Shutoff Valves: A Primer

Understanding how shutoff valves function as well as their general construction, proper installation and maintenance is necessary for the safe operation of refrigeration systems.

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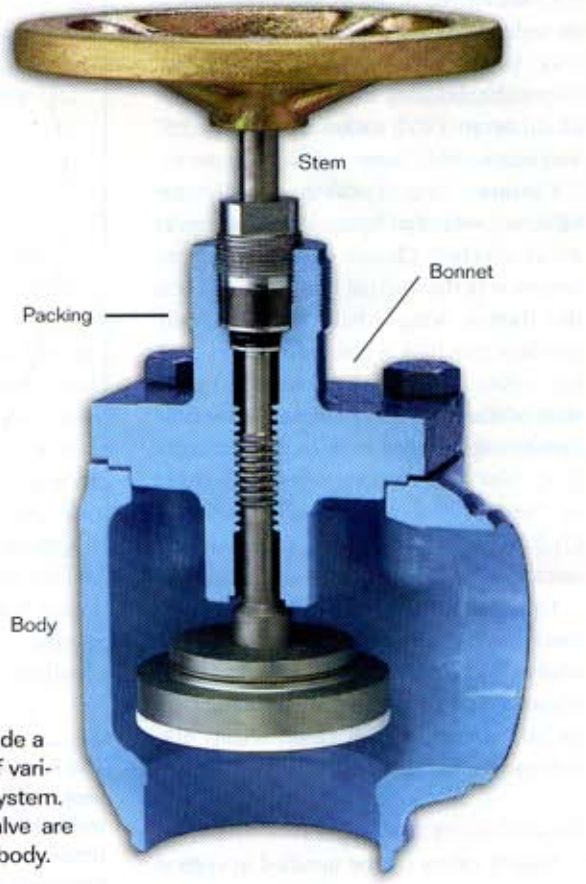


Shutoff valves are used to provide a means of on/off flow control of various portions of a refrigeration system. Main elements of a shutoff valve are the stem, packing, bonnet and body.

Shutoff valves are the most common and plentiful type of valve used in industrial refrigeration systems. Also known as manual valves, hand valves, isolation valves, stop valves and servicing valves, shutoff valves are used routinely, even in automated systems. Because of this, a thorough understanding of their function and general construction as well as proper installation, operation and maintenance is essential for the safe operation of refrigeration systems. Hand expansion valves and stop/check valves will be discussed briefly because of their kinship to shutoff valves.

Shutoff valves serve many functions. In particular, these valves are used to provide a means of on/off flow control of various portions of a refrigeration system. They frequently are used to isolate control valves, pumps, compressors or other equipment for servicing. When proper safety precautions are observed, they also may be used for special maintenance purposes such as oil draining and manual purging.

General Construction

Primarily, there are three types of shutoff valves in today's industrial refrigeration systems: globe, ball and butterfly. Even though the designs can be quite different, they share some common and essential elements: the pressure envelope, connections, closure and operator (actuator).

Pressure Envelope. This is the boundary that separates the refrigerant contained within the valve from the atmosphere. The body and bonnet make up the largest portion of the pressure envelope. Typically, the body is made of steel or iron. The bonnet is a portion of a valve that separates from the valve body to provide access to the valve interior for servicing. Bonnets may be either flanged (bolted) or screwed.

Stems enable the change in position of the valve main seat. Stems are either rising or non-rising design. That is to say, as a rising stem is rotated, the amount of exposed stem surface increases or decreases. Examples of non-rising stems include a quarter-turn ball valve, butterfly valve or very large globe valve where the amount of exposed stem surface does not change with the position of the valve seat. Most manufacturers now use stainless steel stems to minimize the effects of corrosion on the stem packing.

Stem packing is a seal, or combination of seals, located at the junction of the stem (moving) and the bonnet or body (stationary). The function of the stem packing is to allow a change in stem position without permitting any refrigerant leakage to the atmosphere. Today's shutoff valve stem packings typically are manufactured using graphite composite, PTFE (Teflon) or Neoprene. These materials usually are formed into discs, O-rings or braided cords.

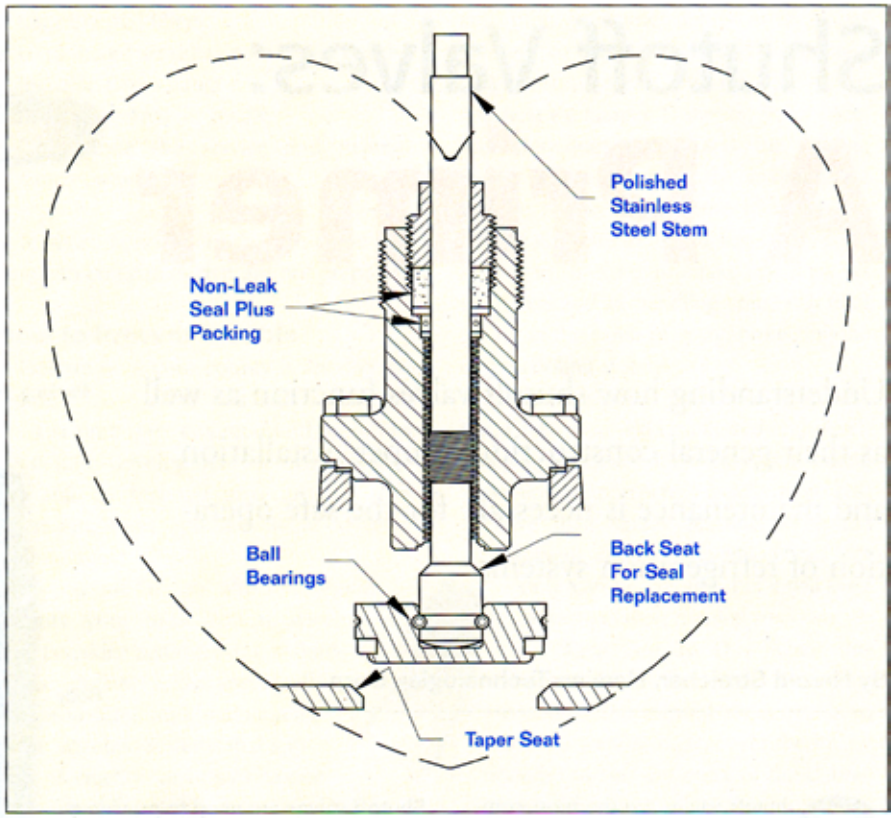
Connections. These are the points at which the valve is joined to piping system. They must be leaktight and strong. Configuration of a shutoff valve body is either straight-through (also referred to as globe) or angle. Straight-through valve bodies have piping connections at oppo-

site ends; angle valves have connections at 90° in relation to one another.

Connections are provided for threading or welding valves to adjacent piping. This may be done directly or via flanges. Generally, threaded (NPT) connections are found up to 1.25", socket weld up to 2.5" and butt-weld in larger sizes.

Closure. Shutoff valves usually are designed such that tight closing occurs in either direction. Closure occurs at the convergence of the internal body seat and seat disc (button, wing or ball). Closure usually involves matching a soft with a hard seating surface. Its position is changed by the stem. When open, valves allow flow through the valve with some pressure drop. Globe valve body seats are tapered or beaded. Seat discs usually are PTFE (Teflon), lead compound or another metal-to-metal.

Operator (Actuator). These devices are used to rotate the stem in order to close or open a shutoff valve. The most common operator is a handwheel. Other operators include wrenches (seal caps), chains and pulleys, motors and pneumatics.



The inner workings of a shutoff valve include a non-leak seal plus packing, a back seat for seal replacement, ball bearings and a taper seat. Shutoff valves are used to isolate control valves, pumps, compressors and other refrigeration equipment for servicing. When proper safety precautions are observed, they also may be used for special maintenance purposes such as oil draining and manual purging.

Installation and Maintenance

Shutoff valves can be installed in vertical or horizontal pipelines. Their orientation should be based on several factors: direction of normal flow, valve type and stem position. Stems can be horizontal, vertical or angled upwards. Generally, stems are not installed downward to avoid the collection of debris at the stems threads and packing. Some valves will have internal bonnet stem-supporting extensions that make orientation less important in this regard.

Usually, shutoff-valve maintenance is minimal. The common use of stainless steel stems and advanced packing and seal materials in the last 10 years has greatly reduced maintenance requirements. Before attempting maintenance on any valve, always refer to the manufacturer's recommendations and safety procedures. Factors that may increase maintenance requirements include frequency of operation, environment, temperature cycling, valve design and materials of construction. Consideration should be given to routine exercising of hand valves. This exercise may be to simply turn the valve stem all the way in and out on a routine basis. It also may include a means of ensuring seat tightness, especially for critical shutoff valves. Only trained refrigerant technicians wearing proper safety equipment should conduct valve maintenance. Eye and face protection is especially important because the valve may contain refrigerant.

Stems should be wiped down occasionally with oil to help prevent rusting. Stems made of stainless steel usually do not require this attention. Where practical, the liberal use of seal caps may be advisable. Seal caps, especially for valves installed outdoors, provide additional protection against the elements and environmental contaminants. In addition, the caps can help minimize any potential loss of refrigerant past the stem packing. Before attempting to service shutoff valves that have seal caps, be aware that refrigerant pressure may exist under the cap. Proceed slowly, taking care to notice any signs of refrigerant.

A noticeable sign that maintenance is required is when refrigerant is leaking past the stem packing. A packing leak may not be so obvious when the valve is on a portion of the system operating in a vacuum. Often, a leak at the stem packing can be resolved quickly by tightening the packing nut (gland). If this does not resolve the issue, try to isolate the leak by utilizing the back-seat of the valve. Many refrigerant valves have what is known as a back seat. This is an auxiliary seat that enables the stem packing to be isolated from the refrigerant inside the main portion of the valve. Back seating can be accomplished by fully opening the main valve seat, stem turned-out, until it stops firmly. Back seating itself may temporarily stop leaks by isolating the packing from the refrigerant

pressure. If you are not sure if the valve has a back seat, it is always best to isolate from the system the valve that is to be serviced. Proceeding with care, loosen and then remove the packing nut. Using appropriate tools, remove old packing or seals, being careful not to scratch the stem or internal surfaces. Install the new stem packing and tighten packing nut per manufacturer recommendations.

When it comes to inspecting or replacing the valve seat, the entire valve must be isolated from system. Note that refrigerant must be safely pumped out of the system. It is important to understand that back seating, or simply closing the valve at the seat, does not isolate the valve from the system.

To replace the valve seat, loosen the bonnet bolts or the screwed bonnet As always, wear appropriate eye protection equipment. Break bonnet gasket seal. Be cautious to notice any refrigerant that might remain. If safe, only then should bonnet be removed. Inspect or replace seat disc if necessary. Marks on valve body seat often can be polished out by using emery paper. When refurbishing small shutoff valves, replacement of the entire bonnet assembly (including seat disc) is often done to save time.

Hand Expansion, Stop/Check Valves

Hand expansion (regulators) valves are a variation of a shutoff valve. Although their appearance is similar to shutoff valves, they usually are identifiable by a distinctive bar handle or differently colored seal cap. This type of valve is intended to meter (regulate) the flow of refrigerant rather than simply enable on/off flow control. Depending on the design, these valves may not provide a tight closing.

Stop/check valves are another variation of the shutoff valve. Like a shutoff valve, it enables the on/off control of refrigerant flow. However, it normally permits flow in one direction only, depicted by an arrow. Like hand-expansion valves, manufacturers attempt to distinguish these valves from shutoff valves using unique colors and machined markings.

Shut-off valves are an integral part of a refrigeration system. It is important for those who select, install, service and use these types of valves to be familiar with their construction and operation. **PCE**

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