



Minimizing Impacts of Antifreeze Use



Introduction

Antifreeze choices can be perplexing. Options and purchasing questions to consider include: Ethylene glycol vs. propylene glycol vs. bio-based? Recycled or virgin? Extended life or conventional? Least toxic constituents? What color should it be? Another limitation to choosing the right product might be the type and make of the vehicle, because some vehicles and international standards only allow specific antifreeze formulations, or prohibit certain constituents.

Reportedly, shops and fleets often carry multiple types of antifreeze to accommodate different original equipment manufacturer specifications. For specialty shops servicing foreign vehicles, or pre-2003 models, or other makes that stipulate a specific antifreeze formulation, it may not be possible to offer recycled content, propylene-based, or certain extended life formulations. Clientele and manufacturer specifications will often dictate the type of antifreeze used. Shops also commonly use reclaimed or recycled content, and/or extended-life antifreeze formulations. In these cases, the base constituent is most often ethylene glycol.

Extended life properties come from a corrosion inhibitor package that is often based on one or a combination of nitrites, phosphates, silicates, and/or organic acid technology (OAT). Some of the OAT inhibitors are ethyl hexanoic acid (2-EHA), sebacic acid, or benzoic acid. In the past, some corrosion inhibitors, including OATs have been corrosive for certain vehicle seals and gaskets, restricting use in those vehicles, or requiring other additives to protect seals and gaskets.

Antifreeze products come in a mind-boggling array of formulations. They need to meet different requirements in different locales. For example, antifreeze needs to be phosphate-free to meet European requirements, silicate-free to meet Japanese requirements, and nitrate-, nitrite-, and/or amine-free to meet some US requirements. The EET Corporation published a [helpful matrix of different antifreeze products](#) and constituents for the North American market. This matrix shows light duty, heavy duty, OAT formulations, and allowable formulations for different autos, and different additives (3). See *Table 1* for additional information on some common antifreeze ingredients.

In this document, PPRC has pulled together information that may help make informed purchasing and use decisions from an environmental and human health perspective. We have also provided some tips to minimize waste, resources, or pollution associated with antifreeze use.

Safer Alternatives from a Human Health Perspective

Ethylene glycol is the most common and abundant constituent of vehicle antifreeze products. Under the Globally Harmonized System (GHS) of Classification and Labelling of Chemicals, its hazard phrase is H302 (“Harmful if swallowed”), meaning it is an acute oral toxin. Depending on the amount of exposure, it can cause skin irritation. If inhaled, effects include: headaches, dizziness, nausea, and heart palpitations. Ethylene glycol is regulated as a hazardous waste and a hazardous air pollutant (HAP), as shown in Table 1, and has a sweet taste. The chance that children or animals might ingest the liquid from vehicle leaks or home or outdoor storage was a true risk in the past. It is now recommended to purchase product (including recycled content) with a bitterant additive.

One of the bitterants, denatonium benzoate, (proclaimed to be one of the bitterest substances known), is also an acute toxin. However, it is present in around 50 parts per million and does deter ingestion due to the undesirable taste.

TABLE 1	Attribute	Constituent										
Background	Constituent(s) evaluated (if > 3% by weight of product)	Ethylene glycol (EG)	Diethylene glycol	Propylene glycol (PG)	Phosphate (e.g. sodium or potassium)	Sodium Silicate	2-EHA (ethyl hexanoic acid)	Sebacic acid	Benzoic acid	Glycerol (Glycerine)	Propane -1,3-diol	Denatonium benzoate
	CAS Number	107-21-1	111-46-6	57-55-6	7601-54-9, 7778-77-0	1344-09-8	149-57-5	111-20-6	16518-26-6, 65-85-0	56-81-5	504-63-2	3734-33-6
	Used in:	Standard and extended life EG	Probable byproduct of EG production	Standard propylene glycol-based	Standard + extended life	Standard + extended life	Extended life, more common in ethylene glycol	Extended life, more common in EG	Extended life, more common in EG	Bio-based	Bio-based	Optional additive, usually in EG
	Purpose	Heat transfer	Not Applicable	Heat transfer	Corrosion inhibitor	Corrosion inhibitor	Corrosion inhibitor	Corrosion inhibitor	Corrosion inhibitor	Heat transfer	Heat transfer	Bitterant
	Percent weight in pre-mixed	50% or >	~3%	~50%	<2%	Not available	<5%	<5%	<5%	15% to 60%	15% to 60%	50 ppm
Regulatory & Hazard Assessment (Excludes metals picked up in spent antifreeze.) ^{a)}	Volatile Organic Content	100%	9%	~28%	N/A	N/A	N/A	N/A	0%	<0.5%	N/A	Negligible
	TRI Reportable	Yes	No	No	No	No	No	No	No	No	No	No
	GHS Hazard Statements - <i>Definitions below^{q)}</i>	H302	H302	H316 H320	H315 H319 H335	H315 H319	H361	H315 H319 H335	H315 H318 H372	None	H315	H302 H315 H319 H335
	Hazardous Air Pollutant	Yes	No	No	No	No	No	No	No	No	No	No
	California Prop 65 List	Yes (developmental)	No	No	No	No	No	Delisted 12/2013	No	No	No	No
	Flammability	Auto ignition ~748dF	At high temps	Auto ignition ~699dF	Explosive (open flame)	Not flammable	Not readily	Not readily	N/A	Auto ignition ~752dF	Above 379 dF	N/A
Fate & Environs ^{a,b)}	Persistence	No	No	No	Yes	Yes	No	No	No	No	No	No
	Bioaccumulation	No	No	No	No	No	No	No	No	No	No	No
	Aquatic Toxicity	No	No	No	No	No	No	No	No	No	No	No

a). Items colored in red text may be of most interest to those concerned about human and environmental health.

b). Source: [Canada Domestic Substance List](#)

c). Definition of GHS Hazard phrases found in Table 1:

- H302 Harmful if swallowed
- H315 Causes skin irritation
- H316 Causes mild skin irritation
- H318 Causes serious eye damage
- H319 Causes serious eye irritation

- H320 Causes eye irritation
- H335 May cause respiratory irritation
- H361 Suspected of damaging fertility of unborn child
- H335 May cause respiratory irritation
- H361 Suspected of damaging fertility of unborn child
- H372 Causes damage to organs through prolonged or repeated exposure



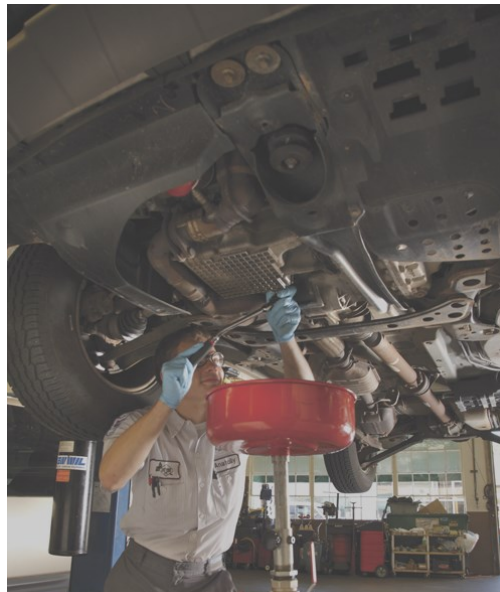
Safer Alternatives from an Environmental Perspective

Opportunities for a safer environment include: purchasing recycled-content and extended life properties; avoiding products with phosphate-based or any metal salts that may be added as supplemental cooling additives (SCA); preventing spills; recycling spent antifreeze; managing wastes responsibly; and educating consumers about the environmental impacts of dumping antifreeze down drains, into septic systems, or on the ground. Ethylene glycol can disturb the biological action of sewage treatment and septic systems. The EET Corp estimates that between 25 and 50 percent of spent antifreeze sold ends up improperly in the environment, with dumping by consumers as a major cause (4).

Antifreeze can be recycled an unlimited number of times, and therefore saves time, material, pollution, and energy over purchasing virgin. (See Purchasing section below for suggested attributes and procurement language examples).

During use, antifreeze picks up hazardous amounts of metals such as lead, cadmium, and chromium, so properly recycling and/or managing spent antifreeze and related wastes is important.

Although extended life antifreeze is more expensive, vehicles will require fewer or no antifreeze changes if original equipment manufacturers' (OEM) guidelines are followed. Fleets and shops will also reduce costs for hazardous waste handling, storage and disposal. Routine maintenance checks are still necessary with extended life formulations. (See Maintenance & Flushing below).



Purchasing Considerations & Example Specifications

Even if an auto shop or fleet wants to use the most environment-friendly antifreeze, purchasing decisions may be dictated by the vehicle or equipment manufacturer's specifications for a specific type of antifreeze, the age of the vehicle/equipment, and climate (exposure temperatures) that the antifreeze must protect against.

Purchasing Recycled: Many purchase reclaimed or remanufactured antifreeze. Shops, fleets, and consumers should not accept simple filtration recycling for any vehicle. The American Society for Testing of Materials (ASTM) establishes requirements for recycled (and virgin) antifreeze per ASTM standards D6471, D6472, and/or E1177 for recycled blends of different glycols. These standards cover performance characteristics such as corrosion protection, purity, and heat transfer.

For reference, King County specifies the following in their public bid for recycled antifreeze (4):

- If recycled ethylene glycol is used, it shall be recycled through fractional distillation, re-refined and shall meet or exceed ASTM E-1177 Standard Specification for Engine Coolant Grade Ethylene Glycol and be delivered in a concentrate that is not more than 5 percent water. On-site recycled product will not be considered.
- Only ethylene glycol based antifreeze shall be provided in concentration form, that is 5 percent or less water. The specified antifreeze shall provide corrosion and cavitation protection and shall reduce the freeze point and increase the boiling point of the ethylene glycol based fluid.



Another potential opportunity to reduce the potential for spills is to have the recycling vendor provide central bulk storage (and spill protection) for used and recycled antifreeze. Larger antifreeze users and shops can often request this service from the antifreeze recycling vendor at no cost, or negotiate with the vendor at a low cost.

Purchasing in Bulk or Concentrate: When possible, purchase in drums instead of individual containers. Also, purchase antifreeze in concentrate when possible (reference King County bid specs above). With concentrates, however, much of the country's tap water contains minerals such as magnesium and calcium that can form deposits in a cooling system, especially on the engine's hottest parts, so it is best to mix with distilled water (5).

Environmental Fate: Consider asking suppliers for product that does not contain phosphate compounds which can contribute to water quality problems, or any metal-based compounds in the corrosion inhibitor package.

Vehicle Maintenance and Flushing Practices

Due to antifreeze leaks and consumers or shops that dispose of spent antifreeze instead of recycling, only a portion of the antifreeze produced in the U.S. is recycled. A very dated statistic (from 1999) estimated the recovery rate at only about 12 percent (6). Many vehicles are simply "topped off" with fresh antifreeze, without checking for leaks.

For fleets, and regular oil-change clientele at auto shops, it may be helpful to establish a "threshold" at which antifreeze levels are evaluated for loss to identify potential leaks or other consumption, rather than just topping off the coolant tank. For instance, King County Transit operates under a policy where the loss/consumption of more than one quart of coolant per oil change interval results in a closer inspection for leaks. Another trigger for further inspection is if an antifreeze leak causes more than a one inch diameter circle of fluid to form.

To maintain the corrosion and heat protection of extended life additives, it is always important to check antifreeze on a regular maintenance schedule, for 'rust', fluid loss (proper dilution), and topping off as needed. Elizabeth Nelson, coolant program manager at Polaris Laboratories, states, "Don't buy into the philosophy that extended-life coolant needs no regular maintenance. The experts recommend inspecting it at the vehicle's regular maintenance intervals to make sure it's clear (no rust), that the color is right ... and that it has sufficient freeze/boil protection, best determined by using a refractometer" (7).

To prevent antifreeze loss or spills and drips during maintenance activities, and to protect water quality in your area (6,8):

- ◇ Use tight fitting lids, leak proof spigots, or funnel or pumps to transfer fluids.
- ◇ Use dedicated drip pans for antifreeze.
- ◇ Drain antifreeze from radiators and heater cores and filters into a recycling container as soon as possible, using a mesh or other basic pre-filter to remove debris from spent antifreeze.
- ◇ Don't dispose of spent antifreeze into a sewer, storm drain, septic tank, or dry well.
- ◇ Prevent leaks of antifreeze to sewers, storm drains, septic tanks, or dry wells.
- ◇ Never allow antifreeze to drip onto the ground outside the shop. If a car arrives leaking antifreeze, immediately get the vehicle inside the shop or place a catch sump or spill pan beneath the car and clean up the spill in the parking lot.
- ◇ Keep spill-control equipment and supplies in a central location, accessible to employees. Train employees to use it.
- ◇ Educate shop or fleet clientele and DIYs about the importance of not dumping spent antifreeze.



Spent Antifreeze, Waste & Recycling

During use, antifreeze can pick up metals such as lead, cadmium, and chromium. Most government agencies recommend antifreeze be recycled by qualified handlers, because:

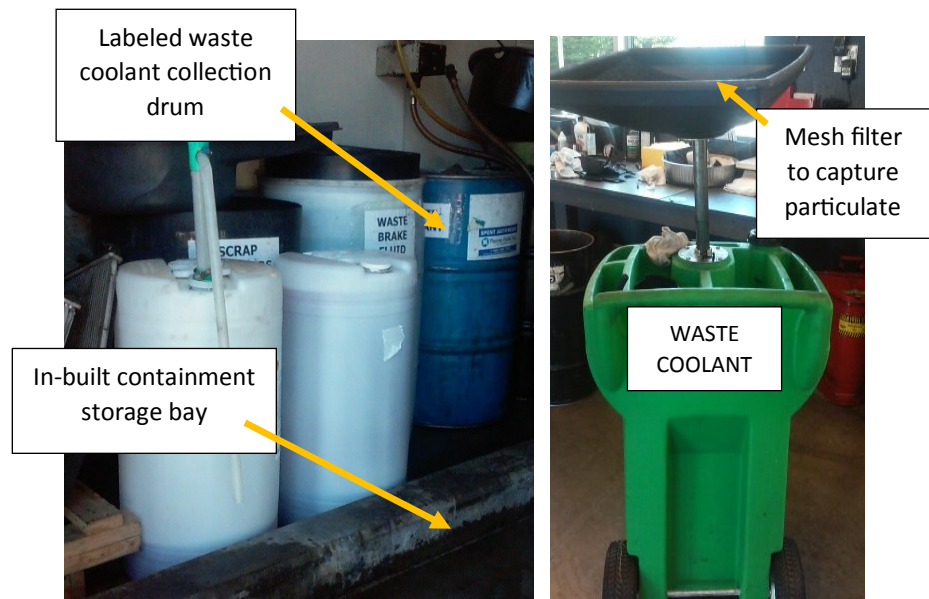
1. Ethylene glycol is a hazardous waste, a hazardous air pollutant, a Toxics Reduction Inventory (TRI) reportable compound (if generated over threshold levels), and is on California's Prop 65 list as a developmental toxin.
2. During use, antifreeze can become contaminated, rendering it a hazardous waste (or in the case of Washington State, a dangerous waste), unless it can be shown by lab analysis to not contain metals or other regulated contaminants. Waste antifreeze filters and particulate generated from collecting and/or recycling antifreeze onsite must also be managed as hazardous waste unless proven non-hazardous through laboratory analysis.
3. It is infinitely recyclable.

Some shops have in-house recycling systems, which requires additional in-house segregation, regulatory oversight and record keeping, and management of sludge and filters as a hazardous waste. The state of Washington offers guidance [here](#) (9). In Washington State, spent antifreeze that is not recycled is designated as a dangerous waste.

When recycling onsite, experts recommend ensuring that proper corrosion inhibitor chemicals are replaced before re-use in another vehicle.

Spent Antifreeze Best Management Practices:

- ◇ Do not mix spent antifreeze with any other waste. Label antifreeze containers "Spent Antifreeze Only" and "TOXIC" on spent collection containers.
- ◇ If different colors or types of antifreeze are collected, ensure to segregate and label properly per requirements of the recycling vendor.
- ◇ Store new/bulk antifreeze and spent antifreeze in secondary containment bays or bins, with a non-porous surface.
- ◇ Keep onsite volumes of spent antifreeze low by properly and routinely recycling the waste (in-house or with a recovery facility).
- ◇ Ensure used antifreeze is transported to a recovery facility by a certified transporter. Keep records of all shipments, dates, volumes, and transporters.



Photos courtesy of Swedish Automotive, Seattle, 2015

References

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