Designation: D4361 – 10

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 D4361; 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 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. Referenced Documents

2.1 *ASTM Standards:*[2]

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *tack, n*—function of the force required to split a thin fluid film of a printing ink or vehicle between two rapidly separating surfaces.

3.1.1.1 *Discussion*—Tack is a 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 as a result of time, temperature, and interactions with the separating surfaces. In practice, one or more of these surfaces usually consist of 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. Tack readings are also sensitive to the calibration and zero accuracy of the tackmeter used. Different manufacturers' tackmeters may use different tack scales.

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

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

3.1.3.1 *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.

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

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

4. Summary of Test Method

4.1 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.

4.2 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

[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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[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.

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

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.

4.3 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.

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

5. Significance and Use

5.1 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.

5.2 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.

5.3 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.

6. Interferences

6.1 *Tackmeter Squeal*—A high pitched whine or squeal may be noted when running high tack fluids or at high rotating speeds, or both. Squeal 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.

7. Apparatus

7.1 *Three Roller Tackmeters of Geometry A:*

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

7.1.1.1 *Mechanical Models* 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.

7.1.1.2 *Electronic Models* 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.

7.1.2 *Tackmeter Rollers,* of suitable composition to be resistant to chemical attack by the particular ink or vehicle system being evaluated (see 11.3.1). A set consists of rollers having dimensions given in Table 1.

7.1.3 *Ink Pipet,* consisting of a metal cylinder and a 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 Key Features of Three-Roller Tackmeters

Feature	Geometry A[A]	Geometry B[A]
Dimensions of central motor driven roller		
diameter, mm	76	74.5
length, mm	154	142
Conversion factor		
m/min to rpm		4.3
rpm to m/min	0.24	
Dimensions of top (measuring) roller		
diameter, mm	79	50
length, mm	155	148
Dimensions of vibrator (oscillating) roller		
diameter, mm	51	40
length, mm	184	160
Surface area of distribution system,[B] m^2	0.107	0.073
Measuring roller mass,[C] kg		
mechanical models	4.2	
electronic models	4.4	1.6
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.

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

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

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

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

7.2 *Three Roller Tackmeters of Geometry B:*

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

7.2.1.1 *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.

7.2.1.2 *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.

7.2.2 *Tackmeter Rollers,* of suitable composition to be resistant to chemical attack by the particular ink or vehicle system being evaluated (see 11.3.1). A set consists of rollers having dimensions given in Table 1.

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

7.2.4 Same as 7.1.4-7.1.7.

8. Reagents and Materials

8.1 *Wash-Up Solvent,* 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.

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

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

9. Hazards

9.1 **Warning—**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.

9.2 Never turn the ZERO button except during the calibration process (see 13.1.2.1).

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

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

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

10. Sampling and Test Specimen

10.1 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.

10.2 When ready to conduct the test (see 13.1.3), 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 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. 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 plunger. Wipe excess material off the top of the pipet.

NOTE 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.

11. Preparation and Conditioning of the Tackmeter

11.1 Locate the tackmeter on a sturdy bench in a draft-free temperature-controlled environment, preferably 23 ± 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.

11.2 Set the water bath at 32.2 ± 0.1°C. All tests are to be run at this temperature. (See also A1.3.)

11.3 Before use, ascertain the nature of the test sample for the following reasons:

11.3.1 *Roller conditioning*—Use only an instrument having rollers well broken in for the type of test system. The break-in procedure is given in A1.2. A separate set of broken-in rollers is mandatory for energy curing systems. The necessity for separate sets of broken-in rollers, or for extensive reconditioning when switching among different types of conventional test systems shall be determined in each laboratory.

11.3.2 *Operating speed*—See Table 2. Any different speed shall be recorded in the report.

11.4 Before the first use of the day, equilibrate the tackmeter as follows:

11.4.1 Warm up the instrument by activating the water-cooling system. Place all the rollers in contact and run at the lowest available speed for about 30 min.

11.4.2 Make a conditioning run with a specimen representative of the system to be evaluated. For Geometry A, apply 1 to 1.5 mL of the test material. For Geometry B, apply 0.4 mL of the material. Run for 5 to 10 min at the specified test speed (see Table 2). Clean up as directed in Section 14.

12. Calibration of the Tackmeter

12.1 Calibrate the tackmeter before initial use, after change of rollers and periodically as needed. First, conduct the necessary steps in 11.3 and 11.4.

12.2 Using the manufacturer's calibration apparatus, follow the directions in the instrument manual.

12.2.1 *Mechanical Models of Geometry A*—Zero and calibrate the balance beam (and direct reading attachment or recorder, if they are to be used) at the test speed specified in Table 2.

12.2.2 *Electronic Models of Geometry A*—Zero and calibrate the digital readout (and recorder, if it is to be used) at 1000 r/min. When calibration is completed, check the dry reading at the specified test speed (see Table 2).

NOTE 2—Some three-roller tackmeters can be calibrated at only one speed, therefore recalibration is required if a different speed is to be used than the calibrated one.

12.2.3 After each calibration or at regular periods, conduct a test run with a standard ink or vehicle. (See A1.5.)

13. Procedure for Tack Evaluation

13.1 *Geometry A:*

13.1.1 If necessary, make preparations as in Section 11 and calibrate as in Section 12. If using an electronic model, make sure the motor is preset to the test speed specified in Table 2 and the drive is in the LOW mode.

13.1.2 Engage the rollers and run at the specified test speed. If the dry reading differs from zero by more than ±0.5 tack units, reclean the rollers in accordance with 14.1 or recalibrate in accordance with Section 12. Note that recalibration of a not perfectly clean roller system will result in bad readings.

13.1.2.1 The dry reading on a properly calibrated instrument is directly related to the condition of the top (measuring) roller; therefore, large deviations from zero are suspect. Usual causes are inadequate cleaning, residual sample or wash-up solvent, or

TABLE 2 Typical Operating Speeds for Various Materials

	Geometry A		Geometry B	
	r/min	m/min	m/min	r/min
Vehicles	400	96	100	430
Sheet-fed inks	800	192	200	860
Web-fed inks	1200	288	300	1290

mechanical damage. Do not turn the ZERO button, as doing so will shift the scale. Do not attempt to compensate by subtracting the dry reading from the test reading. Always reclean or recalibrate. Should large deviations from zero persist, contact the manufacturer about the possibility of serious mechanical damage.

13.1.3 Disengage the rollers and fill the pipet as in 10.2. Transfer its contents to the vibrator (oscillating) roller in a series of thin ribbons around the middle 125 mm of the roller. Wipe any specimen remaining in the pipet onto a clean place on the same roller. Reengage the rollers.

13.1.4 Distribute the specimen on the rollers and start the run as follows:

13.1.4.1 *Mechanical Models with Electronic Transmission:*

(1) Manually turn the motor coupling about ten revolutions or until the specimen appears evenly distributed among the three rollers.

(2) Set the gears at 400 r/min, start the motor and the stopwatch simultaneously, and let the ink distribute for 15 s. Stop the motor but not the stopwatch.

(3) Quickly switch the gears to the test speed (specified in Table 2) and immediately restart the motor, noting the time on the stopwatch.

13.1.4.2 *Mechanical Model MBC:*

(1) Place the fingertips against the sides of the brass roller and manually turn about ten revolutions or until the specimen appears evenly distributed among the three rollers. Do not touch the surface of the rollers.

(2) Place the speed control switch at the 150 r/min position. Simultaneously depress the power switch and start the stopwatch. Let the ink distribute for 15 s.

(3) Quickly reposition the speed control switch to the test speed, noting the time on the stopwatch.

13.1.4.3 *Electronic Models:*

(1) Place the fingertips against the sides of the brass roller and manually turn about ten revolutions or until the specimen appears evenly distributed among the three rollers. Do not touch the surface of the rollers.

(2) Depress the DRIVE button and simultaneously activate the stopwatch. Let the ink distribute for 15 s at the automatic LOW speed of 150 r/min.

(3) Quickly switch to the test speed (preset in 13.1.1) by depressing the HIGH/LOW button again, noting the time on the stopwatch.

13.1.5 After 60 s of running at the test speed, record the apparent tack of the test specimen from the balance beam (see A1.4); direct-reading attachment, or the recorder of a mechanical model or the digital readout, recorder, or printer of an electronic model.

13.1.6 After the run, stop the instrument and clean up, as directed in Section 14.

13.1.7 Make a replicate test with another specimen of the same sample by repeating 13.1.2-13.1.6. The two tests should agree within the repeatability given in 16.1.1.1.

13.2 *Geometry B:*

13.2.1 If necessary, make preparations as in Section 11, and recalibrate as in Section 12.

13.2.2 Engage the rollers and run at 50 m/min. If the dry reading is not between 10 and 15 tack units, reclean the rollers in accordance with 14.1 or, if after careful cleaning the difference is still too large, recalibrate in accordance with Section 12.

13.2.2.1 The dry reading on a properly calibrated instrument is directly related to the condition of the top (measuring) roller; therefore, large deviations from zero are suspect. Usual causes are inadequate cleaning, residual sample or wash-up solvent, or mechanical damage. Do not turn the ZERO button, as doing so will shift the scale. Do not attempt to compensate by subtracting the dry reading from the test reading. Always reclean or recalibrate. Should large deviations from zero persist, contact the manufacturer about the possibility of damage.

13.2.3 Disengage the rollers and fill the pipet as in 10.2. Transfer its contents to the distribution roller in four even ribbons of 0.1 mL around the middle 125 mm of the roller. Wipe any specimen remaining in the pipet onto a clean place on the same roller.

13.2.4 Select speed 100 m/min and place the measuring roller gently on the center roller.

13.2.5 Engage the distribution roller and start the stopwatch or timer simultaneously and let the ink distribute for 15 s.

13.2.6 Select the test speed as specified in Table 2.

13.2.7 After 60 s of running at the test speed, record the apparent tack of the test specimen from the digital readout, recorder, or computer.

13.2.8 After the run, stop the instrument and clean up, as directed in Section 14.

13.2.9 Make a replicate test with another specimen of the same sample by repeating 13.2.2-13.2.8. The two tests should agree within a repeatability of maximum five tack units.

14. Wash-up Procedure

14.1 With the tackmeter running at the lowest speed, apply a small amount of wash-up solvent to the rollers. Remove most of the specimen from the system by placing pads of the clean, soft, absorbent lint-free rags or wipers firmly against the bottom of the central roller. Repeat this procedure with additional solvent and pads until the rollers are free from ink or vehicle. If any material remains on the edges of the composition rollers, remove very gently with a solvent-moistened rag. (**Warning —**Remove material directly from the measuring or vibrator (oscillating) rollers with extreme care. Undue pressure will cause uneven wear of the rollers and may place significant strain on the sensor of some electronic models. Use extreme care to ensure that the cleaning pad does not go through the roller nip; otherwise, serious mechanical problems may result and recalibration will be essential.)

14.2 Dry the rollers thoroughly by running them in contact at high speed for a minimum of 5 min or until all of the solvent has evaporated.

14.3 Check the zero reading as in 13.1.2 or 13.2.2. Continue cleaning and drying until the dry reading reaches 0 ± 0.5 tack units (Geometry A) or 10 to 15 units at 50 m/min (Geometry B).

14.4 When the rollers are satisfactorily clean, leave the tackmeter running at the lowest speed with the rollers in contact to maintain them all at the controlled temperature.

14.5 Clean the pipet, the ink knife, and the glass plate with a solvent-wet rag.

15. Report

15.1 Report the following information:

15.1.1 Complete identification of the sample,

15.1.2 Tackmeter model used,

15.1.3 Test speed,

15.1.4 Ambient temperature,

15.1.5 Any modifications to this test method,

15.1.6 Whether significant flying or misting was observed,

15.1.7 Whether squeal was noted during the test,

15.1.8 Average apparent tack reading of two determinations, and

15.1.9 Any additional apparent tack readings determined at constant speed-constant time intervals or varying speeds-constant time intervals.

16. Precision and Bias

16.1 *Precision:*

16.1.1 An interlaboratory study[3] of this test method was conducted on Geometry A instrumentation. Seventeen laboratories tested six inks covering a range of tacks from low tack coldset black through to heatset and sheet fed inks for coated stock with high tacks. All testing was done in triplicate. Test results were analyzed in accordance with Practice E691. Based on the statistical analysis of the results, the following criteria should be used to judge unacceptability of results at the 95 % confidence level:

16.1.1.1 *Repeatability*—Two results, each the mean of duplicate determinations, obtained by the same operator, should be considered suspect if they differ by more than 0.4 tack units.

16.1.1.2 *Reproducibility*—Two results, each the mean of duplicate determinations, obtained by operators in different laboratories should be considered suspect if they differ by more than 25 % of the average.

16.2 *Bias*—Since there is no accepted reference material, bias cannot be determined.

17. Keywords

17.1 apparent tack; printing inks; splitting forces; tack; tackmeters; three-roller tackmeters; vehicles

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1158.

ANNEXES

(Mandatory Information)

A1. INFORMATION CONCERNING THREE-ROLLER TACKMETERS

A1.1 Routine Maintenance of the Tackmeter

A1.1.1 Routine maintenance is extremely important to the data integrity of the instrument; see the manufacturers' current instruction manual for the specific model.

A1.1.2 Change in shore hardness or surface glazing of the rubber may cause significant change in the apparent tack readings of the ink or vehicle. If either occurs, the rollers should be replaced.

A1.2 Breaking in the Tackmeter Rollers

A1.2.1 New tackmeter measuring and vibrator (oscillating) rollers may selectively absorb certain components of some inks and vehicles, up to a saturation point, at which point they may be said to be broken in. Until this selective absorption is complete, tack determinations made with these rollers may not be repeatable. Break in new rollers using the following procedure:

A1.2.1.1 Place the rollers on the instrument. Choose as break-in samples those representative of the system that will be evaluated on the rollers. Run approximately 1.0 to 1.5 mL of the break-in sample for extended periods of time, wash-up with the solvent to be used, reapply the sample, run, wash-up, and so forth.

NOTE A1.1—Wash-up is a significant part of the break-in process.

A1.2.1.2 Break-in time may vary from several hours to several days. Reproducible apparent tack readings on standard samples (see A1.5.1), over a period of several days, indicate that the rolls are broken in; they may then be put into routine use.

A1.2.2 A major change in ink systems may adversely affect the rollers. When a set of rollers has been used for one system, and it is to be used for another, use this same break-in procedure. The rollers may then no longer be suitable for the original system.

A1.3 Temperature Control of the Tackmeter

A1.3.1 Extremely precise temperature control of the measuring roller is essential for repeatable apparent tack readings.

A1.3.2 Use of an infrared pyrometer to monitor roller temperatures is recommended.

A1.3.3 It may be advantageous to augment the temperature control system with a cold-water cooling coil or, preferably, to use a thermostatic bath equipped with a cryostat.

A1.4 Reading the Balance-Beam of Geometry A Mechanical Tackmeters

A1.4.1 To take a reading from the balance beam of a mechanical model, disengage the beam and move the sliding weight until the beam is continuously in balance. Read the scale at the left of the sliding weight, using the scale alignment cutout to facilitate reading.

A1.4.2 Minimization of parallax is necessary for repeatable apparent tack readings. It may be useful to mount a small reflective surface on the beam stop behind the zero indicator and the balance beam. The zero indicator and the zero line on the balance beam are aligned in the reflective surface when an apparent tack reading is being taken.

A1.4.3 Reengage the balance beam immediately after taking the reading.

A1.5 Standard Test Samples

A1.5.1 It may be useful to designate one or more inks or vehicles as standards. Samples that are stable and have a good shelf life without a change in apparent tack reading are appropriate. Daily apparent tack readings on these samples ensure that the instrument is in calibration and serves as a check on repeatability.

A2. ALTERNATIVE USE OF THREE-ROLLER TACKMETERS

A2.1 Tack Stability Measurements

A2.1.1 Rather than restrict the test to a single apparent tack determination, valuable information may be gained by continuing a run and taking readings at uniform time intervals (facilitated by the use of a recorder or a software program running on a computer) until the apparent tack begins to decrease.

A2.2 Speed Step Measurements (Tack Hysteresis)

A2.2.1 The tackmeter speed may be varied stepwise and a tack reading taken after a specified time at each speed.

A2.3 Misting Measurements

A2.3.1 Place a sheet of plain paper behind the measuring roller, apply an ink film of 12 μm and set the tackmeter to its maximum speed. Stop after 5 min and determine the change in color or density of the paper due to misting.

SUMMARY OF CHANGES

Committee D01 has identified the location of selected changes to this standard since the last issue (D4631 - 09) that may impact the use of this standard. (Approved December 1, 2010.)

(1) Revision of Section 15 to reflect the results and statistical analysis of a recently conducted interlaboratory study.

Committee D01 has identified the location of selected changes to this standard since the last issue (D4631 - 97 (2002)) that may impact the use of this standard. (Approved July 1, 2009.)

(1) Additions of sections relating to particular tackmeter geometries, 1.3, Apparatus, Sampling and Test Specimen, Preparation and Conditioning of the Tackmeter, Calibration of the Tackmeter and Procedure for Tack Evaluation.
(2) Information on units of measurement have been deleted since these vary from instrument supplier to instrument supplier, Scope and 3.1.
(3) Addition of apparatus, 6.1.7.
(4) Annex information on control of temperature now includes recommendations on the use of a pyrometer to monitor roller temperatures and the use of a thermostatic bath equipped with a cryostat, A1.3.
(5) Addition of a second Annex to provide information on alternative uses of three-roller tackmeters. Some of the information in Annex 2 was previously included as optional points in the Procedure section.
(6) Summary of Changes added.