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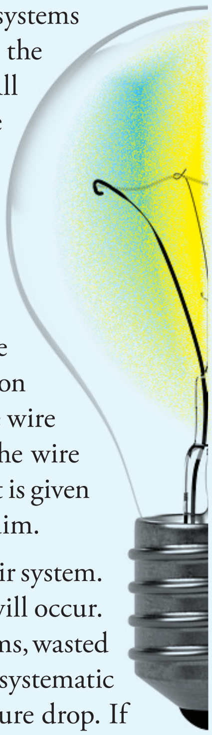
Designing a Compressed Air Distribution System

By John Ball, International Application Engineer

Compressed air is used to operate pneumatic systems in a facility, and it can be segregated into three sections; the supply side, the demand side and the distribution system. The supply side is the air compressor, after-cooler, dryer and receiver tank that produce and treat the compressed air. They are generally located in a compressor room somewhere in the corner of the plant. The demand side is a collection of components that will use compressed air to do "work." These pneumatic components are generally scattered throughout the facility. To connect the supply side to the demand side, a distribution system is required. Distribution systems are pipes which carry the compressed air from the compressor to the pneumatic components. All three sections have to work together to make an effective and efficient system.



As an analogy, the compressed air system is like an electrical system. The air compressor will be considered the voltage source, and the pneumatic components will be marked as light bulbs. To connect the light bulbs to the voltage source, electrical wires are needed. The distribution system will represent the electrical wires. If the wire gauge is too small to supply the light bulbs, the wire will heat up and the voltage will drop. This heat is given off as wasted energy, and the light bulbs will dim.

The same thing happens within a compressed air system. If the piping size is too small, a pressure drop will occur. This is also wasted energy. In both types of systems, wasted energy is wasted money. One of the largest systematic problems with compressed air systems is pressure drop. If too large of a pressure loss occurs, the pneumatic equipment will not have enough power to operate effectively. As shown in *Fig. 1-1*, you can see how the pressure decreases from the supply side to the demand side. With a properly designed distribution system, energy can be saved, and in reference to my analogy, it will keep the lights on.

To optimize the compressed air system, we need to reduce the amount of wasted energy; pressure drop. Pressure drop is based on restrictions, obstructions and piping surface. We can evaluate each one to properly design the distribution system.

1. Restriction: This is the most common type of pressure drop. The air flow is forced into small areas, causing high velocities. The high velocity creates turbulent flow which increases the losses in air pressure. Flow within the pipe is directly related to the velocity times the square of the diameter.

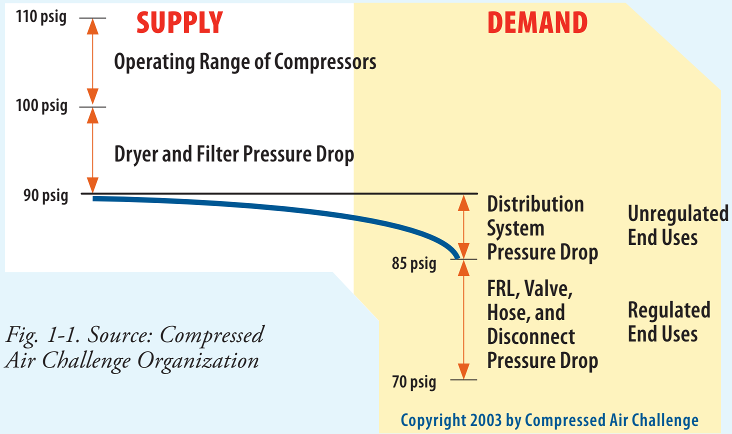


Fig. 1-1. Source: Compressed Air Challenge Organization

If you cut the I.D. of the pipe by one-half, the flow rating will be reduced to 25% of the original rating; or the velocity will increase by four times. Restriction can come in different forms like small diameter pipes or tubing; restrictive fittings like quick disconnects and needle valves, and undersized filters and regulators.

2. Obstruction: This is generally caused by the type of fittings that are used. To help reduce additional pressure drops use sweeping elbows and 45-degree fittings instead of 90 deg. elbows. Another option is to use full flow ball valves and butterfly valves instead of seated valves and needle valves. If a blocking valve or cap is used for future expansion, try and extend the pipe an additional 10 times the diameter of the pipe to help remove any turbulence. Removing sharp turns and abrupt stops will keep the velocity in a more laminar state.

3. Roughness: With long runs of pipe, the piping surface can affect the air stream. Carbon steel piping has a relatively rough texture. Over time the surface will start to rust creating an even rougher surface. This roughness will restrain the flow, causing the pressure to drop. Aluminum and stainless steel tubing have much smoother surfaces and are not as susceptible to pressure drops.

As a rule, air velocities will determine the correct pipe size. It is beneficial to oversize the pipe to accommodate for any expansions in the future. For header pipes, the velocities should not be more than 20 feet/min. For the distribution lines, the velocities should not exceed 30 feet/min. Another area to review is the pressure drop. The pressure drop should be less than 10% from the reservoir tank to the point-of-use. By following the tips above, you can reach that goal and have the system working at peak efficiency.

If you would like to reduce waste even more, EXAIR offers a variety of efficient, safe and effective compressed air products to fit within the demand side. This would be the pneumatic equivalent of changing those light bulbs at the point-of-use into LEDs.

Application Spotlight:

Removing Chips from Machining Centers

Application Goal:

To replace electric vacuums at ten workstations which are prone to failure in industrial applications and require heavy lifting to discard chips and coolant.

The Problem:

Electric vacuums were used to remove cast iron chips and coolant from a machining process. These vacuums continually broke down with clogs, coolant saturation in the electric motors, vacuum hose deterioration, etc, all of which caused down time and loss of production. They were being replaced at a rate of one every three months. The vacuums' small containers also needed to be emptied, on average, (3) times per shift, meaning the operator had to stop work for 10-15 minutes in order to manually empty it.

The Solution:

Initially, (2) electric vacuums were replaced with EXAIR Model 6064 2" Stainless Steel Line Vacs. Now, the operators never have to leave their workstations because the conveyance hoses are routed directly to the point of disposal, and the lifting of the heavy containers for dumping has been eliminated. The Line Vacs have worked flawlessly for over (9) months, in which time they would have had to replace three electric vacuums on each of these two machines.

Editor's Comments:

The Line Vacs have been a huge success in this facility. Replacement electric vacuums cost the company $135.00 each. On (10) machines, replacing a vacuum every three months, costs:

$135.00/vacuum X 4 replacements/year X 10 machines = $5,400.00 in annual replacement cost.

At a price of $393.00 each (2018 pricing) 10 Model 6064 Line Vacs cost $3,930.00 – a savings of $1,470.00 in the first year alone, and continued annual savings of $5,400.00, not accounting for price increases on the electric vacuums.

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New Application Checklist

EXAIR products solve a variety of problems. Please call our Application Engineers at 1 (800) 903-9247 or e-mail them at techelp@exair.com for assistance with yours.

- This customer packs onion sets. In doing so, dirt gets onto the box and prevents the packing label from sticking. A generic blow gun with the nozzle removed was being used. This did not comply with OSHA standards and used an excessive amount of compressed air. By using a **Model 1210 Soft Grip Safety Air Gun** the dirt was cleared off efficiently and quietly, meeting OSHA compliance and saving compressed air.
- A food products manufacturer makes small marshmallows, like those commonly found in breakfast cereals and instant hot chocolate beverage mixes. These were being mixed into their respective products from large bags, dumped by hand into the mixing bins. Using a **Model 6066 3" (76mm) Stainless Steel Line Vac,** they can quickly and easily convey the marshmallows into the mixing bins, saving time and labor. By regulating the compressed air supply pressure, they are able to preserve product quality (e.g., no breakage) and maintain a high conveyance rate.
- A machine shop was experiencing material defects and personnel injury during their machining operations, as the operators had to hand clean the shavings from bores and machining surface area. This caused a lot of cut fingers. They purchased a **Model 6193-5 Mini Chip Vac System** to remove the contaminants, which reduced material defects and increased safety. Operators no longer had to manually clean the shavings.

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