

WI _____ 060809.03 _____

T _____ 205 _____

DRAFT NO. _____ 2 _____

DATE _____ July 11, 2006 _____

TAPPI

WORKING GROUP
CHAIRMAN _____ Method reaffirmed _____

SUBJECT
CATEGORY _____ Pulp Properties _____

RELATED
METHODS _____ See "Additional Information" _____

CAUTION:

This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Forming handsheets for physical tests of pulp (Reaffirmation of T 205 sp-02)

(No comments/negatives)

1. Scope

1.1 This procedure describes a method of forming test handsheets at an oven dry weight of 60 g/m² for determining the physical properties of pulp. The procedure can be used for both unrefined and refined pulps. Appendix B describes a modified procedure for making heavier weight sheets for pulps intended for use in paperboard manufacture.

1.2 The procedures for measuring the physical properties are described in TAPPI T 220 "Physical Testing of Pulp Handsheets."

1.3 The procedure for forming handsheets for determining the optical properties of pulp is described in TAPPI T 218 "Forming Handsheets for Reflectance Tests of Pulp."

1.4 A method for measuring the drainage time and drainage factor of pulp is described in TAPPI T 221 "Drainage Time of Pulp."

2. Significance

2.1 Test results on handsheets made with this procedure are often used to describe properties of market pulps.

2.2 The results are also used to determine properties of mixtures of hardwood/softwood or of fiber species to obtain desired properties for machine made papers.

3. Apparatus¹

A complete description of, and specifications for, the apparatus used in this method is given in Appendix A.

3.1 *Standard disintegrator.*

3.2 *Standard 159-mm-diameter sheet machine with stirrer.*

NOTE 1: Sheet machines having a larger or smaller diameter do not meet the requirements of this method, and may give significantly different results.

3.3 *Standard couch roll.*

3.4 *Standard couch plate.*

3.5 *Standard press with pressure gage.*

3.6 *Press template*, for centering the sheets and plates in the press.

3.7 *Drying discs*, mirror polished, 160 mm diameter (see Note 13).

3.8 *Drying rings*, with rubber seatings for holding the sheets to the polished discs during drying.

NOTE 2: Molded drying rings made of plastic, without rubber seatings, are available and are equally satisfactory; providing they are used with a clamping system or weight to prevent sheet shrinkage during drying.

3.9 *Blotting paper*, sheets of standard blotting paper, 200 mm square, weighing 250 ± 10 g/m² (OD), 0.508 ± 0.013 mm thick, and having a minimum rate of absorbency of 25 s/1.0 mL of water when tested in accordance with TAPPI T 432 "Water Absorbency of Bibulous Paper." Minimum total absorbency shall be 500 ± 50 g/m². The wet stretch shall not exceed 2.5% in the cross direction. The blotters shall be white, produced from fully bleached chemical pulp free of any additives. They shall be flat, uniform, and free of wrinkles and dirt.

NOTE 3: If the expansion when wetted is more than that specified, the central area of the couch blotter will expand while its dry edges will not. Wrinkles are then produced in the test sheet when it and the couch blotter are flattened in the press.

3.10 *Cup*, preferably wide-mouthed, made of plastic, glass, or stainless steel.

¹Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list in the set of TAPPI Test Methods, or may be available from the TAPPI Quality and Standards Department.

3.11 *Bucket*, having a capacity of at least 8 L made of stainless steel, plastic, or other smooth non-corroding material.

3.12 *Graduated cylinder*, 500 or 1000 mL.

NOTE 4: Semi-automated sheet machines are available which reduce some of the manual steps required by this method. These are acceptable so long as the equipment and procedural steps comply in all other regards with the requirements of this method. If air agitation is used, it must be oil-free instrument quality air.

4. Sampling

Obtain a representative sample of the pulp weighing at least 24 g (OD). Make up the sample by taking smaller samples from several bales, by sampling several times from a beater, etc.

5. Storage of pulp samples

Store dry pulp samples away from heat and light. Moist samples should be protected to prevent evaporation during storage, and kept in a cool place away from intense light.

NOTE 5: If prolonged storage is required, use of a preservative such as cupric sulfate (crystal), at a level of 0.1 to 0.5 ppm based on dry pulp weight, will permit storage at 9°C for at least 18 months without changes in freeness, strength, and optical properties. The use of formaldehyde, glutaraldehyde, or similar preservatives is discouraged because of their potential carcinogenicity.

6. Test specimen

Determine either the moisture content of dry pulp or the consistency of wet pulps to obtain a specimen of 24 ± 0.5 g of moisture-free fiber. If the pulp is dry, wet in cold distilled or deionized water and then tear into pieces about 30 mm square. Do not cut the pulp or use cut edges. Soak the pulp at least 4 hr., or in the case of flash-dried mechanical pulp at least 24 hr.

NOTE 6: As far as is known, soaking any pulp for periods longer than specified does not appreciably affect the result.

7.1 *Disintegration.*

7.1.1 Dilute the specimen to 2000 mL (1.2% consistency) with distilled or deionized water at $20 \pm 2^\circ\text{C}$. Disintegrate in the standard disintegrator at 3000 rpm until all fiber bundles are dispersed, but not more than 50,000 revolutions. Include in the report the number of revolutions used. If more than 50,000 revolutions are used, or if the pulp is not satisfactorily dispersed after 50,000 revolutions, note this in the report.

NOTE 7: Disintegration periods as small as 15,000 revolutions will adequately disperse many pulps, especially those furnished in a wet state. Adequate dispersion of the pulp can be checked by diluting a small sample in a glass cylinder and inspecting under transmitted light.

7.1.2 After disintegration, if a freeness measurement is needed, remove 250 mL of stock for this purpose, and then dilute the remaining 1750 mL to 7.0 L (0.3% consistency). If a freeness measurement is not needed, dilute the 2000 mL of stock to 8.0 L (0.3% consistency).

7.1.3 Stir the stock well to ensure proper mixing. Using the graduated cylinders, measure out 400 mL of stock for each handsheet to be formed.

NOTE 8: The accuracy of final sheet weights can usually be improved by first forming a “consistency” sheet, measuring its dry weight, and then calculating the exact volume needed for a 1.2 g (OD) sheet. Handsheets are required to each weigh between 1.14 and 1.26 g moisture-free. Unless a “consistency” sheet is made, it may not be possible to maintain the required sheet-weight accuracy because of fines loss through the forming wire (especially with low freeness mechanical pulp).

NOTE 9: For some long fibered pulps the required sheet-weight accuracy may not be achievable unless the consistency of the stock is reduced below that specified. For those pulps, consistencies as low as 0.15% are recommended. Reducing the consistency of the stock will not affect the properties of the test sheets.

7.2 *Sheetmaking.*

7.2.1 With the sheet machine open, turn on the water and gently rub the surface of the wire with the fingers to clear away any adhering fibers. Close the machine and half fill it with water. Pour the amount of stock needed for one sheet into the sheet machine. Add water until the depth is about 350 mm above the surface of the forming wire. (A line is usually inscribed around the inside of the cylinder at this level).

NOTE 10: Cleanliness of the sheet machine wire is important. Occasional purging with a high pressure water jet or steam, or treatment in an ultrasound bath, is recommended. Washing with dilute acid is recommended only for stainless steel wires. Additional information on wire cleanliness can be found in TAPPI T 221 “Drainage Time of Pulp.”

7.2.2 Insert the perforated stirrer and in 6 ± 1 s move it down and up five times, keeping the perforated disc beneath the level of the liquid. Make a sixth double movement slowly in 6 ± 1 s, and at the end of the up stroke gently withdraw the stirrer. Do not rotate the stirrer during this part of the procedure.

7.2.3 After a pause of 5 ± 1 s, during which time the surface of the liquid should become almost motionless, fully open the drain of the machine with a rapid movement and let the water drain through the sheet under suction from the water leg.

NOTE 11: The formation of the test sheet may be adversely affected if all entrapped air has not escaped during the 5 s pause. For such pulps, use a longer pause time and Note the time used in the report.

7.2.4 Open the sheet machine.

7.3 *Couching.*

7.3.1 Place two pieces of standard blotting paper centrally on the drained sheet with the felt, smoother, side of the lower blotter against the wet sheet. Lay the flat couch plate centrally on the blotters and place the couch roll gently on the middle of the plate. Rotate the roll backward and then forward five times in 10 ± 2 s, with no pressure being applied except from the weight of the roll. The roll should come within less than 5 mm of the edge of the plate each time. After the fifth forward rotation, rotate it back to the middle and lift it off.

7.3.2 Remove the couch plate and set it aside. Lift the blotters in a manner similar to that of opening the cover of a book. The sheet should be found to adhere to the underside of the lower couch blotter. Discard the second blotter. Use an indelible pencil to identify the test sheet if desired.

NOTE 12: Some test sheets will not adhere to the blotter when couched as described above. In these cases, a second couching, with new blotters may be necessary. Any such changes should be noted in the report.

7.3.3 Set the first test sheet aside and make additional sheets as needed. These additional sheets should be made in a short enough period of time so that no appreciable drying of the first sheets occurs.

7.4 *Pressing.*

7.4.1 Place the couch blotter, handsheet side up, on a dry blotter and centrally locate it on the press using the press template. Cover the handsheet with a polished plate, polished side down. Repeat this process so that all sheets from a given pulp are stacked together in the press. Finally lay a single blotter on the uppermost plate.

NOTE 13: Some pulps will bond to the polished plates, making it difficult to later remove the test sheet without damage. For these pulps, use a dull finished plate and Note such use in the report. Plates are available with one mirror finish and one dull finish side.

7.4.2 Place the cover of the press in position and screw the wing nuts hand tight. During a period of 30 s, slowly raise the pressure to 345 kPa (50 psig). Maintain this pressure for an additional 5 min. Release the pressure and remove the press cover.

NOTE 14: Do not press more than 15, and preferably not more than 10, sheets at one time.

7.4.3 Remove the stack from the press. The test sheets should now be adhered to the polished plates so that the blotters can be gently peeled away and discarded. Place a dry blotter on the press. Using the press template as a guide center each plate, with the test sheet facing up, in the press. Place a dry blotter on top of each test sheet.

7.4.4 Place the cover of the press in position, raise the pressure to 345 kPa (50 psig), maintain the pressure for two min., and then release it. Remove the stack from the press.

NOTE 15: Automatic pressing equipment which complies with the requirements of this method is available from distributors of standard sheetmaking equipment. Because of consistency of operation and reduction of human error, this equipment is preferred over manually operated presses.

7.5 *Drying.*

7.5.1 Discard the press blotter from each test sheet. Fit each plate with its attached test sheet into a drying ring, assembled so that each test sheet is uppermost and in contact with the rubber seat of the next ring above it. Place a heavy weight (about 25 lbs. is suitable) on top of the stack of rings, or clamp them together with a suitable clamping system.

7.5.2 A requirement of this procedure is that the sheets be dried from the wet state to equilibrium in a 50% RH, 23°C atmosphere, and then tested in that atmosphere. Hence, the test sheets should be moved to the conditioning atmosphere before any appreciable drying has occurred.

7.5.3 Allow the sheets to become fully dried in position in the rings before removing them. An overnight drying period is recommended. Remove the plates from the drying rings and gently peel the test sheets from the plates.

NOTE 16: An alternative rapid method of drying is discussed in Appendix C. Use of this procedure must be noted in reporting the results of tests made on sheets so dried.

7.6 *Testing of sheets.* Unless the sheets are to be tested immediately after removal from the drying rings, protect them from direct lighting, especially if any optical properties are to be measured. Sheets made from groundwood pulps should be tested within 24 hr of sheetmaking. Test all sheets using the procedures described in TAPPI T 220.

8. **Keywords**

Handsheets, Pulp tests, Pulp properties.

9. **Additional information**

10.1 Effective date of issue: to be assigned.

10.2 This method was first published in 1932 as a Tentative Standard and became an Official Method in 1938. It was corrected in 1940, 1945, 1950, 1953, and 1958; it was revised in 1936, 1942, 1971, and 1988.

10.3 Related methods: AS/NZS 1301.203S:1993 “Forming Handsheets for Physical Testing of Pulp;” PAPTAC C 4 “Forming Handsheets for Physical Tests of Pulp,” Pulp and Paper Technical Association of Canada, Montreal, Canada; SCAN C 26, “Forming Sheets for Testing Physical Properties of Pulp,” Scandinavian Pulp, Paper, and Board Testing Committee, Stockholm, Sweden; VzuPCI 108, Zellcheming, Germany, ISO 5269/1.

Appendix A: **Specification and care of apparatus**

A.1 *Disintegrator.*

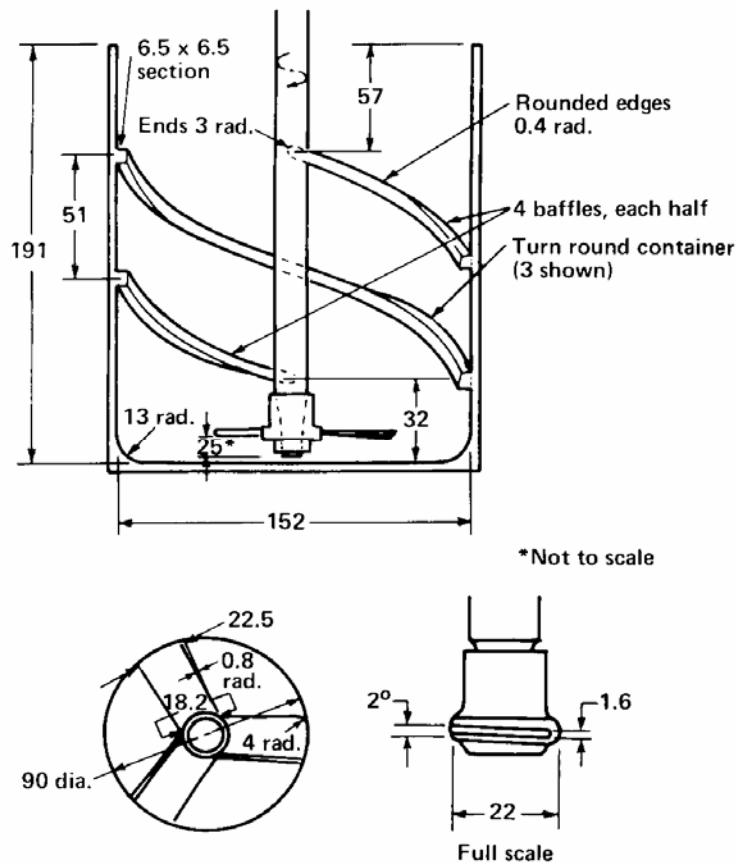


Fig. 1. Standard pulp disintegrator.

A.1.1 The disintegrator (Fig. 1) consists of a removable cylindrical container fitted with four equally spaced spiral baffles extending between 33 mm from the bottom and 57 mm from the lip, each baffle traversing half the internal circumference of the container. The baffles spiral downwards in a clockwise direction. There is a fillet having a radius of 13 mm around the inside base of the container.

A.1.2 The three-bladed propeller is mounted on a vertical shaft centrally in the container and a fixed distance above the bottom. It should be driven at the specified speed and a counter shall be mounted to record the time or the number of revolutions. The counter should preferably be of the preset type, which will shut off the disintegrator.

A.1.3 Specifications and tolerances for the standard disintegrator appear in Table 1.

A.2 *Sheet machine.*

A.2.1 The complete sheet machine is shown in Fig. 2. The main parts of the machine consist of a base, B, connected by a drainage pipe, P, and cock, G, to the sump; a wire-covered grid plate, C, on which the sheet is formed and which rests in the top of the base; and a cylindrical deckle, A, which is provided with a hinge and which fits over the plate and the base.

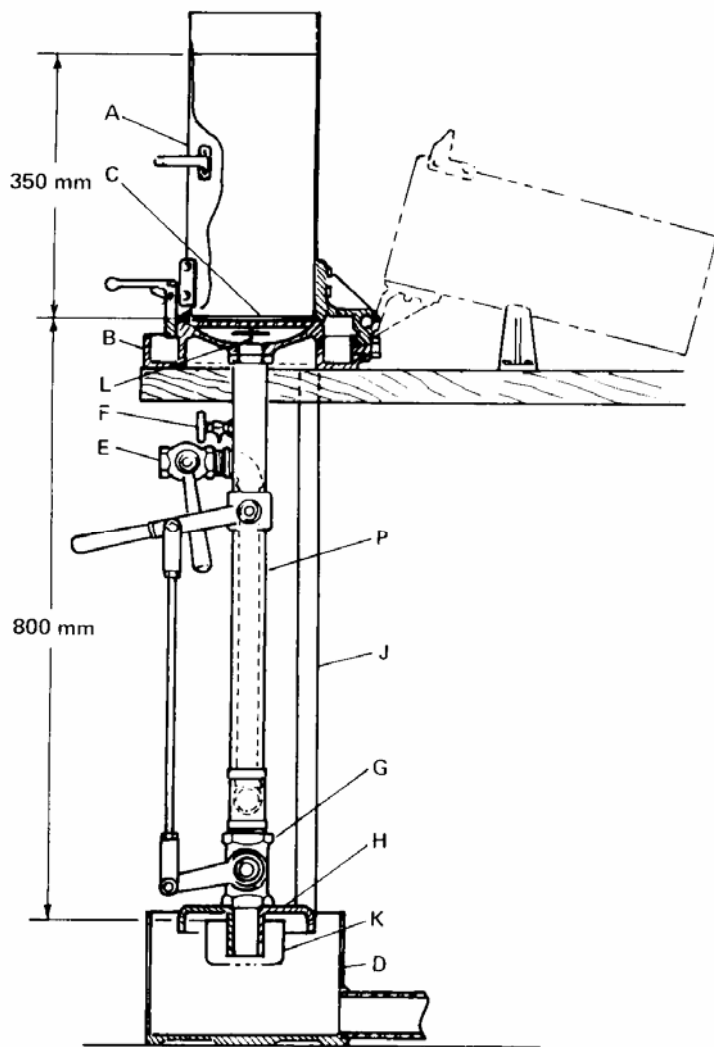


Fig. 2. Sheet machine.

A.2.2 The outer trough for overflow water is connected to the sump by means of two brass or PVC drain pipes, J. Around the top of the funnel of the base is a machined recess on which the grid plate rests.

A.2.3 The inside of the funnel is carefully machined, and a removable, four-fin baffle, L, made up of 1.6-mm brass sheet, rests in it. The function of the baffle is to prevent any possible swirling. A horizontal disc is fitted in the baffle over the drainage pipe to distribute the suction uniformly over the grid plate.

A.2.4 The grid plate consists of a cylindrical plate with square hole perforations, a backing wire and a surface or forming wire on which the wet sheet is deposited during drainage. An outer ring clamp stretches and holds the forming wire securely in place.

A.2.5 The top hinged part, A, of the apparatus is a cylinder which is stepped out at the bottom to fit over the base of the machine and carries a soft rubber gasket ring, which makes contact around the edge of the grid plate. The cylindrical deckle is at least 400 mm high with an inside diameter of 158.8 ± 0.1 mm. A groove (line) is inscribed on the

inside surface of the deckle 349.3 ± 0.5 mm from the surface of the grid plate. This groove indicates a volume of 7 liters of water. The cylinder is provided with a hinge and clamp so that, when closed, water-tight joints are made between the cylinder, the upper edge of the top face of the plate, and upper edge of the base. The drainage valve, G, is operated by a lever mechanism as shown in Fig. 2.

A.2.6 The sump consists of a large cylinder, D, with an outlet hole on either side as shown or, if required, in the center of the bottom. Three lugs are provided for screwing the sump to the floor. A crossbar, H, carries a circular baffle to prevent splashing. An overflow vessel, K, is bolted with spacers to the underside of the bar. The distance from the surface of this vessel to the top of the wire is adjusted to exactly 800 mm. This is the suction head on the wire. The drainage pipe is connected through a T and elbows to the water supply valve, E.

A.2.7 The drainage time of the sheet machine, when filled with water at 20°C to the inscribed line, shall be 3.6 ± 0.1 s. The time is measured from the moment the drainage valve is released until the water level passes the surface of the grid plate screen.

A.2.8 Dimensions and tolerances for the standard sheet machine are shown in Table 2.

NOTE 17: Owing to the accuracy required in the construction and dimensions of the sheet machine and grid plates, it is advisable to use a machine approved by and bearing the official serial number of the British Paper and Board Makers Association, Inc., or the Pulp and Paper Research Institute of Canada. Approved machines are now being manufactured in several countries.

Table 1. Dimensions and tolerances for standard pulp disintegrator.

Part		Dimension, mm	Tolerance, mm
Container	Internal height	191	± 2
	Internal diameter	152	± 2
	Radius of fillet	13	To fit gauge
Baffles	Square section	6.5	± 1.0
	Height from container base	32	± 1
	Distance from rim	57	± 1
	Ends radiused	3	To fit gauge
	Spacing (centres)	51	± 1
Propeller ^a	Diameter	90.0	± 0.3
	Diameter of hub	22.0	± 0.3
	Separation - blades/ container base	25	± 2
Propeller blades	Width at hub	18.2	± 0.3

Maximum width	22.5	± 0.3
Thickness	1.6	± 0.3
Edges radiused	0.8	To fit gauge
Ends radiused	4	To fit gauge
Pitch	2 ^a	To fit gauge

Propeller

shaft	End taper	To fit any
	propeller hub	
	Revolutions per min.	3000 \pm 50

^aA propeller gauge is furnished upon request with the disintegrator and is used to check the blade for possible damage.

A.3 Press.

A.3.1 A side elevation of the press is shown in Fig. 3. The cover, A, is cast aluminum so it can be easily lifted, and the base, B, is of close-grained cast iron. A hard brass disk, C, 175-mm diameter, is embedded in the underside of the cover. The cover is provided with a handle and is held down by means of four 25-mm-diameter phosphorbronze studs and chromium-plated hard brass nuts. The base is recessed to contain a heavy rubber diaphragm, D, held down around the edges by a brass ring with brass counter-sunk screws. A flat platen, E, 175-mm diameter, is loosely fitted inside the ring to rest on the diaphragm, and the platen is prevented from coming out by four lugs, F, which work in four shaped slots around its edge. The upper and lower surfaces of the brass plates that come together in the press are carefully machined flat.

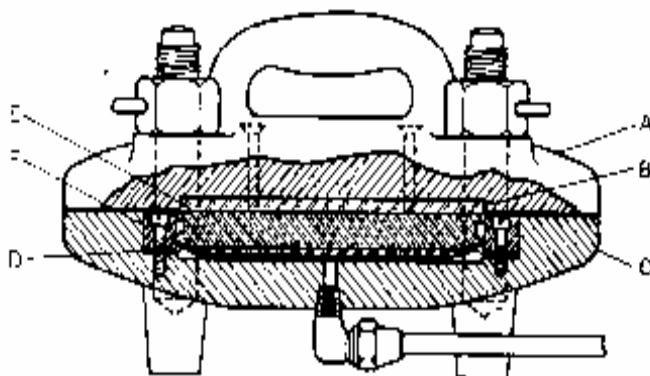


Fig. 3. Press.

NOTE 18: From the construction of the press it will be noticed that the platen is free to float on the rubber diaphragm. This ensures that an even pressure is applied over the entire surface of the pile of sheets and blotters and in this respect is superior to plunger-type presses. The press should never be used for pressing objects smaller than the drying discs since the platen E is liable to bend around the object pressed. If the platen is raised more than 9.5 mm, it will damage the lugs. When the gauge reads 345.0 kPa (50.0 psi), the pressure on the handsheets is about 414 kPa (60 psi).

Table 2. Dimensions and tolerances for standard sheet machine.

<i>Grid plate C</i>		
Disc	173 - mm diameter	± 0.01 mm
	9.4 - mm thick mat	± 0.1 mm
Grating holes	9.7 x 9.7 mm	± 0.1 mm
	on 12.3 - mm center	± 0.1 mm
Grid bars	3.2 - mm thick	± 0.1 mm
	Top tapered and beveled	
	0.8 - mm thick	± 0.01 mm
Backing wire	8/cm; wire 0.381 - 0.396	
	mm diameter	± 0.01 mm
Surface wire	60/cm; wire 0.067 - 0.071	
	mm diameter	± 0.01 mm
<i>Cylinder deckle A</i>		
	4.7 - mm thick; 400 - mm high;	
	158.8 - mm I.D. with inside	
	groove 349.3 mm from	
	surface of wire	± 0.01 mm
<i>Perforated stirrer</i>		
	155 - mm diameter with sixty	
	11 - mm diameter holes;	
	Baffles 0.8 - mm thick by	
	70 mm wide, 152 mm deep	± 0.1 mm
<i>Couch plate</i>		
	Hard sheet brass or 316	
	stainless steel 171 - mm	
	diameter by 0.79 mm thick	± 0.1 mm
<i>Couch roll</i>		
	Brass 102 mm diameter	± 0.1 mm
	178 - mm face, mass 13.0 kg	± 50 g

A.3.2 Present-day installations have the press activated by compressed air supplied through a pressure regulator and activated by a timing mechanism. For some research purposes, the original manual glycerin pump may be more versatile, especially for pressures higher than normal, and so may be preferred. A description of this equipment may be found in earlier revisions of this method and may be obtainable as a photocopy from the TAPPI Information Resources Center.

A.4 *Press template.* The press template for centering the sheets (not shown) is of 3.2 mm thick aluminum plate. The guide slots fit over any two adjacent studs in the press, and when in position the 158-mm diameter semicircle which is cut in it, is concentric with the platens of the press.

A.5 *Drying plates.* The mirror-polished stainless steel or chromium-plated brass plates (not shown) are 158-mm diameter and about 0.8 mm thick. They should be free from bulges or uneven edges, and if any are damaged in this way and are not capable of being repaired, they should be discarded. When not in use, they should be kept in a saw-slotted wooden block, made to hold them separate and stacked vertically in a horizontal row.

A.6 *Drying rings.* The drying rings (not shown) are made of plastic material or of hard brass and arranged to fit into each other to clamp each polished plate and test sheet around the edges. The circumference of the sheet is gripped by the rubber seat in the brass rings and the plate pressed against this by the extended portion of the ring below. The air for drying circulates through 12 holes of 19 mm diameter, drilled or molded in the periphery of each ring.

Appendix B. Board stock

B.1 Pulp suitable for paperboard manufacture is, as a rule, relatively weak and relatively free, and often contains quantities of shives; consequently, it is suggested to use a weight per unit area of 150 g/m² as a standard weight for testing this class of stock, employing 1000 mL of stock at 0.3% consistency for each sheet.

B.2 Two pieces of blotter are employed for couching, as for normal lightweight sheets, but two dry blotters are used in place of the single blotter normally required in both first and second pressings, the rest of the procedure for disintegrating and testing remaining the same as for papermaking stock. The making of structural boards is described in TAPPI T 1001 "Forming Insulating Boards for Physical Tests."

Appendix C. Rapid methods of drying and conditioning

C.1 A rapid method of drying and conditioning the sheets, which shortens the time required to 2 to 4 hr while still conforming to the standard procedure, has been developed by the Pulp and Paper Research Institute of Canada. The apparatus consists of a closed box provided with one or more 153-mm (6-in.) wide vertical slots in its sides, inside and against which the drying rings are stacked. An electric fan *exhausts* air from the box through a suitable opening, the air passing in through the holes in the drying rings and over the sheets. The whole apparatus is kept in the constant-humidity room.

NOTE 19: If a fan is used to *blow* air into the box, the fan motor will become heated and, being in the path of the air, may cause the relative humidity of the air passing over the sheets to be appreciably lower than that of the air in the room.

C.2 Alternatively, for rapidly drying the sheets in a constant-humidity room, it is sometimes more convenient to lead part of the conditioned air being circulated or exhausted through a slotted duct in one of the walls or in a corner of the room, the duct having slides and clamps to hold the rings. The conditioned air is thus drawn through the rings and over the sheets and dries and conditions them effectively. This obviates the need for an additional fan.

Appendix D. Sheet shrinkage

The shrinkage during drying may be determined (with an accuracy of about 0.5 mm) as follows: After pressing, make two marks on the sheet 150 mm apart, preferably with a gauge made from two chisel-pointed pins set in a suitable metal holder, after inking the points with a moistened, indelible pencil. Pull the sheet off the plate in a direction perpendicular to the marks, then allow to dry without restraint and measure the shrinkage between the marks. This shrinkage, expressed as a percentage, is a useful indication of the degree of hydration of the pulp. Some prefer to mark the sheets with two marks at right angles and calculate the shrinkage in area as a guide.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Director of Quality and Standards. ■

WI _____ 060809.03 _____

T _____ 205 _____

DRAFT NO. _____ 1 _____

DATE _____ June 9, 2006 _____

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CHAIRMAN _____ to be assigned _____

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TAPPI

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NOTE 4: Semi-automated sheet machines are available which reduce some of the manual steps required by this method. These are acceptable so long as the equipment and procedural steps comply in all other regards with the requirements of this method. If air agitation is used, it must be oil-free instrument quality air.

4. Sampling

Obtain a representative sample of the pulp weighing at least 24 g (OD). Make up the sample by taking smaller samples from several bales, by sampling several times from a beater, etc.

5. Storage of pulp samples

Store dry pulp samples away from heat and light. Moist samples should be protected to prevent evaporation during storage, and kept in a cool place away from intense light.

NOTE 5: If prolonged storage is required, use of a preservative such as cupric sulfate (crystal), at a level of 0.1 to 0.5 ppm based on dry pulp weight, will permit storage at 9°C for at least 18 months without changes in freeness, strength, and optical properties. The use of formaldehyde, glutaraldehyde, or similar preservatives is discouraged because of their potential carcinogenicity.

6. Test specimen

Determine either the moisture content of dry pulp or the consistency of wet pulps to obtain a specimen of 24 ± 0.5 g of moisture-free fiber. If the pulp is dry, wet in cold distilled or deionized water and then tear into pieces about 30 mm square. Do not cut the pulp or use cut edges. Soak the pulp at least 4 hr., or in the case of flash-dried mechanical pulp at least 24 hr.

NOTE 6: As far as is known, soaking any pulp for periods longer than specified does not appreciably affect the result.

7.1 *Disintegration.*

7.1.1 Dilute the specimen to 2000 mL (1.2% consistency) with distilled or deionized water at $20 \pm 2^\circ\text{C}$. Disintegrate in the standard disintegrator at 3000 rpm until all fiber bundles are dispersed, but not more than 50,000 revolutions. Include in the report the number of revolutions used. If more than 50,000 revolutions are used, or if the pulp is not satisfactorily dispersed after 50,000 revolutions, note this in the report.

NOTE 7: Disintegration periods as small as 15,000 revolutions will adequately disperse many pulps, especially those furnished in a wet state. Adequate dispersion of the pulp can be checked by diluting a small sample in a glass cylinder and inspecting under transmitted light.

7.1.2 After disintegration, if a freeness measurement is needed, remove 250 mL of stock for this purpose, and then dilute the remaining 1750 mL to 7.0 L (0.3% consistency). If a freeness measurement is not needed, dilute the 2000 mL of stock to 8.0 L (0.3% consistency).

7.1.3 Stir the stock well to ensure proper mixing. Using the graduated cylinders, measure out 400 mL of stock for each handsheet to be formed.

NOTE 8: The accuracy of final sheet weights can usually be improved by first forming a “consistency” sheet, measuring its dry weight, and then calculating the exact volume needed for a 1.2 g (OD) sheet. Handsheets are required to each weigh between 1.14 and 1.26 g moisture-free. Unless a “consistency” sheet is made, it may not be possible to maintain the required sheet-weight accuracy because of fines loss through the forming wire (especially with low freeness mechanical pulp).

NOTE 9: For some long fibered pulps the required sheet-weight accuracy may not be achievable unless the consistency of the stock is reduced below that specified. For those pulps, consistencies as low as 0.15% are recommended. Reducing the consistency of the stock will not affect the properties of the test sheets.

7.2 *Sheetmaking.*

7.2.1 With the sheet machine open, turn on the water and gently rub the surface of the wire with the fingers to clear away any adhering fibers. Close the machine and half fill it with water. Pour the amount of stock needed for one sheet into the sheet machine. Add water until the depth is about 350 mm above the surface of the forming wire. (A line is usually inscribed around the inside of the cylinder at this level).

NOTE 10: Cleanliness of the sheet machine wire is important. Occasional purging with a high pressure water jet or steam, or treatment in an ultrasound bath, is recommended. Washing with dilute acid is recommended only for stainless steel wires. Additional information on wire cleanliness can be found in TAPPI T 221 “Drainage Time of Pulp.”

7.2.2 Insert the perforated stirrer and in 6 ± 1 s move it down and up five times, keeping the perforated disc beneath the level of the liquid. Make a sixth double movement slowly in 6 ± 1 s, and at the end of the up stroke gently withdraw the stirrer. Do not rotate the stirrer during this part of the procedure.

7.2.3 After a pause of 5 ± 1 s, during which time the surface of the liquid should become almost motionless, fully open the drain of the machine with a rapid movement and let the water drain through the sheet under suction from the water leg.

NOTE 11: The formation of the test sheet may be adversely affected if all entrapped air has not escaped during the 5 s pause. For such pulps, use a longer pause time and Note the time used in the report.

7.2.4 Open the sheet machine.

7.3 *Couching.*

7.3.1 Place two pieces of standard blotting paper centrally on the drained sheet with the felt, smoother, side of the lower blotter against the wet sheet. Lay the flat couch plate centrally on the blotters and place the couch roll gently on the middle of the plate. Rotate the roll backward and then forward five times in 10 ± 2 s, with no pressure being applied except from the weight of the roll. The roll should come within less than 5 mm of the edge of the plate each time. After the fifth forward rotation, rotate it back to the middle and lift it off.

7.3.2 Remove the couch plate and set it aside. Lift the blotters in a manner similar to that of opening the cover of a book. The sheet should be found to adhere to the underside of the lower couch blotter. Discard the second blotter. Use an indelible pencil to identify the test sheet if desired.

NOTE 12: Some test sheets will not adhere to the blotter when couched as described above. In these cases, a second couching, with new blotters may be necessary. Any such changes should be noted in the report.

7.3.3 Set the first test sheet aside and make additional sheets as needed. These additional sheets should be made in a short enough period of time so that no appreciable drying of the first sheets occurs.

7.4 *Pressing.*

7.4.1 Place the couch blotter, handsheet side up, on a dry blotter and centrally locate it on the press using the press template. Cover the handsheet with a polished plate, polished side down. Repeat this process so that all sheets from a given pulp are stacked together in the press. Finally lay a single blotter on the uppermost plate.

NOTE 13: Some pulps will bond to the polished plates, making it difficult to later remove the test sheet without damage. For these pulps, use a dull finished plate and Note such use in the report. Plates are available with one mirror finish and one dull finish side.

7.4.2 Place the cover of the press in position and screw the wing nuts hand tight. During a period of 30 s, slowly raise the pressure to 345 kPa (50 psig). Maintain this pressure for an additional 5 min. Release the pressure and remove the press cover.

NOTE 14: Do not press more than 15, and preferably not more than 10, sheets at one time.

7.4.3 Remove the stack from the press. The test sheets should now be adhered to the polished plates so that the blotters can be gently peeled away and discarded. Place a dry blotter on the press. Using the press template as a guide center each plate, with the test sheet facing up, in the press. Place a dry blotter on top of each test sheet.

7.4.4 Place the cover of the press in position, raise the pressure to 345 kPa (50 psig), maintain the pressure for two min., and then release it. Remove the stack from the press.

NOTE 15: Automatic pressing equipment which complies with the requirements of this method is available from distributors of standard sheetmaking equipment. Because of consistency of operation and reduction of human error, this equipment is preferred over manually operated presses.

7.5 *Drying.*

7.5.1 Discard the press blotter from each test sheet. Fit each plate with its attached test sheet into a drying ring, assembled so that each test sheet is uppermost and in contact with the rubber seat of the next ring above it. Place a heavy weight (about 25 lbs. is suitable) on top of the stack of rings, or clamp them together with a suitable clamping system.

7.5.2 A requirement of this procedure is that the sheets be dried from the wet state to equilibrium in a 50% RH, 23°C atmosphere, and then tested in that atmosphere. Hence, the test sheets should be moved to the conditioning atmosphere before any appreciable drying has occurred.

7.5.3 Allow the sheets to become fully dried in position in the rings before removing them. An overnight drying period is recommended. Remove the plates from the drying rings and gently peel the test sheets from the plates.

NOTE 16: An alternative rapid method of drying is discussed in Appendix C. Use of this procedure must be noted in reporting the results of tests made on sheets so dried.

7.6 *Testing of sheets.* Unless the sheets are to be tested immediately after removal from the drying rings, protect them from direct lighting, especially if any optical properties are to be measured. Sheets made from groundwood pulps should be tested within 24 hr of sheetmaking. Test all sheets using the procedures described in TAPPI T 220.

8. **Keywords**

Handsheets, Pulp tests, Pulp properties.

9. **Additional information**

10.1 Effective date of issue: to be assigned.

10.2 This method was first published in 1932 as a Tentative Standard and became an Official Method in 1938. It was corrected in 1940, 1945, 1950, 1953, and 1958; it was revised in 1936, 1942, 1971, and 1988.

10.3 Related methods: AS/NZS 1301.203S:1993 "Forming Handsheets for Physical Testing of Pulp;" PAPTAC C 4 "Forming Handsheets for Physical Tests of Pulp," Pulp and Paper Technical Association of Canada, Montreal, Canada; SCAN C 26, "Forming Sheets for Testing Physical Properties of Pulp," Scandinavian Pulp, Paper, and Board Testing Committee, Stockholm, Sweden; VzuPCI 108, Zellcheming, Germany, ISO 5269/1.

Appendix A: **Specification and care of apparatus**

A.1 *Disintegrator.*

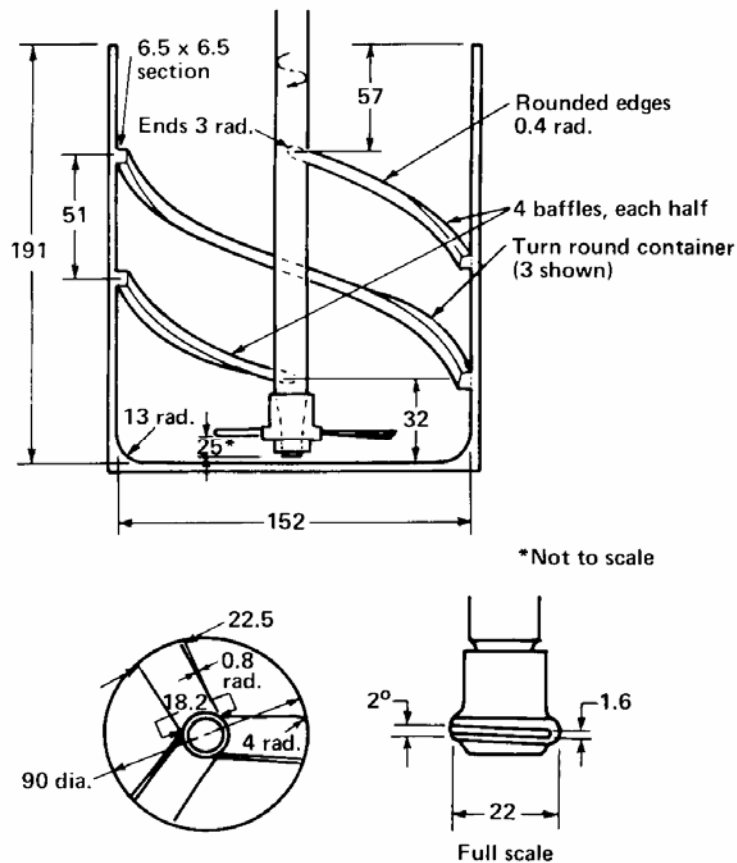


Fig. 1. Standard pulp disintegrator.

A.1.1 The disintegrator (Fig. 1) consists of a removable cylindrical container fitted with four equally spaced spiral baffles extending between 33 mm from the bottom and 57 mm from the lip, each baffle traversing half the internal circumference of the container. The baffles spiral downwards in a clockwise direction. There is a fillet having a radius of 13 mm around the inside base of the container.

A.1.2 The three-bladed propeller is mounted on a vertical shaft centrally in the container and a fixed distance above the bottom. It should be driven at the specified speed and a counter shall be mounted to record the time or the number of revolutions. The counter should preferably be of the preset type, which will shut off the disintegrator.

A.1.3 Specifications and tolerances for the standard disintegrator appear in Table 1.

A.2 *Sheet machine.*

A.2.1 The complete sheet machine is shown in Fig. 2. The main parts of the machine consist of a base, B, connected by a drainage pipe, P, and cock, G, to the sump; a wire-covered grid plate, C, on which the sheet is formed and which rests in the top of the base; and a cylindrical deckle, A, which is provided with a hinge and which fits over the plate and the base.

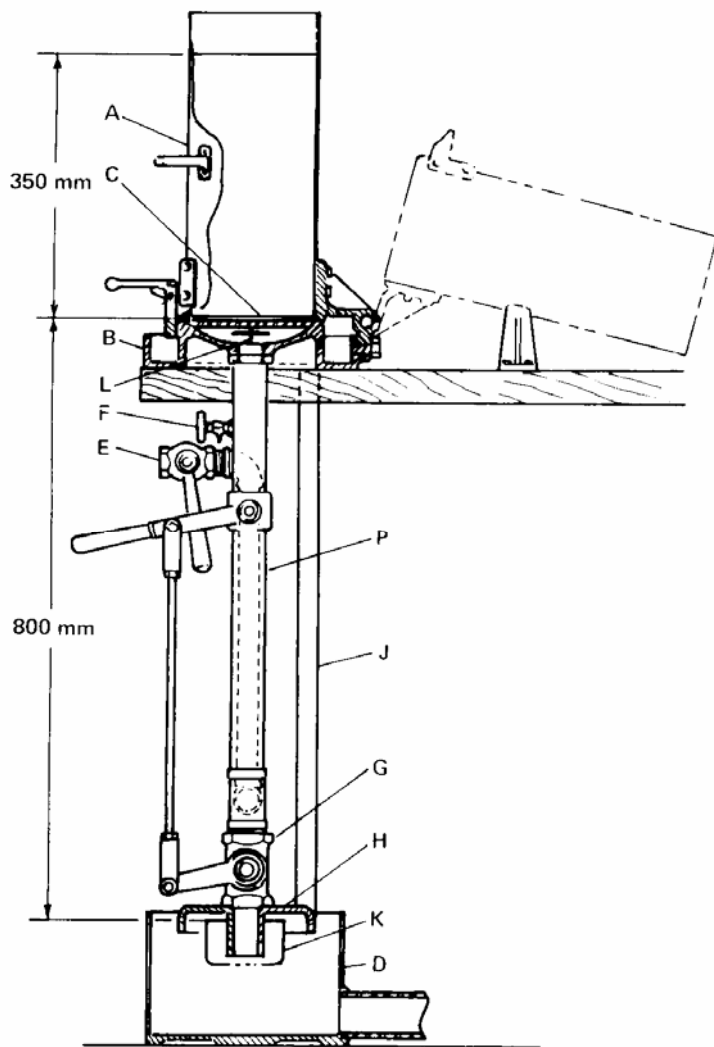


Fig. 2. Sheet machine.

A.2.2 The outer trough for overflow water is connected to the sump by means of two brass or PVC drain pipes, J. Around the top of the funnel of the base is a machined recess on which the grid plate rests.

A.2.3 The inside of the funnel is carefully machined, and a removable, four-fin baffle, L, made up of 1.6-mm brass sheet, rests in it. The function of the baffle is to prevent any possible swirling. A horizontal disc is fitted in the baffle over the drainage pipe to distribute the suction uniformly over the grid plate.

A.2.4 The grid plate consists of a cylindrical plate with square hole perforations, a backing wire and a surface or forming wire on which the wet sheet is deposited during drainage. An outer ring clamp stretches and holds the forming wire securely in place.

A.2.5 The top hinged part, A, of the apparatus is a cylinder which is stepped out at the bottom to fit over the base of the machine and carries a soft rubber gasket ring, which makes contact around the edge of the grid plate. The cylindrical deckle is at least 400 mm high with an inside diameter of 158.8 ± 0.1 mm. A groove (line) is inscribed on the

inside surface of the deckle 349.3 ± 0.5 mm from the surface of the grid plate. This groove indicates a volume of 7 liters of water. The cylinder is provided with a hinge and clamp so that, when closed, water-tight joints are made between the cylinder, the upper edge of the top face of the plate, and upper edge of the base. The drainage valve, G, is operated by a lever mechanism as shown in Fig. 2.

A.2.6 The sump consists of a large cylinder, D, with an outlet hole on either side as shown or, if required, in the center of the bottom. Three lugs are provided for screwing the sump to the floor. A crossbar, H, carries a circular baffle to prevent splashing. An overflow vessel, K, is bolted with spacers to the underside of the bar. The distance from the surface of this vessel to the top of the wire is adjusted to exactly 800 mm. This is the suction head on the wire. The drainage pipe is connected through a T and elbows to the water supply valve, E.

A.2.7 The drainage time of the sheet machine, when filled with water at 20°C to the inscribed line, shall be 3.6 ± 0.1 s. The time is measured from the moment the drainage valve is released until the water level passes the surface of the grid plate screen.

A.2.8 Dimensions and tolerances for the standard sheet machine are shown in Table 2.

NOTE 17: Owing to the accuracy required in the construction and dimensions of the sheet machine and grid plates, it is advisable to use a machine approved by and bearing the official serial number of the British Paper and Board Makers Association, Inc., or the Pulp and Paper Research Institute of Canada. Approved machines are now being manufactured in several countries.

Table 1. Dimensions and tolerances for standard pulp disintegrator.

Part		Dimension, mm	Tolerance, mm
Container	Internal height	191	± 2
	Internal diameter	152	± 2
	Radius of fillet	13	To fit gauge
Baffles	Square section	6.5	± 1.0
	Height from container base	32	± 1
	Distance from rim	57	± 1
	Ends radiused	3	To fit gauge
	Spacing (centres)	51	± 1
Propeller ^a	Diameter	90.0	± 0.3
	Diameter of hub	22.0	± 0.3
	Separation - blades/ container base	25	± 2
Propeller blades	Width at hub	18.2	± 0.3

Maximum width	22.5	± 0.3
Thickness	1.6	± 0.3
Edges radiused	0.8	To fit gauge
Ends radiused	4	To fit gauge
Pitch	2 ^a	To fit gauge

Propeller

shaft	End taper	To fit any
	propeller hub	
	Revolutions per min.	3000 ± 50

^aA propeller gauge is furnished upon request with the disintegrator and is used to check the blade for possible damage.

A.3 Press.

A.3.1 A side elevation of the press is shown in Fig. 3. The cover, A, is cast aluminum so it can be easily lifted, and the base, B, is of close-grained cast iron. A hard brass disk, C, 175-mm diameter, is embedded in the underside of the cover. The cover is provided with a handle and is held down by means of four 25-mm-diameter phosphorbronze studs and chromium-plated hard brass nuts. The base is recessed to contain a heavy rubber diaphragm, D, held down around the edges by a brass ring with brass counter-sunk screws. A flat platen, E, 175-mm diameter, is loosely fitted inside the ring to rest on the diaphragm, and the platen is prevented from coming out by four lugs, F, which work in four shaped slots around its edge. The upper and lower surfaces of the brass plates that come together in the press are carefully machined flat.

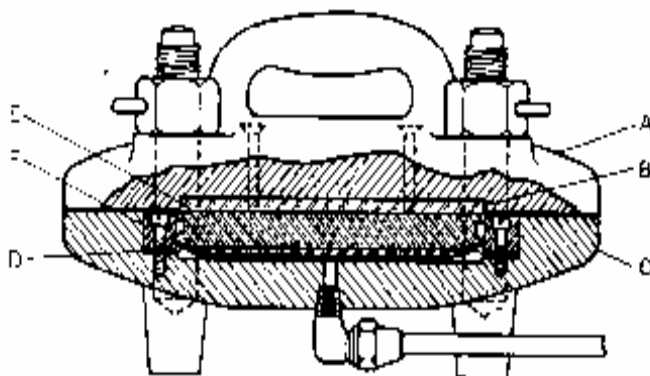


Fig. 3. Press.

NOTE 18: From the construction of the press it will be noticed that the platen is free to float on the rubber diaphragm. This ensures that an even pressure is applied over the entire surface of the pile of sheets and blotters and in this respect is superior to plunger-type presses. The press should never be used for pressing objects smaller than the drying discs since the platen E is liable to bend around the object pressed. If the platen is raised more than 9.5 mm, it will damage the lugs. When the gauge reads 345.0 kPa (50.0 psi), the pressure on the handsheets is about 414 kPa (60 psi).

Table 2. Dimensions and tolerances for standard sheet machine.

	<i>Grid plate C</i>	
Disc	173 - mm diameter	± 0.01 mm
	9.4 - mm thick mat	± 0.1 mm
Grating holes	9.7 x 9.7 mm	± 0.1 mm
	on 12.3 - mm center	± 0.1 mm
Grid bars	3.2 - mm thick	± 0.1 mm
	Top tapered and beveled	
	0.8 - mm thick	± 0.01 mm
Backing wire	8/cm; wire 0.381 - 0.396	
	mm diameter	± 0.01 mm
Surface wire	60/cm; wire 0.067 - 0.071	
	mm diameter	± 0.01 mm
	<i>Cylinder deckle A</i>	
	4.7 - mm thick; 400 - mm high;	
	158.8 - mm I.D. with inside	
	groove 349.3 mm from	
	surface of wire	± 0.01 mm
	<i>Perforated stirrer</i>	
	155 - mm diameter with sixty	
	11 - mm diameter holes;	
	Baffles 0.8 - mm thick by	
	70 mm wide, 152 mm deep	± 0.1 mm
	<i>Couch plate</i>	
	Hard sheet brass or 316	
	stainless steel 171 - mm	
	diameter by 0.79 mm thick	± 0.1 mm
	<i>Couch roll</i>	
	Brass 102 mm diameter	± 0.1 mm
	178 - mm face, mass 13.0 kg	± 50 g

A.3.2 Present-day installations have the press activated by compressed air supplied through a pressure regulator and activated by a timing mechanism. For some research purposes, the original manual glycerin pump may be more versatile, especially for pressures higher than normal, and so may be preferred. A description of this equipment may be found in earlier revisions of this method and may be obtainable as a photocopy from the TAPPI Information Resources Center.

A.4 *Press template.* The press template for centering the sheets (not shown) is of 3.2 mm thick aluminum plate. The guide slots fit over any two adjacent studs in the press, and when in position the 158-mm diameter semicircle which is cut in it, is concentric with the platens of the press.

A.5 *Drying plates.* The mirror-polished stainless steel or chromium-plated brass plates (not shown) are 158-mm diameter and about 0.8 mm thick. They should be free from bulges or uneven edges, and if any are damaged in this way and are not capable of being repaired, they should be discarded. When not in use, they should be kept in a saw-slotted wooden block, made to hold them separate and stacked vertically in a horizontal row.

A.6 *Drying rings.* The drying rings (not shown) are made of plastic material or of hard brass and arranged to fit into each other to clamp each polished plate and test sheet around the edges. The circumference of the sheet is gripped by the rubber seat in the brass rings and the plate pressed against this by the extended portion of the ring below. The air for drying circulates through 12 holes of 19 mm diameter, drilled or molded in the periphery of each ring.

Appendix B. Board stock

B.1 Pulp suitable for paperboard manufacture is, as a rule, relatively weak and relatively free, and often contains quantities of shives; consequently, it is suggested to use a weight per unit area of 150 g/m² as a standard weight for testing this class of stock, employing 1000 mL of stock at 0.3% consistency for each sheet.

B.2 Two pieces of blotter are employed for couching, as for normal lightweight sheets, but two dry blotters are used in place of the single blotter normally required in both first and second pressings, the rest of the procedure for disintegrating and testing remaining the same as for papermaking stock. The making of structural boards is described in TAPPI T 1001 "Forming Insulating Boards for Physical Tests."

Appendix C. Rapid methods of drying and conditioning

C.1 A rapid method of drying and conditioning the sheets, which shortens the time required to 2 to 4 hr while still conforming to the standard procedure, has been developed by the Pulp and Paper Research Institute of Canada. The apparatus consists of a closed box provided with one or more 153-mm (6-in.) wide vertical slots in its sides, inside and against which the drying rings are stacked. An electric fan *exhausts* air from the box through a suitable opening, the air passing in through the holes in the drying rings and over the sheets. The whole apparatus is kept in the constant-humidity room.

NOTE 19: If a fan is used to *blow* air into the box, the fan motor will become heated and, being in the path of the air, may cause the relative humidity of the air passing over the sheets to be appreciably lower than that of the air in the room.

C.2 Alternatively, for rapidly drying the sheets in a constant-humidity room, it is sometimes more convenient to lead part of the conditioned air being circulated or exhausted through a slotted duct in one of the walls or in a corner of the room, the duct having slides and clamps to hold the rings. The conditioned air is thus drawn through the rings and over the sheets and dries and conditions them effectively. This obviates the need for an additional fan.

Appendix D. Sheet shrinkage

The shrinkage during drying may be determined (with an accuracy of about 0.5 mm) as follows: After pressing, make two marks on the sheet 150 mm apart, preferably with a gauge made from two chisel-pointed pins set in a suitable metal holder, after inking the points with a moistened, indelible pencil. Pull the sheet off the plate in a direction perpendicular to the marks, then allow to dry without restraint and measure the shrinkage between the marks. This shrinkage, expressed as a percentage, is a useful indication of the degree of hydration of the pulp. Some prefer to mark the sheets with two marks at right angles and calculate the shrinkage in area as a guide.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Director of Quality and Standards. ■