

# **CHAPTER I: TYPE OF PIPES**

The materials used for manufacturing pipelines vary in nature, manufacturing method, physical characteristics, installation techniques, and cost. Despite these differences, they all share a common point: advancements in their properties enable optimal use depending on site conditions and installation techniques. Current trends focus on using excavated soil for backfilling, reducing construction time, ensuring the longevity of the network, and minimizing environmental impact during installation and use.

The selection of materials for piping depends on various factors, including the distribution network, conveyance (typically made of cast iron, steel, concrete, or prestressed concrete), and special structures. The chosen material must be capable of withstanding pressure and maintaining a circular cross-section; commonly used materials include cast iron, steel, concrete, and plastics.

## **IV.1. Nature of Pipes**

### **IV.1.1. Technical Constraints**

The constraints related to the interior of the pipe are of a physical, chemical, and biological nature.

#### **IV.1.1.1. Physical Constraints**

Relatively high pressures, up to 16 bars for standardized pipelines.

a) **Hydraulic Behavior:** This refers to the ease of water flow. This can be achieved by the inherent properties of the material constituting the pipe's structure or by internal coatings, most often made of cement mortar or even epoxy resin. This results in low roughness coefficients, which minimize head losses and optimize energy expenditure, particularly in pumping. With certain waters, insufficiently cleared of suspended matter or prone to scaling, this roughness can, over time, facilitate deposits that may lead to an almost complete obstruction of the pipe's cross-section. Depending on the case, the phenomena involved are physical and/or chemical, as indicated below.

b) **Chemical Constraints:** The aforementioned coatings, as well as the inert nature of certain pipes, also aim to limit corrosion phenomena induced by the quality of the transported water (acidic pH, low buffering capacity, etc.). This chemical optimization prevents certain undesirable sanitary deposits and the formation of rough internal layers (see above). Obstructions due to scale (generally calcite or aragonite) and those due to iron are the most common and the most dramatic. The structure in contact with the water must not alter its organoleptic qualities, and even less release undesirable or even toxic substances.

c) **Biological Constraints:** The nature of the internal layer must not facilitate the growth or revival of microorganisms that could be pathogenic, nor of higher organisms such as *Asellus*

*aquaticus* (microscopic crustacean), chironomid larvae (mosquitoes), etc. It should be noted, however, that the interior of operational pipelines is not a sterile environment: there exists, particularly along the internal wall, a "biofilm" that must be controlled.

The exterior of the pipes is also subject to three types of constraints:

**a) Chemical Constraints:**

The nature of the soil, particularly its moisture and aggressiveness, are factors contributing to corrosion.

**b) Mechanical Constraints:**

Soil stability, sudden temperature variations, accidental punctures, vibrations, etc., are factors that can lead to breakage. The thickness of the pipes, depending on the constituent material, also responds to mechanical constraints, particularly pressure and potential vacuum conditions.

**c) Electrical Constraints:**

Depending on the type of pipe, this constraint more or less directly affects the exterior of the pipe; so-called "stray currents" found in the soil have very diverse origins: somewhat mysterious telluric currents, currents related to third-party cathodic protections, currents related to rails, etc.

#### **IV.1.2. Constituent Materials, Coatings**

Pipes can be made of a single material or have a composite structure:

**a) Single Material:**

These include cast iron, particularly ductile iron, polyvinyl chloride (PVC), polyethylene (PE), steel, and certain non-reinforced concretes. Lead is prohibited. In internal networks, copper, galvanized metal, and PVC are found.

**b) Composite Material:**

The main one is concrete with a Bonna steel core; glass-reinforced polyester (GRP) should also be mentioned. Asbestos-cement pipes are now prohibited for installation, and various PVC pipes reinforced with fiberglass are no longer produced. Given the constraints mentioned earlier, single-material pipes are very often coated internally, or even both internally and externally. Current internal coatings are based on cement or epoxy resin. Externally, bituminous or epoxy paints are often used.

#### **IV.1.3. Connections, Diameters, Lengths**

Pipes can also be classified based on the types of connections used, which fall into three main categories:

**a) Socket Joint Connection:**

This typically involves a joint to ensure sealing. Pipes made of cast iron, PVC, concrete with a steel core, and GRP (glass-reinforced polyester) fall into this category. These connections almost always require an additional thickness compared to the external diameter of the pipe; as a result, installation techniques such as thrust boring or drilling are not always feasible.

**b) Welded Connection:**

These techniques are reserved for polyethylene (electrofusion using couplers or "butt welding"), steel, and sometimes the steel part of concrete with a steel core pipes. Due to the additional thickness of the coupler, PE welded in this manner is also poorly suited for drilling and thrust boring.

**c) Glued Connection:**

Small-diameter PVC pipes can also be assembled using glue. Pipes are most often supplied in straight lengths of 6 meters, except for PE pipes, which come in coils of several hundred meters depending on the diameter. This latter form facilitates their use in thrust boring or drilling for diameters ranging from 100 to 400 mm.