Designation: D5148 – 10

Standard Test Method for Centrifuge Kerosine Equivalent[1]

This standard is issued under the fixed designation D5148; 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 determines the centrifuge kerosine equivalent (CKE) of aggregate used in bituminous mixtures.

1.2 *Units of Measure:*

1.2.1 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. An exception is made in the values used for mass because this standard was originally developed using even values of grams, and use of ounces as a standard would make those measures cumbersome.

1.2.2 Regarding sieves, per ASTM Specification E11 Section 1.2, "the values stated in SI units shall be considered standard for the dimensions of the wire cloth openings and the diameter of the wires used in the wire cloth. The values stated in inchpound units shall be considered standard with regard to the sieve frames." When sieve mesh sizes are referenced, the alternate inch-pound designations are provided for information purposes and enclosed in parentheses.

1.3 *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.* For specific hazard statements, see 7.1.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

C702 Practice for Reducing Samples of Aggregate to Testing Size

D75 Practice for Sampling Aggregates

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E832 Specification for Laboratory Filter Papers

3. Terminology

3.1 *Symbols:*

3.1.1 *C*—coarse aggregate fraction, that portion of the sample which passes the 9.5 mm (⅜ in.) sieve and is retained on the 4.75 mm (No. 4) sieve.

3.1.2 *F*—fine aggregate fraction, that portion of the sample which passes the 4.75 mm (No. 4) sieve.

3.1.3 *SA*—surface area. The sum, ft^2/lb (m^2/kg), obtained by adding the products of the percent passing each sieve and its corresponding factor, (see 11.1) and dividing by 100.

3.1.4 *K factors*—values determined as described in 3.1.5 through 3.1.8 and identified as K_c, K_f, or K_m.

3.1.5 K_c—determined from the percent of SAE No. 10 oil retained, which represents the total effect of the aggregate's absorptive properties and surface roughness of the aggregates coarse fraction.

NOTE 1—Based on comparative testing in California, the same results can be obtained substituting Shell Tellus No. 100 oil for SAE No. 10 oil.

3.1.6 K_f—determined from the following factors:

3.1.7 Percent of kerosine retained, which represents the total effect of superficial area, the aggregate's absorptive properties and surface roughness of the aggregate's fine fraction.

3.1.7.1 Computed surface area, based on particle size.

3.1.7.2 Percent of aggregate passing 4.75 mm (No. 4) sieve.

3.1.8 K_m—the "mean" or composite value of K for a given combination of coarse and fine materials on which K_c and K_f have already been determined independently.

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Significance and Use

4.1 The CKE furnishes an index, designated as the *K* factor, that indicates the aggregate particle roughness and surface capacity based on porosity.

4.2 The CKE is used as part of the Hveem mix design procedure to determine the approximate bitumen ratio (ABR), as shown in Appendix X1. However, there are other applications such as determining the coarse aggregate fraction constant (K_c) for use as an aid in selecting a bitumen content for open-graded friction courses.

NOTE 2—The quality of the results produced by this standard are dependant upon the competence of the personnel performing the procedure and the capability, calibration, and the maintenance of the equipment used. Agencies that meet the criteria of Standard Practice D3666 are generally considered capable of competent and objective testing / sampling / inspection / etc. Users of this standard are cautioned that compliance with D3666 alone does not completely assure reliable results. Reliable results depend on many factors: following the suggestions of D3666 or similar acceptable guideline provides a means of evaluating and controlling some of those factors.

5. Apparatus

5.1 *Centrifuge,* power driven, capable of exerting a force of 400 ± 8 times gravity (400 G) on a 100-g sample.

$$\text{The required r/min}(\pm 10) \text{ of the centrifuge head} = \sqrt{(14{,}000{,}000/r)}$$

r = radius to center of gravity of sample, in.

(r) = radius to center of gravity of sample/25.4, mm

5.2 *Centrifuge Cups,* 2 13⁄16 ± 1⁄16 in. (71.4 ± 1.6 mm) in height and 2 1⁄16 ± 1⁄16 in. (52.4 ± 1.6 mm) inside diameter (see Fig. 1) complete with perforated brass plate 0.031 ± 0.001 in. (0.787 ± 0.03 mm) thick with a minimum of 100 holes, 0.062± 0.001 in. (1.575 mm ± 0.03 mm) in diameter, per square inch (15 holes/cm^2).

5.3 *Balance*—A balance having a minimum capacity of 500 g and meeting the rquirements of Specification D4753, Class GP2.

5.4 *Metal Funnel,* top diameter 3 7⁄8 ± 1⁄16 in. (98.4 ± 1.6 mm), height 4 5⁄16 ± 1⁄16 in. (109.5 ± 1.6 mm), orifice 1⁄2 ± 1⁄16 in. (12.7 ± 1.6 mm), with a piece of 2.0 mm (No. 10) sieve soldered slightly above the orifice (Fig. 2).

5.5 *Tin Pan,* round, 4 1⁄2 ± 1⁄16 in. (114.3 ± 1.6 mm) diameter, 25.4 ± 1± 1⁄16 in. (1.6 mm) deep.

6. Materials

6.1 *Kerosine.*

6.2 *Lubricating Oil,* SAE No. 10 (see Note 1).

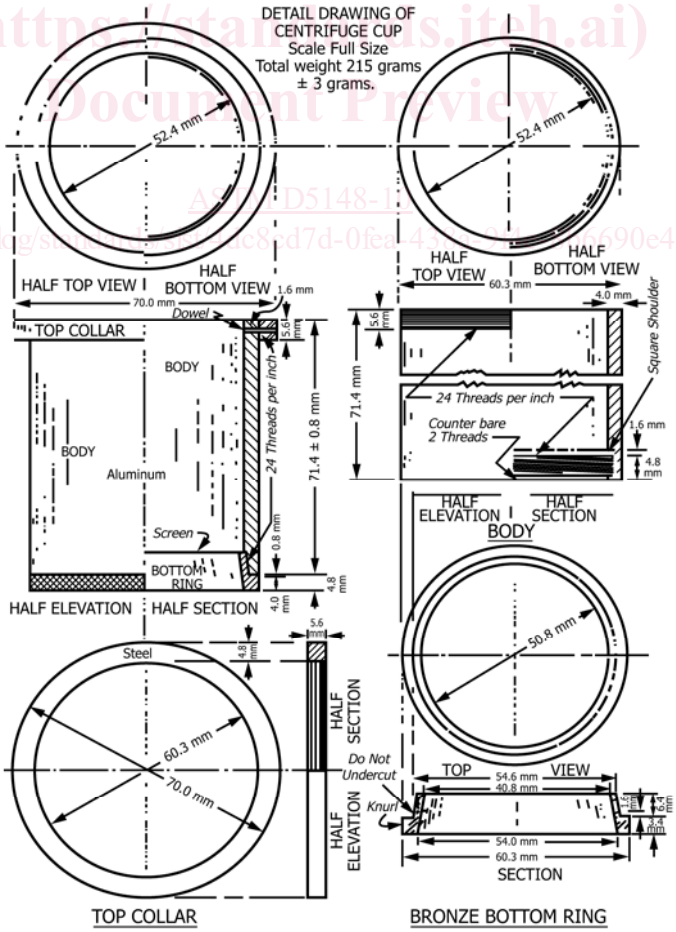

FIG. 1 Detailed Drawing of a Centrifuge Cup

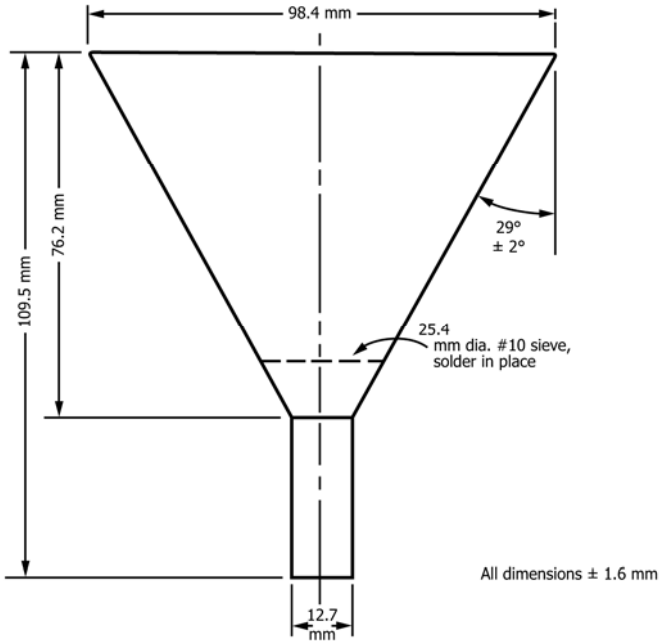

FIG. 2 Detailed Drawing for Metal Funnel

6.3 *Filter Paper,* size 5½-cm diameter, Type 1, Class B.

NOTE 3—VWR Guide No. 613 satisfies ASTM grade Type 1, Class B, Specification E832.

7. Hazards

7.1 **Warning**—Kerosine is flammable, and therefore caution should be used in storage and use.

8. Sampling

8.1 Sampling is done in accordance with Practice D75.

8.2 Reduce the sample in accordance with Practice C702.

9. Preparation of Sample

9.1 Determine the bulk specific gravity of the coarse aggregate (4.1) and apparent specific gravity of the fine aggregate (4.2), using Test Methods C127 and C128, respectively.

NOTE 4—Apparent specific gravity is used for the fine aggregate because it is easier to determine than the bulk specific gravity, and its use does not affect the CKE results.

9.2 *Specific Gravity*—Calculate the average specific gravity for the aggregate based upon the design grading by the following formula:

$$G = \frac{1}{\frac{P_c}{100G_c} + \frac{P_f}{100G_f}} \quad (1)$$

where:

G = average specific gravity,

P_c = coarse aggregate present in the original sample, weight %,

P_f = fine aggregate present in the original sample, weight %,

G_c = bulk (oven dry) specific gravity of the coarse aggregate, and

G_f = apparent specific gravity of the fine aggregate.

9.3 Separate the aggregate into two size groups, "C" material (used for K_c determinations) passing the 9.5 mm (⅜ in.) sieve and retained on the 4.75 mm (No. 4) sieve, and "F" material (for K_f determination) all passing the 4.75 mm (No. 4) sieve.

10. Procedures

10.1 *Procedure for Fine F:*

10.1.1 Quarter or split out approximately 105 g for each sample, representative of the material passing 4.75 mm (No. 4) sieve.

10.1.2 Place on hot plate or in 230 ± 9°F (110 ± 5°C) oven and dry to constant weight.

10.1.3 Allow to cool.

10.1.4 Place 100.0 ± 0.1 g in each of the tared centrifuge cups fitted with the perforated metal disk underlying a disk of filter paper.

10.1.5 Place centrifuge cups containing samples in pan with sufficient kerosine ½ ± ⅛ in. (12.7 ± 3.2 mm) deep to saturate the sample. When specimens are thoroughly saturated (by capillary action), place the cups with samples in centrifuge. Samples should be tested in pairs, placed opposite of each other to avoid damage to the centrifuge.

10.1.6 Spin in centrifuge for 2 min at a force of 400 G.

10.1.7 Reweigh each cup, containing samples, to nearest 0.1 g and subtract original weight. The difference is the percent of kerosine retained (based on 100 g of dry aggregate). The percent of kerosine retained is the CKE value. Record the average of the two values for duplicate samples.

10.2 *Procedure for Coarse C:*

10.2.1 Quarter or split out approximately 105 g for each sample, representative of the material passing ⅜ in. (9.5 mm) and retained on 4.75 mm (No. 4) sieve material.

10.2.2 Dry sample on hot plate or in 110 ± 5°C (230 ± 9°F) oven to constant weight and allow to cool to room temperature.

10.2.3 Weigh out 100.0 g ± 0.1 g and place in funnel (see 5.4).

10.2.4 Completely immerse specimen in SAE No. 10 lubricating oil for 5 min (see Note 1).

10.2.5 Place the funnel in a container, maintaining the axis in a vertical position and allow to drain for 2 min.

10.2.6 Place funnel containing sample in 140°F (60°C) oven for 15 min of additional draining, remembering to keep the funnel axis in a vertical position.

10.2.7 Pour sample from funnel into tared pan, cool to room temperature, and reweigh sample to nearest 0.1 g. Subtract