BEKO TECHNOLOGIES

Practice Guide
Food Safety and compressed air

Better through responsibility

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Content

This practical guide is aimed at:
Managing director, production manager, Quality manager, technical manager, Food inspectors, auditors

Primarily addressed sectors:
food, beverages

Claim:
For all levels of knowledge

Annex

Executive Summary

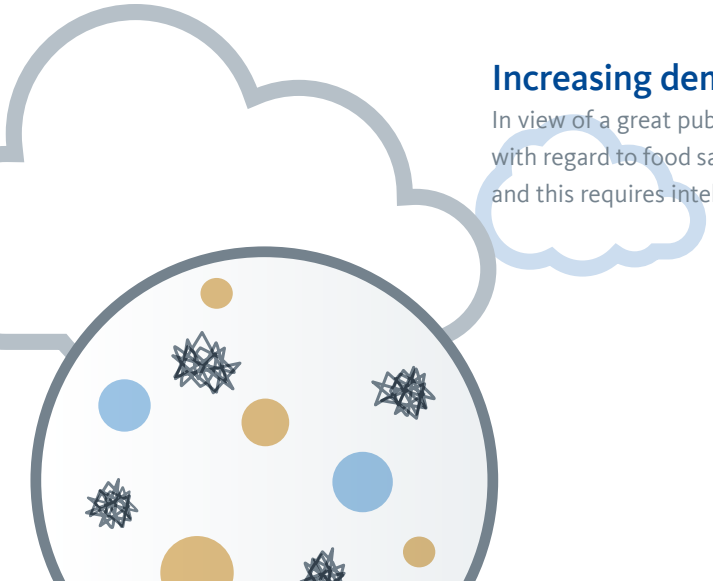
Assured high food quality protects consumers, strengthens the brand image and significantly reduces the risk of time and cost-intensive product recalls. The compressed air frequently used in manufacturing processes is a potential source of contamination. Manufacturers can minimize these risks with appropriate compressed air treatment.

The white paper explains what contamination is likely to occur and provides information on risk and management systems. It presents the compressed air quality classes including recommendations for specific applications.

In the appendix the reader learns how a compressed air line is typically constructed and which are the most important technical components. Finally, there is a comprehensive checklist for checking compressed air preparation in the food industry.

Compressed air: An underestimated Influence variable for safe food

The food and beverage industry uses compressed air in almost every production process. Almost all products and packaging are directly or indirectly in contact with compressed air. Impurities in the compressed air, such as viruses, bacteria, fungi, yeasts, mineral oils, oils, particles or gases can contaminate the food. It is possible that unwanted flavours or moisture are released into the product, which results in drastic quality losses. Careful handling of the compressed air is therefore absolutely essential.



Increasing demands on food safety

In view of a great public interest and sensitised end consumers, the demands on producers with regard to food safety are increasing. The food industry has to deliver flawless products and this requires intelligent quality management.

A worst-case scenario for manufacturers is the recall of a contaminated product that has already entered the market. For example, the Federal Office of Consumer Protection and Food Safety has published a total of 198 food warnings in 2019.

Callbacks always affect the respective company in several fields simultaneously:

» The source of the error must be found and safely excluded for the future.
» Delivered affected products must be retrieved, disposed of and replaced.
» The entire manufacturing, packaging and delivery process is disrupted.
» In addition, any legal fees and claims for damages and expenditure that an activated crisis management system entails for the manufacturers.

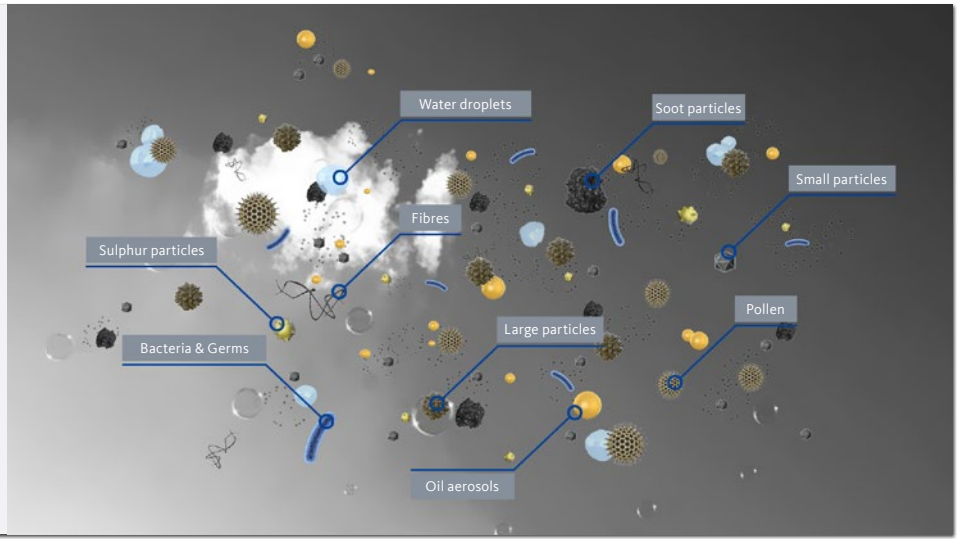
Importance of compressed air in production processes

Many Food manufacturers regard compressed air merely as an energy source in their production processes. Thus the medium is not sufficiently considered in the dimensional and measures for hazard analysis and risk minimization.

Typical applications for compressed air in the food industry are processes such as cleaning, filling, mixing, spraying, cutting, transporting and packaging. During these different steps, depending on the application, there is direct and/or indirect contact between the compressed air and the product.

Polluter

Compressed air is nothing other than compressed ambient air. The impurities contained in the sucked-in air increase according to the degree of compression. Primary contaminants are solid particles, oil and water.



Solid particles

The group of solid contaminants includes, for example, dirt particles such as pollen, dust fibres, soot and heavy metals. Contamination with such solid substances impairs, among other things, the shelf life and taste of food.

Oil or oil vapour

Oil-injected screw compressors are often used to generate compressed air. Here mineral oil is used in the compressor for cooling and sealing purposes. The generated compressed air is therefore inevitably contaminated with the oil.

Oil-free“ compressors are used as an alternative. Even in this case, the compressed air is not automatically oil-free because the ambient air drawn in contains hydrocarbons or oil in gaseous form. Usually the load values are between 0.05 mg/m³ and 0.5 mg/m³. In densely built-up, urban or industrial environments, however, the content can be higher.

Water or moisture

Humid, atmospheric air is compressed in the compressor to compressed air that is 100 percent saturated with water vapour. As the compressed air is stored in the compressed air receiver and then moves through the pipeline network, it cools down and condenses to oily water or water mist. The moisture causes certain water-attracting, hygroscopic products such as powder, spices, salt or sugar to stick together in the production process.

Micro-organisms and germs

find ideal conditions after compression of the ambient air by the compressor. They can easily reproduce themselves in the heated and moisture-saturated compressed air.

Direct contact with food

Direct contact is when the compressed air is directed specifically at the product or at the primary packaging that comes into contact with the product. For example, compressed air is used to evaporate liquids or as a transport medium for dry food. Powdery substances such as coffee, flour or powdered milk or even ground spices are transported with it. Such dry products are subject to high requirements in terms of humidity, as they come into intensive contact with residual moisture due to their large surface area. To prevent the powder from clumping or becoming contaminated, the compressed air must be absolutely dry and clean. Even in sterile compressed air, moisture can activate the dormant (sleeping) micro-organisms contained in the food. To prevent this, the use of dried compressed air is a necessary prerequisite.

The definition of the terms “direct” and “indirect” is made here in accordance with VDMA Standard Sheet 15390-2.

Compressed air also comes into direct contact with the product when processing non-dry food. In some applications the compressed air is even introduced directly into the product. A high degree of care is therefore required when coming into direct contact with food.

Example: Ice cream production:

Direct contact:
Ice cream owes its creamy consistency to the compressed air that is blown into the ice cream base.

Indirect contact with food

Indirect contact with foodstuffs occurs when the expanded compressed air reaches a product over a certain distance and diluted with ambient air. Typical compressed air applications with indirect product contact are cleaning and drying, e.g. blowing off packaging surfaces for quality control, and the transport of food packaging.

In the case of indirect contact between the compressed air and the foodstuff, the requirement for compressed air quality is not as high as for direct contact. Nevertheless, it must be noted that the food can also be contaminated via the packaging.

Example PET bottles:

Direct contact:
PET bottles are given their final shape by compressed air during blow molding. Only then does the foodstuff enter the bottle.

Indirect contact:
Blowing off the bottom of the bottle before the optical quality control.

No clear legal regulation

In contrast to energy sources such as gas, water and electricity, which are usually supplied and are subject to strict tolerances and specifications, compressed air is usually produced on site by the user themselves and provided for various applications with different quality requirements.

General quality and assurance standards apply to food production. There are also nationally and internationally recognised guidelines that explicitly concern the use of compressed air in the food production process. However, these are not legally binding. The BRC Global Standard for Food Safety merely states

> *„Air, other gases and steam used directly in contact with, or as an ingredient in, products shall be monitored to ensure this does not represent a contamination risk. Compressed air used directly in contact with the product shall be filtered".*

However, under Regulation (EC) No 178/2002 producers are in principle obliged to produce a safe product. Since the quality of compressed air has a direct impact on the safety of the food, producers must monitor their compressed air quality.

Do you know the quality of your compressed air?

The food safety standard ISO 22000 is based on the general quality management standard ISO 9001 and contains specific requirements for the area of food safety. An essential component is the definition of management systems and processes required for planning and implementation in food production.

Risk analysis and management systems

Here the focus is on the so-called preventive programs (PRP), which are defined and implemented by the companies themselves. Examples of PRPs include the definition of measures to maintain hygiene, pest control, special on-site measures, foreign object management and the maintenance and repair of systems, which also includes compressed air treatment.

CCP

Basically, when using compressed air, a hazard analysis must be carried out, e.g. based on the HACCP concept (Hazard Analysis Critical Control Points). Depending on the result of the hazard analysis, critical control points (CCP - Critical Control Points) is required. In ISO 22000, control measures that are not defined as CCPs are referred to as preventive programs or operational preventive programs (oPRP). These monitoring and control measures specifically regulate the essential measures for food safety.

The medium compressed air must be taken into account in the measures for hazard analysis and risk minimization.

The most important requirements for risk management in summary:

- Planning and development of a management system for food safety including the associated documentation and monitoring measures
- Definition of food safety requirements through the production process with own “in-house” requirements and specifications
- Risk management and hazard analysis according to the HACCP concept
- Identification and definition of critical control points (CCP) and measures/ procedures through preventive programs (PRP, oPRP) for risk reduction or risk avoidance and monitoring of the processes
- Definition of appropriate validation and verification measures

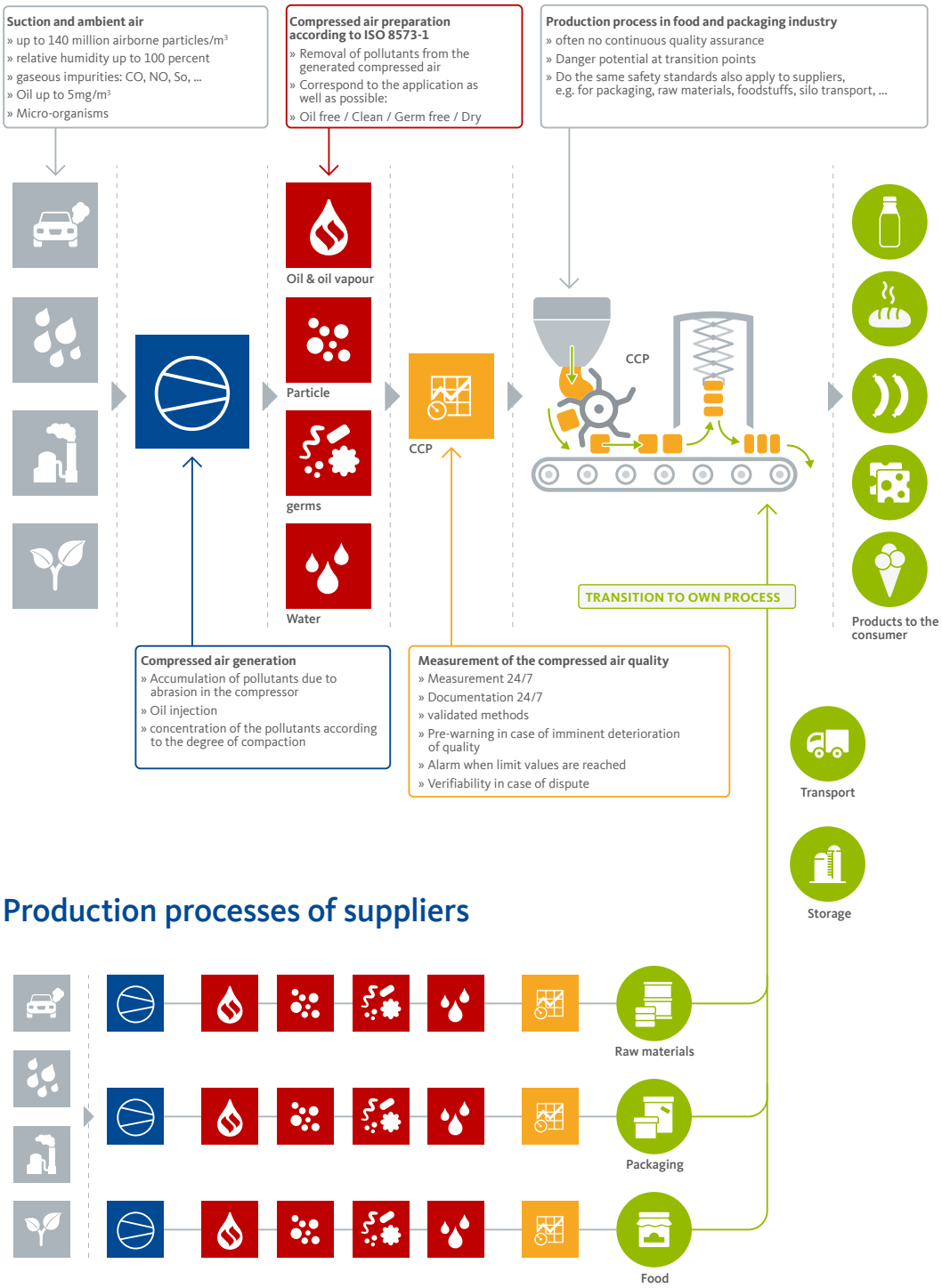
Compressed air quality and purity classes

The ISO 8573-1 standard specifies the permissible quantity of contaminants per cubic meter of compressed air. In various quality classes, the main contaminants solid particles, water and oil are defined by three corresponding indicators particle size, residual moisture and oil content.

Class	Solid particles, max. number of particles per m³			Pressure dew point	Oil content (liquid, aerosol, oil vapor)
	0,1 µm < d ≤ 0,5 µm	0,5 µm < d ≤ 1,0 µm	1,0 µm < d ≤ 5,0 µm	°C	mg/m³
0	As specified by the equipment operator or Suppliers, stricter requirements than class 1				
1	≤ 20.000	≤ 400	≤ 10	≤ -70	≤ 0,01
2	≤ 400.000	≤ 6.000	≤ 100	≤ -40	≤ 0,1
3	–	≤ 90.000	≤ 1.000	≤ -20	≤ 1
4	–	–	≤ 10.000	≤ +3	≤ 5
5	–	–	≤ 100.000	≤ +7	> 5
6	–	–	–	≤ +10	–
	Maximum particle number in µm/per m³ measured according to ISO 8573-4 Reference conditions 1 bar absolute, 20°C, 0% relative humidity			Maximum pressure dew point measured according to ISO 8573-3	Maximum total oil content measured according to ISO 8573-2 and ISI 8573-5 Subscription conditions 1 bar abs., 20°C, 0% r. F.
	unspecified				

Attention: The ISO 8573-1 standard does not consider limit values for the pollution of compressed air by micro-organisms, germs and bacteria!

Diagram: The compressed air process in the food industry



For the choice of compressed air quality: Recommendations of **BEKO** TECHNOLOGIES

This recommendation is based on our many years of competence in compressed air preparation as well as our international practical experience in the application of compressed air as process air for numerous customers in the food industry. It is completely sufficient for the majority of applications.

Process air in **direct** product contact: A compressed air quality of class 2:2:1 *

- The number of solid particles with a size smaller than 5 µm (= 0.005 mm) is limited to 100 per cubic meter. Such a value requires the use of suitable, high-quality compressed air filters.
- The pressure dew point of -40 °C required for quality class 2:2:1 can only be achieved in practice by using adsorption dryers.
- The permissible residual oil content for quality class 2:2:1 is a maximum of 0.01 milligrams per cubic meter. Catalysis or adsorption processes are required to produce this almost oil-free compressed air.

The VDMA goes much further in its VDMA Standard Sheet 15390-2 and makes the following recommendations:

- Direct product contact with dry products: Class 2:2:1 *
- Direct product contact with dry, sterile products: Class 1:2:1 *
- Direct product contact with non-dry products: Class 2:4:1 *
- Direct product contact with non-dry, sterile products: Class 1:4:1 *

Process air with **indirect** product contact: A compressed air quality of class 2:4:2 *

In case of indirect contact of the compressed air with the foodstuff, the requirements are not so high. Nevertheless, it must be taken into account that the packaging and thus the product can also be contaminated in this case.

- The number of solid particles with a size smaller than 5 µm (= 0.005 mm) is limited to 100 per cubic meter. Such a value requires the use of suitable, high-quality compressed air filters.
- The pressure dew point of <= +3 °C required for quality class 2:4:2 can be achieved by using refrigerant dryers.
- The permissible residual oil content for quality class 2:4:2 is a maximum of 0.1 milligram per cubic meter. In order to produce the residual oil content quality class 2, the use of an activated carbon adsorber is sufficient.

*in accordance with the ISO 8573-1 standard

On the safe side with pure compressed air

For safe use of compressed air in the food industry, filtration, suitable measures to ensure oil-free operation and effective compressed air drying are required. The necessary components such as filters, dryers, activated carbon adsorbers or catalysis units must be matched to each other and must function reliably even at different loads.

The critical control points (CCP - Critical Control Points) for the compressed air treatment process must be defined and suitable measures for risk minimisation - the so-called operational prevention programme (oPRP) - must be established and documented.

Continuous monitoring of the compressed air quality with suitable measuring technology is essential. Only in this way can compressed air quality be continuously measured and documented, e.g. for external audits.

Annex

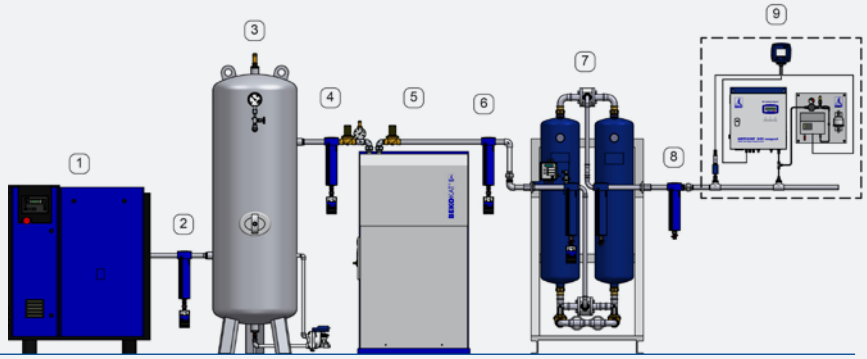
Central components for compressed air preparation and monitoring

The design of a compressed air system depends on the respective application. In principle, a compressor first compresses the ambient air to the required system pressure. The local suction conditions should be taken into account when selecting the location. In most cases, pre-filtering is required.

And: The choice of an oil-free compressor does not mean oil-free compressed air!

Schematic diagram of a compressed air generation, preparation and monitoring system for oil-free compressed air

1. Oil-free or oil-lubricated compressor
2. Water separator with condensate drain
3. compressed air tanks with condensate drain
4. compressed air particle filter with condensate drain
5. Catalytic converter for processing oil- and germ-free compressed air
6. Compressed air particle filter with condensate drain
7. Compressed air adsorption dryer
8. Compressed air dust filter
9. 24/7 monitoring (oPRP): residual oil content measuring system and particle counter with data logger/display



Oil-free through activated carbon adsorption or catalysis technology

In practice, treatment with activated carbon adsorbers in combination with a compressed air dryer is common. The adsorbers remove oil droplets as well as hydrocarbon vapours from the compressed air. Quality impairing oil vapours and odours are adsorbed on the extraordinarily large active surface of the moulded activated carbon pellets. In this way a compressed air quality with a maximum residual oil content of 0.003 mg/m³ for compressed air class 1-2 according to ISO 8573-1 can be achieved.

For the sensitive applications in the food industry, the preparation of compressed air with catalysis technology is recommended. A catalyst can produce not only oil-free compressed air, but also germ-free and bacteria-free compressed air in an environmentally friendly way. This process, which is independent of suction conditions, offers considerably more safety and at the same time requires less maintenance than filtration and can also be retrofitted behind oil-lubricated compressors.

In catalysis technology, hydrocarbons are completely converted into carbon dioxide and water by total oxidation. The process produces constantly oil-free compressed air with a maximum residual oil content of hardly measurable 0.003 milligrams per cubic meter. This means that even the extremely strict requirements of ISO 8573-1, Class 1 oil content are met or exceeded.

Moisture reduction with dryers

Residual moisture in compressed air must be avoided at all costs in the sensitive processes of the food industry, because moisture in combination with heat and residence times promotes bacterial growth. At best, the installation of water separators and coalescing filters can only achieve a classification according to ISO-8573-1 class x:6:x, which is not permitted for the applications.

Refrigeration dryers, membrane dryers or adsorption dryers are used for effective water vapour reduction. The selection criteria for the three processes are the pressure dew point, the volume flow and the required compressed air quality as well as the economy of the system.

Refrigeration dryers are usually used after water separation and condensate drainage at the beginning of the compressed air system.

Membrane dryers are often placed close to the extraction point and serve as so-called end-point dryers for smaller volume flows in addition to the refrigeration dryer.

Adsorption dryers are suitable for very large volume flows and are used either at the beginning of the compressed air system or near the application. The adsorption dryer extracts moisture from the compressed air down to a pressure dew point of -40 °C and is suitable for the highest compressed air quality requirements in the food industry class x:2:x. As an option, pressure dew points down to -70 ° can be achieved, which meets the highest requirements for permissible residual moisture (compressed air quality class x:1:x).

Continuous monitoring of the compressed air quality

Regardless of the type of compressed air treatment, food can be contaminated with impurities such as mineral oil at many points in the process chain. To minimize this risk, real-time monitoring of the compressed air is required. Monitoring systems control the compressed air permanently, precisely and in accordance with standards. The detection of the residual oil vapour content is up to a thousandth of a mg/m³. Furthermore, the measuring systems record parameters such as volume flow, pressure, relative humidity and dew point during operation. Short measuring intervals reliably indicate even minimal deviations and corrective measures can be taken directly. The data of the online monitoring are logged for documentation purposes and to identify sources of contamination.

Careful:
Regular or sporadic sampling with subsequent time-consuming laboratory analysis only allows a statement on the compressed air quality at the time of sampling. A continuous proof of quality has a much higher informative value - this is especially true for tests by auditors.

Checklist

Compressed air quality Food + Beverage

- **Compressed air contact with food**
  - » directly?
  - » indirect?

- **Ambient conditions / Intake air**
  - » Where is the intake?
  - » How is this air composed?
  - » Are there any particularities? (pollen count, leaves, road traffic/ shunting in the vicinity, combustion residues, cleaning agents, building dust, emissions from neighbouring companies, ammonia, ...)

- **Compressor room**
  - » Situation?
  - » Conditions?

- **Compressor**
  - » Which compressor? (Manufacturer, make, performance data, year of construction, type of construction (oil-free, oil-lubricated), control, maintenance condition, ...)
  - » History (which compressors were used before?)

- **Pressure vessels**
  - » Condition (rust, water, steam trap, tightness, maintenance, ...)

- **Piping system**
  - » How long in operation? Impurities? Leaks?
  - » Parallel pipe systems, material (stainless steel, carbon steel, plastic, ...)

- **Compressed air preparation**
  - » Central / decentralized
  - » Pre-filtration
  - » Post-filtration
  - » Sterile Filtration
  - » Condensate treatment
  - » Water separator
  - » Drying
  - » Measurement technology
  - » Condensate Drain

- **Supplier products**
  - » Certificates?
  - » Specifications?

- **Miscellaneous**

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About **BEKO** TECHNOLOGIES

BEKO TECHNOLOGIES GmbH develops, manufactures and distributes components and systems for the treatment and management of compressed air and compressed gas. The independent family-owned company with headquarters in Neuss was founded in 1982 and is today positioned worldwide with around 600 employees and 13 branches.

The spectrum of competence and services ranges from the treatment of compressed air and compressed gas by filtration and drying, through the proven condensate technology, to instruments for quality control and measurement.

BEKO TECHNOLOGIES advises manufacturing companies in all industries to find the optimum solution for their compressed air treatment and to ensure that the required quality and energy efficiency in the process are maintained.

Further information is available at: www.beko-technologies.com

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