Manufacturing

3.1 INTRODUCTION

Machine-made fiberglass pipe is produced using two basic processes: filament winding and centrifugal casting. Each process produces a pipe with characteristics that, although unique and advantageous for some applications, will meet the performance requirements of ANSI/AWWA Standard C950, Fiberglass Pressure Pipe.

3.2 FILAMENT WINDING

Filament winding is the process of impregnating glass fiber reinforcement with resin, then applying the wetted fibers onto a mandrel in a prescribed pattern. Fillers, if used, are added during the winding process. Chopped glass rovings may be used as supplemental reinforcement. Repeated application of wetted fibers, with or without filler, results in a multilayered structural wall construction of the required thickness. After curing, the pipe may undergo one or more auxiliary operations such as joint preparation. The inside diameter (ID) of the finished pipe is fixed by the mandrel outside diameter (OD). The OD of the finished pipe is variable and determined by the pipe wall thickness.

The filament winding process is illustrated in Figure 3-1. Within the broad definition of filament winding, several methods are used, including reciprocal, continuous, multiple mandrel, and ring and oscillating mandrel, each of which is described briefly. Figure 3-2 shows the application of impregnated glass reinforcement onto a mandrel during production of a filament-wound pipe.

3.2.1 Reciprocal Method

The reciprocal method is the most widely used filament winding production method. In this method, the fiber placement head with the associated resin bath drives back and
forth past a rotating mandrel (see Figure 3-1). The angle of fiber placement relative to the mandrel axis is controlled by the synchronized translational speed of the bath and the rotational speed of the mandrel.

### 3.2.2 Continuous Methods

In one type of continuous process, pipe is made on one or more mandrels, which move past stations that apply fiberglass tapes preimpregnated with resin or glass fiber and resin. The winding angles are controlled through a combination of longitudinal mandrel speed, mandrel rotation (if used), or the rotation of planetary glass application stations. Once started, these methods produce pipe continuously, stopping only to replenish or change material components.

A second type of continuous process is the continuous advancing mandrel, which is composed of a continuous steel band supported by beams, which form a cylindrically shaped mandrel. The beams rotate, friction pulls the band around, and roller bearings allow the band to move longitudinally so that the entire mandrel continuously moves in a spiral path toward the end of the machine. Raw materials (continuous fibers, chopped fibers, resin, and aggregate fillers) are fed to the mandrel from overhead. Release films and surfacing materials are applied from rolls adjacent to the mandrel. After curing, a synchronized saw unit cuts the pipe to proper length. This method is illustrated in Figure 3-3. Finished pipe emerging from the curing oven is shown in Figure 3-4.

### 3.2.3 Multiple-Mandrel Method

In the multiple-mandrel method, a single materials-application system applies wetted glass reinforcement simultaneously to two or more mandrels. When the winding operation finishes, the mandrels are indexed to a new position for curing while another set of mandrels is wound.

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*Figure 3-1  Filament winding process*
Figure 3-2  Application of impregnated glass reinforcement of a filament-wound pipe

Source: Floxtite Technology, Sandefjord, Norway.

Figure 3-3  Continuous advancing mandrel method
### 3.2.4 Ring and Oscillating Mandrel Method

The use of 360° glass delivery systems, sometimes in combination with an oscillating mandrel, allows production with both high- and low-winding angles as single circuit patterns (without interlayer crossovers).

*Source: Flowtite Technology, Sandefjord, Norway.*

#### Figure 3-4 Finished pipe emerging from curing oven

- Insert Fiberglass, Remove Mandrel
- Inject Catalyzed Resin in Rotating Mold Tube
- Air Blower to Remove Heat Generated by Exothermic Reaction of the Resin and Catalyst

*Figure 3-5 Preformed glass reinforcement sleeve method*
3.3 CENTRIFUGAL CASTING

Centrifugal casting is used to manufacture tubular goods by applying resin and reinforcement to the inside of a mold that is rotated and heated, subsequently polymerizing (curing) the resin system. The OD of the finished pipe is determined by the ID of the mold tube. The ID of the finished pipe is variable and determined by the amount of material introduced into the mold. Other materials, such as sand or fillers, may be introduced in the process during manufacture of the pipe.

Two different methods of centrifugal casting are used and are described briefly.

1. *Preformed glass reinforcement sleeve method.* A preformed glass reinforcement sleeve is placed inside a steel mold. As the steel mold rotates, resin and a filler, if used, are placed within the mold by means of a feed tube that moves in and out of the mold, thus wetting out the preformed sleeve. This method is illustrated in Figure 3-5.

2. *Chopped glass reinforcement method.* Varying proportions of chopped glass reinforcement, resin, and aggregate are introduced simultaneously, by layer, from a feeder arm that moves in and out of the mold. This method is illustrated in Figure 3-6. Application of glass, resin, and sand within a rotating mold is shown in Figure 3-7.

*Source: Hobas Pipe USA Inc., Houston, Texas.*

*Figure 3-6  Chopped glass reinforcement method*
Source: Hobas Pipe USA Inc., Houston, Texas.

Figure 3-7  Application of glass, resin, and sand

3.4  REFERENCE