SAE International

SURFACE VEHICLE STANDARD

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Ultraviolet Leak Detection: Stability and Compatibility Criteria of Fluorescent Refrigerant Leak Detection Dyes for Mobile R-134a and R-1234yf (HFO-1234yf) Air-Conditioning Systems

RATIONALE

This document is being revised to add the requirements for certification according to SAE J2911.

1. SCOPE

This SAE Standard applies to dyes intended to be introduced into a mobile air-conditioning system refrigerant circuit for the purpose of allowing the application of ultraviolet leak detection. In order to label any product(s) they shall meet SAE J2297, and the certification process as described in SAE J2911 must be followed and the documentation described in the appendix shall be submitted to SAE.

1.1 Purpose

The purpose of this document is to establish testing and acceptance criteria to evaluate fluorescent leak detection dye stability in, and compatibility with, mobile air-conditioning systems.

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 724-776-4970 (outside USA), www.sae.org.

SAE J2298 Ultraviolet Leak Detection: Procedure for Use of Refrigerant Leak Detection Dyes for Service of Mobile Air-Conditioning Systems

SAE J2299 Ultraviolet Leak Detection: Performance Requirements for Aftermarket Fluorescent Refrigerant Leak Detection Dye Injection Equipment for Service of Mobile Air-Conditioning Systems

SAE J2776 Refrigerant Purity and Container Requirements for New HFC-134a 1,1,1,2 - Tetrafluoroethane Refrigerant Used in Mobile Air-Conditioning Systems

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE J2844 R-1234yf New Refrigerant Purity and Container Requirements Used in Mobile Air-Conditioning Systems

SAE J2911 Procedure for Certification that Requirements for Mobile Air Conditioning System Components, Service Equipment, and Service Technician Training Meet SAE J Standards

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI-ASHRAE 97-2007 Sealed Glass Tube Method to Test the Chemical Stability of Material for Use Within Refrigerant Systems

ANSI-ASTM D 664-09 Test Method of Acid Number of Petroleum Products by Potentiometric Titration

ANSI-ASTM D 3233-93 (2009) Method for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Method)

3. SPECIFICATION AND GENERAL DESCRIPTION

3.1 The dye shall be certified that it meets this specification by a qualified, independent laboratory. The laboratory shall maintain documentation of testing to this specification for each change in formulation certified, including all calibration data and equipment calibration dates for a period of 5 years following the end of the production run for a certified dye.

3.2 The dye package shall be labeled "This Dye Certified to Meet SAE J2297 for R-134a and PAG lubricants" or "This Dye Certified to Meet SAE J2297 for R-1234yf and PAG lubricants," as appropriate, on an exterior surface. A dye package meeting all requirements of this specification and intended for use in both R-134a and R-1234yf systems with PAG lubricants shall be labeled "This Dye Certified to Meet SAE J2297 for use in R-134a/PAG and R-1234yf/PAG systems."

4. USE INSTRUCTIONS

The dye manufacturer shall provide use instructions, which shall conform, to the requirements as defined in SAE J2298.

5. ASSOCIATED EQUIPMENT

For aftermarket service addition of a dye, the dye shall be usable via direct addition into an unpressurized system or with an injection device as defined in SAE J2299.

6. TESTING OF FLUORESCENT LEAK DETECTION DYES

6.1 These test procedures and requirements shall be used to determine the stability and the compatibility of a leak detection dye within a mobile air-conditioning system. A dye must meet all of the acceptance criteria for each test to be certified to this specification.

6.2 The same refrigerant-PAG lubricant combination shall be used in all the tests defined in this specification.

6.2.1 For R-134a applications, the PAG lubricant must be one commonly used in the mobile air-conditioning industry in OEM R-134a systems.

6.2.2 For R-1234yf applications, the PAG lubricant must be one recommended for use in the mobile air-conditioning industry in OEM R-1234yf systems.

6.3 Rank order analysis is to be used as the acceptance criteria for the fluorescent leak detection dyes evaluated to the specifications defined by this document. Rank order analysis shall be defined as ordering both the three control groups' and the three test samples' numeric results. A test failure is defined as a total separation of the numeric results of the sample and the control groups where the sample's results negatively affected the desirable properties of the lubricant. A passed test is defined as having overlapping sets of numeric results of the sample and control groups, or a total separation of the numeric results of the sample and the control groups where the sample's results positively affected the desirable properties of the lubricant.

7. STABILITY TESTING

7.1 Stability testing shall be performed by preparing sealed tubes as per ANSI-ASHRAE 97-1993. These sealed tubes are to contain an equal volume (1 cc) of liquid refrigerant and lubricant sample as well as metal catalysts.

7.1.1 For dyes intended for use in R-134a systems, the refrigerant sample is to be composed of 99% R-134a and 1% R-12. The lubricant sample shall be composed of 1/3 PAG (see 6.2), 1/3 polyolester (POE) and 1/3 mineral oil. The POE and mineral oils shall be chosen from those commonly available in the market for use in mobile air-conditioning systems. Common POE lubricants include Lubrizol 2916 and Emkarate RL100S. Common mineral oils include Suniso 5GS, Chrysler 209500, Ford F2AZ19577AB and General Motors 15-117.

7.1.2 For dyes intended for use in R-1234yf systems, the refrigerant sample is to be composed of 98% R-1234yf and 2% R-134a. The appropriate lubricant for R-1234yf is noted in 6.2.

7.1.3 The total acid number of each sample is to be determined according to ASTM D 664 to a final pH of 11.0 before and after aging.

7.1.4 The metal catalysts shall consist of standard metal specimens consisting of 3 mm by 19 mm coupons of steel and copper, separated by aluminum shims so that the copper is not in direct contact with the steel.

7.2 Six samples shall be tested. Three shall be composed of neat lubricant and three shall be composed of the same lubricant containing double the recommended service concentration of the dye.

7.3 These samples shall be aged at 175 °C for 14 days.

7.4 Acceptance criteria shall consist of three separate determinations.

7.4.1 The presence of the dye shall not cause an increase of refrigerant and/or lubricant decomposition when compared to the neat samples via rank order analysis of total acid number increases.

7.4.2 The presence of the dye shall not cause an increase of corrosion or copper plating of the tested metal coupons when compared to those tested in the neat samples via rank order analysis.

7.4.3 The presence of the dye shall not cause an increase in particles, precipitates, or insolubles in the sealed tubes when compared to those tested in the neat samples via rank order analysis.

8. FLUORESCENCE TESTING

8.1 Fluorescence testing shall be performed by preparing sealed tubes as per ANSI-ASHRAE 97-1993. These sealed tubes are to contain an equal volume (1 cc) of liquid refrigerant and lubricant sample as well as metal catalysts.

8.2 The refrigerant sample is to be composed of the appropriate refrigerant, R-134a or R-1234yf, meeting the purity requirements of SAE J2776 or SAE J2844, respectively.

8.3 The lubricant sample shall be composed of the appropriate PAG as specified in 6.2.

8.4 The metal catalysts shall consist of standard metal specimens consisting of 3 mm by 19 mm coupons of steel and copper, separated by aluminum shims so that the copper is not in direct contact with the steel.

8.5 Two samples shall be tested. One shall be composed of PAG lubricant containing the recommended service concentration of the dye, and one shall be composed of the same lubricant containing double the recommended service concentration of the dye.

8.6 The doubly dosed sample shall be aged at 175 °C for 14 days.

8.7 Acceptance criteria shall consist of having the dye in the thermally aged sample exhibit a visual intensity (brilliance) at least equal to that of the un-aged control sample under identical incident UV irradiation and in identical ambient lighting and temperature conditions.

9. NONMETALLIC MATERIALS COMPATIBILITY TESTING

9.1 Nonmetallic materials compatibility testing shall be performed to determine the compatibility of the dye with elastomers and plastic materials typically used in mobile A/C systems

9.2 Materials to be tested shall be representative samples of those used in current OEM vehicle A/C systems**.** Some examples are provided for reference, but may be substituted as noted above.

a. PTFE commercial grade skived sheet (e.g., Tex-O-Lon Manufacturing Company's Teflon)

b. Nylon 66 (e.g., DuPont Plastics Zytel 101L NC010)

c. Polyester (e.g., GE Plastics' PBT 420K Valox)

d. HNBR O-ring (e.g., Dowty Seal Company)

e. Neoprene WRT O-ring (e.g., Dowty Seal Company)

f. NBR O-ring (e.g., Dowty Seal Company)

g. EPDM [e.g.; Hutchinson 23119, Hutchinson seal washers: E11N, PARKER seal washers: E-892-75)

h. Butyl (IIR) (e.g., Goodyear4880)

9.3 For R-134a applications, each material in 9.2 is to be tested with the appropriate dye and PAG as specified in 6.2. For R-1234yf applications, each material in 9.2 is to be tested with the appropriate dye and PAG as specified in 6.2.

9.4 Six samples shall be prepared from each material. Three shall be tested with neat lubricant and three shall be tested with the neat lubricant containing double the recommended service concentration of the dye.

9.5 Before and after the aging procedure, materials a, b, and c shall be tested for hardness by Shore Durometer D, while Shore A shall be used for materials d, e, and f.

9.6 Samples shall be placed in clean, heavy-walled glass tubes, which will then be filled with the oil or oil-dye mixture to the point where the samples are immersed. These tubes shall be placed in a stainless steel bomb, which is to be evacuated and subsequently charged with sufficient refrigerant (R-134a or R-1234yf) to yield a total pressure of 2.1 MPa at the aging temperature.

9.7 Samples are to be aged at 150 °C for 30 days.

9.8 Acceptance criteria shall consist of three separate determinations.

9.8.1 The presence of the dye shall not cause an increase or decrease in hardness when compared to those tested in the neat oil via rank order analysis.

9.8.2 The presence of the dye shall not cause an increase in particles, precipitates, or insolubles in the sealed tubes when compared to those tested in the neat oil via rank order analysis.

9.8.3 The presence of the dye shall not cause an increase or decrease in volume when compared to those tested in the neat oil via rank order analysis.

10. WEAR TESTING

10.1 Wear testing shall be performed as per a modified Falex test procedure ASTM D 3233-93.

10.1.1 The test oil (specified in 6.2) shall be saturated by bubbling the appropriate refrigerant through it at 1 atmosphere pressure for 30 min prior to the test run and continuously during the test run.

10.1.2 A run-in period of 2 min at 68 kg direct load is to be applied.

10.1.3 The test load shall be 113 kg, and held at that level throughout the 5-h run period.

10.1.4 Steel pins (AISI 3135) and aluminum V-blocks (die cast 390) shall be used. The mass of the pins must be recorded before the test run.

10.2 Six samples shall be tested. Three shall be composed of neat lubricant and three shall be composed of the same lubricant containing double the recommended service concentration of the dye.

10.3 Acceptance criteria shall consist of two separate determinations.

10.3.1 The presence of the dye shall not cause an increase of pin weight loss when compared to the neat samples via rank order analysis.

10.3.2 The presence of the dye shall not cause an increase of block wear scar during the 5-h run, measured microscopically, when compared to the neat samples via rank order analysis.

11. VISCOSITY EFFECT TESTING

11.1 Kinematic viscosity shall be determined via the Procedure defined by ASTM D 445-88. The kinetic viscosity shall be measured at both 40 °C and 100 °C.

11.2 Six samples shall be prepared. Three shall be tested with neat lubricant and three shall be tested with the neat lubricant containing the recommended service concentration of the dye.

11.3 Acceptance shall consist of having the presence of the dye not cause a change of kinematic viscosity more than 2% when compared to the neat sample.

12. COMPLIANCE

For Compliance, this Standard shall meet SAE J2911 Procedure for Certification that Requirements for Mobile Air Conditioning System Components, Service Equipment, and Service Technician Training Meet SAE J Standards. This Standard provides manufacturers, testing facilities and technician knowledge requirement providers with a procedure of certifying compliance with the appropriate SAE standard. Only certifying to SAE J2911 allows those verifying compliance to advertise their product as “Certified to the appropriate SAE Standard”. Industry, interested parties and Regulatory agencies will have access to the SAE International public Web Site posting of the results in the official SAE database.

THE COMPLIANCE INFORMATION FOR THIS STANDARD SAE J2297 SHALL BE RECORDED, VERIFIED IN TABLE A AND SUPPLIED TO SAE. THE RESPONSIBLE COMMITTEE SHALL ESTABLISH THE REQUIRED CERTIFICATION INFORMATION.

13. NOTES

13.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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