Compressor Room Advantages with Oil-Free Centrifugal Air Compressors

By the Compressed Air & Gas Institute - Centrifugal Compressor Section

Introduction

Today's industrial manufacturing environment is extremely competitive, requiring companies to constantly search for cost saving opportunities and better efficiencies. In many cases, manufacturers find that centrifugal air compressors are a successful method for reducing the overall plant costs involved in supplying compressed air.

Understanding Centrifugal Technology

Before investigating the benefits of centrifugal air compressors (See Figure 1), it is important to understand the technology behind the compressor.

Centrifugal, sometimes referred to as dynamic compressors, work by transferring kinetic energy from a rotating impeller into potential energy (pressure) in the diffuser. As an impeller accelerates the air, a radial diffuser converts the air velocity into pressure converting kinetic energy into increased pressure. Centrifugal compressors typically feature multiple stages within the design. Between each stage, the air is cooled with an intercooler before moving on to the next stage which also increases the compressor efficiency. Due to the continuous flow through the multiple stages, centrifugal compressors are designed to thrive with higher capacities and are best suited for applications above 200 total horsepower.

Figure 1: Typical Centrifugal Air Compressor

Centrifugal Air Compressors Deliver Class 0 Certified Oil-Free Air

Centrifugal air compressors, as well as some rotary screw air compressors, can supply oil-free air, often referred to as Class 0 per ISO 8573-1. It is important to understand that the Class 0 designation is distinctly different from trace oil designation. Figure 2 presents the classifications of oil-free air. Employing a Class 0 certified centrifugal compressor provides numerous benefits to a manufacturing facility including minimized maintenance, reduced energy costs and an oil-free airstream (assuming the source inlet air is also hydrocarbon free).

Class	Concentration Total Oil (mg/m^3)
0	As specified by the equipment user or supplier and more stringent than class 1
1	≤ 0.01
2	≤ 0.1
3	≤ 1
4	≤ 5

Figure 2 - ISO 8573-1 classifications for oil-free air

Oil-Free Airstream

For some manufacturing plants having trace oil in their compressed airstream is not an issue. But for companies that produce textiles, food products, electronics or even medicines, oil-free, dry air is essential to the manufacturing process. An oil-free airstream eliminates the risk of trace oil reaching the finished product or oil contamination in pneumatic equipment lines leading to higher maintenance and downtime.

Producing an oil-free airstream gives a further advantage because the condensate that is generated by the compressor drain traps is not subject to local regulations that control condensate contaminated with oil, and so it can be disposed of easily and at a much lower cost.

Consumables

All air compressors rely on consumable products, such as filters, separators, and oil, which need to be replaced on a regular basis. The amount of consumable products can vary greatly based on compressor technology. Oil-free compressors do not use oil in the actual compression process, which keeps the oil in the machine out of the actual air path. Minimizing the oil introduced in the air path will reduce the risk of getting oil carryover in the airstream. It also minimizes the number of filter change-outs downstream, keeping costs down.

In addition to the filtration required to keep the air clean, there is the cost of the oil itself. Although oil-free compressors still require oil, it never goes into the compression process. Only minimal amounts are used to lubricate bearings and seals. If a business is unsure of which unit would work best for their application they should ask, “What will the impact to my business be if there is trace oil in the air system?” The less reliance on oil in a machine lowers the risk of oil

carry-over in the air path. Could you be subjecting your business to warranty claims or quality recalls if your product is released with trace oil residue? If you use pneumatic controllers or instruments, the impact could be substantial in downtime and maintenance from oil contamination in the air system lines.

Designed for Lower Maintenance Requirements

Centrifugal air compressors have very few moving parts and key components such as rotating assemblies, bearings, and seals can be easily field serviced. With minimal contacting or wearing parts, reliability is greatly improved and costly downtime minimized. In many cases, centrifugal compressors have remained in service up to 20 years before major overhauls are necessary.

Centrifugal compressors also offer the elimination of the need for oil/water separation units. Condensate from the air compressor drain-traps will likely have oil mixed with the water in oil-flooded machines. Centrifugal compressors have minimal oil in the condensate thus eliminating the need to remove the oil via an oil/water separator before the water discharged properly. The elimination of the maintenance and costs associated with the oil/water separator can help facilities minimize labor and consumable costs.

Highest in Terms of Energy Efficiency

Power or energy is by far the largest cost of operating an air compressor, so it is not surprising that energy efficiency often comes up in the conversation when discussing the benefits of centrifugal compressors. In many cases, a centrifugal compressor can offer some of the highest energy efficiency. Centrifugal compressors operate best at full capacity and are often used for base-load machines. In this capacity, demand is relatively constant and other air compressor technologies are used for trim machines. When centrifugal compressors are operating at full capacity and a constant air supply, efficiencies can exceed other technologies by 5%. This will vary based on the plant-load requirements and the application of a plant's total air delivery system.

Centrifugal compressors also typically employ inlet guide vanes to control the flow of air into the compressor. Inlet guide vanes reduce the amount of power required over traditional butterfly valves, by creating a pre-swirl condition to the air stream delivering excellent part-load performance and energy benefits over a wide range.

There are also various control system settings available on a centrifugal compressor that can maximize energy savings or efficiency. The control management will vary by manufacturer however typical controls include the ability to automatically adjust the compressor surge control line based on changes in environmental conditions. This allows plants to maximize the turndown and minimize the bypass air, ensuring the unit is always running at peak efficiency. Another management tool is the ability to adjust the high and low discharge set points to meet plant demands. Finally, one of the most useful is the ability to link compressors in sequence to minimize the number of compressors for the required demand.

Conclusions

Centrifugal air compressors are best suited for manufacturing plants that require higher flows and a steady supply of oil-free air. When operating expenses are of concern, centrifugal compressors can provide a higher efficiency rating as well as lower maintenance costs. The oil-free air path provides numerous benefits downstream in the manufacturing process that, depending on the manufacturing application, could have large financial returns. In general, manufacturers that require a total of over 250-300 horsepower should consider the benefits centrifugal compressors could offer and how those benefits could help the company achieve their objectives.

For more information, visit the CAGI web site at www.cagi.org.

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