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### A great plus for process safety

#### METPOINT OCV® AT PFIZER (2010)

In the pharmaceutical industry, the quality of compressed air plays a decisive role. Impurities or oil contaminations in medicaments through compressed air can quickly have fatal consequences. To improve the process safety in the production, the Pfizer production location in Freiburg, Germany, relies on continuous quality control of the compressed air by means of the METPOINT OCV residual-oil monitoring device by BEKO TECHNOLOGIES.

More than 250 million medicament packs leave the Freiburg pharmaceutical factory per annum. Behind this enormous figure are employees who produce tablets and capsules against cardiovascular diseases, pain and epilepsy. The Pfizer factory is equipped with one of the most advanced production plants for solids nationwide. But that's not all. This place is also an outstanding location in several other ways, for example as far as the subject matter "energy" is concerned. Environmental protection and energy management are declared corporate goals of the pharmaceutical group and are practically experienced. Pfizer operates Europe's largest pellet heating plant in Germany's greenest city. The plant produces 85% of the thermal heat required for the production plant from renewable energies. In the pharmaceutical industry, quality management and process safety are equally important and are also at the highest level in Freiburg. It was only in 2008 that the worldwide Pfizer quality award was granted to the Pfizer location in Freiburg.

What applies to the overall contexts of the factory in Freiburg can also be applied to the compressed-air supply. Four computer-controlled compressed-air stations feed on average 78 Nm<sup>3</sup>/h into the compressed-air system with an operating pressure of 7.5 bar. Joachim Baer who, as the Reliability Engineer, is the person in charge of the plant availability and supply reliability is also responsible for the compressed-air quality and supply guarantee. He is supported by Harald Kunkler, the project manager.



#### Compressed-air quality in the pharmaceutical industry

Ensuring and controlling the quality of compressed air is in many aspects an unknown element in the different bodies of rules and regulations or the production guidelines which apply to the pharmaceutical industry. General recommendations and requirements can be taken from ISO 8573-1, DIN-EN 12021 and from the pharmacopoeia. Pfizer quality management specifies the requirements following ISO 8573-1. "It is very important for us to meet these requirements or even to outperform them for safety reasons", says Joachim Baer. Currently, even the American Food and Drug Administration (FDA), as the worldwide leading authority for production standards in the pharmaceutical and food industry, gives hardly any advice regarding compressed-air quality and the methods to assure or monitor this quality. However, project manager Harald Kunkler wants to be

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prepared for the day the FDA will attend to this subject matter, as he expects very strict requirements. Joachim Baer adds: "We are optimally prepared for this case, though".

### **Compressed air in contact with the product**

All persons in charge at Pfizer recognize that compressed-air quality in the pharmaceutical production needs to be particularly high, as the compressed air comes into direct contact with the medicaments during coating, where tablets are provided with a protective film, and also during blow-out processes at production machines for the in-process control. Contamination of the products with oil could have fatal consequences. In addition, breathing air needs to be provided in the Freiburg factory for special production sectors where hazardous substances are employed. There, the employees need to wear, similar to astronauts, protective suits which are fully impermeable and in which they are provided with breathing air.

Concerning the processing technology in all stations, Pfizer relies on adsorption dryers with pressure dew points of  $-40^{\circ}\text{C}$  for compressed-air drying. To remove the oil vapour, oil-vapour adsorbers are employed by means of which a compressed-air quality for oil vapour can be achieved which is better than class 1 in accordance with DIN-ISO 8573-1, provided that the exchange intervals are adhered to. Until today, meeting the compressed-air quality requirements at Pfizer was ensured by taking samples at regular intervals with subsequent analysis of the latter in the laboratory.

In the course of a consultation regarding the condensate technology subject matter with BEKO TECHNOLOGIES, both Pfizer compressed-air experts also talked about processing, for which BEKO also offers comprehensive solutions. During the visitation of the stations and by analysis of the available technology, a potential for improvement in the different compressed-air stations. In one of the stations, a complete system solution could thus be developed with the aim of bringing compressed-air processing to an increased process-safety level. In other stations, the condensate technology was analyzed in addition to the filter technology, and adjusted to the requirements.

### **Monitoring of the compressed-air quality**

Besides the analysis and optimization of the compressed-air processing technology, BEKO TECHNOLOGIES was able to score with a second solution at Pfizer: the METPOINT OCV residual oil vapour monitoring device for the continuous monitoring of the compressed-air quality. "The constantly updated indication of the residual oil content of the compressed air with the METPOINT OCV residual oil vapour monitoring device convinced us quickly", says Joachim Baer. "We have the values on the display in the stations constantly in view, like we have them in view via the network at our computer workstations in the office." The traditional method of oil vapour monitoring with the laboratory analyses of compressed-air samples was rather unsatisfactory, according to Harald Kunkler, as it only showed a snap-shot of the compressed-air quality and did not allow conclusions to be drawn concerning the state of the oil vapour adsorbers. "But that was state-of-the-art over a long period of time", says the project engineer. In his opinion, the continuous monitoring of the residual oil content in the volume flow which is possible with the METPOINT OCV residual oil vapour monitoring device is therefore a quantum leap towards process safety. "With this measuring device, BEKO has brought state-of-the-art technology regarding compressed-air quality control to a

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new level. So, it was a matter of course that we wanted to retrofit our compressed-air supply with this technology in the sense of good manufacturing practice", emphasizes Joachim Baer.

### TÜV-certified measurement technology

Therefore, all four compressed-air stations in the Pfizer factory in Freiburg were equipped with the measuring sections, sensor units and display units in the fourth quarter of 2009. At regular intervals, the measured data is transferred to a control center via a network. Now, alarm messages ensure optimum protection of the pharmaceutical production against oil-containing compressed air when limit values regarding the residual oil content are exceeded. Since the end of February 2010, an independent certificate, issued by TÜV Nord, confirms that the devices from BEKO function perfectly and that they reliably carry out measurements in accordance with DIN-ISO 8573.



Besides the great plus for the process safety regarding the compressed-air supply, project engineer Harald Kunkler reckons with another positive effect of the new residual oil monitoring: "Until today, there was always an uncertainty between the sample checks concerning the degree of saturation of our oil vapour adsorbers, and therefore concerning our process safety. With the METPOINT OCV devices, we will be able to detect,

at an early stage, whether or not there is need for action and when maintenance of the processing technology will be necessary. At the same time, this means that we can make full use of the service lives in the sense of condition-oriented maintenance".

### Future-oriented solution

In view of the improvements achieved for the process safety, the two Pfizer engineers are very satisfied with the optimization of compressed-air processing and in particular with BEKO as a solution provider. Joachim Baer is confident: "With the innovative BEKO products and the competent and consultation, we have relied on the right partner regarding compressed-air processing technology." Harald Kunkler adds that even the realization of the project was perfect. With this, one thing is obvious: in Freiburg, not only the compressed-air quality in the pharmaceutical production is right but also the chemistry between Pfizer and BEKO TECHNOLOGIES. And at the same time, the future-oriented and exemplary standard which Pfizer follows regarding the monitoring of the compressed-air quality is a signal for the entire industrial sector of pharmaceutical and food production.

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### A clever move

#### COMPRESSED-AIR PROCESSING ON HYBRID LOCOMOTIVES AT ALSTOM (2013)

A trendy concept in automobile engineering, and an already proven technology on rails: the hybrid drive. The combination of a diesel generator and a battery on state-of-the-art locomotives leads to fuel savings of up to 50%. What is always on board is a complex "mobile" compressed-air processing system for the operation of the hydraulic brakes.

If model railroaders were allowed to dream themselves to a place, Stendal near Magdeburg would have the best chances to be chosen, since here, on grounds and in halls full of tradition, the steels giants that get the rail traffic rolling have been developed for decades: locomotives from ALSTOM. Amongst other models the shunting locomotive which, at present, is possibly the smartest and most economical of its kind: a hybrid locomotive with a combined diesel generator and a battery.

The globally positioned French ALSTOM group is the worldwide leader in the construction of plants and products for the generation of power, energy transmission, and rail infrastructure. The group constructs the fastest train, the world's highest-capacity automated subway and, in the German city of Stendal, the ground-breaking hybrid locomotive.



Here, at the site of the ALSTOM Locomotives Service - which is a joint enterprise with the Deutsche Bahn AG – the concept of the combined drive concept took concrete shape already in 2006. In that year, the ALSTOM engineers brought the first operable prototype of the hybrid shunting locomotive onto the rails. It was constructed on the chassis frame of the proven V100 locomotive with its two bogies. In addition to the

typical diesel-electric generator, a large battery was installed on board as an energy storage device – as well as a fully newly developed system for the processing of compressed air for the brake systems of the locomotive and of the coupled wagons.

#### From the prototype to series-production readiness

Emanuel Bünger, the project manager at ALSTOM in Stendal, accompanied the way into series production and to the current state-of-the-art design. And he is proud of his "steelhorses" – above all, for their performance and economic efficiency.

He explains the principle: "The hybrid version of the shunting locomotive is equipped with a 230-kW diesel generator and a battery. With this design, it is particularly suitable for the heavy shunting operation. A very economical and environmentally friendly diesel generator charges the battery and



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is also capable of directly driving the electric motor for peak loads. In the event of a partial load, the locomotive is operated via battery and saves 30 to 50 per cent of diesel in this variant compared to conventional 700-kW shunting locomotives." The muscular hybrid locomotive with its 220 kN starting tractive effort and up to 60 km/h top speed rolls on four axes.

"During the shunting operation with its numerous load alterations and direction changes, the brake system of a locomotive is particularly challenged", explains Emanuel Bünger, the project manager. And he knows what he is talking about – after all, the graduate engineer, who specialized in electric drives, successfully completed training as a locomotive driver prior to his studies. "Therefore, I know from my own experience as to which forces are applied there and need to be tamed", he says. Correspondingly, the performance and stability of compressed-air processing was the greatest concern already in the earliest development phase of the hybrids.

### **Compressed-air processing directly on board**

The compressed-air production and processing for the brake system of the machine and the coupled wagons takes place fully independently on board every locomotive, in an internal "mobile" compressed-air station directly behind the driver's cabin. Except for the housing, it is installed "in the open", meaning that it is continuously exposed to weather and climatic conditions, e.g. during the shunting operation, when the temperature falls below zero, and also in the scorching heat of summer both during its employment in Nordic regions and also in sultry, hot countries of the southern hemisphere or in Asia. Enormous challenges, above all for the technical equipment of compressed-air processing – and no room for uncertain concepts.

Against this background, ALSTOM in Stendal took a specialist for this field on board already during the project planning phase: the German compressed-air system provider BEKO TECHNOLOGIES GmbH from Neuss.

This company sent its engineers from the Rhine to the Elbe in order to receive one of the most versatile specification documents thus far in the history of project development. It quickly became clear that, in addition to the combination of existing processing components, completely new device versions also had to be developed – above all with a view to oil-water separation.

### **A comprehensive specification document for the compressed-air engineers**

Right from the start, BEKO TECHNOLOGIES accompanied the system development for the ALSTOM hybrid locomotives. Another challenge was that during the shunting operation, the locomotives sometimes hold one position over a longer period of time. At temperatures below zero, this involves the risk of freezing condensate in the compressed-air processing system. So BEKO TECHNOLOGIES had to provide all of the relevant components and lines with a heating system. In addition, all the installed condensate drains are connected with the control of the compressor. Through this, residual condensate that is still in the system at a possible breakdown or deactivation of the locomotive's electrics, is discharged automatically and in a remote-controlled manner before it can freeze."

Via the BEKOMAT condensate drains, it is directly led into an ÖWAMAT condensate conditioner for an oil-water separation. These devices that are developed by BEKO TECHNOLOGIES take into

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consideration the environmental protection and water conservation concerns and follow the holistic approach of sustainability.

Their cartridge technology is particularly user-friendly. It allows the fast re-placement of the filter and facilitates low-waste disposal. In addition, the filter service lives are by far longer than for conventional activated-carbon filters. Moreover, extended maintenance intervals result from the high product quality – which was one of ALSTOM's central requirements for the "mobile", particularly tough employment on the locomotives. Especially for this, BEKO TECHNOLOGIES equips the ÖWAMAT oil-water separators with a corrosion-free and extra robust stainless-steel housing.

### **A complete system in the narrowest space**

The oil-water separator, however, is only the final stage of the compressed-air processing system of the hybrid locomotives which is designed in a form-fit manner. The CLEARPOINT water separator with the first condensate drain is installed directly behind the screw compressor. "Every millimeter counts with these restricted space resources up here on the locomotive", says Emanuel Bünger, the ALSTOM project manager, and points into the narrow housing of the compressed-air system. It only occupies the area of a small garden toolshed and is only half as high.

Anyhow, there is enough space for a finefilter with a condensate drain near the compressor and water separator, as well as even for two DRYPOINT M membrane dryers from BEKO TECHNOLOGIES. One of them is a "plus" version with an integrated nanofilter. The DRYPOINT M is the ideal solution for the compressed-air drying of volume flows between three and 2,500 liters per minute in a pressure range up to 16 bar. Through the parallel connection of modules, also larger amounts of compressed air can be dried.

The DRYPOINT M membrane dryers are based upon the "Twist 60" technology which was developed by BEKO TECHNOLOGIES: the membrane element consists of intersecting layers of hollow fibers which are arranged around an internal core pipe. This structure allows for the highly efficient utilization of physical mechanisms of action and enables the drying of compressed air at low energy consumption. For the drying process, a portion of compressed air is continuously diverted in the outlet area of the membrane element and is used as re-generation or purge air when atmospherically expanded.



### **When it all works out smoothly just like on rails**

Exactly these strong points of the DRYPOINT M compressed-air membrane dryer are indispensable for the employment on the hybrid locomotive: absolute functional safety, highest reliability, and

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immediate availability of dry compressed air even in a discontinuous operation mode, and freedom from maintenance and wear, as there are no moving parts. "After all, we cannot have a service technician for the compressed-air system on board of every locomotive", says Emanuel Bünger. "The system is due to run and in a robust, faultless manner. Until the present, this is exactly the case on all of our hybrid locomotives and, by the way, also on other models of the series."

### Continuous 24-hour real-time monitoring of medical compressed air

#### MEASUREMENT INSTRUMENTATION AT UNIVERSITY CLINIC BONN (2015)

Via a line network with a length of 4.5 kilometers and with 1,671 points of consumption, Universitätsklinikum Bonn provides its operating theatres, surgeries, and patient rooms with a daily amount of 3,500 cubic meters of medical compressed air. Thanks to modern measurement instrumentation, the continuous quality monitoring of the "Aer medicalis" can be implemented in real time. With this, the University Hospital of Bonn leads the way in safe patient care with medical compressed air.

The machinery room, in which the medical compressed air is generated, is situated in the first basement floor of the supply center and is under slight overpressure. The latter prevents ambient air, and with it dust particles, from flowing in. Therefore, the room is extraordinarily clean. However, the intake of fresh air takes place at an elevated point of the supply center in an area which is poor in contamination. The compressors function according to the principle of oil-free compression.

#### Pharmacists in clinics bear the responsibility

Aer medicalis is used as a substitute for normal air, for example for the operation of ceiling-mounted supply units, for anesthetic gas line systems, as air for the breathing of patients, for checking or drying of medical products, hyperbaric chambers etc.

Corresponding to its central significance, the European Pharmacopoeia consequentially classifies Aer medicalis as a pharmaceutical preparation – and transforms the high demands on its purity into legal duties.

The hospital pharmacist needs to comply with this obligation and exercise his responsibility by providing evidence of the compliance with the legally stipulated limit values regarding components and contaminants.

However, like all of his colleagues, the pharmacist Günter Stangenberg also had to face a problem up to now: no solutions and methods existed worldwide that were feasible during the hospital's daily routine in order to meet the test specifications of the European Pharmacopoeia. Even the pharmacopoeia itself only describes schematically represented test set-ups that are difficult to perform in practice.



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The pharmacist Stangenberg describes the difficult situation: "The only thing that we, as hospital pharmacists, could do at best was to perform a random check of the medical compressed air by means of gas test tubes, which was informative only to a limited extent. Apart from the fact that these checks were only snap-shots, they were followed by longer laboratory analyses. We were, therefore, far away from continuous real-time monitoring".

At this time, a new measurement system, that was presented in a brochure from the BEKO company, attracted the attention of Frank Bensberg from the Technical Facility Management (MediStructura). The head of the locksmith had conceded high priority to compressed-air processing.

"Here, in the supply center, we produce a daily amount of approximately 3,500 cubic meters of medical, and 2,500 cubic meters of technical compressed air. We send it via two strictly separated line networks with a length of 4.5 or 4.6 kilometers, respectively, to the points of consumption all over the hospital grounds. For the medical compressed air alone, there are 1,671 points of consumption," says Frank Bensberg, outlining the large interlacing network of the hospital. He adds: "quality assurance is of the utmost concern in view of these dimensions."

This information was also a reason for him to visit the ComVac 2013 fair in order to see the new METPOINT MMA (Monitoring Medical Air) measurement system that was presented there for the first time. The innovation was developed by the German compressed-air system specialist BEKO TECHNOLOGIES. With the new system, it extended its METPOINT measuring



equipment family and, with it, transferred its treasure trove of experience from compressed-air processing and measurement technology also to the quality assurance in the medical field.

The pharmacy already knew BEKO TECHNOLOGIES and its measurement systems since 2007. At this time, the "air for medical applications" was still analyzed at regular intervals by means of gas test tubes by an external company under the general management of the hygiene institute. The purchase of a measuring device through the pharmacy was not realizable by reason of the missing experience regarding the quality and measuring accuracy of such a device and of high costs.

When Frank Bensberg, during a presentation of the new measurement system from BEKO TECHNOLOGIES together with collaborators from the pharmacy and the purchasing department, explained that the financial aspects of the Technical Department were realizable, he could start tackling this project with the full support of the pharmacy. A prototype of the device was provided

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by BEKO TECHNOLOGIES against a monthly rent. This allowed for the inclusion of new ideas on site and the implementation of continuous improvements during the running operation. This phase took about one and a half years.

### **Aer medicalis under control – round the clock in real time**

Frank Bensberg saw huge advantages for the University Hospital of Bonn: METPOINT MMA allows for the continuous 24-hour monitoring of the sensitive air for medical application, which is of utmost relevance to patient safety. With this round-the-clock monitoring of the medical compressed air, the system was far superior to the standard method that was used until now, namely the more or less frequent random check via indicator tubes, also with a view to the economic aspects, since the high time and cost expenditure regarding complex laboratory analyses of samples is fully omitted.

The measured values are available at all times and in real time – in contrast to the laboratory random sample, where several days can lie between the sampling and the results.

METPOINT MMA continuously records and monitors all of the decisive parameters in the central breathing air supply. The values that are recorded are the oxygen, carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen oxide, and water vapour content.

For this purpose, samples are continuously drawn from the compressed-air line and supplied to the measuring systems of the device. Electrochemical measuring cells determine the values for  $\text{SO}_2$ ,  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{CO}$ , and  $\text{O}_2$ . The  $\text{CO}_2$  content is ascertained via non-dispersive infrared light.

The electrical signals that result from the measurements are subsequently amplified and evaluated. The results are displayed on the intuitively operable external 7-inch touch screen of the METPOINT BDL. Simultaneously, recording in the internal memory takes place.

### **Adjustable alarm parameters against the exceedances of limits**

All the measuring results are presented as numeric values and, alternatively, as curve charts on the display. This includes the critical moisture content, the specified trace gases, and the operating pressure. Optionally, the residual oil vapour content of the medical compressed air can also be indicated via the complementing METPOINT OCV residual oil measuring device from BEKO TECHNOLOGIES.

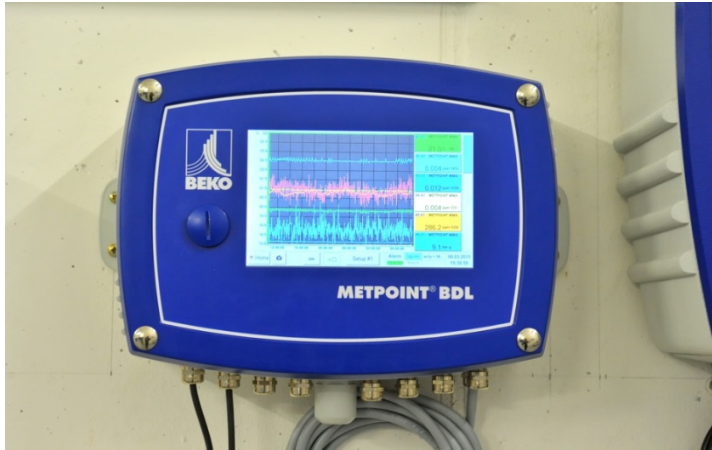
When a limit value is exceeded, the value is marked. The system will immediately release an alarm which will be retrieved in a targeted manner or directly processed in the quality assurance system. It goes without saying that the device is network-compatible and boasts the necessary interfaces such as Ethernet, RS-485, MODBUS, or USB. Therefore, METPOINT MMA renders the purity of breathing air visible even in several ways: preset alarm parameters guarantee the compliance with the limit values that are stipulated in the European Pharmacopoeia, while the continuous documentation of all the measured values supports the quality management of the hospital.

Frank Bensberg and Günter Stangenberg, the hospital pharmacist, explain unanimously: "With it, we obtained an optimum measuring method".

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### Process safety through daily autocalibration

Subsequent to the completion of the field test under real conditions, the METPOINT MMA is in normal operation since the end of 2014. The compact system with the METPOINT MMA and the 7-



inch touch screen METPOINT BDL operating unit is accommodated in the central compressed-air processing of the hospital, meaning that it is in view and accessible at all times for technicians and pharmacists.

"The unique autocalibration function of the measurement system gives me the special feeling of security", Günter Stangenberg points out.

Other than the adjustment that is carried out at most sporadically during maintenance measures, calibration of the METPOINT MMA is effectuated daily and automatically via defined measuring gases. They are conducted via the measuring cells, outside of the normal compressed-air flow and are supplied from spatially separately placed bottles with certified reference gases. Through this, the measuring cells are regularly and automatically calibrated to the reference values.

Therefore, the clinical center can be certain at all times to have correctly determined measured values and does not need to rely on a calibration that is carried out only once or twice a year, a hitherto unattained level of process safety during the processing of medical compressed air.

### Humidification of measuring cells guarantees long-term stability

Another unique selling point of the system was praised by the technician Frank Bensberg: the regular humidification of the measuring cells with water vapour via an internal, closed cycle.

BEKO TECHNOLOGIES explains the advantage: "This technology reliably prevents the electrochemical measuring cells from drying out and overacidifying. The results of this method are a significantly increased operational reliability, higher long-term stability, and noticeably lower maintenance costs through a longer service life of the measuring cells."

The supply of water for this humidification is effectuated optionally via a separate tank with fully processed steeping water or, alternatively, via an available domestic water connection and a BEKO filter cartridge with ion-exchange material for the softening.

It goes without saying that, thanks to the separate circulation, the water that is supplied to the measuring cells for their humidification does not come into contact with the Aer medicalis. It can be discharged via the normal process water network, without requiring further treatment.

Pharmacist Stangenberg draws his conclusion: "With METPOINT MMA, we are on the safe side, even in several respects". "Since we can reliably and continuously document the quality of our

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compressed air, we are well prepared for an audit within the scope of the quality management but also against possible legal claims".

### The key to perfect sparkling water: oil-free compressed air

#### COMPRESSED AIR TREATMENT AT RHEINFELSQUELLEN (2016)

Every hour, 150 cubic meters of purest mineral water are produced by the 14 wells of RheinfelsQuellen in Duisburg-Walsum. Enough to fill 883 bathtubs every 60 minutes – or more than 207,000 bottles. To add sparkle to the water, there is only one solution: oil-free compressed air fed to state-of-the-art bottling plants and peripheral systems. The company uses an innovative catalytic process for the total oxidation of hydrocarbons in the compressed air system.

H. Hövelmann Getränke- und Brunnenbetriebe, the company behind RheinfelsQuellen, is achieving healthy growth from a healthy product, as its water is extracted from the huge natural reservoir located deep under the nature reserve of Rheinaue.

Water is extracted at an hourly rate of 150 cubic meters from a depth of 380 meters. With a yield of 3.6 million liters per day, the company can fill around 207,000 bottles every hour. Of these, 72,000 are returnable glass bottles, 90,000 are returnable PET bottles and 45,000 are recyclable plastic bottles. In addition, the company sells its water in kegs to customers in the hospitality sector. The mineral water is marketed under various names, including RheinfelsQuelle and Römerwall. The water is also used to produce fizzy drinks of the popular Sinalco brand, which we probably have all enjoyed at some time.

RheinfelsQuellen has for many years been certified according to the International Features Standard IFS Food and even meets the requirements of the latest, even more stringent IFS Food version 6. To maintain its excellence in product quality, the company relies on filling technology that excludes any risk of contamination.



"We run a 24/6 plant and therefore need technology that guarantees 100% process safety. Oil-free compressed air is one of the key elements to ensure this," explains Björn Rinke, head of electrical technology at RheinfelsQuellen in Duisburg-Walsum.



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### Oil-free compressed air for sensitive applications

The eight bottling lines of RheinfelsQuellen are supplied through two separate compressed air systems pressurized by two independent compressor stations. The conventional processing air system includes five screw compressors with capacities of between 90 and 120 kW. A frequency-controlled compressor provides the basic air flow, while the other units are automatically switched on and off as required.

The second, smaller system is pressurized by a 50 kW oil-free compressor and supplies oil-free compressed air to dedicated consumption points. Compressed air of this high quality is required in sensitive sections of the bottling plant. Depending on the application, the oil-free compressed air needs to be sterile, for instance at fillers where products free of CO<sub>2</sub> are transferred into containers or tanks, and the carbon dioxide at the top of is to be replaced with sterile air. Oil-free compressed air is also required in date printers at filling stations to prevent the ink from blocking the minute print nozzles. It is equally indispensable for the operation of precision valves used for the high-speed transport of bottles or the labelling of pallets.

"By running a single oil-free compressor, we have eliminated all unnecessary redundancy in this small compressed air system," says Björn Rinke. "In the event of a compressor failure, we don't need to panic, as our innovative catalysis technology provides us with a safety net." What does this mean exactly?

"In an emergency, the catalysis technology enables us to feed the oil-free compressed system from our five conventional screw compressors without any risk of oil contamination. This is achieved by means of a switchover unit installed between the two compressed air systems," explains Björn Rinke. "In other words, we can always supply all consumption points in our Walsum plant with perfectly oil-free compressed air, irrespective of the compressor type."



This is made possible by the BEKOKAT solution developed by BEKO TECHNOLOGIES GmbH, a compressed air system supplier based in Germany. The BEKOKAT is a compact unit that removes hydrocarbons from the compressed air through total oxidation, breaking them up into carbon dioxide and water.



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### Turning hydrocarbons into water and air

BEKOKAT technology guarantees pure compressed air with a maximum residual oil content of 0.003 mg per cubic meter, which is close to the detection limit. The quality of compressed air treated in the BEKOKAT far exceeds that required for technical oil-free compressed air of purity class 1 according to DIN ISO 8573-1.

To achieve this, the hydrocarbons are eliminated through total oxidation in a separate process after compression. This means that the oil is removed from the compressed air in a single system component and in a process that is not affected by the actual ambient conditions, the initial oil concentration or the relative humidity of the compressed air.

The BEKOKAT method removes all oil contained in the air – be it in gaseous, vapour or aerosol form – after compression. These substances contained in the air are converted in a catalytic process into carbon dioxide and water, which is drained from the system after condensation in the downstream cooling unit. The method is environmentally friendly, as the condensate does not contain any oil and can thus be safely disposed of through the sewerage system without any further treatment. The BEKOKAT system is the only one in the world that completely removes all oil from compressed air. For RheinfelsQuellen, a company selling a pure natural product, the BEKOKAT is thus the ideal system.

### Heterogeneous catalysis in seven steps

In the BEKOKAT, a special granular material serves as the catalyst. This material is heated by heating elements to an operating temperature of around 150°C. The oil molecules are broken down into compounds that only contain a single carbon atom. In the final phase of the catalysis, the oil molecules are oxidized to H<sub>2</sub>O and CO<sub>2</sub>.

The entire catalytic process is performed over seven steps. Initially, the substances to be removed, i.e. the oil molecules in the contaminated compressed air, are diffused to the surface of the granules. Subsequently, the reactants are diffused into the pores and absorbed. This process is followed by a surface reaction. In a next step, the reaction products are desorbed and subsequently diffused from the pores. Diffusion into the homogeneous phase concludes the process.

For the process to be effective, the hydrocarbon chains that form the oil molecules must be completely broken up into carbon dioxide and hydrogen. The BEKOKAT has no problems doing this and can break up hydrocarbon chains of any lengths, whether they originate from the ambient air or the compressor lubricants. In the same catalytic process, the BEKOKAT also eliminates polar compounds such as olefins, alcohols, glycols and ketones. The purified compressed air is subsequently cooled to a temperature that is approx. 10 to 15 K below the inlet temperature, and is now ready for use.

The BEKOKAT is the only system in the world ensuring a constant supply of oil-free compressed air with a maximum residual oil content of as little as 0.003 milligram per cubic meter. The compressed air treated in the BEKOKAT thus meets the stringent requirements of the medical, pharmaceutical, food processing and packaging industries.



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The catalytic system is not only highly efficient but also cost-effective, as the special granular material used in the BEKOKAT only needs to be changed every 20,000 operating hours.

### **Peace of mind**

After investing in its first BEKOKAT in 2011, RheinfelsQuellen in Duisburg-Walsum has never looked back. The first BEKOKAT unit was bought to treat the compressed air from the two oil-free compressors in operation at the time. The system always worked to the full satisfaction of RheinfelsQuellen, and when one of the oil-free compressors needed to be replaced, the company decided not to do this. Instead, it invested in two more BEKOKAT units for installation in its second compressed air system fed by screw compressors.

"Should the oil-free compressor fail, we only need to open the valve between the two systems," explains Björn Rinke who is delighted with the fact that all compressed air networks of RheinfelsQuellen are now completely oil-free. Also reassuring are the TÜV certificates for the BEKOKAT, certifying that the unit is suitable for continuous mode operation, providing sterile compressed air with a verified low residual oil content.

Another important issue are of course the running costs. There are huge differences regarding the efficiency of oil-free compressors on the one hand and conventional, oil-lubricated screw compressors with downstream BEKOKAT treatment on the other, which makes the latter a much more cost-efficient solution. In addition, the BEKOKAT units are relatively cheap, while the compressed air treated in such systems is of a constant high quality, irrespective of the air intake conditions. When it comes to maintenance, the costs for systems that combine conventional compressors and BEKOKAT units are lower than those for oil-free converters.

The BEKOKAT is suitable for retrofitting into existing compressor stations. By installing a BEKOKAT, any station with oil-lubricated compressors can be turned into a supply system for oil-free compressed air, as has been demonstrated by RheinfelsQuellen in Duisburg.

### **Ideal for combination with refrigeration dryers**

At the Duisburg plant of RheinfelsQuellen, a system with oil-lubricated compressors and BEKOKAT units has been combined with DRYPOINT RA refrigeration dryers from BEKO TECHNOLOGIES. These remove any residual moisture from the compressed air that has undergone total oxidation in the BEKOKAT. Given the relatively high temperature of compressed air produced in screw compressors, DRYPOINT RA refrigeration dryers are the perfect solution to cool down the air.

In the DRYPOINT RA, the air is dried in a counter-flow process with optimized heat exchange along the entire process path, whereby the downward flow of the air is not obstructed in any way. The large counter-flow heat exchanger unit that consists of an air-air and an air-refrigerant heat exchanger cools the compressed air to a temperature of around 3°C. The size and design of the heat exchangers promote effective cooling while minimizing flow resistance.

"Every month, we produce around 1.3 million cubic meters of oil-free compressed air. By combining catalysis and dryer technology, we have achieved a process safety level that we could previously only dream of," explains a delighted Björn Rinke, who follows this endorsement with a gulp from a freshly filled Römerwall sparkling water bottle.