

White Paper

Gardner
Denver

Compressor **Selection**

Choices Delivered by a Tiered Product Offering



Compressor Selection: The Importance of a Tiered Product Offering

As the term implies, a tiered product offering is one that offers something like “good, better and best” for a given product.

We see this everyday in the goods and services that we purchase as consumers. First, there is the base model car that comes equipped with air conditioning and power windows but not much else. Next, for a few dollars more, you can upgrade and include powered and heated seats, tinted windows and a fancier stereo. And finally, there is the model that has it all – sunroof, sporty tires, more airbags than seats and all sorts of other goodies that make the Owner’s Manual the size of your typical Harry Potter novel. When it comes to air compressors, a tiered product offering can be looked at in a few different ways. As a result, the following should help you navigate your next compressor purchase more effectively.

				
Reciprocating	Rotary Scroll	Rotary Vane	Centrifugal	Rotary Screw
Low Installation Cost Low Maintenance Cost Small Footprint	Low Noise Level Low Installation Cost Small Footprint	Low Noise Level Small Footprint	Compressor Efficiency @ Full Load Low Maintenance Cost Small Footprint	Compressor Efficiency Low Noise Level

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Tiered Technologies

Here we are using the term “tiered” to refer to a company that has multiple compressor technologies to offer. It is not an issue of good, better, best, but more of a “select the correct technology for your application” question. Typical compressor technologies include reciprocating, rotary screw, rotary vane, centrifugal, high-speed centrifugal, scroll and a few others. One technology is not right for every application. As an example, at low HP ranges such as 10 HP and below, several technology choices will work, but one will usually outperform the others depending upon the specifics of the application, including needs and/or wants of the purchaser. If the air requirement is very intermittent, the reciprocating compressor is likely the best choice. As the application specifics change, the technology choice may change as well. The bottom line is when the technology choices are limited, compressors are pushed into the wrong applications and the end result is suboptimal operating performance. Be sure you are considering all the appropriate technology choices for your application.

Compressor Ratings by Technology & Type

LUBRICATED COMPRESSORS (5 = Best, 4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor)

FEATURE OR ISSUE	RECIPROCATING (SMALL)	ROTARY SCREW				ROTARY VANE	
	2-STAGE	FIXED SPEED, 1-STAGE	VARIABLE SPEED, 1-STAGE	FIXED SPEED, 2-STAGE	VARIABLE SPEED, 2-STAGE	FIXED SPEED	VARIABLE SPEED
Compressor Efficiency - Full Load	3	4	3	5	4	3	2
Compressor Efficiency - Part Load	3	3	4	3	5	2	3
Low Installation Cost	5	4	4	3	3	4	4
Low Noise Level	2	5	5	4	4	5	5
Low Maintenance Cost	5	4	4	3	3	4	4
Small Footprint	5	4	4	3	3	5	5

The above numbers compare lubricated products to other lubricated offerings only.

The numbers in the table are generalizations. Specific product options, upgrades or unique designs or features may improve a rating shown.

OIL-FREE COMPRESSORS (5 = Best, 4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor)

FEATURE OR ISSUE	RECIPROCATING	CENTRIFUGAL		ROTARY SCREW		ROTARY SCROLL
	OIL-LESS	HIGH SPEED MOTOR	GEAR DRIVEN	WATER-INJECTED, 1-STAGE	DRY, 2-STAGE	DRY, SMALL HORSEPOWER
Compressor Efficiency - Full Load	3	5	4	4	3	3
Compressor Efficiency - Part Load	3	3	2	4	3	3
Low Installation Cost	5	4	3	3	4	5
Low Noise Level	2	5	3	4	4	5
Low Maintenance Cost	5	5	3	4	3	4
Small Footprint	5	4	2	4	2	5

The above numbers compare oil-free products to other oil-free offerings only.

The numbers in the table are generalizations. Specific product options, upgrades or unique designs or features may improve a rating shown.

Many oil-free compressors are available in variable speed versions. These are not addressed in the table above.

Tiers within a Technology

In the following sections we are talking about a more traditional use of the term “tiered”. For each technology area there are a host of varied offerings, or tiers, from which to choose. Let’s take a closer look within the popular technology areas.

Reciprocating (Piston), Lubricated

This technology has been around for decades, and for lower pressure applications (80 to 250 PSIG), this technology is still a big seller 30 HP and below.

1 The first big tier that can be noted for this technology is between consumer products and commercial/light industrial offerings. The consumer products are low cost, low price compressors found at places like the big box stores. They are designed for light-duty use by your home hobbyist. The commercial-grade unit, on the other hand, is a more robust product that can handle higher duty cycles and provide longer life and greater reliability in harsh environments. Commercial/industrial manufacturers will often stay out of the consumer market because the products and channels-to-market are so different. For the small business, the commercial/light industrial reciprocating compressor is typically worth the investment.

2 The second tier to be noted is within the commercial/light industrial segment. In this segment, we can break the offerings into lower-end and higher-end offerings based upon a few key feature-benefits. Higher-end offerings generally have a cast iron design, operate at slower speeds (below 1000 RPM) and have built a reputation in this segment for durability and reliability. Most often a longer product warranty will reflect the robustness of the offering. Lower-end, lower price units will save cost by reducing the weight of the unit with alternative materials, by running at higher speeds to reduce overall size and by manufacturing abroad. Though there is a tendency to treat a purchase like this as a price buy, it is worth the time to take a closer look to ensure you get the value you desire.



Rotary Screw Compressors, Lubricated

For decades now, the lubricated rotary screw compressor has been the most popular technology for the majority of industrial plant air applications from 20 to 500 HP and from 80-175 PSIG. There are many ways to “tier” the rotary screw offerings, so we will focus on some of the major ways.



Compressor A*, 227 mm



Compressor B*, 165 mm

Larger airends,
running at slower
speeds, maximize
efficiency and
increase reliability.

*Rotor size shown
for 100 hp compressors

1 **Size of airend for a given horsepower** – The airend on a compressor package is the component that takes in the air, compresses it and discharges it to the rest of the package. Using 50 HP as an example, you can utilize a small airend (small rotor diameter), turn it at a relatively fast speed (revolutions per minute) and use about 50 HP worth of power. Alternatively, you can make the airend larger which allows it to rotate at a slower rate while still utilizing about 50 HP worth of power. Thus, the airend size (and cost) for different 50 HP compressors will vary significantly.

It is fairly common for a manufacturer to offer a compressor with a smaller, faster rotating airend and a model with a larger, slower turning airend at the same HP because the larger airend is generally more energy efficient than the smaller airend. Since electrical cost of operation is the largest expense associated with operating a compressor, the larger airend is “worth the money” in many applications where power consumption is a key factor. In providing this size/speed tiered offering in the same flow range, the customer can select the model that best meets the budgetary and operating cost targets that have been set. With tiers to select from, the best fit for the job can be obtained.

2 **Fixed and variable speed compressors** – Nearly every manufacturer offers customers both fixed and variable speed compressors in most size ranges. In general, variable speed (VS) compressors are applied when air demand varies significantly throughout a shift. This is because the VS compressors are more efficient (i.e. use less power (kW) per CFM of air produced) than their fixed speed (FS) counterparts at part load (i.e. when the air system does not need all the air the compressor could make). Since everyone offers this “tier” in their portfolio, the important thing is to determine whether you need an FS or a VS compressor (or a combination), and then to compare the efficiencies of the units involved. To help make an apples-to-

apples comparison, most manufacturers publish Compressed Air and Gas (CAGI) Data Sheets on their website. Be cautious in this area as many times VS compressors are recommended when they are not needed or do not project a reasonable ROI. Just because the VS compressor is the latest technology does not mean it is always the best compressor for the job.

It is important to keep in mind that many times it is best to divide the air requirement between two or more compressors. In addition to providing some compressed air if one unit goes down, a multiple unit arrangement is often the most efficient design. And, this arrangement frequently combines fixed and variable speed units working together.

3 Enclosed and unenclosed compressors – The enclosure or cabinet serves to reduce the noise level of the compressor and to keep the compressor components inside the enclosure cleaner. Most manufacturers have taken the unenclosed compressor out of their portfolio. By making only enclosed units, the cost of the enclosure can be reduced as the volume produced increases. However, there are many instances where an enclosure is not necessary and you are paying for something that adds no value. In many compressor installations, noise is not a concern and cleanliness is not an issue. Additionally, maintenance is generally easier on an unenclosed unit since the unenclosed unit provides easier, unrestricted access to maintenance areas. If an enclosure provides no benefit in your installation, consider unenclosed compressors and put the money you save into another area of the business.

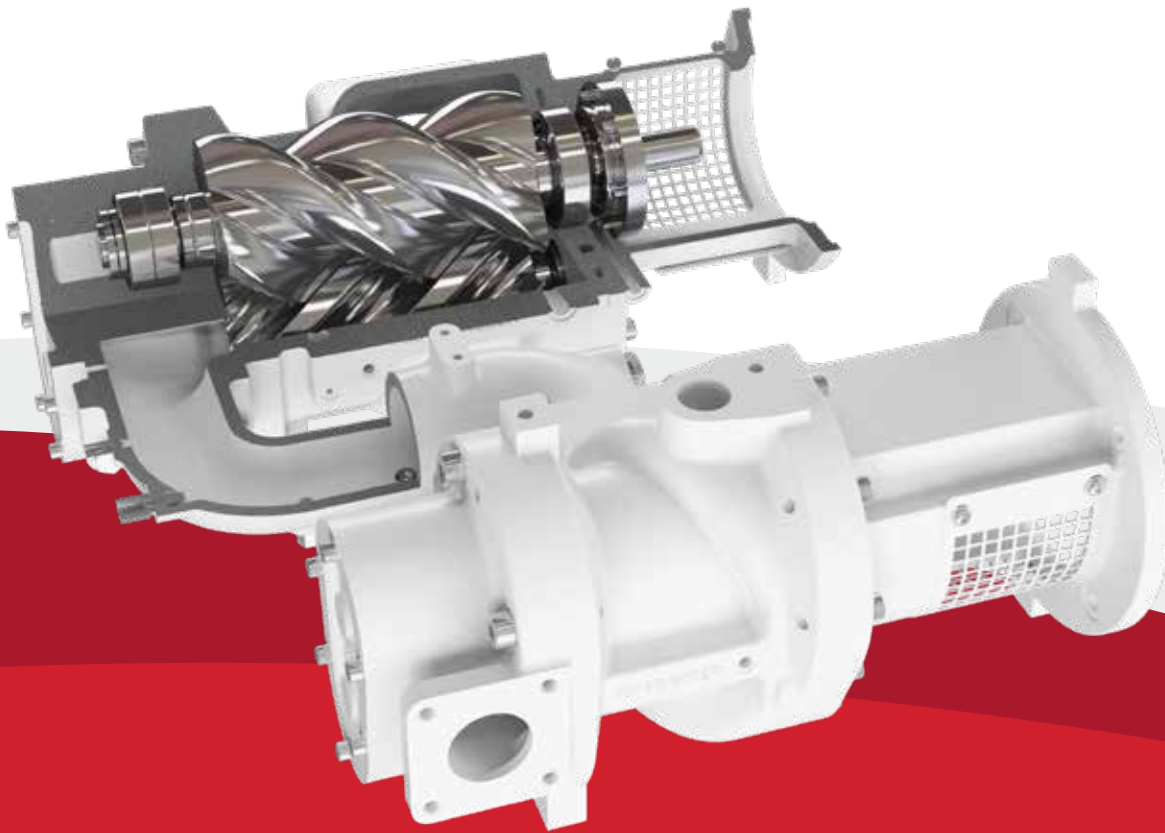


Two-Stage Rotary Screw
Compressor Airend

4

Single and two-stage lubricated - Two-stage

lubricated rotaries compress air in two steps. Step or stage one takes atmospheric air and compresses it part way to the discharge pressure target. Step or stage two ingests the air at the inter-stage pressure and compresses it to the discharge pressure target. Compression in two stages improves efficiency, but adds cost and complexity given the additional rotors, iron and other componentry involved. Only about half of compressor manufacturers offer a two-stage product. Two-stage is generally offered in the higher HP ranges (100 to 500 HP) because the improved efficiencies result in larger dollar savings when air use is large. With this single versus two-stage tier, it is a relatively straightforward calculation to determine what the payback will be from the more efficient but more costly two-stage unit. Remember that the energy cost of operating a compressor is the largest expense over time, so evaluation of a two-stage machine is certainly worth a look.



5 Integral dryers versus compressor and dryer on an air receiver - For certain sizes of compressors, generally 30 HP and below, you can purchase major compressor system components bundled together in a single package. Some manufacturers offer you the option to have the air dryer located within the compressor package, while others offer you the compressor and a like-sized dryer mounted on a single base plate on top of an air receiver. These “air systems” have become very popular due to space savings and reduced installation cost resulting from having the components piped together at the factory. Here are some considerations with these offerings:

- Look for and consider purchasing the optional dryer air bypass so that if the dryer is shut down for some reason you can still have compressed air if you need it.
- In order to service the dryer while the compressor is still operating, the dryer needs to be wired to operate on its own power source. A single power source makes a dryer bypass useless in this instance.
- Make sure you can get a dryer that is sized to handle higher ambient temperatures if you are located in a hot climate.
- Dryers located inside the compressor package have to deal with the heat rejection from the compressor in the cabinet. Some designs struggle with higher dew points or increased moisture in the air because the dryers do not perform as well in the presence of the additional heat from the compressor.
- For a model with a compressor and a dryer on an air receiver, quality interconnecting piping and drain piping is a necessity to prevent leaks and provide durability. Look for quality materials and craftsmanship in this area.



Lubricated Rotary Screw Compressor Review

The lubricated rotary screw compressor is the staple for most industrial plant air applications today. As you can see, there are a number of tiers to consider. Once you get your evaluation started, things will become clear pretty quickly. A high level understanding of your air system strategy will allow you to properly control the cost and productivity associated with pneumatic power.

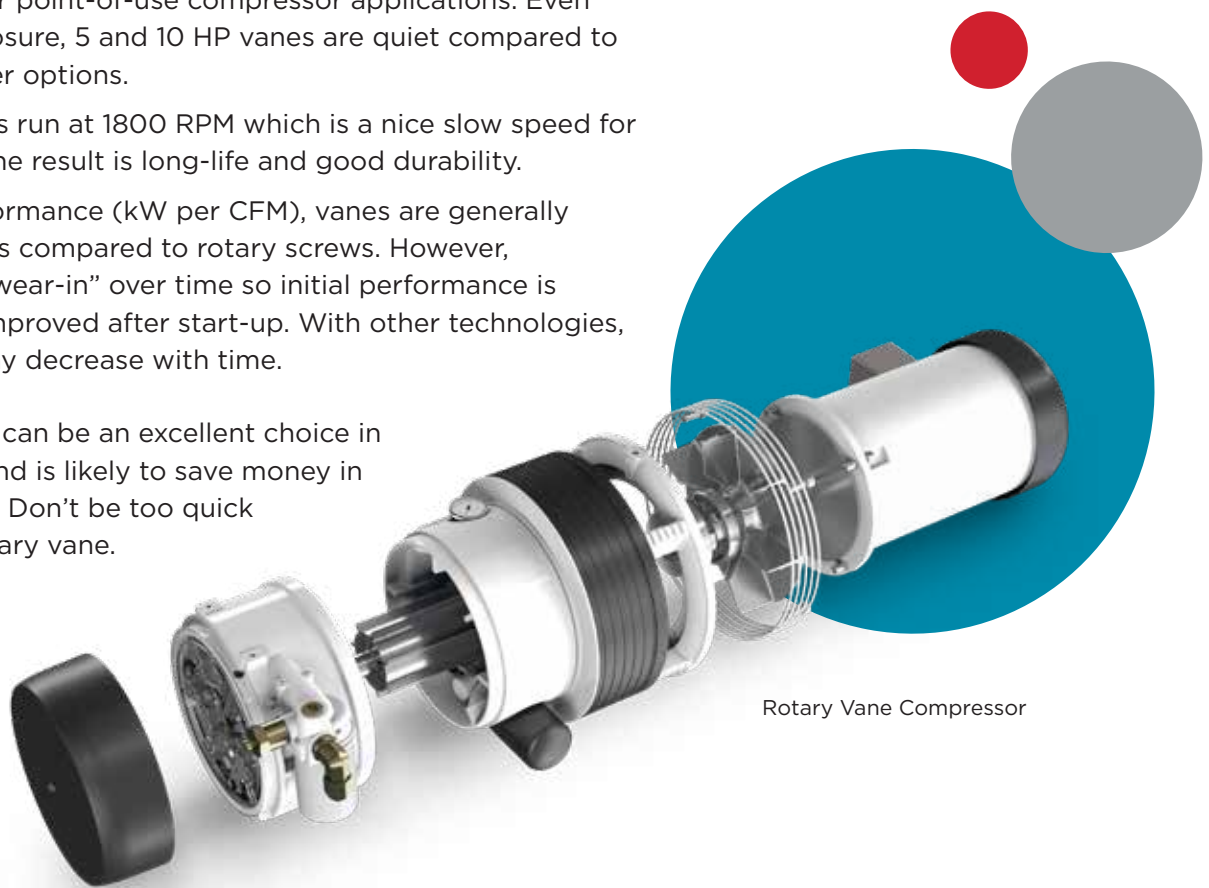
Rotary Vane Compressors, Lubricated

In a vane compressor, compression is accomplished as centrifugal force extends vanes from slots to form individual compression cells. As the cells move around a stator, the trapped air is compressed and expelled from the compression area.

Most compressor manufacturers do not offer the vane technology. They either do not feel there is a sufficient market for it, do not want to complicate their product offering or do not feel they have the expertise to make the product. However, the rotary vane compressor technology is a solid approach to providing pneumatic power and can bring some very helpful feature-benefits to your application. Here are some things to keep in mind when it comes to the rotary vane:

- The units are usually offered in the lower HP ranges, from 5 to 40 HP.
- The rotary vane technology is well-suited for harsh environments. Vanes are used in snow making and other difficult applications due to their robust construction.
- Rotary vanes are generally very quiet making them a strong consideration for point-of-use compressor applications. Even without an enclosure, 5 and 10 HP vanes are quiet compared to most of the other options.
- Most often vanes run at 1800 RPM which is a nice slow speed for a compressor. The result is long-life and good durability.
- In terms of performance (kW per CFM), vanes are generally lower performers compared to rotary screws. However, vanes actually “wear-in” over time so initial performance is maintained or improved after start-up. With other technologies, performance may decrease with time.

All in all, the vane can be an excellent choice in many situations and is likely to save money in initial cost as well. Don't be too quick to rule out the rotary vane.



Rotary Vane Compressor

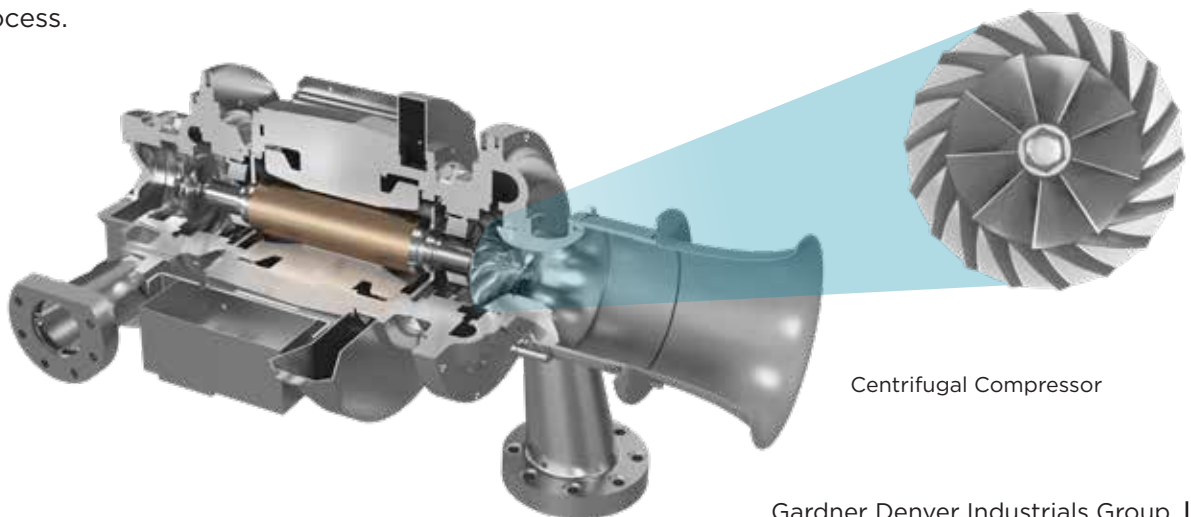
Centrifugal Compressors

This technology is offered by just a few manufacturers. Generally centrifugals are applied in larger air applications, although you can get a centrifugal down to 100 HP. The primary tier to consider here is one of standard versus high-speed design. The typical centrifugal supplier will provide either a standard-speed or a high-speed line, but not both. The lower sales volumes generally make it difficult to justify providing both high and low-speed versions. Key decision making criteria will include:

- Full load efficiency
- Noise level
- Footprint
- Maintenance requirements
- Application expertise

The high-speed centrifugal is a technology that has brought along with it a very strong value proposition. Generally, it will have superior performance, lower noise and a much smaller footprint than the standard-speed counterpart. Comparison of these benefits to the price difference will direct you toward the best unit for your application.

One final note about centrifugal compressors. Be sure to work with someone who knows this technology well. Site conditions, particularly elevation, must be known and carefully evaluated in sizing these units. Air delivery performance is impacted significantly by the site conditions, so to ensure application satisfaction, an experienced professional needs to oversee the compressor selection process.



Centrifugal Compressor

Lubricated versus Oil-Free Compressors

The final “tier” area we will consider is one of lubricated versus oil-free compressed air. Several additional manufacturers are offering oil-free compressors today than was the case five to ten years ago. This is a positive in that it gives you, the consumer, more choices from which to select. The ISO Quality classes of air will help you determine whether or not you need an oil-free compressor. If not, don’t push yourself into one as you will sacrifice efficiency while paying a considerable price premium. But if the air quality requirement and oil carryover concerns dictate oil-free, the investment will deliver the product quality that is demanded and valuable peace-of-mind.

In evaluating oil-free, you will be presented with single-stage, two-stage, water-injected single-stage, scroll and centrifugal technology choices. These technologies do overlap in certain HP ranges, but you will not have to evaluate all of them because, for a given HP/flow size, typically only two to three will be available. So, determine the size of compressor you need and then go to work. A detailed look at oil-free options requires a white paper of its own, but the following information is helpful.

ISO 8573-1:2010 COMPRESSED AIR CONTAMINANTS AND PURITY CLASSES

CLASS	PARTICLES				WATER			OIL
	By Particle Size (maximum number of particles per m ³). See Note 2			By Mass	Vapor Pressure Dewpoint		Liquid	Liquid, Aerosol & Vapor. See Note 1
	0.10-0.5 microns	0.5-1.0 microns	1.0-5.0 microns	mg/m ³	°C	°F	g/m ³	mg/m ³
0	As specified by the equipment user or supplier and more stringent than class 1							
1	≤ 20,000	≤ 400	≤ 10	-	≤ -70	≤ -94	-	≤ 0.01
2	≤ 400,000	≤ 6,000	≤ 100	-	≤ -40	≤ -40	-	≤ 0.1
3	-	≤ 90,000	≤ 1,000	-	≤ -20	≤ -4	-	≤ 1
4	-	-	≤ 10,000	-	≤ +3	≤ +37	-	≤ 5
5	-	-	≤ 100,000	-	≤ +7	≤ +45	-	-
6	-	-	-	0 - ≤ 5	≤ +10	≤ +50	-	-
7	-	-	-	0 - ≤ 10	-	-	≤ 0.5	-
8	-	-	-	-	-	-	≤ 5	-
9	-	-	-	-	-	-	≤ 10	-
X	-	-	-	-	-	-	>10	>5
Microbiological Contaminants				Other Gaseous Contaminants				
No purity classes are identified				No purity classes are identified. Gases mentioned are: CO, CO ₂ , SO ₂ , NOX, Hydrocarbons in the range of C ₁ to C ₅				

Consider the Following:

1 Scroll compressors are typically found in the smaller HP ranges such as 5 to 40 HP. Scrolls are smooth running, quiet units that do not require a lot of regular maintenance. Some of the more common applications would be dental, medical, laboratories and dairy. For rotary scrolls, the pump typically requires replacement in the 20,000 hour range, whereas a rotary screw airend can last two to four times as long.

2 Two-stage dry screws are the most popular technology as they have been around for many years. They are generally found in the 75 to 400 HP range, which covers a large segment of the market. Long-term maintenance can be costly for these compressors, but increased competition in recent years has helped to improve the service support you can obtain.

3 Centrifugals (see page 11) are inherently oil-free by design. These are generally in larger applications and only have good part-load efficiency in some newer designs. Some newer designs can also have very good efficiency when not making air, but are still turned on. Newer high-speed offerings have a superior feature-benefit proposition and should replace the standard-speed units over time.

4 As with oil lubricated compressors, **oil-free units** typically come in both fixed and variable speed versions. Most air applications see varied air use throughout the day, so variable speed deserves careful evaluation. When utilizing more than one compressor, often times a combination of fixed and variable speed units is the best solution. Your local air expert can help you evaluate your needs and present the best options.

5 New entrants into the oil-free market have brought increased competition and new approaches with strong value propositions to a previously stagnant segment. Enjoy the added buying power that comes with these choices.



Scroll Compressors
Enclosed | Tank-Mounted | Unenclosed



Two-Stage, Dry
Rotary Screw Compressor

Oil-Free Landscape Is Changing

More major global manufacturers are now in this segment with traditional technology offerings and new products demonstrating better performance and a host of other key features and benefits. If you are after expense savings and better profitability, you are more likely to achieve these objectives now than in the past given the new oil-free players and the products that have accompanied them.



Ultra Efficient, Two-Stage,
Dry Rotary Screw Compressor

Summary: A Tiered Product Offering

Years ago, a major tire manufacturer advertised with the tagline, “You Can’t Buy the Right Tire if You Don’t Have a Choice”. This is a good thought to keep in mind when purchasing an air compressor as well. The best way to ensure you have the right choices is to deal with suppliers that have a tiered and broad product offering, covering a majority of the areas outlined in this article. When the choices are limited, or the sales team is not familiar with all of the options to satisfy a particular application, many times the incorrect solution gets installed. At best, in these situations, air is provided but at a higher cost than is necessary. At worst, downtime results because the compressor operates in a manner that it is not designed to handle. However, since many compressed air systems are not operating optimally today, the purchase of a new compressor offers the opportunity to identify and implement the optimal, most energy-efficient system. When this is done, it is not uncommon to see savings in the tens of thousands of dollars annually. The tiered product offering is potentially the pathway to greater profitability without expanding your top-line revenue at all. As you look for profitability-enhancing opportunities, remember the air system portion of your business may be one of the best.

YOU CAN'T BUY THE RIGHT
Compressor
IF YOU DON'T HAVE A CHOICE



About Gardner Denver **Industrials Group**

Gardner Denver delivers the broadest range of compressors, blowers and vacuum products, in a wide array of technologies, to end-user and OEM customers worldwide in the industries we serve.

We provide reliable and energy-efficient equipment that is put to work in a multitude of manufacturing and process applications.

Products ranging from versatile low- to high-pressure compressors to customized blowers and vacuum pumps serve industries including general manufacturing, automotive, and waste water treatment, as well as food & beverage, plastics, and power generation.

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Our global offering also includes a comprehensive suite of aftermarket services to complement our products. Gardner Denver Industrials Group, part of Gardner Denver Inc., is headquartered in Milwaukee, Wisconsin, USA. Gardner Denver was founded in 1859 and today has approximately 7,000 employees in more than 30 countries.

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