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SURFACE VEHICLE RECOMMENDED PRACTICE

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

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.

1.3 Rationale

This Standard was revised based on recommendations made at the 14 July 2004 SAE Fuels and Lubricants Technical Committee 8—Aviation Piston Engine Fuels and Lubricants meeting.

2. References

2.1 Applicable Publications

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

Copies of SAE documents are available from the Society of Automotive Engineers, SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001, or through their website at http://www.sae.org.

SAE J1899—Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)

2.1.2 ASTM PUBLICATIONS

Copies of ASTM documents are available from the American Society of Testing and Materials International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, or by phone at (610) 832-9500, or through their website at http://www.astm.org.

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 document.

2.2.1 SAE PUBLICATION

Copies of SAE documents are available from the Society of Automotive Engineers, SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001, or through their website at http://www.sae.org.

SAE J1966—Lubricating Oil, Aircraft Piston Engine (Nondispersant Mineral Oil)

2.2.2 ASTM PUBLICATIONS

Copies of ASTM documents are available from the American Society of Testing and Materials International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, or by phone at (610) 832-9500, or through their website at http://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.