Atlas Copco

Configuration of Compressed Air Piping Systems

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The biggest single cost associated with producing compressed air is the energy required to power the compressor. In fact, compressed air can consume up to 40% of the total energy a facility consumes on an annual basis. Therefore, maximizing compressed air energy efficiency is the smartest thing a facility can do to save money over the long term.

Improperly configured compressed air piping systems contribute significantly to unnecessary costs and wasted energy. This can be corrected through a few simple measures. Efficient compressed air piping design combined with a decrease in turbulence and the velocity management can help minimize pressure drops and increase energy efficiency of the entire system.

Start with a Loop System Design

One of the most efficient compressed air piping system designs is a loop system. In a loop system, the air flows in two directions, thus cutting the demand on the overall pipe length in half. The cooperative nature of the loop system results in reduced pressure drops and the full air flow delivered to downstream equipment, which helps the downstream equipment perform at an optimal level.

Decrease Turbulence

At its essence, turbulence is simply interrupted air flow. Turbulence in a compressed air system negatively impacts performance delivery, resulting in wasted energy, money, loss of productivity and a compromise of the equipment's integrity. Turbulence can occur through direct or indirect interference. An example of direct, or natural, interference is when the air crosses through a pipe fitting. Indirect interference occurs from weak air velocity, usually due to improper pipe sizing or contamination built up within the pipes.

Manage Velocity

In order to correctly manage velocity from the compressor to the point of use, it is important to use the appropriate size pipe. A common mistake in pipe sizing is merely matching the size of the compressor air discharge port, rather than calculating volumetric flow based on actual demand. When this crucial mistake is made, significant pressure drops occur, affecting the compressed air system's overall energy consumption.

Minimize Pressure Drops

High pressure drops increase the loading pressure demands on the compressor, leading to higher energy costs. As previously mentioned, turbulence contributes to improper air velocity, which can directly result in pressure drops. Improper air velocity leads to air delivery that is either too slow or too fast. If air velocity is too slow, then pressure drops occur naturally as a result. If air velocity is too fast, then back pressure can occur, also resulting in pressure drops. Minimizing pressure drops in the air system both maximizes the overall equipment performance and saves energy.

Piping Materials

Compressed air piping systems are made from a variety of materials including black iron, copper, steel and aluminum. Black iron and copper are two of the most popular choices due to abundant material availability and low cost.

Black iron is inexpensive, but installation is time consuming and labor intensive. Because black iron is so heavy, it requires threaded joints; unfortunately, threaded joints have notoriously high leakage rates. Therefore, operating costs are increased for systems that use black iron because the compressors must work excessively hard to compete with the leakage rate.

Copper is somewhat inexpensive and readily available; the material is lightweight and the fittings are also less prone to leakage than black iron. However, many installations require an open flame and are therefore more labor intensive. Because installation can be difficult, adjustments to the compressed air piping system configuration are not easily made.

Aluminum is lightweight and easy to install, but generally comes with a higher initial cost. Its smooth interior reduces line losses; therefore, it is more efficient than black iron at the outset and remains efficient over time. Because of the lightweight nature of the material and easy installation, aluminum piping allows for reconfiguration of the system if the operation grows or moves to a new facility.

Advantages and Disadvantages of Piping Materials

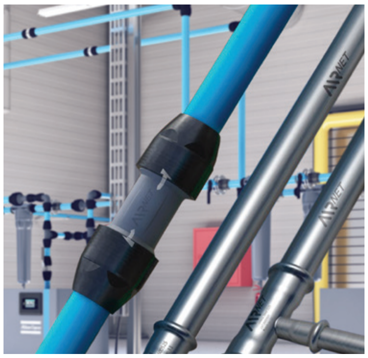
The following chart highlights some of the major advantages and disadvantages for each material used in compressed air piping systems. All material types experience similar issues when it comes to the relationship between air velocity and pressure drop.

Material	Advantages	Disadvantages
Black Iron	• Moderate material costs • Readily available in multiple sizes	• Labor intensive installation • May rust and leak • Rough inside promotes contaminant build up • Energy loss due to pressure drop
Galvanized Steel	• Moderate material costs • Readily available in multiple sizes • Some rust protection	• Labor intensive installation • Often exterior is coated • Rough inside promotes contaminant build up • leakages due to rust and high initial friction factor over a period of time
Copper	• No rust, good air quality • Smooth interior—low pressure drop	• Requires quality brazing to prevent leaks • Susceptible to thermal cycling • Installation requires open flame
Stainless Steel	• No rust, good air quality • Smooth interior—low pressure drop • Easy and innovative installation	• Labour intensive installation is applicable for conventional stainless steel piping • Expensive materials
PVC	• Lightweight • Inexpensive	• Lower safety • Carries static charge • Subject to bursting • Adhesives not compatible • with compressor oils
Aluminum	• Corrosion resistant • Lightweight • Easy to install • Lower cost of ownership • Low pressure drop	• Limited pressure ratings • Material costs

In Conclusion

Various factors contribute to the optimal configuration of a compressed air piping system. When combined with an optimal piping design, the management of turbulence, velocity and pressure drops benefits the entire compressed air system, as well as the bottom line.

Some facts about compressed air piping and leaks:



Increasing the size of your pipe from 2” to 3” can reduce pressure drop up to

50%

Shortening the distance that the air travels can reduce pressure drop by

20-40%

A 0.8 mm air leak at 7 bar costs more than

INR 7000*

a year*

80%

of air leaks are not audible

Did you know?
Pressure drops in piping systems increase with the square of the increase in flow. For example, if you triple the flow, the pressure drop will increase nine times what is was!

Compressor Technique

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