Designation: F995 – 09

Standard Practice for Estimating Toner Usage in Copiers Utilizing Dry Two-Component Developer[1]

This standard is issued under the fixed designation F995; 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 practice describes a procedure for estimating the number of copies that can be produced for a given unit of toner in a copier using dry two-component developer.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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 whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* See Section 9 for specific precautionary statements.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F335 Terminology Relating to Electrostatic Imaging

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

2.2 *ASTM Adjuncts:*

K Charts[3]

3. Terminology

3.1 *Descriptions of Terms Specific to this Standard:*

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

3.1.2 *two-component developer*—a mixture of dry toner and carrier used for developing electrostatic images in copiers (See Terminology F335.)

4. Summary of Practice

4.1 A 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. A known, or estimated, quantity of toner is used to replenish the developer 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.

5. Significance and Use

5.1 This practice may 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 comparisons.

5.2 The practice provides only a point estimate that is subject to a significant number of variables that are not easily measured. As with all dry developers, two-component developer systems are not 100 % efficient. Some toner is lost to the surroundings (inside or outside the copier). This loss is also dependent on copier adjustments and may be significant enough to affect the total number of copies capable of being produced by a specific amount of toner. Anyone making a decision based on the results of this practice 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 practice.

6. Interferences

6.1 Variations in toner usage will occur for many reasons, among them:

6.1.1 Machine adjustments,

6.1.2 Operating environment,

6.1.3 Varying use of special copy controls,

6.1.4 Number of copies on the photoconductor and developer,

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, and

6.1.9 Variation in document area coverage.

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[1] This practice is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.04 on Electrostatic Imaging Products.

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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] Available from ASTM International Headquarters. Order Adjunct No. ADJF0995. Original adjunct produced in 1986.

7. Apparatus

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

7.2 Refer to Test Method F875 for other required instruments.

8. Reagents and Materials

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

8.2 *Test Targets:*

8.2.1 *Density and Background Test Sheet*—As shown in Fig. 1 of Test Method F875.

8.2.2 *"k" Target with 1507 "k"s*—As shown in Fig. 1.[3]

8.2.3 *"k" Target with 2925 "k"s*—As shown in Fig. 2.[3]

9. Precautions

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

9.2 Any comparisons between machines or toners should carefully consider the test conditions used and should be documented.

9.3 The test must be controlled as described in this test method. A casual use of the copier during the test may affect the results.

9.4 The toner usage as 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 User's image quality requirements,

9.4.4 Number of copies per original,

9.4.5 Use of secondary receivers, and

9.4.6 Variations in copy paper.

9.5 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, toner, developer, photoconductor, and copier in the test environment for 24 h prior to initiating the test.

11. Procedure

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

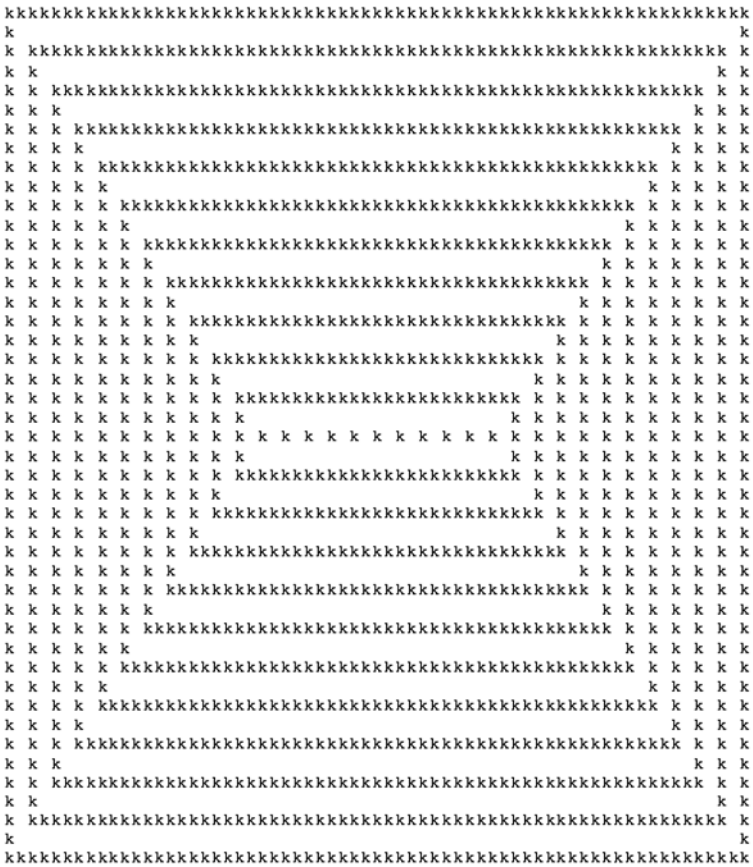

FIG. 1 "k" Chart With 1507 "k"s

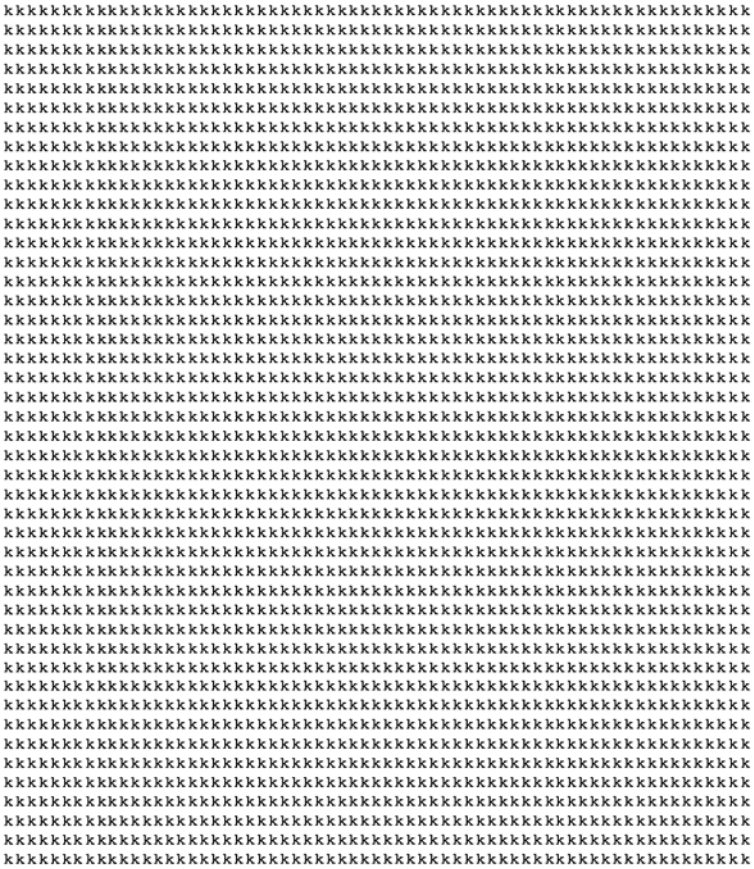

FIG. 2 "k" Chart With 2945 "k"s

should be controlled within ±10 % around the mean relative humidity selected for the test.

11.1.1 The actual temperature and relative humidity should be measured periodically during the test and recorded 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, and any prescribed preventive maintenance performed prior to loading the test toner.

11.2.1 The machine should be adequately serviced to increase the probability of a long copy run without major failure.

11.3 The copier should be set up to the manufacturer's specifications with a new photoconductor and developer. It is also recommended that major replaceable components in the fusing and cleaning subsystems be replaced in accordance with the manufacturer's preventive maintenance schedule to minimize any potential adverse effects.

11.4 A log sheet should be designed on which to record significant events during the running of this test.

11.5 The initial machine copy count from the appropriate indicator should be recorded before the test toner is loaded into the machine.

11.6 The procedure requires that the machine and toner be used sufficiently long enough to provide stable performance. (See Fig. 3.) This is defined as: (*a*) one developer life according to the manufacturer's recommended replacement schedule, or (*b*) 50 times the rated machine speed in copies per hour, whichever comes first. Toner being evaluated should be sequentially added throughout the test.

11.7 The estimated toner usage can be determined by one of two ways, depending on the copier being used and the degree of serviceability. These are:

11.7.1 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 take and record the following measurements during the procedure.

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

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

11.7.1.3 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 added, or determining the net toner added by weighing the toner container before it is loaded in a copier and after it is removed.

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

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

11.7.1.6 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:

Manufacturer of machine tested	_____
Model number	_____
Rated number of copies/minute	_____
Copies/hour (copies/minute × 60)	_____
Test length (or developer life) (copies/hour × 50) [**11.6**]	_____
Copy counter reading at start (C_o) [**11.7.1.2**]	_____
Weight of toner subsystem (W_o) [**11.7.1.1**]	_____ g
Weight of initial toner unit added (T_1) [**11.7.1.3**]	_____ g
Weight of next toner unit added (T_2) [**11.7.1.3** or **11.7.2.2**]	_____ g
Copy counter reading at T_2 addition (C_2) [**11.7.2.1**]	_____
... . . (record T_3... . T_n–1 weight) [**11.7.1.3** or **11.7.2.2**]... .	_____ g
Weight of toner unit *n* added (T_n) [**11.7.1.3**]	_____ g
Copy counter reading at last toner addition (C_n) [**11.7.1.5**]	_____
Total weight of toner added ($T_1 + T_2 + ... + T_n$)	_____ g
Weight of toner subsystem at end (W_f) [**11.7.1.4**]	_____ g
Toner used [**11.7.1.6**] $W_t = W_o + (T_1 + T_2 + ... + T_n) - W_f$	_____ g
Toner usage [**11.7.1.7**] $(1000 \times W_t)/(C_n - C_o)$	_____ mg per copy
Toner usage [**11.7.2.3**] $(1000) \times (T_2 + T_3 + ... + T_{n-1})/(C_n - C_2)$	_____ mg per copy

FIG. 3 Sample Data Sheet

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

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

11.7.2 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 accurately measured, it will be necessary to estimate toner usage over some steady state period of operation. For this method take and record the following measurements during the procedure.

11.7.2.1 Record the machine copy count (C_i) as each unit of toner is installed to replenish the developer. Toner should be added only when the replenishment sensor indicates an "add toner" condition.

11.7.2.2 The net weight (T_i) in grams of each unit of toner added should be calculated and recorded with reference to 11.7.1.3.

11.7.2.3 The toner usage in milligrams/copy can be estimated using the following equation:

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

11.7.2.4 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 the steady state condition.

11.8 The test should be conducted using one of two standard toner usage test targets identified in 8.2.2 and 8.2.3. Selection depends on the desired print coverage (1507 or 2925 "k"s). One may want to use the target that represents the print coverage closest to that commonly used by the copier in the test. This document provides a constant job stream and eliminates one source of variability. The same selected document should be used for all tests in the comparison.

11.9 The toner usage test target should be rotated 180° on the platen every 500 copies to reduce the potential of fatiguing the photoconductors.

11.10 The image quality should be monitored during the test as a check on copy uniformity. The density and background test target identified in 8.2.1 should be used 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. The density data and copy count should be recorded at each measurement. The copier should be readjusted if the density changes by more than 5 %.

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 the populations of machines, toners, service, and operating conditions may result in toner usage values different from those estimated by this test method.

13. Keywords

13.1 copiers; test target; toner usage; two-component toner