Designation: F1424 – 92 (Reapproved 2011)

Standard Test Method for Estimating Toner Usage in Full-Color Copiers Utilizing Dry Mono- or Dual-Component Toners[1]

This standard is issued under the fixed designation F1424; 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 describes a procedure for estimating the number of copies that can be produced for a given unit of toner in a full-color copier using dry mono- or dual-component development.

1.2 *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 hazards, see Section 9.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D5039 Test Methods for Identification of Wire Side of Paper (Withdrawn 2009)[3]

F335 Terminology Relating to Electrostatic Imaging

F875 Test Method for Evaluation of Large Area Density and Background on Office Copiers

2.2 *ASTM Adjuncts:*

Density Target Test Sheet (F875)[4]

Toner Yield Test Target (F1424)[5]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *dual-component development*—a mixture of dry toner and iron oxide developer that is used for developing electrostatic images in copiers (see Terminology F335).

3.1.2 *full-color copiers*—copiers that can reproduce color originals containing gradations of color. Full-color copiers may have up to four individual color developing units containing four different color toners. These colors are frequently cyan, magenta, yellow, and black. The original is scanned by means of an analog system using a series of color filters or by means of a digital scanning process. The full-color copier may require up to four scans to read the original. The copier individually applies one or more color toners to a transfer drum/belt or photoconductor, or both, which is in turn deposited on the paper.

3.1.3 *mono-component development*—a single component dry toner used for developing electrostatic images in copiers (see Terminology F335).

3.1.4 *toner usage*—amount of toner (milligrams per copy) removed from the toner reservoir during the copy process.

4. Summary of Test Method

4.1 A full-color copier is set up to standard operating parameters and operated under a controlled job stream and environment for a length of time sufficient for stable performance (see Fig. 1). A known, or estimated quantity of toner is used over the length of the test and this result along with the total number of copies generated is used to estimate the number of copies produced per unit of toner.

4.2 A full-color copier may have up to four individual developing units containing up to four different color toners (usually cyan, magenta, yellow, and black). In some cases, the black developing unit may be dual-component while the color developing units may be mono-component (or vice versa). This test method is intended to address the toner yield of each type of development systems (mono- or dual-component).

5. Significance and Use

5.1 This test method can be used to evaluate the performance of different toners in a common machine. It can also be used to evaluate the economics of toner usage when making machine-to-machine cost-per-copy comparisons.

5.2 This test method provides only a point of estimate that is subject to a significant number of variables that are not easily

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJF0875. Original adjunct produced in 1994.

[5] Available from ASTM International Headquarters. Order Adjunct No. ADJF1424. Original adjunct produced in 1992.

Weigh Toner-Added Data Sheet

Manufacturer of machine tested	________
Model Number	________
Rated number of copies per minute	________
Copies/hour (copies/minute × 60)	________
Test length (or developer life) (copies/hour × 50) **[11.6]**	________
Copy counter reading at start (C_0) **[11.8.1.2]**	________
Color of toner under test **[11.6]**	________
Weight of initial toner unit added (T_1) **[11.8.1.3]**	________g
Weight of next toner unit added (T_2) **[11.8.2.2]**	________g
Copy counter reading at T_2 addition (C_2) **[11.8.2.1]**	________
Weight of toner units added (T_i) **[11.8.2.2]**	________g
Copy counter reading at T_i addition (C_i) **[11.8.2.1]**	________
Weight of toner units added (T_i as required) **[11.8.2.2]**	________g
Copy counter reading at T_i addition (C_i as required) **[11.8.2.1]**	________
Weight of toner units added (T_{n-1}) **[11.8.2.2]**	________g
Copy counter reading at C_{n-1} **[11.8.2.1]**	________
Copy counter reading at last toner addition (C_n) **[11.8.2.2]**	________
Toner usage **[11.8.2.3]** $(1000 \times (T_2 + T_3 + ... + T_{n-1})/(C_n - C_2)$	________mg per copy

FIG. 1 Sample Data Sheet

measured. Toner-based imaging systems are not 100 % efficient. Some toner is lost to the surroundings (inside or outside of the copier). This loss may be significant enough to affect the total number of copies produced by a specific amount of toner. Anyone making a decision based on the results of this test method should carefully consider the accuracy of the results and other pertinent data.

5.3 Actual use of the copier in normal operating conditions will most likely result in toner usage values different from those generated in this test method.

6. Interferences

6.1 Variations in toner usage will occur for many reasons, such as the following:

6.1.1 Machine adjustments.

6.1.2 Operating environment.

6.1.3 Varying use of special copy products.

6.1.4 Number of copies on the photoconductor or developer, or both.

6.1.5 Variations in copy paper.

6.1.6 Operator variability.

6.1.7 Batch-to-batch toner and developer variability.

6.1.8 Machine-to-machine variability.

6.1.9 Variations in document area coverage.

7. Apparatus

7.1 *Balance,* reading to the nearest 1 g.

7.2 *Reflection Densitometer or Reflectometer,* capable of measuring a 6-mm solid circle.

8. Reagents and Materials

8.1 Sufficient quantities of paper, toner, developer (if required), and photoconductor to run the test (refer to 11.6).

8.2 *Test Targets:*

8.2.1 *Density Target Test Sheet,* as shown in Fig. 1 of Test Method F875.[4]

8.2.2 *"k 's" with Graphic Elements/Toner Yield Test Target,* as shown in Fig. 2.[5]

9. Hazards

9.1 Machine-to-machine comparisons should be made, if possible, with the same manufacturing lot of toner or developer, or both.

9.2 Any comparisons between machines or toners should carefully take into consideration the test conditions used and these conditions should be documented.

9.3 The test must be controlled as described in this test method. Casual use of the copier during the test will affect the results.

9.4 The toner usage estimated with this test method may not accurately predict actual field results. Actual results will depend not only on those interferences listed in Section 6, but also on a number of additional variables:

9.4.1 Type of originals used.

9.4.2 Machine and service variability.

9.4.3 The users image quality requirements.

9.4.4 The number of copies per original.

9.4.5 The use of secondary receivers.

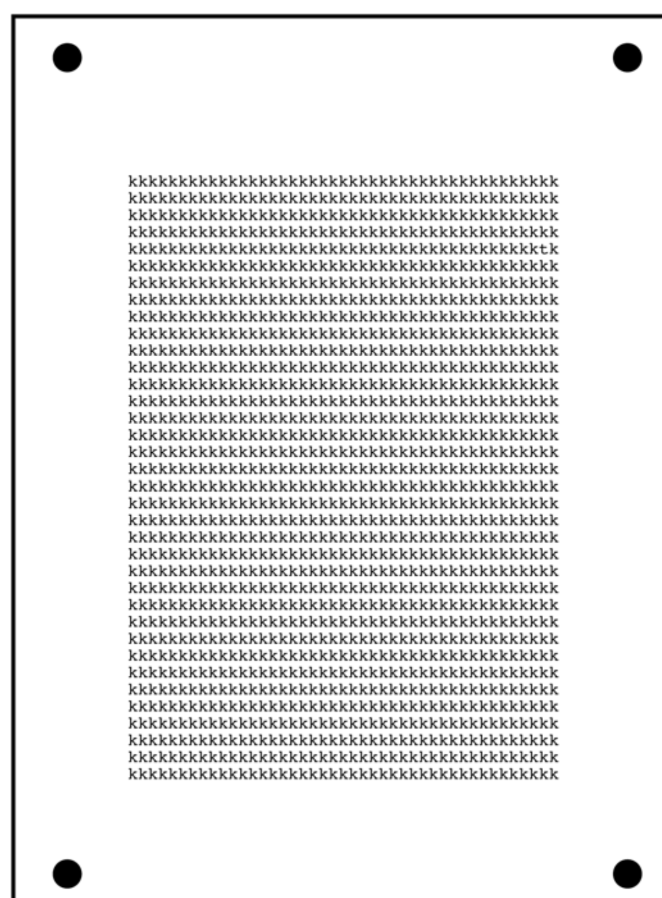

FIG. 2 "*k*'s" with Graphic Elements

9.4.6 Variations in copy papers.

9.4.7 A copier that produces a lower average print density may have a lower average toner usage than a similar copier producing a higher average print density. This is especially important to note when making copier-to-copier comparisons using the same toner.

10. Conditioning

10.1 Condition the paper (in wrapper), toner, developer, photoconductor, and copier in the test environment for 24 h prior to initiating the test.

11. Procedure

11.1 Control the environment in which the following procedure is carried out to reduce adverse effects. Control the temperature within ±5°F around the mean temperature selected for the test. Control the relative humidity within ±10 % around the mean relative humidity selected for the test.

11.1.1 Measure the actual temperature and relative humidity periodically during the test and record for any future comparison tests.

11.2 The machine in which the toner usage will be measured should be thoroughly cleaned by an authorized service representative. Perform any prescribed preventative maintenance prior to loading the test toner.

11.2.1 Adequately service the machine to increase the probability of a long copy run without failure.

11.3 Set up the full-color copier to the manufacturer's specifications with a new photoconductor and each developing unit with new developer (if applicable).

11.4 Design a log sheet on which to record significant events during the running of the test.

11.5 Record the initial copy count from the appropriate counter before the toner is loaded into the machine.

11.6 Record the color of the toner under test and select the copy color desired on the copier control panel.

11.7 The procedure requires that the machine and toner be used long enough to provide stable performance. Use the sample data sheet (Fig. 1 and Fig. 3) or the procedures outlined in 11.8 to 11.11, or both, to verify stable performance. The length of the verification process is defined as: (*a*) one developer life according to the manufacturer's recommended replacement schedule, (*b*) 50 times the rated machine speed in copies per hour, or (*c*) whichever comes first. For mono-component development machines, the length of the verification process is defined as: 50 times the rated machine speed in copies per hour. Throughout the test, sequentially add the toner being evaluated.

11.8 Determine the estimated toner usage by one of the following ways depending on the copier being used and the degree of serviceability.

11.8.1 Some machines, with possible assistance from the manufacturer's service representative, allow for the weighing of all components of the toning subsystem. In this case, record the following measurements during the procedure.

Weigh Entire Toner Subsystem Data Sheet

Manufacturer of machine tested	_____
Model Number	_____
Rated number of copies per minute	_____
Copies/hour (copies/minute × 60)	_____
Test length (or developer life) (copies/hour × 50) [**11.6**]	_____
Copy counter reading at start (C_o) [**11.8.1.2**]	_____
Color of toner under test [**11.6**]	_____
Weight of toner subsystem (W_o) [**11.8.1.1**]	_____ g
Weight of initial toner unit added (T_1) [**11.8.1.3**]	_____ g
Weight of next toner unit added (T_2) [**11.8.1.3**]	_____ g
Weight of next toner unit added (T_n) [**11.8.1.3**]	_____ g
Copy counter reading at end of test (C_n) [**11.8.1.5**]	_____
Weight of toner subsystem at end of test (W_f) [**11.8.1.4**]	_____ g
Toner used [**11.8.1.6**] $W_t = W_o + (T_1 + T_2 + ... + T_n) - W_f$	_____ mg per copy
Toner usage [**11.8.1.7**] $(1000 \times W_t)/(C_n - C_o)$	_____ mg per copy

FIG. 3 Sample Data Sheet

11.8.1.1 Weight (W_o) to the nearest 1 g of the toning subsystem components including any installed toner.

11.8.1.2 The copy counter reading at the start (C_o).

11.8.1.3 Net weight (T_i) to the nearest 1 g of each unit of toner added to the toning subsystem during the procedure. This can be done by directly weighing the toner container before it is loaded in a copier and after it is removed.

11.8.1.4 Weight (W_f) to the nearest 1 g of the toning subsystem components including any remaining toner at the end of the test.

11.8.1.5 Copy counter reading at the end of the test (C_n).

11.8.1.6 Total weight (W_t) of the toner used during the test can be calculated by adding the initial weight of the toning subsystem components and the total net toner added during the test, and then subtract the final weight of the toning subsystem as shown in the following equation:

$$W_t = W_o + (T_1 + T_2 + T_3 + \ldots + T_n) - W_f \quad (1)$$

11.8.1.7 Calculate the actual toner usage in milligrams/copy by dividing the total toner used in grams × 1000 by the number of copies $(W_t \times 1000)/(C_n - C_o)$.

11.8.2 With some copiers, it is not physically possible to weigh the components of the toning subsystem, or service assistance may not be readily available to provide access to these components. Because potentially useful (available) toner in the toning system cannot be measured, it will be necessary to estimate toner usage over some steady-state period of operation. For this method, record the following measurements during the procedure.

11.8.2.1 Record the machine copy count (C_i) as each unit of toner is installed to replenish the development unit. Add the toner only when the replenishment sensor indicates an "add toner" condition.

11.8.2.2 Calculate and record the new weight (T_i) in grams of each unit of toner added in accordance with 11.8.1.3.

11.8.2.3 Estimate the toner usage in milligrams/copy using the following equation:

$$\text{toner usage} = (1000) \times (T_2 + T_3 + \ldots + T_{n-1})/(C_n - C_2) \quad (2)$$

11.8.2.4 Note that the test is considered to begin with the addition of the second unit of test toner. The first unit is used to set the copier into a steady-state condition. The initial toner weight and copy count is recorded to indicate the establishment of a steady-state condition.

11.9 Conduct the test using the standard toner usage test target identified in 8.2.2. This test method provides a constant job stream and eliminates one source of variability. Use the same selected document for all tests in the comparison.

11.10 Rotate the toner usage test target 180° on the platen every 500 copies to reduce the potential of fatiguing the photoconductor.

11.11 Make all copies exclusively on either the wire or felt side of the paper (see Methods D725).

11.12 Monitor the image quality during the test as a check on copy uniformity. Use the density and background test target in accordance with 8.2.1 at the beginning of the test and at intervals equal to the number of copies that can be made in 2 h of machine operation. Record the density data and copy count at each measurement. Readjust the copier if the density changes by more than 5 %.

11.13 Repeat 11.1 to 11.11 for each resident color developing unit.

12. Interpretation of Results

12.1 The estimated toner usage determined by this test method relates only to the relatively limited and controlled conditions under which the test method is used. It is useful in making comparisons between machines or toner only under these conditions. Variations in machines, toners, service, and operating conditions may result in toner usage values different from those estimated by this test method.

13. Precision

13.1 The precision of the procedure for estimating the toner usage in full-color copiers is being determined. Using this test method, one laboratory has begun testing in order to gather mean-range data.

14. Keywords

14.1 dual-component development; full-color copier; mono-component development; toner; toner usage