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An American National Standard

Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings[1]

This standard is issued under the fixed designation D 2122; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of diameter, wall thickness, and length dimensions of thermoplastic pipe. Included are procedures for measurement of the inside diameter of pipe intended to be joined by internal fittings, measurement of the average outside diameter for roundable pipe where out-of-roundness is not of primary concern, out-of-roundness measurement and measurement of the average outside diameter of non-roundable pipe, and for determining length and straightness.

1.2 This test method also includes procedures for dimensioning molded thermoplastic pipe fittings.

1.3 The values given in parentheses are provided for information purposes only.

1.4 *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]

D 618 Practice for Conditioning Plastics for Testing

D 638 Test Method for Tensile Properties of Plastics

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

F 412 Terminology Relating to Plastic Piping Systems

F 1498 Specification for Taper Pipe Threads (60°) for Thermoplastic Pipe and Fittings

2.2 *ANSI Standard:*[3]

B 2.1 Pipe Threads (Except Dryseal)

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Definitions are in accordance with Terminology F 412, unless otherwise specified.

3.1.2 *deviation from straightness*—the maximum deviation from a straight line exhibited by a pipe specimen divided by the length of the specimen.

3.1.3 *nonroundable pipe*—pipe made from a material having a tensile or flexural modulus of elasticity of 150 000 psi (103 MPa) or greater, as determined by Test Method D 638 or D 790, and in addition, having an outside diameter/wall thickness ratio of less than 20.

3.1.3.1 *Discussion*—The above definitions apply to thermoplastic pipe and are based on the ability or inability of a pipe to round out when forced into a tapered socket.

3.1.4 *roundable pipe*—(*1*) pipe made from material having a tensile or flexural modulus of elasticity less than 150 000 psi (103 MPa) as determined by Test Method D 638 or D 790; and (*2*) pipe made from a material having a tensile or flexural modulus of elasticity of 150 000 psi (103 MPa) or greater, as determined by Test Method D 638 or D 790, and in addition, having an outside diameter/wall thickness ratio of 20 or greater.

3.1.5 *socket bottom*—the point at which the pipe stop radius intersects wall.

4. Summary of Test Method

4.1 *Alternate Methods*—Alternate methods and procedures for obtaining dimensions (such as apparatus and procedures using laser, electronic, nuclear, ultrasonic, or other means) are not prohibited.

4.1.1 The user of an alternate method shall validate the alternate method. The alternate method is validated when both the product is measured according to the Apparatus and Procedure sections presented in this test method, and when found to be in compliance with product specifications.

NOTE 1—Validation of the alternate method is a necessary step in ensuring compliance with product specifications. Validation generally involves statistical analysis of data generated using the alternate method.

[1] This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.40 on Test Methods.

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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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

At a minimum, the analysis should include calculating 99 % confidence limits and verifying that these limits are within the product specification tolerances. For guidance on this type of analysis, the user should consult the *Manual on Presentation of Data and Control Chart Analysis.*[4]

4.1.2 Compliance with product specifications shall be based on the measuring apparatus and procedures in this test method. While alternate methods are not prohibited, the measuring apparatus and procedure in this test method shall be the referee method.

5. Significance and Use

5.1 This test method provides for determining the physical dimensions of thermoplastic pipe and fittings. This test method is suitable for determination of dimensional compliance with product specifications.

6. General

6.1 *Specimen Preparation*—Pipe specimens shall be cleanly cut and burrs removed. Some materials, such as polyolefin plastics, may undergo dimensional change near cut ends due to internal stresses. When this condition is noted, care shall be taken to make measurements at a location which is not so affected.

6.2 *Conditioning*—Condition the test specimens at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required.

6.3 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this test method.

7. Wall Thickness—Pipe and Fittings

7.1 *Apparatus*—A cylindrical or ball anvil tubing micrometer accurate to within ±0.001 in. (±0.02 mm) shall be used for wall thickness measurements.

NOTE 2—Care should be taken to avoid excessive closure pressure when using ball anvil micrometers, which may compress the specimen and give falsely low readings. Care should be taken to avoid misalignment of the anvil with the longitudinal axis of the specimen when using cylindrical anvil micrometers, which may bridge specimen surface curvature or indentations and give falsely high readings.

7.2 *Procedure*—Make a series of measurements at closely spaced intervals to ensure that the minimum and maximum wall thicknesses have been determined. Make a minimum of eight measurements.

7.3 *Calculation*:

7.3.1 Calculate the average wall thickness by taking the average of all values measured.

7.3.2 Calculate the wall thickness range, *E*, as a percent, as follows:

$$E = \frac{A - B}{A} 100 \quad (1)$$

where:

A = maximum wall thickness at any cross section, and
B = minimum wall thickness at any cross section.

7.4 *Report*—Report the following information:

7.4.1 Observed minimum and maximum wall thicknesses,

7.4.2 Calculated average wall thickness, and

7.4.3 Calculated wall thickness range in percent.

8. Inside Diameter Measurement of Roundable Pipe

8.1 *Apparatus*—Depending on the requirements, the following apparatus shall be used:

8.1.1 *Tapered Plug Gage*, for checking conformance to an average inside diameter tolerance, having uniform taper of 1:100 and accurate to within ±1 % of its taper and to within ±0.001 in. (±0.02 mm) of its diameter. For each given pipe size and tolerance specification, a mandrel shall be scribed at the diameters representing the minimum and maximum allowable inside pipe diameters. To aid rounding, a 45° by ⅛-in. (3-mm) face bevel shall be provided on the entrance end of the gage.

NOTE 3—Where internal stresses cause change in dimension at the cut end of pipe, tapered plug or sleeve gage measurements may give misleading results.

8.1.2 *Metal Rule* (if it is desired to determine the actual average inside diameter) with at least 0.01-in. (0.2-mm) graduations.

8.2 *Procedure*:

8.2.1 Cut the end of the pipe square and remove burrs. Insert the plug gage into the pipe, causing it to round out but not to expand. Observe whether the end of the pipe falls between the scribed diameters.

8.2.2 In cases of disagreement between the purchaser and the seller, the proper insertion distance as indicated in 8.1.1 shall be defined as that point where an internal light source is just occluded.

8.2.3 If the actual average inside diameter is required, measure the distance from the maximum scribed diameter to the end of the pipe.

8.3 *Calculations*—Calculate the average inside diameter as follows:

$$d = d_m - kl \quad (2)$$

where:

d = average inside diameter, in. (or mm),
d_m = maximum scribed diameter, in. (or mm),
k = taper of plug gage, in. (or mm) of diameter per in. (or mm) of length, and
l = distance from maximum scribed diameter to end of pipe, in. (or mm).

8.4 *Report*—Report the following information:

8.4.1 When determining conformance to tolerances, report whether the average inside diameter is less than the minimum, greater than the maximum, or within the allowable limits as indicated by the position of the scribed diameters with respect to the end of the pipe.

8.4.2 If the actual average inside diameter is required, the result of the calculation in 8.3, as well as the values used in the

[4] Committee E11 on Quality and Statistics, *Manual on Presentation of Data and Control Chart Analysis*, Chapter 2, ASTM International, West Conshohocken, PA, 1990, p. 38.

calculation, shall be reported. The average inside diameter may also be calculated as described in 10.5.

9. Outside Diameter and Out-of-Roundness Measurement of Roundable Pipe

9.1 *Apparatus*—Depending on the requirements, the following apparatus shall be used:

9.1.1 *Flat-Anvil Micrometer or Vernier Calipers*, accurate to ±0.001 in. (±0.02 mm).

9.1.2 *Tapered Sleeve Gage*, for checking conformance to an average outside diameter tolerance of roundable pipe, accurate within ±1 % of its taper and ±0.001 in. (±0.02 mm) of its diameter. For a given pipe size and tolerance specification, the entrance diameter shall be the maximum allowable average outside pipe diameter, while the inside diameter at the opposite end shall correspond to the minimum allowable average outside pipe diameter. To aid rounding, a 45° by ⅛-in. (3-mm) face bevel shall be provided on the entrance end of the gage.

9.1.3 Alternatively, a sleeve window gage, made to the tolerances given in 9.1.2 may be used. The window shall extend beyond the two scribed marks, which shall represent the minimum and maximum permitted diameters. See the Discussion under 3.1.5.

NOTE 4—This gage may also be marked to enable actual average outside diameters to be read directly.

9.1.4 *Circumferential Wrap Tape*, if the actual value of the average outside diameter is desired, calibrated in terms of pipe diameter with 0.01-in. (0.2-mm) graduations, or a vernier wrap tape, with 0.001-in. (0.02-mm) graduations when greater precision is required.

9.1.5 *Out-of-Roundness Gage*—A rigid plate, about ¼ in. (6 mm) thick, bored with a circular hole to the maximum permitted diameter allowed for out-of-roundness, accurate to ±0.001 in. (±0.02 mm), may be used to determine conformance to the out-of-round requirement.

9.2 *Procedure*:

9.2.1 *Flat-Anvil Micrometer or Vernier Caliper*—Take a series of diameter measurements at closely spaced intervals to ensure that the minimum and maximum diameters have been determined. Make a minimum of six measurements.

9.2.2 *Sleeve Gages*—Cut the end of the pipe square and remove burrs. Insert the pipe into the sleeve gage and observe the position of the end with respect to the ends of the tapered sleeve gage or the position of the end with respect to the minimum and maximum scribed marks of the sleeve window gage.

9.2.3 *Circumferential Wrap Tape*—To determine the actual value of the average outside diameter, place the circumferential wrap tape around the pipe, making sure that it is at right angles to the pipe axis and is flat against the pipe surface. Observe the diameter reading, estimating to the nearest 0.005 in. (0.1 mm), or 0.001 in. (0.02 mm) as required.

9.2.4 *Out-of-Roundness Gage*—To determine conformance to pipe out-of-roundness with the gage, the pipe shall be inserted through the gage without forcing rounding of the pipe.

9.3 *Report*—Report the following information:

9.3.1 When determining conformance to tolerances with the tapered sleeve gage, report whether the average outside diameter is less than the minimum, greater than the maximum, or within the allowable limits as indicated by the position of the pipe end with respect to the ends of the tapered sleeve gage.

9.3.2 When determining conformance to tolerances with the sleeve window gage, report whether the average outside diameter is less than the minimum, greater than the maximum, or within the allowable limits with respect to the minimum and maximum scribed marks.

9.3.3 If required, report the average outside diameter as observed in 9.2.3 with the circumferential wrap tape.

9.3.4 When determining conformance to outside diameter tolerances with a flat anvil micrometer or caliper, report the minimum diameter, the maximum diameter, and, if required, the average diameter calculated by taking the average of all diameters measured.

NOTE 5—The actual average outside diameter determined using a circumferential wrap tape is preferred to averaging micrometer diameter measurements.

9.3.5 When determining conformance to out-of-roundness tolerances with a flat anvil micrometer or caliper, report whether the measurements were made with or without a rounding device, and the difference between the minimum and maximum diameters as the out-of-roundness.

9.3.6 If required, report the percent ovality, which is calculated by dividing the out-of-roundness by the average diameter, as determined in 9.2.3 or 9.3.4, and multiplying by 100.

9.3.7 When determining conformance to tolerances with the out-of-roundness gage, report whether the pipe exceeds out-of-roundness tolerance or is within the allowable limits as indicated by the gage.

10. Out-of-Roundness and Average Outside and Inside Diameter of Non-Roundable Pipe and Fittings

10.1 *Apparatus*:

10.1.1 A flat-anvil micrometer or vernier caliper accurate to within ±0.001 in. (±0.02 mm).

10.1.2 *Out-of-Roundness Gage*—A rigid plate, about ¼ in. (6 mm) thick, bored with a circular hole to the maximum permitted diameter allowed for out-of-roundness, accurate to ±0.001 in. (±0.02 mm), may be used to determine conformance to the out-of-round requirement.

10.1.3 *Circumferential Wrap Tape*, if the actual value of the average outside diameter is desired, calibrated in terms of pipe diameter with 0.01 in. (0.2 mm) graduations, or a vernier wrap tape, with 0.001 in. (0.02 mm) graduations when greater precision is required.

10.2 *Procedure*:

10.2.1 *Flat-Anvil Micrometer or Vernier Caliper*—Take a series of diameter measurements at closely spaced intervals to ensure that the minimum and maximum diameters have been determined. Make a minimum of six measurements.

10.2.2 *Circumferential Wrap Tape*—To determine the actual value of the average outside diameter, place the circumferential wrap tape around the pipe, making sure that it is at right angles to the pipe axis and is flat against the pipe surface. Observe the diameter reading, estimating to the nearest 0.005 in. (0.1 mm), or 0.001 in. (0.02 mm), as required.

10.2.3 *Out-of-Roundness Gage*—To determine conformance to pipe out-of-roundness with the gage, the pipe shall be inserted through the gage without forcing rounding of the pipe.

10.3 *Calculations*—Calculate the average outside diameter by taking the average of all diameters measured, and the out-of-roundness as the maximum minus the minimum diameter. If required to be reported, calculate the percent ovality by dividing the out-of-roundness by the average diameter and multiplying the result by 100.

NOTE 6—The actual average outside diameter determined using a circumferential wrap tape is preferred to averaging micrometer or caliper diameter measurements.

10.4 *Report*—Report the following information:

10.4.1 Observed minimum and maximum diameters,

10.4.2 Average diameter as calculated in 10.3 or as observed in 10.2.2,

10.4.3 Out-of-roundness as determined in 10.2.1 and 10.3, or 10.2.3,

10.4.4 If required, ovality as determined in 10.3, and

10.4.5 When determining conformance to tolerances with an out-of-roundness gage, report whether the pipe exceeds out-of-roundness tolerance or is within the allowable limits as indicated by the gage.

10.5 *Inside Diameter*—The average inside diameter may be calculated as follows:

$$d = D - 2\,t_a \quad (3)$$

where:

d = average inside diameter, in. (or mm),
D = average outside diameter, in. (or mm), and
t_a = average wall thickness, in. (or mm), as determined in 7.3.

11. Fittings Socket Dimensions

11.1 *Diameters*—Determine the minimum and maximum diameters of the fitting socket using an internal micrometer or a telescoping gage, accurate to ±0.001 in. (±0.02 mm) at both the socket entrance and socket bottom. Take sufficient readings, a minimum of 8, to ensure that the maximum and minimum have been determined. Calculate the average diameters as the arithmetic mean of all of the diameters measured at each cross section. For socket bottom measurements, the tip radius of the micrometer or telescoping gage shall be less than the radius of the pipe stop to ensure that the tip is in contact with the true socket bottom.

11.2 *Fittings Socket Diameter Gages*—Plug gages may be used to determine conformance to fitting socket inside diameter dimensions for pipe bells and fittings for in-plant quality control. In case of disagreement between purchaser and seller, the fitting socket diameters shall be determined in accordance with 11.1.

11.3 *Socket Depth*—Determine the socket depth using a good quality commercial scale, vernier caliper, or depth gage micrometer with these calibration increments:

Instrument	Calibration Increments
Commercial scale	1/32 in. (1 mm)
Vernier caliper	.001 in. (.03 mm)
Depth gage micrometer	.001 in. (.03 mm)

NOTE 7—Unless otherwise specified, precision of the commercial scale shall be used.

11.4 *Fittings Spigot Diameter Gages*—Straight-side go/no-go ring gages may be used to determine conformance of fitting spigot outside diameter dimensions.

11.5 *Report*—The report shall include the maximum, minimum, and calculated average for each dimension determined with inside micrometer or telescoping gage. Alternatively, the report shall state conformance or nonconformance of the fitting diameters when determined using go/no-go gages.

12. Length of Pipe

12.1 *Apparatus*—For specimens 1 in. (25 mm) long or longer, use a steel tape or rule with marked graduations that are 10 % of the total tolerance on the nominal length or less. For specimen lengths less than 1 in. (25 mm), use a vernier caliper with calibration increments of 0.001 in. (0.03 mm).

12.2 *Procedure*—Lay the pipe specimen on a flat surface and in a straight line. Observe the length to within the nearest marked graduation on the measuring tool.

12.3 *Report*—Report the length of each specimen measured.

13. Laying Lengths of Fittings

13.1 *Apparatus*—A good quality commercial steel scale calibrated in 1/32-in. or 1-mm increments, provided that the dimension is clearly in excess of 1/16 in. or 2 mm or more. For laying lengths within 1/16 in. of the minimum, use a depth micrometer or a micrometer height gage, accurate to ±0.005 in. or ±0.1 mm.

13.2 *Procedure*—Measure the laying length to within 1/32 in. or 1 mm except that when within 1/16 in. or 2 mm of the minimum specified laying length, measure to within ±0.005 in. or 0.1 mm.

13.3 *Report*—Report the laying lengths of each specimen measured.

14. Threads

14.1 All taper pipe threads shall conform to and be gaged in accordance with Specification F 1498.

15. Straightness

15.1 *Apparatus*—A plane horizontal surface, a string, and a metal rule with at least 1/16-in. or 1-mm calibrations.

15.2 *Procedure*—Place the pipe specimen on the plane surface and allow it to come to rest. At a distance of half the outside diameter above the plane surface, stretch the string from one pipe end to the other and draw it taut while in contact with both ends. Holding the ruler horizontally, determine the maximum distance between the pipe and the string. It should be noted that pipe with a non-uniform curvature will not necessarily show the maximum reading at the center.

15.3 *Report*—Report the specimen length plus the deviation from straightness.

16. Precision and Bias

16.1 The precision of these measuring test methods is based on the accuracy of the instrument used and is specified in each

procedure. There is no bias in measuring plastic pipe and fittings dimensions in relation to any standard.

17. Keywords

17.1 dimensions; measurement; plastic fittings; plastic pipe; thermoplastic fittings; thermoplastic pipe