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An American National Standard

Standard Test Method for Dirt in Paper and Paperboard[1]

This standard is issued under the fixed designation D 2019; 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 **(1, 2, 3)**[2] is intended for the numerical estimation of dirt in paper or paperboard in terms of equivalent black area. This test method is satisfactory only for the estimation of visual dirtiness and it may be entirely inadequate when the grittiness or other nonvisual effects of dirt are of importance.

2. Referenced Documents

2.1 *ASTM Standards:*

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product[3]

D 985 Test Method for Brightness of Pulp, Paper, and Paperboard (Directional Reflectance at 457 nm)[3]

D 1968 Terminology Relating to Paper and Paper Products[3]

3. Terminology

3.1 *Definitions*—Definitions shall be in accordance with Terminology D 1968 and the *Dictionary of Paper.*[4]

4. Summary of Test Method

4.1 A dirt speck is compared with black spots on a standard" dirt chart," and the area of the black spot that gives the same visual impression as the dirt speck is recorded. The sum of all such areas (known as equivalent black areas, or e. b. a.) that are 0.04 mm^2 or greater is divided by the total area of the paper inspected. The result, expressed in parts per million, is used as a measure of the dirt in paper or paperboard.

5. Significance and Use

5.1 While dirt in paper is usually that found on the surface of the sheet, some particles embedded in the body of the sheet may be readily discernible, especially in papers that are transparent or translucent. Therefore, as a property, dirt content may affect both the utility and composition of the sheet. The amount of dirt present in a sheet of paper is of importance in practically every type of paper, but especially so in the higher-quality products. For example, bond and fine writing papers are subject to close inspection for dirt content, and the amount of dirt present in the sheet is one of the factors in classifying them into different grades.

5.2 The higher grades of wrapping papers and paperboards, such as those employed for the packaging of foods or other commodities or where a fancy printed design is used, must be free of dirt particles. The value of many papers, such as glassine, waxed sulfite, and vegetable parchment, which come in direct contact with foodstuffs, is determined to a considerable extent by the amount of dirt present in the sheet.

5.3 Dirt in the form of fine gritty particles embedded in a sheet of paper is a serious defect in many printing papers. This type of dirt may cause serious pitting and wear on the printing plates and other parts of the presses. Such gritty particles are often termed "sand spots" in jute linerboard and cause a marked reduction in Mullen burst tests when they occur in the test area. Measurement of dirt content in a sheet based on the equivalent area may be entirely inadequate in such cases, since the dirt is not readily detected nor is its equivalent area a good criterion of the suitability of the sheet for the purpose intended.

6. Apparatus

6.1 *Standard Dirt Chart*[4]—A standardized photographic print of a series of round black spots of various areas on a white background. Using an instrument and method in accordance with Method D 985, Test for 45-deg. 0-deg Directional Reflectance for Blue Light (Brightness) of Paper,[4] with luminous reflectance filter, the Y value for Illuminant C of the CIE system is 81.5 ± 1.0 % reflectance for the white background and 2.4 ± 0.4 % for the black spots.

NOTE 1—It has been found **(4)** that all the round spots on the original chart, except the following, are correct within 2 % or 0.005 mm^2(whatever is the larger). For especial accuracy, the designated areas in square millimeters of the following round spots should be changed to those given in parentheses: 1.00 (1.08), 0.80 (0.76), 0.60 (0.58), 0.40 (0.42), 0.30 (0.31), 0.25 (0.26), 0.20 (0.21), 0.15 (0.16), 0.10 (0.11), 0.9 (0.10). Only the round spots are used for the analysis.

In examining an actual TAPPI Standard Dirt Chart, it will be noted that none of the rectangles stand out nearly so well as do the round dots having the same area. In fact, if examined with a reading glass held out of focus, with the particular shape of rectangles used in that chart, it will be seen that their equivalent black area is only about two thirds that of the round dots of the same actual area. Furthermore, in the actual photographic

[1] This test method is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Test Methods.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this test method.

[3] *Annual Book of ASTM Standards*, Vol 15.09.

[4] Available from the Technical Association of the Pulp and Paper Industry, Technology Park/Atlanta, P.O. Box 105113, Atlanta, GA 30348.

chart, the rectangle adjacent to the 0.02 and 0.03-mm^2 dots are invisible because of their thinness in relation to the resolving power of the photographic emulsions used. If all the rectangles shown were made still more slender, for example, like long, thin, black fibers, and their actual areas were correctly depicted, the discrepancy between their equivalent black areas and their actual areas would be still greater. Thus, as a measure of "dirt," apart from color and background, the true criterion is not the actual area of the dirt specks but their equivalent area.

NOTE 2—Plastic-covered cards, transparencies, or printed charts will not give equivalent results.

6.2 *Illuminant*, lighting arrangements to give about 540 lm/m^2(50 fc) of white light or daylight on the specimens. Because the light affects equally the appearance of both the dirt specks and the comparison spots on the charts, the intensity of illumination is not critical.

6.3 *Optional Apparatus*—Common reading glass or semi-transparent film.

7. Sampling

7.1 Obtain a sample of the paper to be evaluated in accordance with Practice D 585.

8. Test Specimens

8.1 Unless otherwise specified, select at random from the sample, at least 10 (preferably 20 or more) sheets each having a total exposed area (both sides) of not less than 1 $m.^2$ Keep the specimen sheets clean, for example, between two extra outer sheets as a cover.

9. Procedure

9.1 With clean hands and in a clean, dust-free place on a bench top, preferably covered with a large sheet of clean paper, examine both sides of the specimen sheets unless one side, such as the backing of a board, is of no interest.

9.1.1 Select a particular reference spot on the Standard Dirt Chart that has an equivalent black area such that there will be, on the average, at least one such sized speck or larger, to be found on each 1000 cm^2 of the exposed surfaces of the specimens. (The size of the reference spot selected might vary from 0.06 mm^2 for a very clean writing paper to 0.25 mm^2 or more for a very dirty paper.)

9.1.2 From an extra sheet of the sample, prepare a mask the same width as a specimen sheet, but three quarters of its length and, if the paper is very dirty, another mask with one sixteenth of its area, exposed by cutting away, for example, a rectangle at its top right-hand corner. If masks precut to suit the size of the specimen sheets are available, it is preferable to change the exposed surfaces to one fifth and one twentieth, respectively, to facilitate the subsequent calculation.

9.2 Number each specimen sheet, preferably on the top right-hand corner of its top (felt) side. Pick up a specimen with one hand (if thin or transparent, lay it on a stiff white backing) and hold an edge of the Standard Dirt Chart against it with the other.

9.2.1 Ignore the small specks less than the size of the reference spot but examine all the larger dirt specks on the top side of the specimen, and, after scratching each speck with a corner of the chart to make sure that it is not a piece of loose, outside dirt, estimate and record or mentally sum its equivalent black area if equal to or greater than the equivalent black area of the reference spot previously selected.

NOTE 3—Operators can easily train themselves to estimate the equivalent black area of specks more quickly and accurately than they can their actual area, especially if the specks have a shape different from those on the comparison chart. With the dirt chart in one hand and a specimen sheet in the other, they should be able to accurately gage the equivalent black area of each speck on the specimen about as rapidly as they can mentally sum their areas. This is conveniently done by adding the equivalent black areas of the spots in units of hundredths of square millimeters.

NOTE 4—It is helpful when estimating the equivalent black area of a dirt speck on a colored sheet, to ask "How noticeable is this speck?" and proceed to select an appropriate black spot from the Standard Dirt Chart with its white background that is equally noticeable,—that is, both become indistinguishable at the same distance when moved away from the eyes, or disappear together when examined with a common reading glass moved out of focus or where observed through a slightly light-scattering film similar to a transparent glassine paper but more uniform.

9.3 When the equivalent black areas of all the large specks have been recorded or summed, place a suitable mask on the lower part of the specimen sheet and examine the exposed quarter or fifth area at the top for specks smaller than the larger reference spot (but not less than 0.04 mm^2), and sum or record these.

9.3.1 Turn the specimen sheet over and examine and separately record the equivalent black area of the larger specks on the entire surface, and the smaller specks on the exposed surface, of its wire side, in the same way.

NOTE 5—If the sheet is very dirty, select two particular sizes of reference spots,—a "big" and a "medium" spot of about half the size of the larger, such that about 10 or more "big" specks will be found on 20 sides of the specimen sheets and about 10 or more" medium" specks on one quarter or one fifth of this area. After estimating and recording all the "big" and "medium" specks on the face of a specimen, the latter with a three quarter mask, use another mask exposing only one sixteenth of the sheet to estimate the equivalent black areas of those specks less than the equivalent black area of the "medium" spot down to 0.04 mm^2.

9.4 During the count, ignore any odd piece of dirt encountered that is obviously unusual, for example, a crushed insect, or a blotch of dirt that is not representative of the shipment (ascertained by looking over additional sheets).

NOTE 6—Shives or specks that appear dark only at some particular angle of observation are not counted as dirt. However, if their number is noticeable, they should be recorded separately in the report, giving their approximate average actual area, their color or appearance, and the average number per square meter, for each side of the specimen.

NOTE 7—If there are an unusual number of specks present in the sheet less than 0.04 mm^2 and over 0.01 mm^2, which normally are too small to be regarded as "dirt," their total equivalent black area may be estimated by scanning one sixteenth (or less) of the area of each of the specimens and reporting their total equivalent black area separately.

9.5 Measure the area of the specimen sheets.

10. Calculation

10.1 Compute the total equivalent black area of dirt on the top and wire sides of each sheet separately, by totaling the equivalent black areas of the larger specks on the entire area and adding 4 or 5, or 16 or 20, times the equivalent black areas of the smaller specks observed in accordance with the lesser area examined.

10.2 For each side of each sheet, compute the dirt in terms of square millimetres of equivalent black area per square metre of surface examined, that is, in parts per million.

10.3 Compute the average in parts per million for the top side and likewise for the wire side.

11. Report

11.1 Report the following information:

11.1.1 Average equivalent black area of the dirt for each side in parts per million (to the nearest 0.1 for values up to 10 and to two significant figures for values above 10),

11.1.2 Maximum and minimum values obtained (or the standard deviation) for each side,

11.1.3 Area and the number of sheets examined, and

11.1.4 Presence of any unusual number of shives or tiny specks as described above.

12. Precision and Bias

12.1 *Precision*—With practiced observers, duplicate tests in the same shipment are expected to agree within 10 % for the same observer and 20 % for different observers. The actual precision of this method has not been experimentally determined. Because of the interest in image analysis techniques as possible replacements for this test method, no work to measure the precision is currently underway.

12.2 *Bias*—The procedure in this test method has no bias because the value of dirt in paper and paperboard is defined only in terms of this test method.

13. Keywords

13.1 dirt; dirt specks; paper; paperboard

REFERENCES

(**1**) Clark, J. d'A., von Hazmburg, R. S., and Knoll, R. J., "The Estimation of Dirt and Shives in Pulp and Paper," *Paper Trade Journal* **96** (5): 40 (1933).

(**2**) Clark, J. d'A., "Method of Estimating the Dirt in Pulp and Paper," *Tech Assoc. Papers* **16** (1): 347 (1933); *Paper Trade Journal* (June 29, 1933); *Paper Maker* **86** (4): TS 188 (1933).

(**3**) Clark, J. d'A., "An Improved Measure of Dirt in Pulp and Paper," *Tappi* **42** (7): 173A (1959).

(**4**) Graff, J. H., and Nihlen, E. K., "A Chart for the Estimation of Dirt in Pulp and Paper," *Tech. Assoc. Papers* **25**: 331 (1942); *Paper Trade Journal* **114** (21): 61 (1942).

(**5**) "Dirt in Paper," proposed revision of TAPPI Tentative Standard T 437, *Tappi* **46** (3): 131A (1963).