Designation: D 2666 – 96a

An American National Standard

Standard Specification for Polybutylene (PB) Plastic Tubing[1]

This standard is issued under the fixed designation D 2666; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers polybutylene (PB) tubing that is outside diameter controlled, made in standard thermoplastic tubing dimension ratios and pressure rated for water (see Appendix). Included are criteria for classifying PB plastic tubing; a system of nomenclature for PB plastic tubing; and requirements and test methods for materials, workmanship, dimensions, sustained pressure, and burst pressure. Methods of marking are also given.

1.2 The text of this specification references notes, footnotes, and appendixes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

1.4 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification: *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:*

D 618 Practice for Conditioning Plastics for Testing[2]

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[3]

D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings[3]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1603 Test Method for Carbon Black in Olefin Plastics[2]

D 1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens[2]

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings[3]

D 2581 Specification for Polybutylene (PB) Plastics Molding and Extrusion Materials[4]

D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials[3]

F 412 Terminology Relating to Plastic Piping Systems[3]

F 699 Practice for Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing[3]

2.2 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[5]

2.3 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[5]

2.4 *NSF Standards:*

Standard No. 14 for Plastic Piping Components and Related Materials[6]

Standard No. 61 for Drinking Water System Components—Health Effects[6]

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified. The abbreviation for polybutylene plastic is PB.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *hydrostatic design stress*—the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when internal hydrostatic water pressure is applied.

3.2.2 *relation between dimensions, hydrostatic design stress, and pressure rating*—the following expression, commonly known as the ISO equation,[7] is used in this specification to relate dimensions, hydrostatic design stress, and pressure rating:

$$2S/P = (D_0/t) - 1 \quad (1)$$

[1] This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin-Based Pipe.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.04.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[6] Available from the National Sanitation Foundation, P.O. Box 1468, Ann Arbor, MI 48106.

[7] ISO R161-1960, Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressures) Part 1, Metric Series.

where:
S = hydrostatic design stress, MPa (or psi),
P = pressure rating, MPa (or psi),
D_0 = average outside diameter, mm (or in.), and
t = minimum wall thickness, mm (or in.).

3.2.3 *standard dimension ratio (SDR)*—the ratio of outside diameter to wall thickness. For PB tubing, it is calculated by dividing the average outside diameter of the tubing in millimetres or in inches by the minimum wall thickness in millimetres or inches. If the wall thickness calculated by this formula is less than 0.062 in. (1.57 mm), it shall be arbitrarily increased to 0.062 in. The SDR values shall be rounded to the nearest 0.5.

3.2.4 *standard thermoplastic tubing materials designation code*—the tubing materials designation code shall consist of the abbreviation PB for the type of plastic, followed by the ASTM type and grade in Arabic numerals and the hydrostatic design stress in units of 100 psi with any decimal figures dropped. Where the hydrostatic design stress code contains less than two figures, a cipher shall be used before the number; thus a complete material code shall consist of two letters and four figures for PB plastic tubing materials (see Section 5).

3.2.5 *tubing pressure rating (PR)*—the estimated maximum pressure that water in the tubing can exert continuously with a high degree of certainty that failure of the tube will not occur.

4. Tubing Classification

4.1 *General*—This specification covers PB tubing in two standard dimension ratios, namely, 9 and 13.5. These are referred to as SDR9 and SDR13.5.

5. Materials

5.1 *General*—Polybutylene plastics used to make tubing meeting the requirements of this specification are categorized by means of two criteria, namely, (*1*) short-term strength tests, and (*2*) long-term strength tests. Since the maximum physical properties of the tubing are not developed until 10 days after extrusion, burst testing must be delayed for this period.

5.2 *Basic Materials*—This specification covers PB tubing made from PB plastic in accordance with Specification D 2581.

5.3 *Hydrostatic Design Stresses*—This specification covers PB tubing made from PB plastics as defined by hydrostatic design stress developed on the basis of long-term tests (Appendix).

NOTE 1—Information regarding the method of test and other criteria used in assigning this hydrostatic design stress may be obtained from the Plastic Pipe Institute.

5.4 *Compound*—The PB plastic extrusion compound shall meet the requirements of Type II, Grade 1, Class B with antioxidant, or Class C in accordance with Specification D 2581.

5.5 *Rework Material*—The manufacturers shall use only their own clean rework pipe material and the pipe produced shall meet all the requirements of this specification.

6. Requirements

6.1 *Workmanship*—The tubing shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other defects. The tubing shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

6.2 *Dimensions and Tolerances*:

6.2.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in Table 1 when measured in accordance with 7.4 and 7.4.1.

6.2.2 *Wall Thickness*—The wall thicknesses and tolerances shall be as shown in Table 2 when measured in accordance with 7.4 and 7.4.2.

6.2.3 *Wall Thickness Range*—The wall thickness range shall be within 12 % when measured in accordance with 7.4 and 7.4.2.

6.3 *Carbon Black*—The polybutylene tubing extrusion compound Type II, Grade 1, Class C, shall contain at least 2 % carbon black when tested in accordance with 7.5.

6.4 *Sustained Pressure*—The tubing shall not fail, balloon, burst, or weep as defined in Test Method 1598, at the test pressures given in Table 3 when tested in accordance with 7.6.

6.5 *Burst Pressure*—The minimum burst pressure for PB plastic tubing shall be as given in Table 4, when determined in accordance with 7.7.

6.6 *Elongation Value at Break*—The minimum pipe machine-direction elongation value at break shall exceed or equal an average of 125 % when samples are tested in accordance with 7.8.

7. Test Methods

7.1 *Conditioning*—Because of the crystalline transformation which takes place after polybutylene resins are cooled from the melt, it is necessary to delay physical testing until 10 days after extrusion. During this 10-day period, store the tubing at temperatures between 40 and 100°F. Take the test specimens after 8 days and condition 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. In cases of disagreement, the tolerances shall be ±1.8°F (1°C) and ±2 % relative humidity.

TABLE 1 Outside Diameters and Tolerances for PB Tubing

Nominal Tubing Size		Average Outside Diameter		Tolerances			
				For Average Diameter		For Maximum and Minimum[A] Diameter (Out-of-Roundness)	
(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.
(13)	½	(15.9)	0.625	(+0.20 −0.00)	+0.008 −0.000	(±0.38)	±0.015
(16)	⅝	(19.1)	0.750	(+0.20 −0.00)	+0.008 −0.000	(±0.38)	±0.015
(19)	¾	(22.2)	0.875	(+0.20 −0.00)	+0.008 −0.000	(±0.38)	±0.015
(25)	1	(28.6)	1.125	(+0.25 −0.00)	+0.010 −0.000	(±0.38)	±0.015
(32)	1¼	(34.9)	1.375	(+0.25 −0.00)	+0.010 −0.000	(±0.38)	±0.015
(38)	1½	(41.3)	1.625	(+0.30 −0.00)	+0.012 −0.000	(±0.38)	±0.015
(51)	2	(54.0)	2.125	(+0.30 −0.00)	+0.012 −0.000	(±0.38)	±0.015

[A] The maximum and minimum diameter (out-of-roundness) tolerances apply only to tubing before coiling.

TABLE 2 Wall Thicknesses and Tolerances for SDR-PR PB Plastic Tubing

Nominal Tubing Size		Wall Thickness[A]							
		SDR13.5				SDR9			
		Minimum		Tolerance		Minimum		Tolerance	
(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.
(13)	½	(1.57)	0.062	(+0.25)	+0.010	(1.75)	0.069	(+0.25)	+0.010
(16)	⅝	(1.57)	0.062	(+0.25)	+0.010	(2.13)	0.083	(+0.25)	+0.010
(19)	¾	(1.65)	0.065	(+0.25)	+0.010	(2.46)	0.097	(+0.25)	+0.010
(25)	1	(2.13)	0.083	(+0.25)	+0.010	(3.18)	0.125	(+0.30)	+0.012
(32)	1¼	(2.59)	0.102	(+0.25)	+0.010	(3.89)	0.153	(+0.38)	+0.015
(38)	1½	(3.05)	0.120	(+0.30)	+0.012	(4.60)	0.181	(+0.46)	+0.018
(51)	2	(4.01)	0.157	(+0.38)	+0.015	(5.99)	0.236	(+0.61)	+0.024

[A]The minimum is the lowest wall thickness of the tubing at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum requirement.

TABLE 3 Sustained Water Pressure Test Conditions for SDR-PR PB Plastic Tubing

Standard Dimension Ratio	Nominal Tubing Size		Pressure Required for Test, psi (MPa)[A]	
	in.	(mm)	at 73.4°F (23°C)	at 100°F (37.8°C)
9	all sizes	(all sizes)	475 (3.3)	(3.1) 450
13.5	½	(13)	440 (3.1)	(2.7) 395
13.5	⅝	(16)	360 (2.5)	(2.2) 325
13.5	¾ and larger	(19 and larger)	310 (2.1)	(2.0) 290

[A]The fiber stress used to derive these pressures for PB2110 at 3°F (23°C) is 2000 psi (13.8 MPa).
[B] The fiber stress used to derive these pressures for PB2110 at 100°F (37.3°C) is 1800 psi (12.4 MPa).

TABLE 4 Burst Pressure Requirements for Water at 73.4°F (23°C) for PB Plastic Tubing

Standard Dimension Ratio	Nominal Tubing Size		Minimum Burst Pressures, psi (MPa)[A]
	in.	(mm)	
9	all sizes	(all sizes)	550 (3.80)
13.5	½	(13)	480 (3.31)
13.5	⅝	(16)	395 (2.73)
13.5	¾ and larger	(19 and larger)	350 (2.41)

[A]The fiber stress used to derive this test pressure is 2200 psi (15.17 MPa).

7.2 *Test Conditions*—Conduct the test 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 method or in this specification. In cases of disagreement, the tolerances shall be ±1.8°F (1°C) and ±2 % relative humidity.

7.3 *Sampling*—The selection of the sample or samples of tubing shall be as agreed upon between the purchaser and the seller. In case of no prior agreement, any sample selected by the testing laboratory shall be deemed adequate.

7.3.1 *Test Specimens*—Not less than 50 % of the test specimens required for any pressure test shall have at least a part of the marking in their central sections. The central section is that portion of pipe which is at least one pipe diameter away from an end closure.

7.4 *Dimensions and Tolerances*—Use any length of tubing to determine the dimensions. Measure in accordance with Test Method D 2122.

7.4.1 *Outside Diameter*—Measure the outside diameter of the tubing in accordance with Test Method D 2122. The average outside diameter is the arithmetic average of the maximum and minimum diameter at any cross section. The tolerance for out-of-roundness shall apply only to tubing before shipment.

7.4.2 *Wall Thickness*—Make micrometer measurements of the wall thickness in accordance with Test Method D 2122 to determine the maximum and minimum values. Measure the wall thickness at both ends of the tubing to the nearest 0.001 in. (0.025 mm).

7.5 *Carbon Black*—Determine in duplicate the carbon black content of the tubing in accordance with Test Method D 1603.

7.6 *Sustained Pressure Test*—Select the test specimens at random. Test individually with water at two controlled temperatures under the pressures given in Table 3, twelve specimens of tubing, each specimen at least ten times the nominal diameter in length, but not less than 10 in. (25.4 cm) or more than 3 ft (91.4 cm) between end closures and containing the permanent marking on the pipe. Test six specimens at each temperature. Condition the specimens for at least 1 h to within 3.6°F (±2°C) of the specified test temperatures. Maintain the specimens at the pressures indicated for the appropriate temperatures for a period of 1000 h. Hold the pressure as closely as possible, but within ±10 psi (±0.07 MPa). Maintain the test temperatures within ±3.6°F (2°C) of the specified temperature. Test in accordance with Test Method D 1598, except maintain the pressure at the values given in Table 3 for 1000 h. Failure of two of the six specimens tested at either temperature constitutes failure in the test. Failure of one of six specimens tested at either temperature is cause for retest of six additional specimens at that temperature. Failure of one of six specimens tested at either temperature in retest constitutes failure in the test. Failure of the tubing shall be defined as in Test Method D 1598, namely:

7.6.1 *Failure*—Any continuous loss of pressure resulting from the transmission of the test liquid through the body of the specimen under test.

7.6.2 *Ballooning*—Any abnormal localized expansion of a tubing specimen while under internal hydraulic pressure.

7.6.3 *Bursting*—Failure by a break in the tubing with immediate loss of test liquid and continued loss at essentially no pressure.

7.6.4 *Seepage or Weeping*—Failure that occurs through essentially microscopic breaks in the tubing wall, frequently only at or near the test pressure.

NOTE 2—At lower pressures, the pipe may carry liquids without evidence of loss of liquids.

7.7 *Burst Pressure*—Determine the minimum burst pressure with at least five specimens in accordance with Test Method D 1599. The time of testing of each specimen shall be between 60 and 90 s.

NOTE 3—The burst pressure test may be made at other than the standard test temperature, 73.4 ± 3.6°F (23 ± 2°C), in which case the minimum burst pressure requirements shall be adjusted in accordance with the conversion factor or the equations given in Table 5. In case of disagreement, the standard test temperature shall be used.

7.8 *Elongation Value at Break*:

7.8.1 *Test Method*—The test method, test equipment, and test report shall be in accordance with Test Method D 1708, using Speed C, 0.4 to 0.5 in. (10 to 13 mm)/min. At least two (2) microtensile specimens[8] taken 180° from each other from a 3-ft length of pipe shall be a minimum of 10 days old or pressure aged for 10 min at 30 000 psi (2070 MPa), in accordance with Practice F 699. This test method shall be the referee procedure. (An alternative test method is described in Appendix X2.) If the average is more than 10 % below the minimum, the sample fails. If the average is within ±10 % of the minimum, a retest of five additional microtensile specimens shall be taken from the original sample. If the average of the retest specimens is below the minimum, the sample fails.

NOTE 4—Pipe manufacturers have found that pipe tested within 2 h of extrusion give elongation at break values correlating within ±10 % of those for aged pipe. These conditions may be considered in developing elongation values. In the case of disagreement between the seller and the purchaser, naturally or pressure-aged samples shall be used.

[8] Dies are available from M.S. Instrument Co., Castleton-on-Hudson, NY, and Testing Machine, Inc., Amityville, NY 11701.

TABLE 5 Conversion of Minimum Burst Pressures for PB Plastic Tubing in Table 4 to Equivalent Minimum Burst Pressures at Other Temperatures[A]

Test Temperature		Conversion Factor, *r*
°F	(°C)	
50	(10.0)	1.13
60	(15.6)	1.07
73.4	(23.0)	1.00
80	(26.7)	0.96
90	(32.2)	0.91
100	(37.8)	0.85

[A] The equations relating temperature to the conversion factor are as follows:
Celsius Scale:
Above 23.0, $T_C = 123.7 - 101r$
Below 23.0, $T_C = 165.6 - 140r$
Fahrenheit Scale:
Above 73.4, $T_F = 255 - 182\ r$
Below 73.4, $T_F = 328 - 250r$
When *r* is calculated it shall be rounded to the nearest 0.01.

8. Retest and Rejection

8.1 If the results of any test(s) do not meet the requirements of this specification, the test(s) shall be conducted again only by agreement between the purchaser and the seller. Under such agreement, minimum requirements shall not be lowered, changed, or modified, nor shall specification limits be changed. If upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9. Marking

9.1 Marking on the tubing shall include the following, spaced at intervals of not more than 2 ft:

9.1.1 Nominal pipe size (for example, 1 in.).

9.1.2 Type of plastic tubing material, in accordance with the designation code given in 3.2.4 (for example, PB2110).

9.1.3 Standard dimension ratio, SDR9 or SDR13.5.

9.1.4 Pressure rating for water at 73.4°F (23°C).

9.1.5 ASTM designation D 2666, with which the tubing complies.

9.1.6 Manufacturer's name (or trademark) and production code.

9.1.7 Tubing intended for the transport of potable water shall also include the seal or mark of the laboratory making the evaluation for this purpose, spaced at intervals specified by the laboratory.

NOTE 5—Manufacturers using the seal or mark of a laboratory must obtain prior authorization from the laboratory concerned.

10. Quality Assurance

10.1 When the product is marked with this designation, D 2666, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

These requirements apply *only* to federal/military procurement, not domestic sales or transfers.

S1. *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. Federal contracts, the contractor is responsible for inspection.

S2. *Packaging and Marking for U.S. Government Procurement:*

S2.1 *Packaging*—Unless otherwise specified in the contract, the material shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classifications rules or National Motor Freight Classifications rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

POTABLE WATER REQUIREMENT

This requirement applies whenever a Regulatory Authority or user calls for product to be used to convey or to be in contact with potable water.

S3. *Potable Water Requirement*—Products intended for contact with potable water shall be evaluated, tested and certified for conformance with ANSI/NSF Standard No. 61 or the health effects portion of NSF Standard No. 14 by an acceptable certifying organization when required by the regulatory authority having jurisdiction.

APPENDIXES

(Nonmandatory Information)

X1. SOURCE OF HYDROSTATIC DESIGN STRESSES

X1.1 The hydrostatic design stress recommended by the Plastic Pipe Institute is used to pressure rate PB plastic tubing. This hydrostatic design stress is 1000 psi (6.9 MPa) for water at 73.4°F (23°C). This hydrostatic design stress applies only to tubing meeting all the requirements of this specification.

X1.2 One PB tubing material is included based on the requirements of Specification D 2581 and the PPI-recommended hydrostatic design stress as follows:

X1.2.1 Type II, Grade 1, with a hydrostatic design stress for water at 73.4°F (23°C), designated as PB2110.

X1.3 Refer also to Test Method D 2837. Additional information regarding the method of test and other criteria used in developing these hydrostatic design stresses may be obtained from the Plastics Pipe Institute, a division of The Society of the Plastics Industry, 355 Lexington Ave., New York, NY, 10017. These hydrostatic design stresses may not be suitable for materials that show a wide departure from a straight-line plot of log stress versus log time to failure. All the data available to date on PB tubing materials made in the United States exhibit a straight-line plot under these plotting conditions.

X1.4 The tubing is rated for use with water at 73.4°F (23°C) at the maximum internal pressures shown in Table X1.1. Lower pressure ratings than those calculated in accordance with 3.2.2 may be recommended, at the option of the tubing manufacturer, in which case the SDR shall be included in the marking. Experience of the industry indicates that PB

TABLE X1.1 Standard Thermoplastic Pipe Dimension Ratios (SDR) and Water Pressure Rating (PR) at 73.4°F (23°C) for SDR-PR PB Plastic Tubing

Standard Dimension Ratio	Pressure Rating, psi (MPa) for PB2110
9	250 (1.72)
13.5	160 (1.10)

plastic tubing meeting the requirements of this specification gives satisfactory service under normal conditions for a long period at these pressure ratings. The sustained pressure requirements (see 6.4) are related to these ratings through the slopes of the strength-time plots of these materials in tubing form.

X1.5 The hydrostatic design stress recommended by the Plastic Pipe Institute are based on tests made on tubing ranging in size from ½ to 2 in.

X2. OPTIONAL TEST METHOD FOR ELONGATION VALUE AT BREAK

X2.1 Introduction—Because a tensiometer is costly and not readily available at most pipe extruder plants, a simplified quality control procedure has been established. A machinist vise may be modified as shown in Fig. X2.1 to allow clamping of die-cut microtensile specimen.[8] The draw rate should be uniform and approximately 0.4 to 0.5 in. (10 to 13 mm)/min. Microtensile specimens cut from pipe should be a minimum of 10 days old or pressure aged for 10 min at 30 000 psi (2070 MPa), in accordance with Practice F 699. (In view of the greater dependence on the operator in this optional method, in case of disagreement, Test Method D 1708 is the referee procedure.)

X2.1.1 *Procedure*

Die-cut at least two (2) microtensile specimens in accordance with Test Method D 1708, from a 3-ft length of 10-day-old or pressure-aged pipe, following the sampling procedure given in 7.8.1. Mount the specimen in the machinist vise in accordance with Fig. X2.1. The shoulder of the tensile specimen should be in line with the vise jaw faces. Tighten the grips evenly and firmly to the degree necessary to prevent slippage of the specimen during the test, but not to the point where the specimen would be crushed. Before extending the vise, measure the distance between jaw faces (gage length) with calipers or other measuring device to ±0.002 in. (0.050 mm). Extend the vise at approximately 0.5-in. (13- mm)/min jaw separation until rupture. Record the extension between jaws at rupture to ±0.002 in. Test remaining specimens in the same manner. Calculate the percentage elongation at break by dividing the change in gage length at rupture of specimen by the original distance between jaw faces (gage length) and multiply by 100. Report material identification, conditioning procedure, number of specimens tested, average value of percent elongation to three significant figures, standard deviation (if desired), and date of test.

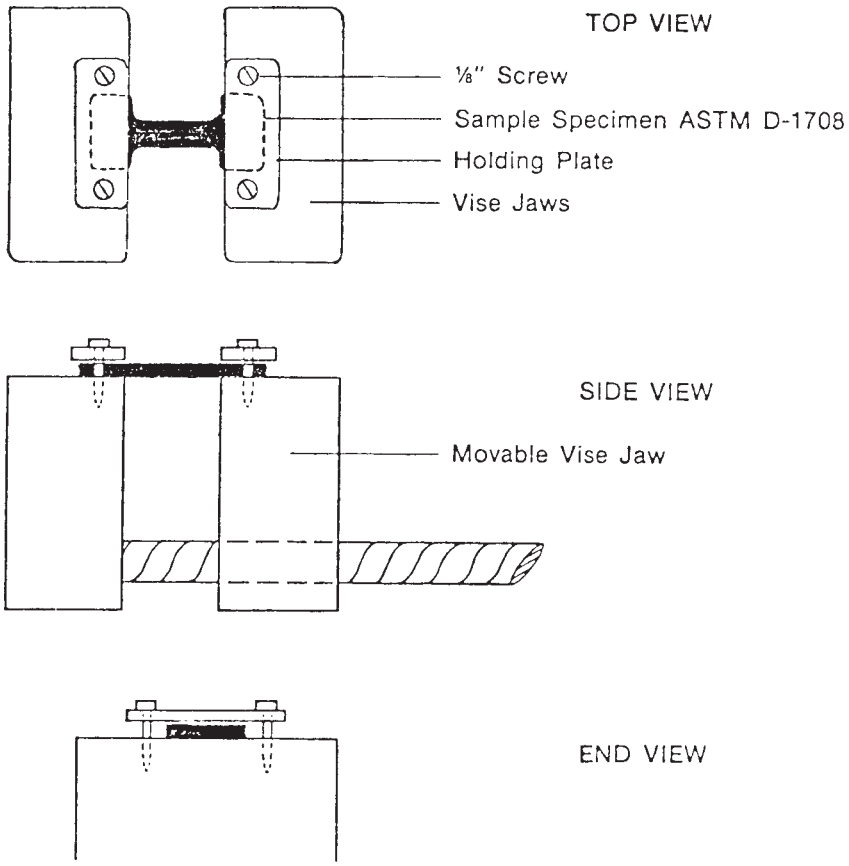

FIG. X2.1 Thin Wall Polybutylene Pipe Quality Control Use of Machinist Vise

X2.1.2 *Product Quality Control*

It is recommended that two samplings per 8 h be made per pipe size per extrusion outlet. Test results should be recorded and filed for inspection, on request. Should a component fail to meet the specification, production should be sampled back to the previous acceptable test result and tested to determine which components produced in the interim do not meet the requirement. Components that do not meet the requirements of this specification should be rejected.