e., <0.02 mg/L.) In most cases, these results can be interpreted as 'non-detectable or zero.' But in some cases the lowest detectable level of toxin in the sample was reported above the regulatory threshold.

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Table 2: Antifreeze TCLP Test Results Summary

Heavy Metals:	
Arsenic	Not present in antifreeze but a testing anomaly was identified.
Barium	Detected at very low levels in three cases (one was virgin).
Cadmium	Not detected in antifreeze.
Chromium	Detected at low levels in three cases.
Lead	Detected in 1/3 of the samples with one case being hazardous.
Mercury	Not detected in antifreeze.
Selenium	Not present in antifreeze but a testing anomaly was identified.
Silver	Not detected in antifreeze.
VOCs	
Benzene	Detected at very low levels in two cases.
Methyl Ethyl Ketone	Not detected in antifreeze.
Carbon Tetrachloride	Not detected in antifreeze.
Chlorobenzene	Not detected in antifreeze.
Chloroform	Not detected in antifreeze.
1,2-Dichloroethane	Not detected in antifreeze.
1,1-Dichloroethene	Not detected in antifreeze.
Tetrachloroethene	Detected in 1/4 of the samples with 9 cases being hazardous.
Trichloroethene	Detected in one case.
Vinyl Chloride	Not detected in antifreeze.

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Conclusions

The study identified three conclusions:

1) The graphite furnace testing method should be requested when ordering TCLP analysis for hazardous waste determination for heavy metals in waste antifreeze.
2) The use of chlorinated brake cleaners should be discontinued in automotive repair shops to reduce the potential for waste antifreeze to be hazardous due the presence of Tetrachloroethene above the regulatory threshold.
3) Test results should be scrutinized to assure that the level of detection is below the regulatory threshold for each parameter. Results with detection limits above the threshold are inconclusive. New sampling and testing would be warranted.

The study showed some surprising results concerning heavy metals, particularly Arsenic and Selenium. Sixteen of the 74 samples had hazardous levels of Arsenic while 34 of the 74 samples had hazardous levels of selenium using the satndard ICP SW6010 testing protocol. An additional sample showed hazardous levels of lead.

These results were unexpected, and the cause for them is not completely understood. Duplicate samples were tested with similar results. Even testing of virgin antifreeze had similar results in some, but not all samples, even among different laboratory testing facilities. It is possible that the results were caused by interference in the testing process itself, or abnormalities in the testing matrix.
The study also showed nine samples with levels of the VOC tetrachloroethene at concentrations above the regulatory limit. Although the reason for the hazardous results are not definitive, it is plausible that the high levels of tetrachloroethene are due to the liberal use of chlorinated brake cleaner in these automotive maintenance facilities. Restricted use or elimination of chlorinated brake cleaner may decrease the chance of generating hazardous waste antifreeze.

Seven VOCs (24 samples) showed results warranting further testing (benzene, carbon tetrachloride, 1,2-dichloroethane, 1,1-dichloroethene, tetrachloroethene, trichloroethene and vinyl chloride). These results were inconclusive because the lowest detectable level was at or above the corresponding regulatory limit. Such results may occur due to interference during testing or discrepancies in the sample.

Overall, the study did not support a generalized statement that automotive dealerships should no longer make a hazardous waste determination through TCLP analysis on waste antifreeze. Some toxins were present in each of the waste streams. It is therefore recommended that all facilities conduct TCLP testing once on a representative sample of the waste stream.

Recommendations

In Iowa, the US EPA regulates hazardous waste. The federal hazardous waste management

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standards require that a hazardous/non-hazardous waste determination be made for any waste with the potential to be hazardous. Waste antifreeze has a potential to be hazardous therefore warrants TCLP analysis by a qualified laboratory.

The Iowa Waste Reduction Center recommends that all automotive dealerships submit a representative sample of waste antifreeze to an analytical laboratory for TCLP analysis for the eight heavy metals and the ten VOCs listed in Table 1. On the sample's chain of custody form specifically request that the graphite furnace procedure be used to test for heavy metals. The summary entitled Requesting TCLP Analysis on Waste Antifreeze may be used to convey the information to the laboratory.

Detailed instructions on sampling procedures can be found at How to Take a Representative Sample of Waste.

Considering the unexpected results for arsenic and selenium, more investigation is necessary to develop a definitive understanding of why such results are seen in some cases, and not others. If such results are seen in individual testing, the IWRC should be contacted for additional assistance.

The most useful information gained from this study was the likely link between the use of chlorinated brake cleaner and hazardous waste antifreeze (due to tetrachloroethene in brake cleaner). To decrease the chance of waste antifreeze contaminated with chlorinated VOCs, facilities are encouraged to use chlorinated brake cleaner sparingly, or eliminate its use altogether.

Eliminating chlorinated brake cleaner has many advantages in addition to possibly eliminating a large hazardous waste stream. Switching to aqueous brake cleaners purchased in bulk and used in refillable spray cans has been shown to have payback periods in as little as five months, and may reduce aerosol use by up to 84%. That translates into huge cost savings for any small business. Cost savings include decreased disposal fees, decreased chemical purchasing costs and reduced liability (inherent in solvent use)[1]. The cost-benefit worksheet at http://www.montgomerycountymd.gov/deptmpl.asp?url=/content/dep/Factsheets/aerosol.asp can help determine if switching to aerosol cleaners makes financial sense. A study conducted by the Institute for Research and Technical Assistance (IRTA) of ten repair facilities concluded that aqueous brake cleaner, even at low concentration levels were adequate in almost all brake cleaning scenarios[2]. The IWRC can assist in finding vendors of bulk cleaners and refillable spray cans.

Environmental benefits from decreasing or eliminating solvent brake cleaner use are also numerous. Propellants in aerosol cans are known 'greenhouse gases' and contribute to smog and ozone formation in the atmosphere. Used aerosol cans may themselves be considered hazardous waste. In addition, many brake cleaners contain F-listed chemicals, which

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means that any waste that is contaminated with even just one drop of the brake cleaner becomes a hazardous waste[1]. Eliminating use of such products is a smart move fiscally and environmentally.

If TCLP results show any parameter at a concentration level equal to or greater than its corresponding regulatory level, the waste antifreeze must be managed as hazardous waste. Hazardous waste must be stored in sealed, labeled containers and disposed by an EPA-permitted hazardous waste management company. Hazardous waste antifreeze must also be included in the facility's hazardous waste inventory and managed on-site in compliance with the applicable generator regulations.

If the TCLP test results of the representative sample show concentrations less than regulatory level for each parameter, then the antifreeze is non-hazardous. Non-hazardous used antifreeze may be sold, recycled or disposed of as a non-hazardous waste through a waste management company such as Safety-Kleen. In some instances, used antifreeze can be discharged in small amounts to the city sanitary sewer system with prior permission from the wastewater treatment plant.

When good antifreeze must be removed for repairs, it should be saved in a clean container for reuse in the system after completion of the repairs to avoid unnecessary disposal of useable antifreeze. Reclaiming useable antifreeze also keeps it from becoming waste. If the antifreeze cannot be reused, recycling is the next best management option. This can be done by an off-site recycling services or on-site recycling equipment such as filtration. Through a "cleaning" process using filtration the reclaimed antifreeze can be reused. A filtration system removes the sediments and contaminants from the antifreeze. Rust and corrosion inhibitors are then added to replace the additives lost during use. The filters in the unit eventually become hazardous waste due to the sludge collected during the filtration process.

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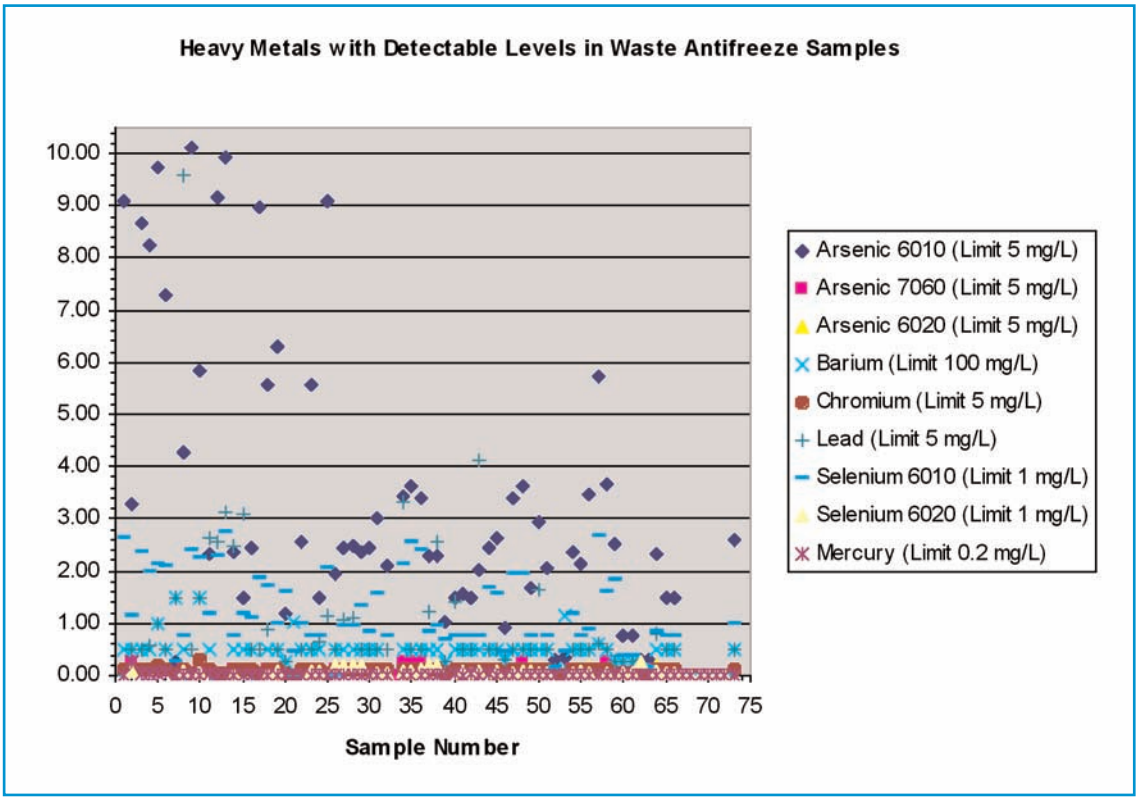
Results

Heavy Metals

TCLP test results on the 74 samples of waste antifreeze tested for 8 parameters showed that 51(of 592) had heavy metal concentration at or above the corresponding regulatory threshold (arsenic 6010, lead and selenium). **Figure1** represents all of the heavy metal TCLP test results.



Figures 2 through 6 show the individual results. It is important to note that in the testing of both heavy metals and VOC's, several samples returned with inconclusive results. More specifically, due to possible interference during the testing procedure, or discrepancies in the sample itself, the result was reported not as a specific quantity, but as 'less than' the lowest detectable level (i.e., <0.02 mg/L.) In most cases, these results can be interpreted as 'non-detectable or zero,' (in the figures they are visualized as the lowest detectable level, i.e. 0.02 mg/L etc.) But in some cases the lowest detectable level of toxin in the sample was reported above the regulatory threshold. This was the case with one sample of mercury and one sample of selenium 6010. Also, data points visualized as zero represent instances where the toxin was not actually detected. All such cases are noted in the figure descriptions.

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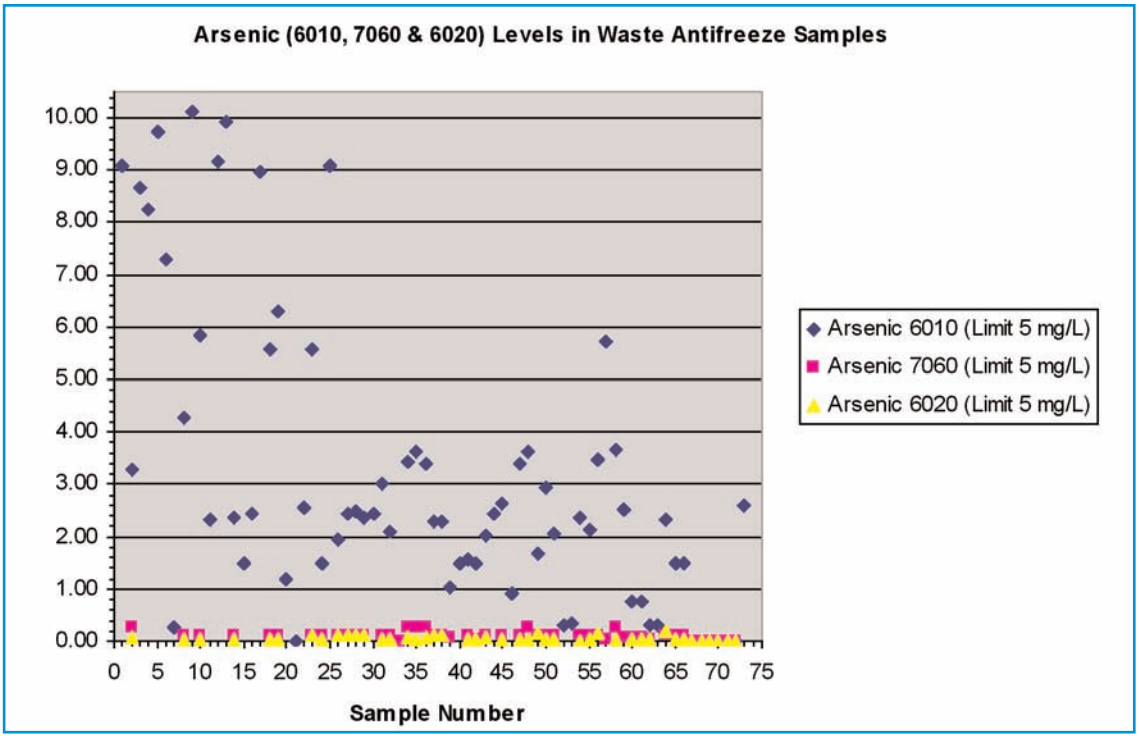

Figure 2. Arsenic (6010, 7060 & 6020) Concentrations in Waste Antifreeze Samples. The regulatory limit for arsenic is 5.0 mg/L. ***Sixteen samples showed arsenic 6010 concentrations higher than the regulatory limit (5.56 mg/L, 5.58 mg/L, 5.71 mg/L, 5.86 mg/L, 6.19 mg/L, 6.29 mg/L, 7.3 mg/L, 8.25 mg/L, 8.68 mg/L, 9.1 mg/L(2), 9.17 mg/L, 9.74 mg/L, 9.93 mg/L, and 10.1 mg/L).*** Arsenic 6010 could not be detected at concentrations less than 3.75 mg/L in one sample, less than 1.5 mg/L in seven samples (9.5%), less than 0.9 mg/L in one sample, less than 0.75 mg/L in two samples (2.7%), less than 0.3 mg/L in three samples (4.1%) or less than 0.25 mg/L in one sample (shown as 3.75 mg/L, 1.5 mg/L, 0.9 mg/L, 0.75 mg/L, 0.3 mg/L and 0.25 mg/L respectively.) One sample had undetectable concentrations of arsenic 6010 (shown as 0.0 mg/L.) Four samples had detectable levels of arsenic 7060, however at concentrations below the regulatory limit. Arsenic 7060 could not be detected at concentrations less than 0.25 mg/L in six samples (8.1%), less than 0.125 mg/L in 32 samples (43.2%), less than 0.0625 mg/L in four samples (5.4%), less than 0.05 mg/L in one sample, and less than 0.025 mg/L in one sample (shown as 0.25 mg/L, 0.125 mg/L, 0.0625 mg/L, 0.75 mg/L, 0.05 mg/L and 0.025 mg/L respectively.) ***Two samples showed Arsenic 6020 concentrations higher than the regulatory limit (5.6 mg/L, and 5.62 mg/L).*** Arsenic 6020 could not be detected at concentrations less than 0.1 mg/L in six samples (8.1%), less than 0.05 mg/L in seven samples (9.5%), less than 0.04 mg/L in three samples (4.1%), less than 0.03 mg/L in one sample, and less than 0.025 mg/L in 15 samples (20.3%, shown as 0.5 mg/L, 0.04 mg/L, 0.03 mg/L and 0.025 mg/L respectively.)

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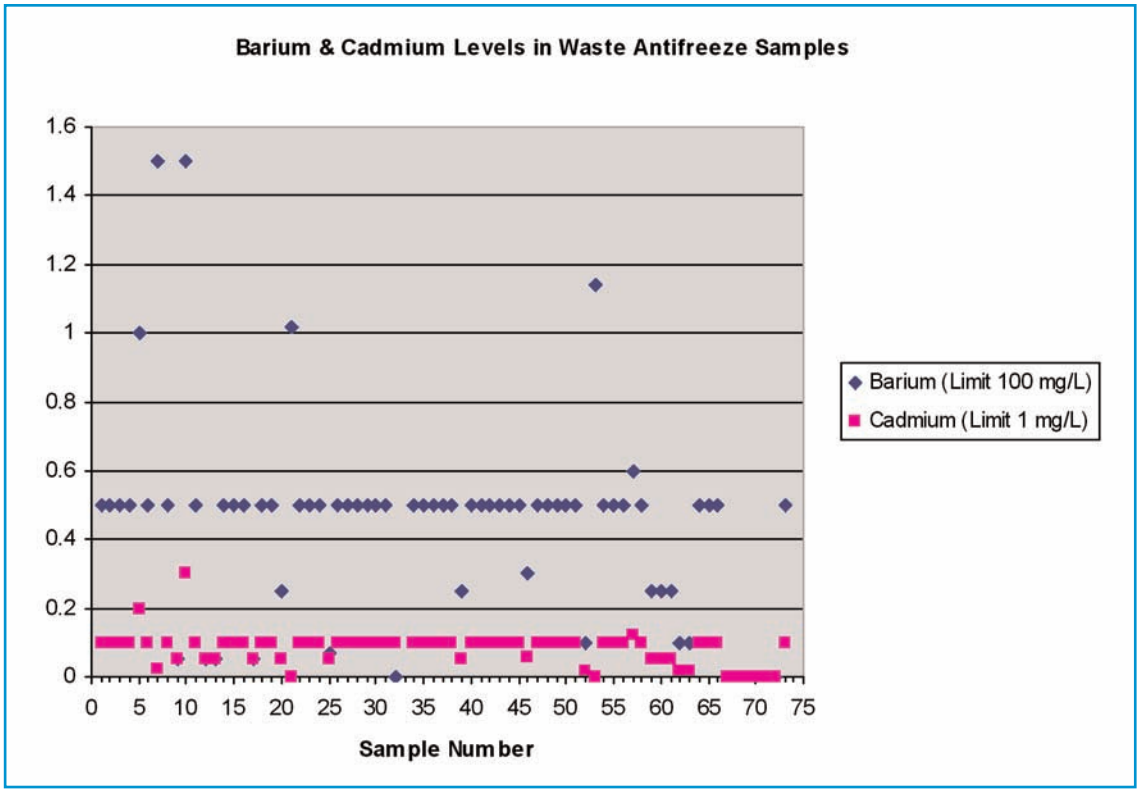

Figure 3. Barium & Cadmium Concentrations in Waste Antifreeze Samples.
The regulatory limit for barium is 100.0 mg/L. The highest detected concentration was 1.14 mg/L. Barium could not be detected at concentrations less than 1.5 mg/L in two samples (2.7%), less than 1.0 mg/L in one sample, less than 0.6 mg/L in one sample, less than 0.5 mg/L in 52 samples (70.3%), less than 0.3 mg/L in one sample, less than 0.25 mg/L in five samples (6.8%), less than 0.1 mg/L in three samples (4.1%) or less than 0.05 in four samples (5.4%, shown as 1.5 mg/L, 1.0 mg/L, 0.6 mg/L, 0.5 mg/L, 0.3 mg/L, 0.25 mg/L 0.1 mg/L and 0.05 mg/L respectively.) The regulatory limit for cadmium is 1.0 mg/L. There were no actual detections of cadmium in any of the samples. Cadmium could not be detected at concentrations less than 0.3 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.12 mg/L in one sample, less than 0.10 in 52 samples (70.3%), less than 0.06 in one sample, less than 0.05 in 10 samples (13.5%), less than 0.025 mg/L in one sample or less than 0.02 mg/L in three samples (4.1%, shown as 0.3 mg/L, 0.2 mg/L, 0.12 mg/L, 0.10 mg/L, 0.06 mg/L, 0.05 mg/L, 0.025 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had no detectable concentrations of cadmium (shown as 0.0 mg/L.)

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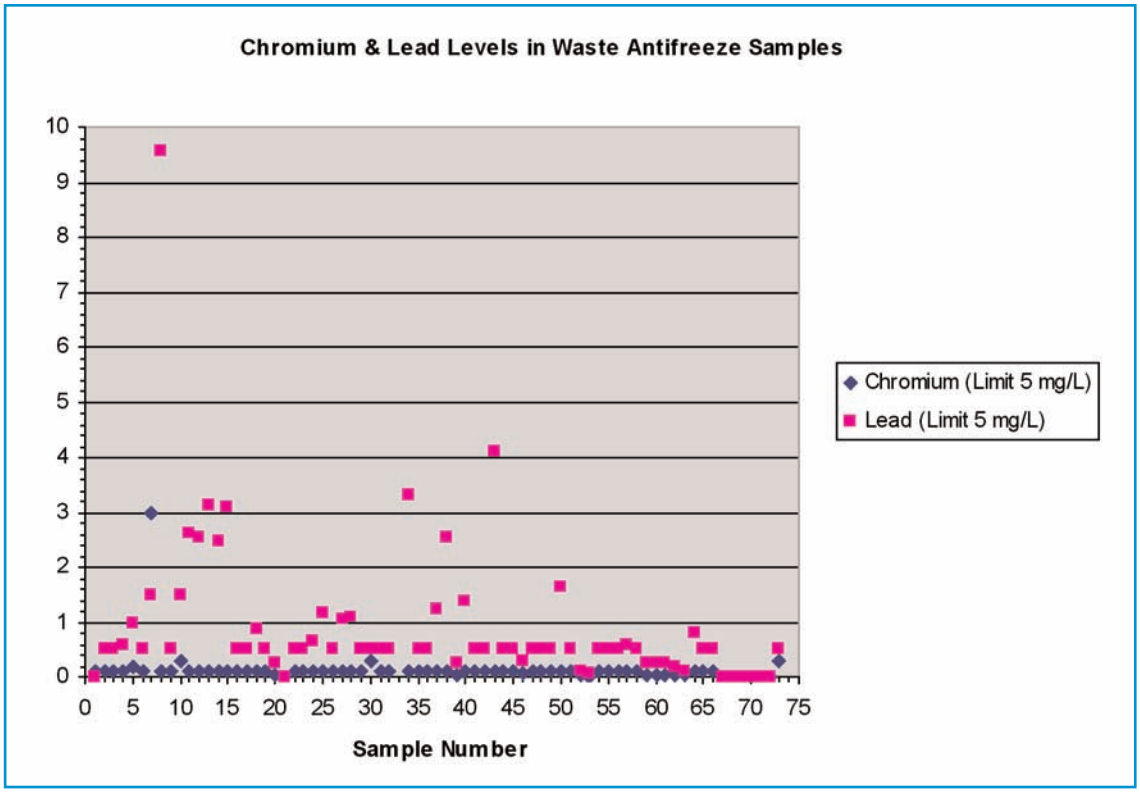

Figure 4. Chromium & Lead Concentrations in Waste Antifreeze Samples.
The regulatory limit for chromium is 5.0 mg/L. The highest detected concentration was 0.286 mg/L. Chromium could not be detected at concentrations less than 3.0 mg/L in one sample, less than 0.3 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.12 mg/L in one sample, less than 0.10 mg/L in 54 samples (73%), less than 0.06 mg/L in one sample, less than 0.05 mg/L in five samples (6.8%) or less than 0.02 mg/L in three samples (4.1%, shown as 3.0 mg/L, 0.3 mg/L, 0.2 mg/L, 0.12 mg/L, 0.10 mg/L, 0.06 mg/L, 0.05 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of chromium (shown as 0.0 mg/L.) The regulatory limit for lead is 5.0 mg/L. ***One sample showed lead concentrations higher than the regulatory limit (9.58 mg/L.)*** Lead could not be detected at concentrations less than 1.5 mg/L in two samples (2.7%), less than 1.0 mg/L in one sample, less than 0.6 mg/L in one sample, less than 0.5 mg/L in 36 samples (48.6%), less than 0.3 mg/L in one sample, less than 0.25 mg/L in five samples (6.8%) or less than 0.1 mg/L in two samples (2.7%, shown as 1.5 mg/L, 1.0 mg/L, 0.6 mg/L, 0.5 mg/L, 0.3 mg/L, 0.25 mg/L and 0.1 mg/L respectively.)

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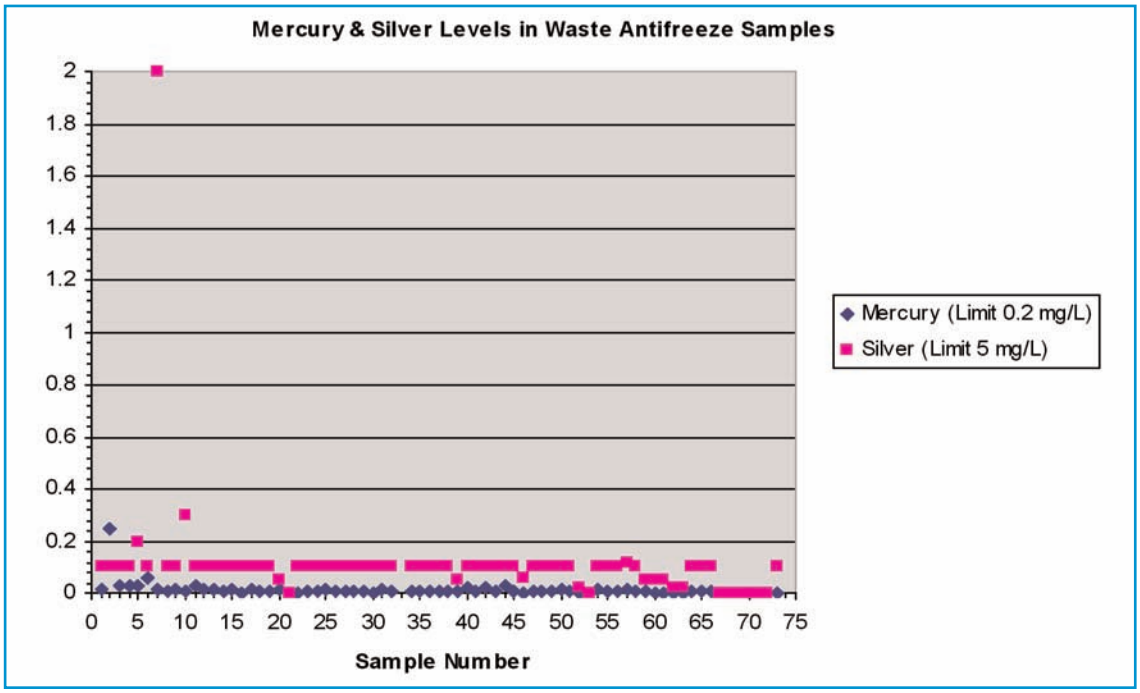

Figure 5. Mercury and Silver Concentrations in Waste Antifreeze Samples.
The regulatory limit for mercury is 0.2 mg/L. There were no actual detections of mercury in any of the samples. One sample showed results warranting further investigation. In this sample, mercury could not be detected at concentrations lower than 0.25 mg/L. This case is noteworthy in that the lowest detectable level is above the regulatory limit. This sample may or may not be representative of a hazardous waste. Mercury could not be detected at concentrations less than 0.125 mg/L in one sample, less than 0.06 mg/L in one sample, less than 0.03 mg/L in five samples (6.8%), less than 0.024 mg/L in one sample, less than 0.02 mg/L in one sample, less than 0.015 mg/L in six samples (8.1%), less than 0.012 mg/L in seven samples (9.5%), less than 0.0072 mg/L in seven samples (9.5%), less than 0.006 mg/L in 29 samples (39.2%), less than 0.003 mg/L in four samples (5.4%), less than 0.002 in five samples (6.8%) or less than 0.001 mg/L in one sample (shown as 0.125 mg/L, 0.06 mg/L, 0.03 mg/L, 0.024 mg/L, 0.02 mg/L, 0.015 mg/L, 0.012 mg/L, 0.0072 mg/L, 0.006 mg/L, 0.003 mg/L, 0.002 mg/L and 0.001 mg/L respectively.) Two samples (2.7%) had undetectable levels of mercury (shown as 0.0 mg/L.) The regulatory limit for silver is 5.0 mg/L. There were no actual detections of silver in any of the samples. Silver could not be detected at concentrations less than 2.0 mg/L in one sample, less than 0.3 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.12 mg/L in one sample, less than 0.10 mg/L in 57 samples (77.0%) less than 0.06 mg/L in one sample, less than 0.05 mg/L in five samples (6.8%) or less than 0.02 mg/L in three samples (4.1%, shown as 2.0 mg/L, 0.3 mg/L, 0.02 mg/L, 0.12 mg/L, 0.10 mg/L, 0.06 mg/L, 0.05 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of silver (shown as 0.0 mg/L.)

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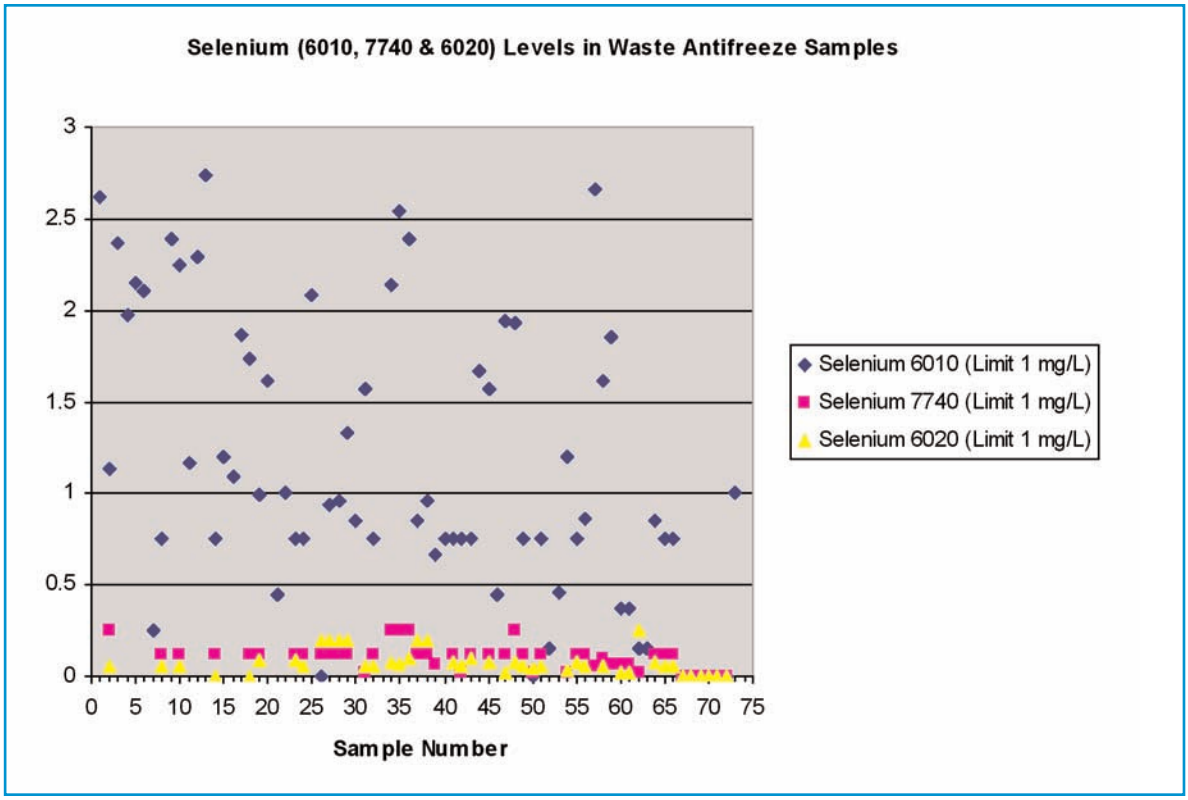

Figure 6. Selenium (6010, 7740 & 6020) Concentrations in Waste Antifreeze Samples. The regulatory limit for selenium is 1.0 mg/L. ***Thirty-four samples showed selenium 6010 concentrations higher than the regulatory limit (1.0 mg/L (2), 1.09 mg/L, 1.13 mg/L, 1.17 mg/L, 1.2 mg/L (2), 1.3 mg/L, 1.33 mg/L, 1.57 mg/L (2), 1.61 mg/L (2), 1.67 mg/L, 1.73 mg/L, 1.76 mg/L, 1.85 mg/L, 1.87 mg/L, 1.93 mg/L, 1.94 mg/L (2), 1.97 mg/L, 2.08 mg/L, 2.1 mg/L, 2.14 mg/L, 2.15 mg/L, 2.29 mg/L, 2.37 mg/L, 2.39 mg/L (2), 2.54 mg/L, 2.62 mg/L, 2.66 mg/L and 2.74 mg/L).*** All other samples with detectable levels of selenium 6010 had concentrations close to the regulatory limit. One sample showed results warranting further investigation. In this sample, selenium 6010 could not be detected at concentrations lower than 2.25 mg/L. This case is noteworthy in that the lowest detectable level is above the regulatory limit. This sample may or may not be representative of a hazardous waste. Selenium 6010 could not be detected at concentrations less than 0.75 mg/L in 17 samples (23.0%), less than 0.45 mg/L in one samples, less than 0.375 mg/L in two samples (2.7%), less than 0.25 mg/L in one sample or less than 0.15 mg/L in two samples (2.7%, shown as 0.75 mg/L, 0.45 mg/L, 0.375 mg/L, 0.25 mg/L and 0.15 mg/L respectively.) There were no actual detections of selenium 7740 in any of the samples. Selenium 7740 could not be detected at concentrations less than 0.25 mg/L in five samples (6.8%), less than 0.125 mg/L in 31 samples

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(41.9%), less than 0.1 mg/L in one sample, less than 0.0625 mg/L in four samples (5.4%), less than 0.05 mg/L in one sample and less than 0.025 in four samples (5.4%, shown as 0.25 mg/L, 0.125 mg/L, 0.1 mg/L, 0.0625 mg/L, 0.05 mg/L and 0.025 mg/L respectively.) The highest detected concentration of selenium 6020 was 0.101 mg/L. Selenium 6020 could not be detected at concentrations less than 0.25 mg/L in one sample, less than 0.2 mg/L in six samples (8.1%), less than 0.085 mg/L in three samples (4.1%), less than 0.075 mg/L in two samples (2.7%), less than 0.06 mg/L in three samples (4.1%), less than 0.055 mg/L in one sample, less than 0.05 mg/L in ten samples (13.5%) and less than 0.025 mg/L in five samples (6.8%, shown as 0.2 mg/L, 0.085 mg/L, 0.075 mg/L, 0.06 mg/L, 0.055 mg/L, 0.05 mg/L and 0.025 mg/L respectively.) One sample had undetectable levels of selenium 6020 (shown as 0.0 mg/L.)

VOCs

TCLP test results on the 74 samples of waste antifreeze showed that nine (9) samples had tetrachloroethene concentrations above the corresponding regulatory threshold. **Figures 7 through 15** show the individual results. It is important to note that in the testing of both heavy metals and VOC's, several samples returned with inconclusive results. More specifically, due to possible interference during the testing procedure, or discrepancies in the sample itself, the result was reported not as a specific quantity, but as 'less than' the lowest detectable level (i.e., <0.02 mg/L.) In most cases, this can be interpreted as 'non-detectable or zero,' but in some cases the lowest detectable level of toxin in the sample was reported above the regulatory threshold. This was the case with 24 samples and seven VOCs (benzene, carbon tetrachloride, 1,2-dichloroethane, 1,1-dichloroethene, tetrachloroethene, trichloroethene and vinyl chloride.) Also, data points visualized as zero actually represent instances where the toxin was not detected. All such cases are noted in the figure descriptions.

Waste Antifreeze Summary

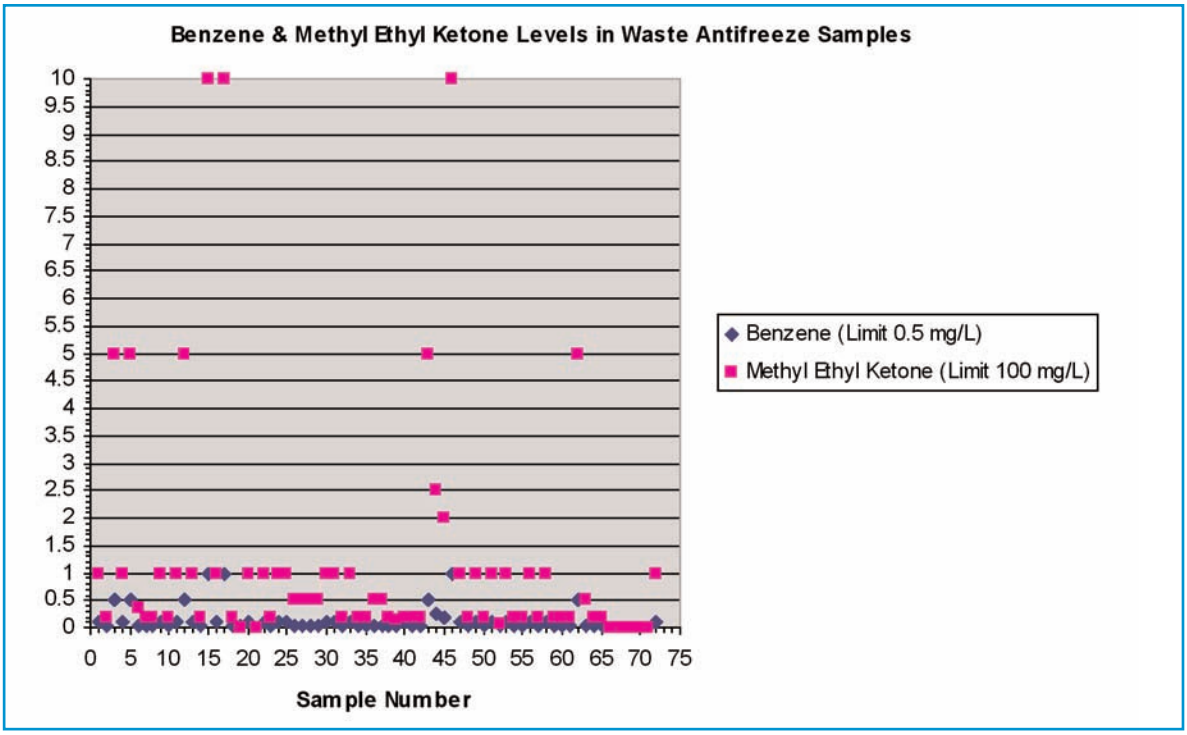

Figure 7. Benzene & Methyl Ethyl Ketone (MEK) Concentrations in Waste Antifreeze Samples. The regulatory limit for benzene is 0.5 mg/L. The highest detected concentration of benzene was 0.0924 mg/L. Eight samples showed results warranting further investigation. In these samples, benzene could not be detected at concentrations lower than 1.0 mg/L or 0.5 mg/L. These cases are noteworthy in that the lowest detectable level is at or above the regulatory limit. These samples may or may not be representative of a hazardous waste. Benzene could not be detected at concentrations less than 0.25 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.1 mg/L in 22 samples (29.7%), less than 0.05 mg/L in eight samples (10.8%), or less than 0.02 mg/L in 29 samples (39.2%, shown as 0.25 mg/L, 0.2 mg/L, 0.1 mg/L, 0.05 mg/L and 0.02 mg/L respectively.) One sample had undetectable levels of benzene (shown as 0.0 mg/L.)

The regulatory limit for MEK is 200 mg/L. MEK was detected in only one sample at 0.085 mg/L. MEK could not be detected at concentrations less than 10.0 mg/L in three samples (4.1%), less than 5.0 mg/L in five samples (6.8%), less than 2.5 mg/L in one sample, less than 2.0 mg/L in one sample, less than 1.0 mg/L in 22 samples (29.7%), less than 0.5 mg/L in seven samples (9.5%), less than 0.35 mg/L in one sample, less than 0.2 mg/L in 29 samples (39.2%) or less than 0.15 mg/L in one sample (shown as 10.0 mg/L, 5.0 mg/L, 2.5 mg/L, 2.0 mg/L, 1.0 mg/L, 0.5 mg/L, 0.35 mg/L, 0.2 mg/L and 0.15 mg/L respectively). One sample had undetectable levels of MEK (shown as 0.0 mg/L.)

Waste Antifreeze Summary

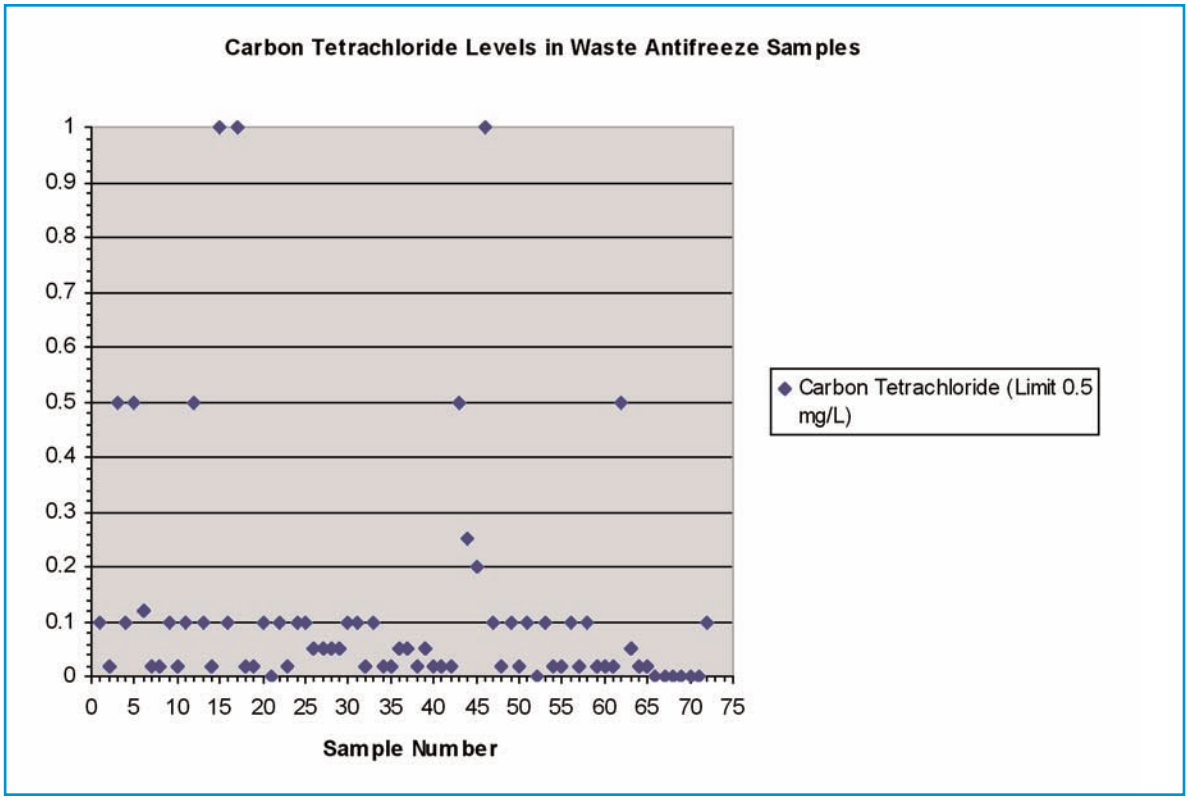

Figure 8. Carbon Tetrachloride Concentrations in Waste Antifreeze Samples.
The regulatory limit for carbon tetrachloride is 0.5 mg/L. There were no actual detections of carbon tetrachloride in any of the samples. Eight samples showed results warranting further investigation. In these samples, carbon tetrachloride could not be detected at concentrations lower than 1.0 mg/L or 0.5 mg/L. These cases are noteworthy in that the lowest detectable level is at or above the regulatory limit. These samples may or may not be representative of a hazardous waste. Carbon tetrachloride could not be detected at concentrations less than 0.25 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.12 mg/L in one sample, less than 0.1 mg/L in 22 samples (29.7%), less than 0.05 mg/L in eight samples (10.8%), or less than 0.02 mg/L in 29 samples (39.2%, shown as 0.25 mg/L, 0.2 mg/L, 0.1 mg/L, 0.05 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of carbon tetrachloride (shown as 0.0 mg/L.)

Waste Antifreeze Summary

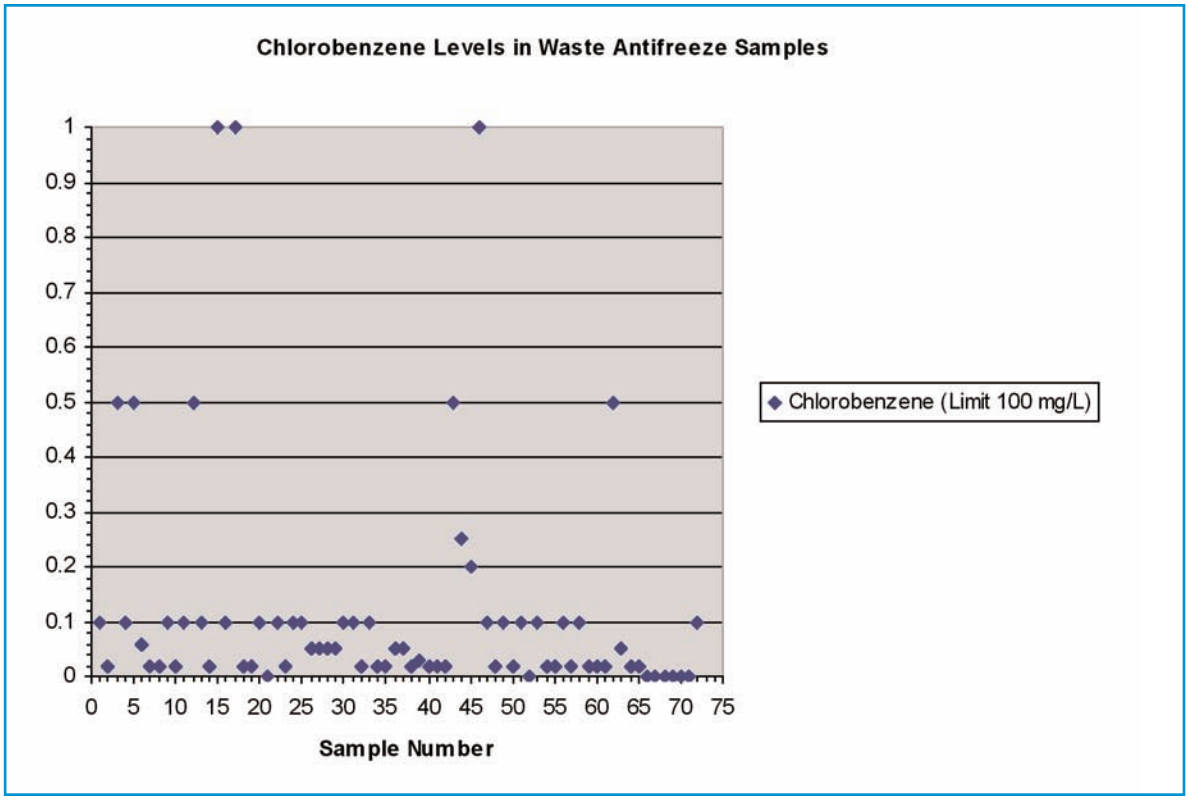

Figure 9. Chlorobenzene Concentrations in Waste Antifreeze Samples.
The regulatory limit for chlorobenzene is 100 mg/L. There were no actual detections of chlorobenzene in any of the samples. Chlorobenzene could not be detected at concentrations less than 1.0 mg/L in three samples (4.1%), less than 0.5 mg/L in five samples (6.8%), less than 0.25 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.1 mg/L in 22 samples (29.7%), less than 0.06 mg/L in one sample, less than 0.05 mg/L in seven samples (9.5%), less than 0.03 mg/L in one sample or less than 0.02 mg/L in 29 samples (39.2%, shown as 1.0 mg/L, 0.5 mg/L, 0.25 mg/L, 0.2 mg/L 0.1 mg/L, 0.06 mg/L, 0.05 mg/L, 0.03 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of chlorobenzene (shown as 0.0 mg/L.)

Waste Antifreeze Summary

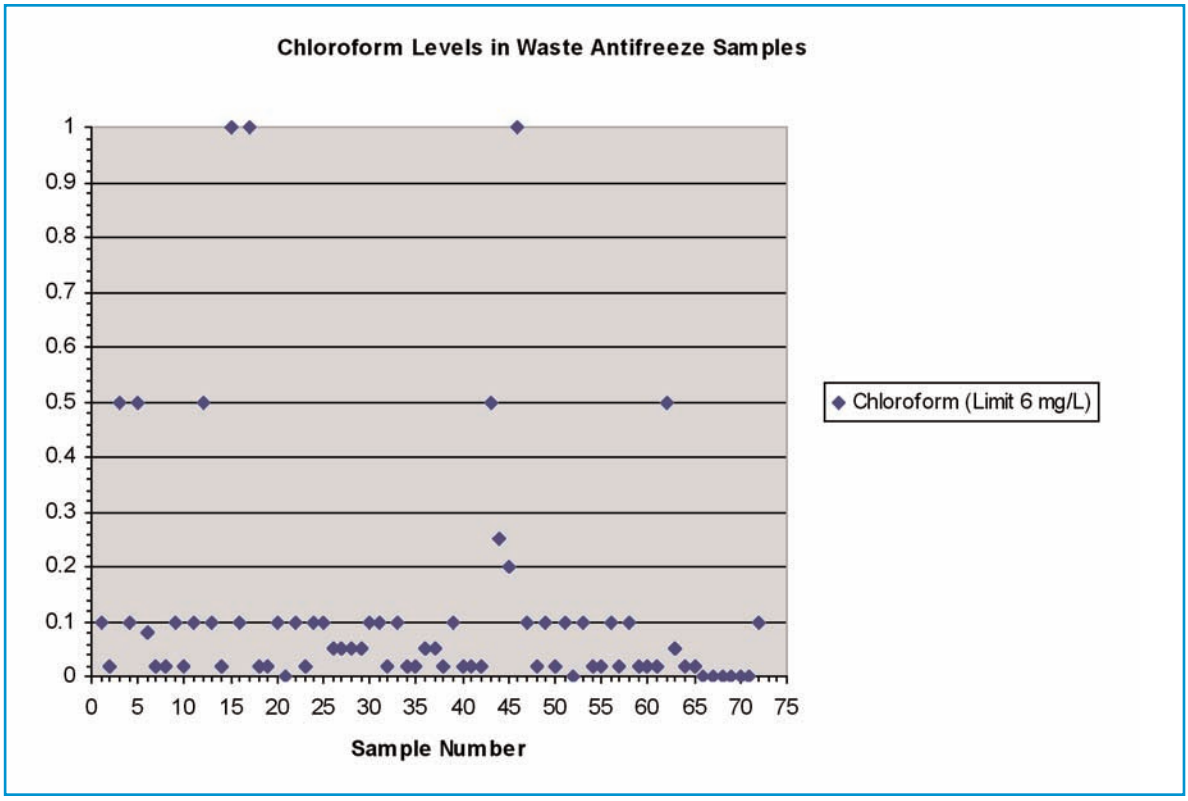

Figure 10. Chloroform Concentrations in Waste Antifreeze Samples.
The regulatory limit for chloroform is 6 mg/L. There were no actual detections of chloroform in any of the samples. Chloroform could not be detected at concentrations less than 1.0 mg/L in three samples (4.1%), less than 0.5 mg/L in five samples (6.8%), less than 0.25 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.1 mg/L in 23 samples (31.1%), less than 0.08 mg/L in one sample, less than 0.05 mg/L in seven samples (9.5%) or less than 0.02 mg/L in 29 samples (39.2%, shown as 1.0 mg/L, 0.5 mg/L, 0.25 mg/L, 0.2 mg/L 0.1 mg/L, 0.08 mg/L, 0.05 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of chloroform (shown as 0.0 mg/L.)

Waste Antifreeze Summary

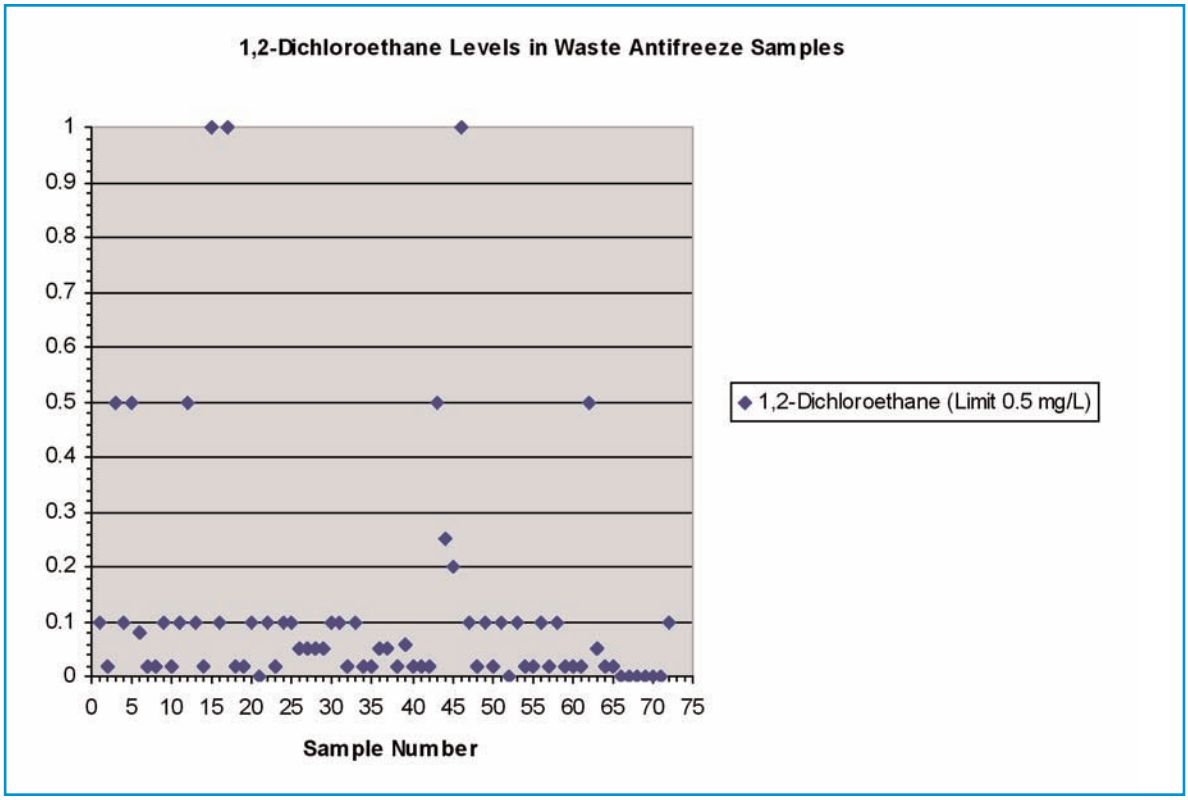

Figure 11. 1,2-Dichloroethane Concentrations in Waste Antifreeze Samples.
The regulatory limit for 1,2-dichloroethane is 0.5 mg/L. There were no actual detections of 1,2-dichloroethane in any of the samples. Eight samples showed results warranting further investigation. In these samples, 1,2-dichloroethane could not be detected at concentrations lower than 1.0 mg/L or 0.5 mg/L. These cases are noteworthy in that the lowest detectable level is at or above the regulatory limit. These samples may or may not be representative of a hazardous waste. 1,2-dichloroethane could not be detected at concentrations less than 0.25 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.1 mg/L in 22 samples (29.7%), less than 0.08 mg/L in one sample, less than 0.06 mg/L in one sample, less than 0.05 mg/L in seven samples (9.5%), or less than 0.02 mg/L in 29 samples (39.2%, shown as 0.25 mg/L, 0.2 mg/L, 0.1 mg/L, 0.08 mg/L, 0.06 mg/L, 0.05 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of 1,2-dichloroethane (shown as 0.0 mg/L.)

Waste Antifreeze Summary

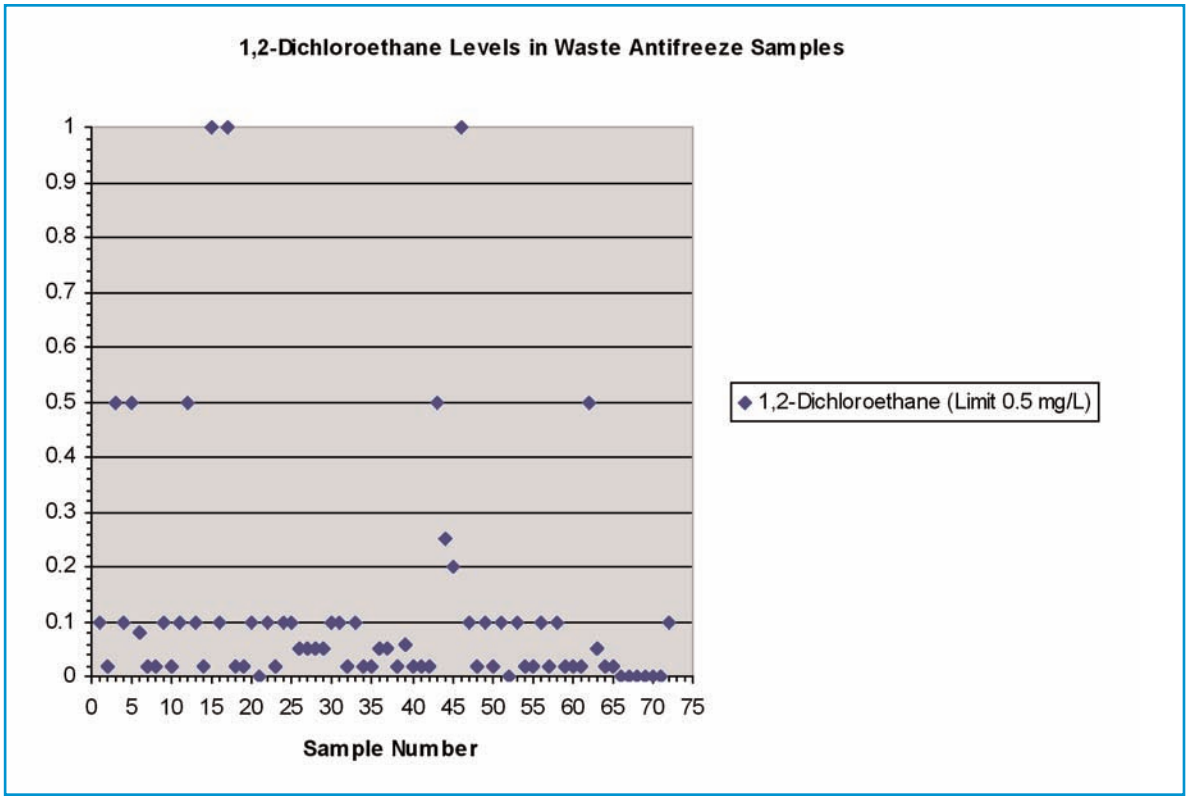

Figure 12. 1,1-Dichloroethene Concentrations in Waste Antifreeze Samples.
The regulatory limit for 1,1-dichloroethene is 0.7 mg/L. There were no actual detections of 1,1-dichloroethene in any of the samples. Three samples showed results warranting further investigation. In these samples, 1,1-dichloroethene could not be detected at concentrations lower than 1.0 mg/L. These cases are noteworthy in that the lowest detectable level is above the regulatory limit. These samples may or may not be representative of a hazardous waste. 1,1-dichloroethene could not be detected at concentrations less than 0.5 mg/L in five samples (6.8%), less than 0.25 mg/L in one sample, less than 0.2 mg/L in one sample, less than 0.11 mg/L in one sample, less than 0.1 mg/L in 21 samples (28.4%), less than 0.05 mg/L in seven samples (9.5%), less than 0.04 mg/L in one sample or less than 0.02 mg/L in 30 samples (40.5%, shown as 0.5 mg/L, 0.25 mg/L, 0.2 mg/L, 0.11 mg/L, 0.1 mg/L, 0.05 mg/L, 0.04 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of 1,1-dichloroethene (shown as 0.0 mg/L.)

Waste Antifreeze Summary

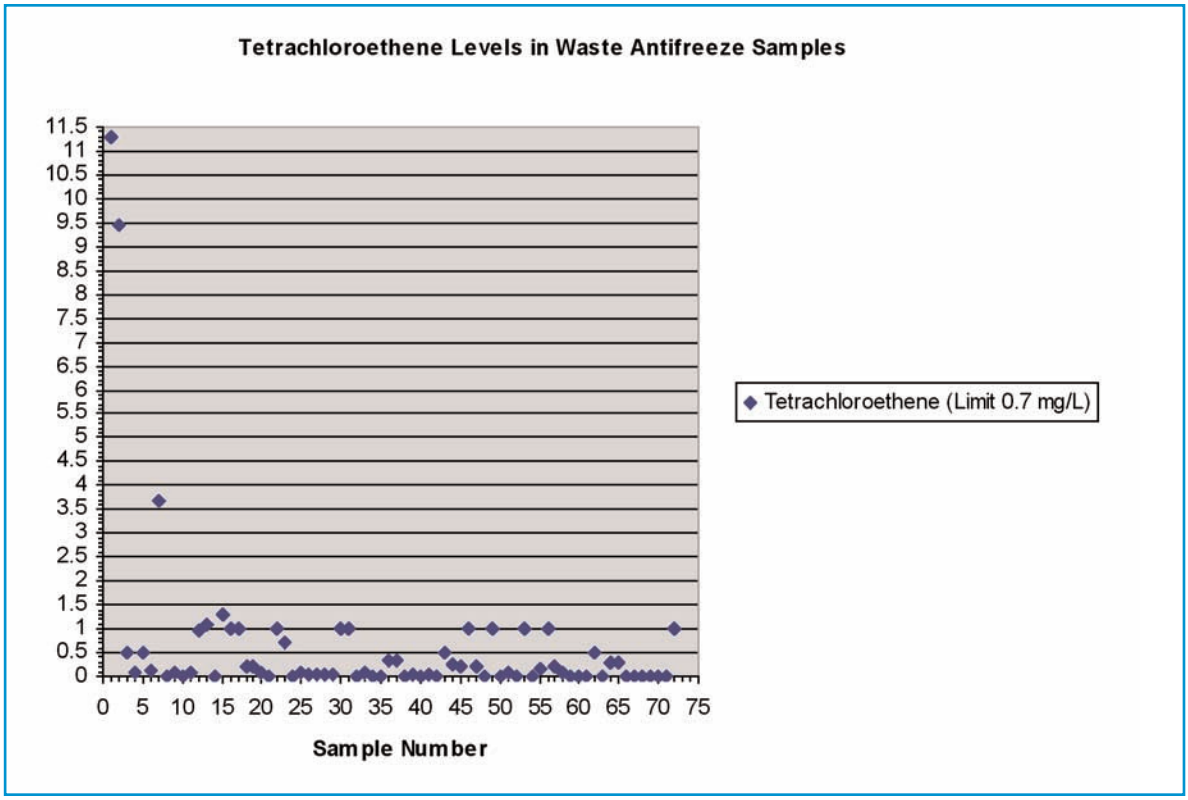

Figure 13. Tetrachloroethene Concentrations in Waste Antifreeze Samples.
The regulatory limit for tetrachloroethene is 0.7 mg/L. ***Nine samples showed tetrachloroethene concentrations higher than the regulatory limit (0.729 mg/L, 0.942 mg/L, 1.07 mg/L, 1.3 mg/L, 2.6 mg/L, 3.7 mg/L, 9.46 mg/L, 11.3 mg/L and 16.0 mg/L.)*** Ten samples showed results warranting further investigation. In these samples, tetrachloroethene could not be detected at concentrations lower than 1.0 mg/L. These cases are noteworthy, in that the lowest detectable level is above the regulatory limit. These samples may or may not be representative of a hazardous waste. Tetrachloroethene could not be detected at concentrations less than 0.5 mg/L in four samples (5.4%), less than 0.25 mg/L in one sample, less than 0.2 mg/L in three samples (4.1%), less than 0.11 mg/L in one sample, less than 0.1 mg/L in 10 samples (13.5%), less than 0.05 mg/L in four samples (5.4%), less than 0.04 mg/L in one sample or less than 0.02 mg/L in 17 samples (23.0%, shown as 0.5 mg/L, 0.25 mg/L, 0.2 mg/L, 0.11 mg/L, 0.1 mg/L, 0.05 mg/L, 0.04 mg/L and 0.02 mg/L respectively.) One sample had undetectable levels of tetrachloroethene (shown as 0.0 mg/L.)

Waste Antifreeze Summary

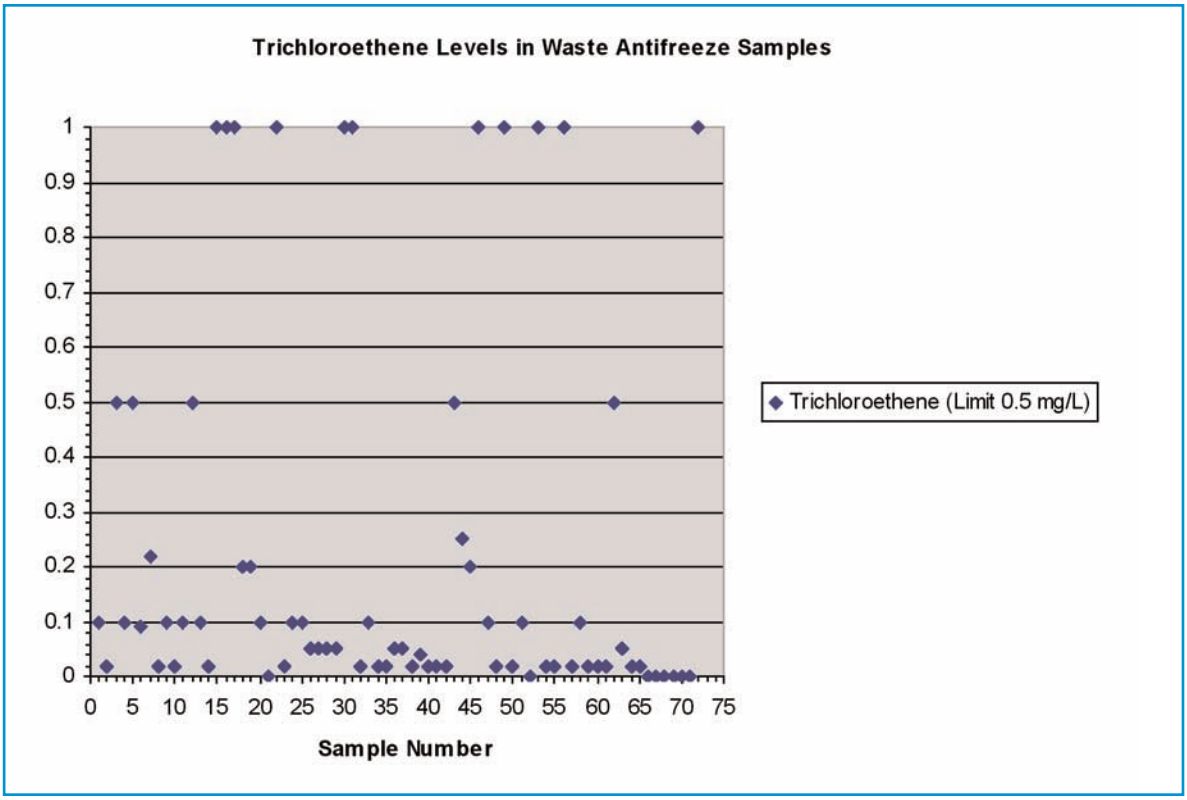

Figure 14. Trichloroethene Concentrations in Waste Antifreeze Samples.
The regulatory limit for trichloroethene is 0.5 mg/L. Trichloroethene was detected in only one sample at 0.22 mg/L. ***Sixteen samples showed results warranting further investigation. In these samples, trichloroethene could not be detected at concentrations lower than 1.0 mg/L or 0.5 mg/L. These cases are noteworthy in that the lowest detectable level is at or above the regulatory limit. These samples may or may not be representative of a hazardous waste.*** Trichloroethene could not be detected at concentrations less than 0.25 mg/L in one sample, less than 0.2 mg/L in three samples (4.1%), less than 0.1 mg/L in 14 samples (18.9%), less than 0.09 mg/L in one sample, less than 0.05 mg/L in seven samples (9.5%), less than 0.04 in one sample or less than 0.02 mg/L in 26 samples (35.1%, shown as 0.25 mg/L, 0.2 mg/L, 0.1 mg/L, 0.09 mg/L, 0.05 mg/L, 0.04 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of trichloroethene (shown as 0.0 mg/L.)

Waste Antifreeze Summary

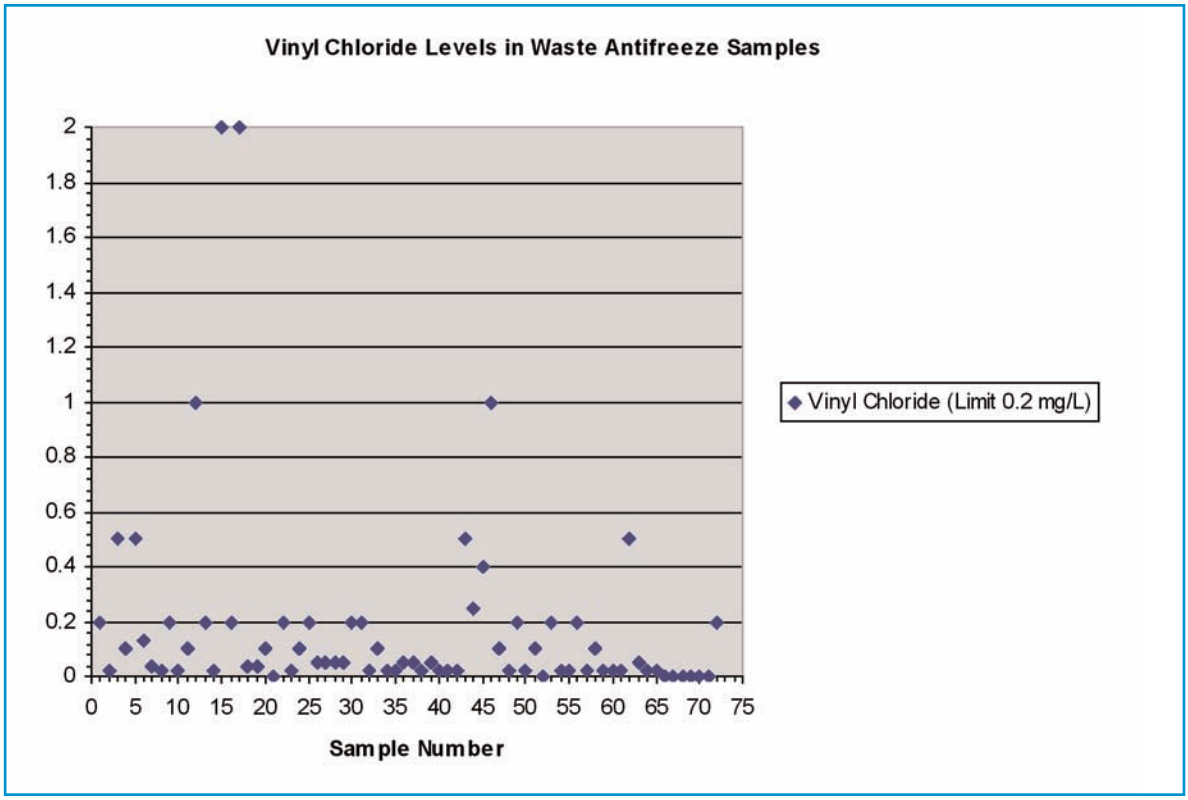

Figure 15. Vinyl Chloride Concentrations in Waste Antifreeze Samples.
The regulatory limit for vinyl chloride is 0.2 mg/L. There were no actual detections of vinyl chloride in any of the samples. ***Twenty-four samples showed results warranting further investigation. In these samples, vinyl chloride could not be detected at concentrations lower than 2.0 mg/L, 1.0 mg/L, 0.5 mg/L, 0.4 mg/L, 0.25 mg/L or 0.2 mg/L. These cases are noteworthy in that the lowest detectable level is at or above the regulatory limit. These samples may or may not be representative of a hazardous waste.*** Vinyl chloride could not be detected at concentrations less than 0.13 mg/L in one sample, less than 0.1 mg/L in 10 samples (13.5%), less than 0.05 mg/L in eight samples (10.8%), less than 0.04 in three samples (4.1%) or less than 0.02 mg/L in 24 samples (32.4%, shown as 0.13 mg/L, 0.1 mg/L, 0.09 mg/L, 0.05 mg/L, 0.04 mg/L and 0.02 mg/L respectively.) Two samples (2.7%) had undetectable levels of vinyl chloride (shown as 0.0 mg/L.)

The Iowa Waste Reduction Center (IWRC) is a free, confidential and non-regulatory small business technical assistance program located at the University of Northern Iowa. The IWRC offers a free on-site review of any Iowa business with fewer than 200 employees. Contact the IWRC at 319-273-8905 or on the web at www.IWRC.org.

Waste Antifreeze Summary

References

1. Montgomery County, Maryland, Department of Environmental Protection, Vehicle Maintenance and Repair Series, Aerosol Cans, http://www.montgomerycountymd.gov/deptmpl.asp?url=/content/dep/Factsheets/aerosol.asp
2. Wolf, Katy, Mike Morris, *Brake Cleaning with Water-Based Cleaning Systems*, Pollution Prevention Review, Summer 2000.

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