Chapter 1

History and Use

1.1 INTRODUCTION

Fiberglass pipe is made from glass fiber reinforcements embedded in, or surrounded by, cured thermosetting resin. This composite structure may also contain aggregate, granular, or platelet fillers; thixotropic agents; and pigments or dyes. By selecting the proper combination of resin, glass fibers, fillers, and design, the fabricator can create a product that offers a broad range of properties and performance characteristics. Over the years, the diversity and versatility of materials used to manufacture fiberglass pipe have led to a variety of names for fiberglass pipe. Among these are reinforced thermosetting resin pipe (RTRP), reinforced polymer mortar pipe (RPMP), fiberglass reinforced epoxy (FRE), glass reinforced plastic (GRP), and fiberglass reinforced plastic (FRP). Fiberglass pipes have also been categorized by the particular manufacturing process—filament winding or centrifugal casting. Frequently, the particular resin used to manufacture the fiberglass pipe—epoxy, polyester, or vinyl ester—has been used to classify or grade fiberglass pipes.

Regardless of the many possible combinations, the most common and useful designation is simply "fiberglass pipe." This name encompasses all of the various available products and allows consideration as a unique and general class of engineering materials.

1.2 HISTORY

Fiberglass pipe was introduced in 1948. The earliest application for fiberglass piping, and still one of the most widely used, is in the oil industry. Fiberglass pipe was selected as a corrosion-resistant alternative to protected steel, stainless steel, and other more exotic metals. Product lines expanded to include applications of increasingly high pressure and down-hole tubing with threaded connections. In the late 1950s, larger diameters became

available and fiberglass pipe was increasingly used in the chemical process industry because of the pipe's inherent corrosion-resistant characteristics.

Since the 1960s, fiberglass pipe products have been used for municipal water and sewage applications. Fiberglass pipe combines the benefits of durability, strength, and corrosion resistance, thus eliminating the need for interior linings, exterior coatings, and cathodic protection. Fiberglass pipe systems offer great design flexibility with a wide range of standard pipe diameters and fittings available, as well as an inherent ability for custom fabrication to meet special needs. Fiberglass pipe is available in diameters ranging from 1 in. through 144 in. (25 mm through 3,600 mm). Fiberglass pipe is available in pressure classes ranging from gravity applications through several thousand pounds per square inch (kilopascals). Few countries in the world have not used fiberglass pipe.

1.3 APPLICATIONS

Fiberglass pipe is used in many industries and for a myriad of applications, including

- chemical processes
- desalination
- down-hole tubing and casing
- ducting and vent piping
- geothermal
- industrial effluents
- irrigation
- oil fields
- potable water
- power plant cooling and raw water
- sanitary sewers
- seawater intake and outfalls
- slurry piping
- storm sewers
- water distribution
- water transmission

1.4 STANDARDS, SPECIFICATIONS, AND REFERENCE DOCUMENTS

Many organizations have published nationally recognized standards, test methods, specifications, and recommended practices on fiberglass piping systems and products. These organizations include the American Society for Testing and Materials (ASTM), the American Petroleum Institute (API), the American Society of Mechanical Engineers (ASME), the NSF International (NSF), Underwriters Laboratories (UL), Factory Mutual Research (FM), the American National Standards Institute (ANSI), and the International Organization for Standardization (ISO).

Following is a list of fiberglass pipe standards and specifications that are commonly used in specifying, testing, and using fiberglass piping systems.

1.4.1 Product Specifications and Classifications

General

ASTM D2310	Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2517	Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM D2996	Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe (Applicable to epoxy, polyester, and furan resins in sizes from 1 in. to 16 in.[25 mm to 400 mm].)
ASTM D2997	Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe (Applicable for 1 in. through 14 in. [25 mm through 350 mm] pipe of polyester or epoxy resins.)
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe (Applicable for pipes 8 in. through 144 in. [200 mm through 3,700 mm] diameter, with or without siliceous sand, and polyester or epoxy resin.)
ASTM D3517	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe (Applicable for pipes 8 in. through 144 in. [200 mm through 3,700 mm] diameter, with or without siliceous sand, and polyester or epoxy resin.)
ASTM D3754	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe (Applicable for 8 in. through 144 in. [200 mm through 3,700 mm] diameter, with or without siliceous sand, and polyester or epoxy resin.)
ASTM D4024	Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Flanges (Applicable for ½ in. through 24 in. [13 mm through 600 mm] ANSI B16.5 150 lb [70 kg] bolt circle flanges.)
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F1173	Standard Specification for Thermosetting Resin Fiberglass Pipe Systems to Be Used for Marine Applications
API 15LR	Specification for Low Pressure Fiberglass Line Pipe (Applicable to 2 in. through 24 in. [50 mm through 600 mm] diameter pipe of epoxy or polyester resin for use at cyclic pressures to 1,000 psi [6,895 kPa].)
API 15HR	Specification for High Pressure Fiberglass Line Pipe (Applicable to 1 in. through 10 in. [25 mm through 250 mm] pipe and fittings for operating pressures of 500 psi [3,500 kPa] to 5,000 psi [35,000 kPa].)
ANSI/AWWA C950	AWWA Standard for Fiberglass Pressure Pipe

US military (MIL) specifications

MIL P24608	Specification for epoxy resin pipe from ½ in. through 12 in. (13 mm through 300 mm) diameters for 200 psig (1,379 kPa) service at 150°F (66°C) for US Navy shipboard applications
MIL P28584A	Specification for epoxy resin pipe and fittings from 2 in. through 12 in. (50 mm through 300 mm) diameter for use as Steam Condensate Return Lines in continuous service at 125 psig (862 kPa) and 250°F (121°C)
MIL P29206A	Specification for epoxy or polyester pipe and fittings 2 in. through 12 in. (50 mm through 300 mm) in diameter for POL services to 150°F (66°C) and 150 psig (1,034 kPa) with surges to 250 psig (1,724 kPa)

1.4.2 Recommended Practices

Dimensions

ASTM D3567	Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

Installation

ASTM D3839	Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
API RP15TL4	Care and Use of Fiberglass Tubulars
API RP1615	Installation of Underground Petroleum Storage Systems

1.4.3 Standard Test Methods

Tensile properties

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D1599	Standard Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings
ASTM D2105	Standard Test Method for Longitudinal Tensile Properties of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube
ASTM D2290	Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe

Compressive properties

ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics

Bending properties

ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2925	Standard Test Method for Beam Deflection of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Under Full Bore Flow

Long-term internal pressure strength

ASTM D1598	Standard Test Method for Time to Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D2143	Standard Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe
ASTM D2992	Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

Pipe stiffness

ASTM D2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading

External pressure

ASTM D2924	Standard Test Method for External Pressure Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

Chemical resistance

ASTM C581	Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures Intended for Liquid Service
ASTM D3681	Standard Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition
ASTM D5365	Standard Test Method for Long Term Ring Bending Strain of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

1.4.4 Product Listings, Approvals, and Piping Codes

NSF International—Standard Numbers 14 and 61. Tests and lists fiberglass pipe, fittings, and adhesives for use in conveying potable water. Additionally, tests and certifies products as to their classification to an applicable national standard or for special properties (Standard 14 only).

Underwriters Laboratories Inc. Provides established standards for testing and listing fiberglass pipe for use as underground fire water mains and underground transport of petroleum products.

Factory Mutual Research. Has established an approval standard for plastic pipe and fittings for underground fire protection service.

ANSI/ASME B31.1—Power Piping Code. This code prescribes minimum requirements for the design, materials, fabrication, erection, testing, and inspection of power and auxiliary service piping systems for electric generation stations, industrial institutional plants, and central and district heating plants.

ANSI/ASME B31.3—Chemical Plant and Petroleum Refinery Piping Code. This code lists some ASTM, AWWA, and API fiberglass pipe specifications as acceptable for use within the code and establish criteria for their installation and use. These codes, in addition to other ASME codes, establish rules regarding the application of fiberglass piping and provide engineering guidance for the use of fiberglass materials.

ANSI/ASME B31.8—Gas Transmission and Distribution Piping Systems Code. This code lists fiberglass pipe manufactured in compliance with ASTM D2517 as acceptable for use within the code.

Department of Transportation, Title 49, Part 192. This is a code of federal regulations that covers the transportation of natural and other gases by pipeline. Minimum federal standards are included.

ASME Boiler and Pressure Vessel Code Case N155. This code provides the rules for the construction of fiberglass piping systems for use in section III, division I, class 3 applications in nuclear power plants.

1.4.5 International Organization for Standardization Standards and Specifications (ISO)

ISO has issued many standards, test methods, and technical reports relating to fiberglass piping systems and products. Many of their titles, as well as the general content, are very similar to the US-issued standards covered previously.

Product specifications

ISO 10467	Plastics piping systems for pressure and non-pressure drainage and sewerage—Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin
ISO 10639	Plastics piping systems for pressure and non-pressure water supply—Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin

Test methods

ISO 7432	Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals
ISO 7509	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes—Determination of time to failure under sustained internal pressure
ISO 7510	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) components—Determination of the amounts of constituents using the gravimetric method
ISO 7511	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Test methods to prove the leak tightness of the wall under short-term internal pressure
ISO 7684	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes—Determination of the creep factor under dry conditions
ISO 7685	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes—Determination of initial specific ring stiffness
ISO 8483	Plastics piping systems from pressure and nonpressure drainage and sewerage glass-reinforced thermosetting plastics (GRP) systems based on polyester (UP) resin—Test methods to prove the design of bolted flanged joints
ISO 8513	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes—Determination of longitudinal tensile properties

ISO 8521	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes—Test methods for the determination of the apparent initial circumferential tensile strength
ISO 8533	Plastics piping systems for pressure and nonpressure drainage and sewerage glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin—Test methods to prove the design of cemented or wrapped joints
ISO 8639	Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Test methods for leak tightness of flexible joint
ISO 10466	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes—Test method to prove the resistance to initial ring deflection
ISO 10468	Glass-reinforced thermosetting plastics (GRP) pipes—Determination of the long-term specific ring creep stiffness under wet conditions and the calculation of the wet creep factor
ISO 10471	Glass-reinforced thermosetting plastics (GRP) pipes—Determination of the long-term ultimate bending strain and the long-term ultimate relative ring deflection under wet conditions
ISO 10928	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Methods for regression analysis and their use
ISO 10952	Plastics piping systems—Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Determination of the resistance to chemical attack from the inside of a section in a deflected condition
ISO 14828	Glass-reinforced thermosetting plastics (GRP) pipes—Determination of the long-term specific ring relaxation stiffness under wet conditions and the calculation of the wet relaxation factor
ISO 15306	Glass-reinforced thermosetting plastics (GRP) pipes—Determination of the resistance to cyclic internal pressure

Technical reports

ISO/TR 10465-1	Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes—Part 1: Installation procedures
ISO/TR 10465-2	Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes—Part 2: Comparison of static calculation methods
ISO/TR 10465-3	Underground installation of flexible glass-reinforced thermosetting resin (GRP) pipes—Part 3: Installation parameters and application limits

1.5 TERMINOLOGY

Fiberglass pipe users may encounter some unique or unfamiliar terminology. A glossary of terms used in this manual and by those in the fiberglass pipe industry is provided at the end of this manual.