SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

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Measurement of the Total Ash Content of Aviation Piston Engine Oils by a Calculation Method

RATIONALE

This standard was revised based on recommendations made at the 22 April 2010 SAE E-38 Aviation Piston Engine Fuels and Lubricants Committer meeting. It is part of the standard SAE five-year review process and includes only editorial changes. The name of the preparing SAE committee has changed to E-38 and is now under the Aerospace Council.

1. SCOPE

This SAE Recommended Practice describes an empirical method for determining the theoretical ash content of aviation piston engine lubricating oils by calculating the equivalent weight of metallic oxides formed at 775 °C based on the metallic elemental concentration.

The calculation method of ash determination may be used as an alternate to ASTM D 482 for application to the standards for aviation piston engine lubricating oils.

1.1 Field of Application

This procedure is recommended for use in the qualification, manufacturing, and quality assurance testing of aviation piston engine lubricating oils where the ash content is limited to a maximum of 0.011%.

1.2 Background

1.2.1 The ash content as measured by ASTM D 482 has very poor precision and repeatability for lubricants having low ash content. The precision statement for the method states that the reproducibility of a sample in the range of 0.001 to 0.079% ash content is 0.005%. Further, the bias of the test cannot be determined and there is no standard reference material containing a known level of ash for this method. This poor precision has led to numerous problems concerning the actual ash content of products on many occasions. The test method is valuable when run by experienced operators, but can provide dubious information if run under the general conditions stated in the method. For example, to obtain repeatable results, a platinum crucible must always be used in place of the silica or porcelain crucibles listed as equivalent substitutes. Meticulous care and procedural knowledge must be used by experienced operators for the method to be productive.

1.2.1.1 The notes provided in ASTM D 482 also suggest that this method may not be appropriate for oils containing ashless additives or for oils containing certain phosphorous compounds which may now be in use in aviation lubricants. For oils containing additives an alternate method, ASTM D 874, is suggested. However, ASTM D 874 includes additional restrictions and reservations which question the suitability of that method as an acceptable alternate or replacement for ASTM D 482 for low ash containing lubricating oils.

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1.2.1.2 These contradictions have led to the development of a “calculated ash content” method as a recommended alternative for use with aviation piston engine oils. This procedure is based on the ideal conversion of selected metallic elements to their theoretical oxide weights and then summing the components to obtain a total value. The seven metallic elements chosen were selected as being those most likely to be present in lubricant manufacturing and packaging plants. As such they would also be the most likely contaminants to be found in the aviation lubricants specified.

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 Publication

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 J1899 Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)

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.

ASTM D 482 Standard Test Method for Ash from Petroleum Products

ASTM D 874 Standard Test Method for Sulfated Ash from Lubricating Oils and Additives

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 Publication

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 J1966 Lubricating Oils, Aircraft Piston Engine (Non-Dispersant Mineral Oil)

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 D 4628 Standard Test Method for Analysis of Barium, Calcium, Magnesium and Zinc in Unused Lubricating Oils by Atomic Absorption Spectrometry

ASTM D 4951 Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry

ASTM D 5185 Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry

3. TEST REQUIREMENTS

3.1 Measurements

3.1.1 The concentration of the selected metallic elements are determined by the appropriate ASTM test method listed in Section 2. The measurements for iron, copper, and silicon have no specified ASTM method and, therefore, are to be determined using standard accepted laboratory methods. For military qualification purposes, the trace metal content for iron, copper, and silicon shall be obtained using the procedure noted in 4.5.2 of SAE J1899. The values are recorded as Kg/mg (parts per million, ppm) of each element. The elements to be measured are listed in Table 1.

TABLE 1 - ELEMENTS TO BE MEASURED

Element	Oxide Conversion Factors
Magnesium	1.66×10^{-4}
Zinc	1.24×10^{-4}
Calcium	1.40×10^{-4}
Sodium	1.35×10^{-4}
Iron	1.43×10^{-4}
Copper	1.25×10^{-4}
Silicon	2.14×10^{-4}

3.2 Calculations

3.2.1 The concentration of each metal element is then converted to its equivalent oxide mass by multiplying the obtained element's ppm value by the corresponding oxide conversion factor shown in Table 1. The product for each conversion is reported individually as “metal oxide, percent mass” for each element. The sum of these combined metal oxide masses are then computed.