



White Paper

High Quality Compressed Air for the
Food and Beverage Industries

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Compressed air contamination is a real problem for the food and beverage industries

In today's modern production facilities, the use of compressed air is often pivotal to manufacturing processes. Irrespective of whether the compressed air comes into direct contact with the product or is used to automate a process, provide motive power, package products, or even to generate other gases on-site, a clean, dry, reliable compressed air supply is essential to maintain efficient and cost effective production.

A tour of any modern food and beverage manufacturing facility will uncover the extensive use of compressed air, however production managers and quality managers are often unaware of the potential hazards associated with this powerful utility.

Untreated compressed air contains many potentially harmful or dangerous contaminants which must be reduced to acceptable levels in order to protect the consumer and provide a safe and cost effective

production facility. Contaminants that may be a potential hazard for human consumption need to be controlled, as a lack of control could potentially result in a prosecution.

Worldwide Standards for Food and beverage Grade Compressed Air

In order to protect consumers against ill health (or worse), most industrialised countries have strict regulations and laws governing hygiene of food and beverage products which must be adhered to during:

**Preparation
Processing
Manufacturing
Packaging
Storage
Transportation
Distribution
Handling
Sale or supply**



Food and beverage Manufacturers – Hygiene Legislation & Duty of Care

Most countries throughout the world have hygiene legislation in place (for example, in Europe this is European Regulation 852/2004) and food and beverage manufacturers have a duty of care to adhere to this legislation or face legal consequences.

Food and beverage Safety Management Systems

Typically, hygiene legislation requires manufacturers to instigate written food and beverage safety management systems (FSMS) based upon the principles of HACCP (Hazard Analysis Critical Control Point).

Normally, hygiene regulations are strictly observed within the manufacturing and supply processes, however, through lack of awareness, they are not often applied to utilities.

The most overlooked utility being the compressed air which powers many manufacturing processes.

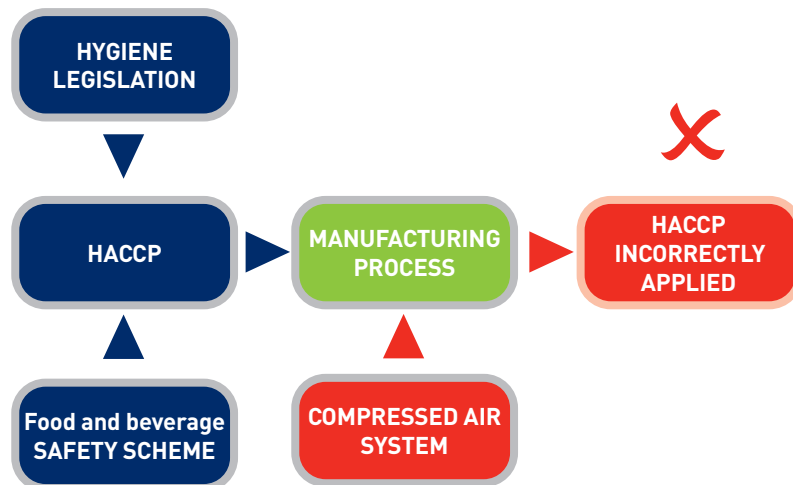
Applying the HACCP Process

No one understands a company's manufacturing process better than the people responsible for the day to day operation of that facility and HACCP works very well when the team carrying out the Hazard Analysis fully understand the manufacturing processes or have clear industry guidelines, GMPs (Good Manufacturing Practice) or SOPs (Standard Operating Procedures) to follow.

The Problem with Risk Based Food and beverage Safety Management Systems

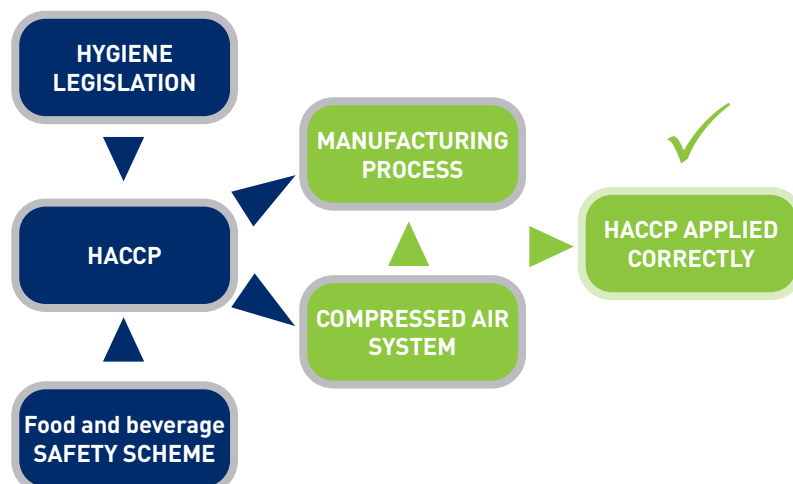
Unfortunately, when it comes to utilities such as compressed air, where industry guidelines, GMPs or SOPs do not exist, serious problems can arise. Most users of compressed air are unaware of the many hazards (contaminants) present in compressed air, the source of those hazards and most importantly, the problems those hazards can present to consumer safety. For this reason, the compressed air system is commonly omitted from the Hazard Analysis (Risk Assessment) process.

Incorrect application of the HACCP process



- The HACCP process being applied only to the main manufacturing process
- Compressed air purification equipment being specified exactly the same as equipment used in a general industrial manufacturing plant, with no regards to the additional requirements of a food and beverage manufacturing facility
- Untreated / under treated hazards in the compressed air directly entering and contaminating the manufacturing process
- Potential for unidentified quality incidents and / or failure of quality audits

Correct application of the HACCP process



- Compressed air system included as part of the Hazard Analysis
- Compressed air purification "experts" called in to assist with the hazard analysis
- All compressed air hazards identified
- Purification system requirements specified correctly
- Hazards reduced to acceptable levels
- Manufacturing processes protected

Performing the Hazard Analysis on the compressed air system

Understanding the sources of compressed air contamination and the types of contaminants which must be reduced or eliminated is a key factor when performing the hazard analysis. In a typical compressed air system, there are ten major contaminants that have to be removed or reduced to protect the consumer and provide a safe and cost effective production facility. These contaminants come from four different sources.

Source 1 Ambient Air

Compressors draw in huge volumes of ambient air which continuously fills the compressed air system with invisible contaminants such as:

- **Micro-organisms**
- **Water vapor**
- **Atmospheric particulates**
- **Oil vapor**

Source 2 The Air Compressor

After the compression stage, the after-cooler will cool the air, condensing water and oil vapor and introducing it into the compressed air as:

- **Liquid water**
- **Water aerosols**
- **Liquid oil**
- **Oil aerosols**

In addition to the contaminants drawn in from the atmosphere, oil lubricated compressors will contribute small amounts of oil from the compression process. The oil will be in the form of:

- **Liquid oil**
- **Oil aerosols**
- **Oil vapor**

Sources 3 & 4 Compressed air storage devices & distribution piping

As the air leaves the compressor it now contains eight different contaminants. The air receiver (storage device) and the system piping that distribute the compressed air around the facility can store large amounts of this contamination. Additionally, they cool the warm, saturated compressed air which causes condensation on a large scale adding more liquid water into the system and promoting corrosion and microbiological growth:

- **Rust**
- **Pipescale**

10 BAR

M.W.S

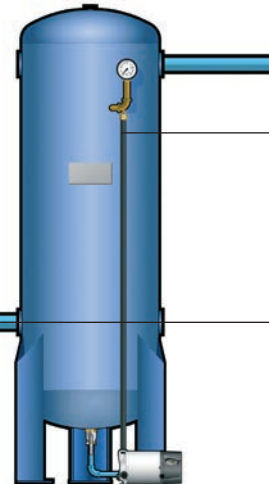
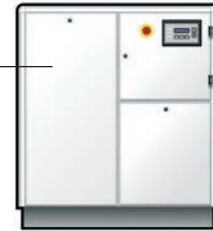
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Contaminants and sources in a compressed air system



Atmospheric contamination entering the compressor

- Micro-organisms
- Water Vapor
- Atmospheric Particulates
- Oil Vapor

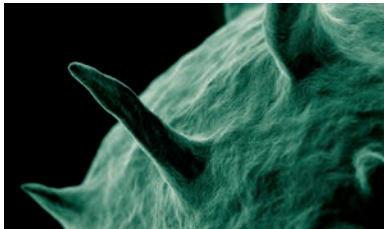


Contaminant Source
No. 1
Ambient Air

Contaminant Source
No. 2
The Air Compressor

Contaminant Source
No. 3
The Air Receiver

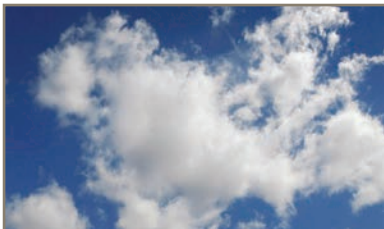
Ambient air is laden with unseen hazards in the form of contamination. In order to supply the manufacturing facility with compressed air, the air compressor must constantly move and compress large volumes of this ambient air.



Micro-organisms

Ambient air can contain up to 100 million micro-organisms per cubic metre. Due to their small size, bacteria, viruses, fungi, yeast and spores will all pass through the intake filter and into the compressed air system. Tests carried out by the Danish Technological Institute proved that microorganisms can survive in compressed

air systems up to 400 bar, where the warm moist environment inside the air receiver and distribution piping provides an ideal environment for their rapid growth. Microbial growth is significant in compressor condensate and care must be taken when discharging condensate.



Water vapor

Water enters the compressed air system as a vapor (gas). The ability of air to hold water vapor is dependent upon its pressure and its temperature. The higher the temperature, the more water vapor that can be held by the air, the higher the pressure, a greater amount of water

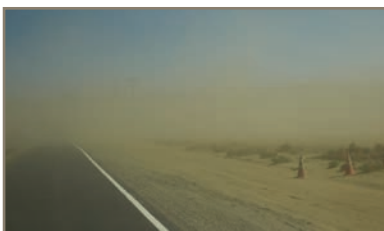
vapor is squeezed out. As ambient air is compressed, the temperature of the air increases significantly allowing the heated air to easily retain all of the water vapor entering the compressor.



Oil vapor

Vehicle emissions and inefficient industrial processes lead to oil vapor contamination in the ambient air. Typical concentrations in ambient air can seem low (between 0.05 and 0.5mg per cubic metre), however values measured in compressed air increase significantly after compression when contaminants become concentrated.

Once in a compressed air system, oil vapor can taint ingredients, finished products and packaging with an oily smell. Cooling also causes oil vapor to condense into liquid oil and form oil aerosols.



Atmospheric particulate

Ambient air in industrial and urban environments will typically contain between 140 & 150 million dirt particles in every cubic metre. As 80% of these particles are less than 2 microns in size, they are therefore too small to be captured by the compressor air intake

filter and will travel unrestricted into the compressed air system.

Compressor Room

Contamination introduced by the air receiver and distribution piping

- Rust
- Pipescale

Contamination introduced by the compressor

- Water Aerosols
- Condensed Liquid Water
- Liquid Oil & Oil Aerosols
- Oil Vapor

Total contamination entering the compressed air distribution system

- Microorganisms
- Water Vapor
- Atmospheric Particulates
- Oil Vapor
- Water Aerosols
- Condensed Liquid Water
- Liquid Oil
- Oil Aerosols
- Rust
- Pipescale

Contaminant Source
No. 4
The Distribution Piping

Once in the compressed air system, many of the hazards found in ambient air change phase, leading to the creation of additional contaminants. The air compressor, air receiver and distribution also add to the problem.



Liquid water and water aerosols

After compression, compressed air is cooled to a usable temperature by an after-cooler. This cooling reduces the air's ability to retain water vapor, resulting in condensation of water vapor into liquid water. The presence of liquid also causes aerosols to be formed.

After-coolers typically incorporate a water separator to reduce the amount of liquid entering the compressed air system (these do not remove 100% of the condensed liquid and have no effect on aerosols).

The air leaving the after-cooler and entering the compressed air system is now 100% saturated with water vapor. Any further cooling of the compressed air will result in more water vapor condensing into liquid water and the generation of more aerosols.

Condensation occurs at various stages throughout the system as the air is cooled further by the air receiver, the distribution piping and the expansion of air in valves, cylinders, production equipment.



Liquid oil and oil aerosols

As with water, oil vapor drawn in with the ambient air is cooled and condensed within the after-cooler leading to the formation of liquid oil and oil aerosols (even with oil-free compressors) which carry downstream.

The majority of air compressors in use today use oil in their compression stage for sealing, lubrication and cooling.

Even though the oil is in direct contact with the air as it is compressed, due to the efficiency of modern air / oil separators built into the compressor, only a small proportion of this lubricating oil is carried over into the compressed air system as a liquid or aerosol (typically no more than 5mg/m³ for a well maintained screw compressor) or as oil vapor.



Rust and pipescale

Rust and pipescale can be directly attributed to the presence of water in the compressed air system and is usually found in air receivers and distribution piping. Over time, the rust and pipescale breaks away to cause damage or blockage in production equipment which can also

contaminate final product and processes. Rust and pipescale problems often increase for a period of time after the installation of dryers into older piping systems which were previously operated with inadequate or no purification equipment.



Compressor Condensate

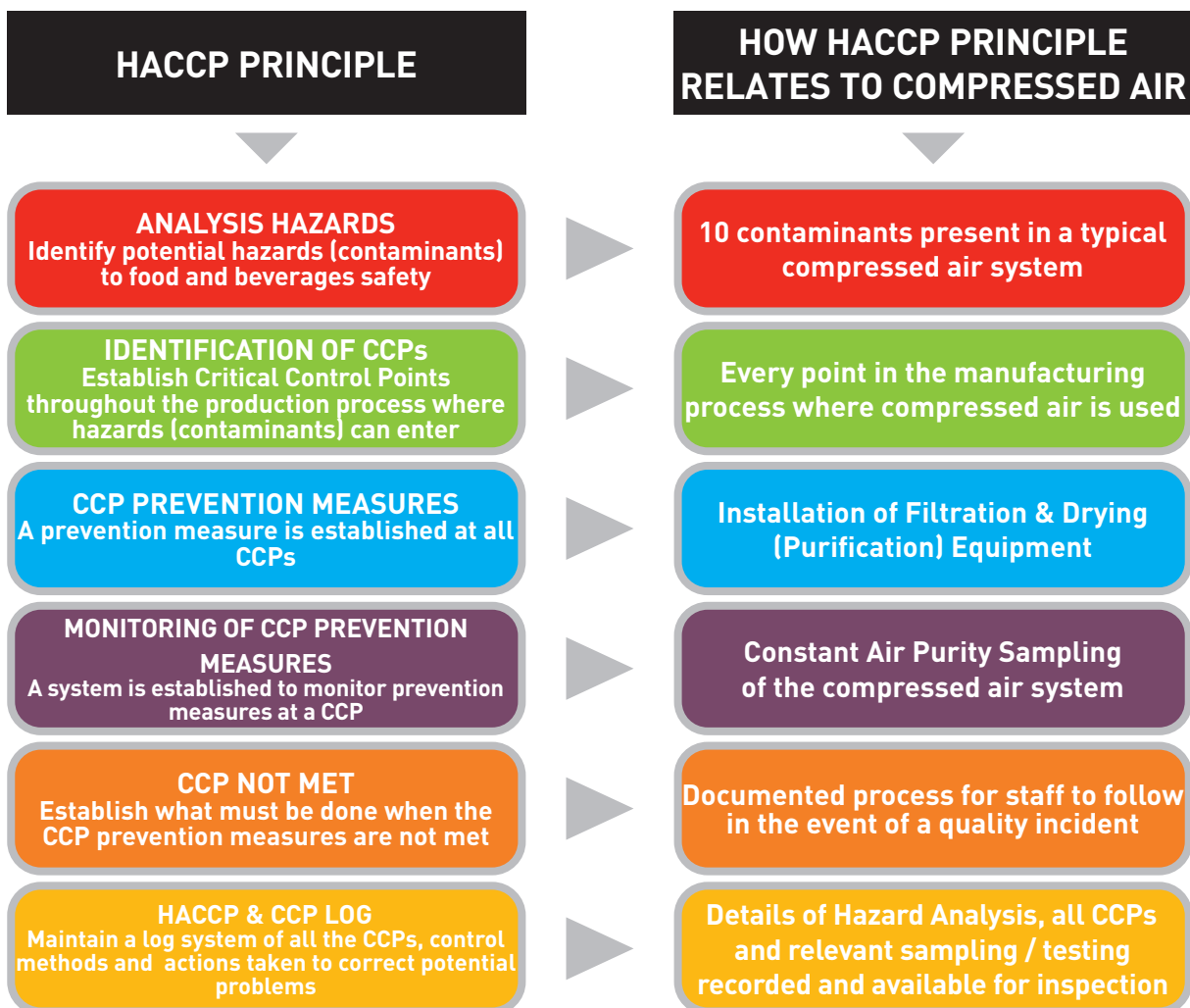
Condensed water and oil carried along in the compressed air system mix together to form an emulsion. This is commonly referred to as "compressed air condensate". Left untreated, this aggressive, oily, acidic sludge can cause severe problems for the compressed

air system. Although containing oil, compressor condensate has no lubricating properties and is also an ideal medium for the rapid growth of micro-organisms.

Critical Control Points

Critical Control Points (CCP's) are identified following the plant Hazard Analysis. Compressed air is known to contain hazards in the form of contamination and there is a risk this contamination can be transferred into the manufacturing process, ingredients, finished product & packaging materials as well as cause potential health issues for factory workers. Therefore, anywhere untreated compressed air is used should be a Critical Control Point.

Applying the HACCP principle to compressed air

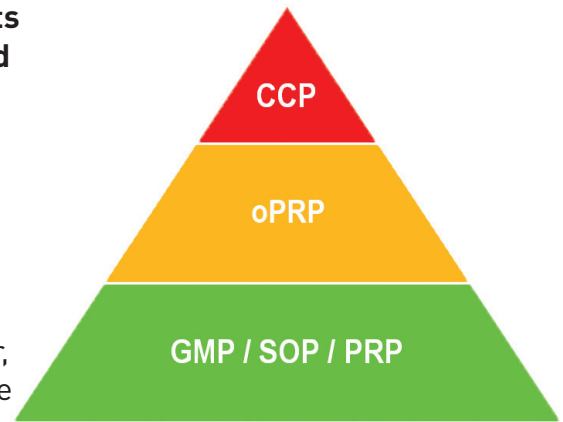


A correctly performed Hazard Analysis which includes the compressed air system has the potential to highlight a high number of new critical control points required around a food and beverage manufacturing facility. Each Critical Control Point requires management, constant monitoring and if they fail, could lead to a quality incident.

A good FSMS does not rely on Critical Control Points alone. If HACCP is correctly implemented, it should be underpinned by:

oPRPs (Operational Pre-Requisite Programs)
PRPs (Pre-requisite Programs)
GMPs (Good Manufacturing Practices)
SOPs (Standard Operating Procedures)

Each is a layer in a security screen and at each layer, the level of security improves. The HACCP CCP is the final layer of protection.



If a CCP is required, then the first two defence layers are missing or inadequate. Therefore, when conducting the Hazard Analysis, if a CCP is identified, first ask “Can this CCP be eliminated by implementing a GMP, PRP or oPRP?”

Definitions

PRPs, GMPs & SOPs

Are procedures that form the foundation of the HACCP process that provide recommendations to help ensure food and beverage safety. They cover all aspects of the food and beverage manufacturing process, with the aim of assuring a safe, hygienic manufacturing environment. These are often, not very detailed, just guidelines and do not control specific hazards or steps in the process.

oPRPs

Are identified by the hazard analysis as essential in order to control the likelihood of introducing food and beverage safety hazards in products or in the processing environment. They are more detailed than PRPs and while having the same generic aim as a PRP (assuring a safe, hygienic manufacturing environment), unlike regular PRPs, they can be used to better control specific hazards and unlike CCPs, their failure doesn't automatically mean a product is unsafe.

CCP

CCPs are a step at which control can be applied and is essential to prevent or eliminate a food and beverage safety hazard or reduce it to an acceptable level. They are considered to have “absolute” control over the hazard at a specific point in the manufacturing process and require constant monitoring.

Examples relating to compressed air usage

PRP

Following ISO22002 which states utilities such as compressed air should be treated for particulates, oil and water. This is very generic and does not state to what levels but means compressed air treatment is at least considered.

oPRP

Treating the compressed air for known contaminants to a recognized specification, for example, following the recommendations of the BCAS Best Practice Guide 102 – Food and Beverage & Beverage Grade Compressed Air. Implemented as an oPRP, the air purity recommendations would be applied to all manufacturing processes in the facility. Contaminants can be monitored using periodic air purity sampling.

CCP

Treating the compressed air for known contaminants to a recognized specification, for example, following the recommendations of the BCAS Best Practice Guide 102 – Food and Beverage & Beverage Grade Compressed Air. Implemented as a CCP, the air purity recommendations would only be applied at a specific point in the manufacturing process. All contaminants would require constant monitoring at each CCP.

For safety, the recommendation is to implement PRPs & oPRPs that will remove or reduce hazards relating to compressed air contamination. Overall, this offers more protection, is more cost effective and removes the burden of managing multiple CCPs.

Contaminant removal

To operate any compressed air system, safely and cost effectively, contamination must be reduced to acceptable limits. The importance of reducing contamination is increased when compressed air is used as part of the food and beverage manufacturing process.

Poor compressed air quality and failure to control contamination can cause numerous problems for an organization, many of which are not immediately associated with contaminated compressed air.

Product

- Contaminated ingredients
- Contaminated food and beverage
- Contaminated packaging
- Spoiled products

Consumer

- Potentially unwell / seriously ill consumers

Manufacturer

- Brand damage
- Legal actions
- Financial loss
- Potential imprisonment

Manufacturing Process

- Inefficient production processes
- Reduced production efficiency
- Increased manufacturing costs
- Failed quality audits

Compressed Air System

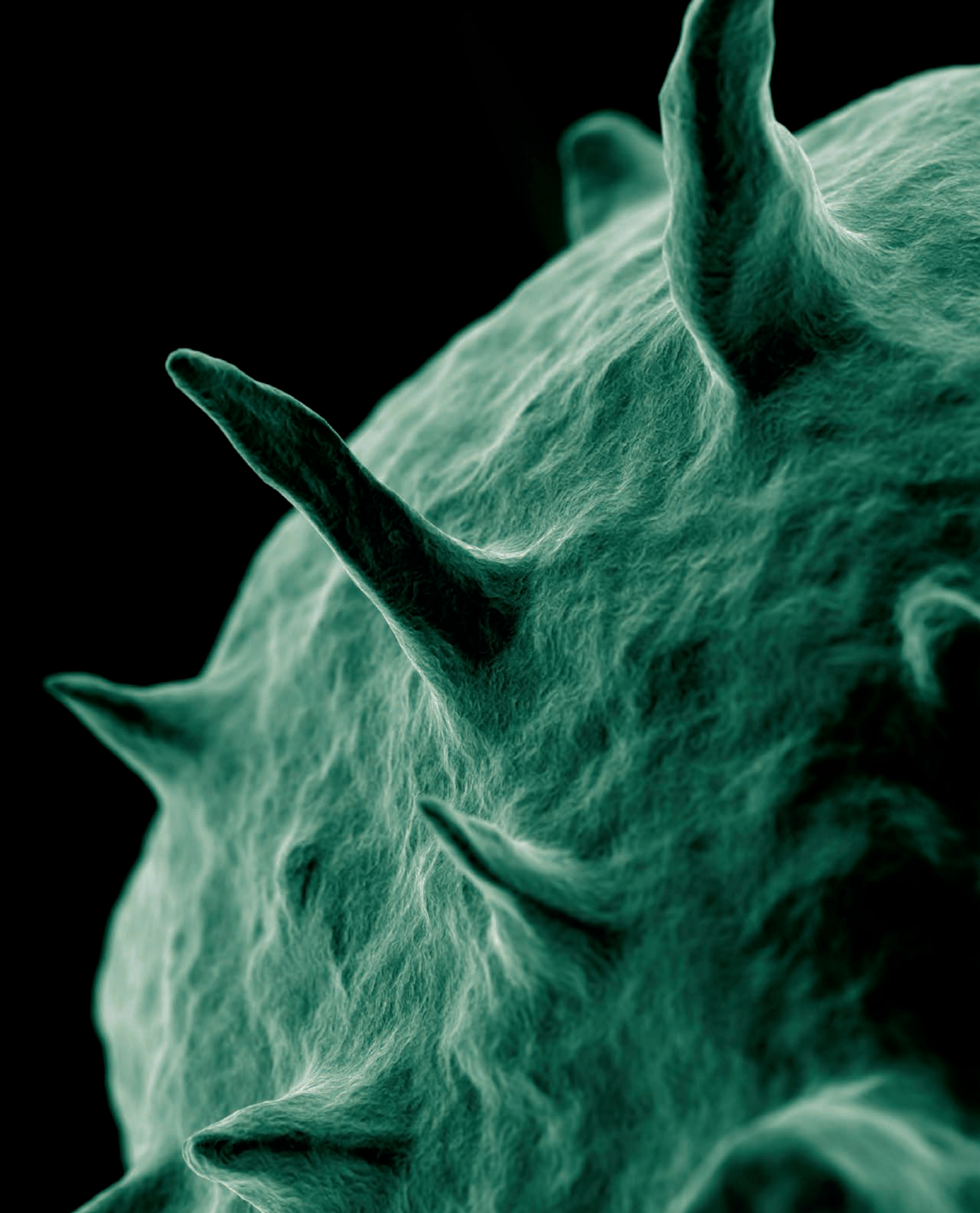
- Growth, storage & distribution of microbiological contamination
- Corrosion within storage vessels and the distribution system
- Contaminated / damaged production equipment
- Blocked or frozen valves & cylinders
- Premature unplanned desiccant changes for adsorption dryers
- High operational and maintenance costs

Contaminant control

Ensuring effective control of compressed air contamination, requires a number of purification technologies. To many compressed air users, the realization that there are ten major contaminants in a compressed air system is somewhat of a surprise. It is often thought that only three contaminants are present (Dirt / Water / Oil), however as those contaminants can be found in many phases, they therefore require a specific purification technology for efficient reduction. The table below highlights filtration & drying technologies that comprise the purification system and the contaminants they reduce.

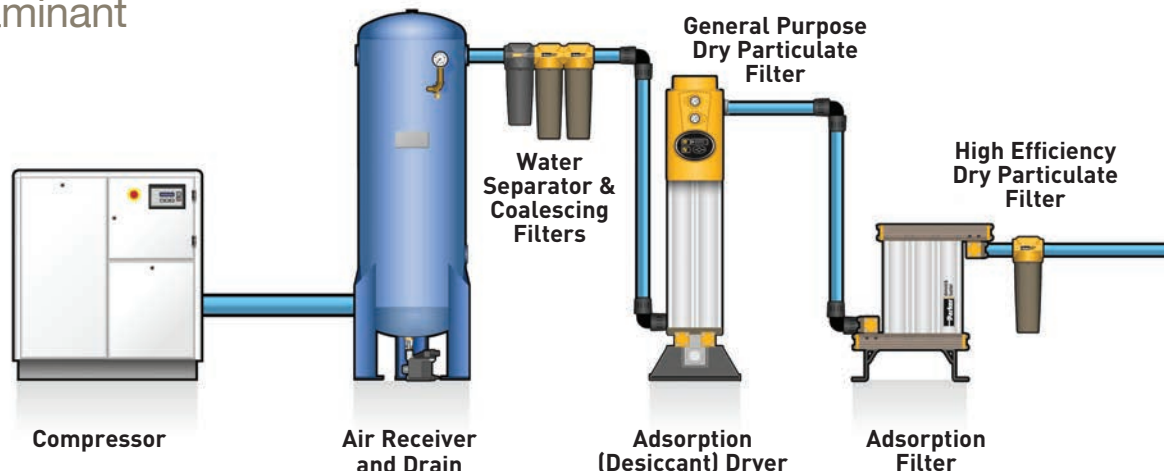
Purification Technologies	Contaminants								
	Atmospheric Particles	Rust & Pipescale	Micro-organisms	Liquid Water	Water Aerosol	Water Vapor	Liquid Oil	Oil Aerosol	Oil Vapor
Water Separator				•			•		
Coalescing Filters	•	•	•		•			•	
Adsorption Filters									•
Adsorption Dryers						•			
Refrigeration Dryers						•			
Dust Removal Filters	•	•	•						
Sterile Filters*			•						

* To ensure the highest level of food and beverage safety and shelf life, Parker recommends that for critical direct contact applications, compressed air is further treated with a sterilizing grade filter to remove all microbial contamination.



A solution for every contaminant

Compressor Room



Water separators

Although called water separators, they reduce the content of all liquids at the point of installation. Liquid in a compressed air system is usually a mixture of oil and water (even when using an oil free compressor).

Water separators are usually the first piece of purification equipment installed downstream of an after-cooler or wet air receiver and should be used to protect coalescing filters from liquid contamination. They will only reduce liquids and will have no effect on water or oil in an aerosol or vapor phase.

Coalescing filters

When considering purification equipment, coalescing filters are vital for the cost effective operation of any compressed air system, regardless of the type of compressor installed.

A purification system will normally consist of two coalescing filters installed in series to remove water aerosols, oil aerosols, atmospheric particulate, micro-organisms, rust and pipescale.

Compressed air dryers

Water vapor is water in a gaseous form and will pass through water separators and coalescing filters just as easy as the compressed air. Water vapor is therefore removed from compressed air using a dryer.

The water vapor removal efficiency of a dryer (its performance) is expressed as a Pressure Dewpoint or PDP.

- **Dewpoint refers to the temperature at which condensation will occur.**
- **Pressure Dewpoint or PDP refers to the dewpoint of air above atmospheric pressure.**
- **Dewpoint is expressed as a temperature (however this is not the temperature of the air).**
- **Compressed air with a PDP of -20°C, would need the temperature to drop below -20°C for any water vapor to condense into a liquid.**
- **A PDP of -40°C is recommended for all food and beverage applications where air is in direct or indirect contact with production equipment, ingredients, packaging or finished products because a PDP better than -26°C will not only stop corrosion, it will also inhibit the growth of micro-organisms.**

Adsorption dryer

Adsorption dryers reduce water vapor in compressed air by passing air over a regenerative desiccant material which strips the moisture from the air. This method of drying is extremely efficient. A typical pressure dewpoint specified for an adsorption dryer is -40°C as it not only prevents corrosion, more importantly it also inhibits the growth of micro-organisms.

There are many types of adsorption dryer available and while they all use the same principle to remove moisture from compressed air, there are a number of different methods used for the regeneration of the wet adsorbent material. For food and beverage applications, care should be taken when selecting an adsorption dryer as some regeneration methods used may have an impact on the contamination levels of the compressed air.

Refrigeration dryers (not shown)

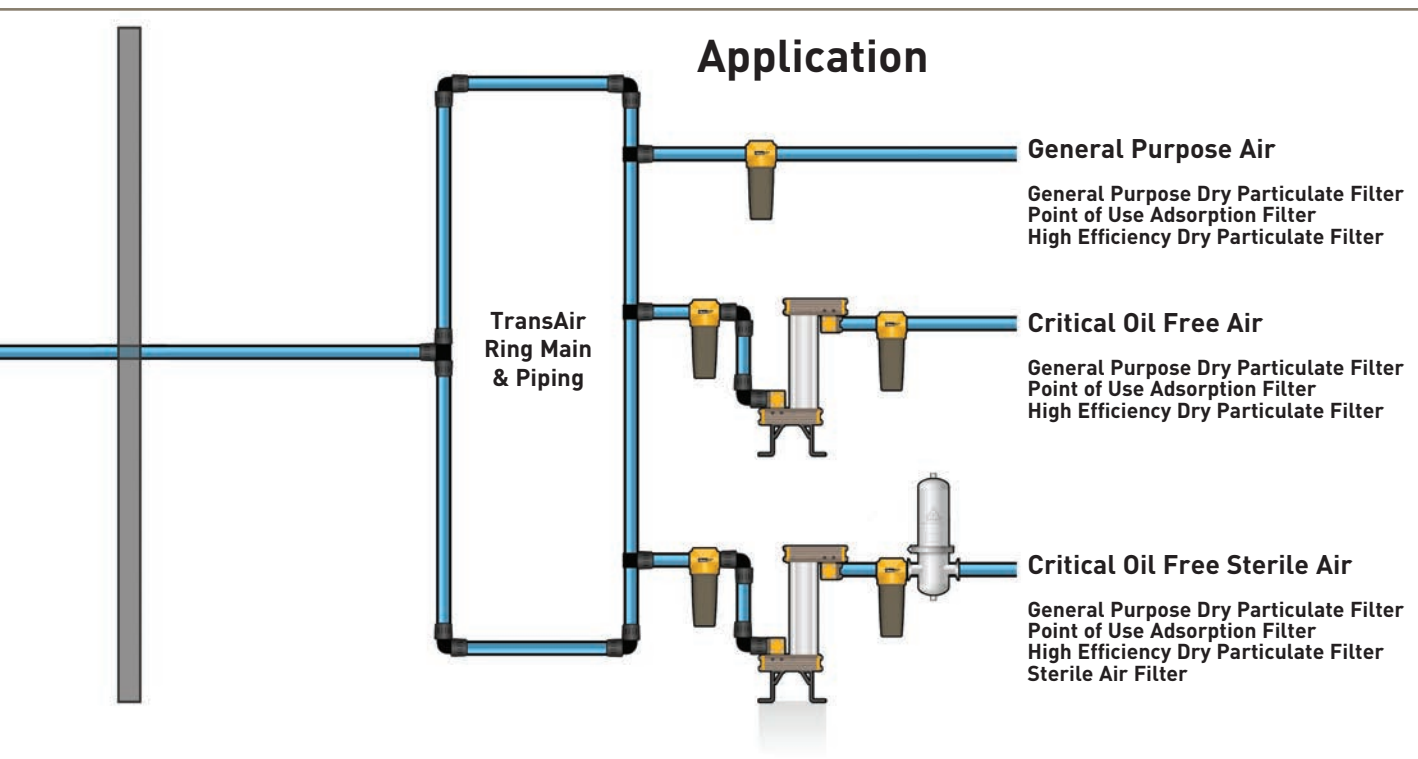
Refrigeration dryers work by cooling the compressed air further and condensing the water vapor into a liquid for removal by a water separator.

Refrigeration dryers are limited to positive pressure dewpoint to prevent freezing of the condensed liquid and are typically used for general purpose industrial applications with indoor piping.

They should also not be used in any facility where piping is installed in ambient temperatures below the dryer dewpoint i.e. systems with external air receivers or piping.

Adsorption filter

To ensure 'technically oil free air', adsorption filters are employed which utilise a large bed of activated carbon adsorbent for the effective reduction of oil vapor.



The combination of coalescing filters and adsorption filters will provide compressed air to the highest air quality classifications of ISO8573-1, the international standard for compressed air quality.

Dry Particulate filters

Dry particulate filters provide identical particulate removal performance to the equivalent grade coalescing filter. Relying on mechanical filtration techniques, high efficiency dry particulate filters can provide particle reduction down to 0.01 micron with a removal efficiency of 99.9999%. When coupled with a -40°C Pressure Dewpoint, to inhibit and control the growth of micro-organisms, they can provide significant reduction of microbiological contaminants.

Sterile filters

Absolute (100%) removal of solid particulates and micro-organisms is performed by a sieve retention or membrane filter. They are often referred to as sterile air filters as they also provide sterilized compressed air. Filter housings are manufactured from stainless steel to allow for in-situ steam serialization of both the filter housing and element. It is important to note that the piping between the sterile filter and the application must also be cleaned and sterilized on a regular basis.

Important Notes:

As adsorption or refrigeration dryers are only designed to reduce water vapor and not water in a liquid or aerosol form, they require the use of coalescing filters to work efficiently. Suppliers of oil-free compressors will often state that one of the coalescing filters is a particulate filter and the other is an oil removal filter, therefore, in oil-free compressor installations, there is no need for the oil removal filter. This is not correct.

In reality, both filters remove exactly the same contaminants. The first filter is a general purpose filter which protects the second, high efficiency filter from heavy contamination.

Omitting one of the filters in the belief that it is an oil removal filter will result in poor air quality due to contaminant bypass (carryover), high operational costs due to the pressure loss across the filter and more frequent filter element changes. Most importantly, omitting one of the filters will also invalidate performance guarantees.

The dual coalescing filter installation ensures a continuous supply of high quality compressed air with the additional benefits of lower operational costs and minimal maintenance compared to a single high efficiency filter.

Refrigeration dryers are not recommended for food and beverage applications where compressed air comes into direct contact (or in-direct contact) with ingredients, production equipment, finished products or packaging as the dewpoints provided are unable to inhibit microbiological growth.

Refrigeration dryers are commonly available with quoted dewpoints of +3°C, +7°C or +10°C, however care must be taken when selecting this type of dryer as unlike adsorption dryers, the dewpoint quoted is not always provided constantly. Integrated dewpoint meters are typically just temperature gauges and do not indicate a true pressure dewpoint, which is often in the range of 8°C to 15°C.

Air quality standards for compressed air used in the food & beverage industries

Once hazards are identified, measures must be put in place to remove the hazards or reduce them to acceptable levels. So what level of compressed air contamination is deemed acceptable in the food and beverage industry?

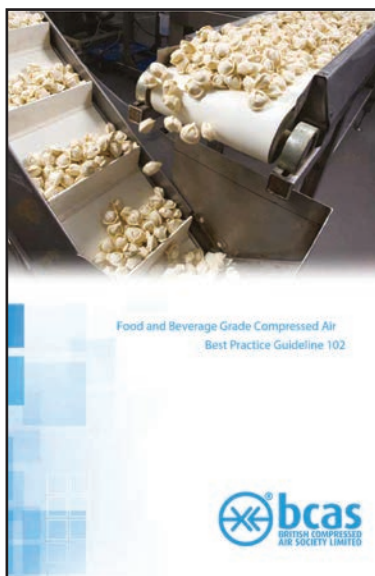
Unlike compressed air that is used for breathing or medical purposes, **NO** standards or laws exist that define a minimum acceptable level of cleanliness (quality) when the compressed air is used for food and beverage manufacture. As food and beverage manufacturers have a duty of care to protect the consumer and compressed air systems are known to carry large quantities of contamination, what actions should be taken?

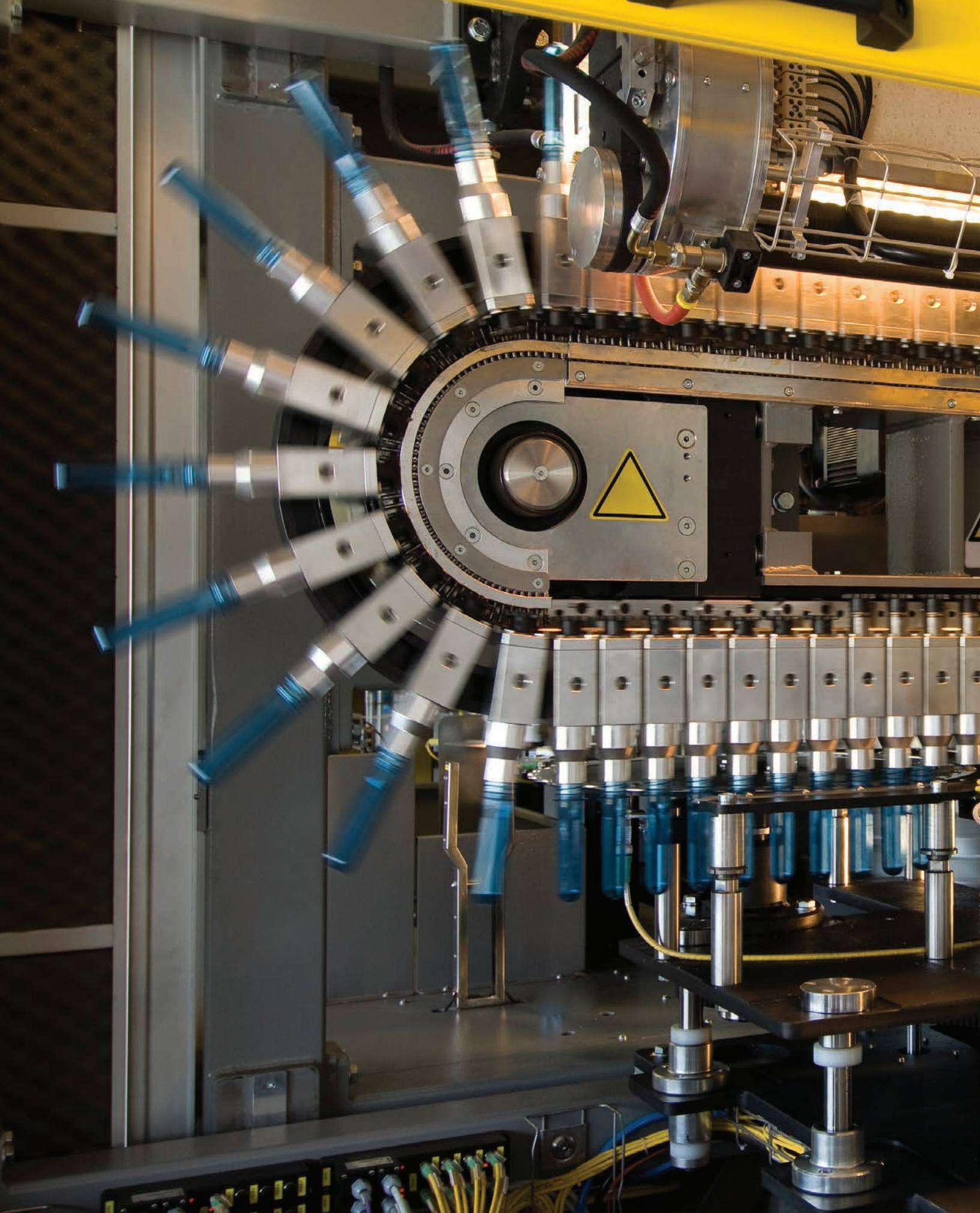
Introducing the BCAS Food and beverage & Beverage Grade Compressed Air Best Practice Guideline 102

In the United Kingdom, the British Compressed Air Society (BCAS) who are the governing body for compressed air and the British Retail Consortium (BRC) who represent the retail industry, have jointly developed a Best Practice Guideline for Food and beverage and Beverage Grade Compressed Air in order to assist food and beverage manufacturers. This Best Practice Guideline evolved because of the absence of compressed air quality standards or legislation specific to the food and beverage manufacturing industries. The Best Practice Guideline provides minimum purity (quality) standards for compressed air and defines allowable levels for dirt, water and oil, in line with air quality levels specified in ISO8573-1 the International Standard for compressed air quality.

Food & Beverage Grade Compressed Air Best Practice Guideline 102

- The Best Practice Guideline references complimentary international standards for air purity, gives recommendations on installation, testing and maintenance of compressed air systems, but most importantly, defines a minimum acceptable purity (quality) for compressed air used in the food and beverage industry.
- The Best Practice Guideline can be applied to the use of compressed air in all food and beverage manufacturing facilities, however it does not cover the quality of other gases used e.g. CO₂ or nitrogen as these are often covered by other standards.
- Following the best practice guideline is not mandatory and not required by law; however following the Best Practice Guideline allows a company to show due diligence should a 'quality incident' reach a court of law.
- The Best Practice Guideline can also be applied to ingredient suppliers should they use compressed air in their manufacturing, transportation or packaging processes.
- Although produced by the British Compressed Air Society, it should not be viewed solely as a document for use in the United Kingdom.
- In the absence of any European or Global recommendations or standards relating to compressed air use in the food and beverage industry, the Best Practice Guideline can be implemented in any country to protect both the consumer and the manufacturer.





Air Quality (Purity) requirements of BCAS Best Practice Guideline 102

Section 4.3 discusses the need for a compressed air strategy. In particular, the need to identify compressed air usage (where the air interacts with a food or beverage), which contaminants may adversely affect the food and beverage and most importantly, establish if the compressed air directly or in-directly contacts ingredients, production equipment, finished product or packaging materials.

Definitions

Direct Contact

Compressed air that directly contacts ingredients, manufacturing equipment, finished product or packaging materials.

Examples

- Sparging • Air knives (cutting / peeling / cooling)
- Spraying / coating • Conveying (movement)
- Direct Cooling • Packaging • Drying

In-direct Contact

Air that is not supposed to come into contact with ingredients, finished food and beverage, packaging materials, storage vessels or the manufacturing machinery, but may inadvertently do so.

Examples

- Valves, cylinders & pneumatics operating in the manufacturing environment where the contaminated exhaust air can then inadvertently contact production equipment, ingredients, finished products or packaging.

Once the compressed air used in the production of food /beverage products has been classified as either direct contact or in-direct contact, section 7 provides a minimum specification for each classification. An equivalent ISO8573-1:2010 classification is also included.

Air Quality Recommendations	Solid Particulate Max Number of particles per m ³			Humidity (Water Vapor)	Total Oil (Liquid + Aerosol + Vapor)	ISO8573-1:2010 Equivalent
	0.1 - 0.5 micron	0.5 - 1 micron	1 - 5 micron			
Direct Contact	≤ 400,000	≤ 6000	≤ 100	≤ -40°C PDP	≤ 0.01 mg/m ³	Class 2.2.1
In-direct Contact	≤ 400,000	≤ 6000	≤ 100	≤ +3°C PDP ¹	≤ 0.1 mg/m ³	Class 2.4.2

The contaminant values for solid particulate and oil are those at the 'Reference Conditions' in ISO8573-1 at a temperature of 20°C, absolute atmospheric pressure of 1 bar and relative water vapor pressure of zero. Humidity is to be measured at line pressure.

¹ See Annex C.2.1.3 for information on drying of compressed air.

Solid Particulate

The purity requirements for solid particulate are identical for both Direct Contact and In-direct Contact. The same level of purification equipment will be required for each. It should be noted this classification is typically achieved by a general purpose 1 micron filter and should be viewed as a minimum specification. Use of a 0.01 micron high efficiency dry particulate filter is recommended as this grade of filtration can significantly reduce micro-organisms.

Water (Direct Contact)

The purity requirements for Direct Contact requires the installation of an adsorption dryer delivering a Pressure Dewpoint (PDP) better than -40°C. This requirement was introduced to combat the growth of micro-organisms as compressed air with a dewpoint of -26°C or better will inhibit microbiological growth. The combination of -40°C PDP & high efficiency 0.01 micron high efficiency dry particulate filters can significantly reduce micro-organisms.

Water (In-direct Contact)

The purity requirements for In-direct contact are less than or equal to +3°C PDP (this dewpoint will not inhibit microbiological growth). Should the hazard analysis determine that In-direct contact use could potentially

be a risk, then the direct contact specification should be used (refer to Annex C.2.1.3 of BPG 102 for information on drying of compressed air).

Oil (Direct Contact)

The purity requirements for Direct contact provide "Technically Oil Free Air".

Oil (In-direct Contact)

The lower specification of the In-direct specification is again a minimum. Should the hazard analysis determine that In-direct contact use could potentially be a risk, then the Direct Contact specification should be used.

Microbiological contaminants

Hazard analysis shall establish the risk of contamination by microbiological contaminants from compressed air.

Microbiological contamination from compressed air can be controlled with the correct dewpoint (-40°C PDP) and point of use filtration (0.01 micron). For applications requiring completely sterile compressed air, an absolute rated sterile air filter should be used.

NOTE: Microbiological testing of end products should not be relied upon for compressed air compliance.



Cost-effective system design

To achieve the stringent air quality levels required for today's modern food and beverage manufacturing facilities, a careful approach to system design, commissioning, installation and operation must be employed. Treatment at one point alone is not enough and it is highly recommended to treat compressed air prior to entry into the distribution system (usually in the compressor room or at point of generation) to a

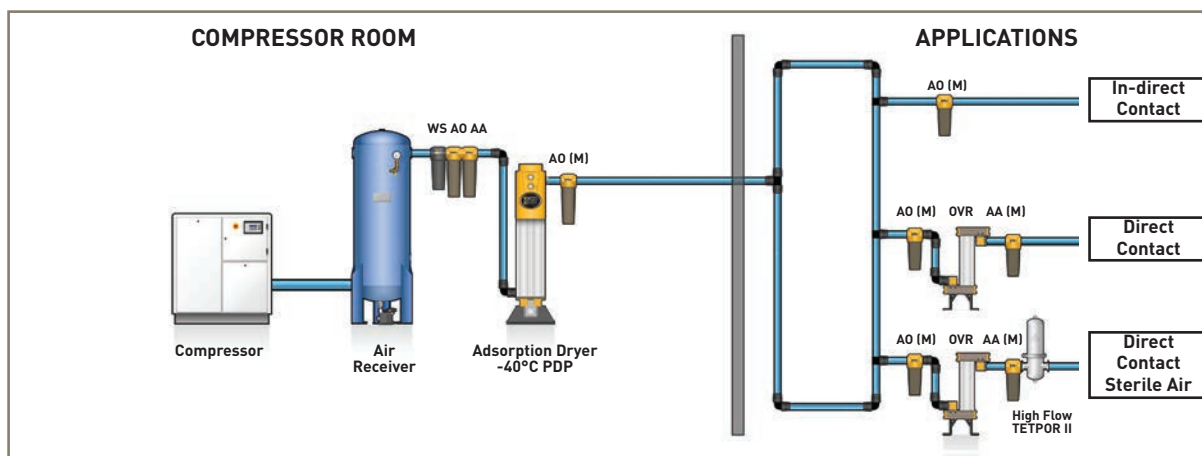
specification that will provide contaminant free air for general purpose applications and protect air receivers and distribution piping from corrosion and damage. Point of use purification should also be employed, with specific attention being focussed on the quality of air required by each application. This approach to system design ensures that air is not 'over treated' and provides the most cost effective solution to high quality compressed air.

Recommended purification equipment for compliance with the Food and Beverage Grade Compressed Air Best Practice Guideline 102

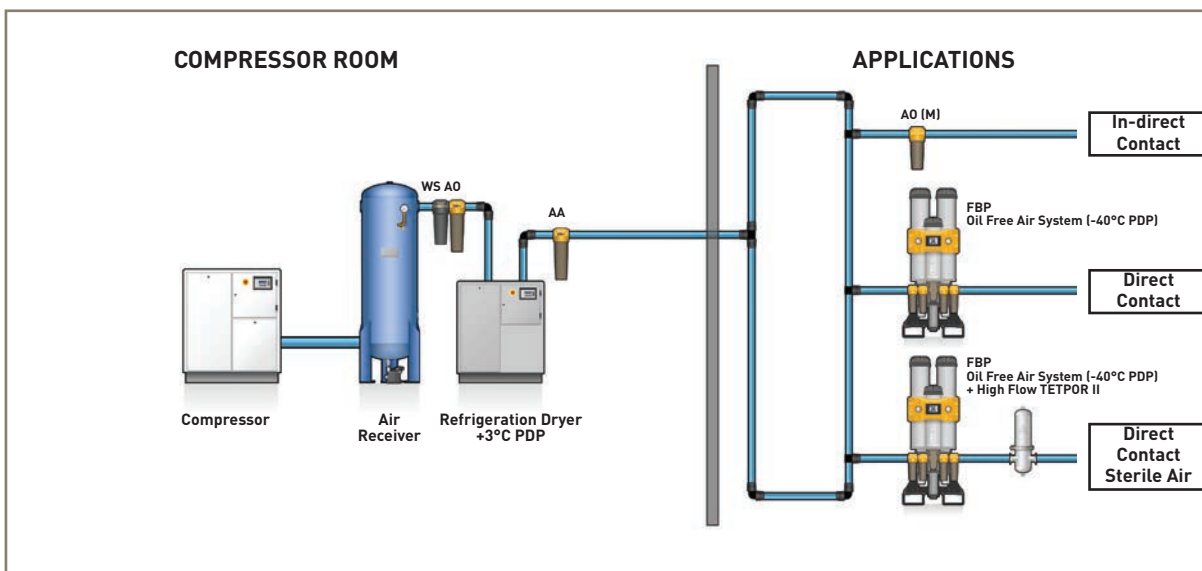
Air Quality Recommendations	Dirt (Solid Particulate)	Humidity (Water Vapor)	Total Oil (Aerosol + Vapor)
Direct Contact	Parker OIL-X Coalescing Filters Grade AO + AA	Adsorption Dryer $\leq -40^{\circ}\text{C}$ PDP	Parker OIL-X Coalescing & Oil Vapor Removal Filters
In-direct Contact	Parker OIL-X Dry Particulate Filters Grade AO (M) + AA (M)	Refrigeration Dryer $\leq +3^{\circ}\text{C}$ PDP	Grades AO + AA + OVR or Parker OFAS Oil Free Air System

For sterile applications or applications where 100% particle retention is required, an additional HIGH FLOW TETPOR II filter should be used. TETPOR II filters can be steam sterilised if required.

System Example 1



System Example 2



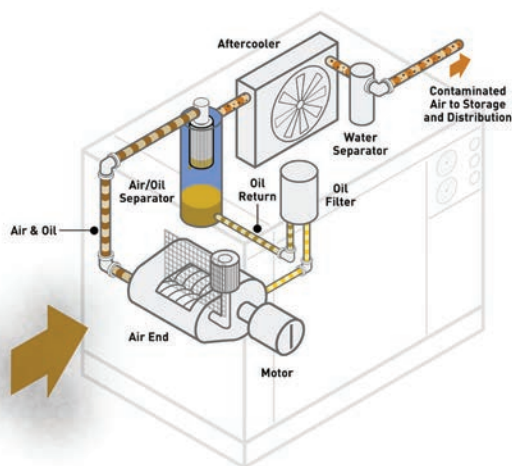


Oil free compressor or oil free air?

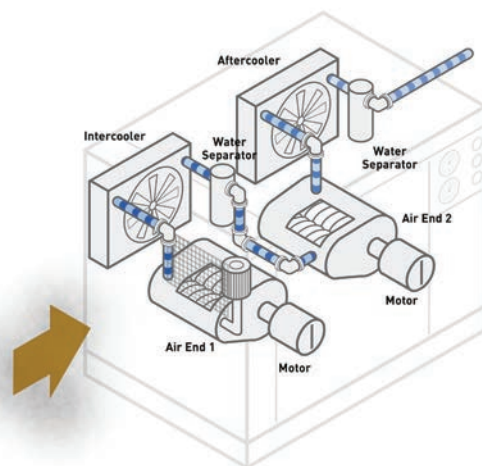
In the food and beverage industries, it is common for manufacturers and auditors to insist on an oil free compressor to be installed. This is often in the mistaken belief that the oil free compressor will provide oil free or contaminant free compressed air.

Changing a facility to an oil free compressor can impose a huge cost burden which is often hidden up front. And most importantly, it is self-imposed, as there is no legislation or standard stating that only oil free compressors must be installed.

The BCAS Food and Beverage and Beverage Grade Compressed Air Best Practice Guideline 102 does not make any specific recommendations regarding compressor type with both oil lubricated and oil free compressors being acceptable choices. There is currently no legislation enforcing the need to use oil free compressors.



Oil Lubricated Compressor



Oil Free Compressor

Compressor lubricants

The BCAS Food & Beverage Grade Compressed Air Best Practice Guideline 102 states:

Oil lubricated compressors

'Where lubricated or oil injected compressors are in use and non-food and beverage grade oil is used and the HACCP process identifies a risk, then the oil shall be replaced with food and beverage grade oils in line with the procedures identified in the EHEDG (European Hygienic Engineering & Design Group) Document 23.'

Oil free compressors (Totally Oil Less)

'Where oil free compressors are used no lubricant is involved in the compression process therefore the procedures identified in the EHEDG Document 23 will not be required'.

Oil free compressors (Containing Lubricant)

However, it also states: 'Compressors that employ lubricants in those parts not involved in the actual compression of the air will be subject to the HACCP process to determine the risks if any to the food and beverage production process.'

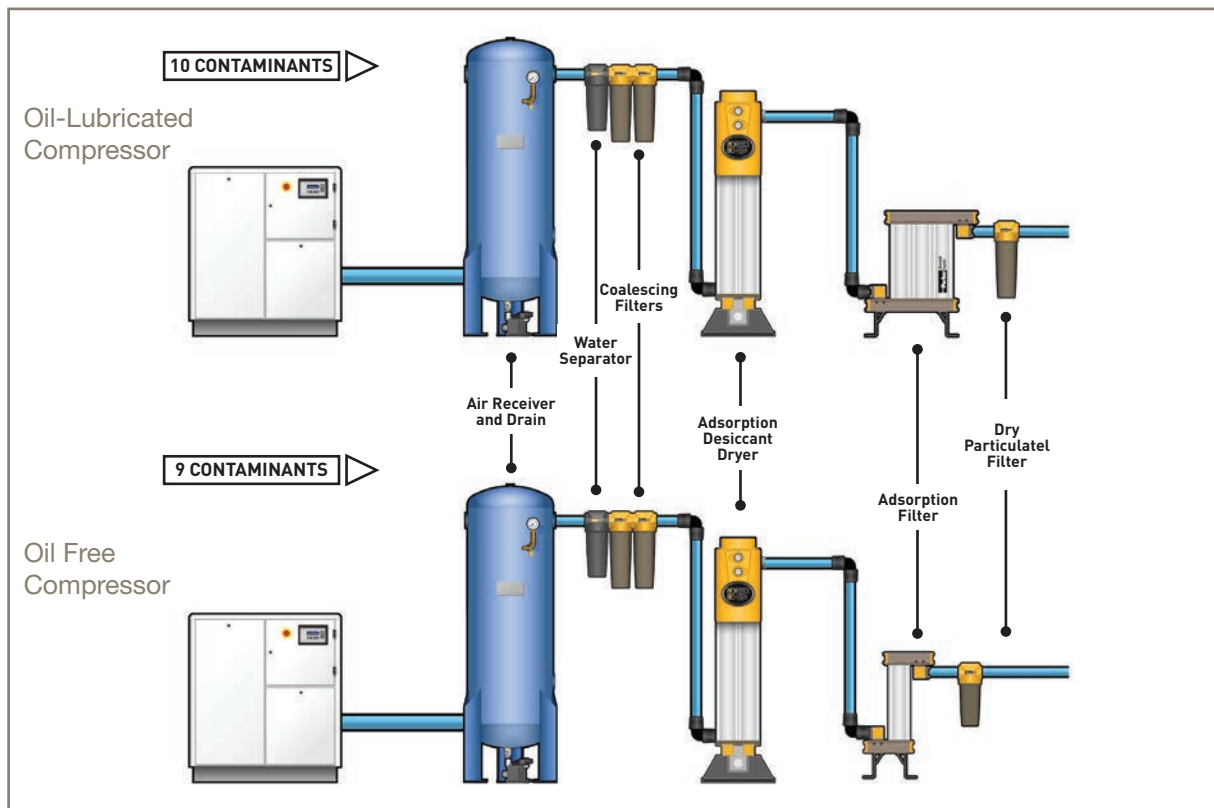
Therefore if the oil free compressor uses oil for lubrication of bearings, gearboxes, etc. then it is still subject to a HACCP risk analysis. If the risk analysis shows a potential for contamination by vapors, aerosols or liquid oil, then the procedures identified in the EHEDG Document 23 will still apply (i.e. use of food and beverage grade lubricant).

Achieving 'Technically Oil Free Air'

To ensure food and beverage safety, the compressed air used for direct contact applications should be 'Technically Oil Free Air'. Most importantly, this quality of compressed air can be achieved from both oil free and oil lubricated compressors. Unfortunately, oil lubricated compressors are often overlooked.

Important Notes:

Oil free compressors alone do not provide oil free / contaminant free compressed air. In order to have 'Technically Oil Free Air' for direct contact applications, purification equipment is required.



Regardless of whether oil lubricated or oil free compressors are installed, the purification technologies required to deliver 'Technically Oil Free Air' is identical.

The size of the adsorption filters used for oil vapor removal may become smaller with on an oil free compressor installation as they only need to remove

ambient oil vapor & vapor in piping systems, not the additional vapor introduced by a lubricated compressor. However, the additional cost of an oil free compressor is much higher than the additional cost for a larger oil vapor removal filter.

Focused on Food and beverage Grade Compressed Air

To guarantee maximum performance and reliability, Parker compressed air treatment products protect the entire compressed air network, providing the best quality, food and beverage grade compressed air, exactly where it is needed.



FOCUSED ON
FILTRATION AND
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FOCUSED ON
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AND COOLING



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Recommended Filtration Products for Food & Beverage Grade Compressed Air



OIL-X Coalescing & Dry Particulate Filters



OVR Oil Vapor Removal Filters

Parker domnick hunter OIL-X filter range and Parker Zander dryer ranges have been designed to provide compressed air quality that meets or exceeds the levels shown in all editions of ISO8573-1, the international standard for compressed air quality and the BCAS Food and Beverage Grade Compressed Air Best Practice Guideline 102.

Filtration & dryer performance has also been independently verified by Lloyds Register.

Water separators

Water separator performance has been tested in accordance with ISO12500-4 and ISO8573-9.

Coalescing filters

Coalescing filter performance has been tested in accordance with ISO12500-1, ISO8573-2 and ISO8573-4.

Dry particulate filters

Dry particulate filter performance has been tested in accordance with ISO8573-4.

Oil vapor removal filters

Oil vapor removal filter performance has been tested in accordance with ISO8573-5.

Dryers

CDAS, OFAS, FBP, MX & MXLE dryer performance has been tested in accordance with of ISO7183

In addition to performance validation, the materials used in the construction of the ranges recommended below for use in food and beverage manufacturing are FDA Title 21 Compliant and EC1935-2004 exempt. Certificates available on request.

Recommended Drying Products for Food & Beverage Grade Compressed Air



FBP Oil Free Air System



MX Adsorption Dryer



MXLE Low Energy Adsorption Dryer

Worldwide Filtration Manufacturing Locations

North America

Compressed Air Treatment

Industrial Gas Filtration and Generation Division

Lancaster, NY
716 686 6400
www.parker.com/igfg

Haverhill, MA
978 858 0505
www.parker.com/igfg

Engine Filtration

Racor

Modesto, CA
209 521 7860
www.parker.com/racor

Holly Springs, MS
662 252 2656
www.parker.com/racor

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Hydraulic & Fuel Filtration

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419 644 4311
www.parker.com/hydraulicfilter

Laval, QC Canada
450 629 9594
www.parkerfarr.com

Velcon
Colorado Springs, CO
719 531 5855
www.velcon.com

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Oxnard, CA
805 604 3400
www.parker.com/processfiltration

Water Purification

Village Marine, Sea Recovery, Horizon Reverse Osmosis

Carson, CA
310 637 3400
www.parker.com/watermakers

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www.parker.com/dhfn

Parker Gas Separations

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Racor Research & Development

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www.parker.com/hfde

Urkala, Finland
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www.kittiwake.com

Process Filtration

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