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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.

Units of measurement and conversion factors

1. Scope

1.1 This Standard Practice deals with the application of the International System of units (abbreviated “SI” or “SI metric units”) within the field of pulp, paper, and paperboard. TAPPI regulations require the use of the SI units as the preferred units in TAPPI Test Methods and other TAPPI publications.

1.2 Details of the SI are given in the various parts of ISO Standard 31: 1981 and ISO Standard 1000: 1981. Application of this information is not always easy, however. For instance, some quantities can be expressed in different units, all within the SI. Such variations can lead to confusion in reporting test results and quoting property values.

1.3 In order to overcome such problems within the pulp, paper, and paperboard field, ISO/TC6 has recommended appropriate units in ISO Standard 5651: 1989 (E). These are reproduced in this Standard Practice, together with other information and recommendations.

2. Summary

2.1 This Standard Practice states the units recommended for use in expressing the properties of pulp, paper, and paperboard and other quantities found in the pulp, paper, and paperboard documents. It also provides the conversion factors for converting customary units to metric units or other recommended units, and marks with an asterisk (*) when the conversion factor is exact.

2.2 Units recommended in ISO 5651 are marked (+) or (#), with the latter indicating that the recommended unit for pulp, paper, and paperboard is not a preferred SI unit.

3. Mechanics of use

3.1 In converting from the customary units to the recommended form, multiply the test value expressed in customary units by the conversion factor to obtain the test value in the recommended form. Suppose that the property of interest is the thickness of a sheet of paper, and that this has been determined to be 5.3 mils. Examination of Table 1 shows that in Section 1.2, Thickness, the conversion factor from mils to micrometers is 25.4. Multiplying 5.3 by 25.4, the test value in the recommended form is 134.62 micrometers. Generally, the converted value should be rounded to the same number of significant figures or one more than is in the value in customary units, depending on whether the first digit of the new value is more or less than that of the original value.

Thus, in this case, the reported value would be 134.6 micrometers. (Note: The rounding rule given here is easy to remember and is “safe” in the sense that it does not result in the loss of significant information.)

3.2 If the property of interest had been the thickness of corrugated board of, say, 180 mils, the value would be converted to millimeters, not micrometers. The conversion factor is 0.0254 and the value in the recommended form is 4.57 mm or 4.6 mm, depending on whether the zero in the last digit of 180 is significant or simply holding the decimal place.

3.3 Generally, if the table allows a choice in the recommended form, choose that form that would have no more than three significant figures in front of the decimal point for most of the values. However, use, for example, 0.13 mm, not 130 μm , if the zero in 130 is not significant.

4. Notation

4.1 The quantities given in square brackets in the second and fourth columns are symbols, not abbreviations. Hence, do not use abbreviation marks. [Exception: TAPPI style usually uses a period after the symbol for *inch* (in.), to avoid confusion with the word *in*.] When two of these symbols are multiplied, as in Part 10.20 of Table 10, Dynamic viscosity in pascal seconds, use a raised dot between the symbols, thus Pa•s.

4.2 The same symbol is used for the plural; so adding an “s” for the plural is incorrect. Thus, write fifty-two grams as 52 g. Also, the symbol for *per* is a slash (/), not the letter p, and scientific notation is used for squares, cubes, and higher powers. Thus, write fifty-two grams per square meter as 52 g/m², not gpsm nor gsm.

4.3 The symbols and the names of units are not mixed in the same expression. Therefore, g per square meter, grams/square meter, grams/m², g/sq m, and g per m² are all incorrect; “g/m²” or “grams per square meter” would be correct.

4.4 In the text, write out the name of the unit, except usually when preceded by a numerical value. Thus use “determine the mass in grams to the nearest 0.1 g;” however, expression like “one gram” or “two to three grams” may be used when the value as well as the name is written out.

5. Keywords

Measurement, Units of measurement, Conversion factors

6. Additional information

- 6.1 Effective date of issue: April 24, 2012.
- 6.2 The information in this Standard Practice is based on material initially documented in TAPPI TIP 0800-01.
- 6.3 Related method: ISO 5651.
- 6.4 Selected conversion factors and units of measurement were corrected in 2000.
- 6.5 Minor additions and editorial changes were made in 2004 and 2012.

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

3 / Units of measurement and conversion factors

T 1210 sp-05

Table 1. General properties

PROPERTY and TAPPI Test Method (if any) [ISO Standard]		To convert values expressed in CUSTOMARY UNITS	Multiply by	To obtain values expressed in RECOMMENDED FORM
		Name [Symbol]	*exactly	Name [Symbol]
1.1	Mass per unit area: Basis weight (mass on ream basis) Grammage (mass in grams per square meter) (See T 410 for other conversions) T 410, T 220 [ISO 536, 3039, 5270, 5638]	pounds per ream, 17 x 22 - 500 pounds per ream, 24 x 36 - 500 pounds per ream, 25 x 38 - 500 pounds per ream, 25 x 40 - 500 pounds per 1000 square feet [lb/1000 ft ²] pounds per 3000 square feet [lb/3000 ft ²]	3.7597 1.6275 1.4801 1.4061 4.8824 1.6275	+grams per square meter [g/m ²] grams per square meter [g/m ²] grams per square meter [g/m ²] grams per square meter [g/m ²] grams per square meter [g/m ²] grams per square meter [g/m ²]
1.2	Thickness, or Caliper T 411 [ISO 534, 3034]	mils (or points or thousandths of an inch) mils [mil or 0.001 in.] inches [in.]	25.4 0.0254 25.4	+micrometers [μm] +millimeters [mm] millimeters [mm]
1.3	Bulking thickness T 411 (Note 4 of T 411) [ISO 534, 3034]	mils [mil or 0.001 in.]	25.4	+micrometers [μm]
1.4	Apparent density (also see 10.9), T 258	pounds per cubic foot [lb/ft ³] grams per cubic centimeter [g/cm ³] grams per cubic centimeter [g/cm ³]	16.01846 *1000 *1	kilograms per cubic meter [kg/m ³] kilograms per cubic meter [kg/m ³] #grams per cubic centimeter [g/cm ³]
1.5	Dimensional change after water immersion [ISO 5635, 5637]	percent [%]	*1	+percent [%]
1.6	Hygroinstability	percent [%]	*1	+percent [%]
*	Exactly			
+	Unit recommended in ISO Standard, 5651			
#	Unit recommended in ISO 5651, although not preferred SI unit Conversions to 6 significant maximum			

Table 2. Strength properties

PROPERTY and TAPPI Test Method (if any) [ISO Standard]		To convert values expressed in CUSTOMARY UNITS	Multiply by	To obtain values expressed in RECOMMENDED FORM
		Name [Symbol]	*exactly	Name [Symbol]
2.1	Tensile strength T 494, T 404, T 456, T 220, T 813 [ISO 1924, 3781]	pounds-force per inch [lbf/in.] pounds-force per 15 millimeter width [lbf/15 mm] ounce-force per inch [ozf/in.] kilograms-force per 15 millimeter width [kgf/15 mm] kilograms-force per 25 millimeter width [kgf/25 mm] kilograms-force per centimeters [kgf/cm] grams-force per millimeter [gf/mm] newtons per 15 millimeter width [N/15 mm]	0.175127 0.29655 10.945 0.65378 0.39227 0.980665 9.80665 66.6667	+kilonewtons per meter [kN/m] kilonewtons per meter [kN/m] newtons per meter [N/m] kilonewtons per meter [kN/m] kilonewtons per meter [kN/m] kilonewtons per meter [kN/m] newtons per meter [N/m] newtons per meter [N/m]
2.2	Tensile strength of wax	pounds-force per square inch [lbf/in. ²]	6.89476	kilonewtons per square meter [kN/m ²]
2.3	Tensile index [ISO 5270]	newton meters per gram [N • m/g] kilometers breaking length [km]	*1 *9.80665	#newton meters per gram [N • m/g] newton meters per gram [N • m/g]
2.4	Breaking length (to be replaced by tensile index) T 220, T 231, T 494 [ISO 5270, 1924]	meters [m] kilometers [km]	*0.001 *1	+kilometers [km] kilometers [km]
2.5	Stretch at rupture (elongation) T 220, T 404, T 494 [ISO 5270, 1924]	percent [%]	*1	+percent [%]
2.6	Tensile energy absorption (TEA) T 494 [ISO 1924]	foot pounds-force per square foot [ft • lbf/ft ²] inch pounds-force per square inch [in • lbf/in. ²] kilogram-force meters per square meter [kgf • m/m ²] joules per square meter [J/m ²]	14.5939 175.127 9.80665 *1	+joules per square meter [J/m ²] joules per square meter [J/m ²] joules per square meter [J/m ²] joules per square meter [J/m ²]
2.7	TEA index	millijoules per gram [mJ/g]	*1	#millijoules per gram [mJ/g]
2.8	Tearing strength T 220, T 414, T 496 [ISO 1974, 5270]	grams-force [gf]	9.80665	+millinewtons [mN]
2.9	Tear index [formerly tear factor] T 220 [ISO 5270]	Tear factor computed as: 100 grams-force per (gram per square meter) [100 gf/(g/m ²)]	0.0980665	#millinewton square meters per gram [mN • m ² /g]

5 / Units of measurement and conversion factors

PROPERTY and TAPPI Test Method (if any) [ISO Standard]		To convert values expressed in CUSTOMARY UNITS	Multiply by	To obtain values expressed in RECOMMENDED FORM
		Name [Symbol]	*exactly	Name [Symbol]
2.10	Edge tearing resistance (Finch) T 470	pounds-force [lbf] kilograms-force [kgf]	4.44822 9.80665	newtons [N] newtons [N]
2.11	Bursting strength T 403, T 807, T 810 [ISO 2758, 2759, 3689]	pounds-force per square inch [psi] points kilograms-force per square centimeter [kgf/cm ²] kilonewtons per square meter [kN/m ²]	6.89476 6.89476 98.0665 *1	+kilopascals [kPa] kilopascals [kPa] kilopascals [kPa] kilopascals [kPa]
2.12	Burst index (formerly burst factor) T 220, T 807 [ISO 2758, 2759, 5270]	Burst factor computed as: Grams-force per square centimeter per (gram per square meter) [(gf/cm ²)(g/m ²)]	0.0980665	#kilopascal square meters per gram [kPa • m ² /g]
2.13	Puncture resistance T 803 [ISO 3036]	centimeter kilograms-force [cm • kgf] scale units [=0.305 cm • kgf] foot pounds-force [ft • lbf] inch ounces-force [in. • ozf] inch pounds-force [in. • lbf]	0.0980665 0.0299 1.35582 7.06155 0.112985	+joules [J] joules [J] joules [J] millijoules [mJ] joules [J]
2.14	Adhesion strength of glue bonds of corrugated fiberboard T 813	pounds-force per inch [lbf/in.] kilograms-force per millimeter [kgf/mm]	0.175127 9.80665	+kilonewtons per meter [kN/m] kilonewtons per meter [kN/m]
2.15	Z-direction strength properties (units as appropriate)	pounds-force per square inch [lbf/in. ²] kilograms-force per square centimeter [kgf/cm ²] pounds-force per inch [lbf/in.] foot pounds-force per square inch [ft • lbf/in. ²] foot pounds-force per square inch [ft • lbf/in. ²]	6.89476 98.0665 0.175127 2101.5 2.1015	+kilopascals [kPa] kilopascals [kPa] +kilonewtons per meter [kN/m] +joules per square meter [J/m ²] kilojoules per square meter [kJ/m ²]
*	Exactly			
+	Unit recommended in ISO Standard, 5651			
#	Unit recommended in ISO 5651, although not preferred SI unit Conversions to 6 significant maximum			