

# PIPE & FITTINGS

## CHAPTER 2

Pipe Sizing & Specifications

Methods for Joining Pipe

Pipe Representation

Pipe Fittings

Buttwelded Branch Fittings

Flanges

Screwed Fittings

## PIPE:

- in general, this is a hollow, tubular body used to transport or move any commodity that possesses flow capabilities; such as liquids, gases, vapors, liquefied solids and powders.
- although there are many varieties of pipe; galvanized, copper, mild steel, cast iron, stainless steel, plastic, fiberglass, concrete and clay, the most common material used in piping industries is carbon steel.
- pipe sizes also vary and can range from ½” to 36” in diameter...there are some situations that might call for smaller or larger sizes
- pipe is also classified by the wall thickness using schedule numbers: Schedule 40, Schedule 80...etc. To identify the schedule of pipe you are working with, check your company standards... in this class, we will typically use the **STD** (standard) schedule for our assignments & projects. See the Fittings chart on page 267 (also illustrated on slide in this tutorial) in your text for complete listings of schedules.

## Pipe Sizing and Specifications:

When referring to pipe size, ALL pipe is noted by NPS or Nominal Pipe Size.

This NPS is not always the same as the internal pipe bore...

- ❖ pipe sizes up to and including 12" diameter have internal bores (inside diameters or ID) that are approx. the same as their NPS... a 6" pipe  $\approx$  6" ID
  - ❖ 6" Sch. 40 wall thickness = 0.280"
  - ❖ 6"OD = 6.625"
  - ❖ 6" ID =  $6.625" - (.280" \times 2) = 6.625" - .560" = 5.69 = 5 \frac{11}{16}" \approx 6"$  ID
- ❖ pipe 14" diameter and greater have a NPS equal to the outside diameter (OD)  
... 24" pipe = 24" OD
  - ❖ 24" Sch. 40 wall thickness = 0.688"
  - ❖ 24"OD = 24"
  - ❖ 24" ID =  $24" - (0.688" \times 2) = 24" - 1.375" = 22.625" = 22 \frac{5}{8}"$  ID

What all that means is that when talking about 14" and larger pipe, the NPS = the OD of the pipe and when talking about ½" to 12" pipe, the NPS  $\approx$  the pipe ID

| Nominal<br>Pipe<br>Size | Pipe<br>OD | WALL THICKNESS |        |        |       |        |        |              |        |            |            |            |            |               |
|-------------------------|------------|----------------|--------|--------|-------|--------|--------|--------------|--------|------------|------------|------------|------------|---------------|
|                         |            | Light<br>Wall  | Sch 20 | Sch 30 | Std   | Sch 40 | Sch 60 | X-<br>Strong | Sch 80 | Sch<br>100 | Sch<br>120 | Sch<br>140 | Sch<br>160 | XX-<br>Strong |
| 1/2                     | 0.840      | 0.083          |        |        | 0.109 | 0.109  |        | 0.147        | 0.147  |            |            |            | 0.188      | 0.294         |
| 3/4                     | 1.030      | 0.083          |        |        | 0.113 | 0.113  |        | 0.154        | 0.154  |            |            |            | 0.219      | 0.308         |
| 1                       | 1.315      | 0.109          |        |        | 0.133 | 0.133  |        | 0.179        | 0.179  |            |            |            | 0.250      | 0.358         |
| 1 1/4                   | 1.660      | 0.109          |        |        | 0.140 | 0.140  |        | 0.191        | 0.191  |            |            |            | 0.250      | 0.382         |
| 1 1/2                   | 1.900      | 0.109          |        |        | 0.145 | 0.145  |        | 0.200        | 0.200  |            |            |            | 0.281      | 0.400         |
| 2                       | 2.375      | 0.109          |        |        | 0.154 | 0.154  |        | 0.218        | 0.218  |            |            |            | 0.344      | 0.436         |
| 2 1/2                   | 2.875      | 0.120          |        |        | 0.203 | 0.203  |        | 0.276        | 0.276  |            |            |            | 0.375      | 0.552         |
| 3                       | 3.500      | 0.120          |        |        | 0.216 | 0.216  |        | 0.300        | 0.300  |            |            |            | 0.438      | 0.600         |
| 3 1/2                   | 4.000      | 0.120          |        |        | 0.226 | 0.226  |        | 0.318        | 0.318  |            |            |            |            | 0.636         |
| 4                       | 4.500      | 0.120          |        |        | 0.237 | 0.237  |        | 0.337        | 0.337  |            | 0.438      |            | 0.531      | 0.674         |
| 5                       | 5.563      | 0.134          |        |        | 0.258 | 0.258  |        | 0.375        | 0.375  |            | 0.500      |            | 0.625      | 0.750         |
| 6                       | 6.625      | 0.134          |        |        | 0.280 | 0.280  |        | 0.432        | 0.432  |            | 0.562      |            | 0.719      | 0.864         |
| 8                       | 8.625      | 0.148          | 0.250  | 0.277  | 0.322 | 0.322  | 0.405  | 0.500        | 0.500  | 0.594      | 0.719      | 0.812      | 0.906      | 0.875         |
| 10                      | 10.750     | 0.165          | 0.250  | 0.307  | 0.365 | 0.365  | 0.500  | 0.500        | 0.594  | 0.719      | 0.844      | 1.000      | 1.125      | 1.000         |
| 12                      | 12.750     | 0.180          | 0.250  | 0.330  | 0.375 | 0.406  | 0.562  | 0.500        | 0.688  | 0.844      | 1.000      | 1.125      | 1.312      | 1.000         |
| 14                      | 14.000     | 0.250          | 0.312  | 0.375  | 0.375 | 0.438  | 0.594  | 0.500        | 0.750  | 0.938      | 1.094      | 1.250      | 1.406      |               |
| 16                      | 16.000     | 0.250          | 0.312  | 0.375  | 0.375 | 0.500  | 0.656  | 0.500        | 0.844  | 1.021      | 1.219      | 1.438      | 1.594      |               |
| 18                      | 18.000     | 0.250          | 0.312  | 0.438  | 0.375 | 0.562  | 0.750  | 0.500        | 0.938  | 1.156      | 1.375      | 1.562      | 1.981      |               |
| 20                      | 20.000     | 0.250          | 0.375  | 0.500  | 0.375 | 0.594  | 0.812  | 0.500        | 1.031  | 1.281      | 1.500      | 1.750      | 1.969      |               |
| 24                      | 24.000     | 0.250          | 0.375  | 0.562  | 0.375 | 0.688  | 0.969  | 0.500        | 1.219  | 1.531      | 1.812      | 2.062      | 2.344      |               |
| 30                      | 30.000     | 0.312          | 0.500  | 0.625  | 0.375 |        |        | 0.500        |        |            |            |            |            |               |
| 36                      | 36.000     | 0.312          | 0.500  | 0.625  | 0.375 | 0.750  |        | 0.500        |        |            |            |            |            |               |
| 42                      | 42.000     |                |        |        | 0.375 |        |        | 0.500        |        |            |            |            |            |               |
| 48                      | 48.000     |                |        |        | 0.375 |        |        | 0.500        |        |            |            |            |            |               |

In the colored Wall Thickness chart above (which is similar to the one in your text) notice that the NPS & OD listings are to the left and the varying thicknesses per schedule are in columns to the right.

By following the row across from the NPS, you will be able to find the specific wall thickness under a designated schedule for each pipe size.

Example: Find 14"NPS and then find the wall thickness for a schedule 40 pipe.

Follow the 14" row across to where it intersects with Sch.40 column... the wall thickness for Schedule 40 14"pipe is... 0.438"

Using the same pipe size: 14", look at the OD of that size of pipe...OD = 14"

So, what's the ID (inside diameter) of that Schedule 40 pipe?

The wall thickness is 0.438" (7/16")... that's the thickness, but remember that thickness is on both sides of the pipe.

To find the ID of this 14" Sch. 40 pipe:

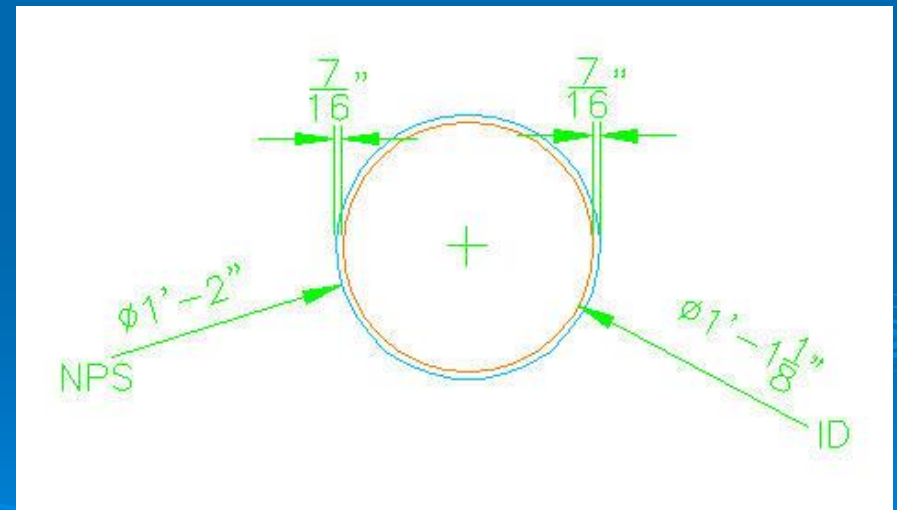
Multiply 0.438" x 2 to get the overall pipe wall thickness.

$0.438" \times 2 = 0.876"$  or approx.  $7/8"$

$NPS - 7/8" = 1'-2" - 7/8" = 1'-1 \frac{1}{8}"$

So, the ID of 14" Sch. 40 pipe =  $1'-1 \frac{1}{8}"$

The NPS & OD are still 14"



Face it, it's just easier to refer to pipe using the NPS...especially when you are working in a process where pipe schedules vary.

Example:

Stronger pipe may have an ID less than the NPS:

8" Sch. 80 pipe has a wall thickness of 0.500". The OD of 8" pipe is 8.625".

$$8.625" - (0.500" \times 2) = 8.625 - 1" = 7.625" \text{ ID}$$

Are you going to say you're working with a 7.625" pipe or an 8" pipe???

Pipe wall thicknesses vary according to the operating temperature and pressure requirements of the system.

Pipe wall thickness is commonly indicated using standards by :

1. ANSI – American National Standards Institute

a) Classifies pipe wall thicknesses by schedule numbers (sch. 40...sch. 80...etc)

2. ASME – American Society of Mechanical Engineers

3. ASTM – American Society for Testing and Materials

} Classify wall thickness as "STD", "XS" & "XXS"

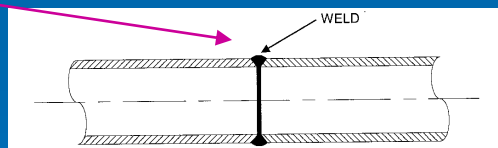
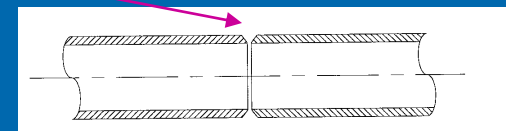
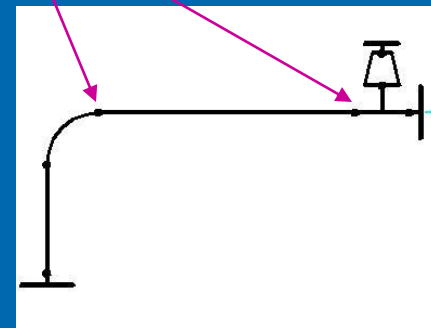
## Methods of Joining Pipe

Pipe can be joined basically using 4 methods:

### 1. BUTTWELD

- ❖ most common type of pipe connection
- ❖ most economical & leakproof
- ❖ 2" pipe and larger are typically buttwelded
- ❖ this type of weld is achieved by “butting” pipe or fittings end-to-end and welding them together
- ❖ the ends of the pipe or fittings are beveled so as to create a deep weld

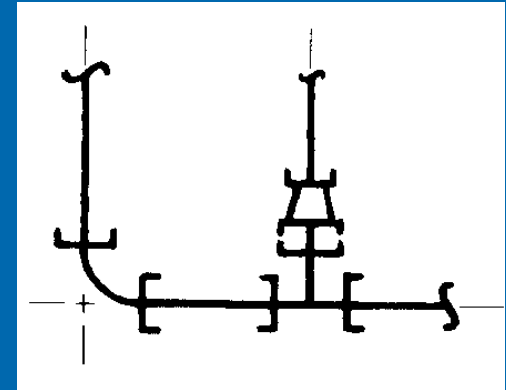
Buttweld marks



To properly align pipe and fittings for welding and maintain equal spacing while welding, a welding ring or backing ring may be used. This split ring has pins or spacer nubs that create an equal space between pipe ends and melt when the pipe is welded. It also helps prevent any of the weld material from dripping into the pipe and causing obstructions inside the pipe that would interfere with the content flow.

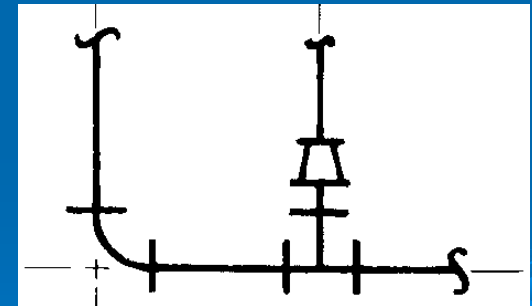
## 2. SOCKETWELD

- ❖ the pipe is “inserted” into a socket in the fitting and then welded
- ❖ the weld is made at the end of the fitting and joins the pipe and fitting with a fillet weld
- ❖ this type of welding is used primarily on lines smaller than 2” diameter



## 3. SCREWED

- ❖ originally screwed or threaded fittings were used in residential plumbing
- ❖ in the industrial setting, screwed piping is used for service lines, utility piping and for small process piping
- ❖ forged steel fittings are used more than cast iron because of greater mechanical strength



## 4. FLANGED

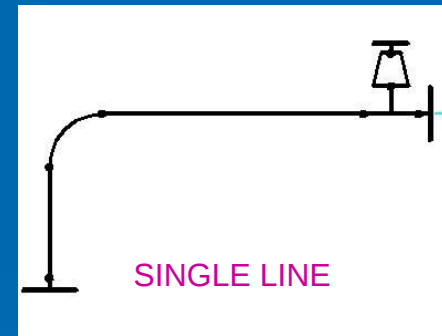
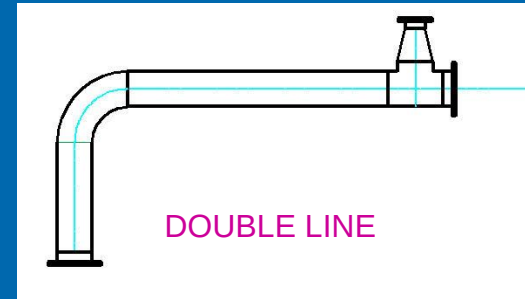
- ❖ a flanged joint is comprised of flanges bolted face-to-face (FTF) with a gasket between the faces
- ❖ the flange is basically a circular piece of steel plate with machined face and equally spaced bolt holes drilled through it
- ❖ the large hole in the center of the flange matches the pipe diameter it's designed to match
- ❖ flanges are used to attach valves to welded pipe
- ❖ flanged sections of welded pipe are used for easy removal as in the need for maintenance purposes or for insertion pieces as when flanged instruments, valves or other components are removed from a pipe line that needs to remain in service



# Pipe Representation

Pipe can be illustrated two ways:

- Double line
  - With computer drafting, there has been a greater use of double line in pipe representation
- Single line
  - Typically when done manually, this is the faster mode of representing pipe



Both types are used in industry.

## Double line piping

- ✓ first, double line representation looks real (see Figure 2-9 pg.34)
- ✓ BUT, it takes longer to draw double line drawings manually

Some companies use double lines to show existing pipe and others use double line for pipe over 12"NPS...and still others use double line for all their drawings. Your company standards and policies will determine whether you use double line representation or not.

In this class we will use double line representation for pipe larger than 12"NPS.

Being able to interpret drawings gets increasingly difficult when viewing pipe lines through objects and other pipe in front of the line you're interested in.

This is where using pipe "breaks" can be helpful:

- showing features hidden from view
- providing more info than it eliminates
- to avoid drawing additional views
- to provide greater clarity to the drawing

## Single line piping

- ✓ utilizes centerline of pipe
- ✓ not as easy to read as double line drawings because in a manual situation, the single lines tend to fade with time so drawing isn't as clear and distinctive
- ✓ typically requires less drawing time
- ✓ provides more open space for dimensions and notes

Pipe “breaks” are also used with single line drawings...AND as with double line, the break symbol is drawn on the pipe nearest the viewer...

Pages 35-37 in your text provide illustrations of pipe breaks.

## Terms:

Riser – refers to vertical pipe in which fluid flows upward

Downcomer – vertical pipe in which fluid flows downward

Fitting-to-fitting (FTF) – refers to an assembly that has no straight runs of pipe, just fittings.

## Pipe Fittings

Pipe typically comes in straight sections of about 20' in length. But, even in the best situations, pipe has to change directions and straight sections can't be used to do this. For this reason, it's important to know the different fittings that can be used to aid in changing direction, size and enabling the addition of “branches” to the pipe. A pipe drafter needs to know the appropriate fittings to assemble or put together to make an efficient pipe assembly.

90° elbow:

- ❖ most common “ell”
- ❖ permits a 90° change of direction
- ❖ most widely used version is “long radius” (LR)
- ❖ centerline radius is 1 ½ times the NPS in ¾” and larger pipe



Reducing elbow:

- ❖ creates a 90° bend, but also changes the diameter of the pipe
- ❖ The centerline radius is 1 ½ times the NPS of the LARGER end

45° elbow:

- ❖ allows for 45° change in the pipe run
- ❖ centerline radius is 1 ½ times the NPS



Straight Tee:

- ❖ creates a 90° branch from the main run of pipe
- ❖ branch is same size as the main run

Reducing Tee:

- ❖ provides a branch off the main run of pipe that is smaller than the main line



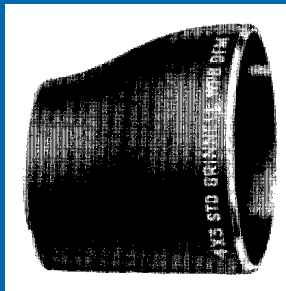
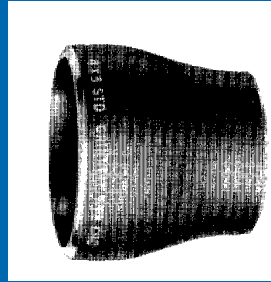
## Reducer:

- ❖ joins pipe of different sizes

- ❖ 2 types:

  - ❖ concentric

  - ❖ eccentric – flat on one side and is used when the top or bottom of the pipe must remain level

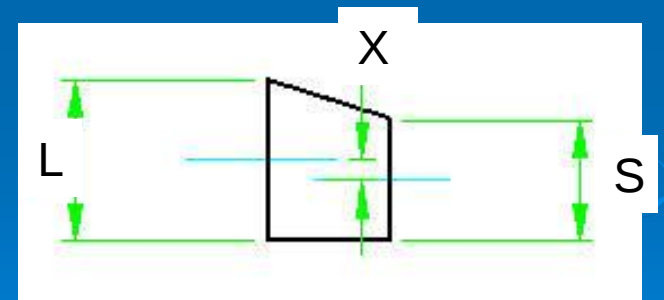


When using eccentric reducers, you have to pay attention to calculating dimensions or elevations involving these fittings because the centerlines of each end of the eccentric reducer are OFFSET.

How to Calculate ECC Red. OFFSET:

$$X = \frac{1}{2} (\text{large end} - \text{small end})$$

$$X = \frac{1}{2} (L - S)$$

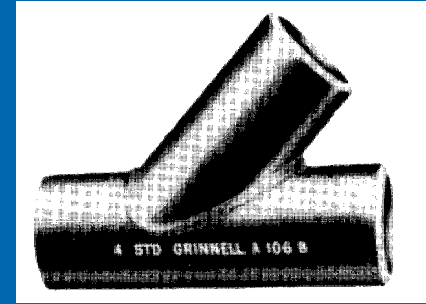


Example: 8"x6" EccRed     $X = \frac{1}{2} (8" - 6")$

$$X = \frac{1}{2} (2") = 1" \text{ OFFSET}$$

## Lateral:

- ❖ a straight line lateral permits 45° entry into the main pipe run and keeps flow resistance to minimum
- ❖ Branch diameter is equal to the main pipe run



## Reducing Lateral:

- ❖ same as straight lateral with the exception that the branch line is smaller than the main pipe run

## Cross:

- ❖ provides two 90° branches
- ❖ more expensive than tees
- ❖ used basically where there are space restrictions



## Weld cap:

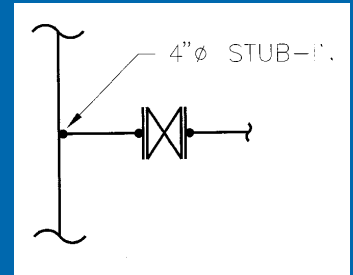
- ❖ used to seal the end of a pipe
- ❖ used where seal will be permanent



## Buttwelded Branch Fittings

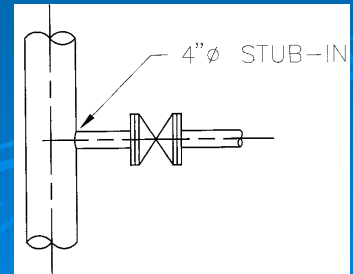
With all the standard fittings that can be used to make a branch line off a pipe run, there are other less expensive methods and fittings that exist to create branches smaller than the pipe run:

1. **Stub-in:** branch pipe welded directly into the main run of pipe.
  - ✓ not really a fitting, but can take the place of an expensive fitting
  - ✓ also know as a “nozzle weld” because it’s a common way to make tank nozzles
  - ✓ used on 2” pipe and larger
  - ✓ full size (diameter of main pipe run) and smaller pipe can be “stubbed-in” to main pipe run



How stub-ins are installed in main line:

- ☐ cut hole in main run of pipe the size of the branch pipe
- ☐ end of branch pipe is prepared for welding
- ☐ branch pipe welded to the main run of pipe

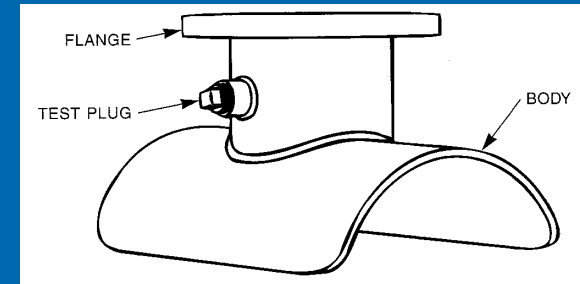
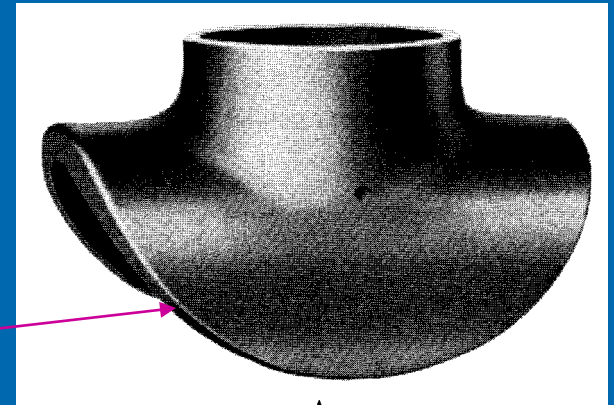


In some instances, a piece of shaped metal is welded OVER the stub-in joint to give it added strength.

It looks like a saddle... and it's called a “saddle”.

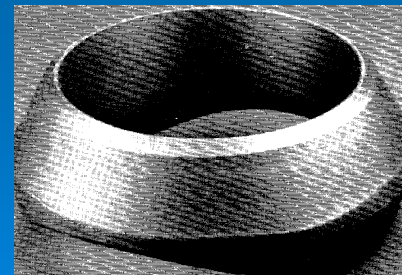
Weld-on tapping sleeve:

- ❖ a variation on the reliable “saddle”
- ❖ it's welded directly to the pipe and has a flanged outlet



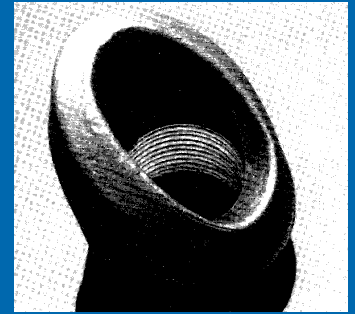
## 2. Weldolet

- ❖ makes a 90° branch on a pipe run
- ❖ the branch can be full size or smaller
- ❖ there are threaded (thredolet) and socketweld (sockolet) counterparts of the weldolet.



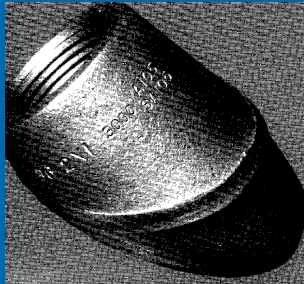
### 3. Elbolet

- ❖ provides reducing branches tangent to 90° elbows



Threaded elbolet

### 4. Latrolet



Threaded latrolet

- ❖ makes a 45 branch on straight pipe
- ❖ the branch will be smaller than the run pipe

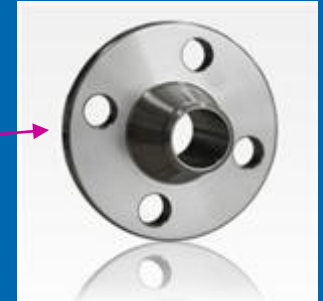
# Flanges

- used to bolt valves to pipe & to attach pipe to tank and equipment nozzles
- a rubber compound gasket (or one made of another material) is ALWAYS placed between the two flange faces to ensure a leakproof seal

Two of the most basic type of flanges used:

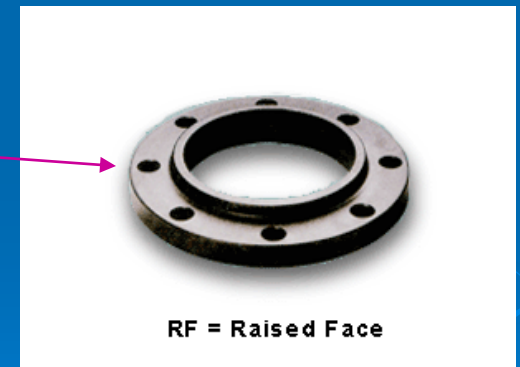
## 1. Weld neck

- ✓ Used in tank and equipment nozzle
- ✓ Used for bolt-up of valves placed next to fittings – typically long neck type provides strength and space for welding operation



## 2. Slip-on

- ✓ Actually slip over the end of the pipe
- ✓ Need two welds compared to the one on the weld neck



Flanges can also be attached to threaded pipe. The threaded flange has the same dimensions as the slip-on flange.



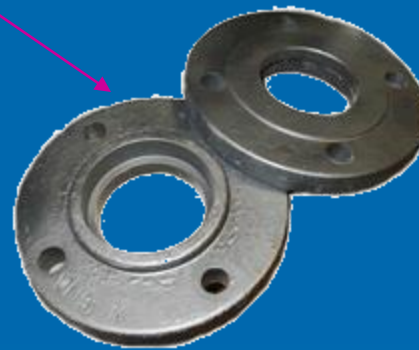
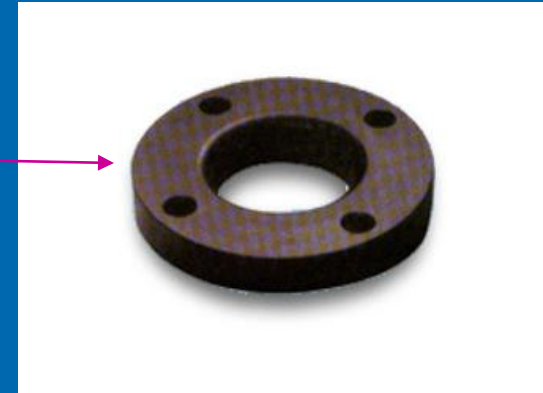
Threaded Flanges

Other flanges that are also used:

➤ lap joint

➤ socket weld

➤ blind



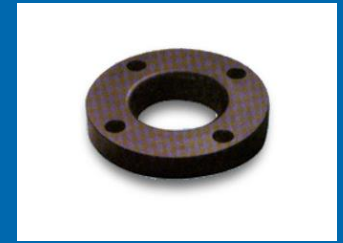
For information and dimensions see ANSI Forged Steel Flanges table in Appendix B on page 268 in your text.

### 3. Lap Joint

- also known as a “Van Stone” flange
- Composed of two parts: “STUB-END” and the flange
- Normally used on expensive pipe; such as stainless steel... the “stub end” needs to be the same material as the pipe run... the flange can be carbon steel instead of stainless.

**DON'T** confuse STUB END with STUB IN...

**TWO TOTALLY DIFFERENT THINGS!!!!**



Lap Joint Flange



Stub END

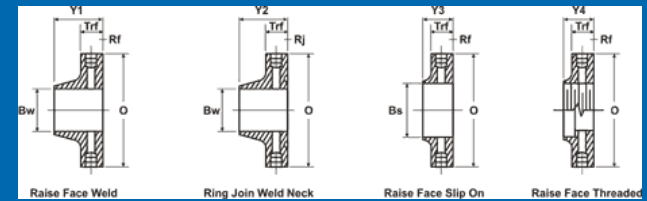
### 4. Blind

- creates temporary seal on the end of a pipe run
- used where future expansion to the process is anticipated



# Orifice Flange

- ✓ Typically 300#
- ✓ used with an orifice plate to measure flow through a pipe
- ✓ Two orifice flanges are bolted together with the orifice plate between them.
  - ❖ There is a gasket between each flange and the plate.
  - ❖ The plate is a disk with a small hole in the center – the diameter of the hole or orifice is smaller than the NPS of the pipe – the size of the orifice depends on the rate of flow to be measured
- ✓ each of the orifice flanges have two drilled and tapped holes either 90° or 180° apart.
  - ❖ usually a small diameter pipe or tubing is run from the tapped holes to a flow meter
  - ❖ the flow rate is measured and recorded as a result of a difference in pressure on the upstream and downstream sides of the orifice flange set.



## Flange facings

- ❑ machined feature applied to the face of the flange
- ❑ can have different finishes applied to it; smooth, serrated or grooved

### 1. Raised face: (R.F.)

- most commonly used
- Face is 1/16" high on 150# and 300# flanges
- for all other pressure ratings, the face is 1/4" high
- a gasket, which is smaller in diameter than the raised faces, is pressed between them

### 2. Flat face: (F.F.)

- Commonly used for mating with non-steel flanges found on pump bodies and other cast iron fittings and valves with pressure rating of 125psi
- Gasket can be greater in diameter than the flange itself
- Using flat face flanges reduces danger of cracking cast iron flanges

### 3. Ring-joint: (R.J. or R.T.J.)

- Contains a machined groove in each flange face
- O-ring type of metal gasket is inserted in the machined grooves
- Expensive flanges and used for high-pressure and high-temperature applications
- Gaskets are the most efficient since the internal pressure acts on the ring to allow for better sealing

## Screwed Fittings

Screwed pipe and fittings are available in sizes from 1/8" to 4"

Maximum size of screwed piping normally used is 2"

Screwed fittings are similar to the fittings already discussed in this tutorial

Appendix C in your text provides more information on screwed fittings and dimensions.

Thanks for viewing this Tutorial.

Any questions, comments or complaints can be registered at the next class meeting, via email or drop by my office.



Email: [rstrube@mail.accd.edu](mailto:rstrube@mail.accd.edu)



# REFERENCES

Parisher, Roy A. & Robert A. Rhea. 2002. Pipe Drafting and Design. 2<sup>nd</sup> Ed. Gulf Professional Publishing\_Butterworth-Heinemann.

Shumaker, Terence M. 2004. Process Pipe Drafting. The Goodheart-Willcox Company, Inc. Tinley Park, Illinois.