

# SURFACE VEHICLE STANDARD

**SAE** J2297

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## ULTRAVIOLET LEAK DETECTION: STABILITY AND COMPATIBILITY CRITERIA OF FLUORESCENT REFRIGERANT LEAK DETECTION DYES FOR MOBILE R-134a AIR-CONDITIONING SYSTEMS

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

**1. Scope**—This SAE standard applies to dyes which are to be introduced into a mobile air-conditioning system's refrigerant circuit for the purpose of allowing the application of ultraviolet leak detection.

### 2. References

**2.1 Applicable Documents**—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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

2.1.2 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8007.

ANSI-ASHRAE 97-1989—Sealed Glass Tube Method to Test the Chemical Stability of Material for Use Within Refrigerant Systems

2.1.3 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 445-88—Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)

ASTM D 664-89—Test Method of Acid Number of Petroleum Products by Potentiometric Titration

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

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### 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" on an exterior surface.
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 PAG lubricant shall be used in all the tests defined in this specification. This lubricant must be commonly used within the mobile air-conditioning industry within OEM R-134a systems. (For example, the following PAGs would be acceptable: Nippondenso ND-8, Sanden SP-10 or SP-20, Zexel ZXL-100 PG or ZXL-200 PG, Ford YN-12B, General Motors 12345923.)
- 6.3 Rank order analysis is to be used as an 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 The refrigerant sample is to be composed of 99% R-134a and 1% R-12.
- 7.1.2 The lubricant sample shall be composed of 1/3 PAG, 1/3 polyolester (POE) and 1/3 mineral oil. The POE shall be one which is commonly used within the mobile air-conditioning industry within R-134a systems (e.g., Lubrizol 2916 or Emkarate RL100S). The mineral oil shall be one which is commonly used within the mobile air-conditioning industry within R-12 systems (e.g., Suniso 5GS, Chrysler 209500, Ford F2AZ19577AB or General Motors 15-117). 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.

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7.1.3 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 four 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 100% R-134a.

8.3 The lubricant sample shall be composed of 100% PAG.

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 samples exhibit a visual intensity (brilliance) at least equal to that of the unaged 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 typical elastomers and plastic materials.

**9.2** The materials to be tested are:

- 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)

**9.3** 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.

**9.4** Before and after the aging procedure, materials 1, 2, and 3 shall be tested for hardness by Shore Durometer D, while Shore A shall be used for materials 4, 5, and 6.

**9.5** 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 R-134a to yield a total pressure of 2.1 MPa at the aging temperature.

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

**9.7** Acceptance criteria shall consist of three separate determinations.

9.7.1 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.

9.7.2 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.

9.7.3 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 shall be saturated by bubbling R-134a through it for 30 min at 1 atmosphere pressure before the test run. R-134a shall be bubbled through the lubricant during the test run as well.

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.