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Standard Practice for Estimating the Performance of a Fuser Oil in an Electrostatic Copier or Printer[1]

This standard is issued under the fixed designation F1434; 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 covers a procedure for estimating the performance of fuser oil in an electrostatic copier or printer.

1.2 This practice describes a procedure for determining fuser oil-related changes in the print quality measured during testing at specific intervals.

1.3 Properties evaluated for all systems include odor emission, paper jam rate, paper wrap rate, paper crinkle rate, and fuser roller life.

1.4 Properties evaluated for recirculating systems include changes in viscosity, volatile matter content, and surface tension.

1.5 This practice describes a procedure for comparing the performance of a subject fuser oil with that of a control fuser oil.

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

1.7 *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 a specific precautionary statement, see 8.3.1.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D1331 Test Methods for Surface and Interfacial Tension of Solutions of Paints, Solvents, Solutions of Surface-Active Agents, and Related Materials

D4559 Test Method for Volatile Matter in Silicone Fluid

D4741 Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered-Plug Viscometer

F335 Terminology Relating to Electrostatic Imaging

F995 Practice for Estimating Toner Usage in Copiers Utilizing Dry Two-Component Developer

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *fuser agent*—a specialized fuser oil designed to withstand the higher temperatures encountered in certain high-speed copying machines.

3.1.2 *fuser cleaning unit*—a mechanical assembly in a copier or printer used to clean the fuser rollers.

3.1.3 *fuser oil*—a specifically formulated fluid, based on polyorgano siloxane or equivalent, used in a fuser unit to prevent offsetting during the toner fixing process.

3.1.4 *fuser roll*—a heated roller that contacts the paper and toner directly and is part of the fuser unit.

3.1.5 *fuser unit*—a mechanical assembly in a copier or printer used to fix the toner to the paper. The fuser unit can include an associated fuser oil applicator.

3.1.6 *non-recirculating system*—a fuser oil application system in which none of the fuser oil that has been removed from the reservoir is returned.

3.1.7 *recirculating system*—a fuser oil application system that removes the oil from a sump, applies a portion of the oil to the fuser unit, and returns the excess fuser oil to the sump.

3.2 For definitions of other terms, refer to Terminology F335.

4. Summary of Practice

4.1 A copier or printer is set up to standard operating parameters and operated in a controlled job stream and environment.

[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.

4.2 Standard OEM supplies, including toner and developer, fuser rollers, and fuser cleaning apparatus, are used and replenished, as required, according to standard service procedures.

4.3 The fuser oil to be evaluated is installed according to the service procedure provided by the equipment manufacturer. Previously used fuser oil should be removed from the fuser unit.

4.4 The test is conducted according to the procedure described in Practice F995.

4.5 For recirculating systems, fuser oil samples are taken from the sump, and the surface tension, viscosity, and volatile matter content are determined using Test Methods D445, D1331, and at the beginning and at specific intervals during the test.

4.6 Print samples are taken during the test at the beginning and at specific intervals. The print quality is evaluated in comparison to initial copies, with reference to gloss uniformity, edge acuity, and offsetting. For printers capable of multiple paper widths, any print quality differences in the areas between the two paper widths used primarily are noted.

4.7 For recirculating systems, the fuser unit is examined at intervals with reference to surface contamination. For printers capable of multiple paper widths, any surface differences in the areas between the two paper widths used primarily are noted.

4.8 For recirculating systems, the minimum duration of the test is equal to the manufacturer's recommended service life of the fuser roller. The fuser roller cleaner, wicks, etc. are replaced during the test at the manufacturer's recommended intervals. The test may be extended to twice the service life in order to observe specific failure modes.

4.9 The volume of fuser oil added during the test is recorded in order to determine an estimated average consumption rate.

4.10 Any odors emitted by the machine resulting from the fuser oil are evaluated relative to user offensiveness.

5. Significance and Use

5.1 This practice can be used to evaluate the performance of different fuser oils in a specific model copier or printer.

5.2 This practice can be used to evaluate a subject fuser oil in comparison to an acceptable control fuser oil.

5.3 This practice can be used to estimate the consumption of a specific fuser oil in a copier or printer.

5.4 This practice can be used with recirculating systems to monitor the change in volatile matter content as the test progresses. An excessive increase in volatile matter content can indicate breakdown of the fuser oil due to the combined effect of the heat of the fuser unit and the catalytic action of contaminants introduced by toner, paper, and other materials encountered in the machine. The production of excessive amounts of volatile materials may damage delicate electrical components within some copying machines.

5.5 This practice can be used with recirculating systems to monitor the change in viscosity as the test progresses. An excessive increase in the viscosity of a fuser oil can indicate that it is beginning to form a gel due to the effect of oxygen, contaminants, and high temperatures encountered in the machine.

5.6 This practice can be used with recirculating systems to monitor the change in surface tension as the test progresses. An increase in surface tension indicates loss of the release properties of the fuser oil and may lead to print offsetting and other adverse effects.

5.7 This practice can be used to evaluate the rate of fuser oil-related buildup on the fuser roll. A rubbery material that consists of gelled fuser oil, paper dust, toner, and other contaminants may build up on the fuser roll as the fuser oil degrades. Inspection of the fuser roll at specific intervals provides a qualitative evaluation of this effect.

5.8 This practice can be used to determine changes in measured print quality, odor emission, paper jam rate, paper wrap rate, paper crinkle rate, and fuser roller life during the test.

5.9 This practice is a single estimate subject to a significant number of variables that are not measured easily. Consequently, a repeated number of tests on more than one machine will yield more reliable conclusions.

5.10 This practice may be used with recirculating systems to establish limits for acceptable change in physical properties based on data correlations. Such limits may provide more efficient evaluation of sample fuser oils and prevent damage to the copying machine by avoiding the need to test to failure.

6. Interferences

6.1 Variations in the fuser agent or fuser oil performance and consumption rate will occur for many reasons, the following of which are among them:

6.1.1 *Fuser Unit Adjustments*—Temperature, pressure, etc.;
6.1.2 *Operating Environment*—Temperature and humidity;
6.1.3 Toner, developer, and paper properties;
6.1.4 Fuser roller properties;
6.1.5 Operator and service variability;
6.1.6 Batch-to-batch fuser oil variations;
6.1.7 Machine-to-machine variations;
6.1.8 Machine standby time with fuser at temperature;
6.1.9 Toner coverage; and
6.1.10 Contamination in the machine.

7. Apparatus

7.1 *Copier or Printer,* to be tested.

7.2 *Sufficient Consumable Supplies,* to conduct the test.

7.3 *Graduated Cylinder,* to monitor the samples removed and returned.

7.4 *Laboratory Equipment,* for viscosity, surface tension, and volatile matter content measurements.

8. Procedure

8.1 *General Instructions:*

8.1.1 Conduct the test according to the procedure described in Practice F995. A regular job stream can be used for

convenience. The job stream must be controlled (run length distribution and run frequency) for comparison performance tests. Use a controlled variation of paper widths if the copiers or printer have this capability.

8.1.2 For recirculating systems, conduct the test for a minimum duration determined by the manufacturer's recommended service life of the fuser rollers. If necessary, in order to observe specific possible failure modes, extend the test period to at least twice the recommended service life.

8.1.3 When appropriate, the test period may be chosen to be 50 × the rated machine speed in number of copies per hour.

8.1.4 At least ten evenly spaced periodic tests should be performed during the test run. Additionally, all tests should be made prior to each addition of fuser oil.

8.1.5 Record the results of tests at each interval on the appropriate sections of a data sheet similar to the sample data sheet shown in the Appendix (Fig. X1.1).

8.1.6 All data should be recorded with reference to copy count and test duration (elapsed time).

8.2 *Instructions For All Systems:*

8.2.1 Examine the fuser unit at each test interval with reference to surface contamination and, for printers or copiers capable of multiple paper widths, any surface differences in the areas between the widths. Grade the degree of contamination visually using a 0–5 scale; 0 = no contamination, and 5 = greatest contamination.

8.2.2 Evaluate the print quality at each test interval in comparison to the initial copies. The print quality is compared visually with reference to gloss uniformity, edge acuity, and offsetting. For printers and copiers capable of multiple paper widths, any print quality differences in the areas between the two paper widths used primarily should be noted. Grade the print quality visually using a scale of 0–5; 0 = no observable change from initial copies, and 5 = greatest copy quality deterioration.

8.2.3 Record each instance of paper wrapping and crinkling.

8.2.4 Record the volume of each addition of fuser oil, added as measured with a graduated cylinder.

8.2.5 Note any uncharacteristic odors emitted by the machine resulting from the fuser oil that are offensive to the user.

8.2.6 Record any service action taken during the test.

8.3 *Instructions For Recirculating Systems Only:*

8.3.1 Take sufficient samples of fuser oil from the sump at the beginning and at each test interval, in order to perform Test Methods D445, D1331, D4559, and D4741 for viscosity, surface tension, and volatile matter content. (**Warning—**All materials and hardware in the fuser unit are hot! Care should be taken to avoid injury when removing or returning samples.)

8.3.2 Measure the quantity of fuser oil removed at each test interval in a graduated cylinder.

8.3.3 Note any contamination visible in the sump sample at each test interval. Grade the degree of contamination using a 0–5 scale; 0 = no visible contamination, and 5 = greatest contamination.

8.3.4 The fuser oil used to perform Test Methods D445 and D1331, surface tension and viscosity, are to be returned to the sump after testing, along with any unused fuser oil. Measure the quantity of fuser oil returned to the sump in a graduated cylinder.

8.3.5 The fuser oil used to perform Test Method D4559, volatile matter content, will be damaged. Do not return it to the sump.

9. Interpretation of Results

9.1 *Typical Fuser Oil-Related Problems:*

9.1.1 Buildup of a solid or gel-like material on the fuser roll: this problem is due to degradation of the fuser oil on the roller.

9.1.2 Paper jamming due to adhesion to the fuser roll (wrap around); this problem may be caused by failure of a fuser oil to act as a release agent.

9.1.3 Print offsetting due to failure of the fuser oil to release the toner from the fuser roll.

9.1.4 Excessive breakdown of the fuser oil into volatile materials that may be harmful to the copying machine or offensive to the user.

9.2 Results from the tests described in this practice may be evaluated in comparison to a control fuser oil. The fuser oil used as a control should be one that has demonstrated performance acceptable to the user.

9.2.1 Compare the number of jams due to wrap around per 1000 copies for the control versus subject fuser oil.

9.2.2 Compare the print quality of copies made using the control fuser oil to that of copies made with the subject fuser oil with reference to gloss uniformity, edge acuity, and offsetting. Comparisons should be made using copy samples taken after an equal number of copies have been produced for each fuser oil. Consideration must be given to the differences in any recent fuser oil additions. Comparison of the graphs of print quality grading may aid in evaluation.

9.2.3 Compare the amount of fuser roll surface contamination for the control versus subject fuser oil. These comparisons should be made after an equal number of copies have been produced using each fuser oil. Comparison of the graphs of surface contamination grading may aid in evaluation.

9.2.4 For recirculating systems, compare the graphs of fuser oil viscosity plotted against the total number of copies produced for the control and subject fuser oil.

9.2.5 For recirculating systems, compare the graphs of fuser oil volatile matter content plotted against the total number of copies produced for the control versus subject fuser oil.

9.2.6 For recirculating systems, compare the graphs of surface tension versus the total copies produced for the control and subject fuser oil.

9.2.7 For recirculating systems, compare the graphs of fuser oil sample contamination for the control versus subject fuser oil. Significant differences in contamination may indicate a difference in consumable supplies (paper, toner, etc.), which are listed as interferences in Section 6.

9.2.8 Compare any odors emitted by the copy machine for the control versus subject fuser oil. Odor is a subjective property, but the user may find a particular fuser oil unacceptable in the particular application.

9.2.9 Compare the quantity of fuser oil used per 1000 copies for the control versus subject fluid.

9.3 More reliable conclusions may be obtained by accumulating and correlating data from several tests.

9.3.1 The user may find a relationship between the rate of change of the properties of a fuser oil and its useful life.

9.4 All results should be interpreted with consideration for the interferences listed in Section 6.

10. Precision and Bias

10.1 This practice describes a procedure that can be used to control the conditions and supplies in an electrostatic copying application so that specific tests can be conducted on the fuser agent in use. The precision and bias data of the specific ASTM test methods used are available in the referenced standards.

11. Keywords

11.1 electrostatic copier; fuser agent; fuser oil; silicone fluid

APPENDIX

(Nonmandatory Information)

X1. SAMPLE DATA SHEET AND GRAPHS

X1.1 Report all results from the procedures described in 8.2 through 8.2.5.

X1.2 Calculate and report the average consumption of fuser agent or fuser oil (μL/print or copy) by dividing the total fluid added by the number of prints or copies made. Adjust for any fuser oil removed from the sump for testing that was not returned. If the paper size was varied, note the number of copies at each size.

X1.3 Prepare graphs of the grading of fuser roll surface contamination, fuser oil sample contamination, and print quality. A sample graph is presented in Fig. X1.2.

X1.4 For recirculating systems, prepare graphs of viscosity, volatile matter content, and surface tension. Sample graphs are presented in Figs. X1.3-X1.5.

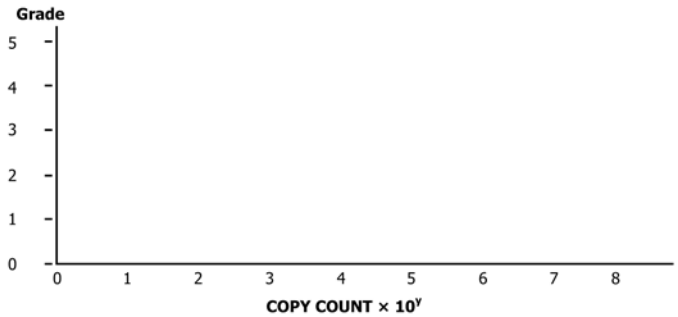
X1.5 Record the test duration (elapsed time) below the corresponding copy count on each graph.

X1.6 Mark each addition of fuser oil on all graphs.

DATA SHEET

Manufacturer of machine used	_____
Model number	_____
Rated number of copies/hour	_____
Copy counter reading	_____
Test duration	_____ hours
Viscosity ASTM D 445	_____ cstks
Surface tension ASTM D 1331	_____ dyne/cm
Volatile matter content ASTM D 4559	_____ %
Volume of fuser oil removed	_____ ml
Volume of fuser oil returned	_____ ml
Fuser oil sample contamination	_____ (0–5)
Print offsetting	_____ (0–5)
Fuser roll surface contamination	_____ (0–5)

FIG. X1.1 Sample Data Sheet



NOTE 1—Adjust the copy count numerical value as needed to obtain full-scale use for the test duration. All comparative analyses should be conducted with graphs using equal copy count increments.

FIG. X1.2 Sample Graph of Grading

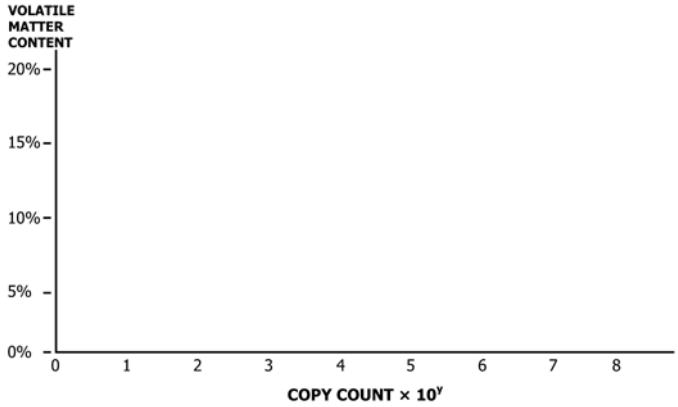


FIG. X1.3 Sample Graph of Volatile Matter Content

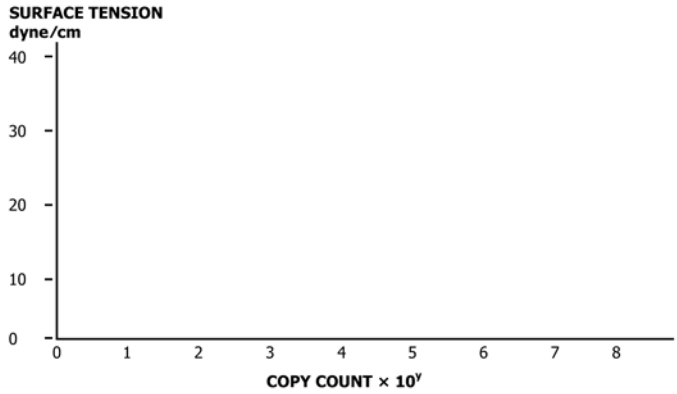


FIG. X1.4 Sample Graph of Surface Tension

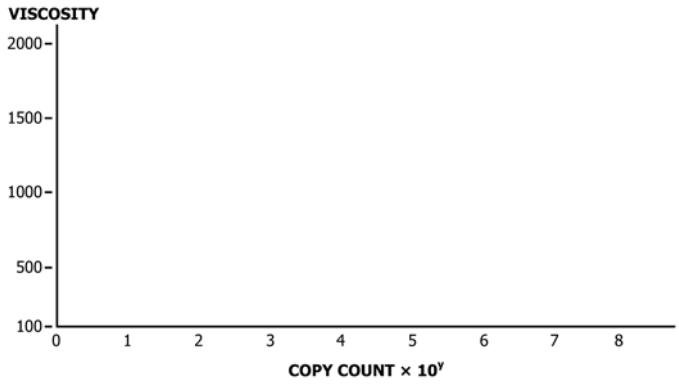


FIG. X1.5 Sample Graph of Viscosity