



Process Piping - Ancillary Equipment

An Online Continuing Education Course for Engineers

Course Number: M-1029

Credit: 1 Hour / 1 PDH / 1 CPD

Process Piping: Ancillary Equipment

1. Flexible Couplings

Flexible couplings are used to join pipe sections, to insulate sections from one other, to absorb concentrated pipe movement, and to join plain end pipe to flanged valves and other equipment. The basic purpose of flexible couplings is to provide flexible but leak-tight connections that will last for the life of the piping. Flexible couplings are generally available in sizes from 15 mm (½ in) to 1.8 m (6 feet) and larger.

a. Metallic Flexible Couplings

The basic configuration of a flexible coupling is a metallic middle ring that slips over the joint between two pipe sections with a gasket and a follower at each end. This configuration compresses the gasket and seals the middle ring (see Figure 1). The middle ring can be provided standard in a number of different materials, such as plastic or rubber lined, stainless steel, aluminum, Monel, carbon steel, and ductile iron.

The gaskets are likewise available in different materials (typically, elastomers and rubber materials).

b. Transition Couplings

Similar to flexible couplings in construction, transition couplings connect pipe with a small difference in outside diameter: the middle ring in transition couplings is pre-deflected to adjust for the differences in diameter. As with the flexible couplings, the transitional coupling's middle ring and gaskets are available in different materials, depending upon the application.

c. Flanged Couplings

Flanged couplings are typically provided with a compression end connection on one end and a flange on the other. The flanges can be provided in different ANSI or AWWA standards, as required for the application. The manufacturer should be consulted for pressure ratings.

d. Couplings for Non-metallic Piping

Flexible couplings for non-metallic piping are very similar to metallic piping couplings. There are three main configuration alternatives for these couplings. The first is the same configuration as the metallic piping, in which there is a middle ring that is sealed by gaskets and held in place with end pieces that are bolted together. The second method is very similar, except that the end pieces are lock rings, similar to compression fittings, threaded to hold the middle ring in place. In both instances, the wetted-parts materials are selected in order to meet the application. The last type of typical flexible coupling for non-metallic piping is a bellows expansion joint (see Paragraph 8c). The bellows expansion joints can accommodate directional changes of compression/extension and lateral offset and angular rotation of the connected piping; however, these joints are not capable of absorbing torsional movement. If a bellows expansion joint is used as a flexible connector, a minimum of two corrugations should be provided. The potential movement of the bellows is calculated to obtain the proper number of corrugations.

2. Air and Vacuum Relief

During startup, shutdown and in normal operations, it is common for liquid process piping system to produce situations where air needs to be exhausted or allowed to re-enter. The devices used include air-release valves, air-vacuum valves, vacuum breakers, and combination air-release and air-vacuum valves. The type of valve required varies for the specific applications.

a. Air-release Valves

For liquid process piping in which air tends to collect within the lines (as occurs under pressure systems as air dissolves and then reappears as the pressure decreases), air-release valves are necessary. A very common operating problem occurs when air collects in the high places of the piping systems, producing air pockets. These air pockets can reduce the effective area of the pipe through which the liquid can flow, causing a problem known as air binding. Air binding results in pressure loss, thus increasing pumping costs.

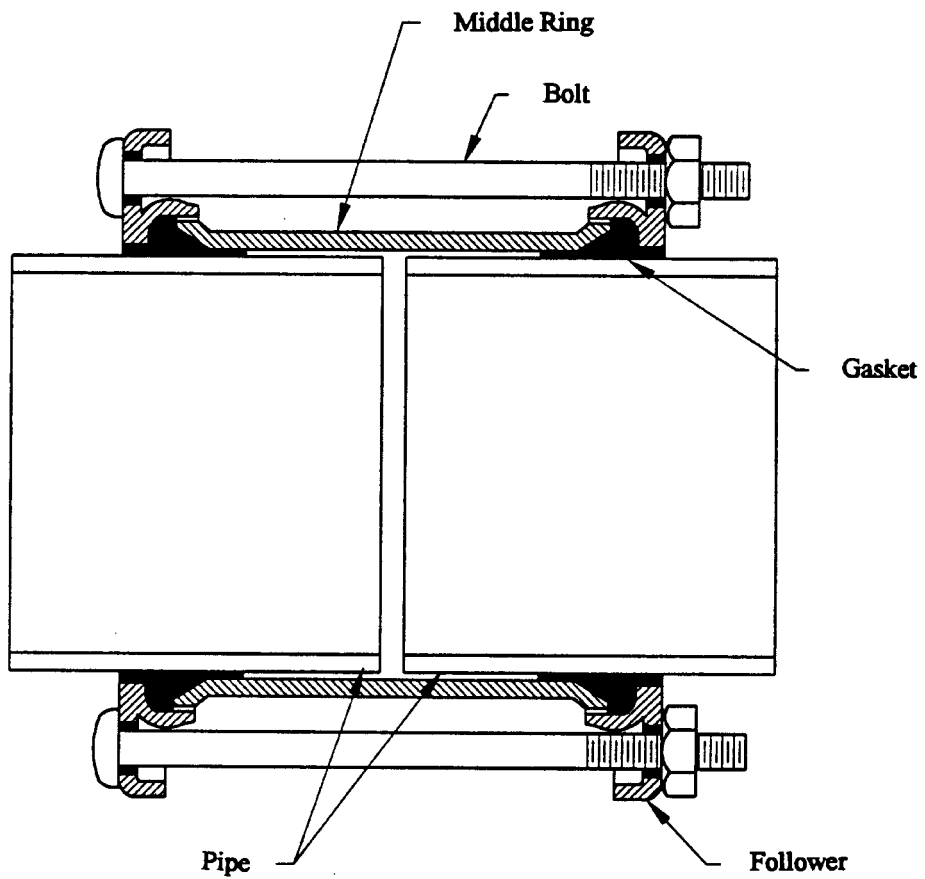


Figure 1. Flexible Coupling
(Source: Dresser Industries, Inc., "Style 38 Dresser Couplings for Steel Pipe Sizes, Sizes and Specifications," Form 877-C Rev. 1095)

It is typical for air-release valves to be installed to eliminate these problems. Air-release valves should be installed at pumping stations where air can enter the system, as well as at all high points in the pipeline system where air can collect. Air-release valves automatically vent any air that accumulates in the piping system while the system is in operation and under pressure. However, the potential for accumulating hazardous gases must be taken into account, and the vents located in a manner such that it does not cause a hazardous atmosphere for the operators. Air-release valves do not provide vacuum protection nor vent large quantities of air as required on pipeline filling; air-vacuum valves are designed for these purposes.

The sizing of air-release valves is based upon engineering judgement and experience. The parameters which affect valve size are the potential for air entrainment, pipe diameter, volumetric flow rate, system pressure, fluid viscosity, surface condition of the pipe wall, and the degree of pipe slope adjacent to the piping high point. Manufacturers' data can assist in the selection.

b. Air-Vacuum Valves

For piping systems that are used intermittently and are therefore periodically filled and drained, air-vacuum valves are used to prevent damage to the piping system. The damage could result from over-pressurization and velocity surges during filling, or collapse during draining.

Air-vacuum valves are installed at piping high points. These valves are float operated, have large discharge and inlet ports that are equal in size, and automatically allow large volumes of air to be rapidly exhausted from or admitted into a pipeline. As with air-release valves, the potential for releasing hazardous gases must be addressed in the design and the vents located to permit a hazard condition for personnel. Air-vacuum valves will not vent gases when the piping system is in normal operation and under pressure. Air-release valves are designed for that purpose.

The sizing of air-vacuum valves is performed independently for each location and requires the review of both functions; i.e., air exhaust and air intake. The largest valve required for either function is selected. The flow capacity required is compared to manufacturers' data relating acceptable pressure drop to valve size. The flow capacity requirements are determined as follows:

$$Q_{\text{exhaust}} = Q_{\text{max}}$$

where:

$$Q_{\text{exhaust}} = \text{volumetric flow rate of exhaust air, m}^3/\text{s (ft}^3/\text{s)}$$

$$Q_{\text{max}} = \text{maximum liquid filling rate, m}^3/\text{s (ft}^3/\text{s)}$$

$$Q_{\text{intake}} = Q_{\text{gravity}}$$

where:

$$Q_{\text{intake}} = \text{volumetric flow rate of intake air, m}^3/\text{s (ft}^3/\text{s)}$$

$$Q_{\text{gravity}} = \text{gravity flow rate of liquid during draining, m}^3/\text{s (ft}^3/\text{s)}$$

c. Vacuum Breakers

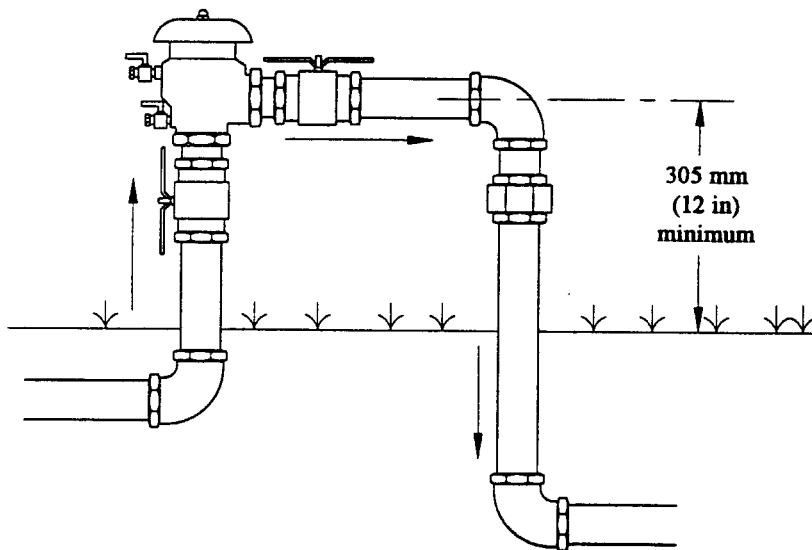
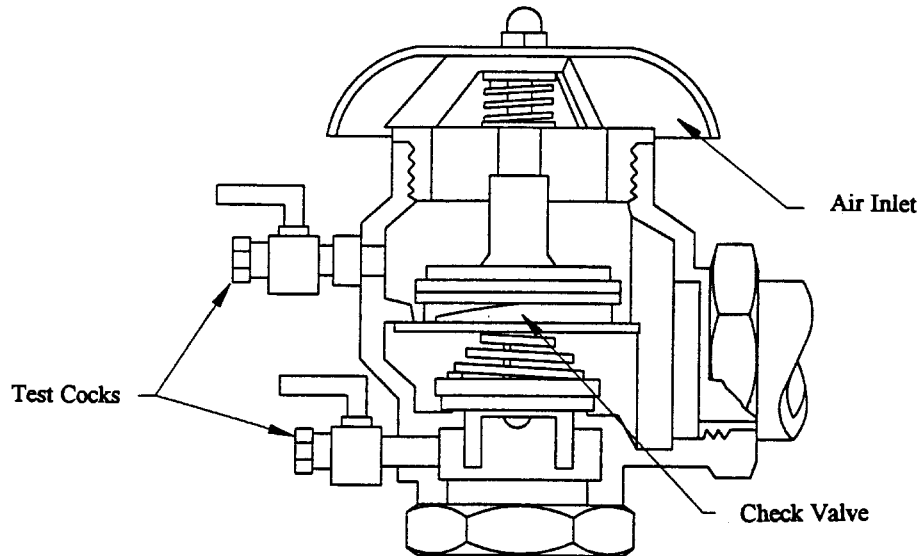
Two primary types of vacuum breakers are available -- atmospheric and pressure. Atmospheric vacuum breakers operate in the event of total pressure loss. Pressure vacuum breakers provide protection against back siphonage and pressure surges. The configuration of pressure vacuum breakers vary by manufacturer. The configuration used to prevent back siphonage of hazardous liquids often involves a check valve as well as an air intake.

Figure 2 depicts a combination pressure vacuum breaker and its typical installation requirements. The pressure vacuum breaker is a spring-loaded check valve that opens during forward flow and is closed by the spring when the flow stops. When the pressure drops to a low value, a second valve will open and allow air to enter the breaker.

The configuration used for applications that may involve pressure surges have associated air-release valves. The latter arrangement allows the large volumes of air, admitted by the vacuum breaker, to be slowly exhausted by the air-release valve under operating conditions and act as a pressure surge reservoir.

d. Combination Air-release and Air-Vacuum Valves

The operating functions of both an air-release valve and an air-vacuum valve are accommodated in a single combination air-release and air-vacuum valve. Using this type of valve in lieu of air-release and air-vacuum valves



Installation Notes

1. Install where accessible for testing, repair and maintenance.
2. Air inlet must be vertical.
3. Install where spillage or liquid releases are not objectionable, or design facility to accommodate the released liquids.

Figure 2. Pressure and Vacuum Breaker
 (Source: FEBCO, Service Information Model 765 Pressure Vacuum Breaker Assembly, vendor bulletin)

typically provides the piping system with maximum protection. However, each individual location should be carefully reviewed.

e. Air and Vacuum Relief Application

Suggested application of air and vacuum relief devices into the piping design is as follows:

- Locate air-vacuum relief devices at locations where the piping system is subject to vacuum. For non-hazardous service, air-vacuum relief devices may be manual valves or combination air-release valves. Combination air-release valves are effective.
- Locate combination air-release valves at all system high points where vacuum accumulation exists.
- Locate air-release valves at high points (1,640 to 2,790 ft) on liquid service. They should be installed with an isolation valve, between the air-release valve and the piping system for maintenance purposes.
- Locate vacuum breakers at all system high points.

3. Drains

All low points in liquid process piping should be provided with drain or blowdown valves to allow flushing of sediment and debris from the entire lines.

Pipelines 50 mm (2 in) and smaller should use 15mm (½ in) valves, as a minimum size. Pipelines that are 65 mm (2½ in) or greater should have a minimum valve size of 20 mm (¾ in).

4. Sample Ports

Materials of construction for sample ports and sample valves match the piping system and the required application.

a. Port Locations

Sample piping should be as short as possible, protected from physical damage, and easily accessed by operators. Sample connections are made on feed, intermediate and Process engineers are consulted in order to determine the number and location of sample ports.

Requirements

It is required that the minimum size connection to process equipment or the piping be 15 mm (¾ in). If the sample line is longer than a meter (3.3 feet), two valves are installed in the sample line. The first valve is located as close to the process equipment as possible. The second valve is a check valve and should be located near the end of the sample line. The valves should be quick opening, and all materials of construction should be compatible with the process material.

Pressure Relief Devices

The ASME Pressure Piping Code provides the requirements for pressure relief devices. The code provides a summary of the requirements for pressure relief devices, but these limits shall not be used without consulting the proper ASME B31 section. Note that high pressure piping is not included.

Pressure relief valves are automatic pressure relieving devices that protect piping systems and process equipment. The valves protect systems by releasing excess pressure. During normal operation, the valve disc is held against the valve seat by a spring. The spring is adjustable to the pressure at which the disc lifts. The valve disc lift is proportional to the system pressure so that, as the system pressure increases, the force exerted by the liquid on the disc forces the disc up and relieves the pressure. The valve will reseat when the pressure is reduced below the set spring pressure. Pressure relief valve materials and process pressure range must be accounted for to specify the correct pressure relief device.

