Process Piping - Fundamentals, Codes and Standards

An Online Continuing Education Course for Engineers

Course Number: M-5021

Credit: 5 Hours / 5 PDH / 5 CPD

Process Piping - Fundamentals, Codes and Standards

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Process Piping Fundamentals, Codes and Standards

One of the most important components of the process infrastructure is the vast network of pipelines —literally millions and millions of miles. The term process piping generally refers to the system of pipes that transport fluids (e.g. fuels, chemicals, industrial gases, etc.) around an industrial facility involved in the manufacture of products or in the generation of power. It also is used to describe utility piping systems (e.g., air, steam, water, compressed air, fuels etc.) that are used in, or in support of the industrial process. Also, certain drainage piping (where corrosive or toxic fluids are being transported and severe conditions may be present, or where it is simply outside the scope of plumbing codes) is also sometimes classified as process piping. Some places where process piping is used are obvious, such as chemical and petrochemical plants, petroleum refineries, pharmaceutical manufacturing facilities, and pulp and paper plants. However, there are many other not so obvious places where process piping is commonplace, such as semiconductor facilities, automotive and aircraft plants, water treatment operations, waste treatment facilities, and many others.

This 5 hr. course provides fundamental knowledge in the design of process piping. It covers the guidance on the applicable codes and materials.

All topics are introduced to readers with no or limited background on the subject.

This course is divided into three (3) chapters:

CHAPTER 1: **THE BASICS OF PIPING SYSTEM**

The chapter covers the introduction to the pipe sizes, pipe schedules, dimensional tolerances, pressure ratings, frequently used materials, criteria for material selection, associations involved in generating piping codes, design factors depending on fluid type, pressure, temperature and corrosion, roles and responsibilities of piping discipline, key piping deliverables and cost of piping systems.

CHAPTER 2: **DEFINITIONS, TERMINOLOGY AND ESSENTIAL VOCABULARY**

This chapter provides essential definitions and terminology that each piping engineer and designer should familiar with. This is based on the Author's experience on the use of vocabulary in most design engineering, procurement and construction (EPC) companies.

CHAPTER 3: **DESIGN CODES AND STANDARDS**

This chapter discusses the associations involved in generating piping codes and material specifications. It provides a description of various ASME pressure piping codes such as B31.1 Power Piping, B31.3 Process Piping, B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons, B31.5 Refrigeration Piping and Heat Transfer Components, B31.8 Gas Transmission and Distribution Piping Systems, B31.9 Building Services Piping and B31.11 Slurry Transportation Piping Systems. It also provides information on the associations involved in material specifications such as API - American Petroleum Institute Standards, ASTM – American Society of Testing Materials, ASME Piping Components Standards, American Welding Society (AWS), American Water Works Association (AWWA) and EN – European Standards.

CHAPTER 1

1. THE BASICS OF PIPING SYSTEM

A piping system is an assembly of pipe, fittings, valves, and specialty components. All piping systems are engineered to transport a fluid or gas safely and reliably from one piece of equipment to another. The system may be easy to define as the pipe and supports from one pump to a tank or multiple pumps to multiple tanks. However, there are almost always other pipe branches in a system for drains, vents, safety relief, introduction of chemicals, extraction for other purposes, etc. It is also necessary to include all hangers and pipe supports in the definition of a piping system, as the design and functioning of these supports have a great deal to do with the reliability and safety of any piping system. It however does NOT include support structures, such as building frames, bents and foundations, except as they may affect the stress (flexibility) analysis.

Piping is divided into two main categories:

- Small bore lines
- Large bore lines

As a general practice, those pipe lines with nominal diameters 2" (50mm) and under are classified as small bore and greater than 2" (50mm) NB as large bore.

The piping system is also classified as:

- Hot systems
- Cold systems
- Cryogenic systems

The fundamental reason for this classification is that hot lines and cryogenic lines must undergo flexibility analysis to determine thermal forces, displacements and stresses.

This course is designed to introduce you to the basic concepts of piping engineering, which is all about designing, fabricating and constructing lines for conveying fluids.

1.1. ABBREVIATIONS

NPS	Nominal Pipe Size
DN	Diamètre Nominal
ID	Inside Diameter
OD	Outside Diameter
SCH	Schedule (Wall Thickness)
STD	Standard Weight Wall Thickness
XS	Extra Strong Wall Thickness
XXS	Double Extra Strong Wall Thickness

1.2. PIPE SIZES

Pipe sizes are designated by two numbers: Diameter and Thickness.

In the US, pipe size is designated by two non-dimensional numbers: Nominal Pipe Size (NPS) and schedule (SCH). Let's check some key relationships:

- Nominal pipe size (NPS) is used to describe a pipe by name only. In process piping, the term nominal refers to the name of the pipe, much like the name 2x4 given to a piece of lumber. The lumber does not actually measure 2" x 4", nor does a 6" pipe actually measure 6" in diameter. It's just an easy way to identify lumber and pipe. Nominal pipe size (NPS) is generally associated with the inside diameter (ID) for sizes 1/8" to 12". For sizes 14" and beyond, the NPS is equal to the outside diameter (OD) in inches.

- Outside diameter (OD) and inside diameter (ID), as their names imply, refer to pipe by their actual outside and inside measurements. Outside diameter (OD) remains same for a given size irrespective of pipe thickness.

- Schedule refers to the pipe wall thickness. As the schedule number increases, the wall thickness increases, and the inside diameter (ID) is reduced. The pipe's inside diameter (ID) can be calculated as:

  ID = OD minus (2 x WALL THICKNESS)

- Nominal Bore (NB) along with schedule (wall thickness) is used in British standards classification.

Important

In process piping, the method of sizing pipe maintains a uniform outside diameter while varying the inside diameter. This method achieves the desired strength necessary for pipe to perform its intended function while operating under various temperatures and pressures. It is also important to maintain certain interchangeability of pipe fittings.

1.2.1. The European designation

The European designation equivalent to NPS is DN (Diamètre Nominal/nominal diameter). The pipe sizes are measured in millimetres.

Relationship - NPS and DN pipe sizes

NPS	½	3/4	1	1¼	1½	2	2½	3	3½	4
DN	15	20	25	32	40	50	65	80	90	100

Note - *For NPS of 4 and larger, the DN is equal to the NPS multiplied by 25 (not 25.4).*

1.3. PIPE SCHEDULES (SCH)

The Schedule of pipe refers to the wall thickness of pipe in the American system.

Eleven schedule numbers are available for Carbon Steel Pipes:

5, 10, 20, 30, 40, 60, 80, 100, 120, 140, & 160

The most popular schedule, by far, is 40.

Schedules 5, 60, 100, 120, & 140 are used very infrequently.

Thickness of the pipe increas... that schedule 40 pipe will have less wall thic...

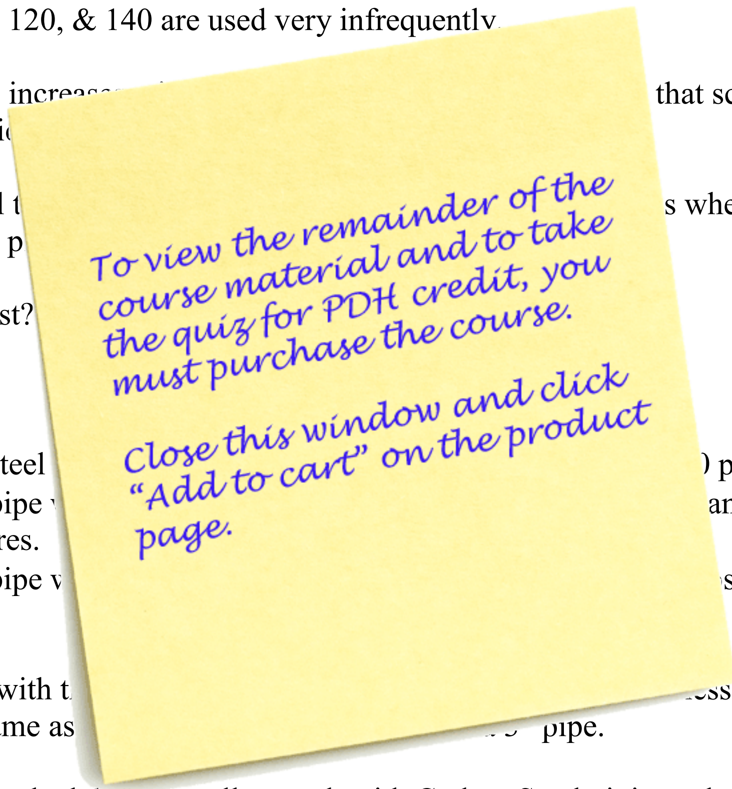
For example, the wall t... s whereas the thickness of 6 inch schedule 80 p...

What does this suggest?

This suggests that:

- Schedule 80 steel ...) pipe.
- Schedule 80 pipe ... andle much higher design pressures.
- Schedule 80 pipe ... stly to make and install.

Schedule also varies with t... ss of Schedule 40 in a 2” pipe is not the same as ... pipe.



Stainless steel piping schedules generally match with Carbon Steel piping schedules, but are always identified with Suffix S from 1/8” to 12”. Schedule 40S and 80S are the same as their corresponding schedule 40 and 80 in all sizes except 12” in schedule 40.

1.3.1. How to calculate Schedule?

Normally, the pipe schedule is determined by the service requirements like pressure, temperature, flow and corrosion of the process. ASME B31.1 code gives the calculations for the design of safe working pressure of the piping based on its type, thickness and minimum diameter.

A simple rule of thumb expression is:

$$\text{Schedule Number} = (1{,}000)\,(P/S)$$