Three Types of Food-Industry Compressed Air Systems

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Compressed air is a key utility supporting the food packaging and food processing industries in North America. Compressed air must be contaminant-free to ensure the protection of the food products processed in each facility. The U.K. Code of Practice for Food-Grade Air helps define three types of compressed air systems and air purification specifications required for each.

Compressed Air Supports the Food Industry

The production facilities of the different segments within the food industry all have different applications for compressed air. The U.S. fruit and vegetable processing industry, for example, operates approximately 1,300 facilities in the U.S. and employs roughly 112,000 people. These manufacturing plants are primarily engaged in the canning, freezing, and dehydrating of fruits and vegetables. This segment represents approximately 7.5% of the dollar value of shipments of the entire U.S. food industry.[1] In many fruit and vegetable processing plants, compressed air systems are used for air cleaning of containers prior to product filling, automated product sorting, and product packaging systems.[2]

There are tens of thousands of factories operating in other segments of the food industry — all using compressed air. Many segments, like bakeries, use compressed air in blow-off applications. Other segments use compressed air to clean containers before filling the containers with food. Compressed air is also used to sort, cut, and shape food products.

Another application comes from machines forming, filling and sealing gable-top cartons in the dairy and juice industries. These machines must be washed-down constantly to maintain sanitary conditions. They are not just subjected to water, but are also exposed to chemical cleaners and sodium potassium hydroxide. Pneumatic systems are preferred over hydraulic systems in these machines because in a wet environment, having leaked oil on a polished tile floor becomes a real safety hazard. Low maintenance and downtime associated with pneumatics is also a key reason why compressed air is preferred.[3] This is an example of where compressed air does not come into contact with food — but there is a high risk that it may occur.

Compressed air has been likened to a "muscle" which is strong and flexible. Compressed air is used in a range of pressures from high-pressures up to 750 psi for blow molding and also at lower pressures of 15 psi for blow-off applications. The food industry has taken full advantage of the benefits of compressed air.

Compressed Air Must Be Contaminant-Free

Compressed air must be purified of contaminants before use in the food industry. The contaminants are water vapor and moisture, solid particulates (including spores) and oil aerosols and vapors.

The presence of moisture is the primary concern for the food industry because moisture creates the ideal habitat for microorganisms and fungus. Moisture may reside in the piping system near point-of-use applications where compressed air comes into contact with food products. Microorganisms and fungus can grow inside the piping system and then be blown into food products or food containers.

In order to inhibit the growth of microorganisms and fungi, pressure dewpoints must be below -15 ˚F (-26 ˚C). Drying the compressed air to a specified pressure dewpoint is the simple way to eliminate moisture in the compressed air system. The dewpoint specification will be of either +37 ˚F (+3 ˚C) or -40 ˚F (-40 ˚C). In some facilities, both of these specifications may be used to reduce energy costs associated with drying the compressed air — depending upon whether compressed air has any possibility of coming into contact with food products.

Solid particulates must be removed with filtration products from the compressed air system. When compressed air is dried below -15 ˚F (-26 ˚C), harmful microorganisms and fungi are converted into spores. These spores are now a “solid particulate” which must be filtered. Other sources of solid particulates are coatings on the air compressor rotors, pipe-scale from the compressed air piping system, and ambient dust and particulates which may be ingested by the air compressor. It is recommended, when selecting compressed air filtration products, that care is taken to request coalescing filters tested to the new ISO Standard 12500 Parts 1-3.

Oil aerosols and vapors are another significant concern. One myth in compressed air systems is that the use of an oil-free air compressor frees the system of any compressed air treatment requirements. This is not the case. Ambient air ingested by air compressors will carry water vapor, particulates, and hydrocarbons and compressed air dryers and filters are always therefore required.

Compressed air pressure dewpoints must be below -15 ˚F (-26 ˚C) to inhibit the growth of fungi and microorganisms in the piping system.

Three Types of Compressed Air Systems

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 facility. The U.K. Code of Practice for Food Grade Air provides a comprehensive resource on compressed air systems in the food industry. The Code was jointly developed, in 2006, by the British Retail Consortium (BRC) and the British Compressed Air Society (BCAS). For

The U.K. Code of Practice for Food Grade Air

Contact Recommendation	Dirt (Solid Particulate) Max Number of Particles per m^3			Humidity (Water Vapour)	Total Oil (Aerosol + Vapour)	ISO8573.1 Equivalent
	0.1-0.5 micron	0.5 – 1 micron	1-5 micron			
Contact	100,000	1,000	10	-40 ˚C PDP	0.01 mg/m^3	Class 2.2.1
Non Contact - Low Risk	100,000	1,000	10	+3 ˚C PDP	0.01 mg/m^3	Class 2.4.1
Non Contact - High Risk	100,000	1,000	10	-40 ˚C PDP	0.01 mg/m^3	Class 2.2.1

Reference Conditions from ISO8573.1 : Absolute atmospheric pressure 1 bar, Temperature = 20˚C.
Humidity is measured at air line pressure.

more information on acquiring a copy of the Code, visit www.bcas.org.uk. The Code defines three specific types of compressed air systems in the food industry; systems with contact with food, non-contact high-risk, and non-contact low-risk.

System #1: Contact

"Contact" is defined in the code as, "the process where compressed air is used as a part of the production and processing including packaging and transportation of safe food production." Another way of defining this is simply if compressed air comes into direct contact with food products. If this is the case, the end user must know that the compressed air must be purified to the "Contact" purity-level as defined in the Code. We often hear the term "incidental contact" used in the U.S. This is an ambiguous term. It is recommended that engineers clearly define between "Contact" and "Non-Contact".

Here is a application example of compressed air coming into "Contact" with food. Vegetable peeling machines utilize compressed air to prepare raw food stocks for packaging and consumption. The vegetable peelers use a jet nozzle of air to peel onions and other vegetables.[4]

In this type of "Contact System", The U.K. Code of Practice recommends a -40 ˚F (-40 ˚C) pressure dewpoint which will ensure that no microorganisms can grow. This can be accomplished with desiccant (adsorption) type compressed air dryers located in the compressor room (centralized air treatment). Each facility will have to determine if further point-of-use air dryers (de-centralized) are required to ensure the dewpoint specifications. Point-of-use air dryers may be of either desiccant (adsorption) or membrane-type technology.

Coalescing filters are required to remove solid particulates and total oil (aerosol + vapor) to the specification levels. Please note that activated carbon filters will be required as well to remove oil vapors. As with the air dryers, each facility will have to determine if de-centralized filtration is required in addition the centralized filtration.

System #2: Non-Contact High-Risk

Non-Contact is defined in the code as, "the process where compressed air is exhausted into the local atmosphere of the food preparation, production, processing, packaging or storage." Within this section we have a High-Risk and Low-Risk distinction. A Non-Contact High-Risk situation may be where compressed air is used in a blow-molding process to create a package — and then product is introduced into the package later in the day. Many food processors and have their own in-house production lines to create their own packaging. Without proper air treatment, it is possible that oil, moisture, and particulates (notably bacteria) could be present on the packaging — waiting for the food product!

The U.K. Code of Practice clearly states that "Non-Contact High-Risk" compressed air systems should establish the same compressed air purity specifications as "Contact" systems.

The U.S. Compressor Lubrication Standard[5]

The only current code in the U.S. applicable to compressed air is centered upon what lubricants are permitted to be used- namely by the air compressor. It is up to each factory to determine what lubricants are required in the factory. The Food and Drug Administration (FDA) specification is identified under "Lubricants with incidental food contact". The specification is summarized as allowing:

1. H1 lubricants are food-grade lubricants used in food-processing environments where there is the possibility of incidental food contact
2. H2 lubricants are nonfood-grade lubricants used on equipment and machinery where there is no possibility of contact
3. H3 lubricants are food-grade lubricants, typically edible oils, used to prevent rust on hooks, trolleys and similar equipment

Compressed air is used to blow crumbs off of bread in a commercial bakery.

System #3: Non-Contact Low-Risk

In "Non-Contact Low-Risk" systems, The U.K. Code of Practice recommends a +37 ˚F (+3 ˚C) pressure dewpoint. This can be accomplished with refrigerated type compressed air dryers located in the compressor room (centralized air treatment). Each facility will have to determine if further point-of-use air dryers (de-centralized) are required to ensure the dewpoint specification.

Defining 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. It is important to understand this relationship and design your system accordingly. We often see desiccant air dryers used to dry all the compressed air in the facility to a -40 ˚F (-40 ˚C) dewpoint — when only 40% of the compressed air needs this dewpoint.

It is worth noting that refrigerated type compressed air dryers normally have significantly lower associated energy costs than desiccant air dryers. Desiccant air dryers will use a portion (can be 15%) of the compressed air to regenerate the desiccant bed and/or use electric heaters. Refrigerated dryers use relatively small refrigeration compressors and can be cycling or non-cycling.

Coalescing filters are required to remove solid particulates and total oil (aerosol + vapor) to the same specification levels as "Contact" systems. Please note that activated carbon filters will be required as well to remove oil vapors. As with the air dryers, each facility will have to determine if de-centralized filtration is required in addition the centralized filtration.

Conclusion

Compressed air efficiently supports the food industry as long as care is taken to remove contaminants from the system. Food industry professionals should define how compressed air is used in their facility and define a specification for compressed air purity based upon the three system types defined by the U.K. Code of Practice for Food-Grade Air.

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Endnotes

1 Eric Masanet and Ernst Worrell, Lawrence Berkeley National Laboratory, "The Energy Star for Industry Program", Compressed Air Best Practices Magazine, October 2006, page 14.
2 Eric Masanet and Ernst Worrell, Lawrence Berkeley National Laboratory, "The Energy Star for Industry Program", Compressed Air Best Practices Magazine, October 2006, page 15.
3 Kjell Lyngstad, Bosch Rexroth Pneumatics, "Milking the Benefits of Pneumatics", Compressed Air Best Practices Magazine, October 2006, page 28.
4 Rod Smith, "Harris Equipment Company", Compressed Air Best Practices Magazine, August, 2007, page 20.
5 Rod Smith, "Oil in the Sausage", Compressed Air Best Practices Magazine, August 2007, page 13.

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