White Paper

Gardner Denver

Considerations for Compressed Air Users

in the Food & Beverage Industry

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Today

Food and beverage companies face many challenges and none more important than protecting and safeguarding the health of their consumers, while maintaining a sustainable business to benefit all involved. A complex and sometimes difficult balance to maintain; there are some activities which are common to achieving both requirements.

One such activity which helps food producers target both areas simultaneously is the correct set up and housekeeping of the compressed air system - a key utility supporting the food packaging and food processing industries. Initially an area of significant investment, this essential utility can often be over looked.

Heavily contaminated atmospheric air is compressed and used throughout food and beverage production in a variety of ways. If actions are not taken to reduce or remove this contamination it is highly probable that it will at some point contaminate the product, rendering it unfit for consumption, resulting in finished product or ingredients rejected as an expensive waste. In the worst case scenario, the contaminated product enters the marketplace, leading to expensive and embarrassing product recall or legal claims should any consumer suffer ill health as a consequence.

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Compressed Air: Did you know?

- 1 m^3 of ambient air can contain up to 100,000,000 micro-organisms, which are drawn into the compressor intake and end up in the compressed air system.
- Micro-organisms grow rapidly in a compressed air system if left unchecked. Having a pressure dewpoint of better than −14.8°F (−26°C) will inhibit breeding or growth of micro-organisms.
- Refrigeration dryers with a 37.4°F (3°C) pressure dewpoint will not inhibit micro-organism growth (refrigeration dryers are commonly used due to their low cost). To inhibit growth, adsorption dryers with a −40°F (−40°C) pressure dewpoint should be used.
- A typical 100kW compressor can introduce up to 18,492 gallons of water a year into the compressed air system, this problem is exaggerated further in hotter more humid climates.

Understand the Legislation

It is paramount to understand legislation and relevant standards set out for the food and beverage sector not only in the country of manufacturing but also those you may be exporting to. The code of Federal Regulation, FDA title 21 Food and Drugs, parts 100 - 169 is important to those supplying to customers within the United States of America. This code is also commonly adopted elsewhere as many food retailers will ask that a food producer be compliant as part of a supply chain quality credential.

What Practical Steps Can You Take?

Regular Risk Assessment

Many food standards relating to compressed air recognize the need to continuously check and test the system with a close eye on potential risk relating to compressed air contamination entering food production. In particular, hygiene regulations designed to protect the consumer and support the use of HACCP (Hazard Analysis Critical Control Points) with audits often carried out in line with procedures covered in ISO22000:2005. This international standard requires that hazards which may be reasonably expected to occur within food production, processes and facilities use, are identified and risk assessed.

In order to understand the level of potential risk, compressed air used throughout the site can be first categorized:

The food industry, faced with the question of how to specify a safe and efficient compressed air system, must first define how compressed air is used in their facilities.

Below are three specific types of compressed air systems in the food industry and recommendations on air quality.

Direct Contact Recommendation

Compressed air coming into direct contact with food/beverage should meet or exceed the following classification, Table 1, as identified from ISO 8573-1:2010 {2:2:1} which translates to:

TABLE 1 - Compressed Air Purity Designation - Direct Contact with Food

Class	Maximum number of particles per m³ **for particle sizes d, (µm) (at reference conditions see 7.3.1)**		
	$0.1 < d \leq 0.5$	$0.5 < d \leq 1.0$	$1.0 < d \leq 5.0$
2	≤ 400.000	≤ 6.000	≤ 100
	Pressure Dewpoint (°C); (°F)		
2	≤ -40; -40		
	Concentration total oil (liquid, aerosol and vapor) (mg/m³) (at reference conditions)		
1	≤ 0,01		

Source: Food and Beverage Grade Compressed Air Best Practice Guideline 102 – BCAS

Indirect Contact Recommendation

Compressed air coming into in-direct contact with food/beverage should meet or exceed the following classification, Table 2, as identified from ISO 8573-1:2010 {2:4:2} which translates to:

TABLE 2 - Compressed Air Purity Designation - Indirect Contact with Food

Class	Maximum number of particles per m³ **for particle sizes d, (µm) (at reference conditions see 7.3.1w)**		
	$0.1 < d \leq 0.5$	$0.5 < d \leq 1.0$	$1.0 < d \leq 5.0$
2	≤ 400.000	≤ 6.000	≤ 100
	Pressure Dewpoint (°C); (°F)		
4	≤ +3; 37.4		
	Concentration total oil (liquid, aerosol and vapor) (mg/m³) (at reference conditions)		
2	≤ 0,01		

Source: Food and Beverage Grade Compressed Air Best Practice Guideline 102 – BCAS

Non-Contact

Interpreting a Non-Contact Low-Risk system is equally important to define because it is common to see food industry systems "over-protect" their compressed air systems. Most plants have significant portions (over 50%) of their compressed air going to "plant air" applications. These "plant air" applications will have absolutely no contact with food products or food packaging machinery.

This is compressed air produced and used on site which does not come into direct or indirect contact with the ingredients, equipment, packaging or finished goods.

Match Your System to Your Needs

After initial risk assessment and categorization of compressed air usage, it is essential to ensure each category and application is being provided with the correct quality of air according to codes of practice in conjunction with suitable standards for air quality such as ISO Air Quality Classes standard 8573-1:2010.

Manufacturers wishing to do all they can to ensure maximum protection against contamination have a variety of compression and purification equipment on hand.

ISO 8573-1:2010 Compressed Air Contaminants & Purity Classes

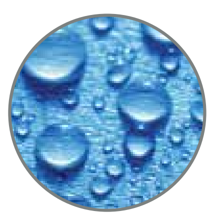
CLASS	PARTICLES				WATER			OIL
	By Particle Size (maximum number of particles per m^3) See Note 2			By Mass	Vapor Pressure Dewpoint		Liquid	Liquid, Aerosol & Vapor See Note 1
	0.10 - 0.5 microns	0.5 - 1.0 microns	1.0- 5.0 microns	mg/m^3	°C	°F	g/m^3	mg/m^3
0	As specified by the equipment user or supplier 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			

Quality Classes of Compressed Air

Three Types of Compressed Air Contaminants

SOLID PARTICLE CONTAMINATION

1) Pipe scale – does the plant have new or old (rusting) pipe systems?
2) Ambient dust taken into air compressor intake
3) Coatings from airend rotors in the air compressors
4) Measured in Micron Size Diameter and Volume.



WATER CONTAMINATION

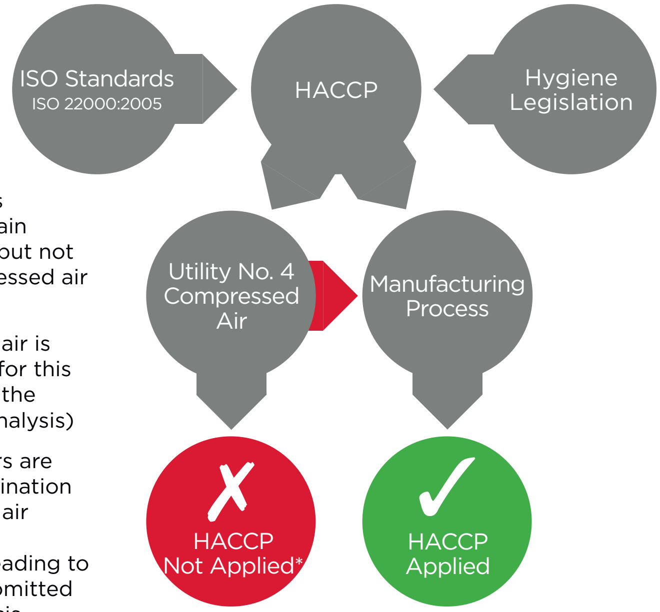
1) Moisture creates an ideal habitat for micro-organisms and fungi
2) These can grow inside piping and be blown into food (direct contact) or onto containers (indirect contact)
3) Measured in terms of pressure dewpoint.

OIL CONTAMINATION

1) Lubricated air compressors introduce oil, as do contaminated piping systems.
2) Ambient hydrocarbons taken into air compressors (both lubricated and oil-free) intake
3) Measured in terms of ppm w/w.

Hazard Analysis & Critical Control Point (HACCP)

The interconnection between hygiene legislation, food safety management systems & compressed air



The Hazard Analysis and Critical Control Point (HACCP) principles which the food/beverage producer is required to perform, are a key practice in the food industry.

These principles are designed to ensure the quality of the final product by identifying potential contamination entry points or zones, known as Critical Control Points (CCP) and implementing rectification and monitoring procedures.

* The HACCP principle is often applied to the main manufacturing facility but not utilities such as compressed air

- In most manufacturing scenarios, compressed air is viewed as a utility and for this reason is omitted from the Hazard Analysis (risk analysis)
- Additionally, many users are unaware of the contamination present in compressed air and the sources of that contamination, again leading to compressed air being omitted from the Hazard Analysis.

Applying the HACCP Principle to Compressed Air

HACCP Principle	How HACCP Principle Relates to Compressed Air
Analysis Hazards Identify potential hazards (contaminants) to foods safety	**10 contaminants present in a typical compressed air system**
Identification of CCP Establish Critical Control Points throughout the production process where hazards (contaminants) can enter	**Every point in the manufacturing process where compressed air is used**
CCP Prevention Measures A prevention measure is established at all CCP	**Installation of Filtration & Drying (Purification) Equipment**
Monitoring of CCP Prevention Measures A system is established to monitor prevention measures at a CCP	**Regular Air Purity Sampling of the compressed air system**
CCP NOT MET Establish what must be done when the CCP prevention measures are not met	**Documented process for staff to follow in the event of a quality incident**
HACCP & CCP LOG Maintain a log system of all the CCP, control methods and actions taken to correct potential problems	**Details of Hazard Analysis, all CCP and relevant sampling / testing recorded and available for inspection**

Security First

Traditional compressor systems utilize oil as a coolant, sealant and lubricant within the compression phase, which leads to a portion of these lubricants entering the air as well as adding to the atmospheric contaminants and hydrocarbons drawn in from the outside environment. While purification equipment is effective in removing this additional oil, it is seen by some as an avoidable risk through choosing compressors which do not use or contain oil.

- Avoid product spoilage or any damage of your equipment
- Avoid product recalls or any production stoppages
- Avoid frequent and expensive maintenance of sensitive equipment
- Don't risk damaging your brand reputation

Selecting the Right Air Compressor – Reducing Contaminant Risk

It is recognized that there are two main sources of contamination in new compressed air systems. The main contaminant source being atmospheric air, which is drawn in to the system. The second major source being the compressor which traditionally uses oil for lubrication and cooling that can carry over downstream. If not treated, this oil will pass freely through the system to the critical control point. Most food and beverage companies are switching to "Oil-Free" compressor technologies which allow the user to remove fully, one of these major sources of contamination.

Switching to 100% oil-free compressors would offer the lowest potential risk of introducing further contamination from the air compressor.

Some food and beverage companies, having carried out a full HACCP analysis, may select 100% oil-free air compressors. These compressors do not contain oil at all, whereas some "oil-free" compressors contain oils within gearboxes and other non-air side areas of the compressor. In terms of risk analysis, food producers should consider the potential impact of this should there be any failure of internal sealing arrangements or even leakage of these lubricants and oils.

Selecting the Correct Ancillary Equipment

The methodology behind the Critical Control Point (CCP) approach should be regarded as a risk monitoring procedure. It is important that this is used in conjunction with compressed air purification equipment which will help prevent problems occurring rather than simply making you aware of them. There are continuous developments in compressed air purification technologies which provide performance improvements while reducing running costs and energy use. It is a good idea to ensure that you are aware of the latest solutions available to make use of these benefits. Many products today have been designed and approved specifically for use in the food and beverage industry, often citing FDA compliance which typically means that materials used are in accordance with FDA guidelines.

Service, Maintenance & Documentation

It is essential that the compressed air system is maintained in line with the equipment manufacturer's guidelines. This will ensure a safe, reliable and efficient system. All service actions, checks, inspections and incidents should be well documented. In many cases it is this area where major clients of food producers are interested, as they seek regular proof that the food they are purchasing has been produced free from contamination.

References & Further Reading

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Factors to consider when selecting compressed air treatment, Mark White, Parker Hannifin Manufacturing Ltd
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About Gardner Denver Industrials Group

Gardner Denver Industrials Group delivers the broadest range of compressors 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.

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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