ETHYLENE GLYCOL ANTI-FREEZE - WASTE REDUCTION OPTIONS

BACKGROUND

Ethylene glycol based anti-freeze is used as a cooling medium for automotive and diesel engines in most vehicles. The use of anti-freeze prevents thermal breakdown of lubrication oils from the excess heat generated from combustion engines. These oils protect the metal parts against friction and heat and are especially critical in diesel engines since they run hotter due to higher compression ratios (1). Anti-freeze is especially useful as a coolant because its freezing point and boiling point are, respectively, lower and higher than that of water. Anti-freeze is chiefly composed of a 50:50 mix of ethylene glycol and water. Other important additives to the water/glycol mixture are corrosion inhibitors, pH buffers, anti-foaming agents to prevent bubble formation, and biocides to control bacterial growth. This mixture optimally provides a -34^{o} F freeze and 235^{o} F anti-boil protection.

Automotive manufacturers generally recommend that anti-freeze be replaced at regular intervals, for example, Ford Motor Company recommends replacement at 36,000 miles or every two years for gasoline engines (6). Volvo recommends replacement at 40,000 mile intervals and Cummins Diesel recommends changes at a 200,000 mile interval (1). Replacement at any interval results in waste generation; i.e., used anti-freeze.

THE PROBLEM

Used anti-freeze consists primarily of the original ethylene glycol and water mixture, glycol breakdown by-products, depleted inhibitors, corrosion by-products and heavy metals from the attack of breakdown by-products on the radiator, engine block and soldered joints. This report will examine the nature of the problem and alternatives available for environmentally sound waste reduction, recycling and reuse of anti-freeze.

Heavy metals generation, primarily lead, zinc and copper and, in some cases, high biological oxygen demand (BOD5) are the principal environmental concerns of waste anti-freeze disposal. In some cases metal concentrations in the used anti-freeze are high enough to require classification as a hazardous waste. If spent fluid is discharged to a municipal treatment system, the facility may exceed its allowable metal and organic limits. Also, discharging to a septic system could cause extensive groundwater contamination. Increasing regulatory controls over disposal of waste anti-freeze is forcing industry to seek other alternatives.

Federal, state, and local environmental controls currently affecting the disposal and/or recycling of anti-freeze are a major and often dominant factor in selecting alternatives available. The U.S. EPA has not listed ethylene glycol as a controlled or priority substance. However, usage can generate a hazardous waste dependent on the heavy metals content and other substances present. Classification as a hazardous substance is now determined on a case-by-case basis. Classification is

determined by certified laboratory testing of a representative sample for concentrations of pollutants. If the anti-freeze is mixed with any other listed hazardous waste, then the mixture automatically becomes hazardous as well.

Most states follow EPA's regulations with some states being more strict than others. In some states, generators are allowed to discharge to a sanitarys sewer as long as it receives treatment in a wastewator treatment plant. Since several states do restrict the disposal of anti-freeze, the state regulatory agency must be consulted as to the restrictions that apply. Any pretesting requirements will be provided by local or state agencies.

City and county wastewater treatment systems also either have laws already on are preparing laws banning the dumping of anti-freezee. Users must contact local municipal wastewater treatment system operators for current regulations and the appropriate characterization and toxicity tests required before treatment and/or disposal.

Violations of local controls can be expensive. A small New Jersey bus company was fined for dumping anti-freeze from some of their vehicles on the ground outside of their garage (2). This company was required to have 6 feet of earth removed all around their property by a waste hauler and replaced with fresh fill dirt. A fine of $5,000 per day was levied until this was completed. They could not comply with the ruling fast enough, and 30 days later filed for bankruptcy. The City of Winston-Salem, North Carolina has banned the dumping of anti-freeze by all users ranging from "do-it-yourselfers" to trucking fleets.(7) More local enforcement ca be expected as inexpensive recycling technologies and disposal alternatives are approved.

Environmental regulations are not the only motivating factor to recycle and reuse coolants. The increase of ethylene glycol prices is a major motivation. Short falls in production due to plant fires and other outages have increased competition between coolant and plastics markets. Ethylene oxide, a precursor used for ethylene glycol manufacture, is also used in polyethylene plastics manufacture. The supply is tight and plastics manufacture is currently more profitable. Recycling could be a cost effective option in addition to being environmentally sound. Thus, recycling anti-freeze is a cost effective alternative to treatment and disposal which could also result in a reduction of vehicle maintenance costs.

This document presents summaries of the technology of anti-freeze, factors affecting a decision to implement an anti-freeze waste reduction program and ethylene glycol recycling systems.

TECHNICAL OVERVIEW

Anti-freeze degrades under normal usage in a vehicle cooling system. Vehicle radiators are composed chiefly of copper amd aluminum, with lead, zinc and tin used in the soldered joints.The chief contaminants in spent fluid are lead, zinc, tin, aluminum hydroxides, and iron from attacks on metal components, and magnesium; and calcium carbonates from the water added to the system to dilute the anti-freeze. Minor contaminants include spent inhibitors and anti-corrosion and anti-foamin agents. Depletion of pH buffering agents and bacterial growth promote formation c acidic compounds. These degradation products are acidic and can cause damage to the radiator. Depletion of the anti-foaming agents can result in bubble formation and cavitation attack on metal surfaces.

It has been suggested that, at a minimum, the recycled anti-freeze should pass the ASTM tests for virgin anti-freeze. These three ASTM tests are D-1384 (coolant corrosion of cast iron, aluminum, steel, brass, copper, and solder), D-4340 (a more severe heated aluminum surface corrosion test), and D-3306 (a comprehensive anti-freeze specification) (5). Reconstituted or recycled anti-freezes may not meet accepted industry specifications or satisfactorily pass performance specifications spelled out by ASTM, SAE and the current truck manufacturers. However, recycling equipment manufacturers claim that their material is equivalent to virgin anti-freeze. Most service providers drain and fill, in which case you are mixing virgin anti-freeze with old anti-freeze. Approximately 20% of the old anti-freeze remains in the engine block after draining. The anti-freeze user must judge as to whether recycled anti-freeze will meet his needs.

Caution should be exercised as recycling systems may not remove heavy metals or corrosive compounds from the spent coolant. It may be possible to distill the spent coolant to remove the contaminants and excess water. Still bottoms are normally classified a hazardous waste.

The industry controversy over the recycling of anti-freeze is not the issue of this document; rather, alternatives to the disposal of engine coolants are presented with supporting information so that vehicle maintenance shop and salvage yard operators can make sound judgements to remedy their waste anti-freeze problems.

RECYCLING OPPORTUNITIES

Both on and off site recycling and recovery opportunities exist now. The systems and techniques available can be divided into three general groups; off-site recycling with treatment, on-site recycling, and on-site recycling with treatment. Off-site recycling systems require the waste anti-freeze to be transported to a fixed facility where the waste coolant is filtered to remove particulates and large contaminants and treated to precipitate dissolved metals and adjust the pH. Finally the pure ethylene glycol and fresh additives (e.g. corrosion inhibitors) are added to bring the treated coolant back to the correct specifications. This process is completed in bulk fashion. A pick-up fee may be charged if the coolant is excessively contaminated with water and soils. The coolant is then processed and resold.

On-site recycling is the most common recycling practice. The waste coolant is simply filtered to remove gross contaminants and returned to the engine. These "vampire" systems are connected directly to the radiator hoses and use high pressure to circulate the coolant through the engine block to flush out the cooling systems. Typically small amounts of virgin anti-freeze are added to the radiator to make up for losses due to filtering. These systems do not recondition the coolant, remove dissolved metals or bring the anti-freeze to any set specifications.

On-site recycling with treatment can operate two different ways; as a vampire system or as a batch system.

The vampire method is identical to the non-treatment recycling method, however the coolant is passed through microfilters or other separation devices (e.g. ion exchange, ultra-filtration, or reverse osmosis) that remove dissolved metal and some of the degradation products. This treated anti-freeze is returned to the vehicle's cooling system and, usually is provided with additives and virgin ethylene-glycol to reach desired specification criteria.

The other on-site recycle and treatment system treats batches (typically 100 - 200 gal) of waste anti-freeze by using filtration, precipitation, and/or the other treatment techniques discussed above to remove both gross and fine contaminants from the coolant. Additives can then be used to bring the recovered fluid up to specification table - lists currently available recovery equipment and off-site recyclers. Vehicle maintenance shops that use this recycling method keep treated, reconditioned anti-freeze on hand to add directly to vehicles after they have been serviced (i.e. drain and flush). According to a sales representative, it is economically profitable to recycle anti-freeze if 50 or more trucks are serviced at one location utilizing a system similar to Glyclean (8).

Table I Provides a list of representative recycling systems currently on the market. No recommendations are made as to the quality or effectiveness of any product or service provided by these vendors.

CURRENT PRACTICES

Radiator and repair shops normally treat the coolant in-house and then dispose of residuals in the sewer. Vehicle maintenance shops usually discharge waste coolants into sewers without treatment. Recycling and reuse of coolants are becoming more common practices due to increased ethylene glycol prices and new environmental regulations governing waste disposal.Some auto salvage yard operators and radiator repair shops collect anti-freeze temporarily in a 55-gallon drum to let solids settle and then decant into one-gallon plastic milk jugs for future sale. One auto salvage operator is able to purchase these jugs from a local dairy for $0.10 per jug. The diluted coolant is tested and the freeze protection temperature marked on the jug. No further attempt is made to clean or bring the coolant into new coolant specifications. The anti-freeze is resold at $1.00 per gallon. This auto salvage operator has been able to sell about 1,000 gallons per year to walk-in customers and service station operators.

Large vehicle fleet operators handle their coolants differently. The present practice of one trucking fleet is to add make-up ethylene glycol or water for freeze temperature protection and occasional additives to adjust the corrosion resistance properties of the coolant. Complete coolant replacement only occurs when the engine undergoes a major overhaul.

Please note that reclaimed coolant should not be used in new automobiles or trucks because of warranty problems, i.e. recycled coolant may void the engine warranty. However, coolants can be reclaimed for reuse in automobiles or trucks whose engine warranties have expired.

SUMMARY

This report has addressed the current status of ethylene glycol usage, waste minimization and waste reduction opportunities available and regulatory considerations. Recycling and reuse of coolants is becoming a more prevalent and preferred approach for handling coolants. Additional information can be obtained by contacting any Waste Reduction Resoure Center Engineer at 1-800-476-8686.

TABLE I ETHYLENE GLYCOL
RECYCLING ALTERNATIVES

METHODOLOGY	PROCESS DESCRIPTION	TRADE NAME	VENDOR
Filtration (Vampire) On-Site Systems	Once Through Filtration	Glyclean	FPPF Chemical Co. 117 W. Tupper St. Buffalo, N.Y. 14201 (800) 735-3773
"	"	Mark X Flush	Wynn Oil Company 1151 West Fifth St. Azusa, California 91702 (818) 334-0231
"	"	Davco Kool Cart	Davco Manufacturing Corp. P.O. Box 2327 Ann Arbor, Michigan 4810 (313) 429-5665
"	"	KLEER-FLO Anti-Freeze Recycler	KLEER-FLO Company 15151 Technology Drive Eden Prairie, MN 55344 (612) 934-2555
Filtration Plus Flocculation (On-Site)	Microfiltration plus flocculation to remove dissolved salts and metals	Custom Design Service	Centaur Equipment Managem Corp. P.O. Box 5964 Metairie, LA 70009-9938
On-Site Collection Off-Site Treatment for Resale	Filtration, Flocculation and/or Ion Exchange or Distillation	Forty^{o} Below	FORTY BELOW S.E. Regional Office 13217 A N. Nebraska Ave. Tampa, FL 33612 (800) 328-5505
On Site Collection off Site Disposal	None	NALCO "Straight To The Point"	NALCO Chemical Company Nalco Center Napperville, IL 60566-10 (800) 241-6053

REFERENCES

(1) "Antifreeze Recycling Using the Glyclean System," Miller, Robert C., FPPF Chemical Company, Inc., Buffalo, NY, Undated.

(2) "Recycling Anti-freeze, The Technology is Here!", Miller, Robert C. & McNally, Mark C., FPPF Chemical Company, Inc., Buffalo, NY, Undated.

(3) "How to Successfully Recycle Your Ethylene Glycol Antifreeze," Centaur Equipment Management Corp., Metairie, LA, Undated.

(4) Private communication 10-10-89 with Mr. John Locks of Safety-Kleen.

(5) "Recycling or Disposal? De-Mystifying the Issues of Spent Coolant." Lopez, Gayle. NALCO Chemical Co.

(6) "Transcription From Audio Tapes 1989 N.A.R.S.A. Convention: Atlanta, March 1989." NALCO publication.

(7) Private communication 10-25-89 with Ms. Crystal Couch, Archie Elledge Wastewater Treatment Plant; Winston-Salem, NC.

(8) Private communication 10- -89 with Mr. Walter Garnet.

SUGGESTED READING:

"Anti-freeze Recycling: Hot Ideas for Keeping Your Coolant," Commercial Carrier Journal. September 1988. Pages 97-98.

"Wastewater, Sludge, Spent Coolant, and the Rest of the Crud," Radiator Reporter. Runzheimer International LTD, Northbrook, IL 60062. 1989. Pages 53-59.

"The Facts and Fallacies of Recycling Used Antifreeze," The BG Hotline. B.G. Products, Inc., Wichita, Kansas.

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6.4 WASTE ANTIFREEZE SOLUTION

Disposal of waste antifreeze solution is a common concern in the garage and service station sectors of the vehicle maintenance industry. Used antifreeze can be classified as a hazardous waste, as it usually contains high concentrations of heavy metals such as lead, arsenic, or zinc. Used antifreeze should be either tested for these hazardous characteristics or assumed to be a hazardous waste and disposed of accordingly.

Antifreeze (ethylene glycol) in its virgin state is not a hazardous waste and may be disposed of through the municipal sewage system. Check with PADER and your local sewage authority about your specific situation.

In some cases, spent antifreeze solution can be separated by distillation and burned as waste fuel. This service is provided by used solvent and oil recyclers. Some of the businesses listed in Chapter 8 may be able to recover waste antifreeze solutions as a fuel.