

Pumps and Compressors for the World Market 2023

with Compressed Air and Vacuum Technology



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Pumps + Systems
Compressors, Compressed Air and Vacuum Technology



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for the World Market 2023
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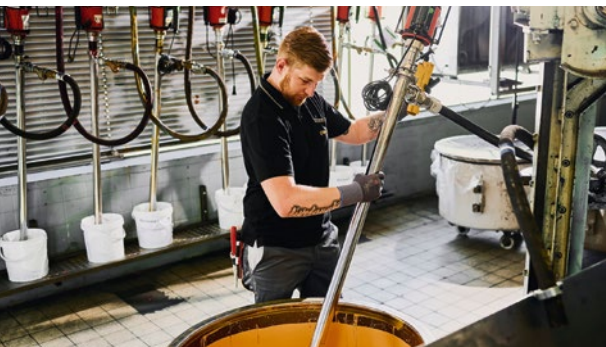


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Pumps and compressors are well equipped for change

Dear Readers,



Dr. Sönke Brodersen

we continue to live and work in turbulent times and in an ever-changing world. It is true that the corona pandemic has become an endemic after three years and many of the restrictions that were still in place last year, such as lockdowns and postponed or cancelled trade fairs, have been lifted. And this once again offers companies the opportunity to present their solutions worldwide. But the war in Ukraine and its consequences – especially human suffering – continue to overshadow our daily actions.



Alexander Peters

Our companies have completed the past year much better than expected due to the war on European soil, global inflation and the sometimes difficult material shortages to cope with, as you can also read in the interview with Christoph Singrün in this year's issue of our magazine "Pumps and compressors for the world market 2023". Thanks to their global presence, companies are much more resilient than previously expected. They are therefore looking ahead with confidence, even if they continue to have to deal with energy supply hurdles or protectionist measures and geopolitical crises, for example in Asia, on the global markets.

After the corona-related shutdown, the trade fair business is picking up speed again – as at this year's Hannover Messe, where we have an information stand for visitors in the Compressed Air & Vacuum exhibition area (Hall 4). As you will read in this issue, companies unfortunately have to live with cuts in the promotion of the foreign trade fair programme (AMP). We at VDMA are doing everything we can to maintain the concept of the so-called German Pavilions and to strengthen the presentation and customer approach in relevant target markets again in the future.

Companies see themselves well equipped for the digital transformation that will determine business success in the future. The technical basis for this is the interoperability of machines and systems, which is guaranteed by the open interface standard OPC UA. In this issue, we will introduce you to how the VDMA has developed industry-specific OPC UA Companion Specifications together with the members of pumps and compressors and created the prerequisites for Industry 4.0 for the user.

Climate protection remains a major challenge for industry. At the same time, however, the topic also offers great opportunities for innovations and for an accelerated conversion of energy generation, predicts Christoph Singrün in an interview. It is not without reason that the topic of the hydrogen economy is becoming increasingly important. By



switching from fossil to renewable energy sources, there will be growth in the process gas compressor industry – especially in applications in liquefaction, pipeline transport, cavern storage and, of course, hydrogen filling stations and trailer filling plants. According to Christoph Singrün, electromobility, the production of green steel and the storage of carbon dioxide are also market environments that have the same goal in mind. And all need efficient pumps and compressors to achieve this goal.

It goes without saying that the products used for this must be energy-efficient. In an interview, Christoph Singrün points out that manufacturers in both industries have been focusing on energy savings and thus energy efficiency for customers for decades and offer corresponding solutions. Manufacturers are already making a decisive contribution to combating climate change and preserving the planet for future generations.

Examples of innovative solutions from our members in the current issue of our magazine: identifying energy and CO₂ savings potential through intelligent pump monitoring, ecologically combating pests in grain silos using compressed air technology and water through save vacuum pumps. These are just a few areas of application for the diverse application possibilities of pumps and compressors. If a topic has aroused your particular interest, please contact the author or author of the respective article. The experts and experts will be happy to exchange ideas with you. But now we wish you an exciting and insightful read.

Dr. Sönke Brodersen
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and Vacuum Technology



“2022 went much better than expected”

■ Pump and compressor manufacturers expect consolidation at a good level in 2023.



Christoph Singrün

Interview with Christoph Singrün, the Managing Director of the VDMA associations Pumps + Systems and Compressors, Compressed Air and Vacuum Technology.

Another pandemic year, the Ukraine war and global inflation. How did this affect companies in 2022?

Although the terrible war in Ukraine began at the end of February, we initially had no slumps in orders and sales in either sector. In the case of pumps, we only recorded a real decline in order intake of 3 percent over the year and speak of a price-adjusted decline in sales of around 2 percent. That is moderate. Order intake for compressors, compressed air and vacuum technology grew slightly by 3 percent. In price-adjusted terms, sales in this area even rose by around 9 percent. This is no reason for euphoria, but also not for a mood of crisis. Overall, 2022 went much better than expected.

How have the global crises affected the development of companies?

The majority of our members, regardless of size, are active in markets worldwide. Experience teaches us that sometimes one market or a user industry works better, sometimes another. In this respect, the sectors have a certain resistance to crises. The global outlook: Companies in no region are starting from scratch.

Keyword global supply bottlenecks. How have these developed for companies over the past year?

Like many others, Pumps + Compressors were affected by supply bottlenecks. While incoming orders grew very well in some cases, sales were not able to keep pace to the same extent. A clear indication of supply bottlenecks. In our survey of VDMA members last December, two-thirds of respondents stated that they felt the impact on supply chains noticeably or severely. Many companies were missing parts that weren't even complex, such as cover panels.

Do you expect the current situation to worsen?

Supply chains have fortunately become more stable again. Our Achilles heel, however, are mostly electronic components such as chips or semiconductors. Here, the surveyed members do not expect relief on the supplier markets until the end of 2023. Now it is time to reduce the historically high order backlog piece by piece.

Have high energy prices had an impact on industries?

Members, for example, who maintain their own foundry, have been very burdened by this. But the plant business was also affected. All companies that test and approve large units on the test benches together with their customers require a lot of electricity. If several pumps and compressors run in parallel, you quickly get into the megawatt range. In contrast to private customers, the companies have not received a fixed price guarantee from their local energy suppliers. The VDMA has campaigned politically in Berlin for energy suppliers to also offer fixed prices to industrial customers so that they have calculation security. Because 18 months pass from order placement to delivery.

Chinese exports fell by 9.9 percent in December, imports by 7.5 percent compared to the same month last year. To what extent does this affect the industries?

The People's Republic was a market full of surprises in 2022. In view of the meanwhile complete figures, pump imports from China have risen by 12 percent, exports to China by around 8 percent. These are good values that surprised us. This is certainly also due to industries such as power plant construction or the



chemical industry, which require pumps in large numbers. The situation is similar with compressors, compressed air and vacuum technology. Imports rose by 14 percent. In terms of exports, we even recorded an increase of 17 percent. I assume that this is due to battery or photovoltaic production.

The switch to electromobility has an impact on sales of pumps and compressors. Can you help us to classify this?

This is a classic case that shows how many user industries we have. Old markets are going, new ones are coming. A newer market is electromobility, in whose production processes pumps are used. Battery production, for example, is highly complex. The liquid pumps used there can also transport acidic media. Even in automotive manufacturing itself, there are many processes that have to deal with difficult fluids. For this, manufacturers need special providers, which they find mainly in Europe. In addition, the production of solar panels requires vacuum and clean room technology – without high-temperature vacuum equipment, this is simply not possible.

A central topic in production is climate protection and the associated efficiency.

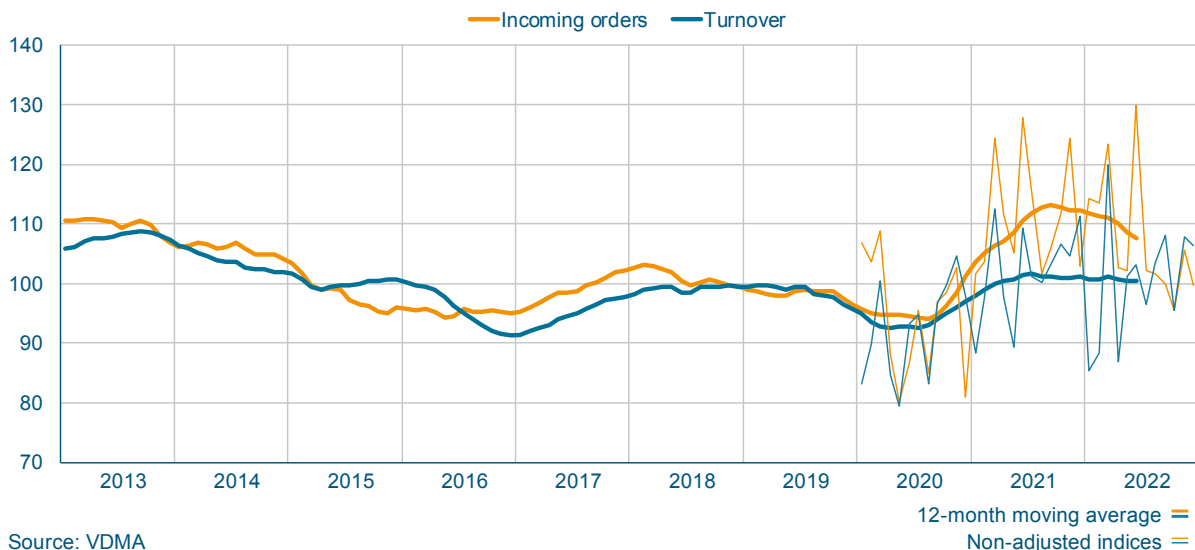
Compressed air is expensive if it is operated inefficiently and thus understandably harmful to the climate. This is the starting point for our manufacturers to develop cost- and energy-efficient products. More than 20 years ago, we launched an information campaign with the Federal Ministry for Economic Affairs and Climate Action. At that time, our focus was on compressed air leakage. With a computer model, we have shown users which adjustment screws they can use to save energy and thus also reduce costs. They will be showcasing their current efficient solutions at this year’s Hannover Messe, among others. After four years, we are finally represented there again with Compressed Air & Vacuum and our industry message “Digital, Sustainable and Forward-Looking”.

Can digital transformation help with climate protection?

Of course. We have standardized digital information models so that manufacturers are able to speak a production language together with their customers. We used the administration

Incoming orders and turnover in Germany – Pumps

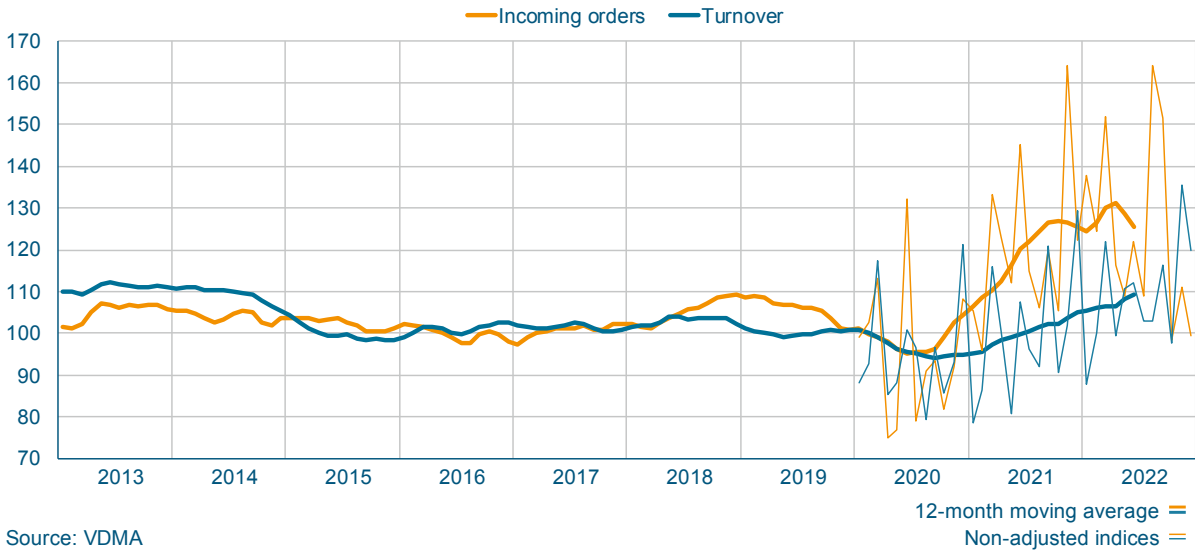
Volume index 2015 = 100





Incoming orders and turnover in Germany Compressors, Compressed Air and Vacuum Technology

Volume index 2015 = 100



Source: VDMA

shell to define what is now referred to as a digital twin. This means that we have described the pump, the compressor and the vacuum pump in terms of information technology so that these components can be read by all involved parties. In addition, we have defined so-called OPC UA Companion Specifications to ensure the interoperability of machines and components. Digitalization offers opportunities to save further energy during operation. This includes monitoring, maintenance, and troubleshooting, as well as the use of digital twins to simulate and optimize system performance. For this purpose, manufacturers must be able to track the machine data during application at the customer's site. The necessary data transparency for all those involved in the process still leads to great uncertainties today. And I do understand that. Here we have to provide information on the part of the association and provide our members with appropriate information.

Are there any key trends in the industries?

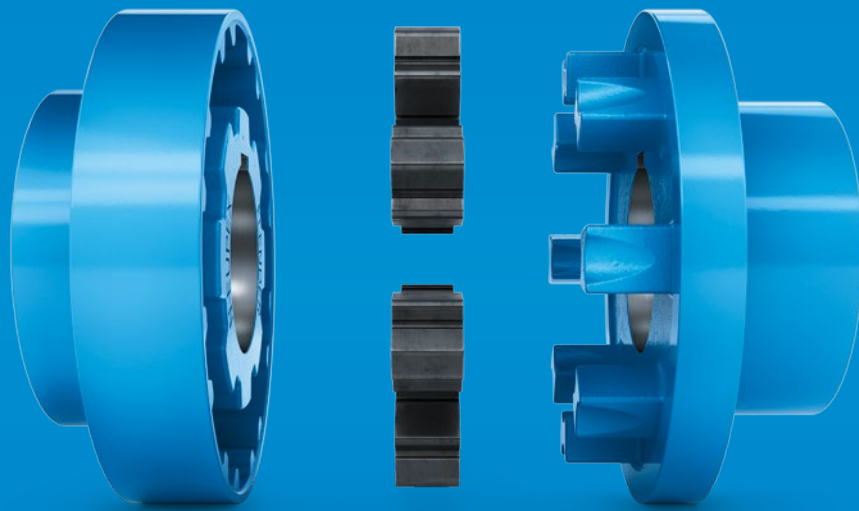
The biggest driver is climate protection. Energy saving is the central issue. The systems can consume a lot of energy, every kilowatt hour we save is a good one. In addition, the hydro-

gen economy is picking up speed. We need to replace fossil fuels with green hydrogen. Pumps are essential for infrastructure and transport or electrolysis plants. Entire industries are currently being turned upside down. Keyword "Green Steel". The chemical industry worldwide must also switch to electricity- or hydrogen-controlled processes. And thirdly, the topic of carbon capture storage is picking up speed again. We will not be able to avoid storing CO₂.

What are your expectations for 2023?

First of all, I hope that the war in Ukraine will soon come to an end and that the geopolitical tensions in the Asian region will subside. I am optimistic about the future if we receive positive economic signals. German and European industry is more resilient than we thought four or six months ago. In this respect, I am cautiously optimistic about both sectors. It will not be a jubilee year. For Pumps + Systems. I expect a growth of up to 5 percent and for compressors, compressed air and vacuum systems 1 to 2 percent. This is a consolidation at a good level.

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The trade show business is back in full swing. At ADIPEC 2023, there will be a „green pavilion“ for the first time, focusing on the topic of climate protection.

Source: VDMA

Trade fairs abroad: Federal Ministry cuts budget

■ Ulrike Mätje

After two years of Covid-19-related standstill, companies can once again turn to trade fairs as an important sales channel for them and exhibit at domestic trade fairs such as IFAT, Achema and Hannover Messe. However, the German parliament recently cut the budget for the foreign trade fair program by a surprising 20 percent. As a result, some of the previous trade fairs will no longer be funded in the future.

With the Foreign Trade Fair Program (AMP), the German Federal Ministry of Economics and Climate Action (BMWK) offers German joint stands at up to 300 international trade fairs. In selecting the trade fairs, the ministry is supported by the Association of the German Trade Fair Industry (AUMA) and the industry associations. The program is aimed at small and medium-sized enterprises, to support them in opening up international markets and in addressing potential customers in the sectors water, oil and gas and renewable energy and thereby to maintain and create jobs in Germany. Participation in the so-called German Pavilions makes it easier for small and medium-sized mechanical engineering companies to present themselves on rele-

vant target markets. The companies appearing on the joint stand under „Made in Germany“ are relieved of many organizational tasks or have them made considerably easier. They can concentrate on the essentials – their exhibits and their own stand personnel.

In the future, the BMWK will supplement the AMP with its new focus on climate protection. „For the first time, a pilot project is planned for this at ADIPEC 2023 in Abu Dhabi. Companies can present their solutions with a focus on climate and sustainability in the so-called green pavilion,“ reports Dr. Alexander Koldau, Consultant for Foreign Trade at VDMA. The German Pavilion at ADIPEC is one of up to 90 pavilions a

Pump technology for complex media

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year that the VDMA actively supports. With almost 1,300 square meters of exhibition space, the Pavilion is one of the largest trade fair participations in the AMP.

Price development and budget cuts

At first glance, however, this is currently the only positive development in the BMWK offering. This is because the price trend in the trade show business has increased significantly: During the Covid-19 pandemic, costs have skyrocketed in terms of space rental, stand construction, and flight and hotel costs. These cost increases are being passed on to exhibitors, resulting in significant price increases for exhibitors with the withdrawal of increased funding in the 2020 to 2022 Covid-19 years. The 20 percent budget cut for the AMP will result in a reduction in the total number of bids, which will also affect the joint stands applied for by VDMA. It is still unclear whether the BMWK will specify focal points for the reduction in the number of projects.

In addition, the BMWK wants to reduce the German economy's dependence on China as a sales market and make it more independent by opening up new markets. The associated consequences for trade participations in China and possible new sales markets are yet unclear. Against this background, the decision to cut funding meets with incomprehension, especially from AUMA. On the one hand, the German government is calling on German companies to position themselves more broadly – especially in times of major geopolitical upheaval. On the other hand, with this funding cut and the price increases, it is restricting the opportunities of small and medium-sized companies in particular. This is because the cuts are hampering companies' ability to open up new markets, find new business partners and thus secure production and employment in Germany.

The still unclear orientation of the BMWK with regard to the future focal points in the AMP is problematic. „However, exhibiting companies need not worry that trade fair participations will be cancelled at short notice,“ says Dr. Koldau, with confidence. He says the current situation is forcing all parties involved – the BMWK, AUMA and the participating associations – to sharpen the AMP's focus and consider for which trade fairs in which countries and for which German companies the limited federal funds are most usefully deployed for the German economy. „We are therefore in close coordination with other associations and with AUMA in talks with the BMWK,“ says Dr. Koldau, adding: „We want to further develop the successful range of services that has existed for over 70 years in the interests of export-oriented small and medium-sized enterprises.“

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www.auma.de/en

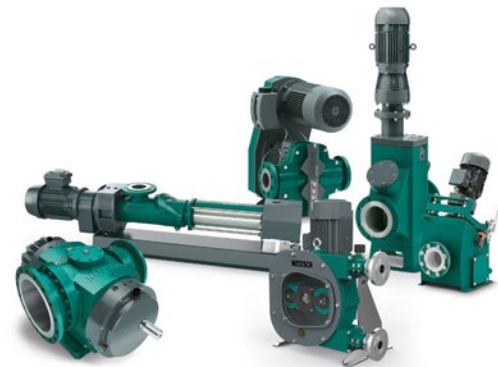
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The OPC Unified Architecture standard enables the platform-independent exchange of data between machines, plants and their components.

Source: Shutterstock

OPC UA – fit for the digital world

■ Friedrich Klütsch and Dr. Andreas Brand

The VDMA Pumps + Systems and Compressors, Compressed Air and Vacuum Technology associations have already created the prerequisites for Industry 4.0-capable products and created industry-specific companion specifications.

In the future, business success will increasingly be determined by digital change. The open interface standard Open Platform Communications Unified Architecture (OPC UA) is a central prerequisite for the successful introduction of Industry 4.0 into production. With OPC UA, machines and systems can be linked together via Plug & Work across manufacturers in a platform-independent way. Furthermore they can be redesigned as required.

In order to achieve this, the VDMA and its member companies have developed industry-specific OPC UA Companion Specifications. These standardized information models are able to display pump, vacuum pump and compressed air system-related data uniformly regardless of manufacturer and location.

On the way to Companion Specification

The initial goal was to create the so-called administration shell: This serves the digital description of a product – the so-called digital twin. Via the administration shell, a device acquires the ability to exchange the described parameters with other devices or control devices (such as a process control system, PCT) and to communicate with other intelligent components. In conjunction with the Internet of Things and corresponding services, it represents an important Industry 4.0 component.

Central components of the administration shell are standardized sub-models that simulate different functions of the pump (identification,

diagnosis, control, etc.) with structured, standardized characteristics according to IEC 61360. In order to be able to transfer the pump profile into a manufacturer-independent administration shell, the phases to be standardized in the pump life cycle (such as planning, ordering, delivery, commissioning, operation, dismantling) must also be defined. Once the administration shell for a product has been created and its semantic description defined, the OPC-UA-compliant implementation is carried out by rewriting it into a machine-readable language – here OPC-UA.

Manufacturer-independent data exchange for pumps and compressed air systems

With the Companion Specification OPC 40223 for Pumps and Vacuum Pumps, every pump manufacturer has been able to make products fit for Industry 4.0 since the end of 2020. The digital, manufacturer-independent data exchange thus implemented enables earlier intervention in processes (e.g. in the event of malfunctions), faster initiation of measures (such as ordering spare parts) and ultimately an increase in availability and higher customer satisfaction.

Unlike pumps, compressed air systems have been chosen to take the direct route to the companion specification. OPC/VDMA 40250-1: OPC UA for Compressed Air Systems regulates the communication between the Main Control System (MCS) of a compressed air system and the higher-level manufacturing system. This involves the transport of status data of a compressed air system (CAS) into higher-level production systems in order to provide and monitor information and to set basic parameters with regard to the setpoints of the respective CAS. The description of the CAS and its components focuses on selected use cases. These include device identification, configuration, general data collection and energy management. The Companion Specification was published in July 2021. Users can easily integrate the standard into the higher-level production control.

Both companion specifications were created through the cooperation of member companies of the respective VDMA associations and the compressed air technology department. The Institute for Technical Building Equipment (TGA) of the Faculty of Systems, Energy and Machine Systems of the TH Köln under the direction of Prof. Dr. Jochen Müller and his team scientifically accompanied the preparation.

Missing companion specifications for other components of a compressed air system will be created in the future. An OPC UA specification for compressors would not only have to map air compressors, but also process compressors.

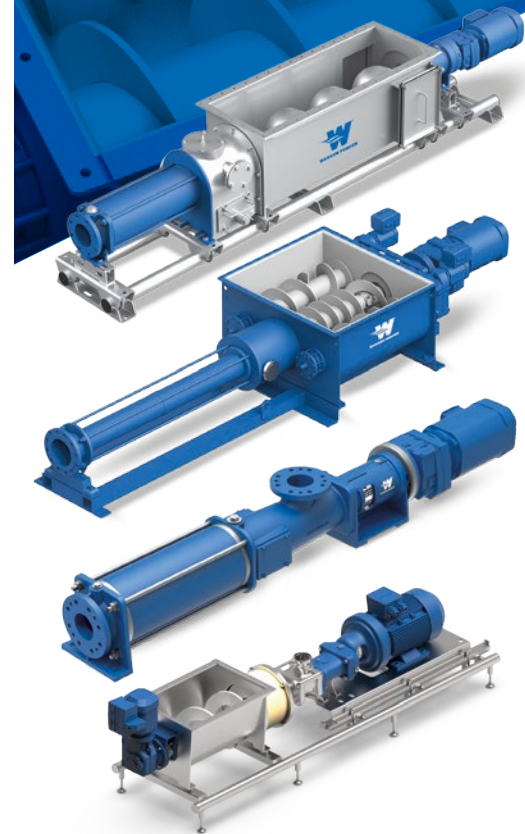
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Among other things, on the test rig, experts test canned motor pumps for characteristics, power requirements and non-contact pump operation.

Source: Hermetic-Pumpen GmbH

Decaffeinating with high-pressure technology

■ Dieter Lau

Italian company Lavazza relies exclusively on the CO₂ extraction method for decaffeination of coffee. Carbon dioxide in a supercritical state is used and is liquefied by high pressure. Due to its high compressibility, the supercritical aggregate state of CO₂ poses a challenge for process stability. In conjunction with the high temperatures and extremely low viscosity of the fluid, the process imposes high requirements on the equipment used. A canned motor pump from serves as the circulation pump. The compact aggregate, including monitoring technology, ensures reliable CO₂ flow through the coffee. Thanks to the low-wear and low-maintenance design principle caffeine can be extracted in 24-hour operation over an extended period of time.



Supercritical Carbon Dioxide (CO₂) is in a liquid state above its critical temperature and above its critical pressure. This means that supercritical carbon dioxide has other properties in this state than it has in its normal state. In this state, its properties are between the properties of a gas and a liquid: It has the viscosity, compressibility and diffusivity of a gas and the density and solubility of a liquid. It can easily penetrate other materials and extract the desired substances from them. Due to its natural properties and the purity of the end product, supercritical carbon dioxide is primarily used in the food industry and pharmaceutical industry.

Decaffeinating under supercritical conditions

Decaffeination is a process that extracts the caffeine from coffee beans while they are still green. Lavazza uses the CO₂ method exclusively. This is the only way to release caffeine from the bean. The procedure has been used since 1991 in the company's Pozzilli production plant in the Molise region of Italy. For this procedure raw coffee beans are first soaked in water. The beans are then routed into an extractor (autoclave) where carbon dioxide flows under supercritical conditions. In this manner, the caffeine is

extracted from the coffee beans and then recovered. Next, the procedure dries the decaffeinated coffee beans to a residual moisture of less than 11 percent.

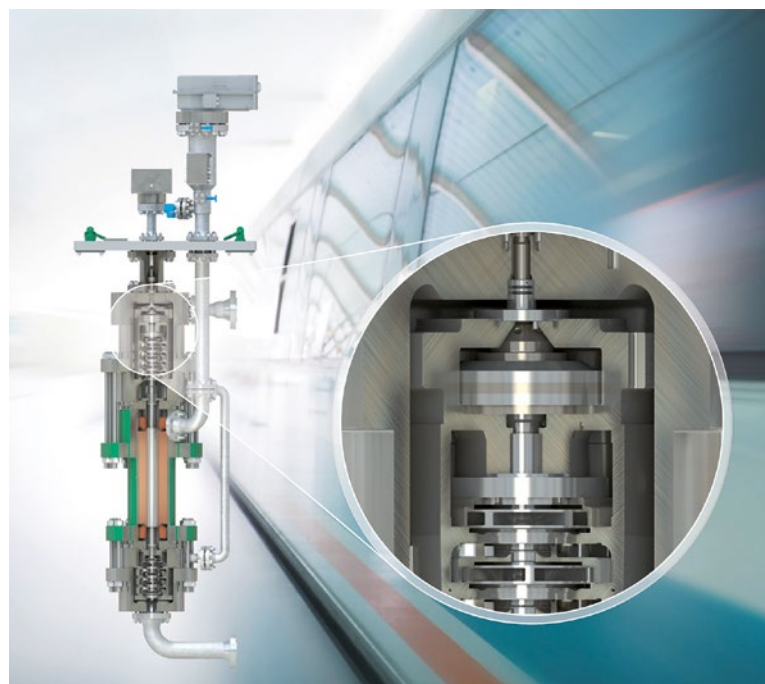
Withstanding high pressure, high temperature, low viscosity

With CO₂ extraction the prevailing high temperature results in extremely high vapour pressure at extremely low viscosities. This subjects the centrifugal pump to significant loads, which the pump must be able to withstand. Flowing through the pump, the mixture of CO₂, water and caffeine may also leave residues or cause blockages.

To avoid these situations, Lavazza relies on a canned motor pump. The multistage centrifugal pump, configured for high-pressure applications, ensures reliable conveyance of the carbon dioxide in the system. In this regard, the prevailing process conditions are pressure greater than 200 bar, temperature greater than 80 degrees centigrade and a CO₂ flow rate of more than 140 m³/h. For canned motor pumps, the motor and hydraulics are one common unit; the rotor and the impeller are arranged on one and the same shaft. The rotor is guided by medium-lubricated



Vertical canned motor pump in high pressure design.



Typical arrangement of magnetic support bearing in vertical pumps.

Source: Hermetic-Pumpen GmbH



radial bearings, the stator of the drive motor is separated from the rotor chamber by a rotor lining. Thus, the rotor chamber of the drive and the hydraulic housing of the pump form a common space, where the pumped liquid circulates.

Low-wear design principle for 24-hour continuous operation

Thanks to its integral and compact design, the canned motor pump does not require shaft seals, conventional bearings or couplings. This is an advantage over pumps with mechanical seals, which are more susceptible to the pressures and temperatures prevailing in the extraction process. The pump also runs very quietly.

A technology based on comprehensive axial thrust balancing using non-contact hydrodynamic plain bearings, ensures non-contact and low-wear operation of the rotor unit. The pump is set up vertically to accommodate the low viscosity of the pumped medium and the resulting reduced load capacity of the bearings. This means that the plain bearings do not have a bearing function at all, but rather they have only a guiding function. The enormous weight of the

rotor is supported hydrostatically. This allows the rotor to work in continuous non-contact operation with no wear whatsoever. Which in turn, enables caffeine extraction in 24-hour operation over several years. Another advantage of the vertical installation is simplified degassing of the pump.

Reliable axial thrust balancing with rotor position monitoring

For canned motor pumps, the axial position of the pump shaft regulates itself automatically in operation. This establishes a force-free state of equilibrium automatically and no axial forces act on the axial bearing collar of the plain bearings. For the pump used by the Italian coffee group, an axial control disc ensures axial thrust balancing. The pump is equipped with a rotor position monitor, for constant monitoring of axial thrust. The monitoring device detects the most minute deviations of the rotor and thus it also detects impermissible modes of operation outside of the defined pump capacity range. It also functions as an early warning system that prevents undesired operating states and expensive damage cases.

Non-contact magnetic bearings for canned motor pumps

The manufacturer has developed a magnetic support bearing that customers can use for vertical canned motor pumps. The support bearing offers reliability even in demanding operating environments. The magnetic bearing technology utilizes two powerful magnetic discs to keep the rotating elements of the pump free of contact in operation and at shut-down. This is accomplished by strong magnetic forces. In operation, the rotating shaft assembly is stable, in order to achieve a defined vertical distance between the rotating magnetic disc and the stationary magnetic disc.

This gap between the magnetic bearings guarantees wear-free, start/stop operation, and prevents contact even when the machine is at a standstill. The magnetic bearing also ensures non-contact function in extreme operating parameters such as low flow conditions, cavitation or temporary gas entrainments. In addition, the magnetic bearing is suitable for operation on frequency converters. This ensures complete thrust balancing and non-contact operation.

The magnetic bearing increases reliability and availability under unstable, fluctuating operating conditions. The mean time between failures (MTBF) values achieved enable extremely long maintenance intervals for the plant operator. The magnetic bearing is used for vertical machines to pump ethylene, propane and many other supercritical gases.

Source: Hermetic-Pumpen GmbH

**Implementation under extreme conditions
in a variety of different industries**

For plant operators in the chemical industry or petrochemical industry, canned motor pumps are preferred. This pump type guarantees maximum safety for humans and the environment, even in the varied production processes of the chemical industry or petrochemical industry. Frequently designed for harsh conditions, canned motor pumps are used wherever plant operators pump liquids and gases with extreme temperatures and with potential hazards. These pumps offer safety, even at high pressures and high capacities. They are also used wherever conventional technologies reach their limits. The second, hermetically sealed containment of canned motor pumps offers reliable protection against undesired leakage of the pumps.

Implementation even for simple pumping tasks
Industrial enterprises also rely on canned motor pumps for simple pumping tasks, such as circulating pumps in industrial refrigeration equipment. These circulating pumps convey:

- aggressive,
- toxic,
- explosive,
- hot,
- cryogenic ,
- malodorous,
- volatile,
- combustible or carcinogenic substances.

These pumped media pose health hazards and environmental hazards. Therefore, manufacturers as well as operators of cryogenic plants need refrigerant pumps that meet the high standards for safety, efficiency and quality.

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Chopper pumps with macerator remove coarse solids and fibers from wastewater.

Source: HOMA Pumpenfabrik GmbH

New chopper pump achieves high efficiency

■ Konstantin Pörsch

The amount of problematic solids, such as cleaning wipes, textiles or household waste, found in waste water is increasing worldwide. Pumping and sewage treatment plants are therefore increasingly reaching their limits; units get clogged up and break down. In times when low lifecycle costs play an increasingly important role, energy efficient chopper pumps offer a reliable solution for applications with high delivery heads. The open impeller of new series achieves an efficiency of up to 67 percent.



Lifecycle costs, particularly in relation to water and waste water applications, are increasingly being scrutinized by users. This is because pumping plant operators often have to contend with the susceptibility of conventional pumps to coarse solids. Coarse solids usually lead to blockages in conventional channel impeller pumps. Large accumulations of wipes and other fibrous solids in particular can clog the impeller. This problem is not a regional phenomenon, it occurs worldwide. Eliminating such faults in the system is always time-consuming and costly. Therefore, low-maintenance and trouble-free operation is the top priority for operators.

To meet these requirements, Homa Pumpenfabrik has developed a chopper pump series that provides a solution to these problems and is also available as an explosion-proof design. Operators can use these if, for example, they are pumping combustible and highly flammable media or if such components can get into the medium. These include vapours and flammable liquids from the sewage system, digester gases from waste water and sewage sludge.

Cutter system shreds all solids

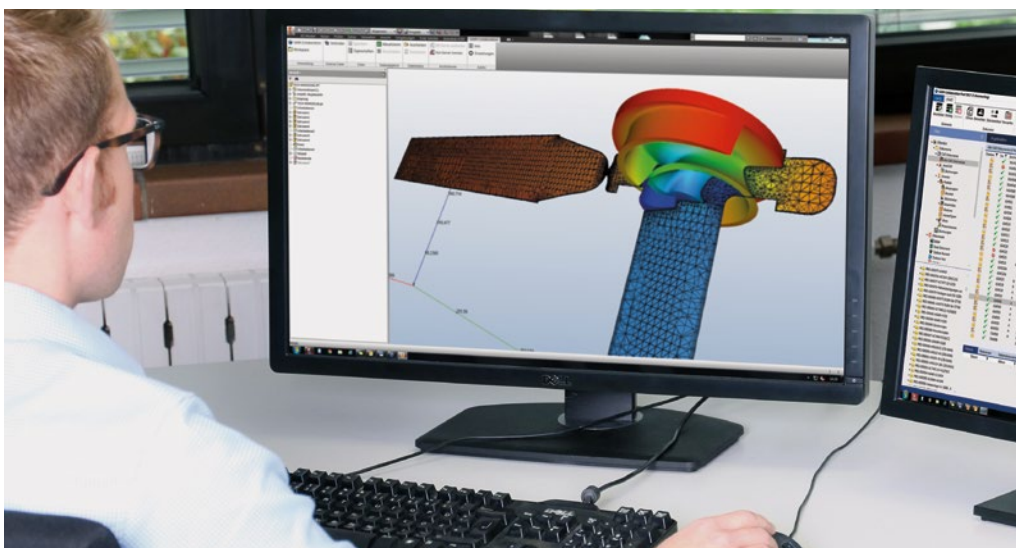
The purpose of developing this pump was to achieve high delivery pressures in the medium flow rate range. Thanks to its efficiency, the chopper pump manages with a smaller, more cost effective and energy saving motor than is

used other pumps in the same operating range, without compromising on pump rate. The company has developed a new cutter system to facilitate this. The cutter system effectively shreds a variety of different solids and transports them away. These include, for example, tear-resistant hygiene wipes, household waste or textiles, which can also enter the waste water via surface water. The specially designed impeller has integrated cutting edges and rotates on a wear plate that is also equipped with cutting edges. These two key components work perfectly together to catch solids, break them down and ultimately remove them from the intake area via integrated grooves in the wear plate.

The components subject to the most stress – impeller and wear plate – are made of extremely resistant chilled chrome cast iron.

High efficiency without inhibiting cutting performance

In order to achieve the highest possible efficiency of up to 67 percent without inhibiting the cutting performance, the impeller blades are sharply curved. Consequently, the 50-Hertz version of the pump achieves a flow rate of up



Source: HOMA Pumpenfabrik GmbH

In the development centre, the manufacturer tests new developments using flow simulation.



Chopper pumps: global use on the rise

The majority of people today live in cities. It is estimated that 80 percent of the world's population will live in cities by the year 2050. Although growth in the metropolises of the industrialized countries is slowing down and in some cases the population in cities is declining. In contrast, urban agglomerations and informal settlements in developing and emerging countries are experiencing major growth.

Increasing urbanization also leads to more wastewater that has to be treated. Hence there has been a growing worldwide demand for pumps capable of handling difficult media for decades. These pumps are often used in aggressive environments, which is why they are designed for tough operating conditions. Typical application areas are:

- Municipal wastewater treatment plants as well as wells and lifting stations
- Biogas plants
- Chemical plants
- Meat, paper and food processing plants
- Slaughterhouses and fish processing plants

to 130 m³/h and a delivery head of up to 57 m with a power consumption of 5 to 12 kW. In the 60-Hertz version, the chopper pump achieves a flow rate of up to 135 m³/h and a delivery head of up to 82 m with a power consumption of 8 to 20 kW. Via the suction cover mounted on the pump housing, users can adjust the cutting gap between the impeller and the wear plate to always achieve optimum cutting perfor-

mance plus high efficiency. The new series, available for wet and dry installation, also has a long service life.

Low lifecycle costs thanks to wear-resistant design

In order to achieve not only the best possible efficiency values in the operating range required for the corresponding waste water applications, but also to reduce lifecycle costs overall, the manufacturer places a great deal of emphasis on low-maintenance operation in addition to efficiency. As a result, the components subject to the most stress – impeller and wear plate – are made of extremely robust chilled chrome cast iron, which withstands even abrasive substances such as sand in the pumped medium. Both components are individually replaceable to minimise maintenance costs.



Source: HOMA Pumpenfabrik GmbH

The impeller has integrated cutters and a sharp-edged radius to the wear plate.

Pumps for an above-average number of different solids

In addition, the manufacturer has used computational fluid dynamics (CFD) to optimally design the hydraulics for the application area



Source: HOMA Pumpenfabrik GmbH

and at the same time increase efficiency. This eliminates the potential of solids building up, which can have a negative impact on performance and result in costly pump failures. This makes the pump particularly suitable for waste water applications that require medium to high delivery pressures, and at the same time have to deal with many different kinds of solids. The manufacturer plans to add DN 80 hydraulics to the two-pole pumps and then add four-pole variants to the DN 80 and DN 100 chopper series, which can also be used at lower delivery heads.

Author:
 Konstantin Pörsch
 Development Engineer
 HOMA Pumpenfabrik GmbH
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The OC impeller of the chopper pump enables low-maintenance operation.

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The data is transferred from the pump to the web portal or app via the cloud.

Source: KSB SE & Co. KGaA

Detecting anomalies early – lowering energy costs

■ Saskia Rothermel

The combination of sensors and smart algorithms along with the expert knowledge of the solution provider make it possible to detect signs of wear at an earlier point. Monitoring solutions offer much more, however. They provide comprehensive transparency, improve operating reliability and the availability of machinery and systems as well as optimise maintenance.



Monitoring solutions are unquestionably an important tool paving the way toward a digitalised system, improved maintenance and energy-efficient processes. To this end, basic data such as vibrations, temperatures, operating hours and information on the operating point are key to success. This data first must be available, however, as well as correctly analysed and interpreted. The overriding objectives are clear – identify incorrectly operated components and predict signs of wear and damage to avoid cost-intensive downtime and reduce energy costs. In this context, the question remains as to how digital solutions can facilitate analysis and interpretation, and how this data can be optimally used.

Transforming data into information – detect anomalies at an early stage

The magic word in this context is anomaly detection. Here, the objective is to be able to make predictions about anomalies based on current operating parameters, allowing precautions to be taken before an unscheduled downtime occurs. This method is also known as predictive maintenance. Predictive maintenance links and evaluates existing machine data using statistical models and intelligent algorithms.

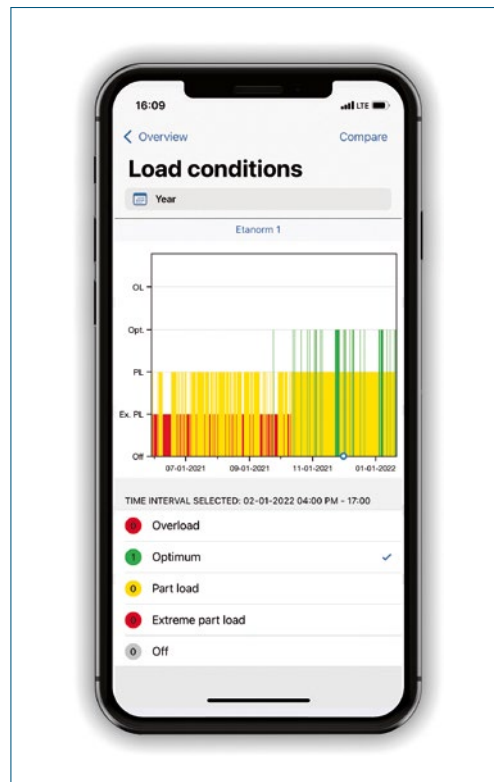
How do operators implement intelligent, yet practical predictive maintenance, however? Reliable, centrally collected digital status data on the machinery in operation is first required. Once this data has been obtained, the status data should be evaluated and visualised – ideally in automated fashion. After the evaluation has been made, users can derive key information. For example, trends can already be recognised based on vibration patterns which can, in turn, point to a potential problem even before actual damage occurs. These trends indicate what type of pump problem exists. Gradually elevated vibrations over the course of a few weeks or months, for example, indicate that there is a technical problem with a pump. This is of course not noticeable to the observer because the pump is running well. Suboptimal pump operation cannot be hidden from an intelligent algorithm, however. This makes it clear that digitalisation brings about sizeable benefits and, thus, also optimises or

can even transform maintenance management. Operators can now benefit from transparency, operating reliability and availability.

Easy entry into predictive maintenance

Studies conducted by the VDMA (German Mechanical and Plant Engineering Industry Association) have shown that 70 percent of unscheduled system downtimes can be detected in advance and avoided by leveraging monitoring solutions. With a digital all-round service, operators can optimise their maintenance management as well as receive targeted support from experts.

Getting started with intelligent predictive monitoring of pumps is easy for users. The sensor unit can be bonded to the pump or other rotating equipment by the customer or the solution provider. The sensor unit records vibrations and temperatures and sends them to a cloud. The data collected is then analysed using patented algorithms and subsequently visualised on the web portal or in the app.



Source: KSB SE & Co. KGaA

An algorithm provides valuable information on the operating point via an app.



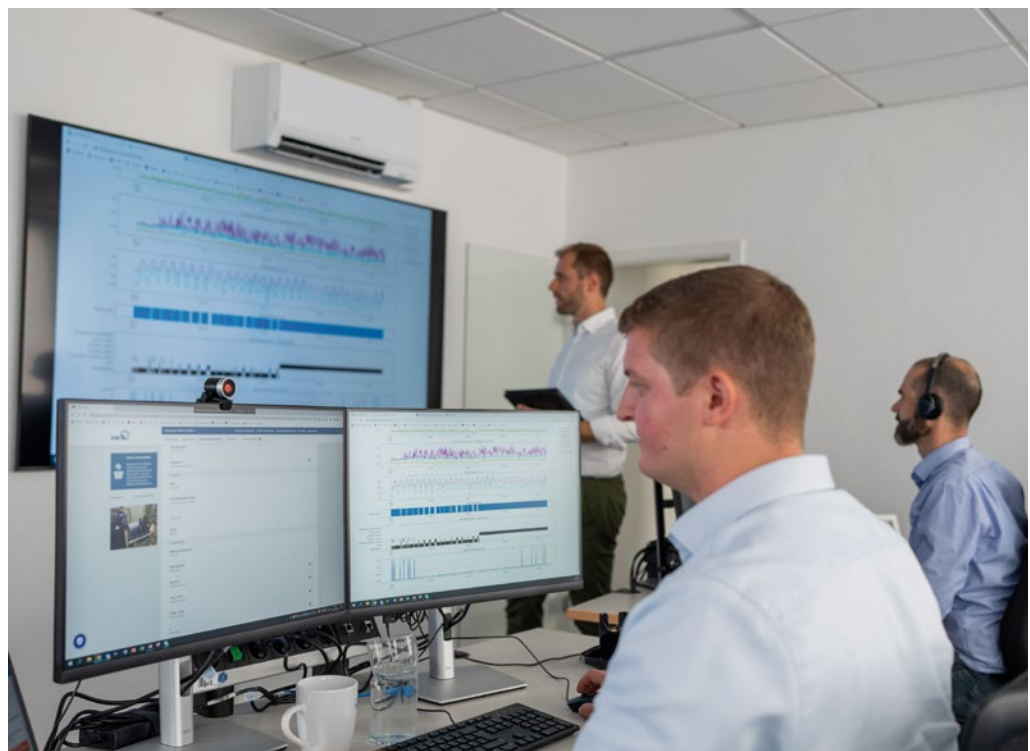
A clearly arranged dashboard provides users with an overview of their pumps at any time and from anywhere. They also receive a great deal of ancillary information on temperatures, vibrations, operating hours and load conditions/profiles. Documentation on the pumps can also be viewed, and a history of all maintenance activities can be configured. This, then, establishes a comprehensive history file for the pump. Whoever is in need of a reminder for bearing replacement or lubrication can also define this accordingly.

Users have an overview of their pumps on a clear dashboard anytime and anywhere and receive a lot of additional information about temperature, vibrations, operating hours as well as load conditions and profiles.

Should a deviation from normal operation be detected, users will be provided with a corresponding notification in the form of a warning or alert. Even notifications are “intelligent” now. This means that the algorithm used sets dynamic limits based on the individual pump’s vibration behaviour and output. While the static limit values of a DIN standard were used previously, now the limits are carefully balanced in line with the algorithm.

Preventing unscheduled system downtime

The combination of sensors and smart algorithms along with the expert knowledge of the solution provider make it possible to detect signs of wear at an earlier point, for example, or avoid possible consequential damage as a result of maintenance measures which have not been performed. Unscheduled system downtime is avoided. Maintenance work can also be better prepared as users can create maintenance schedules for each machine. This also makes it possible to do a more efficient job of spare parts stocking. All of this translates to better operating reliability and greater availability as well as considerable cost savings.



Experts analyse the vibrations measured by the monitoring solution.

Source: KSB SE & Co. KGaA



Adding to this is a monitoring centre with vibration experts contributing their knowledge. To this end, they monitor and analyse the data stream for the user. The team at the monitoring centre identifies changing trends in the measurement data at an early stage, examines these in detail if so required and recommends repair and maintenance measures. In this context, it is not always about damage that may or may not have occurred, but also efficient pump operation. One fifth of the pumps equipped with this system could be repaired based on this measurement data. In five percent of the pumps fitted with this system, the initial measurement already revealed anomalies.

In developing this solution, the provider placed particular focus on IT security. Since the solution operates completely autonomously and independently of the customer's actual network, an intrusion into the customer's network is impossible. The solution provider is also careful to ensure maximum security in the handling of the data itself: All data acquired is encrypted using TLS 1.2 and sent to the provider's gateway via the MQTT-SN application protocol. The data is then forwarded to the provider's cloud via the secure mobile network.

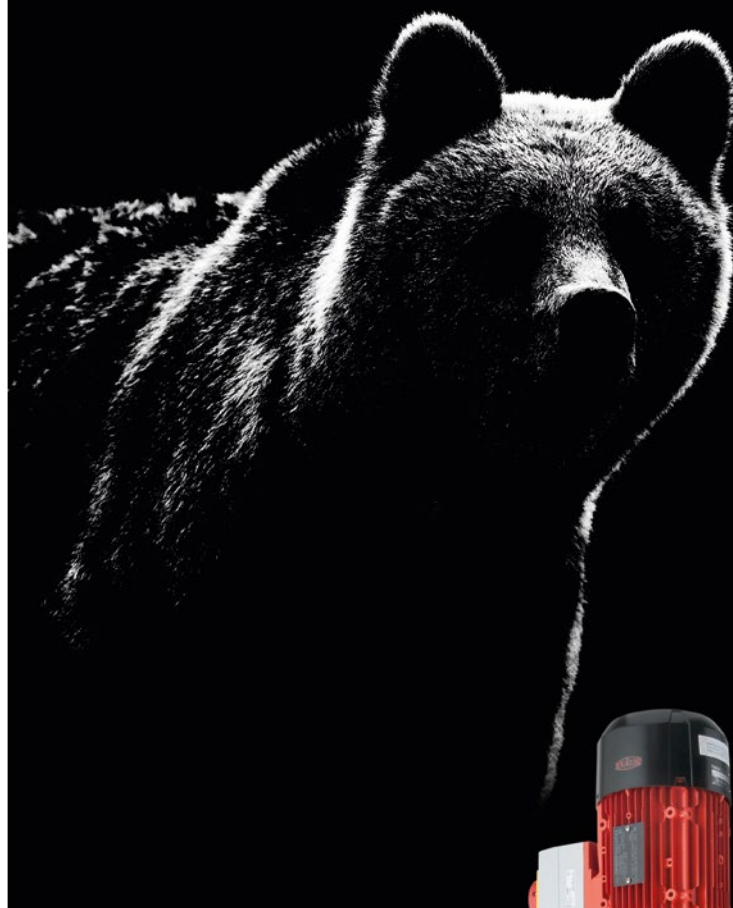
Quickly connecting data silos

Should an evaluation or visualisation tool already be installed on a customer network, the monitoring solution allows the user to synchronise the data of the solution provider with these systems using a standardised REST API data interface. Via the data interface, operators can conveniently integrate all information generated by the monitoring solution into their company's existing solutions. This, in turn, makes it possible to use and manage data centrally as well as combine it with other data.

Practical applications

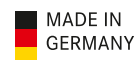
The pump monitoring data interface can be set up quickly. In one example, the solution provider implemented and tested the data interface in just two weeks for a customer in the chemical industry in order to monitor the pumps in the central compressed air supply system. The data collected from the pumps is

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Source: KSB SE & Co. KGaA

Should limit values be exceeded, the expert in the monitoring centre informs the operator accordingly.

Unscheduled system downtime is avoided. Maintenance work can also be better prepared as users can create maintenance schedules for each machine.

now continually fed into the data centre via this interface. Interpreting the data is easy thanks to the standardised interface. The user knows at a glance whether the temperatures or vibrations are okay or whether a limit value has been exceeded. The user can also determine whether only a warning or an alarm is involved. The collected data is supplemented by other data on downtimes and production to provide relevant recommendations for action to maintenance staff and the system operator.

A large water supplier experienced elevated vibration levels last summer, at which point the experts at the monitoring centre contacted the customer and informed him about the condi-

tion of the pump and that bearing damage was imminent. The user then replaced the mechanical seal and a bearing. Soon after, the pump was quickly put back into operation. Major damage was prevented.

At a waste water plant, experts from the monitoring centre repeatedly noticed brief operation with very high vibration levels in excess of 13 mm/s. A glance at the frequency analysis revealed indications of unbalance. The customer then took a more in-depth look at the pump and discovered an excessive bearing clearance. Here, too, monitoring helped avoid consequential damage.

Identifying energy guzzlers – minimising carbon footprint

In addition to facilitating maintenance management, the monitoring solution also provides information on energy efficiency. After all, 75 percent of all pumps are not run at their optimum operating point! Pumps therefore



consume much more energy than necessary. This not only leads to very high costs – which will continue to increase in the years to come – but also directly conflicts with the defined EU target of becoming climate neutral by the year 2050. The monitoring solution identifies the energy guzzlers among fixed-speed pumps in a system as well as optimisation potential.

Detect inefficiencies thanks to intelligent algorithm

This, in turn, is based on the intelligent algorithm for determining the operating point. The load profile identifies the load range in which the pump is currently being run – part load, optimum, and overload – or whether the pump

is currently out of operation. This helps inefficiencies to be detected and, consequently, potential energy or CO₂ savings to be identified. The solution provider also offsets the emissions attributed to the production, use and waste disposal of the monitoring solution. This is yet another step toward sustainable system operation.

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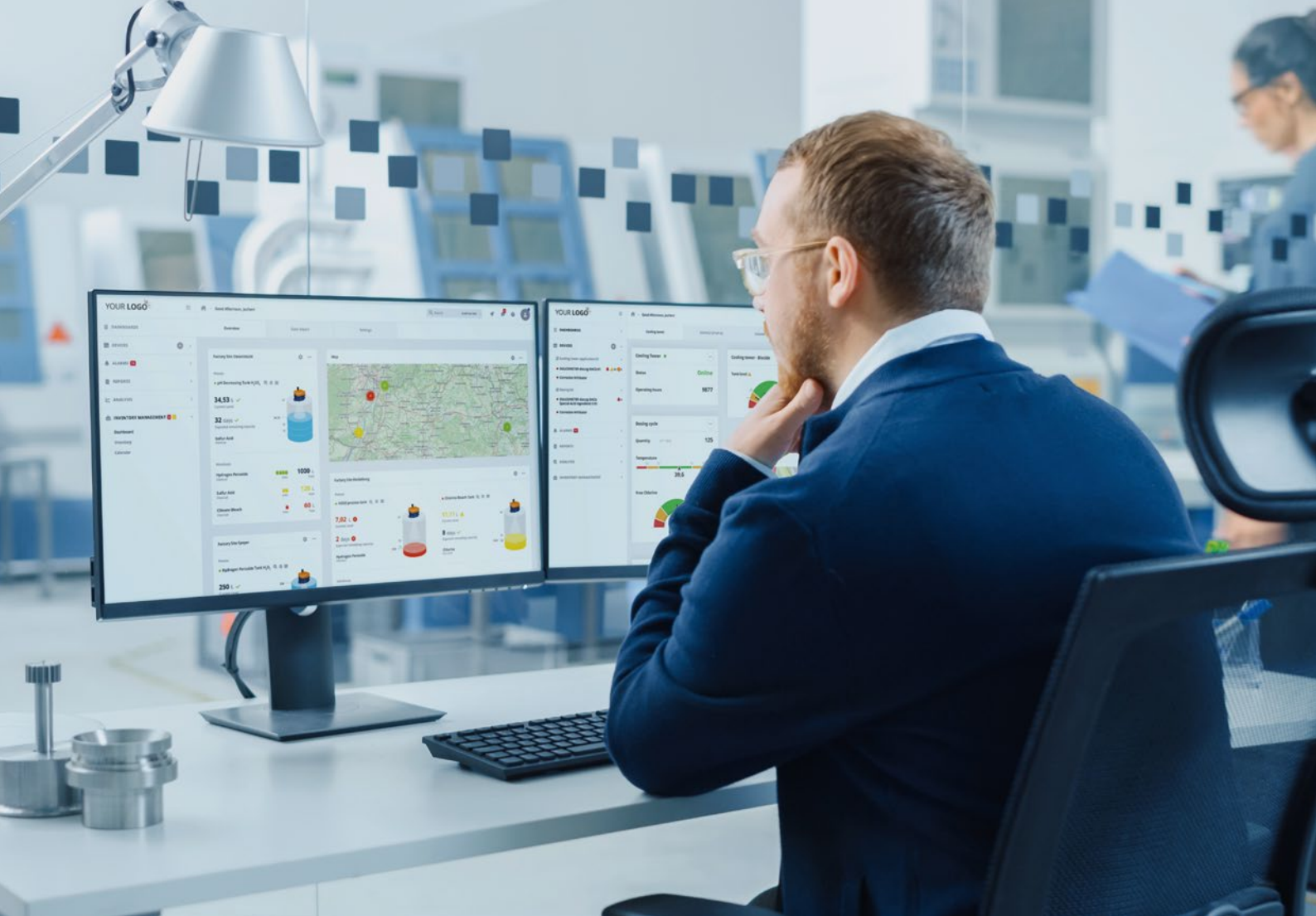


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Employees can monitor, operate and supply any number of sites, remotely and in real time.

Source: Gorodenkoff / Adobe Stock

Digital fluid management with all necessary components integrated

Previously, if you wanted to reap the benefits of digital fluid management, you had to integrate systems from various vendors. But those days are over. Operators can now take advantage of a complete system that includes hardware and software components. This system links pumping and metering with liquid level detection, while providing users with comprehensive diagnostics data and a wide range of services in real time via web application.



The new system features an IIoT-compatible radar level sensor and an Inventory Management module. These are additions to the fluid management cloud platform that has been in use for some years. As a result, operators of water and wastewater technology, as well as chemical distributors and service providers in the disinfection sector, now have access to an integrated digital fluid management system from a single source. All of the products required, from the sensor and pump through to the measuring and control technology, are perfectly matched and can be networked in next to no time.

In practice, this allows for any number of sites with pump installations to be remotely monitored, operated and supplied in real time via the cloud platform. Information on liquid levels, pump rates and consumption or even complete reports are automatically provided. At the same time, smartphone alerts give employees an early warning of low levels and the potential for system interruption so that they can act fast when necessary.

Liquid level sensor suitable for even aggressive media

The radar level sensor can provide information on the levels of any pumpable media with a precision of ± 5 mm. Given the contact-free measurement of the media, the sensor can be used without restriction for even aggressive media, such as sulfuric acid and hydrogen peroxide. The radar technology has an advantage over ultrasound in that it is largely unaffected by fluctuating temperatures and outgassing or foaming liquids.

Intuitive, simple, smartphone-based programming

“The radar sensor is configured intuitively and conveniently via smartphone,” explains Daniel Marcolini, product manager with Prominent in Heidelberg. The app needed for this is free to download from the Google and Apple app stores. The app and sensor automatically recognise each other and pair via Bluetooth once a PIN is entered. All individual settings can then be configured in the app. This primarily means

the key data for the respective tank. If using a tank manufactured by the Heidelberg-based company itself, customers can simply choose the right product from the list. “The app is self-explanatory and extremely easy to use. By just setting a number of threshold values and individual warning ranges, the configuration is complete and the sensor is integrated,” adds the sensor expert.

Configure once, deploy multiple times

The settings configured are subsequently transferred to the liquid level sensor via Bluetooth Low Energy (BLE). The smartphone simply has to be within Bluetooth range of the sensor for this to work. If the sensor is to be used in various tanks, multiple configurations can be saved to the app. When the place of application changes, users simply have to select and then transfer the appropriate configuration. This means that multiple sensors can also be set up in series with the same configuration.

As the sensor does not have a display of its own, a smartphone is also used to read the levels, error messages and alerts. For this, the data is transferred via near field communication (NFC), a technology commonly used when paying by smartphone, for example.



The radar level sensor is installed and configured via plug & play.

Source: ProMinent



Various integration options

Depending on the specific site conditions, the radar level sensor can be integrated into existing pump applications in three different ways:

- **Integration into process control technology:**
Connecting the liquid level sensor to a programmable logic controller (PLC) via a 0/4 to 20 mA interface is a common approach. The sensor is connected using a four-wire cable via which signals are output and power is supplied.
- **Integration into digital process control technology:**
In digital process control systems, the existing communication infrastructure is used. The pump and liquid level sensor are connected via app and communicate with each other over Bluetooth. During operation, the sensor transfers its liquid levels to the pump, from where these are sent together with the pump information to the master control centre via Profibus, Profinet or Modbus. The big advantage of this wireless setup is that the liquid level sensor can be integrated without any further wiring if the pump or metering devices are already cabled within

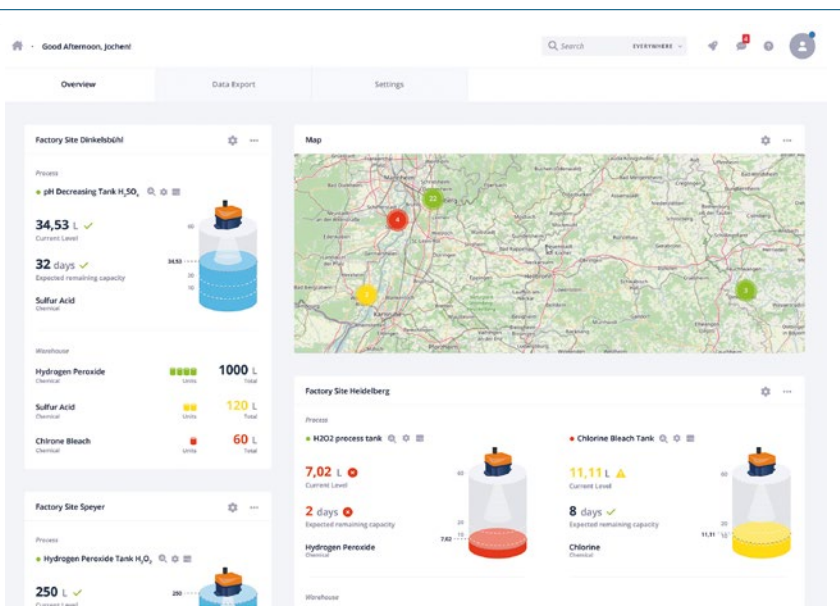


Source: ProMinent

Employees can control metering pumps from their smartphones via app

a system. The only prerequisite is that the pump and sensor have to be installed within the Bluetooth reception range of a few metres.

- **Standalone solution:**
In systems without process control technology, the liquid level sensor and pump are linked together on site. The pump is connected to an IIoT gateway. This sends the values to the cloud platform, where all data is collected and processed.



Source: ProMinent

Inventory Management module: everything at a glance

The finishing touch to the digital fluid management system comes in the form of the platform's Inventory Management module. Application users are shown a graphical overview with all connected sites and systems on a map. Colour coding allows critical states to be identified at a glance on the dashboard itself. Simply by clicking the mouse, users can then access complete records on all installed devices and tanks, including their liquid levels as well as feed rates and consumption. Moreover, the system offers countless pre-built reports that can be automatically run at the press of a button.

Users can view all sites at a glance with the Inventory Management module. The colour coding provides a quick overview.

A typical example is the compliance reporting required when a 35% hydrogen peroxide solution is purchased. This chemical mainly serves as a disinfectant, but can also be improperly used to produce explosives. Trade in this chemical is therefore subject to strict controls and purchasers are required to document consumption in line with regulations. The appropriate report can be produced with a simple click of the mouse.

The main benefit of the digital fluid management system is the significant minimisation of failure risks. Individually configurable alerts for liquid levels, limit violations and critical incidents provide an early warning and can prevent downtime. In addition, real-time system monitoring from any location also offers a range of other advantages:

- Availability of chemicals is assured through 24/7 tank level monitoring
- Just-in-time replenishment of chemicals with event-based alerts sent via email
- Cross-site overview of all process and storage materials
- Overview of reagent consumption over time and per application
- Automated reporting: chemical usage versus inventory
- Compliance with EU and other regulations, such as (EU) 2019/1148

Troubleshooting help

Measurement data and status information from sensors, pumps and controllers can also be very useful during troubleshooting and leak localisation. "For example, if there is a rise in pressure without a decrease in fluid, then this indicates a clogged valve," explains Markus Sharpe, Director of Digitalisation at ProMinent. He adds, "But if the level of a liquid falls without any recognisable metering, this might mean a leak in the line. In response, comprehensive system diagnostics can be run remotely – while meeting regulatory requirements."

Markus Sharpe further reports that radar technology is gaining ground. Sooner or later, it will replace conventional ultrasound technology in the area of liquid level measurement. He would urge customers looking to upgrade their systems now to pay close attention to the connectivity of the devices and sensors as well as the option of connecting to the cloud.

Author:
ProMinent GmbH,
Heidelberg

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Chemical mixes, such as liquid plant fertiliser can be easily decanted into various containers.

Source: Flux-Geräte GmbH

Progressive cavity pump gently pumps fluids

■ Cynthia Steinbach

In many different sectors, media ranging from fluid to pasty have to be gently pumped. In industry, media that is sensitive to shearing, such as paints, pastes or oils, need pumping just as salves or toothpastes do in the pharmaceutical and cosmetic sectors. Even in food production, substances such as molasses or juice concentrates change their consistency if processed too violently. The solution comes in the form of modern positive displacement pumps with eccentric worms. With almost no pulsation and virtually no shearing, they pump geometrically defined volumes per revolution and can even tolerate small solids in the medium. Thanks to clamp connections and a modular structure, they can be used universally and are often a cost-effective solution.



Transferring from one tank to another, filling, metering and other routine tasks require reliable pumps. It is ideal if they are able to pump defined volumes per revolution regardless of pumping pressure or speed. Progressive cavity pumps, which also pump various media almost continuously and very gently can do just that. What's more, a new series of pumps has been designed in a modular fashion. In other words, the pump, riser tube and motor can be put together or replaced as required.

Pump tube – media and delivery volumes can be adjusted with ease

The heart of this pump series is the stator housing with the eccentric screw. With just four different rotor designs, virtually all media, delivery volumes and pressure levels can be adjusted with ease. For example, the special geometry of the R17 rotor permits high pumping pressures at low delivery rate (17 l/min). The R52 rotor as the standard rotor provides a good balance between pumping pressure and delivery rate (52 l/min). Having virtually the same pressure build-up as the R52, the rotor geometry of the R33 is designed for a higher delivery rate. For even higher flow rates up to 83 l/min, the R83 rotor is available. The rotors are driven by torsion shafts, running through the pump tube to the motor. For ease of use, there may be a screw connection or, if required for the application, it may be hygienically welded.

Torsion shafts and pump tubes come in various standard lengths for 60 to 200 litre drums, Intermediate Bulk Containers (IBC) or in special lengths for individual tanks and stirrer vessels. The drive shaft is sealed with a mechanical seal at the motor flange. At its bottom end, the pump's suction side can be fitted with suction tube protection the form of a sieve or protection for inliners, for example. On the motor side, the motor flange is fixed using a quick-release bayonet connection. Standardised 2" clamp connections secure the pump tube to the motor flange and to the hose outflow. These connections are easy to release without the need for tools. Other than the Teflon stator, all the pump parts are made from stainless steel (1.4404). The media-contacting wetted parts, such as centring flange, mechanical seal

and pump tube are therefore easy to clean, disinfect and/or sterilise. What's more, the ball bearings in the bearing flange are protected against contact with the medium by an additional radial seal to ensure a long service life.

Rapid motor replacement and transfer possible

It goes without saying that the range of pumping options also depends on having a range of motors graduated accordingly. Since the bayonet fitting is always the same, the motor can be quickly replaced or if necessary transferred to different pump tubes. Various motors can be used including simple 0.46 to 0.8 kW commutator motors (with speed control as an option), encapsulated 0.75 or 1.1 kW three-phase motors in a normal or EX design or 0.55 kW geared motors for high starting torques. For special usage conditions, for example in areas at risk of explosion, operators can also use a 0.5 to 1.8 kW speed-controlled compressed air drive.

Source: Flux-Geräte GmbH



With the worm designs, virtually all media with various delivery volumes can be pumped with ease.



Source: Flux-Geräte GmbH

Agave syrup or fruit concentrates are gently and hygienically pumped for further processing.

In the food and cosmetics industries, there is increasing demand for pumps that are gentle on the pumped material.

While the commutator motors are relatively light (3 to 6 kg), the much heavier three-phase (20 kg) or geared motors (13 to 20 kg) are suited to continuous use and provide a higher starting torque. For viscous media, such as glue, cold molasses or pastes, this is a real boost for starting up. The compressed air motors achieve good service lives but are noisier due to the flow noise. Regulation can be controlled easily and accurately by adjusting the air volume.

Absolute volumes – using appropriate flow meters

Since the eccentric pump, as a positive displacement pump, always delivers a geometrically defined quantity of fluid per revolution, the user can very easily determine the current flow rate via a speed sensor in the motor flange. This is sufficient for most scenarios. But if manufacturers need absolute volumes, which are not dependent on the minimal gap losses fluctuating with speed or medium, they can use appropriate flow meters. Even media containing larger particles can be pumped by using an appropriate combination of motor and pump components. The pumps can even be used in



Source: Flux-Geräte GmbH

Chemical mixtures such as liquid plant fertilizer can be easily transferred into different containers.



zone 0 if using the explosion-proof models; the explosion-proof outer tubes are then fitted with an earthing connection. Explosion-proof plugs and matched sockets protect the pumps from static charges.

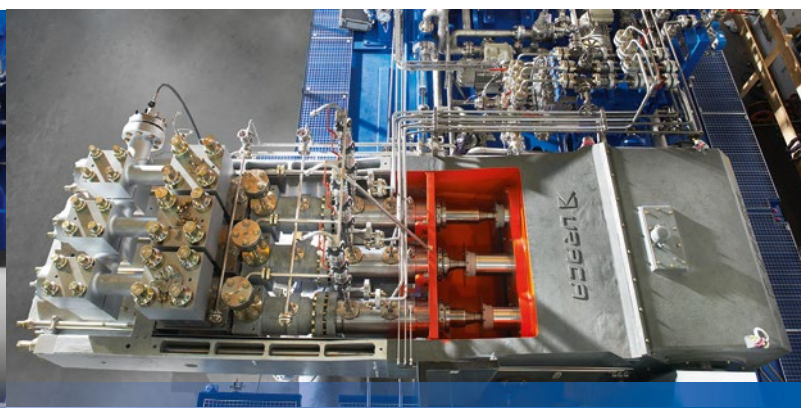
The pump range meets the European safety standards for contact with foodstuffs. It complies with Regulation (EC) No. 1935/2004 as well as the 10/2011 (EU) Regulation on plastic materials and also satisfies the requirements of the Food and Drug Administration (FDA). The manufacturer has dispensed with the usual rinsing connection. The reason is obvious, because the simple disassembly means that all parts can be cleaned individually more quickly. This is not only more economical, because the consumption of cleaning medium is significantly lower than with rinsing, but also allows a visual check for cleanliness and hygiene.

Use in sensitive areas with good metering accuracy possible

Easy cleaning of the individual parts allows the pump to be used for sensitive jobs in the food, pharmaceutical or cosmetics industries. For example, Heimat Distillers, a distiller of spirits, uses 1200 mm long pumps with a two-stage gearbox to fill agave syrup or juice concentrates which are aroma sensitive from IBCs into stainless steel canisters. A closed mechanical seal, the R17 rotor geometry and the PTFE stator, together with a 800-W motor, make hygienic pumping possible so that the media can be further processed into alcoholic and non-alcoholic beverages. It is important that these liquids are pumped gently and without any bubbles with good metering accuracy. Rouven Richter, co-founder of Heimat Distillers, says: "The pump can be dismantled for clean-

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Source: Flux-Geräte GmbH

The R32 stator with connected chemical hose of 1.5 meters length a flow rate of 30 liters per minute.

ing very quickly and practically without tools. This is very important for us because we tend to produce small batches but with ever-changing media.”

In another industrial application, the pumps use two-stage gearboxes with a pump tube length of 1200 mm and a 700-W motor. Connected to a 1.5 m chemicals hose, the R32 stator enables a pump capacity of 30 l/min. Liquid plant fertiliser can therefore be decanted from IBCs into various containers for further processing. The pump capacity of more than 20 l/min needed by the user is in fact exceeded.

The parts in contact with the medium, such as the centering flange, mechanical seal and pump tube, can thus be easily cleaned and disinfected or sterilized.

Progressive cavity pumps for consistency

There is growing demand for handling pumped media with great care, especially in the food and cosmetics industries. It is not only organic products and natural cosmetics where the consistency of the pumped media needs minimal interference. Stringent requirements apply to more viscous substances too. Pectin, egg whites, cross-linked starches and other thickening agents with long chains of molecules often respond sensitively to high centrifugal forces, which are encountered in standard centrifugal pumps. In contrast, progressive cavity pumps hardly interfere at all with the consistency of products such as tomato purée, ketchup or fruit syrups. Even pudding-like consistences or creamy to high-viscosity greases and formulations can be transferred and metered with the pumps. Because the eccentric worm transfers the high-viscosity substances through the pump with ease, it is critical that sufficient media can flow into the



pump. A combination of progressive cavity pump and drum-emptying system, for example, is recommended for such scenarios. Then the viscous drum content is squeezed by a floating pressure cover such that there is always sufficient medium around the pump's intake area for smooth pumping operations.

Trend towards semi-finished products has an impact on pump selection

There is a trend in industry towards semi-finished products. Rather than users combining various components themselves, it is often more cost-effective to buy them pre-mixed. This means that smaller quantities are increasingly supplied by external suppliers just-in-time. This also affects the choice of pumps. Smaller, mobile pump solutions, which are eas-

ily to move and clean, are the product of choice. The modular structure of progressive cavity pumps ensures economic operations even if the pumped media is changed frequently. Should the operating conditions (e.g. the viscosity) change, users can swap over the corresponding parts themselves. Each pump can be simply and intuitively dismantled into the individual modules with virtually no tools thanks to the clamp connections. This simplifies maintenance and cleaning.

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In a new method for insect pest control, nitrogen is taken from the ambient air and is lead directly into the grain silo.

Source: Shutterstock.com

Environmentally friendly method protects against parasites in grain silos

■ Anja Ehrmann

Beer is both a luxury and cultural asset, which is why it is so important to protect both the grain and malt used in the brewing process against wheat weevils and other pests. In addition to these harmful insects, silo owners also face other dangers: smouldering fires, fungal infections and evaporation losses can all have a disastrous effect on wheat and malt silos. But now there's an environmentally friendly method operators can use to protect their valuable crops.



Beers brewed according to the German purity law are considered especially high-quality, and malt – one of its limited ingredients – is stored in silos before the brewing process. During storage, it is susceptible to attack from pests such as the grain weevil that can cause untold damage to the crop. Breweries checking for pest infestations when receiving deliveries will send back any incoming lorries with signs of the weevil, which result in huge economic losses for the malting plants.

Nitrogen displaces oxygen

Pests, as well as other dangers such as smouldering fires and fungal infections, need oxygen to survive. By using nitrogen, breweries can achieve a completely oxygen-free environment. This inert gas has been used widely in the foodstuff industry for years, and is used as a protective gas in packaging for all kinds of perishables. “This process uses the principle of displacement of oxygen by nitrogen,” explains Andreas Jokisch from the Plant Engineering Sales department at BOGE Compressors. “This method is both environmentally sound and sustainable, making it a good alternative to the use of conventional methods. If the EU Commission’s proposal for a new Pesticides Directive is implemented, in the long term companies will be required to use more environmentally friendly methods such as this one”. Specifically, the EU Commission’s proposal from June 2022 contains binding rules on the use of conventional pesticide: this includes the reduction of the use of chemical and particularly dangerous pesticides by 50% by 2030. The proposal also sets companies the challenge of only using chemical pesticides as a final resort. Within these guidelines, the individual EU Member States will be able to set their own national reduction figures.

Obtaining nitrogen from the ambient air

Breweries are already able to use this method to fight against pests in brewing barley and wheat, using the ambient air as a source of nitrogen to feed into the silo. Our air consists of around 78% nitrogen, approximately 21% oxygen, and a small amount of noble gases, water vapour, carbon dioxide and other gases. The

first step involves a frequency-controlled screw compressor generating compressed air and pumping it through a refrigerant compressed air dryer and filtration stages with activated charcoal adsorbers and onto a nitrogen membrane. The air, which has now been cleaned of any hydrocarbons, oils, dust and other contaminants, passes through the membranes to separate the nitrogen from the other gases. The result is high-purity nitrogen gas. The by-product of this process is a permeate with an oxygen content of up to 36% which is released via an exhaust air opening.

Silo owners often add an additional pressure outlet port before the membranes. This compressed air can then be used in a redundant circuit to open shutters and vents in case the compressor is unavailable due to malfunction or maintenance. The compressor, dryer and filter are all integrated into a container available in sizes 10 ft and 20 ft. The nitrogen gas is fed into the silo via pipelines or hoses, for example using existing fire connections or ventilation pipes. Nitrogen moves upward in the silos displacing any oxygen gas.

Nitrogen has been used widely in the foodstuff industry for years, and is used as a protective gas in packaging for all kinds of perishables.

Weevils cannot survive without oxygen

The female weevil is able to lay up to 200 eggs at a time. The overall reproduction cycle from egg to larva and eventually pupae and weevil takes place over several weeks in the grain, with weevils breaking through the outside of the husk and starting to reproduce straight after pupation. Before long, the entire silo is infested. Exposing the weevils to 30 to 40 days of nitrogen prevents them completely hatching. After a period of high nitrogen supply, the rate can often be reduced once the target amount has been reached – ensuring that the wheat remains free of live weevils, larvae or eggs – and can be used in manufacturing. And, even more importantly, the high nitrogen concentration in the silo has no effect whatsoever on the grain’s ability to germinate.



Silos need to be airtight

For the pest treatment to work successfully, it is essential that the silo be completely airtight. The better the seal in the silo, the more efficient the process. “Leaks tend to occur around the inlets and outlets for the wheat, as well as the flow holes or manholes and they tend to be difficult to see with the naked eye,” explains Jokisch. For this reason, the supplier often starts off by providing silo owners with a 10 ft container that can generate a flow rate of 40 to 60 m³/h. It generally only takes an initial two days to establish how airtight the silo is, and therefore identify the size of container required.

Fast, simple installation in different locations

The exact design of the system depends on the size of the silo and the fill time, and requires a connection to either a 63 A or 125 A electricity supply. This environmentally friendly method is ideal for any silo construction and is quick and easy to install. The containers are easy to start up, meaning they can be used by silo owners as

a plug-and-play system for several locations alongside multiple silos. These solutions are tailored and designed exactly according to the silo owner’s specific requirements. “If, for example, nitrogen is only required for one single silo, we are also happy to use any existing facilities and install the separate components where needed,” says Jokisch. To prevent any danger to employees in enclosed spaces as a result of high nitrogen levels, they need to always have an adequate supply of air if located close to the silos. They must always carry a device which can measure the proportion of oxygen in the air. If monitoring of areas at the top of or beneath silos is required, operators should use fixed measuring devices which send the values directly to the control centre.

Market trend: increased demand for ecological products

The nitrogen displacement method is also likely to see increased interest thanks to the growing market in organic products – more and more shoppers are adding ecologically grown food to their shopping baskets. But



Source: Shutterstock

Breweries will send back any deliveries with signs of the weevil found during quality checks.



what happens if organic cereals become infested by parasites? Jokisch explains: “Then the product cannot be used and the silo owner will need to treat it. However, by using chemical treatments, the grain loses its organic status and can only be sold as standard grain”. This, of course, makes the price drop considerably – in silos of around 1,000 tonnes or more, the figures we’re talking about can amount to hundreds of thousands of euros.

According to Andreas Jokisch’s predictions, the organic boom of the last few years won’t be limited to breweries. At the moment, beer brewed from organic wheat is currently still a bit of a niche market, but he says consumers are becoming very savvy when it comes to organically produced products. Sascha Sebastian Brandt, Expert for Special Gases at BOGE, adds: “People are gradually beginning to real-



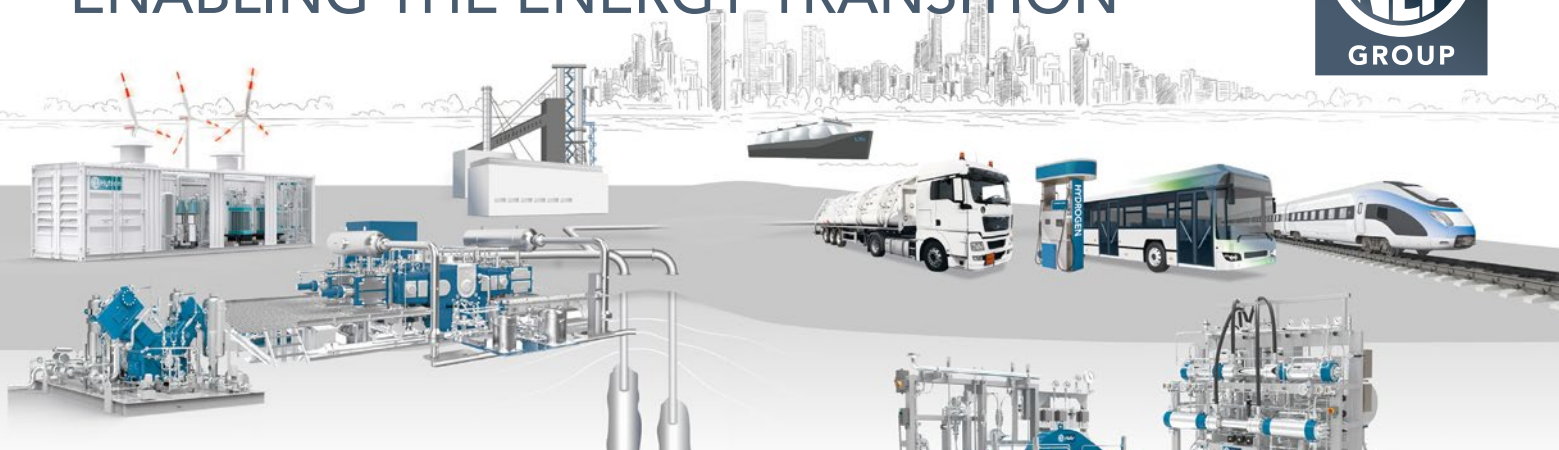
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Silo owners can use the containers as a plug-and-play system for multiple locations.

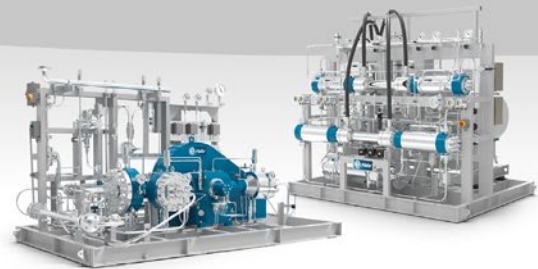
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environment and have detrimental effects on the surrounding air, ground, groundwater, flora and fauna,” says Brandt.

The German Purity Law and modern quality

The brewing of beer in Germany is well-known for having to comply with a law on purity that’s now over 500 years old. The law used to mean that the beer was guaranteed to be completely clean with no artificial chemicals, but that’s no longer necessarily the case. According to Brandt, it would be sensible to look in more detail into the quality requirements of grain storage to increase the quality of the beer manufactured from it. Nitrogen has already proven its safety in the food industry, with manufacturers already using it widely in packaging. The use of nitrogen for the storage of cereals and grains, however, has been faced with some scepticism by silo owners. This environmentally friendly nitrogen-based process, however, does not require any special phytosanitary certification, as no active substances are used. Nevertheless, we have still sought and obtained a declaration of no-objection from the German Federal Institute for Occupational Safety and Health (BAuA) and are awaiting for another to be issued by the German Federal Office of Consumer Protection and Food Safety (BVL).

A membrane separates the nitrogen from the other gases and pumps it into the silo.

ise that sustainability and looking after the environment have qualitative benefits. We’re not just talking about healthy foods, but also conserving natural resources and protecting our ecosystem”.

This environmentally friendly method is ideal for any silo construction and is quick and easy to install.

Given the environmental consequences of conventional pest control measures, using the new nitrogen displacement method has obvious advantages – existing agricultural techniques are known to place a significant burden on the

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Years of research and development have made the balancing process possible using laser ablation.

Source: Pfeiffer Vacuum GmbH

New balancing process increases service life of turbopumps

■ Pascal Wielsch and Alexander Kreuter

Turbopumps play an important role in vacuum technology when pure high vacuum and ultra-high vacuum is to be generated. Inside the hybrid-bearing turbopump, a rotor is supported by a combination of permanent magnet bearings and roller bearings and driven at very high speeds. A new balancing process for hybrid-bearing rotors increases the service life of ball bearings by up to 20 percent, while reducing vibrations and lowering noise emissions.



Turbopumps – high demands on balancing quality

The process of balancing is likely to be familiar to many people from the automotive sector. There, new car tires also need to be balanced. Even objects that appear symmetrical on the outside actually have slight inequalities in their mass distribution. This can be due, for example, to the manufacturing process of the component or an inhomogeneity in the density of the raw material. This uneven mass distribution is known as unbalance. When an unbalanced body is set in rotation, vibrations occur. In the case of a car tire, these can be felt in the steering wheel. The resulting forces depend on the rotational speed as well as the amount of unbalance. They can quickly increase sharply and cause damage to other components of the vehicle. For this reason, the unbalance of rotating objects is reduced by manufacturers by balancing them.

While the speed of automotive tires tend to reach 1,500 to 2,500 rpm, rotors of turbopumps reach speeds of up to 90,000 rpm, or 1,500 rpm/sec. The demands on the balance quality are therefore extremely high. Even the slightest unbalance in the range of a few milligrams can have a strong influence on the operation of the pump. A high balance quality is therefore relevant both for the smooth running of the rotor and for years of damage-free oper-

Source: Pfeiffer Vacuum GmbH



The balancing plane in conventional balancing with holes (left) differs from the new method (right) with laser ablation.



Source: Pfeiffer Vacuum GmbH

An employee checks turbopumping stations.

ation of the turbopump. The balance quality also minimizes the vibrations transmitted to the vacuum chamber and to the customer's application.

Conventional balancing – reducing uneven mass distribution

Pfeiffer Vacuum has been engaged in conventional balancing technology for many years. The balancing procedure used in this process enables vibration-reduced operation of hybrid-bearing turbopumps. By adding additional mass, for example through balancing weights, the manufacturer reduces an uneven mass distribution.

Mass balancing is widely used in technology today, and many manufacturers use machining processes to achieve this aim. This includes, for example, grinding and the removal of material at the point of greater mass accumulation, i.e. on the side on the unbalance. In conventional balancing, the radial deflection of the rotor is measured near the bearing on two measuring planes. With the aid of a special algorithm, the unbalance of the rotor is determined. To reduce the overall unbalance, the rotor is divided along the axis of rotation into several balancing planes with corresponding holes. The manufacturer screws in balancing weights manually along the circumference of the individual balancing planes. This reduces



the uneven mass distribution. In addition, the remaining unbalance of the rotor is reduced to below the necessary limit value. The system determines the unbalance at several speeds and gradually compensates for this to enable a vibration-reduced start-up of the rotor to nominal speed.

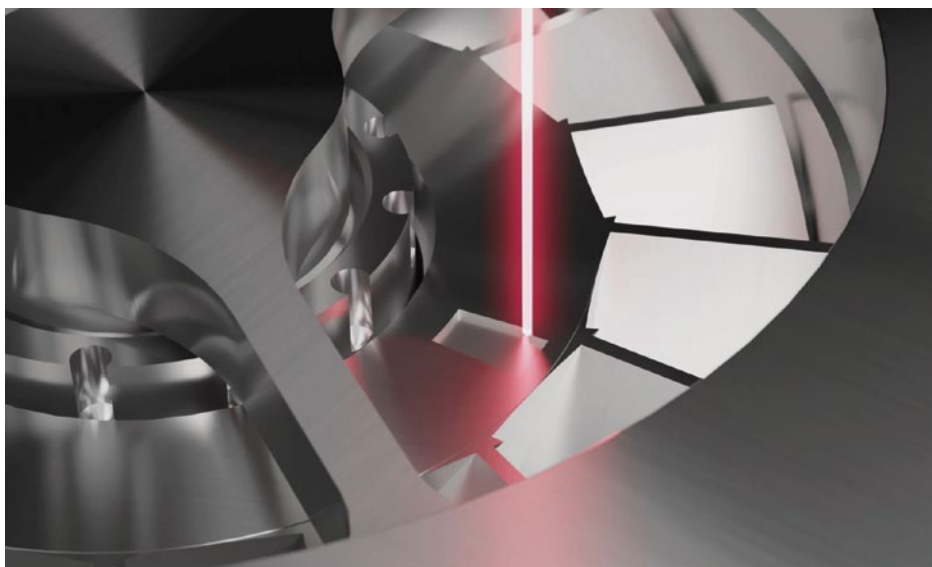
Laser ablation minimizes remaining unbalance

Especially in the area of secondary properties, the application requirements for turbopumps have increased over the last decade. The high-speed rotors are therefore subject to permanent further development, including the:

- service life of the ball bearing,
- vibroacoustic emissions (emitted sound and vibrations on the pump housing) as well as
- cleanliness in terms of the outgassing behavior of the components and surfaces.

With the assistance of the laser this method corrects the uneven mass distribution of the rotor.

Pfeiffer Vacuum has created a further (can we say new) innovation in the field of vacuum technology that enables turbopump rotors to be balanced even more efficiently. Unlike the conventional process, this method eliminates the need for balancing holes and balancing weights. In this balancing process, the mass balancing is reversed by removing material using laser ablation, thereby minimizing uneven mass distribution. The removal of material by laser is much more precise, which means that this process achieves an even lower residual unbalance. Material properties are not affected in the process. By dispensing with geometrically defined balancing holes and graduated balancing weights, defined laser ablation segments can be removed. With the aid of the laser, this method corrects the uneven mass distribution of the rotor at precisely the necessary point in the individual balancing planes.



Due to laser ablation, the new method results in a 20% improvement in the balancing quality of turbopump rotors.

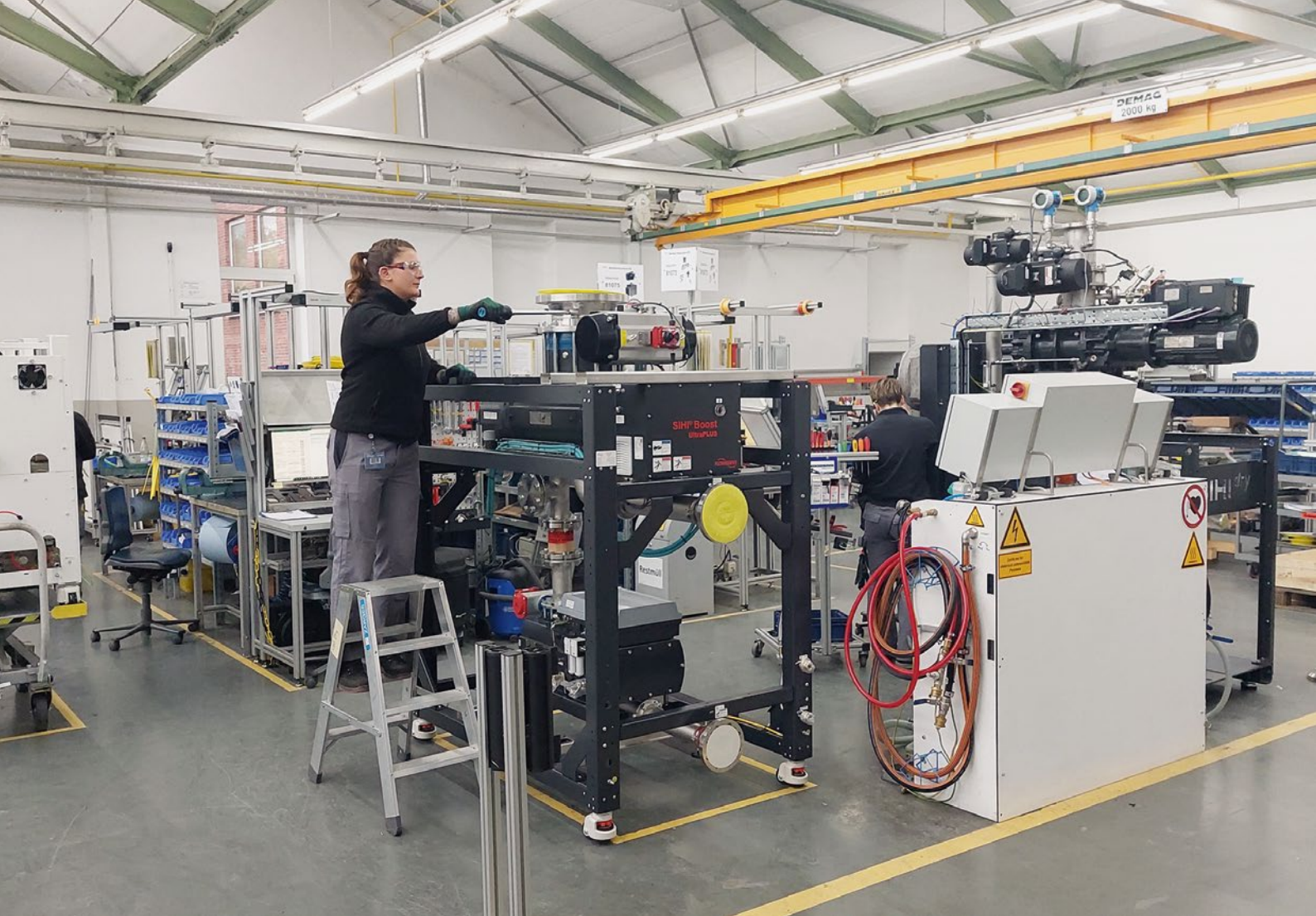
Source: Pfeiffer Vacuum GmbH

Preventing virtual leaks

This method has the advantage that the particles generated during laser ablation are extracted and filtered during the process. The subsequent cleaning of the laser-balanced rotor and the elimination of manual handling during the screw balancing process ensure maximum cleanliness of the surfaces. In addition, the balancing procedure prevents virtual leaks from forming due to air pockets in the balancing holes. In applications where low vibrations and quiet turbopumps are required, the new rotors can now be used even more efficiently. The low vibroacoustic emissions, for example, enable high-resolution images to be generated by electron microscopes with integrated turbopumps.

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Tightening torque of the screw booster vacuum pump: An employee checks the screw connections of the intake flange connection.

Source: Flowserve SIHI Holding GmbH

Screw blowers increase productivity in coating processes

■ Dr. Jörg Temming and Dipl.-Ing. Stefan Lähn

Vacuum coating processes are a key technology in a wide range of industrial applications such as the coating of architectural glass or the production of solar cells in in-line processes. In this process, the substrates to be coated must be continuously fed to and removed from the coating chamber in the optimum case. Decisive for the productivity of the coating system is the pump-down and cycle time at the inlet and outlet. The newly developed screw booster technology focuses on these times and can double the productivity of the systems.



The limits of the Roots blowers

Because the coating chamber is permanently in a vacuum, the aim at the inlet and outlet loading gates is to pump it down from atmospheric pressure to coating pressure as quickly as possible. Dry-running and oil-sealed vacuum pumps implement this today. Because the volumetric performance of these pumps decreases as the inlet pressure decreases, a single-stage pump would require extremely high power consumption even at high vacuum demand and low inlet pressure. Multistage systems are used because they can achieve the required compression with significantly less energy.

Vacuum coating processes have traditionally relied on such a system: a combination of Roots blowers, paired with oil-sealed or dry-running pumps. Although this combination has been standard for many years, it no longer meets today's requirements for faster pump-down of load locks.

Roots blowers are vacuum pumps designed as a booster stage to achieve high pumping speed at low pressure, typically below 10 mbar. However, their operation is limited by the maximum permissible difference between their suction and discharge pressures. By design, they are not suitable for compression directly against atmospheric pressure. For this reason, the pumping speed of a Roots blower at high pressure is limited and determined by the volume ratio between the backing pump and the Roots stage, which is typically 1:2 to 1:4 for this application.

Thermal load as a challenge

Due to its design, the Roots blower has no internal compression. Increasing differential pressure leads to increasing, inefficient compression with high power consumption and high thermal load on the Roots blower. To prevent the rotating Roots pistons from rubbing against the housing, overload protection for the blower is necessary.

The conventional solution to this problem is to ensure the permissible differential pressure via an internal or external bypass between the suction and pressure side of the Roots blower. At a

higher differential pressure (typically approx. 50 mbar), the Roots blower conveys the mass flow in a circuit between the pressure and suction side. Although this makeshift solution protects the blower from overheating, it leads to massive inefficiency of the system. As a result, the suction power of the system is dependent on the backing pump between atmosphere and 100 mbar, and the full suction power of the booster stage is only achieved below 10 mbar. Furthermore, the only way to shorten the pump-down time with a conventional Roots blower is to increase the suction capacity of the backing pump.

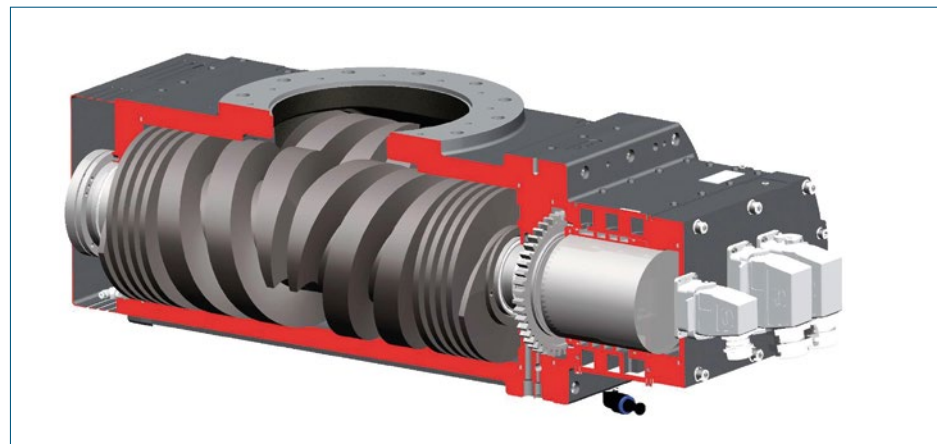
The screw blower increases the throughput of existing production lines and reduces the production costs per piece.

Novel booster based on screw technology

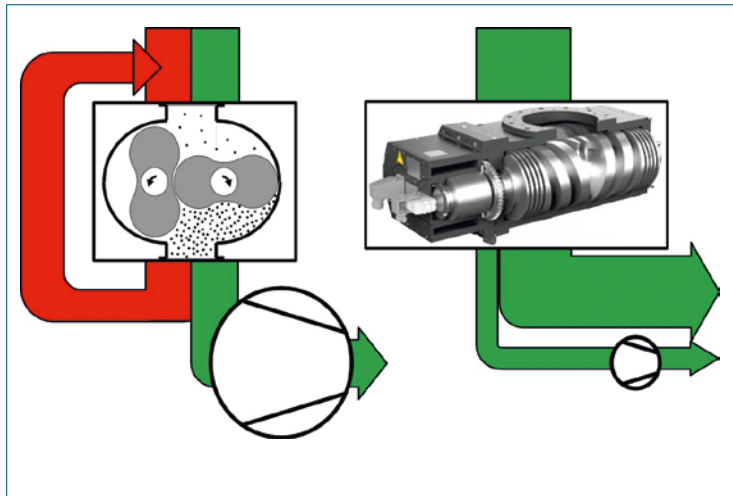
At this point, the newly developed screw booster technology can remedy the disadvantages mentioned. The two-stage system also consists of a backing pump (in this case as a liquid ring or screw pump) and the new screw vacuum booster.

Screw technology offers the possibility of working against high pressure, which is known from its application as a backing pump against atmo-

Source: Flowserve SIHI Holding GmbH



Screw blower in section: The double-flow design of the screw enables the axial forces to be balanced and increases the intake capacity of the screw booster stage.



Source: Flowserve SIHI Holding GmbH

volume ratio between backing pump to booster can be much larger than that of classic roots blowers, ranging from 1:10 to 1:50, allowing a much smaller, more compact and energy-efficient backing pump to be used. The double-flow design of the screw enables axial forces to be balanced and increases the suction capacity of the screw compressor stage.

A More Efficient Alternative: The Screw Blower Principle Compared to Roots Pumps

Based on the load lock application, two basic requirements must be met by the new technology. Firstly, the high pump-down capacity can only be achieved with the booster stage (due to the volume graduation described). Secondly, the mass flow at high suction pressure (between atmosphere and 100 mbar) must be routed past the backing pump (and not backwards around the booster stage back to the suction side through an internal or external bypass valve) in order to discharge it directly into the discharge line of the pumping system.

For load locks, the new technology has to guide the mass flow past the backing pump at high suction pressure.

sphere. This is mainly due to the internal volume compression of such profiles, which reduces the power consumption and thermal load of these pumps compared to pumps without internal compression (such as the Roots blowers). Because of this feature, the suction



Source: Flowserve SIHI Holding GmbH

The screw booster vacuum pumps are low-noise and virtually vibration-free.

First introduced in 2013, the dry-running screw blowers were developed specifically to meet these requirements in industrial vacuum technology. Although the screw blower has a much larger volume ratio to the backing pump compared to Roots blowers, it achieves significantly faster evacuation of the load locks than any other booster unit currently available on the market.

The unique design of the screw blower allows the kinetic energy stored in the spindles to be utilized. These can be subjected to atmospheric pressure at full speed (up to 15,000 rpm), five times faster than conventional Roots machines. The pump's dual-flow and symmetrical displacers ensure equal distribution of forces, with pressure acting on both ends of the booster to balance axial forces.

The system benefits from the inertia of the rotating mass of the spindles when passing through the rough vacuum phase during the pump-down cycles. At this point, the installed motor power is much less than the energy required for compression and the machine begins to slow down. During slowing down the massive screw displacers takes more time than pumping down the load lock, this inertia allows the system to achieve a much higher flow rate. Once the low vacuum pressure is reached, the installed motor power is higher than the energy required for compression and can be used to accelerate the screw displacers back to the desired output speed, ready for the next pump-down cycle.

Targeted innovation to achieve the fastest evacuation speed

The re-acceleration time thus takes on fundamental importance in the novel screw blower system because it decisively determines the minimum cycle time of the system. The main factor here is the permanent electrical power that the screw blower can reliably convert.

The main objective for the further development of the screw blower was to drastically increase the continuous power of the original screw blower introduced in 2013, which was limited to 12.5 kW to protect the machine from thermal run-up (contact of displacer and

World Class.

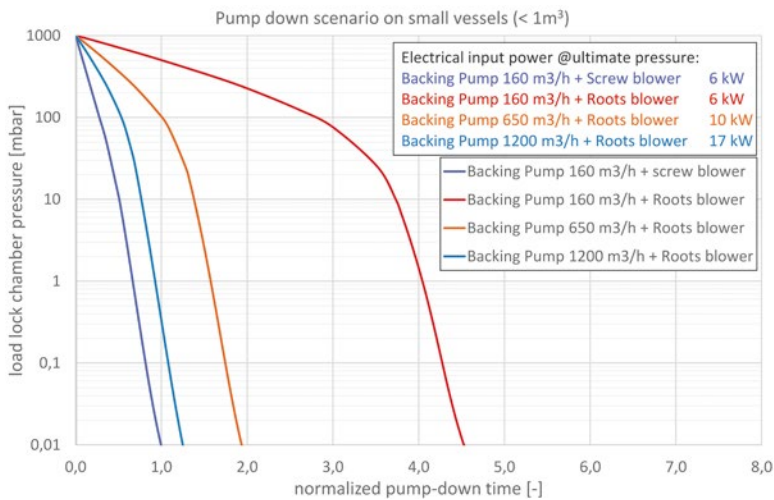


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Source: Flowserve SIHI Holding GmbH

Compared to Roots blowers, the screw blower enables significantly faster evacuation of the load locks.

The design of the screw blower makes it possible to use the kinetic energy stored in the spindles.

Specific measurements were required to qualify the new product for different sizes and combinations with backing pumps. Optimization of the thermal load was only possible through the use of simulations and, above all, measurements of the asymmetric gap distribution between the displacer and the housing during operation. This combination of simulation and testing provided a very accurate understanding of the thermal deformations that can occur during operation. This led to three key solutions: optimized cooling of the housing components, modification of the materials used in certain components to withstand the highest load scenarios, and modification of the pump's gap distribution strategy.

Taken together, these improvements have drastically increased the performance of the machine, so that the continuous output limit of the original, first screw blower series has been more than doubled from 12.5 kW to 28 kW in the new series. The decisive cycle time of the new series is reduced by 50%, while at the same time the pump-out time is again slightly reduced compared to the original series. All this was achieved without changing the size of the pump or modifying crucial components such as the drive electronics.

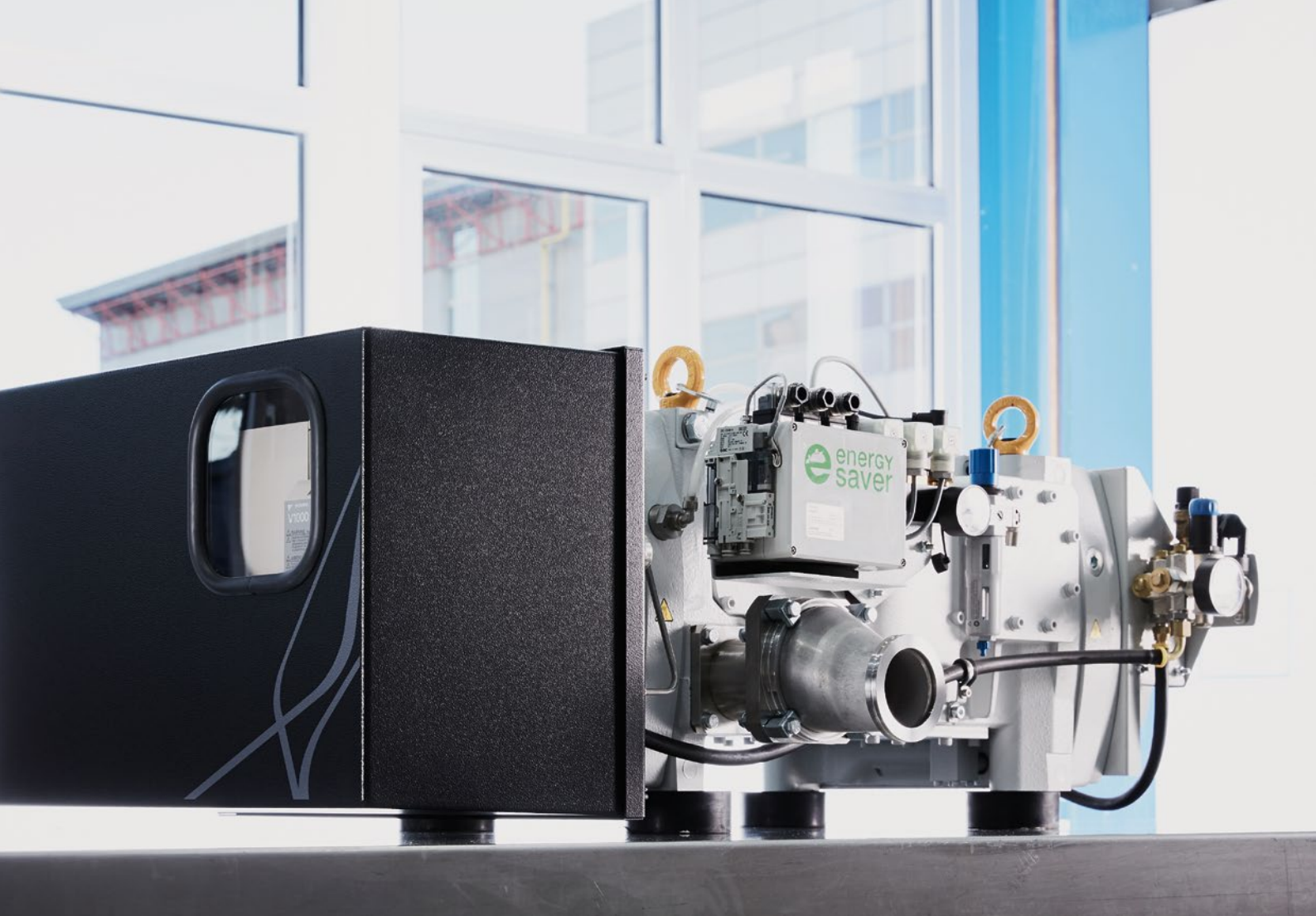
Coating line use case

By combining fast pump-down time with optimized re-acceleration time, the screw blower offers significant opportunities for vacuum coating and other lock processes to increase the throughput of existing production equipment and reduce the production cost per piece. For example, by replacing existing Roots blowers with screw blower units, 20-50% shorter pump-down times can be achieved. At the same time, this can lead to 50% lower energy consumption in final pressure operation compared to standard vacuum systems.

The innovative design of the new screw blower series literally doubles the value of a technology that was already superior to existing Roots technology. The new pump design retains all the benefits of the original series, including oil-free operation and full electronic synchronization, while reducing re-acceleration time by up to 50% or more without increasing the footprint of the unit. By simply replacing the outdated technology of Roots blowers, screw blowers can enable existing coating lines to achieve the fastest pump-down time for load locks to date.

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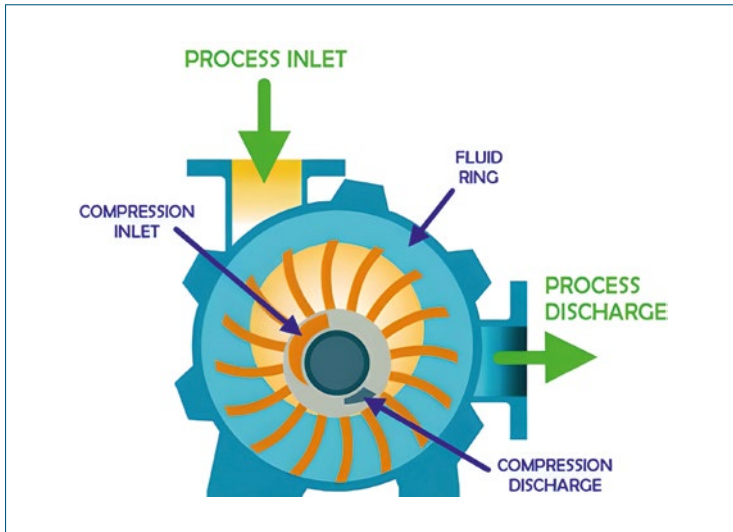
Modern dry screw vacuum pumps are a sustainable alternative to liquid ring pumps.

Source: Leybold GmbH

Alternative to liquid ring pumps avoids water consumption

■ Pierre Lantheaume

Liquid ring pumps are used in a wide range of industrial applications in various sectors – from the oil and gas industry to the food and beverage industry and the chemical market. However, their high demand for water and energy is nowadays neither economically nor ecologically justifiable. Dry vacuum pumps are a sustainable alternative for most applications.



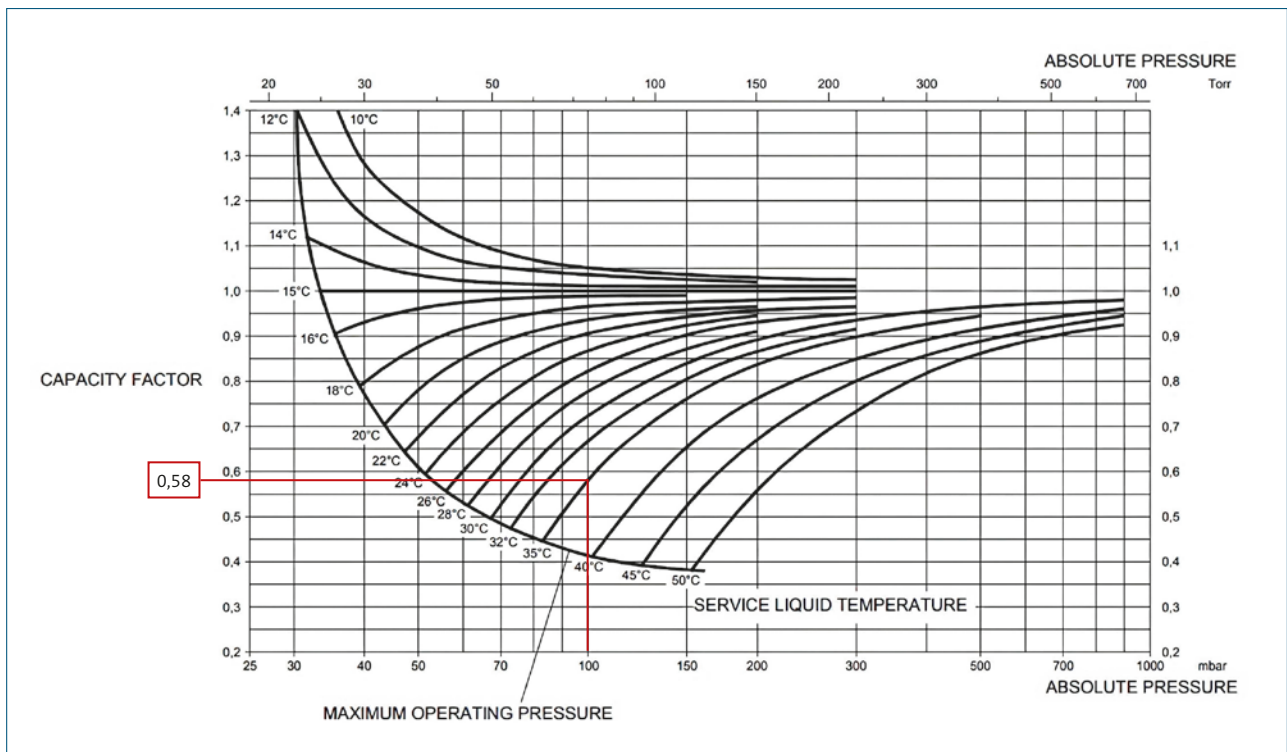
Source: Leybold GmbH

Operating principle Liquid ring pump: The rotation of the impeller compresses the gas, which flows to the pressure port at the end of the casing.

against the stator due to centrifugal force. This liquid ring creates a series of seals between the impeller blades, which form compression chambers. The eccentricity between the rotor and stator causes a cyclic change in the volume enclosed by the blades and the ring. Gas is drawn into the pump through an inlet port and trapped in the compression chambers formed by the impeller blades and the liquid ring. The rotation of the impeller compresses the gas, which flows to the discharge port at the end of the casing. During operation, a constant supply of sealing liquid must be provided, which is conveyed with the gas to the outlet of the pump. The liquid supply can be continuous or recirculated. This requires the use of a heat exchanger in the return line to cool down the heated liquid.

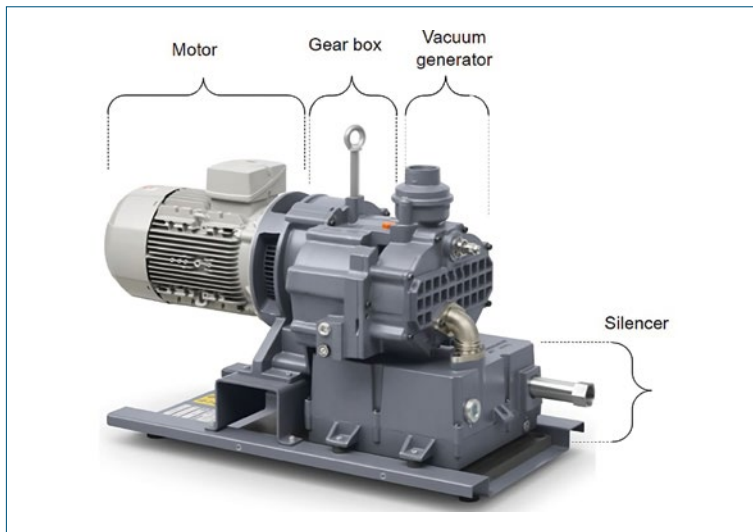
The principle of operation of the pumps is quite simple: A Liquid Ring Pump (LRP for short) compresses gas by the rotation of a vaned impeller (rotor) located eccentrically within a cylindrical casing (stator). The liquid is introduced into the pump and forms a moving cylindrical ring

Due to their simple design (no contact between mechanical parts), LRP are very robust and require little maintenance when used as intended. One of their main advantages is that they can pump large volumes of vapors, considerable liquid slugs and solid particles. They also offer a high level of safety when pumping flammable or explosive mixtures.

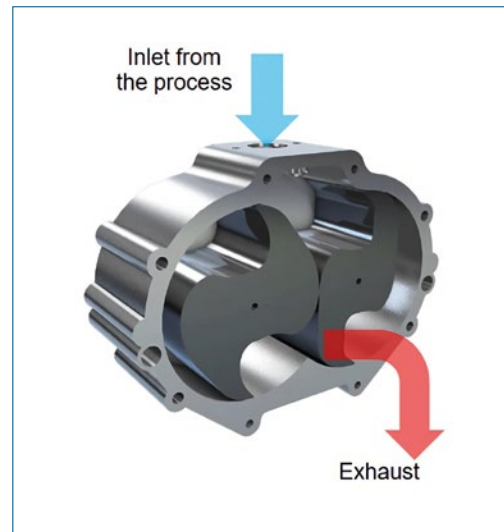


Source: Leybold GmbH

Process quality impaired: Liquid ring pump performance is depending on service water temperature and can fluctuate over time (at 100 mbar and with 35 degrees Celsius water, the pumping speed is only 58 percent of the nominal capacity).



The spur gear synchronises the two rotors of the claw pump.



The claws do not come into contact with the housing.

Source: Leybold GmbH

Principle-related limitations of liquid ring pumps

However, LRP also have some limitations and drawbacks. This mainly concerns the final pressure, which depends on the vapor pressure of the sealing liquid. As a rule, manufacturers specify the performance data of LRP for water at a temperature of 15 degrees Celsius. The corresponding vapor pressure and thus the final pressure of the vacuum pumps is 33 mbar. By using colder water or another sealing liquid with a lower vapor pressure, it is possible to achieve a better final pressure. However, the room for improvement is limited. For example, the final pressure of oil-sealed rotary vane pumps is <1 mbar regardless of temperature. At a cooling water temperature of 35 degrees Celsius, an LRP just reaches 80 mbar, which can impair process quality. The pumping speed is also drastically reduced. At 100 mbar and a water temperature of 35 degrees Celsius, it is only 58 percent of the nominal capacity (for 15°C water).

Disadvantage of cavitation: Gas bubbles can damage rotor bearings

Another disadvantage of these pumps is the cavitation phenomena. At pressures close to the saturation vapor pressure, the operating liquid begins to boil. Gas bubbles form locally, which can collapse again a short time later. The

resulting shock waves can damage the rotor bearings. To avoid this, some LRP are equipped with anti-cavitation lines, but their reliability is limited.

In addition, LRP perform worse in terms of energy efficiency than other vacuum pump types operating in the same pressure range. Their power consumption is up to 20 per cent higher compared to oil-sealed rotary vane or dry-compressing screw pumps. Mainly, the much higher power consumption is due to the energy needed to form and maintain the liquid ring.

Screw vacuum pumps do not require any operating liquid in the pump housing.

The biggest disadvantage of today's LRP, however, is the water consumption. If fresh water is used, the required flow rate can reach high values. If we consider a 1,500 m³/h LRP, the water requirement can reach 10 m³/h. Usually, pumps of this size are rarely operated with fresh water, but rather with partial or total recirculation. However, the heat exchangers needed to recool the water can become clogged and this leads to an increase in water temperature and performance losses. Furthermore, even in systems with full recirculation,



Source: Leybold GmbH

A claw pump replaces the liquid ring pump when mixing and degassing multi-compounds resin.

water consumption can be observed due to leakage and water vapor at the outlet. Therefore, users need to top up the water level regularly and change the total amount of water regularly.

Dry pump technology offers alternative

Two newer vacuum pumps could soon make LRP and its associated drawbacks obsolete. These include two dry pump technologies: claw and screw pumps. Claw pumps have two claw-shaped rotors mounted in a housing that rotate in opposite directions. In doing so, they suck in gas, compress it and then expel it. The claws do not come into contact with each other or with the housing. Lubricants or service fluids for sealing are not required. There-

fore this type of pump is usually called a dry vacuum pump. A directly flanged motor drives the pump. A synchronizing gearbox, isolated from the process chamber, maintains precise rotor timing.

Claw pumps are so-called rough vacuum pumps. Their ultimate pressure is about 50 mbar and thus in the range of LRP. Unlike LRP, however, the pump's performance is constant and not dependent on external factors such as the temperature of an operating fluid. Claw pumps are air-cooled and therefore relatively easy to install.

Screw vacuum pumps are also dry compressing vacuum pumps. The two intermeshing helical rotors turn in opposite directions and convey and compress gas from the inlet to the exhaust. Like the claw pumps, they usually do not require any operating liquid in the pump housing. Sealing between the two rotors and between the rotor and the casing is achieved by the low clearance height and the high speed ($> 6000 \text{ min}^{-1}$). In most screw vacuum pumps, spur gears synchronise the rotors.

New pump generation with low ultimate pressure

A new generation of dry compressing screw vacuum pumps makes the use of lubricating oil for bearings and gearing obsolete. In these pumps, the two rotors are driven and synchronised by a toothed belt. The bearings of the two rotors are grease-lubricated roller bearings that do not need to be relubricated. Screw vacuum pumps can be air-cooled or water-cooled. In addition, the use of sealing gas (in some cases) can protect the bearings and the gear oil. At up to 10-2 mbar, the ultimate pressure of screw vacuum pumps is significantly lower than that of claw or liquid ring pumps.

Since both claw and screw vacuum pumps operate dry and without contact, they are extremely tolerant of vapors, liquids and soft or small solid particles. Due to the increasingly rising prices for energy and the scarcity of water in large parts of the world, the demand for alternatives to classic liquid ring pumps has increased greatly in recent times.



Successful LRP replacement with dry technology

Operators can only replace large liquid ring pumps with >10,000 m³/h with several parallel dry pumps. In some chemical applications, LRP have so far been without alternative due to the presence of explosive atmospheres and liquid residues. In certain applications, however, operators can successfully replace LRP and eliminate the associated disadvantages. They are used particularly in the food and beverage industry: in beer bottling, for example, the vacuum enables a high filling capacity of 40,000 bottles per hour. LRP are used here because even a continuous flow of liquid (beer foam in this case) at the inlet is no problem for them. For hygiene reasons, however, the operators must supply the pumps with fresh water, which must be disposed of as wastewater and thus leads to high operating costs. Dry screw vacuum pumps in combination with liquid separators avoid the use of water completely.



Quelle: Leybold GmbH

In beer filling, the vacuum of the dry screw pumps enable a high filling capacity of 40,000 bottles per hour

The performance of claw pumps is constant and not dependent on external factors such as the temperature of a service liquid.

Other industries, such as plastics, also commonly use liquid ring pumps to degas extruders from vacuum or to mix and degas multi-component resins. In these processes, operators often use small LRP. The aim is to remove air pockets, moisture, or other highly volatile substances, as these degrade the mechanical and optical properties of the end product. Water and other vapors simply condense in the vacuum pump. While this is not a problem with LRP, condensation in oil-lubricated rotary vane pumps leads to frequent oil changes. Dry vacuum pumps, however, can handle this without any problems. In addition to eliminating water consumption, the pressure and thus the entire process can be controlled much better.

Replacing an LRP with a dry screw vacuum or claw pump means a not inconsiderable investment. But due to complete savings in water costs and lower power consumption, the pay-back is often less than a year. For the food or beverage industry, but also for other industries such as the plastics industry, dry vacuum pumps are therefore a sustainable and economical solution.

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Cologne



Applications Process & Compressed Air Technology

	Hygiene	Breweries	Medical technology	Food industry	Packaging (except Food)	Laboratory	Cleaning (Purging)	Oil/Gas	Natural gas industry	Oil fields	Petrochemical industry	Refineries	Biogas	Gas stations (natural gas, LPG)	Handicrafts/Workshops	Workshops	Handicrafts	Garages	Pneumatic	Mechanical engineering			Switchgear
ABN Apparatebau Nittenau GmbH www.abn-drucklufttechnik.de		●	●	●	●	●	●						●		●	●			●				
Aerzener Maschinenfabrik GmbH www.aerzener.de		●		●	●		●		●	●	●	●	●			●				●	●	●	
ALMiG Kompressoren GmbH www.almig.de		●	●	●	●	●	●		●	●	●	●	●			●	●	●		●	●	●	
ALUP Kompressoren GmbH www.alup.com/de		●	●	●	●	●	●		●	●	●	●	●			●	●	●		●	●	●	
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Atlas Copco Energas GmbH, Gas and Process Division www.atlascopco-gap.com		●		●					●	●	●	●	●	●									
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BORSIG ZM Compression GmbH www.borsig.de/zm									●	●	●	●	●										
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CVS engineering GmbH www.cvs-eng.de									●		●		●			●	●	●					
Deprag Schulz GmbH & Co. www.deprag.com		●	●	●	●	●			●	●	●	●	●	●		●	●			●			
Donaldson Filtration Deutschland GmbH www.donaldson.com		●	●	●	●	●	●		●		●	●	●							●	●	●	
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Gardner Denver www.gardnerdenver.com		●	●	●	●	●	●		●	●	●	●	●	●		●	●	●		●	●	●	
Gardner Denver Deutschland GmbH, CompAir www.compair.com		●	●	●	●	●	●		●	●	●	●	●	●		●	●	●		●	●	●	
Gardner Denver Deutschland GmbH, Elmo Rietschle www.gd-elmorietschle.com		●	●	●	●	●	●		●	●	●	●	●	●		●	●	●		●	●	●	
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Applications Process & Compressed Air Technology

	Hygiene	Breweries	Medical technology	Food industry	Packaging (except Food)	Laboratory	Cleaning (Purging)	Oil/Gas	Natural gas industry	Oil fields	Petrochemical industry	Refineries	Biogas	Gas stations (natural gas, LPG)	Handicrafts/Workshops	Workshops	Handicrafts	Garages	Pneumatic	Mechanical engineering				Switchgear	
Gardner Denver Deutschland GmbH, Nash www.gdnash.com								●	●	●	●	●													
GEA Group Aktiengesellschaft www.gea.com		●		●					●		●	●													
HAUG Sauer Kompressoren AG www.haug.ch		●	●	●	●	●	●		●	●	●	●	●								●	●	●		
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KAESER Kompressoren SE www.kaeser.com		●	●	●	●	●	●		●	●	●	●				●	●	●			●	●	●		
KNF Neuberger GmbH www.knf.com		●	●	●	●	●	●		●	●	●	●	●	●		●	●	●			●	●	●		
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Applications Process & Compressed Air Technology

	Hygiene	Breweries	Medical technology	Food industry	Packaging (except Food)	Laboratory	Cleaning (Purging)	Oil/Gas	Natural gas industry	Oil fields	Petrochemical industry	Refineries	Biogas	Gas stations (natural gas, LPG)	Handicrafts/Workshops	Workshops	Handicrafts	Garages	Pneumatic	Mechanical engineering				Switchgear	
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SPX Flow Technology Moers GmbH www.spxdehydration.de		●	●	●	●	●	●		●	●	●	●	●	●		●	●	●		●	●	●			
STASSKOL GmbH www.stasskol.de		●	●	●					●	●	●	●	●	●						●			●		
Ultrafilter GmbH www.ultraair.de / www.ultra-filter.de		●	●	●	●	●	●		●		●	●	●	●		●	●	●		●	●	●			

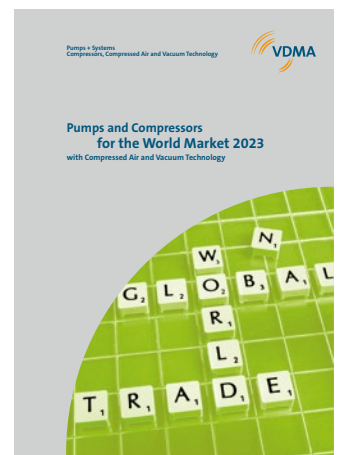


Control air				
Instrument air				
Chemical industry				
Chemical industry			●	●
Fertilizer production			●	●
Construction/Woodworking/Textile				
Construction			●	●
Woodworking and processing			●	●
Textile industry			●	●
Storage and transport				
Filling systems			●	●
Silos			●	●
Bulk handling			●	●
Pneumatic dispatch blowers			●	●
Sewage plants				
Sewage plants			●	●
Aerating			●	●
Foundries/Wind channels				
Foundries			●	●
Wind channels			●	●
Blast furnace blowers			●	●
Coke oven blowers			●	●
Oil field blowers			●	●
Paint plants/Sand blasting plants				
Paint plants			●	●
Sand blasting plants			●	●
Vehicles and Navigation				
Railway vehicle			●	●
Road vehicle			●	●
Navigation			●	●
Starting of engines and power units			●	●
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Applications Vacuum Technology

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Aerzener Maschinenfabrik GmbH www.aerzener.de	●	●	●	●	●	●				●	●	●	●	●	●	●	●	●	●	●		●	●	●	●
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Dr.-Ing. K. Busch GmbH www.busch.de	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●
CVS engineering GmbH www.cvs-eng.de						●																			
Flowserve-Sterling SIHI GmbH www.flowserve-sihi.com	●	●	●		●		●			●	●	●	●	●	●	●	●	●	●	●		●	●		
Gardner Denver www.gardnerdenver.com	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●
Gardner Denver Deutschland GmbH, Elmo Rietschle www.gd-elmorietschle.com	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●
Gardner Denver Deutschland GmbH, Robuschi www.robuschi.com	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●			●	●	
Gardner Denver Deutschland GmbH, Nash www.gdnash.com	●	●			●					●	●	●	●	●	●	●	●	●	●	●		●			
GEA Group Aktiengesellschaft www.gea.com										●	●	●	●	●	●	●	●	●	●	●		●			
HERMETIC-Pumpen GmbH www.hermetic-pumpen.com										●	●	●	●												
KAESER Kompressoren SE www.kaeser.com	●	●	●	●	●	●				●	●	●	●	●	●	●	●	●	●	●		●	●	●	●
Koellmann Airtec www.koellmann-airtec.com	●						●			●	●	●	●	●	●	●	●	●	●	●					
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Leybold GmbH www.leybold.com	●	●			●		●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●

1 (Metal Degassing, Melting, Re-melting, e-beam welding, casting, ...)
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 3 for Semiconductor including focused ion beam systems and electron beam systems



Brand name & trade fair register

 <p>Alltech Dosieranlagen mit Know-how</p>	<p>Alltech Dosieranlagen GmbH Rudolf-Diesel-Str. 2 76356 Weingarten Phone +49 7244 7026-0 Fax +49 7244 7026-50 info@alltech-dosieranlagen.de www.alltech-dosieranlagen.de</p>	<p>We offer dosing systems from a single source: from planning and production through to installation / service. Our products: solution preparation and dosing systems for dry, liquid and gaseous products, piston diaphragm metering pumps FKM with intelligent control iReg, with linear and infinitely variable dosing, even for highly viscous media, dosing stations and accessories, process and storage tanks, control and regulating systems.</p>	
	<p>Gebr. Becker GmbH Hoelker Feld 29-31 42279 Wuppertal Phone +49 202 697-0 info@becker-international.com www.becker-international.com</p>	<ul style="list-style-type: none"> • Rotary vane vacuum pumps and compressors • Screw vacuum pumps and compressors • Claw vacuum pumps and compressors • Side channel vacuum pumps and blowers • Radial vacuum pumps and blowers • Roots Booster Packages • Vacuum systems with tanks • Centralized air supply systems 	<p>For current exhibition activities please visit our website www.becker-international.com</p>
	<p>BEKO TECHNOLOGIES GmbH Im Taubental 7 41468 Neuss Phone +49 2131 988-0 Fax +49 2131 988-900 info@beko-technologies.com www.beko-technologies.com</p>	<p>High-quality product and system solutions:</p> <ul style="list-style-type: none"> • BEKOKAT catalytic converter for oil-free compressed air • DRYPOINT and EVERDRY compressed air dryers • CLEARPOINT compressed air filters • BEKOMAT condensate drains • QWIK-PURE and BEKOSPLIT oil-water separators • METPOINT flow and dew point meters, air quality control • Consulting, Engineering, Training, Service 	<p>For up-to-date exhibition activities please visit our website www.beko-technologies.com</p>
	<p>BOGE KOMPRESSOREN Otto Boge GmbH & Co. KG Otto-Boge-Str. 1-7 33739 Bielefeld Phone +49 5206 601-0 Fax +49 5206 601-200 info@boge.com www.boge.com</p>	<p>BOGE AIR – THE AIR TO WORK: Customers in more than 120 countries worldwide trust the BOGE brand. The BOGE product range includes oil-free and oil-lubricated screw compressors and piston compressors, scroll and turbo compressors, compressed air treatment, control units, heat recovery devices as well as tailored special solutions.</p>	<p>HANNOVER MESSE, Hanover, 17-21/4 2023, Hall 7 For up-to-date exhibition activities please visit our website: www.boge.com</p>
	<p>BORSIG ZM Compression GmbH Seiferitzer Allee 26 08393 Meerane Phone +49 3764 5390-0 Fax +49 3764 5390-5092 sales@borsigzm.de www.borsig.de/zm</p>	<ul style="list-style-type: none"> • Reciprocating compressors for <ul style="list-style-type: none"> – process gases (API 618) up to 1,000 bara, 115,000 Sm³/h, 21,000 kW – PTX oil-free hydrogen up to 450 bara, 1,500 Sm³/h, 200 kW • Integrally geared centrifugal compressors for process gases (API 617 and 672) up to 150 bara, 300,000 Sm³/h, 25,000 kW • Compressor services and spare parts 	<p>13th EFRC Conference 2023, Zagreb, Croatia, 19-21/9 2023 Hydrogen Technology & Carbon Expo, Bremen, 27-28/9 2023 ADIPEC 2023, Abu Dhabi, UAE, 2-5/10 2023 For further events please refer to www.borsig.de</p>
	<p>BRINKMANN PUMPEN K.H. Brinkmann GmbH & Co. KG Friedrichstr. 2 58791 Werdohl Phone +49 2392 5006-0 Fax +49 2392 5006-180 sales@brinkmannpumps.de www.brinkmannpumps.de</p>	<p>BRINKMANN PUMPS offers a complete range of powerful pump solutions based on Centrifugal Pumps or Screw Spindle Pumps for various applications: Multiphase fluid handling, Plastic recycling, Mechanical engineering, Electric mobility, Optical machines, Dosing technology, Pump control, Drive technology, Renewable energies</p>	<p>For current trade fairs, please visit our website: www.brinkmannpumps.de/en</p>
	<p>Dr.-Ing. K. Busch GmbH Schauinslandstr. 1 79689 Maulburg Phone +49 7622 681-0 sales@busch.de www.buschvacuum.com</p>	<p>Busch Vacuum Solutions operates worldwide as one of the largest manufacturers of vacuum pumps, blowers and compressors. The extensive product portfolio covers vacuum and overpressure applications in all industry sectors. A dense service network coupled with many years of experience and expertise in developing vacuum systems makes it possible to provide customised integrated solutions.</p>	<p>For our trade show dates and more information about the world of vacuum, please visit www.buschvacuum.com</p>



	<p>EDUR-Pumpenfabrik Eduard Redlien GmbH & Co. KG Edisonstr. 33 24145 Kiel Phone +49 431 6898-68 Fax +49 431 6898-800 info@edur.de www.edur.com</p>	<p>EDUR is a specialist for high-quality individual centrifugal pumps. As a developer and manufacturer, we produce custom-fit pumps for various applications, which stand out due to their reliable, efficient and long-lasting performance. At the same time, we are competent consultants and technology partners with an international orientation and comprehensive service for our customers.</p>	<p>Aqua Nederland, Gorinchem, NL, 21–23/3 2023, Booth D115 PUMPS & VALVES, Dortmund, 29–30/3 2023, Hall 6, Booth S06 HANNOVER MESSE, Hanover, 17–21/4 2023, Hall 13, Joint booth of Star Pump Alliance For all exhibition dates please refer to: www.edur.com</p>
	<p>Hammelmann GmbH Carl-Zeiss-Str. 6-8 59302 Oelde Phone +49 2522 76-0 Fax +49 2522 76-140 mail@hammelmann.de www.hammelmann.com</p>	<p>Hammelmann has been a market-leading supplier of powerful high-pressure pumps, process pumps and systems for high-pressure applications for 70 years. Years of experience in the development of tailor-made solutions and the highest quality standards make Hammelmann a pioneer in highpressure technology.</p>	<p>Upcoming exhibition dates can be found at: www.hammelmann.com/events</p>
	<p>HOMA Pumpenfabrik GmbH Industriestr. 1 53819 Neunkirchen-Seelscheid Phone +49 2247 702-0 Fax +49 2247 702-44 info@homa-pumps.com www.homa-pumps.com</p>	<p>Pumps for sewage disposal, sanitary engineering, dewatering and drainage: Submersible drainage water and sewage pumps, grinder pumps for pressure sewage disposal, sewage disposal units, drainage water disposal units, condensate pumps, mixers, tank cleaning systems, propeller pumps, garden pumps, electronic booster units, pump control boxes.</p>	<p>For current trade fairs, please visit our homepage: www.homa-pumps.com We are looking forward to your visit!</p>
	<p>J.A. Becker & Söhne GmbH & Co. KG Hauptstr. 102 74235 Erlenbach Phone +49 7132 367-0 Fax +49 7132 367-8305 info@jab-becker.de www.jab-becker.de</p>	<p>JAB is a globally active medium-sized company with 125 years of experience in mechanical and plant engineering. Our product portfolio includes air- and water-cooled compressors for the compression of air, inert gases and natural gas as well as for a wide range of customized solutions up to 400 bar.</p>	<p>Current exhibition dates at: www.jab-becker.de/en/trade-fairs</p>
	<p>KAMAT GmbH & Co. KG Salinger Feld 10 58454 Witten Phone +49 2302 8903-0 Fax +49 2302 801917 info@KAMAT.de www.KAMAT.de</p>	<p>High-pressure plunger pumps + systems Mining pumps + systems Process pumps + systems Water hydraulic pumps + systems Operating pressures up to 3500 bar Flow rates up to 3482 l/min Systems in mobile and stationary design KAMAT valve technology and water tools</p>	<p>For KAMAT's current global trade fair participations, please visit www.KAMAT.de/en We are looking forward to your visit!</p>
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ILMAC, Basel, Switzerland, 26–28/9 2023
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DIAM, Bochum, 8–9/11 2023



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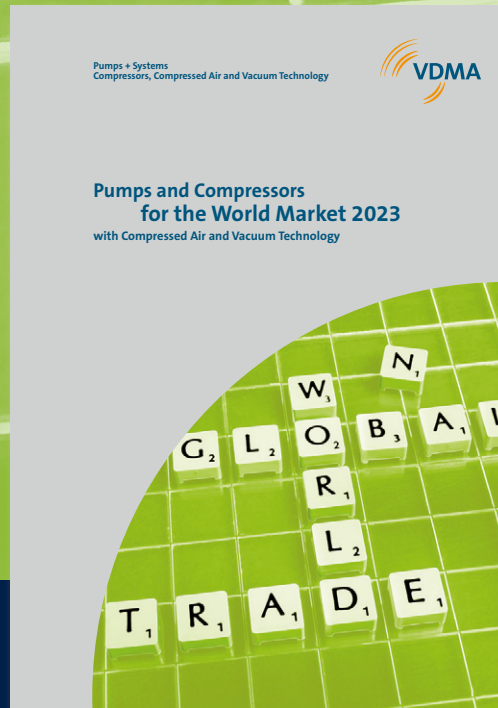
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	<p>WILO SE Wilopark 1 44263 Dortmund Phone +49 231 4102-0 Fax +49 231 4102-7363 wilo@wilo.com www.wilo.de</p>	<p>The Wilo Group is a global leading premium provider of pumps and pump systems for Building Services, Water Management and Industry. Using smart solutions that bring together people, products and services, the Wilo Group is on the path to becoming the digital pioneer in the sector. More than 8,000 employees support the company worldwide.</p>	<p>More Information www.wilo.de</p>
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	<p>WOMA GmbH Kärcher Group Werthäuser Str. 77–79 47226 Duisburg Phone +49 2065 304-0 Fax +49 2065 304-200 info@woma.kaercher.com www.woma-group.com</p>	<p>WATER AS A TOOL</p> <ul style="list-style-type: none"> • High-pressure plunger pumps for industrial cleaning applications • Ultra-high-pressure water jetting units • High-pressure hot water units • Water tools and accessories for various water blasting applications in industry and construction • Industrial Jetting Solutions • Service, maintenance and training 	<p>Current trade show dates and events are listed on our website www.woma-group.com</p> <p>We are looking forward to your visit!</p>
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	<p>Zwick Armaturen GmbH Egerstr. 1 58256 Ennepetal Phone +49 2333 9856-5 Fax +49 2333 9856-6 info@zwick-gmbh.de www.zwick-valves.com</p>	<p>Zwick Armaturen GmbH, a family-owned company for over 40 years, manufactures metal-seated shut-off valves. The product range includes the butterfly valves TRI-CON, TRI-CHECK valves and the TRI-BLOCK for double block and bleed designs. Also part of the product portfolio are the LNG valves TRI-TOP and TRI-ENTRY, as well as the well-known TRI-SHARK control valves.</p>	<p>International Scientific & Expert Meeting of Gas Professionals, Opatija, Croatia, 10–12/5 2023 Oil & Gas, Kenya, 18–20/5 2023 Kraftwerkstechnisches Kolloquium, Dresden, 10–11/10 2023 Valve World Southeast Asia, Singapore, 26–27/10 2023</p>
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