Iris valves: How they work and how to apply them

Most of us are familiar with the common iris mechanism, a simple device that opens and closes a circular hole. Common examples are camera shutters and the irises in our eyes, which both control the entrance of light. Maybe you’ve even seen iris doors opening and closing in space ships in sci-fi films. The iris mechanism also has a place in the real world of dry bulk solids handling, where it’s called an iris valve. The iris valve’s function is to gently control the discharge of free-flowing powders, granules, and pellets — including chemicals, food and dairy products, pharmaceuticals, minerals, and plastics — in gravity-flow applications.

The iris valve is a lightweight, compact device typically installed on bulk bag dischargers, bin bottoms, and chute outlets. On a bulk bag discharger, the valve closes off the bulk bag’s spout without directly contacting the flowing material, while in other applications the valve directly contacts the material. The valve’s gentle closing action makes it especially suitable for handling friable materials that degrade easily, such as pharmaceutical tablets and coffee beans, and for potentially explosive materials. However, the iris valve is not well-suited to direct-contact applications with abrasive materials, high material flowrates, or frequent open-close cycles because they can expose some valve components to blast abrasion.

How the valve works

The iris valve consists of a metal casing, called the valve body, enclosing two concentric rings that are connected by a short, flexible, tubular sleeve, as shown in Figure 1. One ring is fixed inside the valve body, and the other, called the control ring, can be rotated. One sleeve end is attached to the valve body, and the other sleeve end is attached to the control ring, which has an external handle. As the handle is rotated through a 180-degree arc, as shown in Figure 2, the sleeve twists to a point where it forms a flat, tight, solid barrier.

Figure 1

Typical iris valve

| Shawn Werner | Vortex Valves North America |
| Travis Young | Vortex Valves International |
Unlike a conventional gate or butterfly valve, in which a gate or disc crosses and obstructs the column of flowing material, the iris valve has a circular opening that closes toward the center of the material column. When the iris valve opens, its circular opening creates a small “cone” of material that flows directly into the receiving container’s center, allowing for precise container filling.

The iris valve can be manually, pneumatically, or electrically actuated. A manually actuated valve commonly has an external twist or quick-lock handle (Figure 1) attached to the control ring. With the twist handle, the operator rotates the handle to control the valve’s opening in an infinite number of positions across the 180-degree arc. With the quick-lock handle, which incorporates a locking mecha-

Figure 2
Iris valve operation

Open
Partially closed
Closed

Valve body and fixed ring materials. The iris valve body and fixed ring are commonly constructed of aluminum. The aluminum may also be anodized or Teflon-coated to suit a direct-contact application with a caustic environment. Type 304 and 316L stainless steels are also available for sanitary applications but have a significantly higher cost than aluminum. Some iris valve suppliers offer aluminum valve bodies in which only the material-contact areas are lined with stainless steel, which reduces the valve’s cost.

Sleeve materials. The sleeve can be constructed of fabric, coated fabric, or rubber. Commonly available materials include nylon, Terylene (a polyethylene terephthalate [PET]), Teflon, urethane, natural rubber, and Buna N rubber (nitrile rubber); other materials are also available, depending on the valve supplier. Sometimes apparently easy-to-handle bulk solids can be too caustic or abrasive for certain fabrics or rubbers, so it’s best to consult your valve supplier to determine which material will best handle your solids. For instance, a rubber material is suitable for handling some abrasive powders or for applications requiring washdown. A sleeve made of two layers of fabric is often used to handle a fine powder that generates dust; the two-layer sleeve also provides greater valve-closing force for use with high-bulk-density solids.

Component construction materials

The valve components can be made of various materials to suit your application.

Control ring and handle materials. The iris valve control ring can be made of polycarbonate, bronze, or stainless
steel, depending on the supplier. The ring’s external twist or quick-lock handle, as well as the locking mechanism on a quick-lock handle, can also be made of polycarbonate, bronze, or stainless steel. Carefully selecting construction materials for these components will prevent operating and other problems. For instance, the iris valve is subject to torsional stress, especially as it closes, which can eventually distort or break a polycarbonate handle, locking mechanism, or control ring. A bronze control ring tends to produce metal flaking as a result of contact between the bronze control ring and the metal valve body. This problem can lead to a damaged sleeve, introduce contaminants into the material, and cause the valve to actuate erratically. A stainless steel control ring will provide longer service life, and a Type 316L stainless steel control ring is best for handling corrosive materials.

Evaluating iris valve pros and cons
While the iris valve can be an efficient and cost-effective means of controlling the discharge of dry bulk solids in many applications, it has some limitations. Before selecting an iris valve for your discharge application, consider these pros and cons.

Pros. On the plus side, the iris valve:
• Is inexpensive when manually actuated.
• Has a simple, compact design, is light-weight, and disassembles easily, making it easy to install, clean, and maintain, especially in confined areas.
• Is ideal for use with friable and explosive materials. (In applications handling explosive materials, the valve and surrounding equipment must be properly grounded to avoid electrostatic discharges, and when the valve is equipped with an electric actuator or controls, these must meet applicable NEMA standards in the US or ATEX standards in European Union countries.)
• Has an unobstructed opening and closes toward the valve’s center, allowing the discharged material to more evenly fill containers.

Cons. The iris valve’s limitations are that it:
• Isn’t well-suited to handling high-volume, continuous material flow.
• Can’t close through a standing column of material.
• Can’t handle frequent open-close cycles in direct-contact applications.
• Can’t support heavy equipment suspended from it.
• Has a bolt-hole mounting pattern that usually differs by supplier.

Choosing an iris valve
For help determining whether the iris valve is right for your bulk solids discharge application, consult an iris valve supplier. Based on the details you provide about your operation and your material’s physical characteristics and flow properties, the supplier can determine if the iris valve is a good choice. If it is, work closely with the supplier to select the right valve components, construction materials, and actuation method to keep the iris valve operating smoothly and efficiently in your handling operation.

References
1. Information on NEMA standards is available from National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Suite 1752, Rosslyn, VA 22209; 703-841-3200, fax 703-841-5900 (www.nema.org).

For further reading
Find more information on iris valves and other valves for handling dry bulk solids in articles listed under “Valves” in Powder and Bulk Engineering’s comprehensive article index at www.powderbulk.com and in the December 2007 issue.

Shawn Werner is chief engineer at Vortex Valves North America, 1725 Vortex Avenue, Salina, KS 67401; 785-825-7177, fax 785-825-7194 (shawn@vortexvalves.com, www.vortexvalves.com). He holds a BS in mechanical engineering technology from Kansas State University, Manhattan, Kans. Travis Young is managing director of Vortex Valves International (travis@vortexvalves.com) and holds a BA in marketing and international business from Kansas State University, Manhattan, Kans.