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Food Safety & Compressed Air: Meeting Safety Goals Without Wasting Capital And Resources

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For food manufacturers, plant operating costs are a major concern. To keep costs low, you want to make sure you're not using technology that's more expensive — in terms of purchase, operation, components required, and upkeep — than what is needed. When selecting compressed air equipment, you want to make sure you're buying equipment that is appropriately sized for the plant, is easily maintained, and delivers the ROI and benefits expected.

At the same time, food safety is a priority among food manufacturers. Using compressed air in manufacturing and packaging processes adds a layer of complexity in achieving contaminant-free food products. Unfortunately, regulating bodies and standards programs, such as the FDA, USDA, SQF, etc., are not specific in their guidance for using compressed air in food manufacturing. This leaves the food manufacturer with a lot of ambiguity in their decision-making processes regarding how to best balance food safety with choosing the right air compressor, designing the compressed air system, and keeping equipment prices and operating costs low.

Oil-Free vs. Oil-Flooded Air Compressors

Food and beverage processors face several choices when selecting compressed air equipment. The type of compressor and the processes it will be used for play major roles in compressor selection. The vast majority of food manufacturers choose between two types: oil-flooded and oil-free compressors. Understanding the differences between oil-flooded and oil-free compressors will help plant managers and engineers design a compressed air system that will meet air quality needs while reducing operational, maintenance, and life cycle costs.

Historically, the selection of oil-free compressors was limited and very few compressor manufacturers offered them. However, in recent years more and more compressor manufacturers are developing oil-free models, offering end users more choices when evaluating oil-free compressor technology and planning new systems with oil-free compressors.

In ***oil-flooded compressors***, oil is purposely injected to serve four functions. It seals the clearances between rotors and housings to ensure efficient compression; it removes the heat of compression;

it lubricates bearings; and it removes particulate contaminants. Discharge temperatures are relatively close to ambient temperatures, so moisture is easy to remove via tanks, moisture separators, and refrigerated dryers.

In oil-free compressors, no oil is used inside the compression chamber(s) for lubricating, cooling, or sealing. So by design, oil-free compressors do not add any oil to the compressed air. This "insurance" that the compressor isn't adding more oil to the air can provide valuable peace of mind in cleanroom and food manufacturing applications. And, as with oil-flooded compressors, the physical location of the air compressor impacts operation, efficiency, and the ability to mitigate risks. Oil-free screw compressors do, however, contain oil. There is oil in the gear cases and bearings, which, though isolated from the compressed air stream, may create aerosol traces in the ambient air. Likewise, ambient air may already contain hydrocarbons. For instance, an air compressor installed near a loading dock will be subject to a lot of contamination risk from the exhaust of delivery trucks. Hydrocarbons in the ambient air can be pulled into the compressor inlet. This highlights the importance of proper siting to minimize the chances of compressors pulling in contaminants.

The design of oil-injected and oil-free compressors results in two key differences: cost and efficiency. An oil-free compressor can cost 20 percent or more than oil-injected — sometimes 40 to 50 percent, depending on the size/horsepower and technology. Further differentiating the two compressors is energy efficiency. Typically, oil-flooded compressors are 10 to 16 percent more efficient compared to oil-free compressors. Some believe there is a trade-off between the increased purchase price, energy cost, and maintenance costs with a reduction in the need for air treatment equipment. This is not the case, as we'll discuss below. The only offset is a reduction in perceived risk.

Clean Air Treatment

Regardless of the compressor type, clean air treatment is required to remove moisture, particulate, and hydrocarbons (including oils). In many applications—including food manufacturing—oil is considered a contaminant so manufacturers often believe choosing an oil-free compressor is a common and simple way to reduce contamination risk. However, contamination issues aren't completely solved by choosing an oil-free compressor over an oil-flooded one. Because of this, plant operators must select the right mix of dryers, filters, drains, and other equipment to mitigate ambient sources of contamination—no matter the type of compressor chosen for the application. Typically, the process is as follows:

Liquid removal — Compressing ambient air, which includes oil at .1 to .5 parts per million (or higher depending on compressor siting, as mentioned earlier), then cooling it creates condensed water that needs to be removed. This is done through liquid separators and receiver tanks.

Particle removal — After bulk liquids are removed, solid particles — dirt, dust, etc. — must also be removed using particle filters. Some particulate will be removed along with bulk liquids and aerosols.

Aerosol removal — Aerosols are fine liquid mists suspended in the air—including water and hydrocarbons/oils. Depending on what the compressed air is being used for, desiccant, refrigerated, or membrane dryers can be used to remove water and lower the dewpoint of the facility's air to meet the specific system requirements. Oils and other hydrocarbon mists can be effectively removed with coalescing filters. Further, vapor filters or carbon towers can be added to eliminate the smell and taste of hydrocarbons/oils if necessary.

The specific application of the compressed air system, along with its filtration and drying components, also plays a role in which type of compressor will be needed. Many food manufacturers see how an oil-free compressor can reduce the chance of oil contamination in their facility. However, that oil-free compressor may not be the best choice for their application. For instance, a manufacturer may use compressed air to produce cans for food packaging. These cans are created, packaged, shipped, and arrive in a wide-open container enabling dust and other airborne contaminants, including oil, to collect within them. The cans must then be washed at the filling plant before food product can be added. Because of the washdown steps required to mitigate contamination before filling, an oil-free compressor doesn't make sense for the can manufacturing but may be recommended for the actual filling and sealing of the cans.

Managing Compressor Operating Costs

Operating costs are also a factor in choosing a compressed air system, with the primary cost being the machine's power source: electricity. When choosing compressors, we recommend comparing specific performance to get a true picture of electrical efficiency. This is easily done with the use of Compressed Air and Gas Institute (CAGI) datasheets. Most manufacturers will supply these on request and some publish them on their websites.

Keep in mind that system design and controls play a large role in system efficiency, sometimes more than the compressor's efficiency. Bigger operations may require larger air compressors, but regardless of compressor type, it is wise to avoid the "bigger is better" attitude. This is very common and results in many systems being grossly oversized. This wastes energy, and it also drives up maintenance costs and may cut equipment life short.

Further cost savings can be achieved through small, operational initiatives, such as simply turning the compressor off when not in use. Even if plants are designed to run 24/7, other means of energy savings — eliminating leaks and other inefficiencies, reducing air pressures as needed, and routine maintenance (more on this below) — can be planned for and executed.

Some operators choose food-

grade lubricants in their oil-injected compressors. While this is a good avenue for contamination prevention, it does present added costs to the operation of equipment. Food-grade lubricants are more expensive than standard fluids, and they have limited lifetimes (typically 50 percent), which means they need to be replaced more often.

The maintenance costs associated with oil-free compressors are generally lower than oil-flooded machines until compressor elements (air ends) must be replaced or rebuilt. At that point, the costs of the two types equalize. However, in terms of life expectancy of the machine, oil-flooded compressors typically last longer than oil-free when using full-synthetic lubrication accompanied with regular maintenance.

Maintenance of Air Compressors

Good maintenance practices, regardless of compressor type, are the best way to maximize a compressor's life expectancy. A good first step is to follow the maintenance schedule and recommendations set by the equipment's manufacturer. In addition, some models have sensors in their components that let users know when it's time for maintenance. A balance of both practices is the optimal approach to extending compressor life. For instance, the manufacturer's recommendation might be to change the compressor's oil after every 4,000 hours of use. If the electronic monitoring component indicates an oil change is needed prior to the 4,000 hours being reached, the best practice is to change the oil as routine preventive maintenance.

An air compressor maintenance check includes, but is not limited to:

- Oil level inspections
- Oil leak inspections
- Oil and oil filter changes at appropriate intervals
- Noise/vibration inspections
- Address loose bolts, nuts, screws, etc.
- Air leak inspection
- Belt/coupling inspections
- Filter inspections
- Clean/replace cabinet and inlet filters
- Safety valve inspections

Departments responsible for keeping compressors running efficiently and maximizing their life are focused on reliability and keeping maintenance costs low. And while all the above bullet points are necessary parts of compressor maintenance, the biggest concern is the compressor's filters, even if the maintenance crew isn't in direct contact with food products or responsible for food safety.

Proper maintenance of filters is a major component of mitigating contamination, keeping consumers safe, and keeping the business compliant with food safety and quality regulations. If compressed air filters aren't routinely replaced, they become susceptible to failure ranging from lower separation efficiency to rupture, in the worst cases. This dramatically increases food safety risks and the possibility of a recall, which on average costs a food business about $10 million.

Ultimately, a person or a department at a food plant using compressed air is responsible for the safety of their products. At a minimum, using those previously mentioned digital/electronic sensors (such as differential pressure switches/sensors on filters to guide maintenance/replacement intervals) is an added insurance policy for producing the highest quality food products that are safe for consumers.

Finally, compressor downtime is a headache. When compressors aren't running, products aren't being made, and your company is losing money via lost sales, replacement parts costs, labor costs, and downtime costs. Regular preventive maintenance practices help inhibit these losses while simultaneously protecting your capital investment.

About Liam Gallagher

Liam holds a Bachelor of Science degree in Mechanical Engineering from Norwich University. As Kaeser Compressors' Product Engineer - Air Treatment, he is responsible for the technical sales support and education of the extensive line of air treatment products including filters, dryers, drains, and condensate management. Liam works closely with the field sales and service personnel to develop custom solutions for the customer's air treatment needs from basic shop air to instrument air and breathing air. Liam is also EPA Section 608 Universal Certified (for Stationary HVACR Systems and Equipment).

About Werner Rauer

Werner Rauer is the Product Manager for oil-injected and oil-free screw compressors at Kaeser Compressors, Inc. With over 30 years in the industry, Werner has extensive experience troubleshooting air systems large and small and a deep knowledge of effective compressed air system design. An active leader in the Compressed Air and Gas Institute (CAGI), he helped develop CAGI compressor performance datasheets and supported the development and implementation of ISO 11011 and EA4 for compressed air energy audit standards. Werner has a degree in Mechanical Engineering, has completed the DOE Compressed Air Challenge I and II and is a CAGI Certified Compressed Air System Specialist.

About Kaeser Compressors, Inc.

Kaeser Compressors is a leader in reliable, energy efficient compressed air equipment and system design. We offer a complete line of superior quality industrial air compressors as well as dryers, filters, SmartPipe™, master controls, and other system accessories. Kaeser also offers blowers, vacuum pumps, and portable gasoline and diesel screw compressors. Our national service network provides installation, rentals, maintenance, repair, and system audits. Kaeser is an ENERGY STAR Partner.