BOGE COMPRESSED AIR SYSTEMS

High Speed Turbo: the new benchmark for oil-free compressed air

The food and drink sector relies heavily on compressed air systems to power its process, production and packaging lines, with the compressed air system of choice often being designated as oil-free.

Oil-free compressors, however, tend to be more expensive to operate and maintain, making total cost of ownership one of the key factors to consider when planning fresh investment in additional systems.

Now, a new breakthrough in technology is reducing total cost of ownership by around 30%. This white paper takes a look at how this has been achieved.

Living without oil

Compressors traditionally use oil, injected into the compression cavities of the machine, to improve the sealing properties of each air path and reduce pressure drop, and help the dissipation of heat during the process of air compression.

Although this approach creates an efficient method of generating compressed air, there is inevitably the risk that oil vapour and aerosols suspended in the compressed air stream will find their way to the point of use. If the downstream systems are completely sealed, then this risk can be acceptable. In reality, however, even the best maintained pneumatic system is likely to have a degree of leakage into the production environment, while applications where the air stream comes into contact with the end product, packaging or other product-contact surfaces clearly need to be protected from contamination.

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To address the challenge of removing oil from the compressed air stream, manufacturers have introduced so-called 'oil-free' machines.

These are typically rotary screw compressors, where air is compressed by the action of two rotating helical screws, or piston compressors, where a piston is used to compress air to high pressures. Although these systems eliminate the need to inject oil into the compressed air flow, they are by no means completely oil free, as oil is still required to lubricate moving parts elsewhere within each machine and there is always the possibility of contamination within the machine.

Additionally, if the air drawn into the compressor contains oil, this will be concentrated during the compression process and subsequently transmitted to downstream processes. To eliminate this risk, a number of manufacturers such as BOGE fit catalytic converters at the compressor outlet, to 'open' the long chain hydrocarbon molecules and leave a clean supply of air containing carbon dioxide and water; the latter may require a separate dryer to be installed for optimum air quality.

A further option is to continue to use standard (non-oil-free specification) compressors, but to use food grade machine and air-line lubricants. These synthetic products are specially formulated to provide a range of characteristics at different operating temperatures, and are free from mineral hydrocarbons, nut oils and genetically modified ingredients.

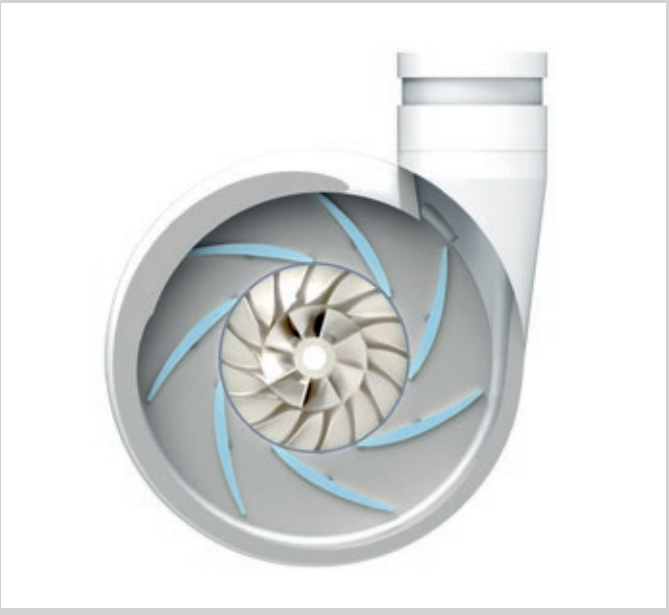
Food grade lubricants are normally manufactured to comply with the National Sanitation Foundation (NSF) H1 standard, which allows 'incidental contact with food'. They are, however, more expensive that conventional products. It is also worth noting that the use of non-standard or non-approved food grade lubricants may also invalidate any warranty on the compressor.

Although food grade lubricants can offer a solution, they inevitably add to ongoing operating costs, requiring additional downstream clean up equipment maintenance processes and the replenishment and eventual replacement of oil as it ages and degrades.

A new approach

Although rotary screw and piston compressors offer efficient and reliable options in many applications, they are not always the best solution. In particular, in their 'oil-free' versions they can be expensive to purchase, operate and maintain, with relatively large numbers of moving parts and high levels of energy consumption; they also tend to be noisy, sizeable and heavy units, to accommodate the necessary lubrication, cooling, oil reservoir and control devices.

Now, with the advent of new high speed turbo technology, it has become possible to eliminate oil completely from the compressor, providing for the first time a truly oil-free machine.



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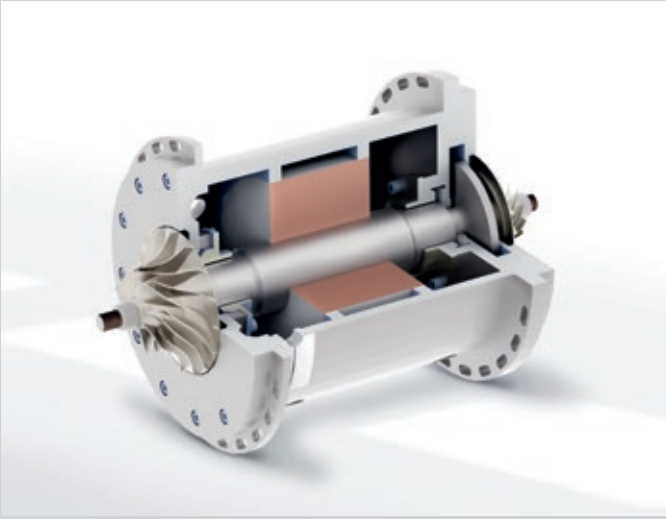
How it works

High speed turbo compressors, such as the HST 55, 110 and 220kW machines from BOGE, represent a step change in compressor design. By comparison with traditional oil-free machines, these Class 0 compressors are 50% smaller and lighter; they are also quieter, typically just 63dB(A) for the 55kW machine – a traditional screw compressor normally generates 80dB(A); and have a total cost of ownership that is at least 30% lower.

These major improvements have been achieved by adopting innovative turbo technology.

At the heart of the compressor are two compact permanent magnet motors. Each has a central rotor, suspended on self-stabilising air foil bearings, with two precision balanced titanium impellors, one mounted at each end of each rotor.

The design of the motors allow the impellors to rotate at exceptionally high speeds – typically in excess of 100,000 rpm – with the impellors on each motor being of different sizes and blade arrangements. This allows air drawn in via an intake funnel and specially designed spiral casing to be boosted in three stages to reach operating pressures quickly and extremely efficiently, with minimal energy losses due to friction between moving parts.



This simple design has a number of important benefits:

- There are far fewer moving components, which minimises the risk of wear. For example, each drive motor has only one moving part; unlike a traditional oil-free compressor there is oil system, no conventional bearings and no gear units, while the number of seals is reduced from 17 to just 3.
- The impellor, diffuser and spiral casing design effectively reduces air pressure on the intake side. This has the constant effect of sucking fresh air through the motor and eliminates the need for a separate fan cooling motor and control unit.
- The air bearing is virtually frictionless and maintenance-free; by comparison, other turbo compressors use magnetic bearings, which consume higher levels of power, require greater maintenance and demand additional electronics, including a power backup device to protect them in the event of a mains power failure.
- The air bearing is continuously pressurised, which protects it from any risk of contamination.
- The use of integrated frequency inverters and a dedicated touchscreen control system allow the volumetric flow to be instantly adjusted to meet demand.
- The low levels of internal friction, design of the motors and sophistication of the control systems, plus the elimination of parts such as fan motors, allows energy efficiency to be significantly improved; for example, energy use in idle state is less than 1.9% of nominal power, while CO2 emissions are around 20% lower than traditional compressors.

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The development of precision high speed turbo technology, linked with the use of advanced electronic control systems, has created a new generation of oil-free, Class 0 compressors that offer companies throughout the food and beverage sector the potential to improve the quality, productivity and reliability of their production processes, while simultaneously reducing operating costs.

These benefits can be extended still further, as compressors such as the BOGE HST can be supplied with a range of options. These include heat recovery units, and sophisticated data interfaces and analytics, which offer the potential for remote monitoring or integration into higher level plant or business-wide control systems. The latter can enhance productivity still further as part of the evolving initiatives embedded in Industry 4.0 and the Industrial Internet of Things.

Why oil-free is needed

Compressed air is used for a wide range of functions in the food and drinks sectors, for example, in automation, transportation, cleaning, aeration, fermentation, cooling and spraying. Regardless of whether compressed air comes into direct contact with food or drink products, it has to be clean, dry and free from contaminants. In particular, oil has to be completely removed to eliminate the risk of product contamination and spoilage, and to protect both consumers and the brand reputation of suppliers.

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Food grade compressed air standards

Food and drinks companies often adopt a Hazard Analysis and Critical Control Points (HACCP) approach. This is intended to prevent biological, chemical, and physical hazards affecting production processes. A HACCP prerequisite programme, for example, identifies the basic environmental and operating conditions essential for safe food and drinks production. It also introduces the concept of critical control points – the steps or procedures that must be addressed to prevent a safety hazard occurring.

In addition, many companies comply with ISO 8573.1. This is an international standard that specifies varying levels of air quality for use across industry. Air quality is defined by the content of particles, water and oil in liquid, vapour and aerosol forms, with each level described as a 'class'; with class 1 being the tightest standard definition. Additionally, there is what is called a 'user defined class 0', which is described as 'specified by the equipment user or supplier and more stringent than class 1'. It should be noted that class 0 does not stipulate that no contaminants are present, only that the level of contamination is below that of class 1; i.e. total oil concentration not exceeding 0.01mg/m3.

To find out more about BOGE Compressors and specialist gas generators, please contact us or visit our website:

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