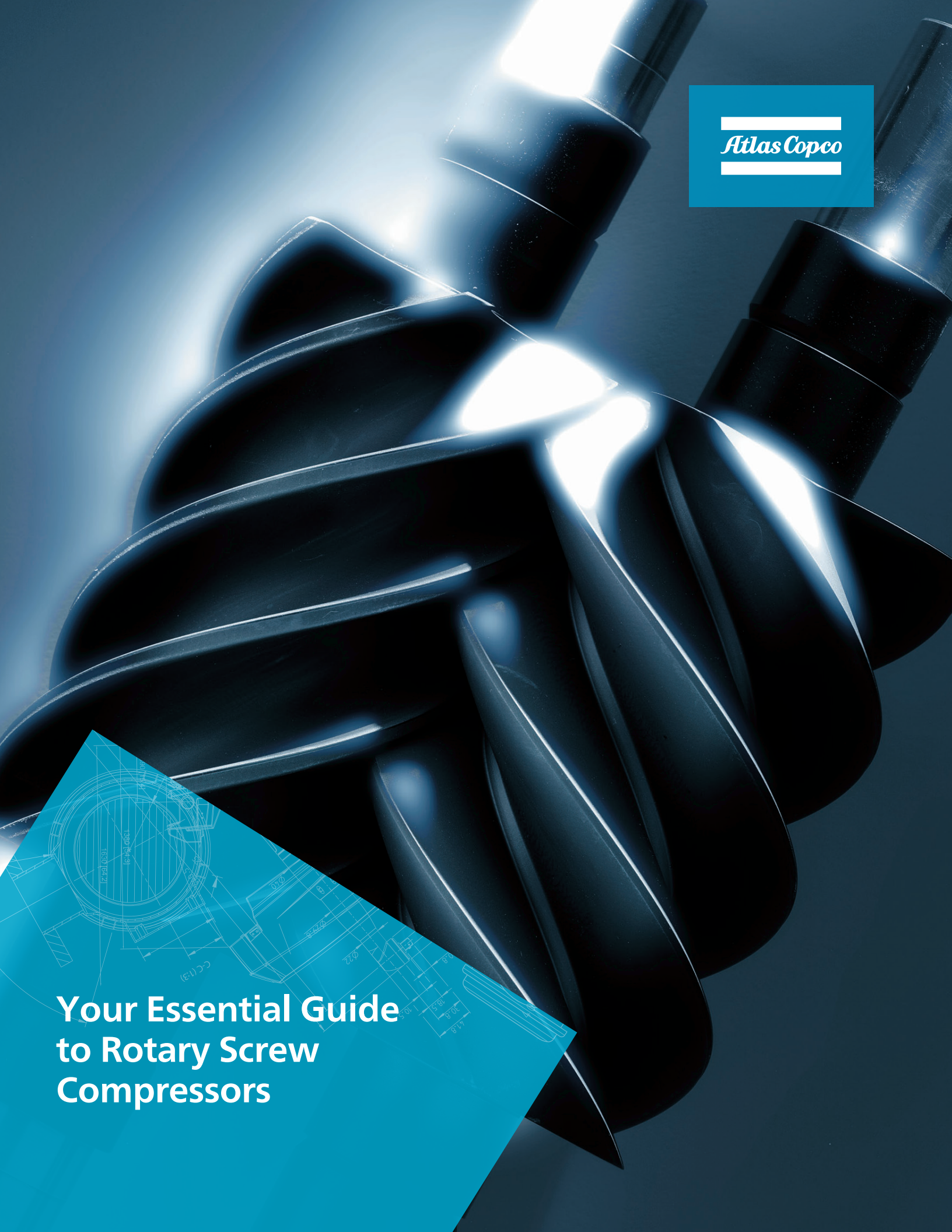


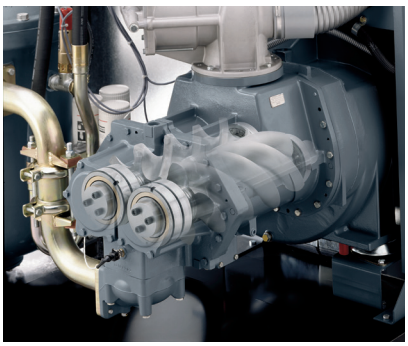
Your Essential Guide to Rotary Screw Compressors

What is a Rotary Screw Compressor?

Simple in design, yet precision engineered to deliver with great efficiency, rotary screw air compressors are the mainstays of the industrial world. As one of the most common compressor technologies available on the market today, rotary screw compressors are often the right choice for applications that require a constant supply of compressed air. They are extremely common in industrial and manufacturing settings and are used for operations of all sizes – including the largest manufacturers to the smallest one-person shop.

They combine a range of useful features that has made them very popular and successful, including being built specifically for long lifetimes of reliable use and for operations that require up to a 100% continuous duty cycle. One of the other biggest perks of this technology? They're extremely energy efficient, which makes a significant difference when you consider that the bulk of the total cost of ownership of air compressors consists of electricity costs. Screw compressors are also typically low maintenance.

It's also worth noting that there are three different types of rotary compressors – belt-driven, gear-driven, and direct drive compressors. These refer to how the electric motor is connected to the rotary screw element. Belt-drive compressors, as their name would suggest, are equipped with a belt that connects the motor to the element with pulleys. Gear drive means that the motor connects to the element via a gear. Direct driven compressors, meanwhile, have the motor directly connected to the element coupling. As you move from belt drive to gear drive to direct drive, energy efficiency increases - as does the cost of the compressor.



How Does a Rotary Screw Compressor Work?

Rotary screw compressors operate via positive displacement – meaning they draw air into a chamber, reducing the volume. Air is drawn into one or more of its compression chambers, which are then closed from the inlet. As the volume of each chamber decreases, the air is compressed internally until the pressure reaches the designed pressure ratio. The valve then opens and the air is discharged into the outlet system.

A rotary screw compressor's defining characteristic is the presence of screws (usually there are two, but the compressor may have more or less). These are also called the male and female rotor elements, and they are driven either by the male rotor or by a timing gear. In oil-injected screw compressor technology, the male rotor drives the female rotor. In oil-free compressor technology, a timing gear drives both rotors for harmonic running, with minimum calculated clearance between both elements.

The twin elements rotate and spin in opposite directions. Air fills the space between the rotors and, as they rotate, the volume between them and the surrounding housing decreases, squeezing or compressing the air into a smaller space. The compressed air is then displaced to the outlet. Beyond that, there are no valves, or other mechanical forces that can cause unbalance, which allows a screw compressor to operate at high speeds while combining a large flow rate with small exterior dimensions.

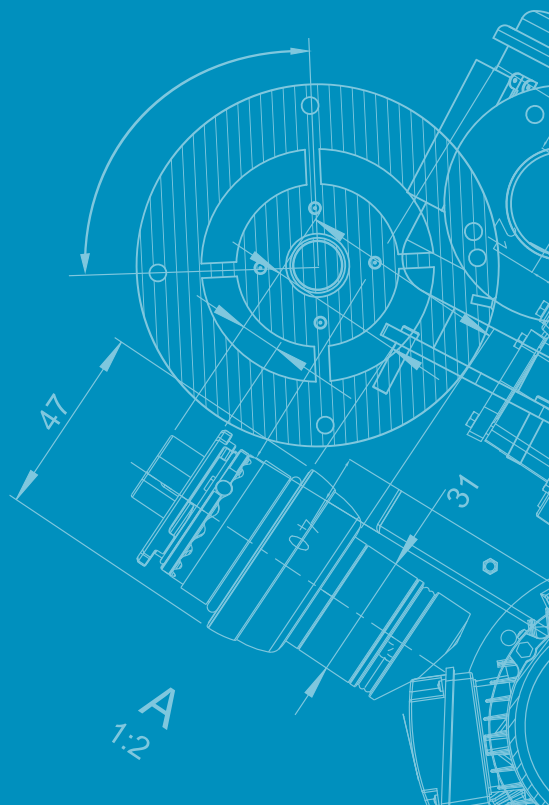
One note: although they belong to the same class of positive displacement technology, rotary screw compressors are more complex than piston compressors. As such, the speed of the screw rotors is optimized at a certain level. This is to minimize mechanical losses (due to heat at very high speed) and volumetric losses (air losses due to very low speed) during compression.

Oil-Free Rotary Screw Compressors

External gears synchronize the position of the counter-rotating screw elements, and, because the rotors do not come in contact and create friction, no lubrication is needed within the compression chamber. As a result, the compressed air is oil-free. Precision engineering within the housing keeps pressure leakage (and drops) from the pressure side to the inlet at a minimum. And because the internal pressure ratio is limited by difference in air temperature between the inlet and discharge ports, oil-free screw compressors are frequently built with several stages and inter-stage cooling to maximize the pressure reach. The gearbox driving the mechanism does contain lubricants; oil-free refers to the compression chamber itself, and the delivered air is free of foreign contaminants beyond those found inherently in the air that passes through the intake.

Oil-Injected (Oil-Flooded) Rotary Screw Compressors

In liquid-injected rotary screw air compressors, a liquid (usually oil) is injected into the compression chamber to assist with cooling, lubrication, sealing, and noise dissipation. More specifically, the liquid injected helps to cool and lubricate the compressor elements moving parts, to cool the air being compressed in the chamber, and to help minimize leaks from returns into the chamber during discharge. While oil is the most common liquid used today because of its lubricating and sealing properties, water and other polymers are sometimes used. The oil is then separated and passes through a filter and cooler before it cycles back into the process again. The compressed air can still be hot and is often run through a cooler, depending on end usage.



Available Options: Variable Speed Drive (VSD), Air-Cooled, and Water-Cooled

Variable Speed Drive or Not?

If your compressor will run continuously to match steady demand, a fixed speed compressor will do the job cost-effectively. But if your demand for compressed air varies by production cycle, shift, or time of day, a variable speed drive compressor that matches production of compressed air to demand can significantly reduce energy cost – especially when compared to a fixed speed machine that has to run unloaded when demand drops. One variable speed drive compressor also can work in concert with one or more fixed speed compressors to meet varying demand for air cost-effectively. Variable speed compressors are available in oil-flooded and oil-free models.

Air Cooled or Water Cooled?

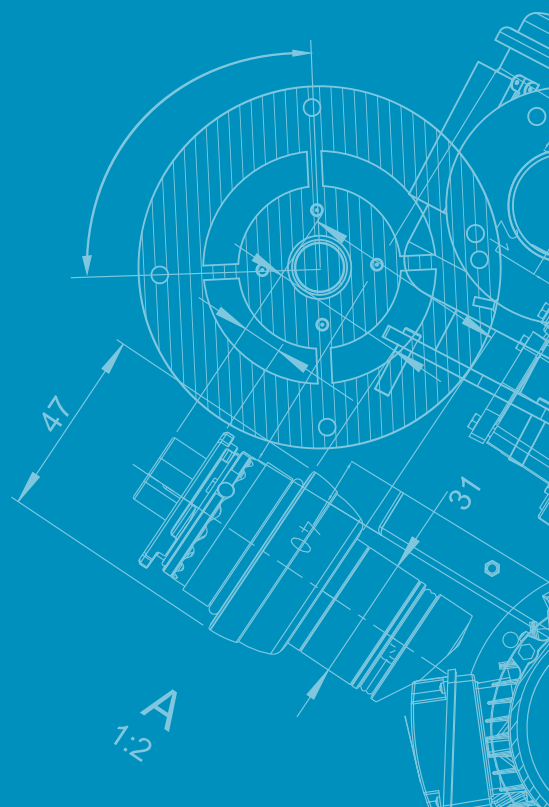
It's simple physics: when air is compressed, heat is produced. In order for an air compressor to run efficiently, the heat generated must be dissipated. The simplest approach is air cooling, with a supply of fresh air picking up heat from the compressor body. The warmed air is then vented, typically outside. Another option for cooling an air compressor is water cooling. It works much like the cooling system in a car engine, with water moving through a network of passages in the compressor body to pick up and remove excess heat.

When Should I Choose a Rotary Screw Compressor?

1. The first question you should ask yourself is this: "How can I get the most amount of compressed air for the lowest overall cost?" Inexperienced consumers may consider only a small fraction of the life-cycle cost, or the initial cost of the machine. You're more likely to spend more in energy costs in the first year to run the machine than the actual purchasing price! That's why, when comparing compressors, it's important you examine all aspects of the costs associated.

2. When selecting the correct rotary screw air compressor, we recommend sizing it as close to your air demand (in CFM) as possible. If you oversize it, it simply will not run enough!

3. Rotary screw air compressors are designed to run 100% of the time. It's important that a screw compressor is sized appropriately so that stop/start cycles are minimized and loaded hours are maximized.



Rotary Screw Compressor Maintenance

Rotary screw air compressors are built to last! However, compressors (like any other piece of equipment), do require systematic maintenance to ensure optimal performance and efficiency. This means that screw compressors need to be placed on a consistent maintenance schedule! Thanks to the simplicity of the internal components, maintenance is relatively easy for most rotary screws. Sticking to a rotary screw compressor maintenance schedule will help ensure that your machine experiences many years of optimal productivity.

The earlier you identify a problem, the easier and less costly it is to remedy. In many cases, a problem detected early can be rectified in a few minutes with no money spent. Routine maintenance also saves time in the long run. In any industry, system downtime is costly and time-consuming. The time that a compressor remains down and inoperable is productivity lost. Even just a few hours of downtime can result in untold losses. With regular air compressor maintenance, you lower the risk of costly downtime.

Benefits of Rotary Screw Air Compressors

Rotary screw compressors are popular – and for good reason! There are many benefits to using this type of technology, when compared to other compressor technologies. They include:

- Energy efficient
- No duty cycle limitations
- Can operate continuously
- Low oil-carryover (as little as 2 ppm) in oil lubricated machines
- Zero loss of capacity over time
- Shockless, non-wearing compression technology
- Fewer wearing parts to maintain or replace
- Simplified maintenance procedures
- Less overall oil consumption
- Proven reliability in harsh environments
- Smaller physical footprint, typically by 50 percent
- No "unbalanced" forces, less vibration transfer
- Lower noise outputs to meet OSHA requirements
- Less heat generation
- Significant reduction in weight, typically by 50 percent

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