



# Process Piping - Materials

An Online Continuing Education Course for Engineers

**Course Number: M-6022**

**Credit: 6 Hours / 6 PDH / 6 CPD**

# Process Piping - Materials

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Pipe materials are selected on the basis of service requirements, the most important being strength and corrosion resistance (stability). In making a choice, it is necessary to know what materials are available and to what extent they are suited to the specific application. The decision is quite involved and the choice is significantly affected by the environment and intended use. Some problems may occur because of distortion and cracking caused by thermal expansion/contraction; typically, a high-temperature alloy might change 4 inches per ft., from ambient to 1,000°C (1,832°F).

This 6-hour course provides fundamental knowledge of the design and selection of process piping materials. It covers guidance on the applicable codes and materials. It gives pertinent information on the most common ASME/ASTM codes and material standards, while highlighting the applications for which these are suited.

This course is the 2<sup>nd</sup> of 9 modules in a series that covers the entire gamut of piping engineering. All topics are introduced to readers with no or limited background on the subject.

The course material is divided into four (4) distinct chapters as follows:

**CHAPTER -1: PIPING MATERIAL SELECTION & CHARACTERISTICS**

This chapter discusses the selection criteria for piping materials covering service life, temperature, and pressure and corrosion considerations. It discusses the characteristics of piping materials required to prevent failures resulting from environment, normal operation time exposure and upset conditions.

**CHAPTER – 2: MATERIALS – METALLIC PIPING**

This chapter discusses the most commonly used ASTM material designation standards for carbon steel, stainless steel, alloy steels, duplex steel, cast iron, copper, aluminium; titanium and other materials. It gives pertinent information on all relevant ASME/ASTM codes and standards highlighting the applications for which these are suited.

**CHAPTER -3: SPECIAL PIPING MATERIALS**

This chapter discusses some specific considerations for piping selection for extreme high and cold temperatures. It provides specific information for the hydrocarbon industry and piping selection issues for mitigating the effects of Wet CO<sub>2</sub> corrosion, hydrogen exposure,

offshore environment, sulfides and sulfurous gases, halogenation environments, carburizing, nitriding, sulfur, amine, caustic and chloride environments. Other applications include cooling water, fire water, sour water services and Microbiological Induced Corrosion (MIC).

#### CHAPTER – 4: MATERIALS – UNDERGROUND PIPING

This chapter discusses the piping materials for underground services. Ductile iron, concrete pipes, plastic materials such as polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), fiber reinforced plastic (FRP), reinforced polymer mortar (RPMP), polypropylene (PP), high density polyethylene (HDPE), cross-linked high-density polyethylene (PEX), polybutylene (PB), and acrylonitrile butadiene styrene (ABS) are discussed.

# CHAPTER - 1

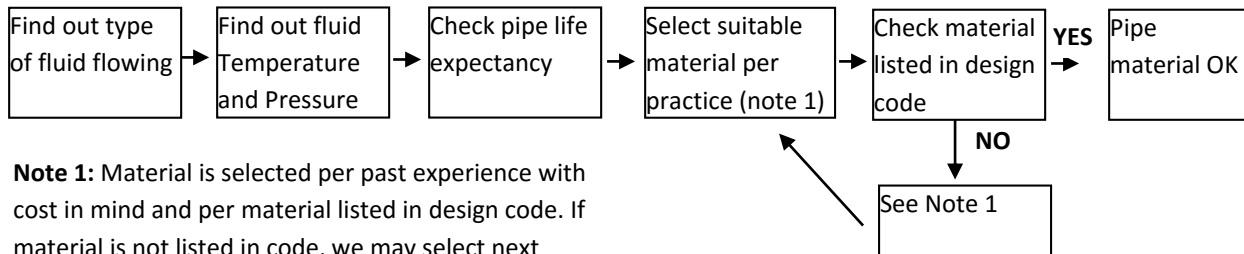
## PIPING MATERIAL SELECTION & CHARACTERISTICS

### 1. Pipe Material Selection

Appropriate material selection is the cornerstone of pressure equipment and piping design. The primary objective in materials selection is the achievement of metallurgical stability to prevent failure resulting from environment, normal operation time exposure and upset conditions. The secondary objective is the economy for the achievement of design life through the use of appropriate materials of construction.

The process consists of following steps:

#### Pipe Material Selection



**Note 1:** Material is selected per past experience with cost in mind and per material listed in design code. If material is not listed in code, we may select next suitable material listed.

#### 1.1. Selection Criteria

The material selection may involve several factors such as high strength requirements combined with high corrosion resistance of the material.

The first step is to understand the plant processes and environmental conditions to which the plant will be subjected.

- The process information can be obtained from Process Flow Diagrams (PFD) and Heat and Material Balance spread sheets provided by the Process Engineering Discipline.
- The environmental exposure conditions can be obtained on the basis of the design document.

Once this information is collected, a material selection philosophy is developed and discussed with the owner. When the philosophy is agreed to, the next step is to create Material Selection Diagrams (MSD). Once issued, these drawings are used by the other engineering disciplines to ensure that the selected materials are properly utilized. Material Selection Diagrams (MSDs) provide a summary of the process loop conditions and the selected materials of construction. Material selection is based on:

- Fluid composition. A chemical analysis of the produced fluids is generally required for an evaluation of the corrosive components such as hydrogen sulfide, carbon dioxide and chlorides. Other components like scaling potential, water content, temperature profile, pressure profile and stresses on the piping and tubulars are also to be considered.
- Economic and practical considerations (purchasing, constructability, etc.) – total installed cost.
- Maximum normal operations pressure, temperature, pH, velocity, dew point, phase, and process fluid composition including contaminants.
- Start-up, shutdown, and upset conditions.
- Cyclic service and steam-out operations.

The basis of material selection will be under:

#### **1.1.1. Design Life**

The design life is the length of time the pipe must provide adequate performance. In comparison, the length of time a pipe is estimated to provide adequate performance before maintenance, repair, or replacement is its service life. The service life should be equal to or in excess of the design life.

The following are the general guidelines to be considered while designing the systems.

- Alloy steel piping / stainless steel piping – 20 years of service life minimum.
- Carbon steel piping – 15 years of service life minimum.

Corrosion can cause a pipe to deteriorate and will shorten its service life.

#### **1.1.2. Code Requirements**

The governing Code may depend upon the area where the unit is installed. Power generation applications may fall under the Power Piping Code (ASME B31.1), while units installed in chemical plants or refineries may be covered by the Process Piping Code (ASME B31.3). Each Code has design and material requirements for high temperature applications. Most requirements are the same in both Codes, but there are exceptions. Of note, tubing manufactured to ASTM Standard A-213 is accepted by the Power Piping Code, but not the Process Piping Code. The reverse is true for tubing manufactured to ASTM Standard A-269. This is not necessarily a problem as most tubing materials are available under both specifications. Also, the Code allows for materials not specifically recognized to be used as long as they are qualified for the application.

