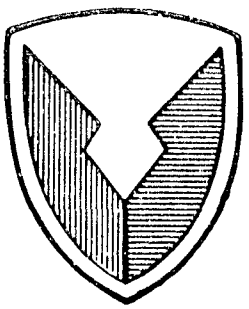

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CCL REPORT NO. 190

EXTENDED USE OF IMPROVED COOLING SYSTEM INHIBITOR - FIELD EVALUATION

INTERIM REPORT

BY

JAMES H. CONLEY

3 DECEMBER 1965

AMCMS CODE NO. 5025.11.803
DA PROJECT 1C024401A109

U. S. ARMY COATING & CHEMICAL LABORATORY
Aberdeen Proving Ground
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ABSTRACT

The object of this investigation is to determine if Federal Specification O-I-490a, Corrosion Inhibitor is suitable for use in vehicle cooling systems for extended periods. The improved inhibitor was placed in the vehicle cooling systems with antifreeze compounds meeting Federal Specification O-A-548a, Type I, or commercial materials similar to the Type I. The inhibitor was added at the rate of 1 ounce per 2 quarts of water used in making up the antifreeze solution. Four government vehicles and four private passenger cars were utilized for tests. Solutions were checked every three months and if necessary the coolant freezing point, pH value and reserve alkalinity (R.A.) value were adjusted.

Data indicates that inspection periods of longer than three months permits the coolant to get out of control. In the event the Army adopts the continued use of antifreeze solutions for two years, the coolant solutions must be checked every three months by technical personnel and adjusted, if necessary, to insure safe continued use.

TABLE OF CONTENTS

I. INTRODUCTION

Aberdeen Proving Ground, Maryland, was directed by AMC program directive AMCMS Code 5025.11.803, dated 24 July 1964 to investigate improved antifreeze mixtures.

Several inhibitor systems were examined in both glassware bench corrosion tests and simulated service tests. Data reported in CCL Reports Nos. 125, 145, 155 and 156 showed that glassware bench tests gave satisfactory results with cast iron-aluminum systems. Data also showed that in simulated service tests utilizing cast iron-aluminum systems corrosion was evident using Federal Specification O-A-548a Type I antifreeze inhibited with Federal Specification O-I-490 corrosion inhibitor. CCL Report No. 156 showed that by adding phosphate the corrosion in a cast iron-aluminum system was greatly reduced. As a result of this Federal Specification O-I-490a was issued. Field tests were set up. Preliminary results were recorded in CCL Report No. 156.

This interim report contains additional data on the field evaluation of the improved inhibitor.

II. DETAILS OF TEST

A. Vehicles.

Two test vehicles, two facility vehicles and four civilian vehicles were utilized for the field evaluation. All the vehicles except one contained a cast iron block and head and a copper radiator. One civilian vehicle had a cast iron block and aluminum head and a copper radiator.

B. Test Solution.

The two test vehicles and two facility vehicles were filled with Federal Specification O-A-548a, Type I antifreeze, and distilled water containing Federal Specification O-I-490a, Corrosion Inhibitor. The inhibitor was added at the rate of 5 ounces per 10 quarts of water used.

The four civilian vehicles were filled with commercial antifreeze compounds purchased by the vehicle owners. These antifreeze compounds were similar in nature to the Type I antifreeze and were adjusted to contain approximately the same inhibitor system as the two test vehicles and two facility vehicles.

Solution concentrations are indicated by the freeze points in table I of the Appendix.

C. Preparation for Test.

All vehicles were drained and flushed. All unserviceable parts were replaced. The vehicles were then filled with the test solution. A sample was taken and the initial pH, reserve alkalinity (R. A.), and freezing point data recorded.

D. Sampling and Solution Check.

The sampling on the two test vehicles was made at approximately every 5,000 miles.

The sampling on the two facility vehicles was made at approximately every four to six months.

The sampling on the four civilian vehicles was made every three months.

The pH, reserve alkalinity (R.A.), and freezing point of the coolant were determined at each inspection. Adjustments, if necessary, for coolant level, pH, R.A. and freezing point were made at each inspection.

III. RESULTS

Results of the tests are listed in Table I of the Appendix. The two test vehicles were intended to be run for 30,000 miles but at approximately 10,000 miles each vehicle had a failure not attributed to the antifreeze inhibitor system. The test solutions were lost and the tests stopped.

The two facility vehicles both show that even though they were being monitored by the laboratory, water was being added to the cooling systems in the field by the drivers. One was recharged after 24 months and the test is continuing. Both vehicles were two years old at the start of the test.

The four civilian vehicles were checked every three months and the systems were not tampered with by the drivers between checks. All coolant adjustments were made by the laboratory. Civilian vehicles nos. 1 & 2 are continuing with good service and no difficulty. Both of these vehicles were filled with the antifreeze test solution soon after they were purchased. The cooling system of civilian vehicle no. 3 constantly had to be refilled, sometimes with water and sometimes with antifreeze make-up solution. A leak was indicated but was not located. The test on this vehicle was started after it was approximately 1 year old. Civilian vehicle no. 4 was 4 years old when the test began. It had to be recharged after a leak developed around the filler neck at nine months and again twenty one months later when a heater hose broke and

the solution was lost. This vehicle test is continuing.

IV. DISCUSSION AND CONCLUSIONS

The data shows that the inhibitor system under test caused no malfunction of any vehicle tested. The coolant inhibitor performance was satisfactory in every vehicle. There was no coolant loss due to foaming. There was no corrosion of metal parts causing leaks. There were no hose leaks which could be attributed to attack by the coolant.

The data also shows that with proper maintenance and constant checking of the chemical and physical properties of the coolant by technical personnel at three month intervals, the coolant inhibited with Federal Specification O-I-490a Corrosion Inhibitor can be used in excess of 24 months without serious inhibitor depletion.

Equally important to safe continuous use is the conscientious checking and reporting of coolant system irregularities to the monitoring agency by the vehicle driver as soon as the irregularities are noted. No adjustments to the coolant should be made by the driver unless it is virtually impossible to move the vehicle without damage to the engine.

Data also indicates that the older the vehicle the more frequently breakdowns occur. In order to maintain a coolant system at maximum efficiency for extended periods very close control and constant maintainance will be required of both the monitoring agency and the vehicle driver.

V. REFERENCES

1. AMC program directive AMCMS code 5025.11.803 dated 24 July 1964.
2. Federal Specification O-I-490, Inhibitor, Corrosion, Liquid Cooling System, dated 27 November 1957.
3. Federal Specification O-I-490a, Inhibitor, Corrosion, Liquid Cooling System, dated 26 April 1965.
4. Federal Specification O-A-548a, Antifreeze, Ethylene Glycol, Inhibited, dated 30 Dec. 1958.
5. CCL Report No. 125 - Compatibility of Coolants with Automotive Cooling Systems Containing Aluminum Components - 1st Report, dated 21 June 1962.
6. CCL Report No. 145 - Final Report on Compatibility of Coolants with Automotive Cooling Systems Containing Aluminum Components, dated 14 June 1963.
7. CCL Report No. 155 - New Corrosion Inhibitors for Antifreezes, dated 16 January 1964.
8. CCL Report No. 156 - The Development of an Improved Cooling System Corrosion Inhibitor, dated 10 February 1964.

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APPENDIX A

TABLE I

FIELD TEST DATA

Vehicle	Operating Time	Mileage	pH	R.A.	Freeze Point	Added at Laboratory	Remarks
Test Vehicle #1	--	0	7.68	9.20	-12°F.	--	Start test
	2 weeks	5098	7.62	9.00	-12°F.	12 qts. make up	Break down in the field
	5 weeks	9300	7.72	7.30	- 4°F		Test stopped, radiator damaged
Test Vehicle #2	--	0	7.68	9.45	-13°F	--	--
	2 weeks	4857	7.60	9.20	-13°F	--	--
	4 weeks	8479	7.62	9.00	-16°F	3½ qts. make up	--
	5 weeks	10800	--	--	--	--	Test stopped, head pulled, sol'n. lost
Facility Vehicle #1	--	0	7.60	10.50	-15°F	--	Start test
	4 months	12470	7.52	9.85	-24°F	--	--
	8 months	24247	7.42	9.00	-23°F	--	--
	13 months	33910	7.38	7.60	-22°F	1 qt. make up	--
	18 months	41192	7.35	7.80	-22°F	1½ qts. make up	Heater leak repaired
	24 months	50726	7.48	4.10	+ 4°F	--	Test stopped, sol'n. diluted
Facility Vehicle #1 Recharge	--	0	7.62	11.10	-32°F	--	Restart test
	2 months	3277	7.60	10.50	-32°F	2½ qt. make up	Thermostat replaced
	8 months	12570	7.42	7.40	-27°F	--	Test continuing

TABLE I - Cont'd.

FIELD TEST DATA

Vehicle	Operating Time	Mileage	pH	R.A.	Freeze Point	Added at Laboratory	Remarks
Civilian Vehicle #3 Cont'd.	11 months	9439	8.08	8.80	- 9°F	1 qt. water	--
	16 months	18342	7.98	9.30	-17°F	1½ qts. make up	--
	20 months	23218	8.10	8.60	-14°F	--	--
	23 months	26226	7.98	7.90	-13°F	1 qt. make up	--
	26 months	31863	7.93	7.90	-12°F	2 qts. make up	--
	28 months	33662	7.95	8.40	-12°F	1 qt. make up	--
	32 months	36073	8.13	8.00	- 9°F	--	--
	35 months	39229	7.90	8.00	- 9°F	--	--
	36 months	41779	7.90	8.00	- 9°F	1 pt. make up	--
	37 months	42355	7.95	8.20	-10°F	1½ qts. make up	--
	41 months	45795	7.98	8.50	-13°F	3 qts. make up	--
	42 months	46887	8.13	8.40	-13°F	1 gal inhibited water	Test stopped, restarted
Civilian Vehicle #4	--	0	8.20	13.80	-22°F	--	Start test
	3 months	3295	8.15	12.85	-22°F	--	--
	5 months	4884	8.12	11.00	-11°F	2 qts. water	--
	8 months	7868	8.32	8.50	+ 2°F	4 qts. water	Test stopped. Leak around top filler outlet. Restarted.
Civilian Vehicle #4 Repeat	--	0	8.18	14.30	-14°F	--	Start test
	6 months	1299	8.00	14.10	-14°F	--	--
	9 months	3623	7.98	13.10	-14°F	--	--
	18 months	8686	7.95	11.40	-14°F	1 qt. make up	--
	21 months	12245	--	--	--	--	Hose brake, sol'n. lost, systems re-charged & continuing

TABLE I - Cont'd.

FIELD TEST DATA

Vehicle	Operating Time	Mileage	pH	R.A.	Freeze Point	Added at Laboratory	Remarks
Facility	--	0	7.52	11.00	-19°F	--	Start test
Vehicle	4 months	12560	7.45	10.40	-30°F	--	--
#2	8 months	20043	7.50	8.60	-22°F	--	--
	16 months	24132	7.50	7.40	-11°F	1½ qts. make up	--
	22 months	35277	7.90	6.10	+ 4°F	--	Test stopped, sol'n. diluted
Civilian	--	0	8.10	12.50	-14°F	--	Start test
Vehicle	6 months	7770	8.18	11.40	-14°F	--	--
#1	9 months	14537	8.18	10.70	-14°F	1 pt. make up	--
(Aluminum	12 months	19676	7.95	10.20	-14°F	--	--
Head)	15 months	22935	7.95	10.10	-14°F	--	--
	18 months	27302	8.00	10.10	-14°F	--	--
	21 months	33045	8.00	10.10	-14°F	--	Test continuing
Civilian	--	0	8.23	13.70	-14°F	--	Start test
Vehicle	6 months	5066	8.20	12.70	-14°F	--	--
#2	9 months	7766	8.12	12.10	-14°F	--	--
	13 months	11745	7.92	11.60	-14°F	--	--
	21 months	17820	7.92	11.36	-14°F	--	--
	24 months	19617	7.92	11.20	-14°F	1 pint make up	Pressure cap replaced Test continuing
Civilian	--	0	8.15	11.50	-24°F	--	Start test
Vehicle	2 months	1494	8.12	10.80	-20°F	1 qt. water	--
#3	5 months	3501	8.02	10.80	-21°F	--	--
	6 months	4187	8.08	10.00	-17°F	2 qts. water	--
	8 months	7143	8.12	9.15	-12°F	1½ qts. water	--

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13. ABSTRACT

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