Designation: D 4056 – 00

An American National Standard

Standard Test Method for Estimation of Solubility of Water in Hydrocarbon and Aliphatic Ester Lubricants[1]

This standard is issued under the fixed designation D 4056; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure for estimating the equilibrium solubility of water and its vapor in hydrocarbon and aliphatic ester lubricants, at temperatures between 277 and 373 K. The test method is limited to liquids of low to moderate polarity and hydrogen bonding, with predicted solubilities not over 1000 ppm by weight in hydrocarbons, or 30 000 ppm by weight in oxygenated compounds, at 298 K.

1.2 Specifically excluded are olefins, nitriles, nitro compounds, and alcohols.

1.3 This test method is recommended only for liquids not containing widely different chemical species. This excludes blends of esters with hydrocarbons, and lubricants containing detergents, dispersants, rust preventives, or load carrying additives.

1.4 The values stated in SI units are to be regarded as the standard. Values in parentheses are given for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 94 Test Method for Saponification Number of Petroleum Products[2]

D 1218 Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids[2]

D 1298 Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method[2]

D 2502 Test Method for Estimation of Molecular Weight (Relative Molecular Mass) of Petroleum Oils from Viscosity Measurements[2]

D 3238 Test Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the n-d-M Method[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *charge transfer parameter*—the portion of the solubility parameter not attributed to London or Keesom forces.

3.1.1.1 *Discussion*—It includes hydrogen bonds, induced dipoles, and other quasichemical forces.

3.1.1.2 *Discussion*—The square of the solubility parameter equals the sum of the squares of the three partial parameters.

3.1.2 *dispersion parameter*—the portion of the solubility parameter attributed to London forces.

3.1.3 *polar parameter*—the portion of the solubility parameter attributed to Keesom (permanent dipole) forces.

3.1.4 *solubility parameter*—the square root of the cohesive energy density (heat of vaporization minus work of vaporization, per unit volume of liquid), at 298 K.

3.2 *Symbols:*

C_A = percentage of aromatic carbons,
C_N = percentage of naphthenic carbons,
d = density of lubricant at 298 K, g/mL,
G = solubility by weight, mg/kg (ppm),
M = molecular weight of lubricant, g/mol,
n_D = refractive index of lubricant at 298 K,
RH = relative humidity, %
S = saponification number, mg of KOH/g of lubricant,
T = system temperature, K,
V = molar volume of lubricant, mL/mol,
x = mole fraction of water in equilibrium mixture,
y = Lorentz-Lorenz refractivity function,
δ_d = dispersion parameter, $(MPa)^{0.5}$,
P = polar parameter, $(MPa)^{0.5}$,
H = charge transfer parameter, $(MPa)^{0.5}$,
ϕ_1 = volume fraction of lubricant in equilibrium mixture, and
ϕ_2 = volume fraction of water in equilibrium mixture.

4. Summary of Test Method

4.1 Data required are the density, refractive index, and molecular weight of a hydrocarbon. The saponification number

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricantsand is the direct responsibility of Subcommittee D02.11on Engineering Science and High Performance of Fluids and Solids.

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[2] *Annual Book of ASTM Standards,* Vol 05.01.

[3] *Annual Book of ASTM Standards,* Vol 05.02.