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Standard Test Method for Apparent Tack of Printing Inks and Vehicles by a Three-Roller Tackmeter[1]

This standard is issued under the fixed designation D 4361; 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

~~1.1This test method covers the procedure for determining the apparent tack of printing inks using a mechanical or electronic model of a three-roller tackmeter.~~

~~1.2This test method is applicable to paste-type printing inks and vehicles that are essentially nonvolatile under ordinary room conditions.~~

~~1.3The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.~~

~~1.4~~*

1.1 This test method covers the procedure for determining the apparent tack of printing inks using a three-roller tackmeter.

1.2 This test method is applicable to all paste-type printing inks and vehicles that are essentially nonvolatile under ordinary room conditions, provided that any elastomer covered rollers in the tackmeter are resistant to attack by the particular ink or vehicle chemistry. Different elastomers may be required for different ink or vehicle chemistries.

1.3 This test method covers three-roller tackmeters of two different geometries, referred to as Geometry A and Geometry B.

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

1.5 *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.*

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *tack*, *n*~~—a function of the force required to split a thin fluid film of a printing ink or vehicle between two rapidly separating surfaces; it is a rheological parameter indicative of internal cohesion of the fluid.~~ —function of the force required to split a thin fluid film of a printing ink or vehicle between two rapidly separating surfaces.

2.1.1.1 *Discussion*—Tack ~~of~~is a ~~printing ink or vehicle~~ rheological parameter indicative of internal cohesion of the fluid. It is not a fixed number but varies with operating conditions, primarily separation velocity, splitting area, force applied by the measuring roller and film thickness. Tack also varies with changes in the rheological properties of the ink or vehicle ~~due to~~ as a result of time, temperature, and interactions with the separating surfaces. In practice, one or more of these surfaces usually consist of ~~rubber-like~~elastomer rollers that may differ in composition and geometry and whose properties tend to change with age, nature of previously run fluids, type of wash-up solvent, and mechanical flaws. ~~On laboratory instruments, tack~~ Tack readings are also sensitive to the calibration and zero accuracy of the tackmeter ~~employed.~~ used. Different manufacturers' tackmeters may use different tack scales.

2.1.2 *apparent tack*, *n*~~—a~~— tack reading obtained at a specific set of conditions.

2.1.3 *flying*, *n*~~—the tendency~~—tendency of a printing ink or vehicle to be ejected as large globules from a roller distribution system.

2.1.3.1 *Discussion*—Flying is generally most severe during rapid roller acceleration such as occurs when switching immediately from zero or a slow speed to a high operating speed.

2.1.4 *misting*, *n*~~—the tendency~~—tendency of a printing ink or vehicle to be ejected as a fine aerosol from a roller distribution system.

2.1.4.1 *Discussion*—Misting is generally most severe at high operating speeds and with fluids that produce long filaments.

[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.56 on Printing Inks. Subcommittee D01.37 on Ink Vehicles assisted in the development of the vehicle portion of this test method.

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***A Summary of Changes section appears at the end of this standard.**

3. Summary of Test Method

~~3.1A thin film of the test printing ink or vehicle is applied to the three-roller distribution system of the tackmeter, which operates at speeds comparable to those on production printing presses. Measurement of the frictional torque induced by drag forces in the splitting film provides an arbitrary value for apparent tack. On mechanical models, the torque is determined with a manually balanced lever arm, a direct-reading attachment, or a recorder; on electronic models, with a digital readout, recorder, or printer. Readings are in units of gram-meters (g-m).~~

~~3.2The procedure in this test method is designed to give a single value for apparent tack at a specific set of instrument conditions. Typical conditions are as follows: a cooling water temperature of 90°F (32.2°C); a volume of 1.32 mL (film thickness 12.3 µm) of the test printing ink or vehicle applied to the rollers; an operating speed of 400 r/min for vehicles, 800 r/min for sheet-fed offset inks, and 1200 r/min for web-fed inks; and a reading after 1 min of operation. Alternative conditions may be used by agreement between the supplier and the customer.~~

~~3.3Instructions are also given for calibration of the Inkometer and for minimizing effects of interactions among the rollers, test fluids, and wash-up solvents.~~

3.1 A thin film of the test printing ink or vehicle is applied to the three-roller distribution system of the tackmeter, which operates at speeds comparable to those on the roller trains of production printing presses. Measurement of the frictional torque induced by drag forces in the splitting film provides a value for apparent tack. Readings may vary from instrument supplier to instrument supplier and from geometry to geometry.

3.2 The procedures in this test method are designed to give a single value for apparent tack at a specific set of instrument conditions. Typical conditions are as follows: a cooling water temperature of 32°C; a film thickness of 12 µm of the test material applied to the rollers for Geometry A and 5 µm for Geometry B; and a reading after 1 min of operation. Different speeds are specified for different types of instruments. Alternative conditions may be used by agreement between the supplier and the customer.

3.3 Depending on the geometry and model, the torque is determined with a manually balanced lever arm, a direct-reading attachment, a digital readout, printer, computer or a recorder.

3.4 Instructions are also given for calibration of the tackmeter and minimizing effects of interactions among the rollers, test fluids, and wash-up solvents.

4. Significance and Use

4.1 Tack of printing inks controls their high-speed transfer properties, as manifested by throughput in roll milling, picking of paper during printing, and wet trapping in multicolor printing. Although an apparent tack measurement does not completely predict the transfer performance of an ink or a vehicle, it provides a meaningful parameter for quality control, development, and research.

~~4.2A given tackmeter will produce repeatable results on a day-to-day basis only if proper attention is paid to calibration and maintenance procedures and to control of experimental variables referred to in 2.1.1.1.~~

~~4.3Two or more instruments may not produce identical apparent tack readings, but if each gives repeatable results, they may be mathematically correlated.~~

~~NOTE 1—A number of three-roller tackmeters are available which differ in design features such as roller weight, geometry, and composition of the distribution system. It cannot be presumed that test results from these other types of tackmeters will either agree or correlate with those from the tackmeters specified in 6.1 and 6.2 of this test method.~~

4.2 A number of three-roller tackmeters are available that differ in design features such as roller weight, geometry, and composition of the distribution system. Instruments of different types do not give the same apparent tack readings.

4.3 Instruments of the same type will only give apparent tack readings within tolerance, provided that they are maintained and calibrated properly and in the same manner.

5. Interferences

5.1 *Tackmeter Squeal*~~—A high pitched whine or squeal may be noted when running high tack fluids or at high rotating speeds, or both. Squeal may result in instability of the balance beam or direct reading attachment of mechanical models, or fluctuation of the digital readout of electronic models, making definite readings difficult.~~ —A high pitched whine or squeal may be noted when running high tack fluids or at high rotating speeds, or both. Squeal usually results in unstable readings or in unreliable/wrong values. If readings are taken where squeal occurs this has to be recorded in the report.

6. Apparatus

~~6.1*Three-Roller Tackmeter*—Models differ in available speeds and type of readout as follows:~~

~~6.1.1~~

6.1 *Three Roller Tackmeters of Geometry A*:

6.1.1 Models differ in available speeds and type of readout as follows:

6.1.1.1 *Mechanical Models* ~~, operate three or four fixed speeds selected from among 400, 800, 1200, and 2000 r/min. A direct reading attachment or a recorder is recommended to supplement the manually operated balance beam.~~

~~6.1.2~~*operate with a number of fixed speeds of the central motor driven roller, selected from among 400, 800, 1200, and 2000 r/min or higher. A direct reading attachment or a recorder is recommended to supplement the manually operated balance beam.*

6.1.1.2 *Electronic Models* , operate at variable speeds ranging from 100 to 2000 or 3000 r/min. A recorder or printer, or both, are recommended to supplement the digital readout.

NOTE 2—To convert to units of linear speed, multiply revolutions per minute by 0.785 to obtain feet per minute or by 0.004 to obtain metres per second.

6.2*operate at variable speeds of the central motor driven roller, ranging from 100 to 2000 or 3000 r/min. A recorder or printer, or both, are recommended to supplement the digital readout.*

6.1.2 *Tackmeter Rollers*, of suitable composition, preferably one set for each major system to be evaluated (see , of suitable composition to be resistant to chemical attack by the particular ink or vehicle system being evaluated (see 10.3.1.) A set consists of a top (measuring) roller 3⅛ in. (79 mm) in diameter and 6⅛ in. (155 mm) in length, and a vibrator 2.0 in. (51 mm) in diameter and 7¼ in. (184 mm) in length. Together with the fixed brass roller, the total surface area of the distribution system is 166 in.^{2} (0.107 m^2). The measuring roller weighs 9.2 lb (4.2 kg) on mechanical models and 9.6 lb (4.4 kg) on electronic models.

6.3*). A set consists of rollers having dimensions given in Table 1.*

6.1.3 *Ink Pipet*, consisting of a metal cylinder and a metal or TFE-fluorocarbon plunger. Suitable pipets include fixed-volume pipets, 1.32-mL capacity; and variable volume micropipets, 2-mL capacity, accurate to 0.01 mL.

TABLE 1 Standard DKeviy Feation and Purecisi on of Appa Thrente-Roller Tack Rmeadingters

Feature	Samples	Tackmeter Typ A[A]	GeSpeedof Rollers, r/min	Standard Deviation	Repeatability	Reproducibility
Feature	Ges		Geomin	Standard Detion	Repeatability	
1min	5 min	Tackometry A[A]	1 m			
Dimensions of central motor driven roller						
in	76	74.5 min				
diameter, mm	76	74.5				
I nk	mechanical	800142				
length, mm	154	142				
	0.49	0.47				
	0.52	0.97				
Conversion factor						
	2.0	1.83				
m/min to rpm		4.3				
rpm to m/min	2.0	3.8				
rpm to m/min	0.24					
	electronic	800				
	0.31	0.46				
Dimensions of top (measuring) roller						
	0.67	1.2650				
diameter, mm	79	50				
length, mm	1.2	1.8				
length, mm	155	148				
	2.6	5.0				
Vehicles	electronic	400				
Dimensions of vibrator (oscillating) roller						
	0.38	0.37				
diameter, mm	51	40				
	1.30	1.60				
length, mm	184	160				
	1.1	1.0				
	3.8	4.7				
Surface area of distribution system,[B] m^2	0.107	0.073				
	electronic	800				
	0.26	...				
Measuring roller mass,[C] kg						
	1.20	...				
mechanical models	4.2					
	0.7	...6				
electronic models	4.4	1.6				
	3.4					
Applied ink amount, mL	1.32	0.4				
Film thickness,[C] µm	12.3	5				

[A] Geometry A applies to Inkometers and Inkomats. Geometry B applies to Tackoscopes and Tack Testers

[B] Top roller and vibrator roller together with fixed central roller.

[C] Includes mounting system.

6.1.4 *Stopwatch or Timer*, accurate to 1 s.

~~6.5~~

6.1.5 *Ink Knife*, small, free from nicks and rough edges.

~~6.6~~

6.1.6 *Manufacturer's Calibration Apparatus*, for the specific model tackmeter.

6.1.7 *Infrared Pyrometer or Internal Temperature Sensor*, to monitor tackmeter roller temperatures.

6.2 *Three Roller Tackmeters of Geometry B*:

6.2.1 Geometry B models differ in available speeds and types of readout as follows:

6.2.1.1 *Model 1* operates fixed speeds selected from among 50, 100, up to 450 m/min or more. A recorder, printer or PC is recommended to supplement the digital readout to plot the curve of the measurements.

6.2.1.2 *Model 2* operates at variable speeds ranging from 0 to 450 m/min or more. A computer with additional software, a printer or a recorder or all of these are recommended to supplement the digital readout.

6.2.2 *Tackmeter Rollers*, of suitable composition to be resistant to chemical attack by the particular ink or vehicle system being evaluated (see 10.3.1). A set consists of rollers having dimensions given in Table 1.

6.2.3 *Ink Pipet*, consisting of a metal cylinder and a plunger, 2-mL capacity, accurate to a minimum of 0.01 mL.

6.2.4 Same as 6.1.4-6.1.7.

7. Reagents and Materials

7.1 *Wash-Up Solvent*~~, compatible with the test system, fast evaporating, and having minimal effect on the rollers; it should be acceptable environmentally. Hydrocarbon solvents with an initial boiling range of 250 to 350°F (120 to 177°C), a final boiling range of 300 to 400°F (150 to 205°C), a Kauri-Butanol value of 30 to 40 and less than 1% benzene content are appropriate for many sheet-fed and heat-set systems. Specific solvents may be required for unique systems.~~ , compatible with the test system, fast evaporating, and having minimal effect on the rollers. Hydrocarbon solvents with a boiling range of 100 to 140°C, a Kauri-Butanol value of 30 to 40, and less than 1 % benzene content are appropriate for many sheet-fed and heat-set systems. Specific solvents may be required for unique systems.

7.2 *Rags or Wipers*, clean, soft, absorbent, lint-free.

7.3 *Manufacturer's Current Manual* , for the specific model tackmeter.

8. Hazards

~~8.1Never let an ink or a vehicle dry completely on the rollers of the tackmeter. (~~

8.1 **Warning—**~~Never turn the ZERO button except during the calibration process (see 12.2.1)).~~

~~8.2Take care not to damage the rollers during the cleaning process or by leaving them in contact when the instrument is not in use.~~

~~8.3Do not disengage the balance beam of a mechanical model except when taking a reading.~~ Since solvents may be hazardous to the skin and eyes, wear rubber gloves and safety glasses during cleanup to avoid solvent contact with skin and eyes. In case of contact, wash skin with water; flush eyes for 15 min with water and call a physician. See supplier's Material Safety Data Sheet for further information on each solvent used.

8.2 Never turn the ZERO button except during the calibration process (see 12.1.2.1).

8.3 Never let an ink or a vehicle dry completely on the rollers of the tackmeter.

8.4 Take care not to damage the rollers during the cleaning process or by leaving them in contact when they are not rotating.

8.5 Do not disengage the balance beam of a mechanical model except when taking a reading.

9. Sampling and Test Specimen

9.1 Carefully select a sample that is free of skin and other contamination and representative of the lot being evaluated. A minimum of 3 to 4 mL is sufficient for two specimens. Transfer to a clean container, protect with skin paper, close, and seal.

9.2 When ready to ~~make a run~~conduct the test (see 12.1.3), fill the ink pipet as follows: Transfer 1.5 to 2 mL of sample to a clean glass plate; close and reseal the container. Gently ~~work up~~ shear the sample with an ink knife but do not aerate. For Geometry A, fill the ink pipet with 1.32 mL of the worked ~~sample (or with a smaller volume (0.5 to 1.0 mL) if a thinner film thickness is desired).~~ sample. For Geometry B, fill the pipette with 0.4 mL of the worked sample. Use the ink knife to force the specimen into the cylinder of the pipet while slowly pulling back the ~~ram.~~plunger. Wipe excess material off the top of the pipet.

NOTE~~3—A specimen volume of 1.32 mL, divided by the roller surface area of 0.010 ft^2 (0.107 m^2), gives an initial film thickness of 12.3 µm when distributed uniformly on the roller system. However, the occurrence of appreciable flying or misting will result in loss of specimen from the rollers. Hence, operating film thickness is unknown.~~ 1—As seen in Table 1, the two volumes give initial ink film thicknesses of 12.3 µm and 5.0 µm respectively. However, the occurrence of appreciable flying or misting will result in loss of specimen from the rollers. Hence, operating film thickness may be unknown.

10. Preparation and Conditioning of the Tackmeter

10.1 Locate the tackmeter on a sturdy bench in a draft-free temperature-controlled environment, preferably ~~73.5~~23 ± ~~3.5°F (23 ± 2°C).~~ 2°C. Humidity control is necessary for test samples that are moisture-sensitive or prone to misting. In this case 50 ± 5 % RH is standard.