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Project Summary

Automotive and Heavy-Duty Engine Coolant Recycling by Distillation

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Product quality, waste reduction, and economic issues were evaluated for a distillation technology designed to recycle automotive and heavy-duty engine coolants. Coolant recycling was found to have good potential as a means of waste reduction and to be economically viable. The product quality achieved by this unit was promising. Product quality was evaluated by conducting selected performance tests recommended in ASTM D 3306 and ASTM D 4985 standards and by chemically characterizing the spent, recycled, and virgin coolants.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The objective of the U.S. Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection's (NJDEP) Prototype Evaluation Program is to evaluate, in a typical workplace environment, examples of prototype technologies that have potential for reducing wastes. The goal of the engine coolant recycling study was to evaluate (a) the quality of the recycled coolant, (b) the waste reduction potential of the technology, and (c) the economic feasibility of the technology.

The coolant recycling unit in this study was manufactured by Finish Thompson, Inc. (FTI)*, Erie, Pennsylvania. The unit (shown in Figure 1) operates on up to 15 gal of spent coolant per batch. Spent coolant is poured into the distillation still along with an additive to control boiling. The unit is switched on and allowed to operate until water and ethylene glycol are distilled off into two separate clean drums outside the unit. This may take between 12 and 15 hours for a full 15-gal load of spent coolant, depending upon the amount of water present. Water distills out first at atmospheric pressure. As the temperature rises, the vacuum pump switches on automatically and starts drawing out the glycol. The vapors are condensed by using tap water as the heat exchanger fluid. A chiller is available as an option, but was not used in this testing. The condensate enters the primer tank, where it mixes with the primer (ethylene glycol) and overflows into the "processed glycol drum". Three gallons of distillation residue collects at the bottom of the still and is emptied out, typically after five batches.

The study was conducted in cooperation with the New Jersey Department of Transportation (NJDOT) vehicle maintenance and repair facility in Ewing, NJ. Currently all the spent coolant at the NJDOT garage (approximately 8, 812 gal/yr) is shipped offsite for disposal.

Product Quality Evaluation

Engine coolants are intended to provide protection against boiling, freezing, and corrosion. Through use, the coolants lose some measure of these functions because of the accumulation of contaminants and the depletion of additives such as corrosion inhibitors and anti-foam agents. The recycling process attempts to restore the functions of the coolant to standards specified in ASTM D 3306-89 and SAE J1034 (for automotive coolant) and ASTM D 4985 and SAE J1941 (for heavy-duty coolants).

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use. This document is intended for informational purposes only for the automotive repair industry.

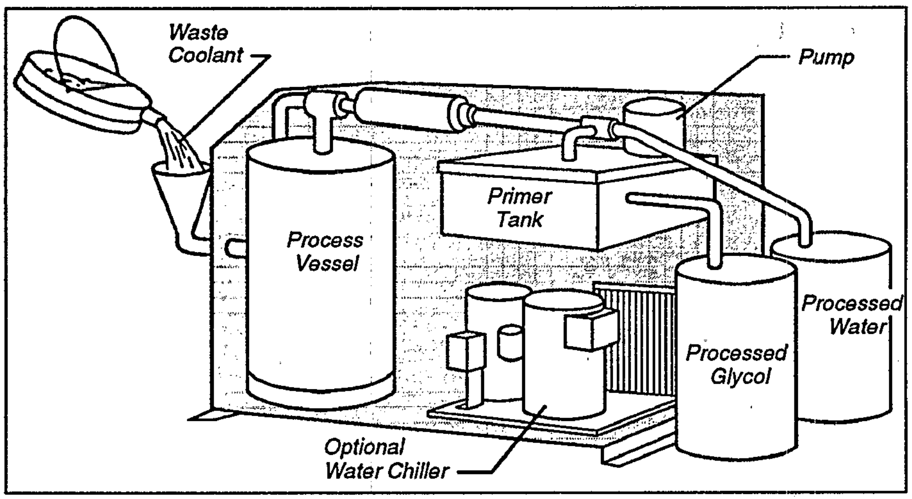

Figure 1. Coolant distillation process.

In addition to running batches of spent coolant (primary batches), test batches in which one or more characteristics of the coolant were intentionally altered (spiked batches), were run to test the limits of the recycling process. All batches, except Batch 5, consisted of spent coolant obtained from NJDOT. Batch 5 was spent coolant obtained from a local radiator shop. A blank, consisting of equal portions of virgin coolant and tap water, was also run through the unit. Samples of the virgin, spent, and recycled coolant were collected for analysis.

Batches 3 and 4 were run at less-than-full capacity to conserve time and materials. Because both units shut off while 3 gal of residue remained, as they are programmed to do, there was not enough recycled coolant for sampling from each individual batch. Hence, residue from Batches 3 and 4 was combined and rerun. This combined batch is henceforth referred to as Batch 3/4.

Results of the analyses were compared against ASTM and/or SAE standards. After recycling, the freezing point was measured by a hand-held refractometer, and the ratio of processed water to processed glycol was adjusted accordingly to meet freezing point specifications. As shown in Tables 1 and 2, the pH and corrosiveness of the recycled coolant were also within specified limits.

The spent and recycled coolants were characterized chemically and contaminant levels were measured to determine if these constituents affected performance. Table 3 shows the levels of metallic contaminants. The levels of calcium, magnesium, iron, and zinc were reduced considerably in the recycled coolant. Reduction in levels of lead and aluminum could not be estimated because of low levels of these metals in the spent coolant and due to matrix interference in the analysis.

One limitation of this product quality evaluation was that the performance of the recycled coolant from successive batches processed on the same recycling unit could not be assessed because the five batches were run on five separate units. Evaluation of the recycled coolant obtained after running several batches on the same unit would be a good adjunct to this study, especially because the primer (ethylene glycol) in the primer tank has a diluting effect on the initial batches. Later batches may have slightly higher levels of contaminants.

Waste Reduction Potential

Waste reduction potential was measured in terms of (a) volume reduction and (b) pollutant reduction. Volume reduction addresses the gross waste streams (i.e., spent coolant and spent filters); pollutant reduction involves individual pollutants (such as ethylene glycol and heavy metals) contained in the waste stream.

To estimate the amount of coolant that NJDOT disposes of annually, the amount of new coolant that NJDOT purchases annually was decreased by 10% to account for the environmental loss of coolant through leaks in the vehicles' cooling systems. Because the coolant is recycled rather than disposed of, the volume of waste reduction for NJDOT was calculated to be 8,812 gal. The side streams of the recycling process (residue) were also accounted for in this evaluation.

Since contaminants (e.g., lead) contained in the spent coolant will reach the environment whether or not the coolant is recycled (either through spent coolant disposal or residue disposal). The measurable hazard reduction of recycling comes from the amount of ethylene glycol that does not reach the environment or find its way to disposal. Ethylene glycol is considered a hazardous waste in some states (such as California). Recycling coolant offers considerable potential for reducing the amount of ethylene glycol released to the environment.

Economic Evaluation

The economic evaluation took into account the capital and operating costs (shown in Table 4) of the recycling equipment, as well as the savings provided by decreasing the needed amount of raw materials (virgin coolant and water) and by reducing disposal costs. The purchase price of the recycling unit at the time of this evaluation was $5,115. Because of the relatively high price of virgin coolant and the high volume of virgin coolant purchased by NJDOT, the payback period for the recycling process was much less than

Table 1. pH (ASTM D 1287-85) and Corrosivity (ASTM D 1384-87) As Measured in Laboratory

Batch No.	Description	Sample [a]	pH [b]	Weight Loss per Specimen (mg)[c,d]					
				Copper	Solder	Brass	Steel	C. Iron	C.Al
1,2	Primary	Spent	8.3	0	2	1	0	4	1
1	Primary	Recycled	10.9	0	4	3	1	2	5
2	Primary	Recycled	11.0	0	6	1	0	0	1
3/4	Spiked	Spiked	8.7	0	4	2	0	72	1
		Recycled	10.7	0	6	2	0	1	0
5	Primary	Recycled	10.8	0	7	1	0	1	0

a A recycled sample indicates 50:50 processed glycol and processed water, plus additives. No spent sample analyzed for Batch 5.
b SAE Standard for pH 7.5 to 11.0
c Average of triplicate results.
d ASTM D 3306 Standard for Corrosion:
(allowable weight loss per specimen)
Copper = 10 mg max
Solder = 30 mg max
Brass = 10 mg max
Steel = 10 mg max
Cast Iron = 10 mg max
Cast Aluminum = 30 mg max

Table 2. Corrosion of Cast Aluminum Test (ASTM 4340-89) Results

Batch No.	Description	Sample [a]	Corrosion Rate mg/cm²/wk [b]
1,2	Primary	Spent	16.8
1	Primary	Recycled	0.8
2	Primary	Recycled	0.9
–	Blank	Virgin	0.9

a A recycled sample indicates 50:50 processed glycol and processed water, plus additives.
b SAE Standard: Corrosion rate not greater than 1.0 mg/cm²/wk

Table 3. Concentrations of Metallic Contaminants in Coolant

Batch No.	Description	Sample [a]	ppm in Coolant [b]						
			Aluminum	Calcium	Copper	Iron	Lead	Magnesium	Zinc
1,2,3/4	Primary	Spent	<0.19	0.46	2.34	0.28	0.34	0.78	2.7
1	Primary	Recycled	0.63	<0.20	0.081	<0.04	2.88	<0.20	0.13
		Processed water	<0.19	<0.20	<0.036	0.04	<0.2	<0.20	0.062
2	Primary	Recycled	0.88	<0.20	0.32	0.04	1.0	<0.20	0.83
3/4	Spiked	Recycled	1.01	<0.20	0.21	0.63	1.59	<0.20	0.35
5	Primary	Processed glycol	1.20	<0.20	0.15	0.098	2.9	<0.20	0.29

a Recycled sample is 50:50 processed glycol and processed water, plus additives.
b In succeeding batches on the same distillation unit, concentrations in the "recycled" and "processed glycol" streams may be slightly higher as the glycol primer in the primer tank starts accumulating contaminants present in the glycol distillate vapors. This increase is not likely to significantly affect coolant performance (see Section 2.4 of the full report).

1 yr. Therefore, coolant recycling would make economic sense.

Conclusions

This evaluation shows that automotive coolant recycling has much potential as a waste reduction option. The NJDOT facility where this evaluation was conducted could potentially reduce spent coolant waste volume from over 8,000 gal to approximately 400 gal/yr. The recycled product in this evaluation also fared very well in the selected ASTM performance tests and the chemical characterization analyses. Boiling point, freezing point, pH, and corrosion resistance functions of the coolant were restored to specifications. Metals, salts, and organic contaminants were considerably reduced in the recycled coolant. Recycling was found to be economically viable for the NJDOT facility, with a return on investment (ROI) of over 300% in the first year.

Figure 2 describes how the ROI varies depending on the amount of spent coolant generated annually by the user. If a user generates 100 gal of coolant annually, the initial investment may not be recoverable. A slightly larger generator, with 500 gal/yr of spent coolant, would have a payback period of approximately 7 yr (ROI greater than 15%). The ROI improves as the amount of spent coolant generated becomes larger. The manufacturer plans to improve economics by reducing the heating requirement and also by eliminating the No Foam™ additive in the 1992 model of this unit. Also, as regulations become more stringent, the economical attractiveness of the technology can be expected to grow.

The full report was submitted in fulfillment of Contract No. 68-CO-0003, Work Assignment 0.06, by Battelle Memorial Institute under the sponsorship of the U.S. Environmental Protection Agency.

Table 4. Major Operating Costs

Item	Quantity/yr	Unit Cost, $	Total Cost, $/yr
Current Practice			
Disposal:			
- Coolant	8,812 gal	$140/ 55 gal drum	22,431
- Drums	160	30	4,800
- Labor (no overheads)	160 hr	15	2,400
			Total 29,631 [a]
Recycling			
No-Foam™ (additive)	700 bottles	1.86	1,302
FTI Treatment™ (additive)	700 bottles	8.60	6,020
Water (for condenser, flush)	252,140 gal	.0011	277
Electricity	35,990 kwh	.12	4,319
Labor (no overheads)	257 hr	15/hr	3,855
Residue Disposal	420 gal	$450/ 55 gal drum	3,436
Drums	8	30	240
			Total 19,449[a]

[a] *This total does not include maintenance costs or overhead.*

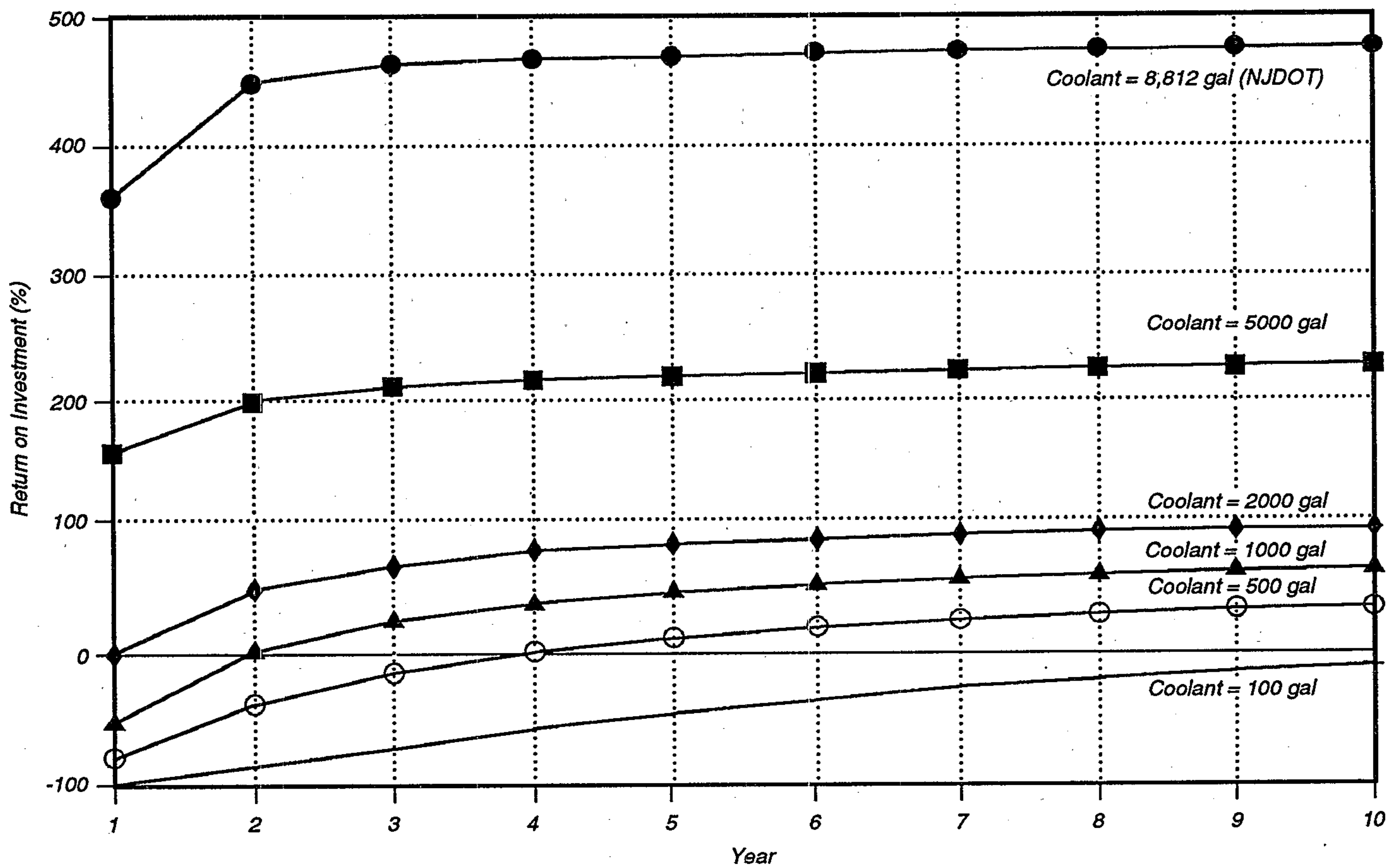

Figure 2. *Summary of ROI for various sizes of shops generating spent coolant.*

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Paul Randall *is the EPA Project Officer (see below).*
The complete report, entitled "Automotive and Heavy-Duty Engine Coolant Recycling by Distillation," (Order No. PB92-153 444/AS; Cost: $19.00, subject to change) will be available only from:
National Technical Information Service
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