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STORAGE STABILITY OF BRAKE FLUIDS

FINAL REPORT

BY

C. B. JORDAN

23 FEBRUARY 1965

AMCMS CODE NO. 5025.11.802
DA PROJECT 1C024401A108

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

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ABSTRACT

The object of this study was to investigate the stability of corrosion inhibiting systems found in brake fluids approved under Federal Specification VV-H-910a after extended storage of the fluids in steel and glass containers.

Corrosion and oxidation stability tests outlined in VV-H-910a were conducted on twenty-two approved fluids after $2\frac{1}{2}$ years storage in 5-gallon steel containers and on eight approved fluids after 5 years storage in 1-gallon glass containers.

In all tests conducted there was evidence of inhibitor instability or depletion. Sixteen of the twenty-two fluids stored in cans and five of the eight fluids stored in glass failed to meet minimum requirements of specification VV-H-910a. Nine of the fluids stored in cans and three of the fluids stored in glass also fail the more relaxed requirements of Society of Automotive Engineers Specification, 70R1, which is the controlling specification of the Federal Register.

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I. INTRODUCTION

The U.S. Army Coating and Chemical Laboratory, Aberdeen Proving Ground, Maryland, was authorized by AMC Directive, AMC Code 5025.11.802, dated 24 July 1964 to conduct research on hydraulic brake fluids.

One area of investigation concerned the effectiveness of corrosion inhibitor systems of brake fluids after prolonged storage in containers. Experience had indicated that sometimes the inhibitors were chemically unstable and were rendered ineffective by the interreaction of the chemicals which composed the inhibitor formulation. This was evidenced by the formation of precipitates or sediment in cans of stored brake fluids. It was believed that inhibitor depletion may also occur in other instances not visually evident. In order to determine if this was the case, corrosion and stability tests were conducted on brake fluids which had been approved under Federal Specification VV-H-910 and stored in their original steel containers for $2\frac{1}{2}$ years and in glass bottles for 5 years. This report contains the results of these tests.

II. DETAILS OF TEST

A. Brake Fluids Tested

Series 1 - Twenty-two fluids which had been approved under Federal Specification VV-H-910a were tested. These fluids had been in storage in an unheated warehouse in their original 5-gallon steel containers for 30 months. Each can contained approximately 2 to 3 gallons of fluid. Eight different brake fluid manufacturers were represented in this series of tests.

Series 2 - Tests were conducted on eight of the above fluids which had been stored in glass bottles at room temperature for five years. Six different manufacturers were represented in this series of tests.

B. Tests Conducted

a. Corrosion test - All fluids were subjected to the corrosiveness test specified in paragraph 4.5.11 of Federal Specification VV-H-910a. This test consists of the immersion of a set of six different metals (in electrolylic contact) in the fluid being tested, and heating at 210°F. for 120 hours. Weight loss of the metal specimens is measured and visual evidence of corrosion is noted.

b. Stability test - All fluids were subjected to the stability test specified in paragraph 4.5.14 of Federal Specification VV-H-910a. This test consists of the partial immersion of a set of aluminum and cast iron test specimens (electrolytically coupled) in a sample of the fluid to be tested. 0.2% Benzoyl Peroxide and 5% water is dissolved in the fluid. The test specimens are immersed for 3 days at room temperature and for 7 days at 158°, after which weight loss is calculated and visual evidence of corrosion noted.

III. RESULTS OF TESTS

Fourteen of the twenty-two brake fluids in Series 1 failed to meet the

minimum requirements of VV-H-910a in the corrosion test. Ten of the fluids failed the oxidation stability test.

Four of the eight fluids in Series 2 failed the corrosion test and four failed the stability test.

Nine of the fluids stored in cans and three of the fluids stored in glass also be judged to fail the more relaxed requirements of Society of Automotive Engineers Specification 70R1, which is the controlling specification of the Federal Register.

A comparison of test results with the results received at the time the fluids were originally qualified showed that in nearly every test there was evidence of inhibitor depletion upon storage, even though several of the fluids still met the minimum requirements of the specifications.

It is of interest to note that five of these fluids were placed in systems simulating standby storage. Four failed after one year's storage and one passed. All four fluids failing the standby storage test also fail in this storage test and the one which passed in standby storage was satisfactory in this test.

IV. DISCUSSION

Public Law 87-637, approved September 4, 1962 states that hydraulic brake fluids sold through interstate commerce must meet certain minimum physical and chemical requirements as set forth in the Federal Register without any time requirement. In addition it would be completed undesirable from the military point of view to have a brake fluid in a vehicle which would fail in storage. Results included in this report show that there is a serious problem and that a comprehensive study must be made to eliminate instability of brake fluid upon aging.

Brake fluids are composed of many combinations of base lubricants, solvents, and inhibitors. Since Federal Brake Fluid Specifications are "Performance" specifications, a wide variety of components are used. The most commonly used base lubricants are either castor oil or polyoxyglycol types. Solvents are usually alcohols, glycols, glycol-ethers, or combinations of these materials. The inhibitor system generally consists of alkaline materials in combination with antioxidant chemicals. Fluids may contain mixtures of base lubricants, many solvents, and many reactive inhibitors. The inhibitors may interreact, deteriorate or become depleted. Some of the situations which may accelerate the breakdown of the inhibitor system are: contact with metals, presence of water, and fluctuating temperatures. However, the fact that it is possible to prepare hydraulic brake fluids which are stable in storage is indicated in the test results. (Tables I and II).

The following studies are in progress or planned:

1. Correlation between brake fluid composition and storage stability.
2. Factors affecting inhibitor breakdown.
3. Development of accelerated test methods for predicting shelf life of brake fluids.

The matter of instability of hydraulic brake fluids upon aging has been brought to the attention of fluid suppliers and the automotive industry through the Society of Automotive Engineers Ad Hoc Committee on Brake Actuating Systems.

V. REFERENCES

1. Authority: AMC Directive, AMC Code 5025.11.802 dated 24 July 1964.
2. Federal Specification VV-H-910a, Hydraulic Fluid, Non-Petroleum Base, Automotive.
3. Public Law 87-637, dated 5 September 1962.
4. Specification 70R1, Society of Automotive Engineers, 485 Lexington Avenue, New York, New York.

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APPENDIX

TABLE I

SERIES I - $2\frac{1}{2}$ YEARS STORAGE IN 5 GALLON STEEL CONTAINERS - VV-H-910a BRAKE FLUIDS

Fluid No.	Corrosion Test	Stability Test
1	O. K.	O. K.
2	O. K.	O. K.
3	**Aluminum - Pitted	*Aluminum - Pitted
4	O. K.	*Aluminum - Pitted
5	*Aluminum & Brass - Moderate Stain	**Aluminum & Cast Iron - Pitted
6	*Brass - Moderate Stain	**Aluminum & Cast Iron - Pitted
7	*Brass - Moderate Stain	O. K.
8	*Aluminum - Moderate Stain	*Aluminum - Pitted
9	*Aluminum - Moderate Etching	O. K.
10	**Aluminum - Pitted, Brass - Moderate Stain	O. K.
11	*Brass - Moderate Stain	O. K.
12	**Steel - Pitted, Cast Iron - Moderate Stain	O. K.
13	*Brass - Severe Stain	O. K.
14	O. K.	O. K.
15	*Aluminum Moderate Etching	**Aluminum & Cast Iron - Pitted
16	*Aluminum - Pitted	**Aluminum - Pitted
17	O. K.	O. K.
18	O. K.	O. K.
19	O. K.	*Aluminum - Pitted

TABLE I - Cont'd.

SERIES I - 2½ YEARS STORAGE IN 5 GALLON STEEL CONTAINERS - VV-H-910a BRAKE FLUIDS

Fluid No.	Corrosion Test	Stability Test
20	O. K.	*Aluminum - Pitted
21	**Aluminum - Pitted	*Aluminum - Pitted
22	**Aluminum - Pitted, Brass - Severe Stain	**Aluminum - Pitted

*, Fails to meet minimum VV-H-910a requirements.
**Fails VV-H-910a and SAE 70R1.

TABLE II

Series 2 - 5 Years Storage in Glass Containers

VV-H-910a Brake Fluids

Fluid No.	Corrosion Test	Stability Test
4	O. K.	**Cast Iron - Pitted
5	*Brass - Severe Stain	O. K.
7	*Brass - Severe Stain	*Aluminum - Pitted
9	O. K.	O. K.
10	**Aluminum - Pitted	*Aluminum - Pitted
12	O. K.	O. K.
15	O. K.	O. K.
21	**Steel-Pitted, Brass-Severe Stain	**Aluminum - Pitted

* Fails to meet minimum Specification VV-H-910a Requirements.
** Fails VV-H-910a and SAE 70R1.

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