



SURFACE VEHICLE RECOMMENDED PRACTICE

J1705™

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(R) Low Water Tolerant Brake Fluids

RATIONALE

This document has been edited to bring it back to revised and current status. This edit includes replacing Section 3 with a test procedures and requirements table similar to the formatting found in SAE J1703 and SAE J1704.

1. SCOPE

This SAE Recommended Practice was prepared to provide engineers, designers, and manufacturers of motor vehicles with a set of minimum performance requirements in order to assess the suitability of silicone and other low water tolerant type brake fluids (LWTFs) for use in motor vehicle brake systems. These fluids are designed for use in braking systems fitted with rubber cups and seals made from styrene-butadiene rubber (SBR), or a terpolymer of ethylene, propylene, and a diene (EPDM).

In the development of the recommended requirements and test procedures contained herein, it is concluded that the LWTFs must be functionally compatible with braking systems designed for SAE J1703 and SAE J1704 fluids. To utilize LWTFs to the fullest advantage, they should not be mixed with other brake fluids. Inadvertent mixtures of LWTFs with fluids meeting SAE J1703 are not known to have any adverse effects on performance, but not all combinations have been tested. Vehicle manufacturer's recommendations should be followed where indicated. These fluids are not necessarily suitable for use in central hydraulic or pumped systems and are not intended for use below temperatures of -50 °C (-58 °F). Brake fluids covered under this document are not required to tolerate water and extreme caution should be exercised to prevent accidental entry of water which might lead to brake failure. Other performance characteristics of these LWTFs not covered in this document are discussed in Appendix A.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1703 Motor Vehicle Brake Fluid

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SAE WEB ADDRESS:

Full document details: SAE J1705_202105

For more information on this standard, visit
https://www.sae.org/standards/content/J1705_202105

Documents

Document Sharing Hub

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D91 Test Method for Precipitation Number of Lubricating Oils

ASTM D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)

ASTM D1120 Test Method for Boiling Point of Engine Coolants

ASTM D1415 Test Method for Rubber Property - International Hardness

ASTM D2240 Test Method for Rubber Property - Durometer Hardness

ASTM E1 Specification for ASTM Thermometers

ASTM E145 Specification for Gravity Convection and Forced-Ventilation Ovens

ASTM E203 Test Method for Water Using Karl Fischer Reagent

2.1.3 Federal Specifications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

FMVSS 116 Motor Vehicle Brake Fluids

2.1.4 Military Specifications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, <http://quicksearch.dla.mil/>.

MIL-B-46176 Brake Fluid, Silicone, Automotive, All Weather, Operational and Preservative

2.1.5 Other Publications

USAMERDC Report 2132 AD A-12849 - Feb. 1975

USAMERDC Report 21264 AD-02618 - Jan. 1976

Tichy, J.A. and Winer, W.O., "A Correlation of Bulk Moduli and P-V-T Data for Silicone Fluids at Pressure up to 500,000 PSIF," ASLE Transactions 11,338 - 344 (1968)

3. REQUIREMENTS

Requirements are given in Table 1 using the test procedure according to Section 4.

Table 1 - SAE J1705 test procedures and requirements

Test Procedure Section	Test Description	Unit	Requirement
4.1	Equilibrium reflux boiling point (ERBP)		
4.1.1	Equilibrium reflux boiling point (ERBP)	°C	≥260
4.1.2	Wet equilibrium reflux boiling point (WERBP)	°C	≥180
4.2	Viscosity		
4.2.1	At -40 °C	mm ² /s	≤900
4.2.2	At 25 °C	mm ² /s	≤50
4.2.3	At 100 °C	mm ² /s	≥1.5
4.3	Metal corrosion		
	Weight change of metal strips		Maximum
	Tinned iron (RM-06a)	mg/cm ²	±0.1
	Steel (RM-07)	mg/cm ²	±0.1
	Aluminum (RM-08)	mg/cm ²	±0.1
	Cast iron (RM-09)	mg/cm ²	±0.1
	Brass (RM-10)	mg/cm ²	±0.2
	Copper (RM-11)	mg/cm ²	±0.2
	Zinc (ISO-2)	mg/cm ²	±0.4
	Appearance	-	No pitting or roughening outside contact area
	Staining and discoloration	-	Permitted
	Liquid characteristics after test		
	Appearance		No gelling or crystalline deposit
	Sediment	%	≤0.1
	Rubber characteristics, after test		
	SBR (RM-3a)		
	Blister or sloughing	-	None
	Hardness decrease, maximum	IRHD	15
	Base diameter increase, maximum	mm	1.4
4.4	Fluidity and appearance at low temperature		
4.4.1	At -40 °C		
	Stratification/sedimentation/crystallization	-	None
	Bubble inversion time	seconds	≤10
	Appearance at room temperature	-	As original
4.4.2	At -50 °C		
	Stratification/sedimentation/crystallization	-	None
	Bubble inversion time	seconds	≤35
	Appearance at room temperature	-	As original
4.5	Water tolerance		
4.5.1	At -40 °C		
	Stratification/sedimentation/crystallization	-	None
	Bubble inversion time	seconds	≤10
	Appearance at room temperature	-	As original
4.5.2	At 60 °C		
	Stratification	-	None
	Sedimentation, by volume after centrifuging	%	≤0.05

Table 1 - SAE J1705 test procedures and requirements (continued)

Test Procedure Section	Test Description	Unit	Requirement
4.6	Effect on rubber		
4.6.1	SBR (RM-03a)		
	At 25 °C for 168 hours		
	Volume increase	%	+5 to +20
	Base diameter increase	mm	0.15 to 1.4
	Hardness decrease	IRHD	0 to -10
	Blistering or sloughing	-	None
	At 70 °C for 70 hours		
	Volume increase	%	+5 to +20
	Base diameter increase	mm	0.15 to 1.4
	Hardness decrease	IRHD	0 to -10
	Blistering or sloughing	-	None
	At 120 °C for 70 hours		
	Volume increase	%	+5 to +20
	Base diameter increase	mm	0.15 to 1.4
	Hardness decrease	IRHD	0 to -15
	Blistering or sloughing	-	None
4.6.2	EPDM (RM-69)		
	At 25 °C for 168 hours		
	Volume increase	%	0 to +10
	Hardness decrease	IRHD	0 to -10
	Blistering or sloughing	-	None
	At 70 °C for 70 hours		
	Volume increase	%	0 to +10
	Hardness decrease	IRHD	0 to -10
	Blistering or sloughing	-	None
	At 120 °C for 70 hours		
	Volume increase	%	0 to +10
	Hardness decrease	IRHD	0 to -10
	Blistering or sloughing	-	None
4.7	Compatibility		
4.7.1	At -40 °C		
	Sedimentation/crystallization	-	None
	Cloudiness	-	Permissible
	Appearance at room temperature	-	No cloudier than the original fluid
4.7.2	At 60 °C		
	Sedimentation, by volume after centrifuging	%	≤0.05
4.8	Fluid stability after 185 °C for 2 hours		
	Equilibrium reflux boiling point (ERBP)	°C	≥260

4. TEST PROCEDURE

4.1 Equilibrium Reflux Boiling Point

Determine the equilibrium reflux boiling point of the fluid by ASTM D1120 with the following exceptions:

a. Apparatus

1. Thermometer: ASTM E1, 76 mm immersion, calibrated. Use ASTM 3C or 3F thermometer. For fluids boiling below 300 °C (572 °F), ASTM 2C or 2F thermometer or other suitable non-mercury containing temperature measuring device—such as a thermocouple capable of operating in the same temperature range and having equal or better accuracy—may be used.
2. Heat source: Variable autotransformer-controlled heating mantle designed to fit the flask, or an electric heater with rheostat heat control.
3. Boiling point stones #8: Silicon carbide boiling stones #8.

b. Preparation of Apparatus

1. Thoroughly clean and dry all glassware before use. Attach the flask to the condenser. Place the mantle under the flask and support it with a suitable ring clamp and laboratory type stand, holding the whole assembly in place by a clamp.

NOTE: Place the whole assembly in an area free from drafts or other types of sudden temperature changes.

4.1.1 ERBP Measurement

When everything is in readiness, turn on the condenser water and apply heat to the flask at such a rate that the fluid is refluxing in 10 minutes $\pm$ 2 minutes at a rate in excess of 1 drop per second.

The reflux rate shall not exceed 5 drops per second. Immediately adjust heat input to obtain a specified equilibrium reflux rate of 1 to 2 drops per second over the next 5 minute $\pm$ 2 minute period. Maintain a timed, constant equilibrium reflux rate of 1 to 2 drops per second for an additional 2 minutes; record the average value of four temperature readings taken at 30 second intervals as the equilibrium reflux boiling point.

If the temperature exceeds 260 °C (500 °F), the test shall be stopped and the temperature recorded as exceeding 260 °C (500 °F).

4.1.2 Wet ERBP

4.1.3 Humidification Procedure

Lubricate the ground-glass joint of a 250 mm (9.89 inch) ID bowl-form desiccator having matched tubulated glass cover and fitted with a No. 8 rubber stopper. Pour 450 mL $\pm$ 10 mL (15.22 ounces $\pm$ 0.34 ounce) of distilled water into the desiccator and insert a perforated porcelain plate (Coors No. 60456 or equivalent). Immediately place one open RM-49 corrosion test jar containing 350 mL $\pm$ 5 mL of the test brake fluid into the desiccator. Place a second open RM-49 corrosion test jar containing 350 mL $\pm$ 5 mL of TEGME (triethylene glycol monomethyl ether, brake fluid grade—Appendix B) (RM-71) into the same desiccator. The water content of the TEGME control fluid at the start of exposure shall have been adjusted to 0.50% $\pm$ 0.05% by weight (Karl Fischer analysis or equivalent). Replace desiccator cover and insert at once into an ASTM E145, Type II A, forced ventilation oven set at 50 °C $\pm$ 1 °C (122 °F $\pm$ 1.8 °F).

Periodically, during oven humidification determine water content of the control fluid. When the water content of the control fluid has reached 3.70% $\pm$ 0.05% by weight, remove the desiccator from the oven and seal the test sample. Allow the sealed jar to cool for 60 to 90 minutes at 23 °C $\pm$ 5 °C (73.4 °F $\pm$ 9 °F).

Humidify the fluid as described in 4.1.3 and determine the boiling point as described in 4.1.

4.2 Viscosity

Determine the kinematic viscosity of the fluid by ASTM D445.

Report the viscosity to the nearest mm^2/s (centistoke).

4.3 Corrosion

Prepare two sets of strips from each of the metals listed in Table 1, each strip having a surface area of $25 \text{ cm}^2 \pm 5 \text{ cm}^2$ (approximately 8 cm long, 1.3 cm wide, and not more than 0.6 cm thick). Drill a hole between 4 mm and 5 mm in diameter and about 6 mm from one end of each strip. With the exception of the tinned iron strips, clean the strips by abrading them on all surface areas with 320A waterproof carborundum paper (RM-29) or P400 waterproof carborundum paper and isopropanol or ethanol until all surface scratches, cuts, and pits are removed from the strips, using a new piece of carborundum paper for each different type of metal. Wash the strips, including the tinned iron, with isopropanol or ethanol and dry the strips with a clean lint-free cloth and place strips in a desiccator containing desiccant maintained at $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$ ($73.4 \text{ }^\circ\text{F} \pm 9 \text{ }^\circ\text{F}$) for at least 1 hour.

Handle the strips with gloves, clean forceps, or cotton cloths after polishing to avoid fingerprint contamination.

Weigh each strip to the nearest 0.1 mg and assemble each set of strips on an uncoated steel bolt (RM-61) in the order tinned iron, steel, aluminum, cast iron, brass, copper, and zinc, so that the strips are in electrical contact. Bend the strips, other than cast iron, so that there is a separation of at least 3 mm between adjacent strips for a distance of about 6 cm from the free end of the strips.

Measure the base diameter of two standard SBR cups (RM-03a) using an optical comparator or micrometer to the nearest 0.02 mm (0.001 inch) along the centerline of the SAE and rubber type identifications and at right angles to this centerline. Take the measurements within 0.4 mm (0.015 inch) of the bottom edge and parallel to the base of the cup. Discard any cup if the two measured diameters differ by more than 0.8 mm (0.003 inch). Average the two readings of each cup. Support the rubber cup on a rubber anvil or cylinder having a flat circular top surface of at least 19 mm in diameter, a thickness of at least 9 mm, and a hardness within 5 IRHD of the hardness of the rubber test cup. Determine the hardness of each cup thus supported by the procedure specified in ASTM D1415 using the standard tester.

NOTE: ASTM D2240 may be used for quality control and routine tests when a Type A durometer is equipped with a fixture for keeping the plane of the pressure foot on the durometer parallel to the plane of the cup face during measurement.

Obtain two straight-sided round glass jars¹ (RM-49) having a capacity of approximately 475 mL and inner dimensions of approximately 100 mm in height and 75 mm in diameter.

To the RM-49 corrosion test jar, apply four wrappings of 19 mm (3/4 inch) Teflon tape around the jar threads allowing a 3 mm (1/8 inch) height above the top of the jar. Place one rubber cup with lip edge facing up in each of the two glass jars. Use only tinned steel lids vented with a hole $0.8 \text{ mm} \pm 0.1 \text{ mm}$ in diameter (RM-64).

Insert a metal strip assembly inside each cup with the bolted end in contact with the concavity of the cup and the free end extending upward in the jar. Add 400 mL of the humidified fluid (see 4.1.3) to cover the metal strip assembly in each jar. Tighten the lids and place the jars in an oven maintained at $100 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ ($212 \text{ }^\circ\text{F} \pm 3.6 \text{ }^\circ\text{F}$) for 120 hours ± 2 hours.

Allow the jars to cool at $23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$ ($73.4 \text{ }^\circ\text{F} \pm 9 \text{ }^\circ\text{F}$) for 60 to 90 minutes.

¹ Obtainable from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.