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Superseding ARP5996B

Evaluation of Coking Propensity of Aviation Lubricants Using the Single Phase Flow Technique

RATIONALE

The tendency of a lubricant to form deposits in an engine oil system is a critical factor that can influence engine design, performance and maintenance intervals. Therefore it is important to have an understanding of the coking propensity of the lubricant. The ARP has been revised to make the method more applicable to the use of more modern instruments and to introduce a procedure for extending the test for a further 20 hour period.

1. SCOPE

This method is designed to evaluate the coking propensity of synthetic ester-based aviation lubricants under single phase flow conditions found in certain parts of gas turbine engines, for instance in bearing feed tubes. This method is applicable to lubricants with a coking propensity, as determined by this method, falling in the range 0.01 to 5.00 mg.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 Alcor, Hot Liquid Process Simulator (HLPS), or Falex Thermal Fouling Tester (FT2), user's Manual appropriate to the type and series of instrument being used.

3. WARNING

This document may involve hazardous materials, operations, and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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4. OUTLINE OF METHOD

4.1 A measured volume of sample is placed in the apparatus. The apparatus is pressurized with air and the sample is then pumped through the system over a resistance-heated, tube-in-shell, heat exchanger for a specified period (normally 20 or 40 hours). The weight of deposit formed on the tube is then determined.

4.2 This method assumes a degree of familiarity with the test equipment. Users must, therefore, familiarize themselves with the apparatus, and the user's manual, before attempting to use this method.

5. APPARATUS

5.1 Any of the instruments listed below are considered suitable for this method. It is recommended that the instrument be operated in a temperature-controlled environment to reduce the impact that room temperature fluctuations may have on method precision.

5.1.1 Alcor, Hot Liquid Process Simulator (HLPS) 300 series.

5.1.2 Alcor, Hot Liquid Process Simulator (HLPS) 400 Series.

5.1.3 Falex Thermal Fouling Tester (FT2).

5.2 Data recording/storage device suitable for recording the output from the various instrument thermocouples.

5.3 Oven capable of maintaining a temperature of 100 °C ± 5 °C.

5.4 Desiccator, dedicated solely for this test, filled with a suitable desiccant. It is recommended that the desiccator is operated in a temperature controlled environment to reduce the impact that room temperature fluctuations may have on method precision.

5.5 Laboratory balance capable of weighing heater tubes to 0.01 mg. It is recommended that the balance is operated in a temperature controlled environment to reduce the impact that room temperature fluctuations may have on method precision.

5.6 Measuring cylinders, 100 ml and 250 ml capacity.

5.7 Boiling tube, of dimensions such that the top of the center section of the heater tube is at least 30 mm below the top of the boiling tube, or other suitable receptacle, in which to soak the heater tubes in petroleum spirit.

6. REAGENTS AND/OR MATERIALS

6.1 Stainless steel (grade 316) short heater tubes. A diagram showing the tube dimensions is shown in Appendix G. The following heater tubes have been found to be satisfactory:

PAC/Alcor part number 91747

Falex part number 400-560-003

6.2 Acetone GPR/LG.

NOTE: GPR/LG = general purpose reagent grade / laboratory grade.

6.3 Petroleum spirit (any type between BP 40 to 60 °C and BP 80 to 100 °C) GPR/LG. Heptane may be used as an alternative.

6.4 Trisolvent (equal quantities of acetone, propan-2-ol and toluene; all GPR/LG grade).

6.5 Lead, 99% minimum purity, for thermocouple performance verification.

6.6 Tin, 99% minimum purity, for thermocouple performance verification.

6.7 Pre-weighed filter papers, Teflon 5 µm (suggest Millipore Cat no LSWP04700) (see Appendix C).

6.8 Reference Heater Tube

A heater tube complying with the requirements of 6.1 of known mass. This tube is used solely as a control for detecting inconsistencies in the method weighing process and is not to be used as a sample analysis tube.

6.9 Compressed air supply, clean, dry and oil free, capable of pressurizing the sample reservoir to 1380 kPa ± 140 kPa (200 psi ± 20 psi).

7. SYSTEM VERIFICATION

NOTE: Apart from the daily tube thermocouple calibration (7.1.1), it is not necessary to perform all of the system verification tests indicated below before every test. They should be conducted as often as is necessary to provide the user with confidence that the system is functioning correctly and consistently. It is recommended, however, that the temperature profile obtained during the test procedure (9.10) be compared with that obtained during the last system verification check to detect any inconsistencies.

7.1 Heater Tube Temperature Control Thermocouple

7.1.1 The thermocouples should be checked in accordance with the method stated in the instrument user's manual. If the manual states to use the eutectic temperature of tin (232 °C), the performance should also be evaluated using a lead standard which has a eutectic point of 327.5 °C. The temperature and power levels quoted in the manual have to be adjusted to accommodate the eutectic temperature of the lead. Some users may find it more convenient to use a central or external calibration service in lieu of the above. This is permissible provided the service results are in a degree of calibration equivalent to that provided by the above method. In cases of dispute, the tin and lead eutectic method shall be the referee method. Calibration should be carried out every 6 months as a minimum.

7.1.2 The values obtained for the eutectic temperatures of lead and tin should be within ±3 °C of the quoted eutectic temperature. If this is not the case then the thermocouple in question should be replaced and the verification step (7.1.1) repeated.

7.1.3 Whichever calibration scheme is used, any deviation from the true melting point temperature values of more than 1 °C shall be compensated for when setting control temperatures, and when taking temperature measurements, by applying an appropriate correction to the setting or measurement. The degree of correction required may not be constant across the temperature range being used. Therefore, the extent of the calibration should be sufficient to determine the corrections necessary for the critical temperature settings.

7.1.4 Check the heater tube thermocouple for proper position. Raise the thermocouple so that the tip is flush with the top of the heater tube and upper bus bar end cap. The corresponding position on the thermocouple height scale must be 51 mm above the zero point on the scale.

7.2 Pump Flow Rate

7.2.1 Set the pump to obtain a flow rate of 1 ml min^{-1}. It has been determined that a flow rate of 1 ml min^{-1} will yield 20 drops (including a count of drop zero) in 30 seconds from the reservoir return tube. For instruments with a window at the top of the reservoir the appropriate flow controller setting can be determined by this method. The flow should be set to obtain 20 drops in 30 seconds ± 1 second.