

# Ease Your Purchasing Pressure

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For some time, collision industry experts have highlighted the trend of modeling modern body shops after product-line manufacturing. The goal is to analyze equipment, shop practices and procedures and to take steps to increase shop productivity rates while minimizing resource costs. But the impact of compressed air systems on workflow and product quality is often overlooked.

The compressed air system is critical for two main reasons. First, compressed air is a utility; it's the energy source for most shop equipment. Inadequate airflow or pressure interrupts workflow just as an electric power outage would. Second, compressed air mixes with the product in paint spraying operations. For this simple reason, air pressure, airflow and air quality are critical to product quality. Both air quality and supply directly impact the paint finish. Costly rework due to poor quality paint jobs and productivity losses/workflow interruptions due to inadequate air supply can increase cycle times, causing real losses in hard dollars.

Though compressed air is a utility, there's a major difference between compressed air and other utilities: You have complete control over your compressed air system. While this presents a great opportunity, it requires major considerations as well.

### The Source of Your Air

Avoid a common pitfall — don't over-pressurize. If asked, many shop users say they need 145 or 175 psig (pounds per square inch gauge) compressors. The fact is, very few tools require pressures above 100 psig. Many shop owners ask for high pressure because they're most familiar with piston compressors, which operate on a wide pressure band to allow the unit to shut down and cool. Another reason for operating at unnecessarily high pressures is that it provides additional storage. This is true to an extent, but keep in mind that compressors generally produce less volume at higher pressures and that leak losses increase with pressure. Refer to the tool manufacturer's manual to determine your shop's exact pressure and flow requirements.

### Don't Confuse Pressure and Volume

Many users don't understand the inverse relationship between the pressure and the volume of air delivered in a compressed air system. End users often complain there's "not enough air" and increase the pressure setting on a compressor to compensate. This actually reduces the volume of air delivered

and increases the air consumption. In most cases, the problem is inadequate flow due to an undersized compressor, poor compressor performance, inadequate pipe size or leaks. Increasing system pressure will increase the amount of air lost through leaks, wasting both air and electricity. And everyone has leaks. Numerous compressed air system industry studies confirm that as much as 35 percent of all compressed air produced is lost through leaks. A rule of thumb is that every 2 psi increase in pressure increases energy consumption by 1 percent. In addition, the higher the system pressure, the greater the volume lost through leaks. A 1/16-inch leak loses 7 to 8 cfm at 120 psig. At 150 psig, it loses 9 to 10 cfm. A 1/8-inch leak loses 30 cfm at 120 psig and nearly 38 cfm at 150 psig.

### **Determine Flow Requirements**

Compressor size isn't determined by pressure requirements. It's determined by the compressor's output capacity in cubic feet per minute (cfm). To properly size your compressor, you need to know how much air is needed in terms of volume, not pressure. Some tool and compressor manufacturers publish charts with air consumption rates. Adding all of these together for the tools you use yields the total potential flow requirements. But it doesn't take into account the percentage of time each tool is used. This requires some analysis of how the different parts of your shop operate throughout the day. Electronic data logging devices are a convenient way to measure and record compressor usage.

### **Compressor Type**

The piston (or "recip") compressor is still the most common type found in body shops. A piston compressor may provide adequate flow for a short period, but its allowable duty cycle must be considered. The duty cycle is the percentage of time a compressor operates without the risk of overheating and causing excessive wear to the compressor.

## **It's a Dirty Business ... Clean It Up**

Many sources recommend improving paint finish quality by eliminating contamination in the spraybooth, but the quality of your compressed air plays an equally important role.

Water/moisture — usually in the form of vapors, mist or liquid — may:

- Cause defects in finishes (e.g., fish eyes).
- Cause excessive wear in tools.
- Freeze in pipes.
- Cause rust in iron pipes.
- Reduce the volume available for storage and cause piston-type compressors to run beyond the recommended duty cycle.

Ambient conditions have a large impact on system operations. Summer is the busy season for compressor service and sales people, who get many more calls from customers with burnt-out piston pumps and excess water in their lines. Cooler months are typically dryer months. There's less moisture in the air, and shops have relatively few problems with moisture. Also, compressors run cooler, resulting in less moisture adsorption, less oil carryover and less strain on the pump and motor. Once the weather warms up and humidity increases, compressors introduce more moisture into your system. Piston units often run hotter, which increases oil carryover and may further increase moisture content. For example: Assuming 24-hour operation on a 75-degree-F day with 75 percent relative humidity, a 10-hp compressor can introduce seven gallons of water into a compressed air system. On a 90-degree day with 90 percent humidity, the same compressor can introduce 15 gallons of water.

Particulate — dirt, dust, rust, powders, etc. — build up in system piping, causing defects in paint finishes, pressure drop and excessive tool wear.

Oils, usually in the form of vapors or mists, cause defects in finishes and can combine with particulate to clog tools and spray guns. They may also build up in piping and cause significant pressure drop.

Most small shop piston compressors are air-cooled and have an allowable duty cycle of 60 to 70 percent. For this reason, they're often oversized and operate over a wide pressure band to allow the compressor to frequently shut down and cool off because of the relatively high operating temperatures (often 300 to 400 degrees F).

Rotary vane and screw compressors have closed circuit, thermostatically controlled cooling systems that provide a 100 percent allowable duty cycle with operating temperatures of only 170 to 200 degrees F. This is an important consideration for spraybooths and other moisture-sensitive applications, since hot air carries more moisture. The higher the compressed air temperature, the more moisture is carried in vapor form through the system. An important

rule of thumb is that every 20 degrees F decrease in temperature cuts moisture vapor content in half, making it easier to remove moisture from your system.

### **Reliability, Maintenance and Performance**

Compressor reliability, maintenance requirements and long-term compressor performance are essential considerations. Piston compressors and rotary compressors have different maintenance and service requirements.

Piston compressors have proven to be reliable and require relatively little preventive maintenance other than sustaining a minimal oil level, changing the oil periodically, replacing the air inlet filter and maintaining proper belt tension. Rotary compressors also may require these, as well as oil filter

and air/oil separator changes.

The pistons, cylinders, rings and valves in reciprocating units will wear over time, causing the compressor to deliver less air and send more lubricating oil past the rings into the compressed air system. Without proper filtration and added filter maintenance, this will cause paint finish problems. Preventive maintenance will slow this process. This is also true of some rotary vane compressors. Rotary screw compressors are designed so they won't wear because the rotors don't touch each other or the rotor housing.

## System Components

*Air storage tanks* (receiver tanks) are a critical air system component, so it's important to understand some of their functions and benefits:

- To provide the first stage of moisture separation.
- To store air for short periods of high air demand.
- To allow the compressor to shut off to save energy and prevent piston units from overheating.

When selecting a tank:

- Allow 2 to 4 gallons per cfm.
- Be sure the tank pressure rating exceeds the highest possible system pressure.
- Be sure the tank has a safety relief valve, a pressure gauge and a drain to remove liquids.
- Be sure it meets ASME or other required code (check with local authorities).

*Dryer performance* is stated in terms of specific conditions (ambient temperature, compressed air inlet pressure and compressed air temperature).

Refrigerated dryers are the most common type. They employ a refrigeration system to lower the compressed air temperature below the ambient temperature. This condenses the moisture that's in vapor form at higher temperatures into liquid form that can be drained out of the system. This lowers the "pressure dew point" of the compressed air. As long as the compressed air isn't cooled below this

new dew point, any remaining moisture will remain in vapor form. Refrigerated dryers are designed to produce dew points between 35 and 50 degrees F at rated conditions.

High-temperature refrigerated dryers are similar to standard refrigerated dryers but include an aftercooler and are primarily used with piston compressors, since the air must be pre-cooled prior to entering the dryer. These are usually designed to achieve dew points of 50 degrees F at rated conditions.

Desiccant dryers operate differently from refrigerated dryers. They work by directing the compressed airflow across a bed of desiccant material that adsorbs moisture vapor out of the air. Desiccant dryers are used to produce dew points as low as -100 degrees F and are recommended when air quality requirements are extremely high.

*Filters* are categorized based on the contaminants they're designed to capture and may be designed to capture more than one type.

- Moisture separators are designed to mechanically separate liquid water and oil from the air stream.
- Particle filters are designed to capture dirt, dust, etc., but may remove some water and oil mists.
- Coalescing oil filters are finer filters designed to remove oil aerosols/mist and fine particles. These are usually placed after a refrigerated dryer.
- Vapor adsorbers are designed to eliminate oil vapors only and should be placed after all other filters and dryers.

• Staging the filters in a system provides more effective filtration, lower pressure drop at each filter and longer filter life. Some have differential pressure gauges, liquid level indicators and built-in drains.

Keep in mind that filters also need drains and that differential pressure gauges will indicate when the filter elements need replaced. Periodic filter changes will minimize pressure drop and ensure good air quality.

*Condensate drains/traps* are

critical but often overlooked components. Drains remove liquid contaminants from the system. If the filtered and separated contaminants (mostly water with some oils and particulate) aren't drained and removed from tanks, refrigerated dryers and filters, they build up and find their way back into the air system. Liquid accumulation in tanks will gradually eliminate the air storage capacity in the tank, causing periods of inadequate air flow/pressure and possibly causing a reciprocating compressor to exceed its duty cycle and overheat.

Several types of drains are available: manual, timed and automatic demand (a mechanical or electric device that activates when the liquid level reaches a certain point inside the drain). Invest in quality drains to protect your investment in filters and dryers.

## Piping and Air Distribution

Restrictions in airflow create air turbulence that results in reduced system pressure. This occurs in many components, including the dryer, filters, valves and piping. The degree to which this occurs depends on the materials you've chosen and pipe size. You can greatly reduce pressure drop with proper system design and maintenance, but there will always be some drop. (Be sure to account for the total pressure drop when selecting the compressor's operating pressure.)

Pipe size has a major impact on system performance. Pressure drop changes exponentially with pipe diameter. Bigger is better. Look ahead when planning your system and allow for business growth. It's time consuming and expensive to install a larger distribution system later. We see many compressed air users who have quickly outgrown the capacity of their piping system. They need more air, so they buy more compressors. Unfortunately, the piping can't handle the increased flow, and the end users don't get more air. A small step up in pipe diameter

## Location, Location, Location

The type of compressor used affects where it's installed. Compressors are often installed where their noise, vibration and heat will be least bothersome to staff and customers rather than where they'll best perform and be easily serviced. Here are some guidelines for where to install a compressor:

- Avoid extreme hot or cold temperatures.
- Ensure an adequate airflow for cooling.
- Avoid dirty/dusty areas.
- Allow enough space around the compressor for maintenance access.

— as little as  $\frac{1}{4}$  inch — may make a large difference in the capacity of the system. There are standard charts published that provide guidelines. Check with a compressed air specialist or contact the Compressed Air and Gas Institute ([www.cagi.org](http://www.cagi.org)).

For example, the pressure drop of 40 cfm (from a 10-hp compressor) through 500 feet of  $\frac{3}{4}$ -inch straight pipe would be about 8 psi. If the shop added another 10-hp compressor, the total flow would be about 80 cfm and the pressure drop would increase to 32 psi. An increase to 1-inch diameter pipe would change these numbers to 2 psi and 9 psi, respectively. Pressure drop also increases with the number of turns in the system and with rough interior surfaces.

When setting up your compressed air system, you can

choose from several piping materials. What you choose has a large impact on both air quality and flow. Common materials include black iron, galvanized, copper, PVC or other plastics, and aluminum. Copper offers an excellent combination of performance, material and installation costs. Plastics aren't recommended.

When installing your air compressor system piping:

- Plan for future growth and install the largest pipe diameter feasible.
- Minimize the use of pipe "T"s and right angles.
- Install a flexible hose between the compressor/or tank and the piping to eliminate stress on joints caused by compressor vibration.
- Provide adequate bracing/support when hanging pipe from ceilings or walls.


- Use only full flow ball valves to minimize pressure drop. Always open and close valves slowly.

- Loop distribution to balance pressure and flows at all points of use.

- Connect point-of-use pipe drops to the top of the header to reduce moisture carryover.

### Don't Error with Your Air

It's a given that no one wants to spend more money on compressed air equipment. After all, you may argue, you've been using the same system for years and it's just like everyone else's. But have you ever calculated the cost of refinishing one fish eye? The labor, material and workflow-interruption costs far exceed the price of investing some thought and money in your current compressed air system.

A thorough analysis goes a long way in building a reliable, cost effective system. Carefully consider each system component and its impact on the application. And remember: Value is more than initial price. Purchasing quality equipment now will save time and money for years to come. 

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