How to Select Pneumatic Conveying Elbows

Given that pneumatic conveying has been around for more than a century, something as simple as choosing bends for a system should have long become a routine task. However, engineers still routinely misunderstand the significance of choosing the right pneumatic conveying elbow. This lack of education about an important component in the system has consequences. Haphazard usage of the wrong type of elbow often plays a role in system pressure drop, system wear, and product degradation. Given the common confusion when seeking the best elbow, this article seeks to help designers and users make better decisions regarding the proper conveying elbow given their unique manufacturing needs.

There are a number of variables that affect the efficiency of bends in a system. However, the one that has the most of effect is the style of elbow selected. There are three main categories of elbows: long radius elbows, short radius elbows, and impact/vortex elbows.

The most common elbow for conveying material is the long radius elbow. A long radius elbow is any elbow whose centerline radius is 10x (or longer) than the outer diameter of the elbow. For example, a 4-in. tube elbow would have a centerline radius of at least 40 inches. The original industry standard was a 12x radius because it corresponded to 1ft in radius, and this is method is still sometimes used because it makes the math easy. A 2-in. pipe would need a two-ft radius, 3-in. pipe would need a 3-ft radius, 4-in. pipe would need a 4-ft radius, and so on.

The next most common elbow is the short radius elbow. These elbows are like the long elbows, but have shorter radii, typically 2.5 to 4 times the outer diameter of the elbow. There are also short radius “weld-fitting” type elbows. They are 1 to 1.5 times the elbow diameter. However, these elbows are usually too tight; they are not typically used for pneumatically conveying product.

The last category of elbow is the impact or vortex elbow fitting. These short fitting-style elbows protect themselves from abrasion by mechanical means. Dead-end tees (blind tee) or vortex style elbows fall into this category.

Short radius elbows have many advantages. They are readily available, less expensive, lighter, easy to install, easy to replace, and take up a lot less space. For some applications, they can be the perfect elbow. However, they do have some major disadvantages, too. Short radius elbows – which have a severe angle of impact – take a lot of punishment in one spot just off the centerline of the elbow, making them more likely to blow out if the product is abrasive. Additionally, the greater impact in short radius elbows often creates greater product degradation.

Long radius elbows, by comparison, are more difficult to handle but offer some innate wear protection. By having a shallower angle of impact - and allowing product to drag all the way along the back of the elbow – impact is reduced and wear spread more evenly down the back of the elbow. Product degradation is also less than in short radius elbows. (The exception to this rule are products that smear and/or create streamers – like polyethylene pellets. These applications have a worse time with degradation because of the amount of time they spend dragging the back of the elbow. When this happens, an elbow with a grooved/surfaced interior or a fitting/specialty elbow is used). As a final consideration, some products could bounce and cause multiple wear points in a long radius elbow. This problem is rare in dilute phase conveying. When it does happen, it can be avoided by using a short radius or impact elbow, but it then usually results in the bounce still occurring and wearing out pipe on the outlet side of the elbow instead of the elbow itself.

The final type of elbow is the impact elbow. The elbows in this category are the dead-end tee (blind tee) and the vortex style elbow. Both of these elbows can work well to minimize abrasion and product degradation. Moreover, the dead-end tee also has the extra advantages of being readily available and inexpensive. However, neither elbow should be used if the products are moist, cohesive, or sticky. Also – and there is conflicting data, and opinions, on this point - using these elbows may have an adverse effect on system pressure and conveying efficiency in some situations. While this is not a reason to avoid impact elbows, use caution before changing out a bunch of radius elbows for impact elbows in an existing system.

After looking at the different elbows, then what is the best elbow to use? That depends on your problem. If you have an abrasion problem, then there is no one best solution. There are many effective answers for abrasive applications; they come in all different price ranges. Both short and long radius elbows have several direct replacement solutions: special coatings, tile elbows, replaceable back elbows, and channel back elbows - just to name a few. Direct replacements are great because they fit right in the same spot as the old elbows without any change in the convey lines. However – if you do not mind changing your system - the impact elbows can also achieve effective results.

Here are some considerations when choosing the right elbow for wear:

• *Do not pay for any more of a wear solution than you really need.* Be sure to match up the cost of the wear solution against life of the elbow - and hassle of changing that elbow.

• *Bare long radius elbows offer some basic protection against wear*. If there is very light wear, they can be a good alternative to bare short radius elbows. However, the cost savings of any wear protection gained needs measuring against the extra installation costs of using a larger, heavier elbow (weight, space, support, etc.).

• *Remember that wear is a war of attrition.* If you are getting two months out of a Schedule 40 pipe elbow, you will not even get four months out of a Schedule 80 elbow. Plan to use a different solution than just using thicker pipe.

• *A wear resistant elbow is only as good as its weakest point.* Putting in a wear resistant elbow made of very thin walled tube material - or using threaded pipe ends - means that elbow will only be in the system for as long as it takes the tube to wear out underneath the compression coupling - or for the pipe threads to wear out.

• *Velocity is a killer.* The elbow that wears out fastest is usually the one in the system where the highest velocity occurs. Beware of elbows at the end of a long run of pipe.

• *Channel back (aka hollow-back) elbows can be quite effective.* They protect against wear by filling up with product and allowing the product to wear against itself. However, do not use these in applications where the built-up product can spoil and cause contamination: applications like grain, food, or pet food.

• *Proprietary elbows* – like Ni-Hard bends and vortex elbows – come in set standard degrees only, like 90 and 45 degrees. If you have some other degree, you will need to use a different solution for those bends.

• *A simple dead-end tee can be an elegant fix* - and it is cheaper than a specialty vortex elbow. They also can do a great job acting as a target box right before dropping into a storage container.

• *Impact elbows often have problems wearing out pipe immediately* after the outlet due to turbulence. Using an abrasion resistant spool of pipe connected to the outlet is often very useful for minimizing the problem and allowing the changing of the piece quickly when it does wear out.

Well, what if there are no abrasion problems in the system? What then? If you do not have wear issues – and product degradation is not a concern - then the choice is clear: use a short radius elbow. There are too many cost and labor saving advantages to go any other way.

Moreover, one last piece of advice regarding elbows in already operating systems. If you are happy with the wear you are experiencing in your system, particle degradation, and system output, then do not change a thing. If it is not broken, do not fix it. There are numerous variables that affect the efficiency of bends. Sometimes changing just one bend has unexpected consequences. If you are up for doing some research - and controlling all the variables while figuring out what optimizes your system - then great, do some experimentation. However, most production facilities - who are more concerned about output and production consistency – will appreciate leaving well enough alone.

Just as there are many different applications, there are many different types of elbows in pneumatic conveying. This article does not cover every variable in the elbow selecting process. There are important considerations not even discussed here like pressure, temperature, and corrosion. However, I hope that this brief guide will help you to ask better questions which will lead to better selections.