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ASTM D 1599

Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings

Test Method:
This test method establishes the short-time hydraulic failure pressure of pipe and fittings. In simple terms this is burst test in which the test specimen is subjected to an increasing level of internal pressure until failure occurs. Failure is defined as the first weep or leaking of fluid. The minimum allowable time to failure is 60 seconds however the time to failure may be extended beyond 60 seconds yielding a more conservative result.

Use:
The most common use of the data obtained by this test is determination of the ultimate short term hoops stress value for pipe or determination of the ultimate short term pressure capability for a fitting or joint.

ASTM D 2105

Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube

Test Method:
This test method established the axial tensile loading properties of a pipe. A length of pipe is placed in tensile test machine and is subjected to an increasing axial tensile load until failure occurs. The length change of the specimen and the corresponding load is recorded at set intervals during the test. Strain gauges may be attached to the test specimen to measure dimensional changes in the axial and hoop directions.

Use:
The data obtained from this test is used to calculate ultimate axial tensile stress capability of a pipe section by dividing the load at break, by the reinforced end area of the pipe section. The length change of the specimen in the axial direct is used to calculate the axial tensile modulus of elasticity, which is a measure of how much something will "stretch" subject to tensile load. Poison's ratio can be determined from the hoop and axial strain gauge data.

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ASTM D 695

Standard Test Method for Compressive Properties of Rigid Plastics

Test Method:

This test method established the axial compressive loading properties of a pipe. A length of pipe is placed in compression test machine and is subjected to an increasing axial compressive load until failure occurs. The length change of the specimen and the corresponding load is recorded at set intervals during the test. Strain gauges may be attached to the test specimen to measure dimensional changes in the axial directions.

Use:

The data obtained from this test is used to calculate ultimate axial compressive stress capability of a pipe section by dividing the load at break, by the reinforced end area of the pipe section. The length change of the specimen in the axial direct is used to calculate the axial compressive modulus of elasticity, which is a measure of how much something will “compress” subject to compressive load.

ASTM D 2412

Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

Test Method:

This test method measures the hoop deflection of a short section of pipe when compressed between two flat parallel plates. A short length of pipe is loaded between two rigid parallel flat plates. The plates are moved together at a controlled rate, effectively flattening the pipe in the hoop direction. The load versus hoop deflection data is recorded. If cracking, crazing, de-lamination, or rupture occurs, the corresponding load and deflection are recorded.

Use:

Data obtained from this test is used to determine the load-deflection characteristics and pipe stiffness of the pipe, primarily used in burial design.

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ASTM D 2925

Standard Test Method for Beam Deflection of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe Under Full Bore Flow

Test Method:

This test method measures the deflection of a single span of simply supported fiberglass pipe under full bore water flow at elevated temperature. A section of pipe is placed on two pipe supports to create a single span. The pipe section is connected to a circulating hot water loop set at the desired test temperature. The mid span deflection of the pipe is measured and recorded at specific intervals over a minimum test time 1,000 hours.

Use:

Data obtained from this test is used to calculate the long term beam bending modulus of elasticity at various temperatures. The long term beam bending modulus of elasticity is used in calculate the maximum allowable unsupported span length for pipe.

ASTM D 4024

Standard Specification for Machine Made "Fiberglass'' (Glass-Fiber-Reinforced Thermosetting Resin) Flanges

Test Method:

Flanges shall meet the following performance requirements:

- **Sealing** - Flanges shall withstand a pressure of at least 1.5 times the rated design pressure without leakage for a period of 168 hours or longer.
- **Short-Term Rupture Strength** - Flanges shall withstand a short term internal pressure of at least four times their rated design pressure without damage to the flange.
- **Bolt Torque** - Flanges shall withstand a bolt torque of at least 1.5 times the published rating without visible signs of damage.

Use:

This specification covers only machine-made fiberglass flanges and establishes the requirements for materials, workmanship, performance, and dimensions.
This standard defines:

- Type – Method of manufacture
- Grade - Type of resin
- Class - Configuration of joining system
- Pressure rating

Flanges complying with this specification are also given numerical classifications relating to rupture pressure, sealing test pressure, and bolt torque limit. The test requirements provide classification and performance criteria for the purpose of qualifying the flanges published ratings.

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ASTM D 5685

Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings

This specification covers fiberglass fittings and established the requirements for materials, workmanship and performance.

This standard defines:

- Type - Method of manufacture
- Grade - Resin type
- Class - Liner type
- category - Configuration of joining system
- Pressure rating

The test requirements provide classification and performance criteria for the purpose of qualifying the published ratings for the fittings.

Elbow, couplings, tees, concentric reducers, flanges and joints in 3", 6", 12", 16" and 24" must be tested

Fittings, couplings, and connections shall meet the following qualification test requirements:

Short Term Pressure Strength - Each type of component and its field-jointed configuration shall be capable of sustaining a short-time hydrostatic pressure of at least (3) three times its static-rated pressure for 1 min without visible weeping or leakage.

Long Term Pressure Strength - Each type of component and its field-jointed configuration shall be capable of sustaining without leakage a minimum internal pressure of (2) two times the published static rating, at rated temperature. The minimum test duration is 168 hours for static rated components. The test should is conducted at maximum rated temperature for the component and joint.

Glass Transition Temperature (Tg) - The Tg for each resin used, as determined by thermal analysis shall be no less than a minimum statistically significant value established by the manufacturer. Samples shall be taken from manufactured fittings when thermal analysis testing is accomplished by differential-scanning-calorimeter (DSC).

Factory Leak Test –A factory leak test shall be conducted at a pressure of 1.5 times the pressure rating at a frequency determined by an agreement between the purchaser and the seller.

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ASTM D 2996

Standard Specification for Filament-Wound "Fiberglass'' (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

This specification covers machine-made reinforced thermosetting resin pressure pipe (RTRP) manufactured by the filament winding process up to 24 in. nominal size. The standard includes a material classification system and requirements for materials, mechanical properties, dimensions, performance, methods of test, and marking.

Pipe meeting this specification is classified by type, grade, class, and hydrostatic design basis in accordance with Classification D 2310 and by a secondary cell classification system that defines the basic mechanical properties of the pipe.

The type, grade, and class cell classification designations are:

- Types: Type 1 = Filament wound
- Grades Grade 1 = Glass fiber reinforced epoxy resin pipe
  Grade 2 = Glass fiber reinforced polyester (vinyl ester) resin pipe
  Grade 7 = Glass fiber reinforced furan resin pipe
- Classes Class A = No liner
  Class B = Polyester resin liner (nonreinforced)
  Class C = Epoxy resin liner (nonreinforced)
  Class E = Polyester resin liner (reinforced)
  Class F = Epoxy resin liner (reinforced)
  Class H = Thermoplastic resin liner (specify)
  Class I = Furan resin liner (reinforced)

Pipe meeting this specification must be tested to determine the following properties:

Hydrostatic Design Basis - Pipe meeting this specification shall be tested in accordance with ASTM D 2992 using either the static or cyclic test method to determine the long term pressure rating of the pipe

Short Term Burst Strength. – Pipe shall be tested per ASTM D 1599 to determine the short term internal pressure capability.

Longitudinal Tensile Strength – Pipe shall be tested per ASTM D 2105 to determine the longitudinal (axial) tensile strength.

Longitudinal Tensile Modulus – Pipe shall be test per ASTM D 2105 to determine the longitudinal (axial) tensile modulus of elasticity

Pipe Stiffness – Pipe shall be tested in accordance with ASTM D 2412 to determine the stiffness factor.

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ASTM D 2997

Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

This specification covers machine-made reinforced thermosetting resin pressure pipe (RTRP) manufactured by the centrifugal casting process. The standard includes a material classification system and requirements for materials, mechanical properties, dimensions, performance, methods of test, and marking.

Pipe meeting this specification is classified by type, grade, class, and hydrostatic design basis in accordance with Classification D 2310 and by a secondary cell classification system that defines the basic mechanical properties of the pipe.

The type, grade, and class cell classification designations are:

- Types: Type 2 = Centrifugally cast
- Grades Grade 1 = Glass fiber reinforced epoxy resin pipe
  Grade 2 = Glass fiber reinforced polyester (vinyl ester) resin pipe
  Grade 3 = Glass-fiber reinforced polydicyclopentadiene resin pipe
  Grade 7 = Glass fiber reinforced furan resin pipe
  Grade 8 = Glass-fiber-reinforced polyester-resin mortar pipe.
  Grade 9 = Glass fiber reinforced epoxy resin mortar pipe
- Classes Class A = No liner
  Class B = Polyester resin liner (nonreinforced)
  Class C = Epoxy resin liner (nonreinforced)
  Class D = Polydicyclopentadiene-resin liner, (nonreinforced)

Pipe meeting this specification must be tested to determine the following properties:

Hydrostatic Design Basis - Pipe meeting this specification shall be tested in accordance with ASTM D 2992 using either the static or cyclic test method to determine the long term pressure rating of the pipe

Short Term Burst Strength. – Pipe shall be tested per ASTM D 1599 to determine the short term internal pressure capability.

Longitudinal Tensile Strength – Pipe shall be tested per ASTM D 2105 to determine the longitudinal (axial) tensile strength.

Longitudinal Tensile Modulus – Pipe shall be test per ASTM D 2105 to determine the longitudinal (axial) tensile modulus of elasticity

Pipe Stiffness – Pipe shall be tested in accordance with ASTM D 2412 to determine the stiffness factor.

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ASTM D 2992

Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

This standard established the procedures, for obtaining the hydrostatic design basis (HDB) or a pressure design basis (PDB) for fiberglass piping products, by evaluating strength-regression data derived from testing pipe or fittings. The data obtained from this test method is used for establishing the hoop stress or internal pressure versus time-to-failure relationships, at selected temperatures which simulate actual anticipated product end-use conditions. This pressure versus time to failure data is used to establish the pressure rating for specific a piping product. This practice defines an HDB for material in straight, hollow cylindrical shapes where hoop stress can be easily calculated, and a PDB for fittings and joints where stresses are more complex.

The standard allows two test procedures:

Procedure A - A minimum of 18 specimens of pipe or fittings, or both are placed under cyclic internal pressures at a cycle rate of 25 cycles per minute, at several different pressures. The stress or pressure values for test shall be selected to obtain a distribution of failure points as follows:

Cycles to Failure	Failure Points
1,000 to 10,000	at least 3
10,000 to 100,000	at least 3
100,000 to 1,000,000	at least 3
1,000,000 to 10,000,000	at least 3
After 15,000,000	at least 1
	Total at least 18

The cyclic Long Term Hydrostatic Strength (LTHS) of a pipe is obtained by an extrapolation of a log-log plot of the linear regression line for hoop stress versus cycles to failure.

Procedure B - A minimum of 18 specimens of pipe or fittings, or both, are placed under constant internal pressures at differing pressure levels in a controlled temperature environment. The time to failure for each pressure level is recorded. The stress or pressure values for test shall be selected to obtain a distribution of failure points as follows:

Hours to Failure	Failure Points
10 to 1,000	at least 4
1,000 to 6,000	at least 3
After 6,000	at least 3
After 10,000	at least 1
	Total at least 18

The static Long Term Hydrostatic Strength (LTHS) of a pipe is obtained by an extrapolation of a log-log linear regression line for hoop stress versus time to failure.