

# TECHNICAL BRIEF

## Technical Brief on Distribution (Piping)

### Choosing the Right Piping System for Your Compressed Air System

A large component of reducing compressed air system energy costs and increasing plant efficiency is choosing and designing the right air distribution system. The overall goal is to make sure that the piping system is working efficiently in concert with the supply side of the compressed air system – delivering the quality of compressed air at the proper pressure to each point of use through the plant.

There are different types of piping materials acceptable for use in compressed air systems. Each material has its advantages and disadvantages that should be considered when installing a new system or when identifying ways to reduce energy consumption and improve air quality. We should note that often this key component of the compressed air system is not given enough thought.

Always check and consult with Federal, State and Local building and safety codes before deciding on the type of piping to be used in your application. A common standard is ANSI B31.1. Your application may also be required to comply with special industry standards.

Common materials used for piping include the following:

- Black iron
- Galvanized
- Copper
- Plastic
- Aluminum
- Stainless steel

**Black Iron** (steel) is the most widely used material today, mainly due to low material cost, availability, and high pressure rating (exceeds 400 psi). Steel piping is generally sized by the internal bore measurement. It is also labor intensive, highly susceptible to corrosion, and can be prone to leaks and costly to repair. It may also be difficult to modify an existing system. The interior surface of the pipe is generally rough, which causes pressure drop and traps contaminants. Airflow is further reduced greatly by the rust that appears quickly on the inside of black iron pipe.

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**Galvanized steel** is similar to black iron but has increased corrosion protection. The same issues exist with leakage and pressure drop due to rough interior. Corrosion protection is sometimes compromised at the joints.

**Copper** is the second most common piping material. It is a readily available metal that is resistant to corrosion, which means less contaminants and better air quality when the air reaches its point of use. However the need to solder or braze it often requires a fire watch during installation. The material itself is expensive compared to steel. It is lighter, and installation is generally faster than with threaded steel pipe. Well brazed/soldered copper joints are very leak resistant, and copper can be easily modified.

**Plastic** is sometimes chosen for its easy installation by the end user. It is also inexpensive, resistant to corrosion, and lightweight. Be aware that the pressure rating is often stated at 80° F, and this rating decreases as temperature increases. PVC is the most common plastic piping, and it may become brittle and shatter, causing a workplace hazard. Because of this, PVC is prohibited by OSHA in many uses. This limits this type of piping in many compressor applications. Synthetic lubricants used in some compressors can act as a solvent for the pipe materials and/or adhesives used in the joining. Hence, it is also extremely prone to leaks, and therefore requires continuous labor for maintenance.

**Aluminum** piping systems can be all metal (tubing and fittings) or a combination of aluminum tubing with polymer fittings.

**Aluminum with polymer fittings** is a relatively new choice that is growing due to advantages like being corrosion-resistant, lightweight, easy to install, having smooth bore (low pressure drop), and a lower overall cost of ownership than many other materials. Its main benefit is being faster to install with potentially lower costs. It is also easily adapted to changes in the plant. Many specialized manufacturers offer a wide variety of fittings and accessories that minimize or potentially eliminate leak risk, allow for ease in system repair or modifications, and maximum flexibility. Downsides of modular aluminum systems are higher material costs (mainly due to the fittings) and pressure ratings limited to plant air applications. Maximum pressure is usually 200 psig.

**Aluminum systems with metal fittings** offer many of the same advantages as Aluminum Piping with polymer fittings but offer additional features and benefits. They can experience reduced expansion and contraction compared to plastic (polymer) fittings that can potentially lose structural strength of the fitting engagement or leak over time in some environments. Even though metal fittings have an initial higher cost, they are able to maintain pressure better and maintain no leak seals.

**Stainless Steel** advantages include being resistant to corrosion and its high-pressure rating, but it is generally the most expensive option. Some food, beverage, textile, pharmaceutical, electronics industry, and other plants using oil-free compressors install stainless steel piping to avoid or minimize potential corrosion and other contaminants down-stream. Like black iron and galvanized, installation can be labor intensive, and its threaded joints can be prone to leaks. When designing and installing a new piping system, size it to minimize pressure drop. This is mostly a function of flow vs. pipe diameter, although pipe material, layout, and pressure also play roles. Size the piping for growth to avoid downtime when your production expands and needs more air.

The total pressure drop in a system from the point of use back to the air compressors will determine the required compressor discharge pressure. A rule of thumb for a typical 100 psi system is that every 2 psi increase in compressor discharge for a positive displacement compressor operating at full capacity increases the energy requirement by 1%. Minimizing system pressure drops is crucial, and operating a system at lowest possible pressure is prudent.

Remember that operating at higher pressures leads to more waste through pipe leaks. Leaks are a major cause of pressure drop. The increased flow due to leaks causes a drop in system pressure, which can make all the air operated equipment function less efficiently and could negatively affect production and productivity rates. An on-going leak detection and maintenance program is always recommended, and your compressed air system provider can assist you in this area.

Restrictions in airflow also reduce the system's efficiency. Piping with rough interior surfaces (steel pipes) has higher pressure drop due to friction. Corrosion in black iron can increase restrictions over time. Always consider – is the compressed air dryer properly selected and sized for local plant operating condition and application? Are there going to be any piping runs outside or between building that could be affected by temperature changes and swings? Will the piping system be exposed to temperature extremes and fluctuations? Have condensate drains been installed in the proper and most advantageous positions? All these factors could affect corrosion rates for black iron systems. The smooth surface of copper and aluminum piping does result in lower pressure losses at high rates of flow.

Normal piping schematics show horizontal and vertical runs entering another pipe or header at right angles. Pressure losses can result from having too many bends in the piping, too small of a pipe, too many sharp right angles, and/or an un-serviced filter. Keep these factors in mind to maximize your airflow. Long radius elbows are available and are designed to help in minimizing pressure losses.

Because of all these factors – it is always best and recommended to consult with a compressed air expert. A consultation will provide you with useful insights to the best material selection, best piping layout, the type and size of headers to use, as well as properly sizing and locating the piping drops. In the end you can be assured that the piping system will be efficiently working in concert with the other various elements of the compressed air system, delivering the required pressure and flow of compressed air to your equipment with optimum efficiency.