Wear can be a problem in any pneumatic conveying system, especially when conveying abrasive materials or operating at high velocities. This article will discuss ways you can limit elbow and other fitting wear in a pneumatic conveying system.

Wear should be considered when a pneumatic conveying system is being designed, but it’s often overlooked since a fitting designed for long wear may not always be the most efficient choice for the system. Even so, wear is inevitable and parts will eventually fail due to wear no matter which option is installed. Therefore, wear must be managed appropriately by choosing appropriate components and scheduled inspection or replacement in problematic areas.

All of the options discussed in this article will add cost to a standard elbow, valve, or gate valve, but they can also help increase the lifespan of your fittings. When choosing an option, consider the component’s replacement cost, including the labor, downtime, and lost material. The higher initial cost of a specialized wear-resistant component compared to a standard component may be offset if the components fail frequently and the replacement cost is high. However, in a case where components fail infrequently or the costs associated with failure are low, a standard item may be more cost-effective.

**Reducing elbow wear**

To provide the necessary performance characteristics (desired pressure drop), elbows and fittings in a new installation should be selected based on the pneumatic conveying system’s geometry while also providing the necessary wear characteristics and minimizing material degradation. This is an important aspect to consider during the design phase because it’s not always feasible to make changes to elbow geometries after the system is installed.

In an already existing pneumatic conveying system, changes to geometry aren’t feasible, so any changes made to increase elbow life must work within the system’s confines. The elbows can be especially problematic for wear because the change in material direction causes material to impact the elbow itself. Any elbow replacements must match the original elbow’s angle and its center line radius. Luckily, there are several options that may provide longer elbow life.

The easiest option to combat elbow wear is to replace the existing elbow with one made from a thicker material or to change it to a more wear-resistant material. This will work only if there’s a thicker or more resilient material available. For example, a 16-gauge aluminum elbow may be replaced with an 11-gauge stainless steel elbow for additional life. The downside of changing an elbow’s construction material is that the change in thickness, either the outside diameter (OD) or the inside diameter (ID), will no longer match the existing pipe or tubing. This can introduce a slight flow restriction, create an area that may trap material (if the IDs don’t align), or make joining the tubing together with couplings difficult (if the ODs don’t align). To prevent these problems, a suitable elbow may instead be modified in various ways to prevent total failure from wear.

Elbow modifications to combat wear can include adding material to the elbow where the wear will occur. These modifications can take a few different forms, depending on your application requirements.

An **open-cavity-back elbow** is created when the outside of a standard smooth-flow elbow is boxed in with heavy-gauge steel, which provides high abrasion resistance. Shown in Figure 1a, the elbow initially will perform as a standard elbow, but as conveyed material wears through the main elbow, the material will fill the open cavity and wear on itself. The material will eventually wear through the outside metal backing, requiring that the elbow be replaced. This is a relatively low-cost option since it’s based on a standard elbow. An additional option is to fabricate the outside surface so that it’s fastened with bolts (instead of being welded), which allows for easier replacement once the material has worn through. The replacement can be completed without removing the entire elbow from the line.
A **filled-cavity-back elbow** is similar to the open-cavity-back elbow, but the cavity created between the elbow and the outside wall is instead filled with concrete. This means the conveyed material must wear through the elbow first, then through the concrete, and then through the metal backing. This significantly increases the elbow’s life but at the cost of introducing concrete into the pneumatic conveying system. This elbow type is prone to trapping the conveyed material, which makes it unsuitable for applications where cross-contamination may be an issue.

A **ceramic-lined elbow** is a smooth-flow elbow where the inner surface is coated with a thin layer of ceramic material (0.006 to 0.008 inches thick) along the entire inner surface of the elbow's length. The ceramic lining provides a hard and smooth surface finish to reduce friction caused by the conveyed material without adding to the elbow’s overall dimensions.

A **ceramic-back elbow** is a metal elbow with a hard ceramic material applied to the elbow’s outside. When the conveyed material wears through the metal elbow, the material will encounter the ceramic on the outside and wear on that additional ceramic material. Shown in Figure 1b, the backing is approximately 0.5 inches thick and typically takes a great deal of time to wear through. A ceramic backing adds significant weight and increases the elbow’s overall dimensions, which may make installation difficult at great heights or in tight spaces.

A **flat-back elbow** is an alternative solution to elbow modifications based on using a standard smooth-flow elbow. This elbow has a square cross section and is fabricated from sheet steel with square-to-round transitions on either end, as shown in Figure 1c. The back section and the transitions are typically fabricated from thick or abrasion-resistant steel with the back bolted to the main elbow, which allows the flat back to be readily replaced. A flat-back elbow is an effective solution where cross-contamination may be a concern because the elbow won’t trap and hold the conveyed material. The flat back should be installed in a pneumatic conveying system where the elbow is easily accessible so the backing can be easily replaced.

**Minimizing valves and gate wear**

Valve and gate wear can also be a problem in a pneumatic conveying system. For gravity-fed systems, several options are available to reduce component wear, including abrasion-resistant steels and material pockets. However, material pockets aren’t usually suitable for a high-velocity pneumatic conveying system because the air-entrained material’s velocity can cause material degradation as the material in the airstream deflects off of the collected material in the pocket.
Stream. Knife-type or slide-gate valves are often the most suitable in pneumatic conveying since they offer no obstruction to the material flow, which minimizes wear.

Using a diverter valve in a pneumatic conveying system can cause additional wear since the act of diverting a moving material stream will subject the valve to wear. Many diverter valves used in pneumatic conveying systems consist of either a tube or pipe wye fitting where one leg of two is opened to allow material to flow through. Since this diverter relies on the wye fitting to divert material, the fitting itself is extremely susceptible to wear. Strategies to combat this wear are similar to those used for elbows, including using a thicker valve construction material or adding an open-cavity or ceramic backing.

A diverter valve that uses a flexible hose to divert material will handle wear better. The hose can be made from a wide range of materials depending on the application, but the hose is typically either rubber or polyurethane, which is soft enough to be abrasion-resistant. A tube diverter valve is highly recommended if the system is conveying a variety of materials and cross-contamination needs to be avoided.

For further reading
Find more information on this topic in articles listed under “Pneumatic conveying” in Powder and Bulk Engineering’s comprehensive article index in the December 2017 issue or the Article Archive on PBE’s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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