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T 258

DRAFT NO. 02 SARG

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WORKING GROUP CHAIRMAN

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.

Basic density and moisture content of pulpwood
(Five-year review of Official Method T 258 om-16)
(No changes made from last draft)

1. Scope and summary

1.1 This method describes the measurement of the basic density (bone-dry weight per unit of maximum volume) of pulpwood in the form of chips or disks from the cross section of logs. The method also gives procedures for determining the moisture content of wood in either form.

1.2 For moisture content of wood in the form of sawdust see TAPPI T 264 "Preparation of Wood for Chemical Analysis (Including Procedures for Removal of Extractives and Determination of Moisture Content)."

1.3 Moisture content is determined by the difference in weight as received and after drying at 105 ± 3°C.

1.4 Volume is determined by the amount of water displaced by the test specimen of wood.

1.5 Because wood swells or shrinks, respectively, with absorption or loss of water, it is necessary to express the density at a specified moisture content and corresponding volume. The usual conditions are the minimum

(oven-dry or moisture-free) weight and the maximum (green) or the minimum (oven-dry or moisture-free) volume. For most purposes, the maximum volume basis is sufficient. In the present method the specimen is considered to have swollen to its maximum volume when its moisture content exceeds the "fiber-saturation point," which lies between 18 and 26% by weight (wet basis) for most species. Procedures for obtaining the volume, both green and oven-dry, are described in this method.

NOTE 1: Many wood technologists consider the density of wood is best expressed only on the basis of oven-dry weight and maximum volume, because at moisture contents above the fiber-saturation point the maximum volume is essentially constant.

2. Significance

Pulpwood, as logs or chips, is often purchased on a volume basis. It is also normally charged to the digester by volume. The moisture content and density of the wood are significant values for comparative pulpwood costs, for inventory control, and for proper processing such as digester load and alkali charge.

3. Definitions

3.1 *Density* is the ratio of the mass of a quantity of a substance to its volume and is expressed in terms of weight per unit volume.

3.2 The density of the wood portion of pulpwood and chips may be expressed as:

3.2.1 *As-received density*, obtained by dividing the as-received weight by the as-received volume.

3.2.2 *Green density*, obtained by dividing the green (maximum swollen) weight by the green (maximum swollen) volume.

3.2.3 *Basic density*, obtained by dividing the oven-dry weight by the green (maximum swollen) volume.

3.2.4 *Oven-dry density*, obtained by dividing the oven-dry weight by the oven-dry volume.

3.2.5 *Bulk density*, obtained by dividing the weight (at specified conditions) of the specimen (chips) by the bulk volume at the conditions indicated. It can be expressed in the same terms as basic density (see TAPPI UM 23 "Bulk Density of Wood Chips").

NOTE 2: At initial moisture contents above the fiber saturation concentration (18-26% moisture), as-received and green densities will be identical.

TEST PROCEDURES FOR DISKS

4. Apparatus

4.1 *Balance*, capacity 1 kg, sensitivity 0.1 g.

4.2 *Balance*, minimum capacity 500 g, sensitivity 0.05 g. This balance has a weighted hook substituting for the left balance pan and hanger, and so mounted on a support that the hook will be suspended above an open 114-L (30-gal) container (see Fig. 1). Electronic balances equipped with a hanger to permit below-the-balance weighting are also suitable when mounted in an appropriate manner above the 114-L container. The weighted hook should be exactly the weight of the pan and hanger which has been replaced or sufficiently close to the same weight so that it can be counterbalanced by the adjusting screws.

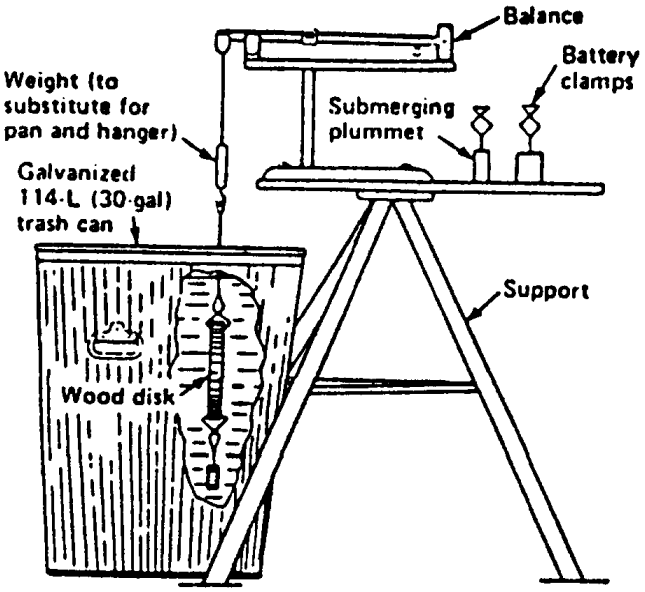

Fig. 1. Apparatus for suspended submergences method for volume determination of disks.

4.3 *Container*, for holding water for submerging disks. A 114-L (30-gal) galvanized or plastic trash container is satisfactory for the purpose.

4.4 *Holding clamp*. This clamp, such as a 200-A battery clamp, should be attached to a fine wire or thread, which, in turn, is attached to an eye for hanging the clamp from the weighted hook on the balance. The wire or thread must be long enough that the clamp and the eye to which the wire is attached are completely submerged in the water held in the container.

4.5 *Submerging plummets* (3 or 4), in the range of 50 to 500 g (as for example 50, 100, 200 and 500 g). Each of these plummets must be attached to a clamp (200-A battery clamps are suitable).

4.6 *Drying oven*, forced air, constant temperature 105 ± 3°C, with drying rack of wire, so constructed that the disks can be placed on edge in the oven, and several thus held without touching one another.

4.7 *Saw*, circular or chain.

5. Materials

Paraffin wax, commercial grade.

6. Sampling

Select a number of sample logs according to TAPPI T 257 "Sampling and Preparing Wood for Analysis."

7. Test specimens

7.1 From each sample log, with a sharp saw, cut a specimen disk of solid wood 20-25 mm (3/4-1 in.) thick from an undamaged, sound, and knot-free section. Preferably cut the disks from the center or at least 300 mm (at least 12 in.) from the end of each log so as to avoid end checks. Quickly remove any bark, adhering splinters, and sawdust from each disk. Reduce the size of any disks too large for the available vessel used for obtaining the submerged weight by cutting a wedge or half disk section and mark the pieces for identification.

NOTE 3: The volume of the specimen required is the outside boundary, exclusive of surface depressions; therefore, cleanly cut the disks.

7.2 Place the specimen disks in a covered container as soon as cut to prevent loss of moisture.

8. Procedures

8.1 *Moisture content.*

8.1.1 Determine the moisture content from the as-received weight and the oven-dry (or moisture-free) weight. If the moisture content alone is desired, it is necessary only to determine the as-received weight as described in Section 8.1.2 and then immediately proceed to the measurement of oven-dry weight in Section 8.2.4.

8.1.2 *As-received weight of disks.* Brush off sawdust and dirt from surfaces of disk and weigh disk promptly. If the disk is too large in diameter to be weighed readily, cut it into pie-shaped segments, weigh each segment and total the weights of the segments. Record as-received weight of disk in grams.

8.2 *Basic density.*

8.2.1 *Soaking*. Unless the wood is green, submerge the disk in water at 23 ± 2°C for a minimum of 1 h.

NOTE 4: The purpose of soaking the wood is two-fold: first, to ensure that the specimen is swelled to its green volume, with its internal cavities filled, and second, to eliminate an error resulting from the wood absorbing water while being weighed to obtain its volume. If the moisture content is above the fiber-saturation point, a 1-h soaking period is usually sufficient to accomplish both these conditions; otherwise the soaking should be prolonged until 1 h after checks, if any, are closed.

8.2.2 *Green weight*. Drain the free water from the soaked disks by patting them lightly with a cloth or piece of blotting paper and allowing them to stand 5 min prior to weighing. Brush off sawdust and dirt from surfaces of disk and weigh each disk promptly. If a disk is too large in diameter to be weighed readily, cut it into pie-shaped segments, weigh each segment and total the weights of the segments. Record green (water-soaked) weight of disk in grams. While draining, do not expose the disks to a draft, fan, or direct heat. Return to the soaking vessel those disks whose surfaces show signs of drying out before the weighings can be completed.

8.2.3 *Green volume*. As shown in Fig. 1, set the scales on the left end of a table so constructed that specimens can be suspended in place of the left-hand pan. Place a vessel of sufficient size containing water at room temperature below the scales directly under the left side of the balance. Hang on the left-hand arm a stirrup and chain or other convenient device with large battery clamp attached. Counterbalance the stirrup, clamps and plummet, immersed in water, and record this tare weight.

8.2.3.1 Suspend the disk edgewise (vertically) by clipping it to the large battery clamp attached to a light chain or cord which is hung from the left-hand pan of the scales. Clip the large battery clamp, to which is fastened the weight or plummet, to the lower edge of the disk. Carefully lower disk and plummet into the water so as not to entrap air. Adjust and clamp the disk so that it is completely immersed and not touching the sides of the vessel. Balance the scale by adding weight to the right-hand pan. The green volume in mL of the disk is equal to the weight of the water displaced by the disk. The weight of the volume of water equivalent to the volume of the disk is the green weight plus the tare weight of apparatus and plummet immersed in water minus the weight of the system obtained here. If density of disk is less than 1.0 (and most are) the weight of the system will be less than the tare weight.

NOTE 5: Raise and lower the disk in the water several times to dislodge any adhering air bubbles before attaching it to the balance. Neither the disk nor the submerging plummet must be allowed to touch the walls or bottom of the vessel during the weighing.

NOTE 6: Another technique for determining green volume is described by Heinrichs and Lussen (1).

8.2.4 *Oven dry (or moisture-free) weight*. Dry disk in an oven at 105 ± 3°C to constant weight. Record that weight as the oven-dry (or moisture-free) weight in grams.

8.2.5 *Oven-dry (or moisture-free) volume*. Dip the dried disk (still warm or even reheated) in hot paraffin, remove it at once and allow it to drain thoroughly. When the paraffin has solidified, conduct the volume determination by the steps outlined in Section 8.2.3 using the weight of the paraffined disk in air for the weight in the computation of volume. Compute the volume in mL as directed in Section 8.2.3 and record it.

NOTE 7: As skill with the basic procedure is developed, the final weighing can be completed in 15 s or less. The expansion of the disk in this length of time is negligible and the paraffin dip can be eliminated. Use oven-dry weight obtained in 8.2.4 for computation.

TEST PROCEDURES FOR CHIPS

9. Apparatus

9.1 *Those items listed in Section 4* (4.1, 4.6) and:

9.2 *Pycnometer*, a can of 1 L (1 qt) or slightly smaller capacity, with a tight lid, with a screen near its top and an opening in its lid (see Fig. 2). Ordinary glass pycnometers are unavailable in the size required for this determination. However, some scientific supply houses list a pycnometer top for determining specific gravity of sand and gravel. Such a top fits a quart screw cap jar, and this combination when equipped with a suitable screen as shown would be satisfactory. Polyethylene containers are also quite acceptable. A commercially available cocktail shaker can easily be adapted for this use by inserting the screen, drilling the hole and fixing the outlet tube as shown

9.3 *Screen*, 6-7 mm openings (3 mesh), 450-600 mm square or diameter.

9.4 *Screen shaker*.

9.5 *Mixer*, twin-cone or twin-shell.

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10. Reagents

10.1 *Shellac solution*, commercial shellac (containing 0.6 g of ordinary orange shellac per mL of denaturated alcohol) diluted with an equal volume of alcohol (i.e., 1.1-kg cut).

10.2 *Kerosene*, commercial grade.

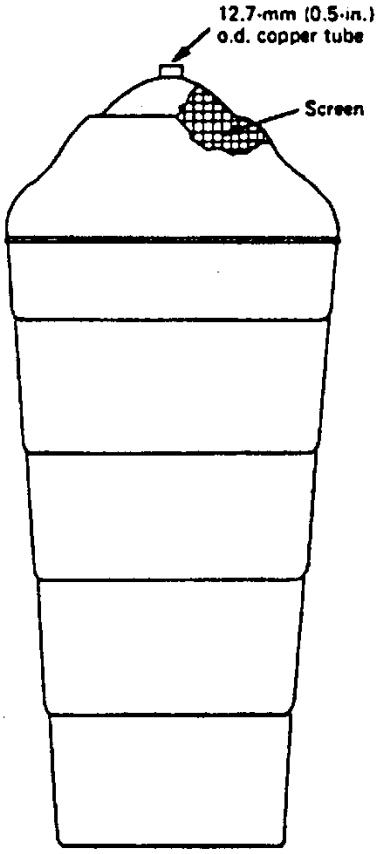

Fig. 2. Apparatus for pycnometer method for volume determination of chips.

11. Safety precautions

These chemicals are flammable and appropriate cautions should be taken by the user of this method.

12. Sampling and test specimens

12.1 From 300 to 350 g (0.60 to 0.75 lb) of chips are required for a determination. Run duplicate determinations. Select the chips to be as representative as possible of the lot being tested. If the chips have been previously screened to the desired size, step 11.3 can be eliminated.

12.2 Store the chips in reasonably air-tight containers until ready for further preparation. Cans such as 114-L (30-gal) trash receptacles (if provided with close fitting lids) are satisfactory for the purpose. Specimens which are to be used within two or three hours can be stored safely in these cans without additional covering. Place those to be stored a longer time into moisture-proof bags and securely tie them before placing in the storage cans. Brush sawdust and dirt from the surfaces before use.

NOTE 8: Procedures for the determination of wood properties should be carried out as rapidly after sampling as possible so as to avoid changes in these properties while the chip sample is in storage.

12.3 Before the determination of any of the several values herein described, chips, as sampled, should be screened to the desired size.

12.3.1 Screen the sample used for determinations through a three-mesh standard screen (9.3). Discard the dust which is passed by this screen. Use only the material retained on the screen.

12.3.2 Thoroughly mix the screened chips in a closed dry solids mixer such as a twin-shell mixer.

13. Test procedures

13.1 The computation of density requires figures to be developed describing the weight and volume of the same sample of wood chips. Also, on occasion, information relating to moisture content becomes important; therefore, methods are presented below for making these three measurements. If the moisture content alone is desired, it is necessary only to determine the as-received weight as described in Section 8.1.2 and then immediately to proceed to the measurement of oven-dry weight in Section 8.2.4. Because the values to be used for the various density computations must (unless moisture content is appropriately applied) relate to the same wood sample, it is recommended that the measurements on a specimen of chips be made in the following sequence:

As-received weight (13.2)
As-received volume (13.3)
Green (water-soaked) weight (13.4)
Green (water-soaked) volume (13.5)
Oven-dry weight (13.6)
Oven-dry volume (13.7)

NOTE 9: Make certain that chips are not lost during the conduct of the several steps.

13.2 *As-received weight.*

13.2.1 Weigh the empty pycnometer and record this tare weight.

13.2.2 Place chips in pycnometer and weigh. Subtract the tare weight of the pycnometer to determine the as-received weight in grams.

13.3 *As-received volume.*

13.3.1 After determining as-received weight, carefully fill the pycnometer with water to the extent that when the cover is replaced the water overflows through the top outlet hole. Shake the pycnometer to dislodge air bubbles. Add water to the outlet hole as necessary to restore the water level.

13.3.2 Weigh the pycnometer with chips and water.

13.3.3 Determine weight of pycnometer when filled with water without chips (water filled weight).

NOTE 10: Be sure pycnometer does not leak when lid is positioned and that lid is similarly positioned for above weighings.

13.3.4 Chip volume in mL is obtained by subtracting the unfilled or void volume (the weight of the pycnometer when filled with chips and water, minus the chip-filled weight) from the volume of the pycnometer (the water filled weight minus the tare weight).

13.4 *Green weight*. After soaking as in 8.2.1, sponge off surface water from chips with several thicknesses of paper towels. Place chips in pycnometer and weigh. Subtract the tare weight of the pycnometer to determine the green weight in grams.

13.5 *Green volume*. After determining green weight in grams, proceed as in 13.3 to determine green volume and green density in grams.

13.6 *Oven-dry weight*. Spread out the chips in a wire-mesh tray or basket in the oven. Dry the chips to constant weight in grams at 105 ± 3°C, which will require from 24 to 48 h.

13.7 *Oven dry volume*. Because of the proportionately high volume of paraffin coating on a quantity of chips as compared to that on an equal quantity of wood in the form of disks, as well as the difficulty of immersing paraffined chips in water without entrapping air, the determination of the volume of dried chips by the method used for disks is not recommended. The volume, however, can be obtained satisfactorily by coating the chips with shellac and immersing them in kerosene. Weigh the dried chips, and while still warm, place them in the wire basket, immerse them in the alcoholic solution of commercial shellac for a period of 3-5 min, then spread them out to air-dry. Obtain the weight of the shellac-coated chips in air before obtaining the weight suspended in kerosene. Make weighings with the shellac-coated chips as described in the basic procedure, except substitute kerosene for water in the submergence bath. Compute the volume in mL as directed in Section 13.3.4. Divide the volume as calculated by the density of the kerosene to obtain the oven-dry volume and record it.

NOTE 11: The density of the kerosene in g/mL must be known or must be determined by standard liquid density procedures.

14. Calculations

14.1 Let the following equal the quantities as indicated:

a = as-received weight of disks (from 8.1.2), g
b = oven-dry weight of disks (from 8.2.4), g
c = as-received weight of chips (from 13.2), g
d = oven-dry weight of chips (from 13.6), g
e = green volume (from 8.2.3), mL
f = oven-dry volume of disks (from 8.2.5), mL

14.2 Calculate the moisture content of the disks ("as-received basis") as follows:

$$\text{Moisture, \%} = [(a - b)/a] \times 100$$

14.3 Calculate the moisture content of chips (as-received basis) as follows:

$$\text{Moisture, \%} = [(c - d)/c] \times 100$$

14.4 Compute the basic density as determined by the various procedures described by the formulas given below. Calculate the density separately for each specimen of disks as follows:

14.4.1 Calculate the basic density, g/mL, as follows:

$$\text{Basic density} = b/e$$

14.4.2 If desired, calculate the bone-dry density, g/mL, as follows:

$$\text{Bone-dry density} = b/f$$

14.4.3 *Volume of the pycnometer* in mL is obtained by subtracting the tare weight (in grams) from the water-filled weight (in grams):

Pycnometer volume = water-filled weight - tare weight

14.4.4 *Weight of the chip* sample is obtained by subtracting the tare weight (in grams) from the chip-filled weight (in grams):

Weight of chip sample = chip-filled weight - tare weight

14.4.5 *Unfilled volume* or void volume is obtained by subtracting the chip-filled weight (in grams) from the weight of the pycnometer (in grams) when filled with chips and water:

Unfilled volume = chip and water-filled weight - chip-filled weight

14.4.6 *Chip volume*, as described in 13.3.4.

14.4.7 *Oven-dry weight*, as determined in 13.6.

14.4.8 *Green volume*, as determined in 13.5.

14.4.9 *Oven-dry volume*, as determined in 13.7, is the difference in weight between the pycnometer when filled with chips and kerosene and the weight when filled with shellacked chips which must be divided by the density (in g/mL) of the kerosene. This gives the volume (in mL) occupied by the liquid kerosene, and the difference between this figure and the total volume (13.3.4) gives the volume of the chips.

Bone-dry volume = pycnometer volume - (weight of kerosene/density of kerosene)

15. Report

15.1 *Moisture content*. For disks or chips, report the results on the "as received" basis to the nearest 0.1% moisture.

15.2 *Density*. For disks or chips, report the basic or oven-dry density in g/mL to three significant figures.

16. Precision

16.1 *Disks* (*2*, *3*, *4*). A series of 156 tests of green volume basic density in duplicate on disks was conducted by one laboratory for a repeatability of 6%.

16.2 *Chips (4).* Within one laboratory, the density of 12 specimens of sweetgum chips measured an average of 0.460 g/mL with a repeatability of 0.00556 g/mL.

16.3 These values are in accordance with the definitions in TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility." Since it is impractical to ship pulp around to different labs, no reproducibility statement is necessary.

17. Keywords

Wood, Density, Moisture content, Weight, Chips, Bulk density, Volume, Logs

18. Additional information

18.1 Effective date of issue: To be assigned.

18.2 Related method: PAPTAC Standard A.8P.

18.3 The changes made in the 2011 revision are editorial and the addition of a safety section.

References

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2. United States Department of Agriculture Forest Service Research Paper FPL, "Properties of Major Southern Pines," U.S. Department of Agriculture, Forest Products Laboratory, Madison, Wisconsin, 176 (1972).
3. Saucier, J. R., "Wood Specific Gravity of Eleven Species of Pine," *Forest Prod. J.* **22**(3): 32 (1972).
4. Eslyn, W. E., "Reliability of a Method for Measuring Specific Gravity to Determine Wood Losses in Outside Deep Storage," *Tappi* **54**(8): 1269 (1971).

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