



SURFACE VEHICLE INFORMATION REPORT

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Fluid for Passenger Car Type Automatic Transmissions

RATIONALE

Each manufacturer of passenger-car automatic transmissions has their own specifications for automatic transmission fluid (ATF). This Information Report provides an overview of the key ATF properties and performance desired by all manufacturers. This revision includes minor editorial corrections throughout the document.

1. SCOPE

This SAE Information Report details some of the equipment and procedures used to measure critical characteristics of automatic transmission fluid (ATF) used in current automatic transmissions. It is intended to assist those concerned with the design of transmission components, and with the selection and marketing of ATFs for the use in passenger car and light-duty truck automatic transmissions. The information contained herein will be helpful in understanding the terms related to properties, designations, and service applications of ATFs.

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 J110 Seals - Testing of Radial Lip

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 D665 Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water

ASTM D892 Foaming Characteristics of Lubricating Oils

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ASTM D1275 Method of Test for Corrosive Sulfur in Electrical Insulating Oils

ASTM D1748 Method of Test for Rust Protection by Metal Preservatives in the Humidity Cabinet

ASTM D2882 Indicating the Wear Characteristics of Petroleum and Non-Petroleum Hydraulic Fluids in a Constant Volume Vane Pump

2.1.3 GM Publications

Available from General Motors Corporation, GM ATF Committee, 30500 Mound Road, M/C 480-106-160, Warren, MI 48090.

GM-6137M DEXRON®-IIE Automatic Transmission Fluid Specification, General Motors Corporation, August 1992

GM-6417M DEXRON®-III Automatic Transmission Fluid Specification, General Motors Corporation, December 1998

2.1.4 Ford Motor Publications

Available from Ford Motor Company, ATF Committee, 36200 Plymouth, Livonia, MI 48150.

MERCON® Automatic Transmission Fluid Specification, Ford Motor Company, September 1992

MERCON®-V Automatic Transmission Fluid Specification, Ford Motor Company, February 1996

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 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.

Haviland, M. and Davison, E., "Automatic Transmission Fluid Viscosity Requirements," SAE Technical Paper 710838, 1971, <https://doi.org/10.4271/710838>.

Deen, H. and Ryer, J., "Automatic Transmission Fluids—Properties and Performance," SAE Technical Paper 841214, 1984, <https://doi.org/10.4271/841214>.

Deen, H., O'Halloran, R., Outten, E., and Szykowski, J., "Bridging the Gap Between DEXRON®-II and Type F ATF," SAE Technical Paper 790019, 1979, <https://doi.org/10.4271/790019>.

Florkowski, D., King, T., Skrobul, A., and Sumiejski, J., "Development and Introduction of Chrysler's New Automatic Transmission Fluid," SAE Technical Paper 982674, 1998, <https://doi.org/10.4271/982674>.

Friihauf, E., "Automatic Transmission Fluids - Some Aspects on Friction," SAE Technical Paper 740051, 1974, <https://doi.org/10.4271/740051>.

Haviland, M., "Engine and Transmission Lubricant Viscosity Effects on Low Temperature Cranking and Starting," SAE Technical Paper 690768, 1969, <https://doi.org/10.4271/690768>.

Haviland, M., Anderson, R., Davison, E., Goodwin, M. et al., "Dexron-II Automatic Transmission Fluid Performance," SAE Technical Paper 740053, 1974, <https://doi.org/10.4271/740053>.

Kemp, S. and Linden, J., "Physical and Chemical Properties of a Typical Automatic Transmission Fluid," SAE Technical Paper 902148, 1990, <https://doi.org/10.4271/902148>.

Kemp, S. and Linden, J., "The Oxidation Stability of General Motors Proposed Factory-Fill Automatic Transmission Fluid," SAE Technical Paper 922371, 1992, <https://doi.org/10.4271/922371>.

Linden, J. and Kemp, S., "Improving Transaxle Performance at Low Temperature with Reduced-Viscosity Automatic Transmission Fluids," SAE Technical Paper 870356, 1987, <https://doi.org/10.4271/870356>.

SAE International. (2012). *Design practices: Passenger car automatic transmissions* (Fourth edition). Warrendale, PA: SAE International. Product code AE-29. <https://doi.org/10.4271/ae-29>.

Smith, G., Ross, W., Silbert, P., and Herndon, W., "Putting Automatic Transmission Clutch Friction Researchers on Speaking Terms," SAE Technical Paper 670051, 1967, <https://doi.org/10.4271/670051>.

Stambaugh, R. and Preuss, A., "Laboratory Methods for Predicting the Viscosity Loss of Polymer Thickened Hydraulic Fluids," SAE Technical Paper 680438, 1968, <https://doi.org/10.4271/680438>.

Willermet, P. and Kandah, S., "The Aluminum Beaker Oxidation Test for MERCON™ World-Wide Service ATF," SAE Technical Paper 881673, 1988, <https://doi.org/10.4271/881673>.

Willermet, P., Mahoney, L., Kandah, S., and Sever, A., "The Prediction of ATF Service Life from Laboratory Oxidation Test Data," SAE Technical Paper 801363, 1980, <https://doi.org/10.4271/801363>.

2.2.2 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 D445	Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)
ASTM D808	Chlorine in New and Used Petroleum Products (High Pressure Decomposition Device Method) (Withdrawn 2021)
ASTM D971	Interfacial Tension of Oil Against Water by the Ring Method
ASTM D1298	Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D2717	Thermal Conductivity of Liquids
ASTM D2766	Specific Heat of Liquids and Solids
ASTM D2780	Solubility of Fixed Gases in Liquids
ASTM D2983	Low-Temperature Viscosity of Automotive Fluid Lubricants Measured by Brookfield Viscometer
ASTM D4951	Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry

2.2.3 Daimler Chrysler Corporation Publications

Available from Daimler Chrysler Corporation, Auburn Hills, MI 48326.

MS-9602 Automatic Transmission Fluid Specification, October 1998

2.2.4 Other Publications

Booser, E.R. (1984). *CRC handbook of lubrication. Theory and practice of tribology: Volume II: Theory and design*. CRC Press.

Maxwell, J.B. (1950). *Data book on hydrocarbons: Application to process engineering*. Robert E. Krieger Publishing Company.

Nelson, W.L. (1958). *Petroleum refinery engineering* (Fourth edition). McGraw-Hill.

3. DEFINITIONS

3.1 AUTOMATIC TRANSMISSION FLUID (ATF)

Automatic transmission fluid is a lubricating oil specifically designed for use in fully automatic transmissions. ATF consists of a base oil and an additive package, which is added to enhance the properties of the base oil.

4. BASIC PERFORMANCE REQUIREMENTS

ATFs are complex because they are intended to provide good transmission performance and durability and serve a variety of functions: power transfer medium, hydraulic control fluid, heat-transfer medium, lubricant for sliding surfaces, gear lubricant, and lubricant for frictional surfaces. In order to ensure satisfactory performance in all intended applications under normal use and severe operating conditions, the fluid must satisfactorily meet the following requirements:

- a. Miscibility with fluids used for initial original equipment manufacturer (OEM) factory fill and with other OEM qualified fluids.
- b. Resistance to oxidation, including the formation of sludge and/or varnish.
- c. Operation from very low temperatures to very high temperatures.
- d. Component lubrication.
- e. Anti-foam performance.
- f. Protection against corrosion or rusting.
- g. Compatibility with elastomeric materials.
- h. OEM shift-feel characteristics.
- i. Stability of band and plate clutch friction characteristics over time and duty cycle at various temperatures.
- j. Anti-wear protection.

5. PROPERTIES OF AUTOMATIC TRANSMISSION FLUIDS

5.1 Physical and Chemical Properties

The physical and chemical properties of an ATF are important transmission design criteria. The transmission design engineer must have data on these properties to solve the many momentum and heat-transfer calculations required to design today's complex automatic transmissions. In general, air solubility, thermal expansion, and specific heat increase with increasing temperature; whereas surface tension, specific gravity, viscosity, bulk modulus, density, thermal conductivity, and electrical conductivity decrease with increasing temperature.

5.1.1 Typical Value

a. Brookfield viscosity, cP

-20 °C	600 to 1200
-40 °C	8000 to 20000

b. Kinematic viscosity, cSt

40 °C	33
100 °C	7.0

c. Thermal conductivity, W/m·K

40 °C	0.158
100 °C	0.149

d. Coefficient of thermal expansion, mL/mL C

6×10^{-4}

e. Specific gravity (relative density)

40 °C	0.8534
100 °C	0.8116

f. Specific heat, J/kg·K

40 °C	2018
100 °C	2244

g. Density, g/cm³

40 °C	0.853
100 °C	0.816

h. Bulk modulus (tangent isothermal), MPa

37.8 °C @ 6.9 MPa	1372
37.8 °C @ 55.16 MPa	2034
37.8 °C @ 137.9 MPa	2930
93.3 °C @ 6.9 MPa	1110
93.3 °C @ 55.16 MPa	1613
93.3 °C @ 137.9 MPa	2530

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i. Electric resistivity, ohms/cm	
40 °C	8.05·10 ⁹
100 °C	1.44·10 ⁹
j. Surface tension, dynes/cm	
93 °C	28.9
135 °C	25.5
k. Flash point, COC, °C	190
l. Fire point, °C	210

5.2 Viscosity

Viscosity is the measure of a fluid's resistance to flow and is one of the most important physical properties of a lubricant. The viscosity must be low enough at all operating temperatures to ensure adequate fluid flow and minimize viscous drag, but high enough at high temperatures to provide adequate fluid-film strength and prevent excessive internal transmission fluid leakage.

Viscosities chosen vary with the individual manufacturer, but are generally within the range of 6.5 to 8.5 cSt at 100 °C for fresh fluid. Both kinematic (centistokes) and absolute (centipoises) viscosities are determined on these fluids. The absolute viscosity divided by the density of the fluid equals the kinematic viscosity.

Fluid kinematic viscosity shall not fall below what is required for proper operation of the automatic transmission for which the fluid is used. Typical minimum viscosities during transmission operation range from 5 to 5.5 cSt at 100 °C.

Detailed discussion of fundamental principles and measuring equipment is available in current literature.

5.3 Chemical Content

An ATF consists of 85 to 90% base oil and 10 to 15% of a performance additive package containing chemical compounds necessary to impart the desired characteristics. The base oil may be naphthenic, paraffinic, hydro-treated, or synthetic (or any combination) depending on the type of service, the needs of the transmission manufacturer, and the oil company marketing plans for the ATF. The chemical compounds that form the additive package contain, in general: dispersants to control sludge and varnish; corrosion inhibitors to prevent the corrosion of bushings; thrust washers and any other copper-based components; anti-wear additives to prevent wear of gears, bushings, washers, and other rubbing components; friction modifiers to improve shift-feel and friction material durability; anti-oxidants to control fluid degradation and increase fluid useful life; pour point depressants to lower the fluid pour point; anti-foam additives to reduce fluid foaming tendencies; viscosity modifiers to increase the viscosity index of the fluid; seal swell additives to insure elastomer compatibility and performance; and a red dye to identify the fluid as an ATF.

6. OXIDATION AND THERMAL STABILITY

Oxidation is the chemical reaction of a substance with oxygen and is a major cause of ATF deterioration. The oxidation process involves the formation of free radicals, acidic compounds, and polar compounds that attack and degrade the ATF additive package, the ATF base oil, transmission elastomeric compounds, copper alloy components, and other sensitive transmission parts. Degrading an ATF can change the properties of the ATF significantly. Transmission designers must take such changes into consideration in the design of transmission components and fluid change interval recommendations.