NSRIC Inc. (Nature Science Research and Innovation Centre)

Ontario (ON), Canada Online Education (OE) Division

Basic Design and Pipe Drafting

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Lecture Times : Tuesdays EST 14-16 on class days

Tutorial Times: Sunday EST 14-15

Steel Pipe –Sizing of Pipe

Pipe is identified by three different size categories: nominal pipe size (NPS), outside diameter (OD), and inside diameter (ID).

Nominal pipe size (NPS) is used to describe a pipe by name only. Pipe sizes (NPS) 1⁄8" through 12" have an outside diameter greater than its nominal pipe size, whereas pipe sizes 14" and above have an outside diameter equal to its nominal pipe size.

Steel Pipe –Wall Thickness

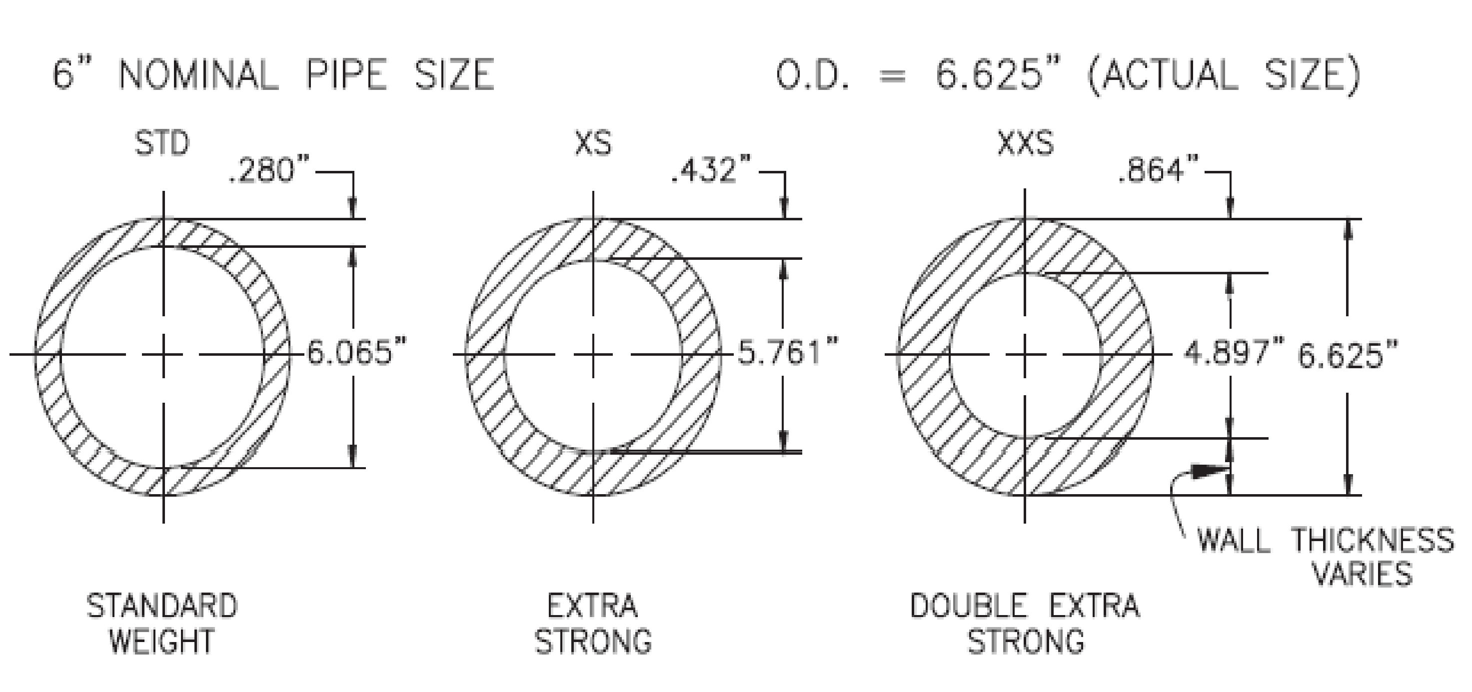
There are three systems in which a pipe’s wall thickness can be categorized: the weight system, the schedule system, and the fractional/decimal system.

- The weight system uses three categories to define the thickness of a pipe: standard, extra strong, and double extra strong.
- Now called schedules, these additional wall thicknesses allow a designer to specify a particular pipe. Pipe is manufactured in the following schedules: 10, 20, 30, 40, 60, 80, 100, 120, 140, and 160.
- The third system of categorizing wall thickness is to simply measure the thickness in either a fractional or decimal value.

PIPE SIZES

NPS[5]	DN [2]	OD [in (mm)]	Wall thickness [in (mm)]											
			SCH 5	SCH 10s/10	SCH 20	SCH 30	SCH 40s/40 /STD	SCH 60	SCH 80s/80 /XS	SCH 100	SCH 120	SCH 140	SCH 160	XXS[5]
4	100	4.500 (114.30)	0.083 (2.108)	0.120 (3.048)	—	0.188 (4.775)	0.237 (6.020)	0.281 (7.137)	0.337 (8.560)	—	0.437 (11.100)	—	0.531 (13.487)	0.674 (17.120)
4½	115	5.000 (127.00)	—	—	—	—	0.247 (6.274)	—	0.355 (9.017)	—	—	—	—	0.710 (18.034)
5	125	5.563 (141.30)	0.109 (2.769)	0.134 (3.404)	—	—	0.258 (6.553)	—	0.375 (9.525)	—	0.500 (12.700)	—	0.625 (15.875)	0.750 (19.050)
6	150	6.625 (168.28)	0.109 (2.769)	0.134 (3.404)	—	—	0.280 (7.112)	—	0.432 (10.973)	—	0.562 (14.275)	—	0.719 (18.263)	0.864 (21.946)
7[5]	—	7.625 (193.68)	—	—	—	—	0.301 (7.645)	—	0.500 (12.700)	—	—	—	—	0.875 (22.225)
8	200	8.625 (219.08)	0.109 (2.769)	0.148 (3.759)	0.250 (6.350)	0.277 (7.036)	0.322 (8.179)	0.406 (10.312)	0.500 (12.700)	0.593 (15.062)	0.719 (18.263)	0.812 (20.625)	0.906 (23.012)	0.875 (22.225)
9[5]	—	9.625 (244.48)	—	—	—	—	0.342 (8.687)	—	0.500 (12.700)	—	—	—	—	—

Steel Pipe –Wall Thickness



The following formula can be used to calculate a pipe's inside diameter (ID):

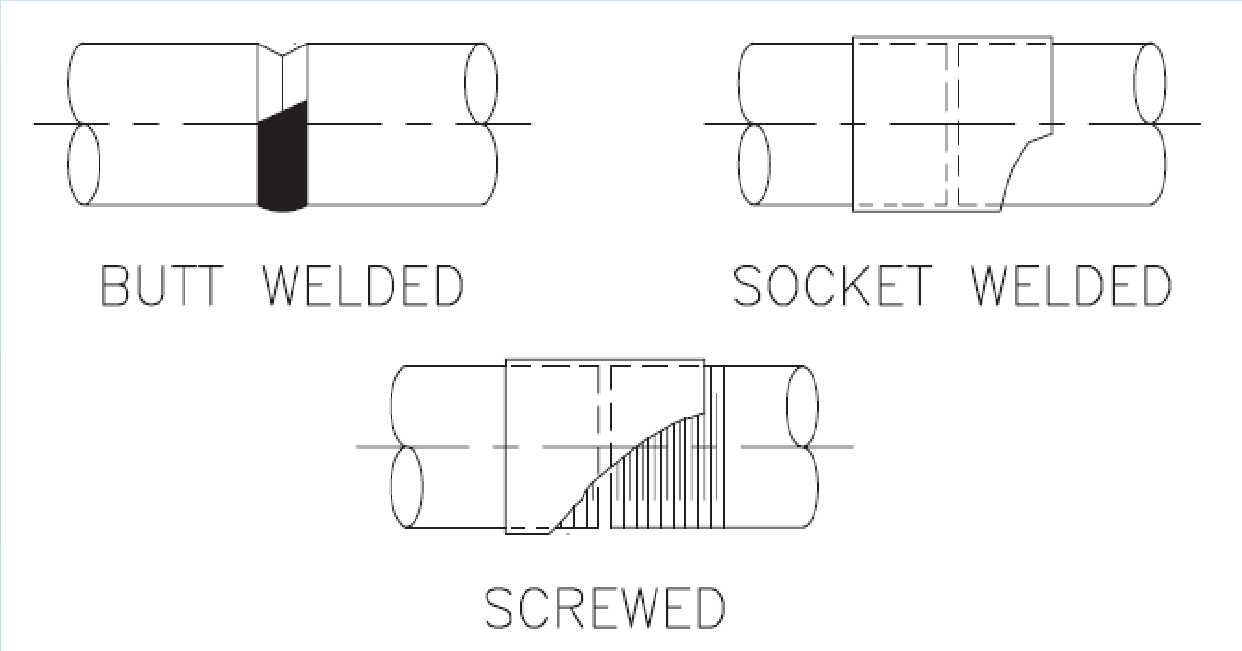
$$ID = OD - (2 \times \text{Wall Thickness})$$

Steel Pipe –Wall Thickness

Before selecting pipe, careful consideration must be given to its material, temperature and pressure allowances, corrosion resistance, and more such as safety and cost.

Steel Pipe –Methods of Joining Pipe

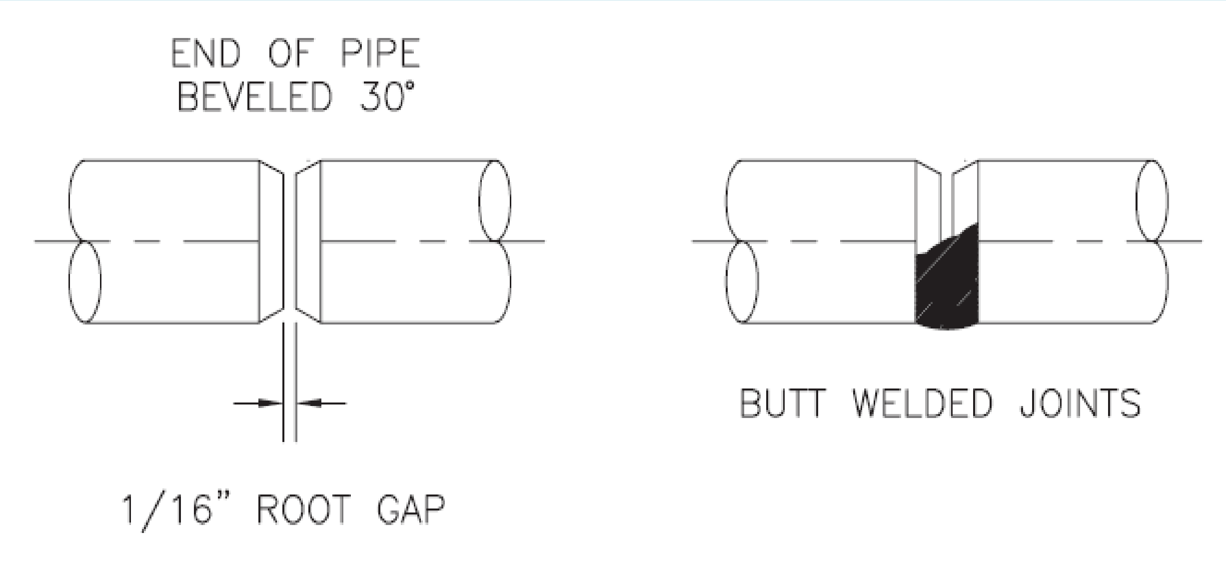
There are several methods for joining pipe together. The three methods we will focus on are those most widely used in piping systems made of carbon steel, as shown below. They are butt-welded (BW), screwed (Scrd), and socket-welded (SW).



Steel Pipe –Methods of Joining Pipe

Butt-Weld Connections:

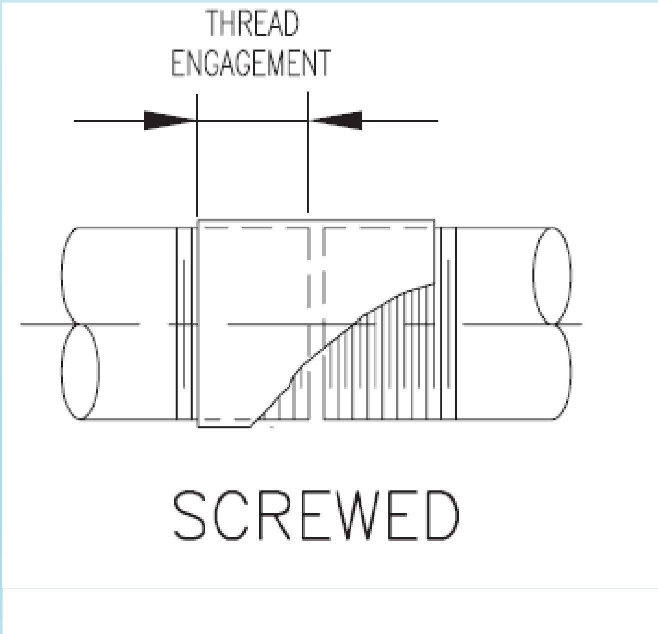
A butt-weld joint is made by welding the beveled ends of pipe together.



Steel Pipe –Methods of Joining Pipe

Screwed or Threaded Connections:

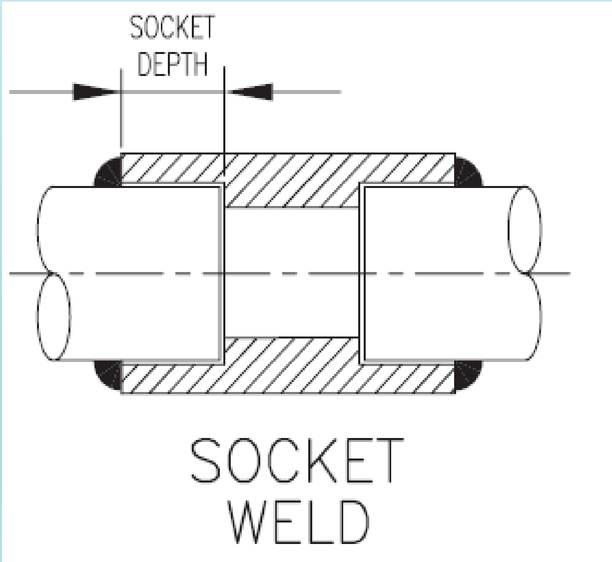
Typically used on pipe 3" and smaller, threaded connections are gener-ally referred to as *screwed* pipe. Screwed pipe and screwed fittings can be easily assembled without welding or other permanent means of attachment.



Steel Pipe –Methods of Joining Pipe

Socket-Weld Connections:

The third method of joining carbon steel pipe is socket welding. When assembling pipe with socket-weld fittings, the pipe is inserted into the fitting before welding. Pipe used for socket-weld connections will be prepared with a plain end.



Steel Pipe –Cast Iron Pipe

Cast iron pipe is used primarily in gravity flow applications such as storm and sanitary sewers, and waste and vent piping installations due to its corrosion resistance.

The term cast iron refers to a large group of ferrous metals that contain more than 2% carbon and 1% or more silicon. Cast iron, like steel, does corrode. What makes cast iron different is its graphite (insoluble) content. As cast iron corrodes, an insoluble layer of graphite compounds is produced. In steel the compounds created during corrosion cannot bond together.

Cast iron is the least expensive of the engineering metals.

Steel Pipe –Cast Iron Pipe

Cast iron pipe is grouped into two basic categories: (1) hub and spigot, and (2) hubless.

(1) Hub, or bell + spigot which is inserted into the bell

Two methods of preventing leaks on bell and spigot joints are compression and lead and oakum (loose fibres).

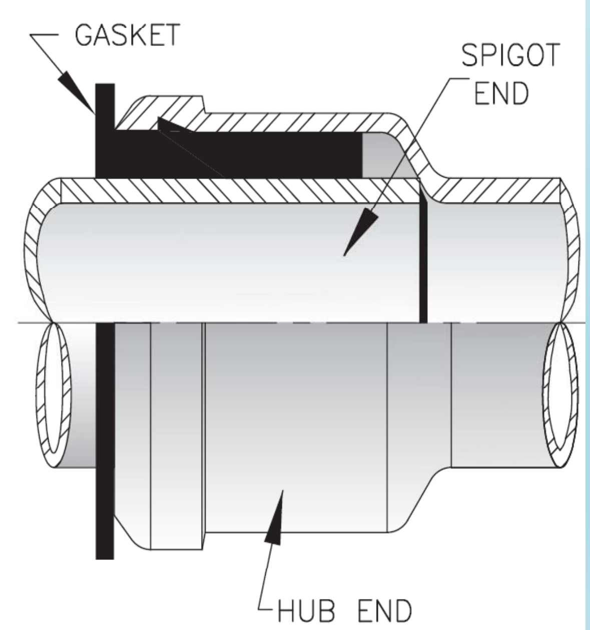


FIGURE 2.9 Cast iron pipe compression joint.

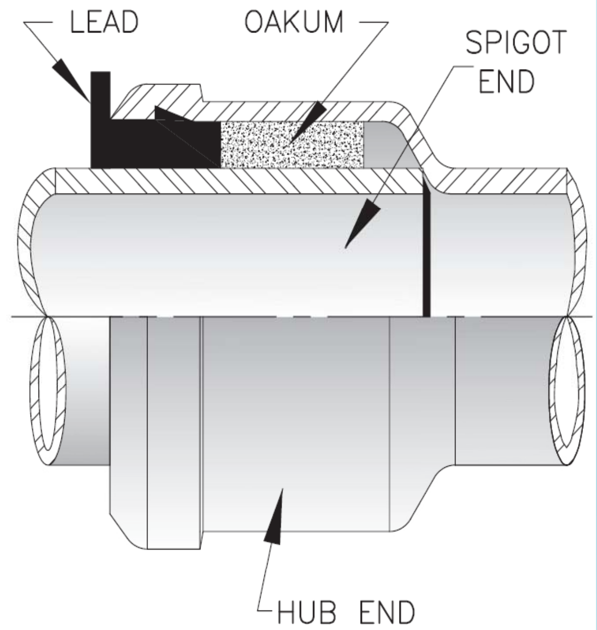


FIGURE 2.10 Cast iron lead and oakum joint.

Steel Pipe –Cast Iron Pipe

(2) Hubless. Hubless cast iron pipe uses pipe and fittings manufactured without a hub. The method of joining these pipe and fittings uses a hubless coupling that slips over the plain ends of the pipe and fittings and is tightened to seal the ends.

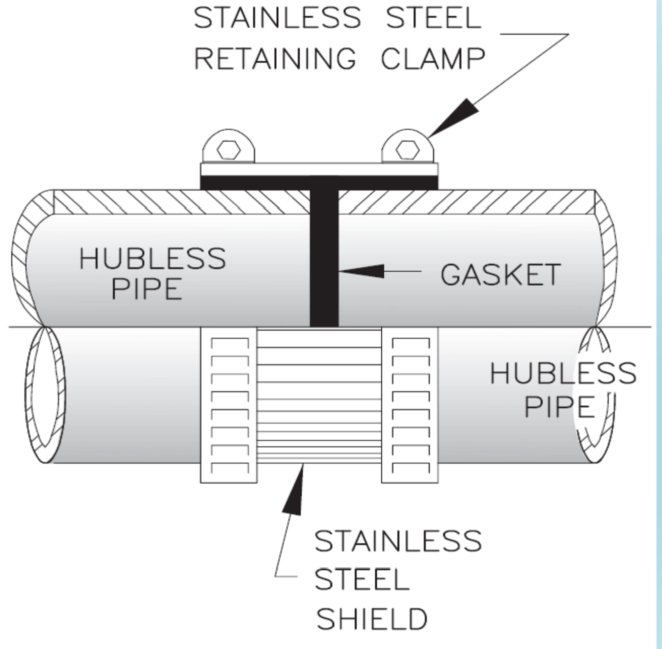


FIGURE 2.11 Cast iron hubless pipe coupling.

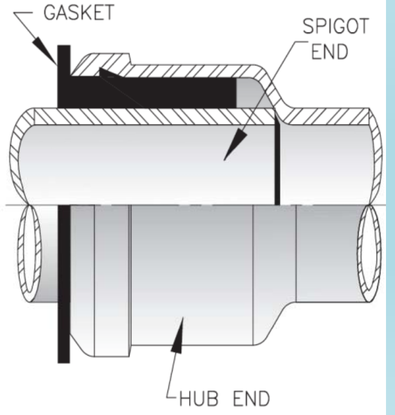


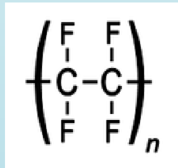
FIGURE 2.9 Cast iron pipe compression joint.

Plastic Pipe

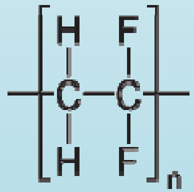
For plastic piping systems as a reliable, safe, and cost-effective alternative material, two categories are most effective: fluoroplastics and thermoplastics.

Fluoroplastics : PTFE, PVDF, ECTFE, CTFE, PFA, and FEP. As a group, fluoroplastics perform extremely well in aggressive chemical services at temperatures from –328 to 500 °F (-200 – 260 °C).

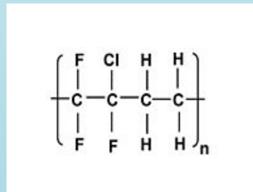
Polytetrafluoroethylene (PTFE, teflon)



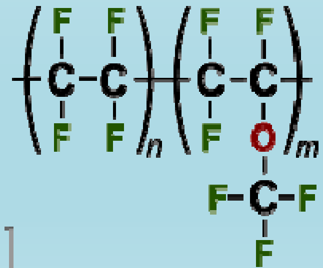
Polyvinylidene difluoride (PVDF)



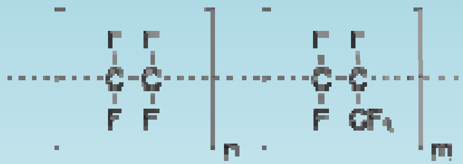
Ethylene ChloroTriFluoroEthylene (ECTFE)



Perfluoroalkoxy Alkanes (PFA)



Fluorinated Ethylene Propylene (FEP)



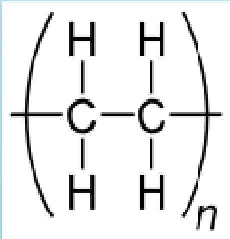
Plastic Pipe

Thermoplastics are those plastics that require melting during the manufacturing process.

Pipes made from plastic are replacing traditional, expensive materials like glass or ceramic-lined pipe. Some plastics such as UHMW PE, PVDF, CTFE, and nylon have such excellent wear resistance that they prove in Taber Abrasion Tests to be 5–10 times better in this regard than 304 Stainless Steel.

Acrylonitrile butadiene styrene (ABS)

Ultra-High-Molecular-Weight Polyethylene (UHMWPE)



n> 100, 000

Nylon-6

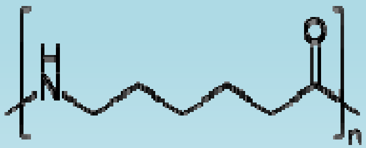


TABLE 2.4 Tabor Abrasion Test Results

Abrasion ring CS-10, load 1 kg	
Nylon 6–10	5 mg/1,000 cycles
UHMW PE	5
PVDF	5–10
PVC (rigid)	12–20
PP	15–20
CPVC	20
CTFE	13
PS	40–50
Steel (304 SS)	50
ABS	60–80
PTFE	500–1000

Plastic Pipe

Plastic pipe can be joined by one of the following methods: threading (expensive), solvent cement (reliable), or fusion (heat).

Pipe can either be butt-joined or socket-joined.

Caution must be exercised when using plastic pipe (tested). Four important variables must be evaluated: chemical resistance, pressure limitations, temperature limitations, and stress.

Drawing Pipe

The pipe 12" and smaller is typically drawn single line (0.9mm) and the pipe 14" and larger is drawn double line (0.7mm). Single-line drawings are used to identify the centerline of the pipe. Double lines are used to represent the pipe's nominal size diameter.

Drawing Pipe

The standard scale used on piping drawings is 3⁄8" scale for 1 feet or 1:50 (SI). Figure 2.12 provides several representations of pipe as it may appear on a drawing (Practice).

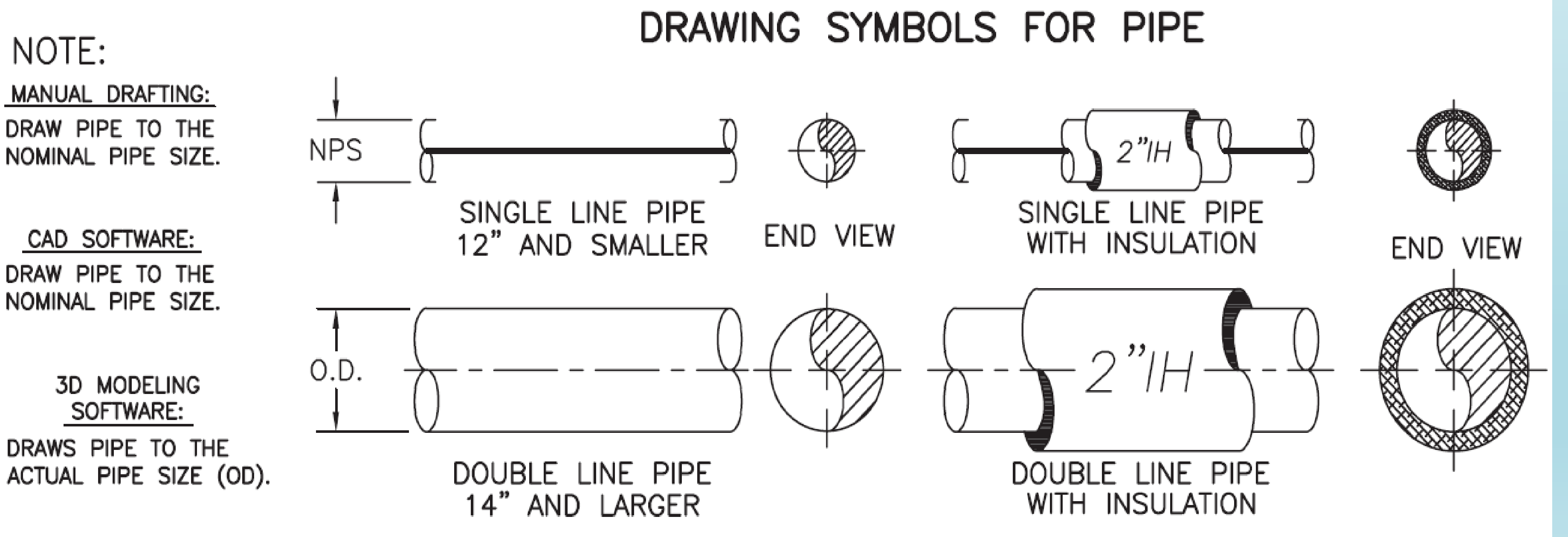


FIGURE 2.12 Drawing representations of pipe.

Summary

This chapter introduces pipe size, pipe materials (steel, cast iron and plastic), pipe manufacturing, joining and drawing.

Please read the review quiz in the end of chapter.

Quiz

1. Name three methods of manufacturing carbon steel pipe.
   ____
   ____
   ____

2. Name the three most commonly used *end preparations* for joining pipe.
   ____
   ____
   ____

3. What is meant by the term *nominal pipe size*?
   ____

4. Which diameter of pipe varies as the wall thickness changes?
   ____

5. What is the most common material used in the manufacture of pipe used in petrochemical facilities?
   ____
   ____

6. When drawing pipe, which pipe sizes are drawn single-line and which sizes are drawn double-line?
   Single-line ________ Double-line ______________

7. How long is the gap between two lengths of pipe when a back-up ring separates them?
   ____
   ____

8. What is the name for the amount of pipe *"lost"* when screwed connections are used?
   ____

9. What is the standard scale piping drawings are plotted to?
   ____

10. Name three methods for joining carbon steel and plastic pipe.
    ____
    ____
    ____

3 Pipe Fittings

This chapter covers different fittings and drafting. Fittings are fabricated pipe components that are used to perform specific functions throughout the routing of a pipeline.

Text: lecture materials

Pipe Fittings

Fittings are fabricated pipe components that are used to perform specific functions throughout the routing of a pipeline.

Fittings can make directional changes (elbow), create a branch from a main pipe (tee), or make a reduction in the diameter of the pipe (reducer) .

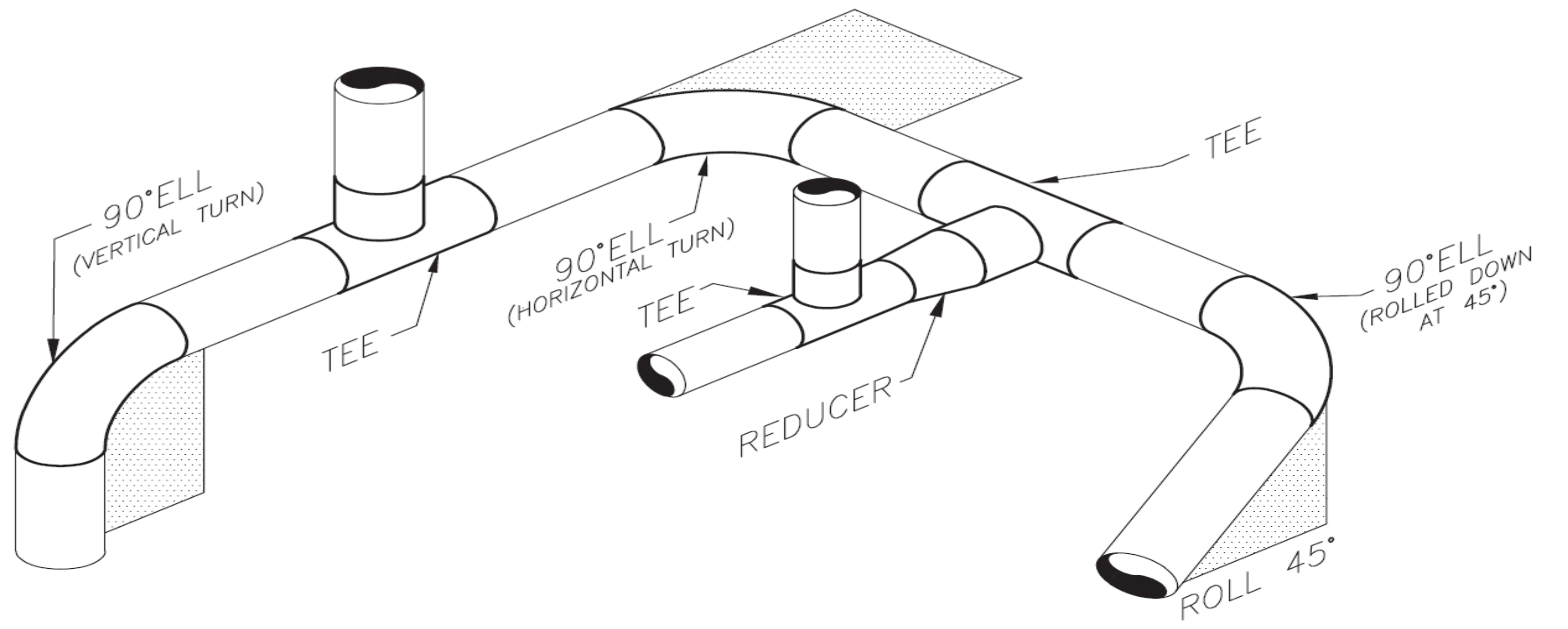


FIGURE 3.1 Fittings.

Pipe Fittings

In the petrochemical industry, most companies have guidelines known as Piping Specifications that state pipes 3" in diameter and larger used in their facility will have butt-welded connections. These specifications, or specs as they are more commonly referred, may also require pipes smaller than 3" in diameter to have screwed or socket-weld connections.

Pipe Fittings - 90° Elbows

Of all the fittings, the elbow is the one most often used. Simply put, the elbow, or ell, is used when a pipe changes direction.

Elbows can turn up, turn down, turn left, right, or any angle in between (see Figure 3.1).

The 90° elbows can be classified as one of the following:

- long-radius elbow;
- short-radius elbow;
- reducing elbow;
- mitered elbow.

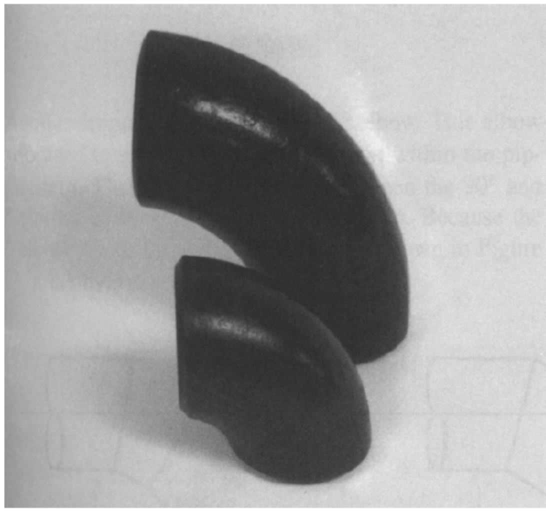


FIGURE 3.10 Long-radius and short-radius elbows.

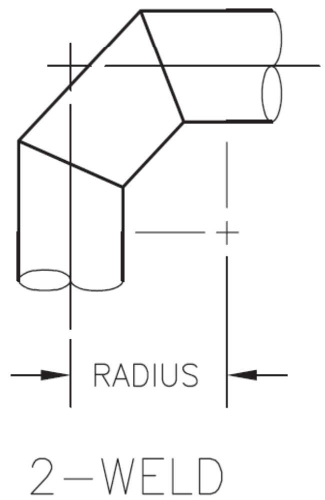


FIGURE 3.13 Mitered elbows.

Pipe Fittings - 90° Elbows

An elbow's length is commonly referred to as the center-to-end dimension and is measured from the center point of its radius to the end of either opening (see Figure 3.3).

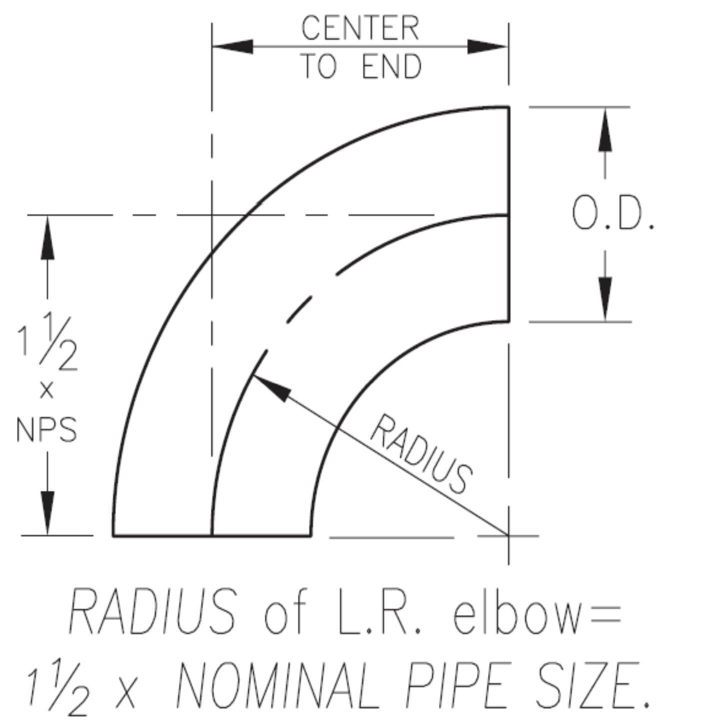


FIGURE 3.3 Center-to-end dimension of a 90° long-radius elbow.

Pipe Fittings - 90° Elbows

The 90° elbow's length is equal to the nominal pipe size plus one-half of the nominal size. A simple formula that makes calculating this dimension easy to remember is: Fitting length equals 1½ times NPS (nominal pipe size).

Example: The length of an 8"90° long-radius elbow is

$$8'' \times 1\tfrac{1}{2} = 12''$$

NOTE: Use this formula for butt-weld fittings only.