Piston Versus Rotary Screw Compressors

A Short Comparison for the Collision Market

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Piston compressors are still the most common type of compressor found in the automotive service industry that includes gas stations, general service, quick lube shops, tire stores, fleet maintenance facilities, dealer fixed operations, and collision repair. For most of these facilities, the relatively low air demand and quality needed make the piston a cost effective choice. Collision repair shops, however, typically use much more compressed air and have higher air quality needs than other automotive service businesses. In these respects, collision repair is similar to manufacturing. In fact, many modern body shops might be more accurately referred to as automotive *re-manufacturers.*

FIGURE 1: *Collision repair shops are unique in the automotive service industry because they often need larger volumes of higher quality air for body work (shown here) and applying high quality automotive finishes.*

These days, many body shop owners are finding out they have similar compressed air needs to larger industrial facilities and that rotary compressors offer significant operational benefits. Rotary compressors provide an extremely reliable supply of clean, dry compressed air. This may not be as critical for general repair, but collision repair stands apart because the end product is directly affected by air quality. When deciding between rotary and piston compressors, it is important to consider duty cycle and performance, energy efficiency, air quality, maintenance, and installation costs.

Duty Cycle and Flow

An important difference between piston and rotary compressors is their duty cycle. Duty cycle is the percentage of time a compressor may operate without the risk of overheating and causing excessive wear. A piston compressor may provide adequate flow for a short period, but its allowable duty cycle must be considered. Most small piston compressors have an allowable duty cycle of 60-70%. For this reason, piston compressors are usually oversized to allow the compressor to periodically shut down and cool off because of the relatively high operating temperatures. Even with adequate

air storage this can cause capacity problems during peak operating hours. Further, if the shop expands or business increases, lack of air capacity can become even more of an issue.

Rotary screw compressors have a 100% allowable duty cycle and operate continuously if the need arises. This is possible because rotary compressors are fluid cooled. The fluid performs four important functions:

- Lubricates the bearings in the pump,
- Removes contaminants from the air,
- Forms a non-wearing seal between rotors and casing,
- Removes the heat generated by compression as part of a thermostatically controlled fluid circuit.

Heat and Moisture

All of these benefits are important, but this last point is very relevant to the body shop. Piston compressors operate at internal temperatures of 300°F-400°F, while a rotary compressor runs at much lower internal temperatures (between 170°F and 200°F). Just as hot summer air holds more humidity, hotter compressed air can hold more moisture and requires additional components to dry and clean it. A rule of thumb is that every 20 degree (F) increase in temperature doubles air's ability to hold moisture.

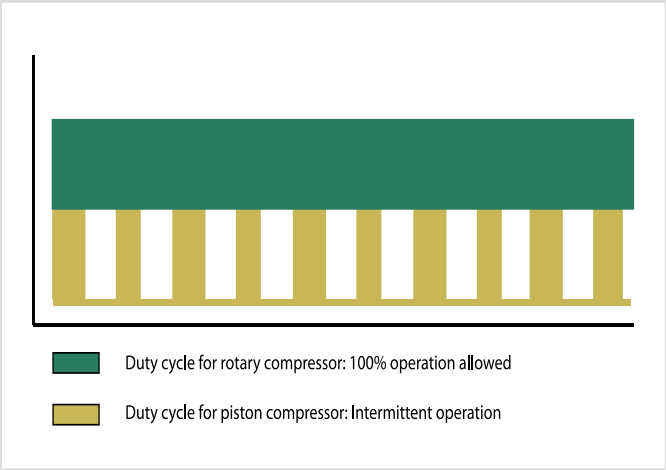

FIGURE 2: *Duty cycle comparison between rotary and piston compressors.*

FIGURE 3: *Although routine maintenance for piston compressors is inexpensive, they have much higher oil carry-over and have higher operating temperatures.*

Modern rotary screw compressors now come with built-in aftercoolers designed with ample surface area and a powerful fan to lower the compressed air's temperature as it exits the compressor. By comparison, the air exiting a piston compressor is very hot and hard to dry. Even with an aftercooler and a specially designed high temperature dryer, it is difficult to reach the same dew point as a rotary screw compressor.

Lower operating temperatures make it easier to remove moisture and other contaminants, which is very beneficial for facilities with expensive tools, paint spray booths, and other moisture sensitive applications.

Oil Carry-over

As pistons, cylinders, rings, and valves wear, the piston compressor delivers less air. A side effect is that more lubricating oil gets past the rings into the compressed air piping and down to the points-of-use. This is often referred to as oil "carry-over".

Even new piston compressors pass several times more oil than rotary compressors. This is highly undesirable if you are spraying finishes.

With rotary screw compressors, there is little or no change in performance over time because the rotors do not touch each other or the rotor housing, so they don't wear down. The compressor fluid acts as a non-wearing sealant. It is captured, filtered, cooled, and recirculated. This greatly extends the life of the compressor pump and very little lubricant gets downstream.

Energy Efficiency

Energy efficiency may not matter much for a repair or tire shop that intermittently runs a 5-10 hp unit, but collision repair typically requires more volume. Many shops have compressors as large as 30 hp. At these sizes, energy efficiency becomes a competitive advantage, especially where electricity is expensive.

Rotary compressors typically deliver more air per unit of input energy than piston compressors. Piston compressors generally deliver 3-4 cfm per hp. Rotaries deliver 4-5 cfm per hp. Of course, you pay for kWh used so it is more practical and accurate to compare efficiencies in terms of kW and cfm. The Compressed Air and Gas Institute (CAGI) has created a form for manufacturers to state their energy efficiency for better "apples-to-apples" comparison. Most manufacturers make them available on their websites.

FIGURE 4: *Rotary screw compressors have a higher initial purchase price, but can be a long term cost effective solution.*

Maintenance

Routine maintenance for piston compressors is simple and inexpensive. Drive belts, inlet air filters, and lubricating oil should be checked and replaced on a routine schedule. It is also common to add "make-up" oil due to the oil carry-over, and doing so frequently will slow wear on the machine.

Let there be no mistake: Rotary screw compressors have more maintenance points than piston compressors, including the fluid filter and separator. The routine annual service costs will be higher.

Piston units will, however, eventually wear to the point that they need major service (rebuild) to reverse the gradual loss of flow and increase in oil carry-over. This expense must be considered in a lifecycle cost comparison.

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FIGURE 3: *CAGI data sheets publish compressor performance information and are verified by third party testing. Manufacturers publish these date sheets on their website. For more information, visit www.cagi.org.*

Noise Levels and Vibration

Typical shop piston compressors have a well-earned reputation for high noise and vibration that may be heard and felt throughout the shop. For these reasons, they are often put in separate rooms, in forgotten corners, or outside—exposed to the elements. *Where* you put a compressor directly impacts air quality and compressor life. A hot stuffy room, for example, will increase operating temperature, shorten compressor life, and make it harder to remove moisture and oil from compressed air. Also, the cost of building separate rooms or enclosures for the compressor must be considered in an accurate cost comparison.

Rotary compressors are far quieter and produce far less vibration. They don't need special rooms built and they don't need to be bolted to the floor to keep them in one place. The sound is low enough to have a normal conversation near the machine (a convenience and a plus for safety). Being relatively quiet and vibration free, they offer more flexibility where you put them. This usually results in a placement with better ventilation, lighting, and service access.

The Real Cost

The main reason cited for selecting piston compressors is often lower purchase price. But the actual cost comparison really extends beyond the initial transaction. Consider all the facts when setting up a new shop or retrofitting an existing facility.

• Rotary screw compressors do not need to be oversized to compensate for limited duty cycle and are more efficient than piston models. A 7.5 hp rotary will often do the job of a 10 hp piston. The smaller horsepower unit will use less electricity and reduce operating costs.

• Better compressed air quality creates significant savings in labor, paint, and other materials.

• Better compressed air quality will extend air tool and equipment life.

• More reliable air compressors keep employees working and productive, not waiting for the compressor to catch up or be repaired.

• Lower heat, noise, and vibration eliminate the need for a separate room or enclosure.

Each of these advantages contributes to the positive ROI for a rotary compressor. Some of them will very quickly make up the difference in initial price. Think about what you spend on labor and finishing materials each month. The savings will pay for the investment many times over.

	Rotary Screw Compressor	Piston Compressor
Duty Cycle:	100 %	Limited
Oil Carry-over:	1 - 5 ppm	10 ppm - no upper limit
Noise Levels:	72 dB(A)	>80 dB(A)
Flow:	4 - 5 cfm/hp	3 - 4 cfm/hp
Internal Operating Temp.:	170°F - 200°F	300°F - 400°F
Discharge Temp.:	15°F - 25°F above ambient	100°F and higher above ambient

Table 1: *At a glance differences between a rotary screw and piston compressor.*