GREEN EFFICIENT TECHNOLOGIES 2022

Hydrogen and Process Technology

Energy Supply

Industrial Processes | Circular Economy | Ressources

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High Pressure Technology

Hydrogen in the atmosphere

Dear readers,

You are no doubt aware that the EU and Germany are investing 6.2 billion euros in 62 hydrogen projects. These projects are essentially concerned with infrastructural aspects of quite remarkable performance size, up to and including the testing or low-cost production of new technologies. In the GET H_2 initiative, for example, various industrial sectors in Lower Saxony are to be converted to hydrogen and connected to a pipeline. Another example is the AquaVentus project, in which electrolysis cells are to be attached to offshore wind power plants and the hydrogen is to be piped to the island of Helgoland, where it will be stored in LOHC and shipped. There is also a group of companies in the south of the republic dedicated to the low-cost production of fuel cells.

At the same time, gas consumption and light pollution from night-time shutdowns are to be reduced on a larger scale. New ideas are constantly coming onto the market that make processes run more efficiently, that use waste as a source of raw materials or that fight plant diseases such as downy mildew in viticulture more effectively with plant extracts than copper can.

In other words, a lot is already happening, but it is also necessary. Because the planet is suffering. In many cases, however, there is a lack of ideas about how. A question I often encounter is "What can I do?". An important aspect for moving forward is therefore information. For this reason, we have decided to fill exactly this gap, with appropriate information.

You are now receiving the first English edition of GET - Green and Efficient Technologies. It has hereby appeared a total of two times this year, a German and an English edition. We want to take up all sustainable topics and, together with our authors, show possible solutions. It is intended to be a magazine that stimulates discussion and is fun to read.

We therefore hope you will find many suggestions in this new publication that you can turn into ideas. This is necessary, because the task ahead is big and needs many people. And if you would like to discuss an idea with us, we are happy to do so.

Yours sincerely

Prof. Dr.-Ing. Eberhard Schlücker
Prof. (ret.), advisor on hydrogen and energy issues

Title

Millions for climate protection and sustainability

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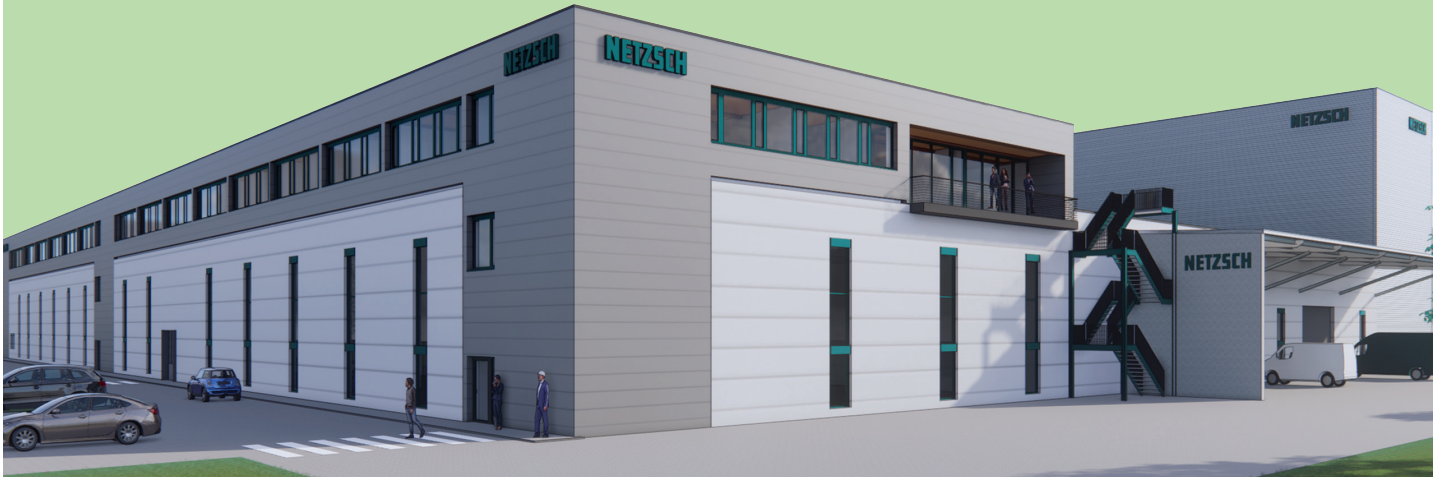

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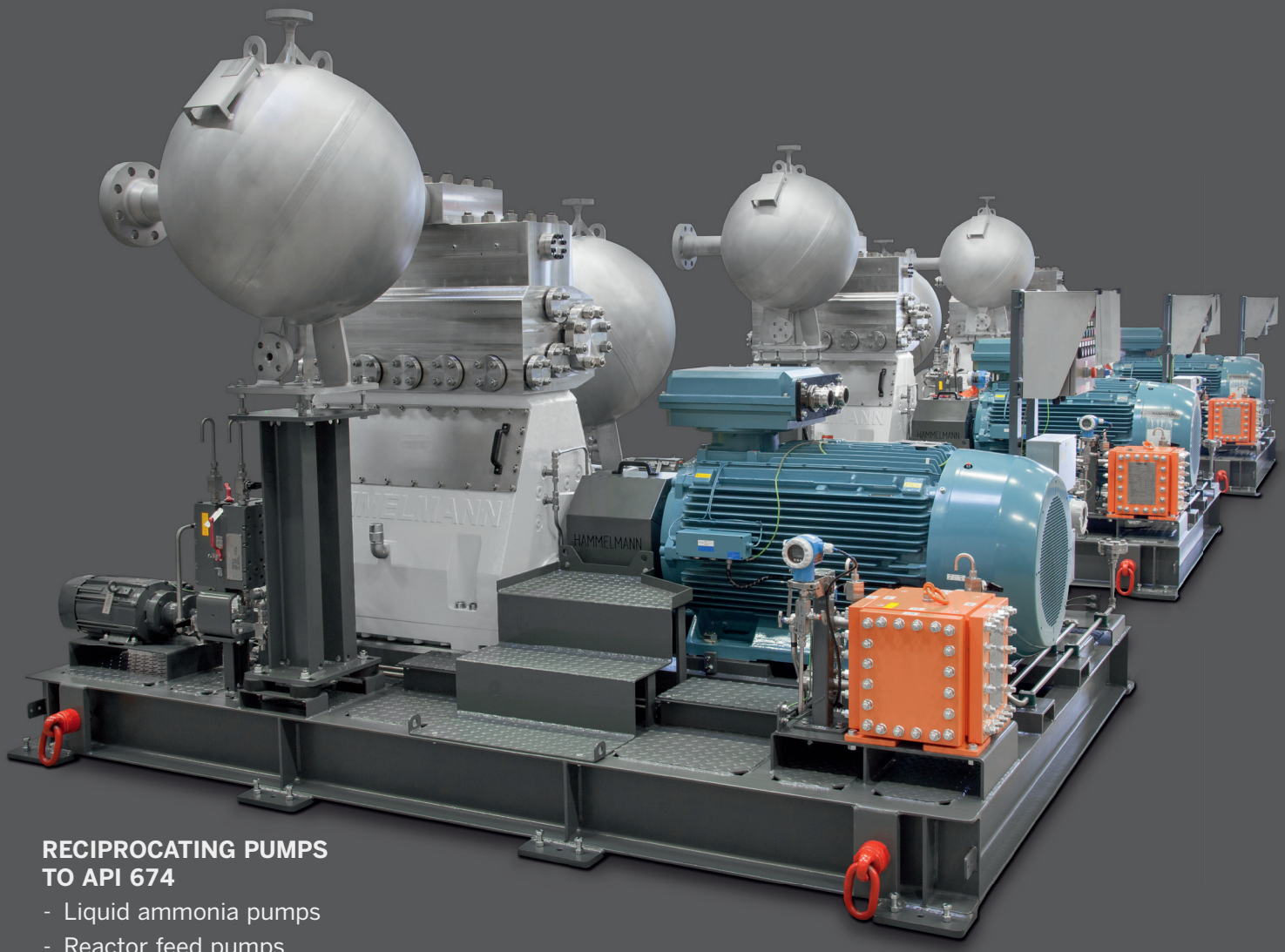

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The hydrogen society

Prof. Dr.-Ing. Eberhard Schlücker

Right now, hydrogen is the word I encounter most often in my profession while the term "hydrogen society" is rarely heard. The defining topics are the numerous essential issues of the energy supply, the conversion of industry to hydrogen and where to obtain this at low cost. Competition is already entering the discussion again. First 2 euros per kg was publicised, now Australia wants to deliver hydrogen for 1.50 euros per kg. The transport form is always ammonia, a good basic material for various chemicals in the chemical industry. Meanwhile, splitting off the hydrogen again with the use of energy (1) for delivery in its pure form also works well. Separating hydrogen that, for example, is sent through pipelines mixed with natural gas is also working very well now with the use of membrane technology (2). Thus import and transport appear to be resolved, especially since around 90% of our natural gas pipelines in Germany are suitable for hydrogen and mixtures containing hydrogen.

Countries close to the equator naturally have the most favourable solar conditions for hydrogen production. Importing energy therefore appears sensible. However, a discussion about efficiency factors and the climate impact of hydrogen is sometimes lacking. For example, the heat generated during ammonia production, waste heat to a large extent, remains unused in the production country. The final efficiency factor is likely below 50%. This also means that while the ammonia is inexpensive, the climate impact is the same as if we were producing it here. There is another aspect as well, which is rarely discussed. When hydrogen is released into the atmosphere, it goes up. In the troposphere, it finds methane cracked by the sun, which it repairs, thus allowing it to do damage for an additional year. Hydroxidion, which is also produced from water by the sun, turns back to water and thus loses its purifying effect on the atmosphere, just like ozone in the troposphere. Ozone is also broken down and turned into water in the stratosphere, especially in the polar regions with the aid of polar wind. That could lead to more cloudiness. Thus we alter the climate with hydrogen as well. This means it should not be released into the atmosphere. We should therefore do it right this time and simultaneously strive for a very good energy balance and efficiency factors.

Maximum efficiency factors as a social objective

We have to pay attention to efficiency factors. When hydrogen gas is compressed to approximately 350 bar, about 20% of the hydrogen's energy content is used for this compression. From this perspective, a filling station supply chain (compression, transportation, decanting, cooling to -40 °C, compression to 700 bar) has a final efficiency factor of merely 20–30%. Assuming the vehicle is equipped with a PEM fuel cell, its efficiency factor is only about 50%. Therefore, a mere 10 to 15% of the energy contained in hydrogen is actually utilised! This is not the way to manage our future energy carrier. Hydrogen gas should not be transported like oil. Especially since transportation is always associated with the risk of accidents and leaks, and we cannot build pipelines all over the place. Furthermore, even though Toyota has meanwhile launched an exchangeable cartridge in the market, the vehicle market will be dominated by batteries over the medium term. This considerably improves the overall efficiency. New, low-lithium or lithium-free designs with a higher storage density are also on the horizon in battery development (for example, solid oxide batteries, nano-batteries). Thus we are only talking about hydrogen in the context of industry, where it is needed for processes and chemical products. Since electricity is the highest form of energy, everything else is done with electricity to the greatest possible extent and hydrogen is merely an electricity conversion product. Anything else is then energy storage in times of excess to cover future shortages.

Domestic hydrogen production?

That being said, we need to ask if we fundamentally want to import everything or whether producing hydrogen here in Central Europe could also pay off. Since electricity, the basis for hydrogen, depends on space going forward, anyone with a roof or other another usable space or area could produce hydrogen. It has been shown that 10 KWp PV is, on average, sufficient to meet the annual demand for a detached house (4 people) with storage. This resource becomes even more attractive considering that PV efficiency factors will keep improving (currently 20%, 24-40% in a few years). Villages and perhaps even towns could therefore supply themselves in the future. Only with storage, of course, since PV yields are considerably less in winter than summer. The storage medium has to be safe, non-combustible, non-toxic and easy to manage. Such storage media include LOHCs (liquid organic hydrogen carriers) on the basis of butyltoluene or dibenzyltoluene (cannot be ignited even with a welding torch) and the magnesium hydride "power paste" developed by Fraunhofer (Dresden). Both have a similar storage density (LOHC 2.1 KWh/kg, MgH_2 1.6 KWh/kg). LOHCs need heat to separate the hydrogen. Magnesium hydride merely has to be wetted with water to release the hydrogen.

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However, the latter is more combustible and highly viscous, which makes pumping difficult. Thus this storage medium is better suited for small units. Pre-filled cartridges can be used here. The disadvantage of these storage media is that waste heat is always produced centrally during storage, in a professional storage facility. This waste heat needs to be utilised, but magnesium hydride storage in the home cannot be realised. The electricity to electricity efficiency factor is similar for both. Thus one only needs to differentiate which method is a better fit for what process and application. We therefore have storage methods to help us realise a hydrogen society.

Tools for change

Electrolysis and fuel cells are at the core of the hydrogen society. Polymer exchange membrane (PEM) fuel cells are currently the most commonly used type. However, the solid oxide fuel cell appears to be the better technology for "home use". It can be operated as both a fuel cell and an electrolysis cell. This means it can both produce hydrogen and turn it into electricity. Switching operating modes actually extends the service life of the unit. A very good efficiency factor combined with a high waste heat temperature is an advantage of this equipment technology. This waste heat can be used to separate the hydrogen from the LOHC (Fig. 1, winter mode, patented). If a home owner, for example, had such a unit, hydrogen could be produced at home (Fig. 1, summer mode). Photovoltaic energy could be used to produce hydrogen during the summer for storage in the LOHC. Electricity would then be available in winter from the LOHC with the help of the fuel cell. The corresponding hydrogenation unit is easy to build. What might such a hydrogen society look like? No doubt divided into small sections in many cases, with a decentralised infrastructure. However, the magnitude and location of the energy demand also has to be differentiated.

Big industry

Since the electricity supply for such enterprises works today, it will also work in the future. Where hydrogen is needed as a material – for example, in the chemical industry – ammonia imports are surely the most beneficial. The closer production is to the use of ammonia or hydrogen as a material, the more it benefits. The mechanical engineering industry on the other hand mainly needs electricity, with a large proportion surely produced by wind farms. Rooftop PV should nevertheless be installed in all industries, striving for a degree of self-sufficiency. Some of the electricity could come from nearby (PV) in the form of electricity, hydrogen or stored hydrogen, establishing some level of supply security. Part of the required process heat could be supplied through the delivery of electricity from private production to industry, where hydrogen is produced and stored to utilise the waste heat (electrolysis and hydrogenation). Then the LOHC could be supplied to private producers for electricity generation in winter (Fig. 1, left). Synergies between an industrial enterprise and its environment are therefore by all means conceivable. This would also cause the local population to better identify with the enterprise. Heat generation using pure oxygen (which will be in plentiful supply in the future) and

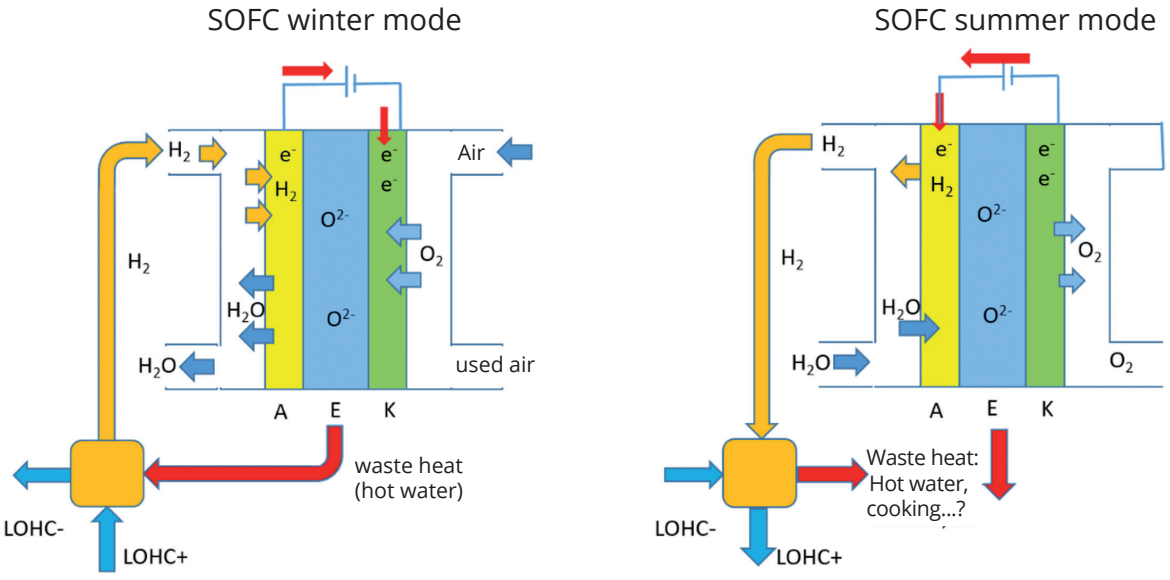

Fig. 1: SOFC fuel-electrolysis cells used to separate hydrogen from LOHC with direct subsequent electricity generation (winter mode) and to produce hydrogen (summer mode): A: Anode, E: Electrolyte, K: Cathode. (patented)

combustible waste (sewage sludge, scrap wood…) is another option for the production of electricity and therefore hydrogen or also just heat during the winter. Heat pump technologies also exist that can deliver a supply temperature of up to 300 °C. This means that heat pumps are now an alternative for process technology as well.

Decentralised small industry

Small industry (SMEs) distributed across the country represents a key economic stability factor. Rooftop PV should be installed throughout in this sector as well. Small wind turbines may also be sensible depending on the building height. In summer, the electricity shortfall is made up by neighbours in the greater surrounding area. Depending on the product type and the process technology being used, the heat from hydrogen production and storage can be utilised or something has to be built to use the heat (in rural areas, for example, a distillery, bakery…). With regard to heat utilisation, the heat supply will not be sufficient in winter. The oxygen produced in summer could be stored in this case (easier to store than hydrogen). Heat could then be produced in winter using combustion processes with pure oxygen (at least 600° C hotter). Separating the hydrogen from the LOHC is another source to offset the electricity shortage in winter. A heat pump (see above) would also be a good solution here for supplemental heat.

If heat energy is only needed for heating in winter, a heat pump could also be used to meet the entire heating demand. The electricity for this and the infrastructure could come from winter sunlight or from LOHC stored everywhere in summer.

Synergies with the environment are conceivable here as well (nearby houses supply electricity to companies in summer and get back loaded LOHC in winter). This would almost certainly have a positive impact on coexistence.

Residential buildings and areas

Electrolysis and fuel cells form the core of such a supply (Fig. 1). While these are still very expensive right now, the SOFC technology (solid oxide) could be an initial step. The investment is halved since they can be operated as both a fuel cell (F) and an electrolysis cell (E). Once developed to series production readiness, the price will also be in an acceptable range. Switching from E to F and back has the advantage of extending the cell's service life, further decreasing the cost. The efficiency factor from hydrogen to electricity is 60 % to 80 %. Waste heat is naturally produced, in the temperature range up to 1000 °C. Any temperature below 1000 °C can thus be reached when this is properly used, which covers domestic hot water, cooking and heating. However, the amount of energy is insufficient for the latter since we need at least three times as much heat energy as electricity. The SOFC technology could be used to produce electricity and hot water (winter) as well as hydrogen (summer). Heating does however require additional sources or measures.

Improving the insulation of residential units would be the first step. Heating oil savings of at least 60 % could be obtained relatively easily here. A heat pump would be the next or possibly also the final step. A geothermal heat pump with a COP (coefficient of performance) greater than 6 is recommended here. This unit eliminates the noise of an air/air heat pump that is a nuisance for neighbours. Temperatures up to 80 °C are now possible with this technology, meaning normal radiators can also be supplied (Fig. 2). It is of course conceivable to obtain heat from a district heating network supplied, for example, by a waste water treatment plant energy centre.

Energy storage in summer is straightforward. The F/E cell produces hydrogen that is stored. In winter, the waste heat from fuel cell operation is sufficient to separate the hydrogen from the LOHC and generate electricity. Self-sufficiency is therefore possible in principle. But what to do with the waste heat in summer? Hot water and swimming pool heating are obvious options. Still, there will be extra heat. The heat could be stored in a mobile heat storage unit (salt, sand…) and then sold to industrial enterprises. Cooperation with several neighbours would be sensible here.

Examining the price in proportion to the size of an F/E cell shows that a system shared between 4 to 5 houses is sensible. Currently there are two manufacturers of such units for home use. Both have 10 KW units on the market or in the planning phase. The larger the community, the more readily heat can be sold. A PV system on every roof is the basis for all of this. Self-sufficiency is therefore possible for houses.

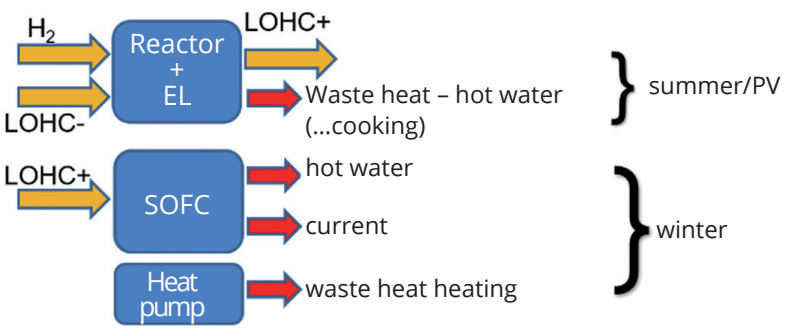

Fig. 2: Energy supply concept for residential buildings and areas, self-sufficient solution

Inner city and high-rise districts

Where such installations are not possible (dense development, high-rises), the heat has to be produced elsewhere and transported. If there is a nearby waste water treatment plant, it could be developed into an energy centre that stores hydrogen in LOHC and supplies this to the residential areas, along with the waste heat from electrolysis as district heating. Companies and data centres often have unused waste heat as well. This lends itself to connection and utilisation in combination with heat pumps. In such cases, the electricity supply for residential areas can be provided with the help of fuel cells. The heat from the waste water treatment plant or from companies could be used by the LOHC, storing the hydrogen produced internally or supplied from the region to utilise the waste heat. Such buildings should also have rooftop PV installations to cover the own demand as far as possible (Fig. 3).

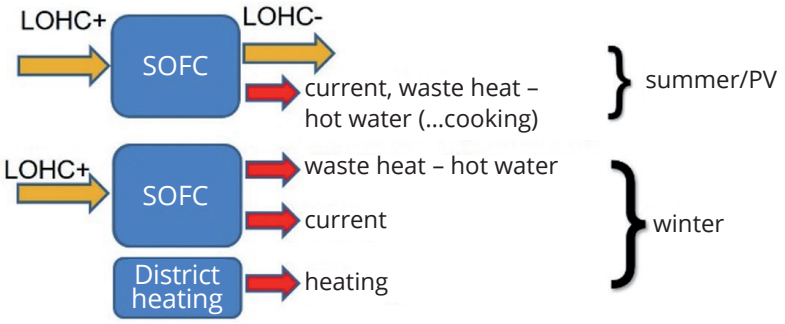

Fig. 3: Energy supply concept for multi-family houses, inner city. District heating refers to all types of sources.

Companies in the neighbourhood are another option, for example, catering, bakeries, wood drying, distillation processes, plastic processing etc... They too could store hydrogen and supply the waste heat from storage and electrolysis for heating after high-temperature utilisation. Here too, waste materials can also be incinerated with pure oxygen, producing very high temperatures for process heat of any kind or, in case of excess heat, electricity generation using small steam turbines. This heat can also be used for district heating when needed. If none of that exists or is possible, something would have to be built or classic district heating would have to be used.

Social opportunities for society

As you can see, the future will be more decentralised with a great deal of personal involvement and cooperation. This can lead to the social pacification of critical urban regions. Other benefits are possible as well. Everyone should have the opportunity to participate financially in their energy centre, with electricity coming not from the outlet but from your own energy centre. This could be organised as a cooperative but should always include social capital as well, permitting the participation of less well off citizens. The cooperative would have to decide whether shares can be sold. My calculations to date support the conclusion that a profit for cooperative members is possible if the system is efficiently designed and operated. When this is viewed as an opportunity, disagreements could be resolved through the natural need to communicate with regard to joint ownership. People on the margins could also be made to feel that they belong.

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Prof. Dr.-Ing. Eberhard Schlücker, Prof. i.R., Hydrogen and Energy Consultant

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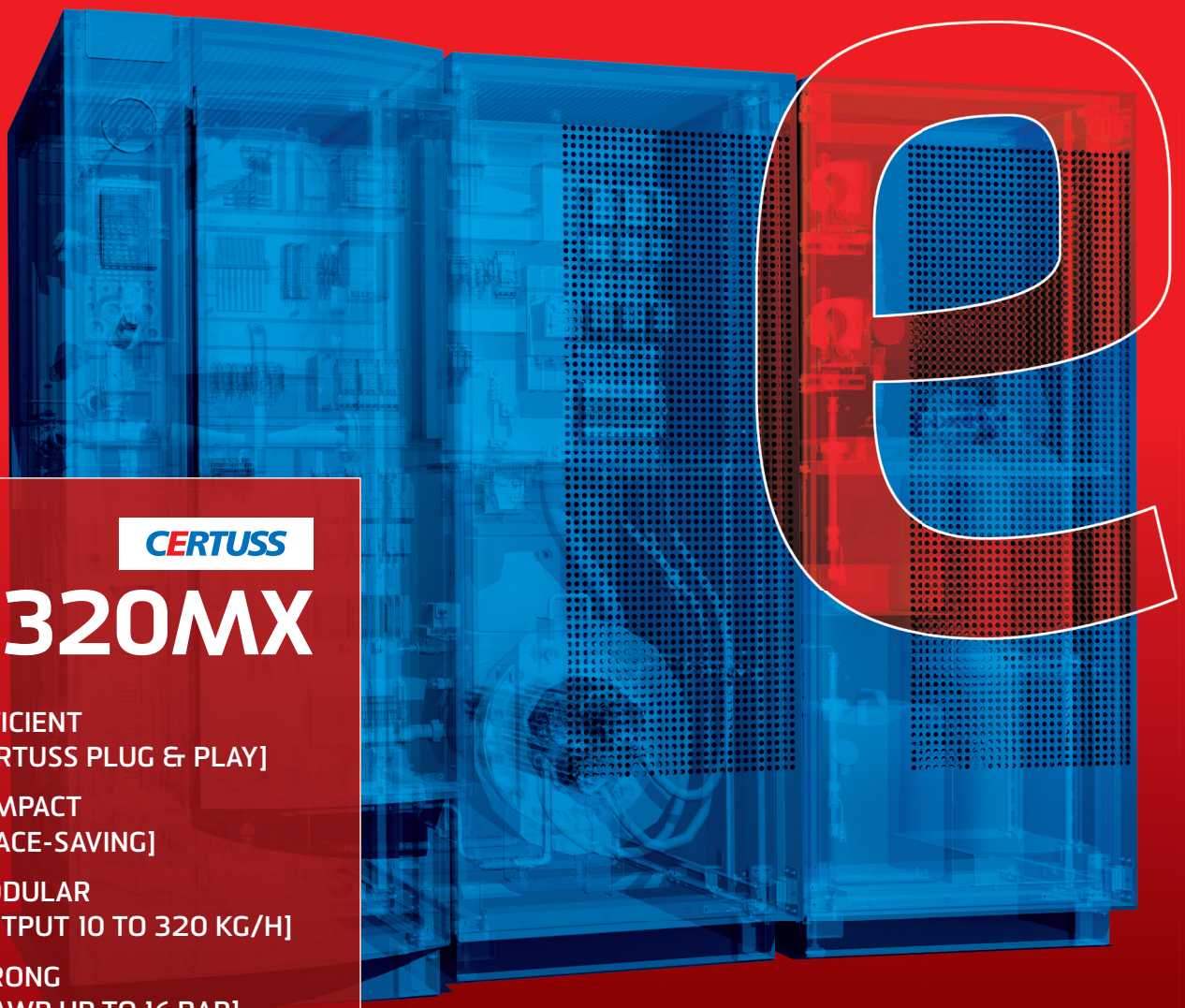

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The NETZSCH Campus is being built in Waldkraiburg:

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At NETZSCH Pumps & Systems, the idea of environmental protection begins at the factory gate. Water is taken from a well and fed to the new assembly hall via a network of pipes. Depending on demand, the water temperature is used to heat or cool the hall. This saves energy. With the new building in Waldkraiburg, the company is setting new standards for climate protection and sustainability. The global specialist for complex fluid management has set itself the goal of achieving complete climate neutrality by 2045.

The NETZSCH Campus in Waldkraiburg, currently in the final phase of construction, is making a decisive contribution. But the existing buildings will also be brought up to the highest energy standard in the coming years.

Room air conditioning in new buildings using groundwater

"We can operate the entire new building without the use of fossil fuels", says Jakob Bartinger, the pump manufacturer's overall project manager. In future, groundwater will be used for heating and cooling. Two boreholes have been drilled in recent months, which will be used to pump water at a temperature of around six degrees Celsius from 40 to 45 metres. The groundwater will be cooled or heated by a heat pump to cool or heat the buildings. In addition to the rooms, the technical systems are also cooled using groundwater. Thanks to the innovative room air conditioning, the company will save 250,000 kWh of natural gas and 320 tonnes of CO_2 per year, which not only makes the company more independent in the future but also makes an essential contribution to climate protection.

Campus Waldkraiburg: KfW Standard 55

The entire new building in Waldkraiburg complies with the KfW Standard 55, which means that the premises require 55 percent less primary energy than the EnEV reference building. The transmission heat loss is only 70 percent. This means that the structural thermal insulation is 30 percent better. Primary energy demand is defined as the maximum energy consumption for heating, hot water, ventilation and cooling, including the entire upstream chain (energy required for production and delivery). The transmission heat loss shows how much heat is lost to the outside through a heated house's walls, windows, doors and roof. In addition to the heat pump and the insulation, the special glazing of the windows also contributes to achieving these excellent values.

Fig. 1: The various buildings are connected by a glazed bridge. The special glazing of the windows helps to contain the transmission heat loss.

Fig. 2: By replanting, the tree population on the site was preserved despite the construction measures.

Optimisation of logistics through plant consolidation

With the new building, three locations at the pump manufacturer in Waldkraiburg will be merged into one campus. This optimises processes and logistics, and the customers will benefit. As part of the global strategy, the company aims to increase efficiency and reduce its throughput and delivery times with the new building. Trips and transport between the individual plants will be eliminated in the future. This optimises throughput and delivery times and contributes to a considerable reduction in CO_2 emissions.

Fig. 3: In the course of the new construction, the existing buildings are also being renovated to improve their energy efficiency.

Photovoltaics for green electricity in Waldkraiburg

The Campus in Waldkraiburg is also setting new standards for generating its electricity. A total of 1,542 photovoltaic modules with a total system output of 510 kWp are installed. This will cover a significant part of the electricity demand. This significantly reduces the consumption of fossil resources and thus protects the climate.

Renovation of existing buildings

The existing buildings will also be renovated in the new construction to improve their energy efficiency. In the coming years, all the premises at the emerging Campus will be brought up to the highest Kfw standard. In addition to the energy renovation, numerous new systems and machines with the lowest possible power consumption will be installed. Compensation will take place in areas the procurement of new machines does not make sense at this point. For this purpose, 8,500 square metres of industrial fallow land have already been converted into ecologically valuable flower meadows.

Fig. 4: Electric cars are already available to employees, and the corresponding refueling station is already in use.

Renewal of the fleet of vehicles

Parallel to the new building, the company's pool cars are also being renewed. Two electric cars are already available to the employees. These can be operated with electricity generated from the company's photovoltaic systems. In addition, the company has been using green electricity generated from renewable energy sources for some time. By switching to green electricity, the company will save 3,619 tonnes of CO_2 per year.

The company has already done a lot in terms of environmental protection and sustainability in recent years. As a global specialist in complex fluid management, the supplier produces durable capital goods and support its sustainable approach thanks to a worldwide spare parts distribution and service.

NETZSCH
Pumpen & Systeme GmbH
Waldkraiburg, Germany

Hydrogen-island grid of Ansbach University of Applied Sciences

Smoothing volatile power generation and delivering green power in a predictable way

Daniel Schultheiß, Dipl.-Ing. (FH) Dieter Jarosch, Prof. Dr.-Ing. Jörg Kapischke

The greatest challenge for the energy supply of the future lies in the storage of large amounts of sustainably generated electricity. Although the expansion of renewable energy sources is still far from supplying countries like Germany in a carbon neutral way, photovoltaic and wind energy plants are already shutting down due to temporary overproduction. Electricity from private rooftop solar systems can easily be buffered in battery storage. For solar and wind farms on a megawatt scale, however, storage in batteries is not a practical solution. Ansbach University of Applied Sciences has implemented an innovative approach that temporarily stores photovoltaic electricity in the form of hydrogen gas. This allows large amounts of electricity to be retained almost loss-free, even over long periods of time. The system is designed as a self-sufficient island grid and can be coupled with the public power grid if required.

Description of the island grid system

The photovoltaic system of Ansbach University of Applied Sciences supplies laboratories with electricity, generates hydrogen and optionally feeds into the public grid. Due to the easy scalability of the system, the laboratories can be considered representative of the energy balance of a building, a commercial area, a company or a district. The building integration of the photovoltaic system (1) with its inverters (2) is shown in the upper part of Fig. 1. The special feature of the carbon dioxide-neutral system is the combined storage system, consisting of battery (4), fuel cell (5), electrolyzer (6) and hydrogen storage (7). If the labs need more electricity than the photovoltaic system can supply, the battery storage is discharged and at the same time the saved hydrogen is converted back into electricity with the fuel cell. If this is still not enough, additional electricity is received from the public grid. If the photovoltaic system produces more electricity than currently demanded in the laboratories, the battery storage unit is charged and the electrolyzer produces hydrogen. If more electricity is available than consumers, battery storage and electrolyzer can absorb, the surplus is supplied to the public grid. The combination of battery storage and hydrogen brings together the advantages of both systems and eliminates their disadvantages. Battery storage systems can take in and release large amounts of electricity, but they only can do this for short periods of time. Electrolyzer, fuel cell and hydrogen storage can store and provide electricity over long periods of time and in large quantities. But they are not designed to handle peaks in generation and consumption. The vision being pursued with the demonstration plant is a system of many such self-sufficient plants that are nevertheless networked with each other and can

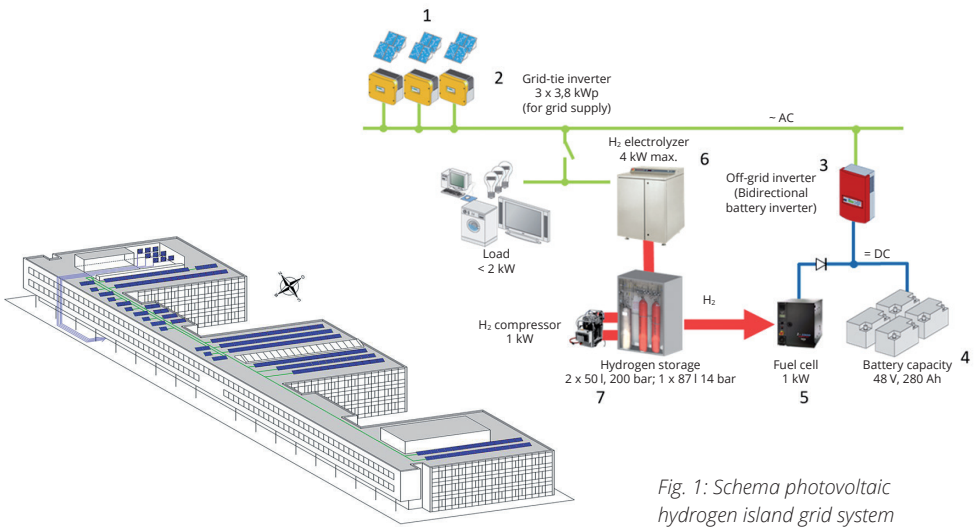

Fig. 1: Schema photovoltaic hydrogen island grid system

System components at a glance:

(1) Photovoltaic system with inverter for supplying power to the grid (2): 38.7 kW Switching station to island grid operation
(3) Off-grid inverter: 4.2 kW
(4) Battery storage: 8 kWh
(5) Proton-exchange membrane fuel cell: 1 kW
(6) Proton-exchange membrane electrolyzer: 4 kW, 13.8 bar
(7) Compressed gas storage station: 87 l, 13.8 bar; compressed gas storage: 50 l, 200 bar; Hydrogen compressor: 200 bar

operate as a cluster when needed. If the energy sources of the individual cells differ (i. e. wind, solar, biogas), the systems can support each other in energy storage and supply.

In addition to consumption and yield profiles, the demonstration plant will be used to investigate performance parameters, reliability, fail-safe operation, durability and economic efficiency.

Description of overall system

The photovoltaic hydrogen island grid system can be operated in two modes, grid-connected and off-grid. Grid-coupling with the public grid comes into consideration when several power generation cells are connected together in regional vicinity in order to support each other with electricity via the public grid. It is conceivable, for example, that a photovoltaic power generation cell supplies a wind power generation cell with electricity when there is a high volume of solar power and a breather in the wind. A power supply system that is both green and stable is thus possible. The photovoltaic hydrogen island grid system at Ansbach University of Applied Sciences is being investigated primarily off-grid, i. e. in the island grid mode of operation. This enables practical tests of energy supply scenarios to be inspected in a well-defined system boundary at different times of the year and the day over longer periods of time.

Description of system components and tasks

An off-grid system with alternating current supply, which can be connected to the public grid if desired, consists of different system components with different performance data. Basic components are the energy generators, the inverters, the grid former, the power grid and, if applicable, energy storages. The special components of the presented system must fulfil defined tasks. The photovoltaic system either supplies the electricity to the public grid via current-controlled inverters (see Fig. 1: (1) and (2)) or the interconnected solar modules supply the electricity for an alternating current grid, which is set up via a grid former. System components and functions are described below.

Fig. 2: Solar modules on the roof of the university building

Photovoltaic system and solar modules

The photovoltaic system at Ansbach University of Applied Sciences consists of a total of 180 solar modules with a total area of 296 m² and a nominal power of 38.7 kW (see Fig. 1: (1)). These modules are interconnected in strings of ten each. The orientation of the system is towards south with a 25° inclination. The IBC 215P polycrystalline solar modules have a surface area of 1.64 m² each and a nominal power of 215 W at a nominal voltage of 28.7 V.

Inverter for grid supply

Two of the strings, each equipped with ten solar modules, lead to an inverter (see Fig. 1: (2)). The inverter has the task of converting the direct current (DC) of the solar modules into a 230 V alternating current (AC) that can be used by all standard technical 230 V devices. A total of nine SB 3800 inverters convert the DC voltage of two parallel-connected strings into the grid-synchronous AC voltage and either feed this AC current into the public grid or make it available to the island grid. The inverters operate grid-connected and require the AC voltage pulses of an external grid, for example those of the public grid, to produce a grid-identical voltage and frequency. The inverters are equipped with a control system that changes the power depending on the measured grid frequency. This means for example that, as soon as an increase of grid frequency is detected and a certain limit value is exceeded, the inverters supply less electrical power. If the grid frequency drops, an increasing power output from the inverter takes place.

In order to achieve the maximum power from the solar modules always despite varying irradiation, a maximum power point tracker is integrated. The maximum power point tracking changes the internal resistance of the inverter minimally in certain time periods, whereby voltage and current change simultaneously and thus the power of the photovoltaic

Fig. 3: Photovoltaic-inverter for grid supply

generator. With the power increasing, the inverter maintains the new voltage and current values. If, the other way round, there is a drop in power of the photovoltaic generator, the inverter operates again with the original values until the next measuring interval.

Off-grid inverter as grid former

An off-grid inverter (see Fig. 1: (3)) is responsible for maintaining the grid voltage and grid frequency on the AC side. Therefore, it monitors the output of the solar modules to the connected loads and storage units. In every electrical grid, at least one voltage source must be used as a grid former, which requires current-controlled, grid-connected inverters as a reference for its own feed-in. The Sunny Island 4248 FC grid former is a bidirectional, self-guided battery inverter. On the AC side, it regulates voltage and frequency, active and reactive power (PAC: generated AC power, Max: 4.2 kW). On the DC side, it works as a battery charger with intelligent charge control as well as power limitation of the solar modules and safe deep discharge protection by load shedding.

Due to the missing ability of the grid of storing energy by itself, any imbalance between generation and consumption leads to a change in the grid frequency. Therefore, a battery is needed as a buffer storage to maintain grid stability. If the power supply of the solar system exceeds the power demand of the consumers, first the battery is charged. As soon as the buffer storage is full, the grid-connected inverters are limited in their power output. The grid-connected inverter is oriented to the battery voltage. If the permissible final charging voltage (56.4 V) is exceeded, the grid frequency is increased to max. 52 Hz. The grid-connected inverters register this frequency increase and regulate their output from 100 % at 51 Hz down to 0 % at 52 Hz. If, in turn, the permissible discharge voltage (43.2 V) is undershot, the loads are disconnected from the grid via a protection.

Lead-fleece battery

Four lead-fleece batteries connected in series with a total capacity of 280 Ah C10 and a weight of 436 kg serve as a cost-effective buffer power storage unit (see Fig. 1: (4)) that can quickly absorb and release energy. From this battery set, 28 A of current can be taken for more than 10 hours. The weight and volume of the battery set for a stationary application is not as relevant as for a mobile application. As electrolyte in the batteries sulfuric acid is used. During the discharging process, lead sulfate is produced and does not completely dissolve during recharging. Over time, this residue weakens the performance and shortens the useful life of the storage device. In order to reduce this residue formation of lead sulfate, it is necessary to inhibit the charging process. Therefore, the lead-fleece batteries have a protective glass-fibre fleece layer to support the delay.

Fig. 4: Fuel cell with off-grid inverter

Fig. 5: Fuel cell system

Hydrogen-air-proton-exchange membrane fuel cell

A 1-kW hydrogen-air-proton-exchange membrane fuel cell is connected in addition to the batteries via a protective diode (see Fig. 1: (5)). The fuel cell requires 1 standard cubic meter of hydrogen per hour to generate 1 kilowatt. The unit is designed to support the batteries when solar power is insufficient. To ensure this, the fuel cell only runs when the grid frequency is below 50 Hz. This frequency is set at night or during the day when the power demand of the consumers is higher than the power that can be delivered from the energy converters. Compared to a lead battery, the fuel cell reacts more slowly to a load step. It needs more time to adapt its power to the consumer. The fuel cell is supplied with pure hydrogen at atmospheric pressure.

Hydrogen-proton-exchange membrane electrolyzer

All surplus solar energy is to be stored in batteries in the short term and in the form of hydrogen in the long term. Here, too, the grid frequency serves as a source of information about energy production and consumption. The hydrogen production is regulated by the grid frequency. Above a frequency of 51 Hz, the electrolyzer (see Fig. 1: (6)) produces hydrogen gas with its maximum power of 4 kilowatts and limits the frequency linearly to 50 Hz.

The electrolyzer produces high-purity 6.0 hydrogen at an overpressure of 13.8 bar. For this, it requires ultra-pure water with a conductivity inferior to 10^{-6} S/cm.

Its production rate is 0.5 cubic metres of hydrogen per hour. The output is controlled by a mass flow controller at the product hydrogen output, i.e. the mains frequency controls the setpoint of the mass flow controller. The electrolyzer produces oxygen at an overpressure of 2 bar, which is not used and escapes into the environment without any harm for it.

Hydrogen storage

The produced hydrogen first enters an intermediate pressure tank (87 l). From there the hydrogen is compressed by a reciprocating compressor from 13.8 bar to 200 bar into a 50 l gas cylinder (see Fig. 1: (7)). To prevent oxygen from getting into the hydrogen system, all piping, containers and fittings are made of stainless steel. The system is constantly under pressure and is protected by non-return valves.

Fig. 7: Compressed gas storage for hydrogen

Outlook

Not only companies, municipalities and industrial estates are potential users of hydrogen-based island grids but also data centers, public authorities and financial service providers. The latter are significantly dependent on a long uninterruptible power supply. The benefit and value of a hydrogen island grid based on renewable energy sources for a public building was successfully demonstrated at Ansbach University of Applied Sciences. In remote areas, this island grid system offers an excellent alternative to systems based on diesel generators, as it is cleaner, efficient and reliable. Further tests with the system will focus on varying storage sizes and function algorithms to verify optimization approaches. The efficiency of the system can be improved in the process. Reliable models for dimensioning an island grid system must be further developed. Based on suitable boundary conditions, hydrogen can contribute to opening up new fields of application for this promising technology as a perspective-rich long-term storage for surplus electrical energy.

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Fig. 6: Proton-exchange membrane pressure electrolyzer

sera makes seawater drinkable

Morocco is an arid country which is badly affected by climate change. Population growth, the progression of industrialisation, the growth of the tourism industry and agriculture have led to the groundwater table sinking continuously in recent years. Large seawater desalination projects for drinking water production are intended to counteract the drinking water scarcity, and sera is contributing to this.

Morocco, cultural, political and economic link between Europe and Africa, has always been one of the countries with water shortages. Climate change and the increased expansion of the export of agricultural products have made the situation even worse in recent years. A programme launched by the Moroccan government and supported by the EU therefore provides for the expansion and new construction of seawater desalination plants for drinking water and irrigation water production by 2030. Currently, 30 million cubic metres of seawater and brackish water are treated annually in ten plants in Morocco; by 2030, this figure is expected to rise to 400 million cubic metres per year.

Largest seawater desalination plant in Africa – most modern in the world

The Souss-Massa region in southwestern Morocco is home to more than 2.7 million people on an area of about 51,600 km². Agriculture is the most important economic sector in the region, and its capital, Agadir, is an important fishing and tourist port. Here, too, drought and water shortages are prevalent, recently costing thousands of jobs in agriculture.

In order to counteract the water shortage, the construction of a seawater desalination plant for the region was put out to tender, which is to cover both the water demand for domestic consumption and the irrigation needs of the region. As such, it is expected to contribute to the development of the main economic sectors, tourism and agriculture, while maintaining the region's groundwater level at current levels. In early 2019, the Moroccan Ministry of Agriculture and Economy awarded the construction to the Spanish company Abengoa, a leader in innovative technology solutions for sustainability in the energy and environment sectors.

Seawater desalination is an energy-intensive process. The company planned to desalinate seawater by reverse osmosis, which involves forcing seawater at high pressure through semi-permeable membranes that retain the salt. Compared to distillation, which requires about ten kilowatt hours per cubic metre of water, this process requires only three kilowatt hours. Still a high energy input. For this reason, the desalination plant in Agadir is

Fig. 1: Panorama of Agadir, Morocco, Photo: Adobe Stock/Maciej Czekajewski

powered exclusively by renewable energies: it draws its electricity from the Noor Ourzazate solar power plant, about 400 km away, making it the largest solar-powered seawater desalination plant in the world. An expansion and use of wind turbines is planned for the future. The total cost of the project is over 370 million euros. Farmers in the region have each contributed around € 930 in exchange for a discount on future desalinated water.

German-Spanish sera cooperation

The Spanish company was aware that sera had already supplied dosing systems for a seawater desalination plant in Salaha in Oman (113,500 m³ of drinking water daily) and therefore relied on the expertise of sera's Spanish subsidiary. The planned plant in Agadir was initially to produce 275,000 m³ of desalinated water per day, later reaching a maximum capacity of 450,000 m³ per day.

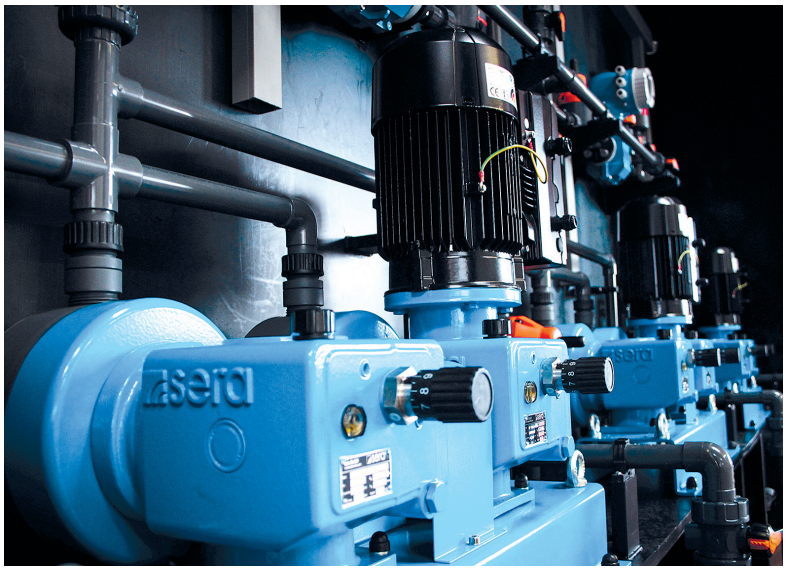

Fig. 2: Dosing system

This makes it the largest seawater desalination plant in Africa – and such a large project for the system supplier and dosing pump manufacturer that the Spanish branch implemented it together with the headquarters in Immenhausen.

A wide variety of dosing and conveying systems were required at different process steps in seawater desalination. The Spanish subsidiary was in charge of the extensive, customer-specific project. The entire engineering was carried out in Spain, as was

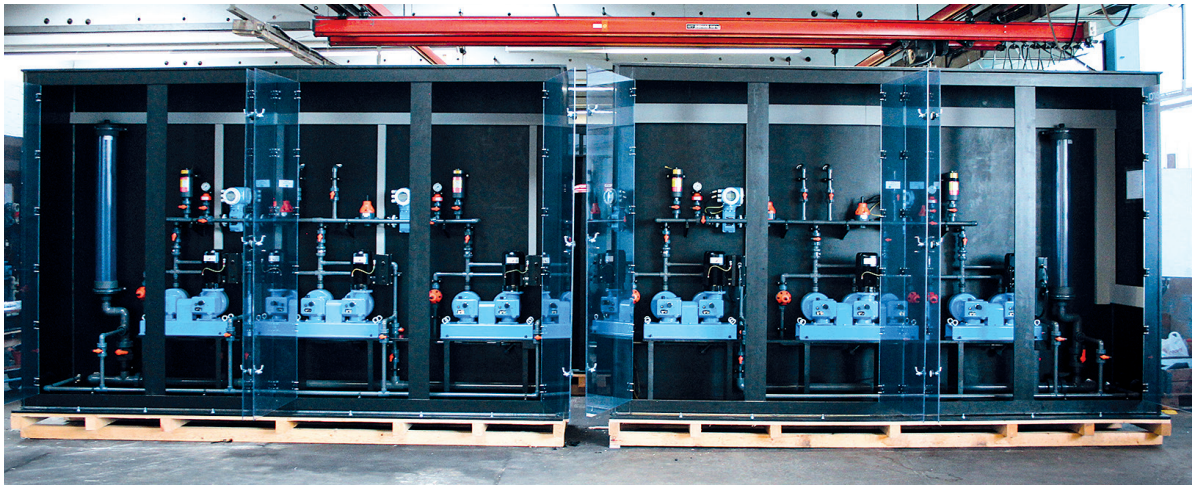

Fig. 3: Metering pumps from Immenhausen

the project documentation. The control cabinets of the systems were also designed and installed at the Spanish subsidary.

The dosing systems were finally produced and implemented by a German-Spanish team at the Immenhausen site. Together they developed working methods to be able to process a large project like this quickly and effectively. A total of 17 systems had to be built in 25 PE cabinets – dimensions that are quite demanding for the production of a medium-sized company. Here, clever action had to be taken in order not to overstretch the limited storage and production space.

After the cabinets were built from a total of 15 t of technical plastics (PE, PVC, PP and PVDF), they were equipped: In addition to a total of 77 pumps (dosing, feed and combination pumps), over 900 fittings such as strainers and ball valves, more than 1,000 fittings and over 600 m of pipes were installed. Three colleagues were exclusively involved in fitting out the cabinets for several weeks – not including supplying departments such as pump construction. The joint project with all its challenges welded the colleagues from Germany and Spain even closer together.

After the successful customer acceptance in January 2020, the first 20 cabinets went on a long journey by truck via Spain to Agadir in February, the remaining five cabinets were delivered at the end of 2020. All test runs by the Spanish operator were completed in summer 2022 and the seawater desalination plant near Agadir will go into operation shortly.

Dosing systems in the seawater desalination plant in Agadir

- Sodium hypochlorite for intake
- Sodium hypochlorite for chemically enhanced backwash and ultrafiltration
- Sodium hypochlorite for secondary treatment
- ferric chloride
- Sulphuric acid for reverse osmosis, Cleaning In Place and ultrafiltration
- Sulphuric acid for chemically enhanced backwash and ultrafiltration
- Sulphuric acid waste water
- Sodium hydroxide for pH adjustment Reverse osmosis
- Sodium hydroxide for Cleaning in Place ultrafiltration and reverse osmosis
- Sodium hydroxide for ultrafiltration and chemically enhanced backwash
- Sodium hydroxide wastewater treatment
- Sodium hydroxide remineralisation
- Antiscalant intermediate pump before high pressure
- Antiscalant intermediate for energy recovery
- Bisulphite intermediate pump after high pressure
- Bisulphite intermediate pump for energy recovery

In the process of sea water desalination

In order to ensure proper functioning and to guarantee the longest possible service life of the seawater desalination plant, sufficient pre-treatment of the input water is essential. This is where the dosing and delivery systems from the supplier are used. The water is analysed and, depending on the composition/contamination, various chemicals are added to enable reverse osmosis. From chlorine against bacteria and microorganisms to sodium hydroxide for pH adjustment to sulphuric acid for Cleaning in Place – the supplier from Immenhausen doses the right agent in the right concentration. And not only for pre-treatment, but also for the important cleaning of the membranes. Once again, the company ensures clean water and creates added value for people and the environment – in a state-of-the-art seawater desalination plant with the highest environmental standards.

sera GmbH, Immenhausen, Germany

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Hydrogen: the key to an emission-free future?

Possibilities, challenges, opportunities – and how AERZEN supports industry and companies

Hydrogen technology plays a key role on the path to the desired climate neutrality. Hydrogen is regarded as the energy carrier of the future and is an important milestone for the decarbonisation of industry. Michael Leitsch, Head of Opportunity Engineering at AERZEN, talks about the potential of green hydrogen, the challenges of compression and the advantages of screw compressors.

Mr. Leitsch, what is the significance of hydrogen for industry and what is the significance of the different colours grey, blue and green?

Michael Leitsch: hydrogen has been used since the early 20th century as a process gas for the production of ammonia according to the Haber-Bosch process and nowadays plays an important role in three industries in particular: as a raw material in the chemical industry (mainly for the production of methanol and ammonia), in oil refineries for the desulphurisation of fuels and in so-called hydrocracking processes as well as in direct reduction plants for steel production. Since hydrogen occurs in bound form in nature, it must be produced with the use of energy. Depending on the production process, a distinction is made between grey, blue and green hydrogen. Grey hydrogen is produced from natural gas by steam reforming and thus causes corresponding emissions. Currently, between 60% and 70 % of hydrogen is produced from natural gas. In the case of blue hydrogen, the CO_2 produced is captured, which is then further used or stored, i. e. does not escape into the atmosphere. Alternatively, hydrogen can also be produced by water electrolysis, i. e. an electrochemical process. If the electricity used for this comes from renewable energy sources, it is called green hydrogen, which is CO_2-neutral.

Hydrogen is traded as an indispensable resource for a climate-neutral industry. What contribution does the gas make to reducing CO_2 emissions?

Michael Leitsch: currently, almost all of the hydrogen produced is obtained from fossil fuels. If grey hydrogen is replaced by green hydrogen, the industry's CO_2 footprint can be significantly reduced. At the same time, new perspectives are opening up, for example in power generation. Here, hydrogen as an energy carrier and storage medium can enable a further increase in the share and availability of renewable energies. Other areas are transport, especially long-distance and heavy-duty transport, but also rail transport, shipping and aviation, as well as heating and the application in process heat, with a focus on the metalworking industry. These are promising fields of application, which could all make an important contribution to achieving climate targets in future.

How optimistic are you about the development of green hydrogen?

Michael Leitsch: we consider green hydrogen to be an important future market. Avoiding CO_2 is becoming increasingly important. In addition, power generation from renewable energies will be further expanded. Worldwide, more and more governments are pushing forward research, innovation and product development by means of national hydrogen strategies, which is also accompanied by a corresponding upscaling of electrolysis plants. From this point of view, we see a further strong market ramp-up for green hydrogen as very realistic. This assessment is also consistent with the opinion our clients, whom we support in the development of projects at various stages of planning. Hydrogen still plays a subordinate role in the energy transition, but this could soon change.

As a rule, hydrogen must be compressed to a certain pressure after electrolysis for the subsequent processes. What special features need to be taken into account?

Michael Leitsch: hydrogen is the lightest naturally occurring element, which makes compression more difficult in general. Since it has a very low energy density in relation to the volume flow (energy content per volume unit), large electrolysis plants also have to compress correspondingly high volume flows, which has an effect on the sizes and thus on the investment costs, installation areas, etc. of the machine equipment. In addition, hydrogen is very reactive, i. e. highly flammable. Special attention is, therefore, paid to the required explosion protection. The formation of an ignitable mixture with the atmospheric oxygen must be avoided

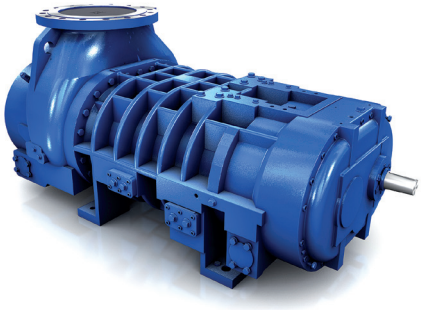

Fig. 1: With this water injected screw compressor AERZEN further expands its portfolio of screw compressors for hydrogen compression.

at all costs. However, this also applies to other applications with flammable or combustible gases, with which AERZEN's process gas division has extensive experience.

Where do you see the advantages in using screw compressors compared to other compressor technologies?

Michael Leitsch: screw compressors combine decisive advantages of reciprocating and turbo machines. Due to the displacement principle, they are also suitable for compressing very light gases – in contrast to turbo machines, with which only a very small pressure difference per stage can be achieved for gases with low molecular weights. In addition, screw compressors are rotary machines which, compared to reciprocating compressors, have fewer moving parts, a much smaller space requirement and a considerably reduced effort for maintenance and for the compensation of pulsations induced in the piping.

Another important advantage is the possibility of injecting water into the conveying chamber. On one hand, this makes it possible to reduce the heat of compression, and on the other, water can act as a sealing medium between the oil and gas chambers, e. g. when using a water-purged mechanical seal. Since the hydrogen leaves the electrolysis in a water-saturated state anyway, the injection of water is not critical.

Where can screw technology best play to its strengths?

Michael Leitsch: screw compressors can play a decisive role, especially for pre-compression in atmospheric electrolysis plants – especially for large installed electrolysis capacities from approx. 50 MW, which corresponds to a volume flow of approx. 11,000 m³/h. Reciprocating compressors usually reach their limits in terms of size (piston diameter and required installation area) with these quantities. Today's plants are getting bigger and bigger, reaching up to several 100 MW. Screw compressors can be used here to pre-compress the hydrogen. The resulting reduced volume flow enables economical use of the downstream reciprocating compressors, which are still needed to achieve the required discharge pressures. In the meantime, however, we have also received feedback from our customers, who consider the use of screw compressors to be the favoured solution even for smaller volume flows.

What added value does AERZEN provide for the hydrogen industry?

Michael Leitsch: as process gas specialist, AERZERN has been dealing with the topic of hydrogen compression for decades, as it occurs as a component in gas mixtures for typical process gas applications, for example in hydrogen recovery in PSA applications or in direct reduction plants for steel production. For certain chemical applications we have already successfully manufactured screw compressors for pure hydrogen compression, which means that AERZEN has already gained relevant experience and expertise in the subject.

Compared to most competitors, we have both oil-flooded and oil-free screw compressors in our portfolio, as well as – for lower compression ratios – blowers based on the Roots principle. In addition, we are specialists for customised compressor and blower solutions in the process gas sector and thus have the necessary flexibility to offer the right solution for the respective application. In addition, we are consistently driving forward the further development of our products in this area. In August, for example, we have presented the newly developed screw compressor VRW at the Achema chemical trade fair in Frankfurt, with which we can realise significantly higher pressure differences and efficiencies in hydrogen compression. With 50 locations worldwide, we are also represented near the installation sites with contact persons, who take care of the respective service support for existing plants.

Mr. Leitsch, thank you very much for the interview.

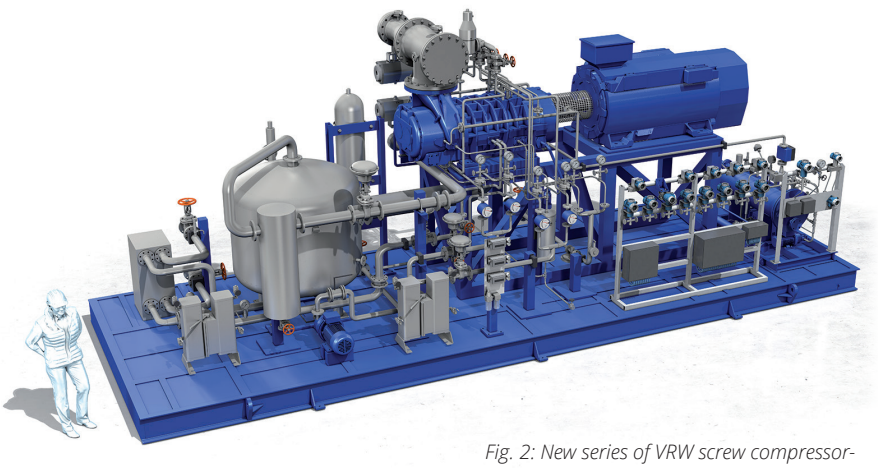

Fig. 2: New series of VRW screw compressor-package for hydrogen compression

Using biomethane as a fuel – making climate protection economical!

Helai Ammura

Since 01.01.2021, new rules apply in the area of renewable energy subsidies, which force operators of biogas production plants to rethink: The subsidy entitlement from the "Renewable Energy Sources Act" (EEG) for the first generation of so-called "renewable energy (RE) plants", which were subsidized for the last 20 years, has expired. This circumstance will affect an increasing number of sites in the future. However, for environmental and energy reasons, it would make absolutely no sense to discontinue operations. The good news is that despite the discontinuation of subsidies, operators have an economically interesting solution if they switch to an intelligent self-consumption concept. In this case, the fuel produced is not fully fed into the grid, as was previously the case, but is used – in a particularly attractive financial way – for tax-free refueling of the operator's own fleet.

In recent years, the processing of biogas produced in the plant into biomethane has become increasingly established. As a CO_2-neutral alternative to fossil natural gas, it has great climate protection potential. The political and economic conditions are currently more favourable than ever: with around 10,000 biogas plants, Germany is the frontrunner in terms of production [as of 2021].

The market is currently developing rapidly: biomethane had already been subsidized by means of feed-in tariffs for the last 20 years since the EEG 2000 decision came into force. The new resolution of 2021 stipulates that by 2050, electricity generated in Germany should be 100 % greenhouse-neutral. Furthermore, the EU's RED II27 (Renewable Energy Directive) sets a greenhouse gas reduction quota that requires companies to increase the share of renewable energy in fuels to 14 % by 2030.

Refuelling solutions – climate protection with a system

As a premium manufacturer and pioneer in the field of natural gas compression with more than 40 years of global experience, BAUER KOMPRESSOREN offers the necessary state-of-the-art technology in the form of customized turnkey refuelling systems from a single source. As a sustainability-oriented company certified in accordance with ISO 14001, the highest value is placed on actively promoting the achievement of climate protection and energy transition goals. It therefore strongly supports the continued operation of expiring RE plants in the biomethane sector. In general, the supplier's refuelling systems are designed for operation with biomethane as well as with classic natural gas. They usually consist of a high- or medium-pressure compressor unit tailored to the refuelling requirements, a gas drying and filter system, the appropriate storage solution and the dispenser. The sophisticated modular system design enables fast and uncomplicated installation as well as integration into existing infrastructures.

Tailored to the respective requirements, plant variants with low, medium and high daily outputs are available, as the following examples illustrate:

Waldkraiburg depot filling station – A compact and particularly economical solution

The energy provider ESB Südbayern had a filling station designed here for its Waldkraiburg depot to refuel its own customer service fleet, consisting of natural gas-powered minivans. Public refuelling was not planned. In accordance with the customer's requirements, the supplier focused in particular on a compact design and economic efficiency when designing the system.

The small and compact module consists of a compressor with volume

Fig. 1: Waldkraiburg Mini Fill ECO 120 (B800, Fast fill post)

flows between 11–51 Nm³/h, or 7.9–36.7 kg/h, intake pressures between 0.05–4 barg and an output pressure of 300 bar. In continuous operation, the daily delivery rate of the compressor unit is between 190–880 kg in 24 h. The unit has integrated filter and post-drying cartridges installed on the high-pressure side, which clean the compressed gas and remove the residual moisture from it.

The high-pressure gas storage system is made up of individual high-pressure cylinders mounted together on a frame. The standard capacity is up to 42 high-pressure storage cylinders, each with a filling volume of 80 litres per storage module.

Thus, capacities of 265 m³ up to 1105 m³ natural gas geometric filling volume at 300 bar can be realized.

Since no public refuelling is planned here, a "Fill post" is used as a dispenser. This model was specially developed for simple, temperature-compensated and cost-saving refuelling. The dispenser series is very often used in natural gas fueling stations at depots, especially when they are not staffed.

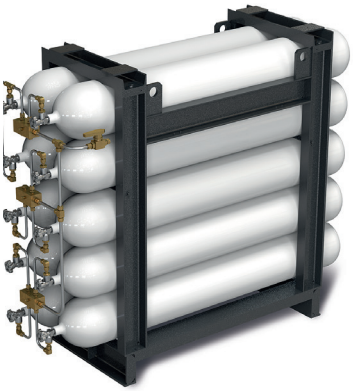

Fig. 2: B800 Storage module

Depending on the fill size of the refuelling volume and the compressor model, refuelling times of about 5 minutes are achieved when using the "Fast fill post" version used here. For applications where the refuelling time is not of primary importance, the Munich-based manufacturer offers as a variant the "Slow fill post" without integrated storage module.

Fig. 3: Fast fill/slow fill post dispensing station

Here, the vehicles are refuelled directly from the compressor. For technical reasons, the refuelling times vary greatly. An ideal application scenario is the refuelling of vehicles during the night hours.

Biogas filling station Coesfeld – Powerful stand-alone solution in container design

The organic wholesaler Weiling GmbH from Coesfeld, west of Münster, is also consistently focusing on sustainability. In the future, the vehicle fleet for transporting products to customers throughout Germany will be powered by regeneratively produced biomethane. As there were no suitable refuelling facilities in the immediate vicinity, the company decided to build its own station near the factory premises and commissioned the Bavarian supplier to carry out the project planning and turnkey installation. The significantly higher refuelling volume required resulted in a completely different requirement profile: With a delivery volume of almost 500 m³/h, the station is designed to safely supply the company's current 20 semi-trailer trucks during ongoing operation and also offers generous reserves to easily cover the planned expansion of the fleet to 30 trucks. Thanks to its modular design, the refuelling capacity can be further expanded at a later date by installing additional storage banks.

Biomethane/natural gas complete refuelling systems, which are installed stand-alone, are built in container solutions.

Compared to the installation in Waldkraiburg, the much larger and more powerful module consists of a compressor with a volume flow of 500 Nm³/h, or 360 kg/h, an intake pressure of 3.9 barg and an output pressure of 300 bar. In continuous

Fig. 4: Coesfeld CS 26.12 (B3360, Gilbarco dispenser)

operation, the compressor module delivers 8640 kg of biomethane in a 24-hour period. Integrated filter and post-drying cartridges installed on the high-pressure side clean the compressed gas and remove residual moisture from it.

As in most applications, the storage is used here as a 3-bank system consisting of three individual sub-storages, the high, medium and

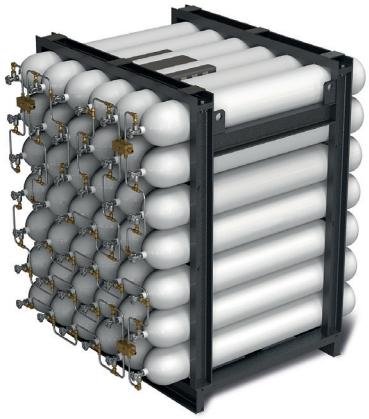

Fig. 5: B3360 Storage module

low banks. This division allows an optimum utilization rate. Thanks to the larger quantity of gas available, vehicle refuelling can be carried out in immediate succession.

The filling and refuelling control regulates the priority filling of the

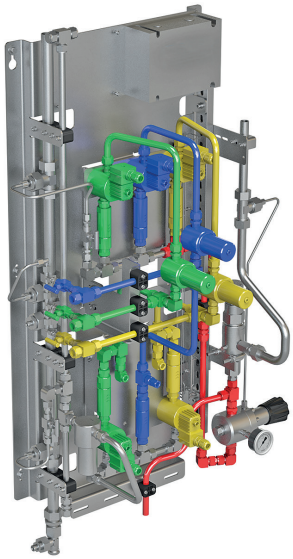

Fig. 6: Priority order monitoring control (VRÜ)

high-pressure accumulator and the sequential gas withdrawal from the high-pressure accumulator. It is possible to control one or more filling lines.

The dispensing device can be designed with a flow measuring device (display of the dispensed refuelling quantity in kg or m³) as well as a display field with the indication of the specific gas price as well as the total price in the desired currency. The filling and refuelling control system regulates the filling process and thus ensures economical refueling with short filling times at the same time.

For the operation of a public service station, the use of a fuel dispenser is required by law. The display shows both the unit price, the quantity refuelled and the final price at the same time. The dispensers are available with one or two hoses and with one or two devices for mass flow measurement. This allows either separate or simultaneous vehicle refuelling on both sides of the dispenser. With an automatic fuel dispenser, it is possible to realize an accounting of the fuel data without a manned cashier's store. With regard to operation, the different fuel dispenser models can be optionally tailored to fleet card operation and/or credit card operation. All of the company's large systems offer interfaces for optional connection to an Internet-capable PC or cell phone. This allows the operator to monitor the operating status remotely around the clock.

Comprehensive and seamless project management – a core competence

According to customer specifications and in close consultation, BAUER project engineers first select the best location for the filling station. Special focus is placed on exact compliance with applicable legal regulations. By minimizing explosion protection zones and tailoring the size of the refuelling systems, the supplier is able to find an optimal solution for installation even in difficult space conditions. After installation, the complete piping of the system including all pressure lines from the compressor to the storage tank and further to the dispensing point or dispenser is carried out according to the relevant guidelines. This is followed by an inspection by an approved acceptance organization, such as the TÜV. The project team coordinates the necessary scheduling with the companies and authorities involved.

Fig. 7: Dispenser unit with billing system

Service technicians carry out the electrical wiring of both the compressor unit and the dispenser/dispenser in accordance with the agreed plans. Only a high-voltage connection must be provided by the operator. After installation, the compressor unit is booted for the first time and thoroughly checked again.

The supplier takes over the entire project organization. It ranges from the installation and commissioning of the compressor storage unit and the dispenser technology to the precise coordination of deadlines. As a result, commissioning can usually take place after just a few days. After a successful assembly at the installation site, the installation is inspected by an expert. This acceptance at the installation site is also carried out by the service team together with the respective supervisory authority. The comprehensive service also includes detailed instruction of authorized

persons of the client in the technology and electrics of the system so that the operator of the system can carry out basic settings and simple maintenance work independently.

On request, seamless monitoring of the compressor unit is offered in conjunction with a 24 h service and after-sales. Changes in settings or adjustments can then be made around the clock online via the Internet or via a mobile phone connection. Status reports on operating hours and sales of gas volumes sold can be transmitted via SMS or e-mail, as can maintenance requests or fault reports.

Biomethane injection – Munich-based company supplies the technology

In addition to filling stations, the compressor manufacturer from Munich has also developed special compressor systems for the area of biomethane production based on its many years of expertise and has successfully established them on the market. Among other things, they are used for seasonal compensation of transport fluctuations and network overloads: In case of overload of a low-pressure pipeline, e. g. due to increased biomethane feed-in, the excess natural gas-biomethane mixture can be fed into a higher-quality network. In this way, existing buffer volumes in high-pressure transport networks are better utilized. Biomethane is fed into a natural gas network in different network types with pressure ratings from PN10 to max. PN100.

Shaping the future today: Climate-neutral mobility with hydrogen!

Based on its sustainability-oriented corporate philosophy, the company stands uncompromisingly for climate-friendly mobility concepts. For this reason, the technology-leading mechanical engineering group and member of the Center Hydrogen.Bavaria (H_2.B), is consistently supporting the broad establishment of this energy carrier of the future with a recently launched development offensive for H_2 filling station systems.

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Bipolar plates & the multi-stage CellForm® technology

Simon Brugger

For the hydrogen technology to succeed in economy, mobility, and society, big challenges are yet to be tackled. These are for instance factors like costs, efficiency, and suitability for series production. Progress in these areas is only made possible through intensive research and development efforts. The focus of CellForm hereby lies on the development of the key component of the hydrogen technology, the bipolar plate.

The bipolar plate

The hydrogen technology consists of two principles: the electrolytic splitting of water into hydrogen and oxygen (electrolysis) by means of external energy and the usage of the energy through the reversed chemical reaction (fuel cells). These electrochemical processes take place in every single cell which are stacked on top of each other to a so-called stack. The main part of this stack is the bipolar plate, consisting of two very thinly formed metal sheets welded together. Depending on the application, several hundred bipolar plates are needed for a single stack.

As the name („bi“) suggests, a bipolar plate serves as a basis for the two poles of a fuel cell: the negative anode plate and the positive cathode plate. The plates are responsible for the distribution and reaction indication of the gases in the fuel cell as they control the chemical reaction of hydrogen and oxygen to electrical energy and water. They also ensure, for instance, electrical contact between the individual cells and separate the membrane electrode assemblies (MEA). The membrane electrode unit serves as a semi-permeable membrane which is only permeable to protons and forces the electrons emitted by the hydrogen from the anode via an electrical device to the cathode. The remaining protons migrate through the membrane and finally react with the oxygen atoms to form water. A cooling medium for temperature control of the individual cells is passed between the tightly welded individual plates. The channel structure of the so-called flow field that serves as the contact surface between hydrogen and oxygen and can be seen in Fig. 3.

Fig. 2: Metallic bipolar plate under a measuring device

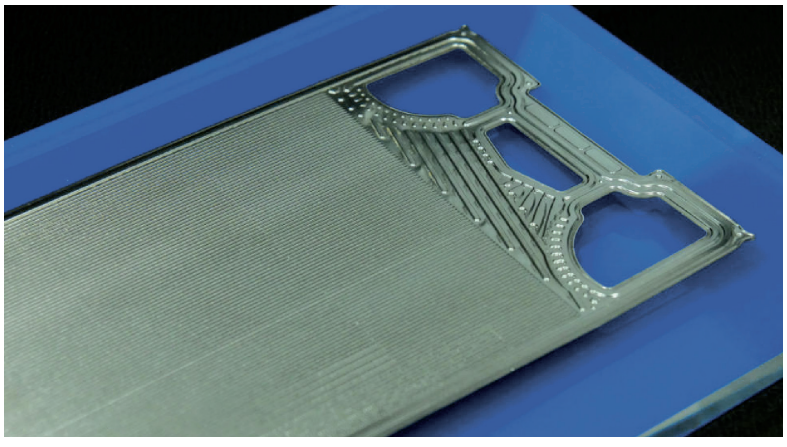

Fig. 1: CellForm's metallic bipolar plates

Hydrogen – advantages and disadvantages

Hydrogen has many advantages as an energy carrier compared to alternative technologies such as batteries. For example, the resources required are significantly more sustainable in terms of extraction and recycling, the refuelling time in the mobile sector is significantly shorter, and hydrogen-based energy chains have a potentially lower TCO. However, the main advantage of hydrogen can be derived on the basis of the energy transition: In a future with

energy from fully renewable sources, our society faces a fundamental challenge, namely the local and temporal differences between energy production and usage. Energy generation from wind and sun – in contrast to nuclear energy and coal-fired energy – does not always match with our usage patterns. This presents us with the task of storing energy on a large scale in order to transport and use it time-independent. Under the given conditions, the only solution to this task is hydrogen.

At the same time, hydrogen has a major disadvantage compared to batteries when it comes to the overall efficiency. Hydrogen is produced sustainably by means of electrolysis and returned to its original energy state in the fuel cell. Although this conversion results in the advantages mentioned above, a large part of the original primary energy is lost. This disadvantage is the central problem that must be solved in the best possible way.

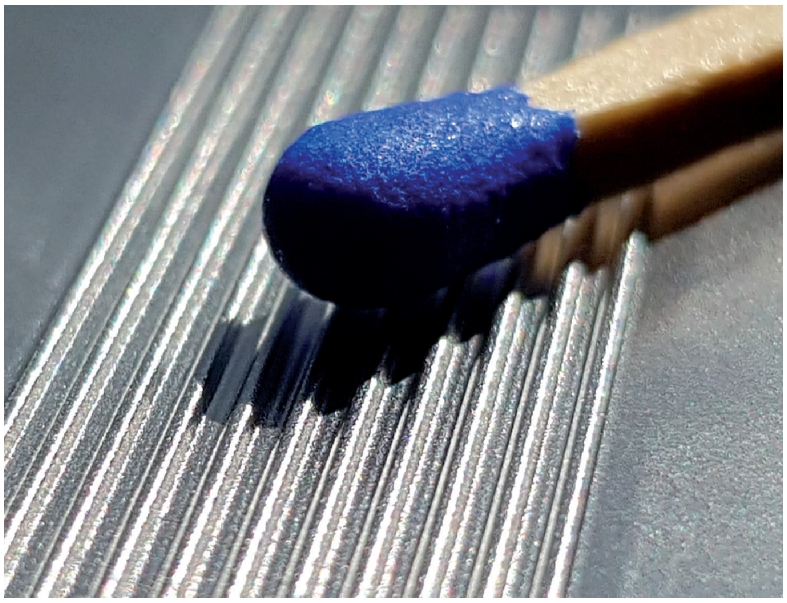

Fig. 3: flow field of a bipolar plate

Material aspect

Bipolar plates are mainly made of metallic and graphite materials. The different materials are associated with different properties and advantages for the functionality of the bipolar plates. Due to slight efficiency advantages and a lack of manufacturing methods for competitive metallic bipolar plates, the graphite alternative dominated in the past. However, especially in sophisticated applications, graphite bipolar plates have significant volumetric and gravimetric deficits compared to metallic variants. Graphite is also very brittle and can break easily. Nevertheless, graphite plates are often used in stationary applications where installation space is not a limiting factor.

Regarding the cost perspective, metallic plates are in a leading position. With the right manufacturing method, sheet thicknesses can be further reduced to as little as 0.05 mm. In this range, metal is at a completely different price level than graphite. With the fact that several hundred bipolar plates are used for a single stack, the cost effect on the final application is enormous. Another advantage of the metallic variant is that the material has a positive influence on the cold-start capability of the fuel cell.

Due to the corrosive behaviour of the metallic material, the bipolar plates are coated with e. g. chromium nitride. This is usually done with a thermochemical treatment. The CellForm® technology was developed for metallic bipolar plates and can form and weld both pre-coated and post-coated plates.

Production of the bipolar plates

There are several production technologies for bipolar plates depending on the materials and the applications. They vary in terms of cycle time, filigree of the flow field and costs. A finished bipolar plate consists of an anode and a cathode, which are formed separately. The two individual pieces are then tightly welded together. The difficulty in producing the bipolar plates lies in the extremely thin sheet thickness. Forming with such a thin starting sheet and such a precise and demanding geometry of the channel structure quickly leads to cracks due to physical restrictions, which makes the bipolar plate unusable.

As mentioned before, the challenge for manufacturers of bipolar plates lies the high-quality requirements with low error tolerances, which must be guaranteed in series production with high quantities. Only those who fulfil this requirement will be able to succeed in this growing and competitive market.

There are several processes for the production of bipolar plates, which are still in development. Many manufacturing processes will be limited in their output quantity for future large-scale production due to physical restrictions (e.g. heat generation). This problem is not yet apparent with small quantities but will become more and more apparent in the coming years with higher demand. CellForm relies on a self-developed multi-stage forming process that can be easily scaled. The scalability of the manufacturing process determines the production costs and price of the individual bipolar plate and thus significantly influences the attractiveness of the climate-friendly hydrogen technology as a whole.

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A big wheel with a sustainable drive system minimizes energy consumption

Big wheel, small footprint

Gunthart Mau

Ferris wheels, big wheels, Giant Wheels– whatever you like to call them, they have certainly been a big draw ever since the 1893 world's fair in Chicago. When a technical concept has been around that long, you might not expect it to offer much scope for innovation. However, the new transportable RR 40 Giant Wheel from Gerstlauer Amusement Rides holds some surprises in store. Thanks to Power and Energy Solutions from SEW-Eurodrive, it minimizes both energy consumption and the need for electrical power input at the set-up location.

Assembling and installing a big wheel was once a very complicated affair. The first genuine big wheel – the "Ferris Wheel" erected in the U.S. in 1893 – had to be supported with scaffolding during construction. This added complication caused it to open to the public seven weeks late. By contrast, the transportable RR 40 Giant Wheel from German-based company

Fig. 1: After dark, economical and long-lasting LEDs transform the Giant Wheel into a sparkling sea of light. The color of these LED lights can also be changed, so the attraction can be presented in a whole new light again and again. (all photos: SEW)

Fig. 2: Gerstlauer Amusement Rides manufactures its Giant Wheels in both stationary and transportable versions (shown here). They also come in different sizes. One particularly striking feature of Giant Wheel RR 40 is that it is designed with four columns instead of the usual eight. This provides greater transparency and an elegant look.

Gerstlauer practically sets itself up. Hydraulic cylinders make light work of extending the four central columns up from a semi-trailer, and a small crane is all you need to assemble the remaining components from four other low-loaders. The Giant Wheel is turned by four friction wheels and is highly economical in terms of energy consumption, thanks to LED lighting and an innovative drive system from SEW-Eurodrive.

The four DRN helical gearmotors on the friction wheels exhibit excellent efficiency and are powered via modular frequency inverters. These, in turn, are connected to the local grid via a DC link downstream from two power supply modules from the supplier. The braking energy of big wheels was previously converted into heat and therefore lost but – thanks to Power and Energy Solutions – it is now buffered and can be utilized as and when required. Eight double-layer capacitor modules absorb energy as it is released from the suppliers, which cuts the eco-friendly Giant Wheel's energy costs by between

Fig. 3: Special v-shaped gondola hanging arms allow each of the gondolas to hang more freely and give every passenger an unobstructed view. The enclosed design of the gondolas also makes them especially suitable for younger passengers.

20 and 30 percent. This new power supply concept also provides another, very important benefit. While a similar big wheel will need a power connection that can supply far in excess of 250 kW, this new system can manage with a line connection around 140 kW less power-

Fig. 4: A total of eight energy-efficient helical gearmotors with a nominal power rating of 18.5 kW drive the giant wheel via pairs of friction wheels.

ful, which is considerably more cost effective. This is good for both the environment and the budget of fairground operators. What's more, operators can set up in locations that previously would have been unsuitable due to a lack of electrical infrastructure.

The DC link and its supercaps also balance out peak loads, reducing their impact when connected to the grid by a factor of five.

Fig. 5: The control cabinet contains two power supply modules and four single-axis modules. The block storage unit and its double-layer capacitor modules is installed underneath.

Despite a much lower connected load, the drives can draw on full power at all times. Moreover, because the state-of-the-art power supply devices have been specially developed with this in mind, a power factor of 0.95 keeps harmonics in the grid much lower, which is good for grid quality. The interplay between energy storage unit, drive control and the DC link is managed by an controller. This is where the Movikit® PowerMode software module comes into use. It captures output and energy data and takes care of managing the DC link, the AC connection and the energy storage unit, with functions such as device management, energy meters, real-time data acquisition, etc.

The economical giant wheel, which measures around 43 meters in height, is an attraction of long-established Munich-based fairground operator Heinrich Willenborg GmbH, which specializes in transportable big wheels. Each of the 24 gondolas, which are mounted on the outside of the wheel using v-shaped arms, offers eight passengers unobstructed panoramic views. The drive technology of the Bruchsal-based specialist SEW-Eurodrive ensures maximum efficiency. "In specialist plant engineering, it is crucial to have partners who know what really matters and can provide the service you need," emphasizes the head of electrical engineering, who designed the new mobile giant wheel with the Augsburg Technical Office of the drive manufacturer. The two companies have been working together successfully for a good two decades so far.

Power and Energy Solutions

When it comes to running its Giant Wheel RR 40, Gerstlauer has opted for innovative active energy management solutions. The "Power and Energy Solutions" management system from the Bruchsal-based drive manufacturer ensures that braking energy from the inverter's DC link is not lost, and is instead taken up by an energy storage unit. Most importantly, however, it helps reduce start-up load peaks. This in turn hugely reduces the peak load that the Giant Wheel draws from the electricity grid. The storage system contributes to high system availability by ensuring that energy from the storage unit is available for use – even during a power failure.

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Is organic the solve-all solution?

Applying elastomer seals with biogenic media

Dipl.-Ing. (FH) Michael Krüger

An ever-increasing number of biogenic fluids are being used in wide-ranging technical applications. Soaring numbers in fact. And for many different reasons. Despite an applicable scope ranging from the chemical process industry and related elements to usage in forestry, agriculture and water management, deploying these biogenic media poses an enormous challenge to elastomer seals.

Biological fluids are environmentally friendly, rapidly biodegradable and non-toxic media, most often produced from biomass. But why are more people using such fluids and what is the main motivation? As well as the move to a greener approach and avoid vehicles contaminating soil or bodies of water, the need to protect the climate protection and reduce CO_2 emissions is also becoming an increasingly crucial argument. Moves like this also help wean people off petroleum, since most of the products described are renewable raw materials. Ultimately, though, the key thing making the difference and helping a range of biogenic media break through may have been legislation in the form of EU directives. Many public tenders, for example, prescribe the use of biogenic fluids in construction vehicles.

Even so, hurdles remain to the wholesale replacement of such fluids with existing mineral oil-based media. For many components, some of the effects remain unknown and numerous elastomer seals are also unsuitable for this application. Here, carburettor fuel E10 is introduced as a result of regulatory market interventions and similarly, it triggers a different response in many components compared to conventional petrol. Accordingly, this impacts on the entire chemical process industry, directly and indirectly, when producing, storing and transporting media like these.

Fig. 1: Biodegradable hydraulic fluids in mobile hydraulics. Photo: Fotolia/GHotz

Issues when deploying hydraulic fluids in sensitive ecosystems

Generally speaking, the greenest fluid solutions involve no fluid escaping from machinery in the first place. But however cutting-edge the machines in place, leaks can still contaminate bodies of water and soil when stationary hydraulic systems like locks, weirs and hydroelectric power plants are used. The same applies when operating construction machinery, piste equipment in the mountains, and agriculture and forestry equipment. The key here is ensuring the hydraulic fluids and lubricants are free of substances with a critical ecotoxicological impact.

This explains the increasing use of biodegradable hydraulic fluids in hydraulic drive technology. Beware however - they can severely attack conventional FKM seals and render long-term use virtually impossible. Biodegradable hydraulic fluids comprise either triglycerides, which are often vegetable oils (e.g. rapeseed oil) called HEES (hydraulic environmental ester synthetic) or synthetic esters known as HEES. These fluids are designated as class I pollutants.

In modern hydraulics, more and more special high-performance hydraulic fluids are also being used. While they contain additives, they are not based on mineral oil. These substances constitute synthetic, anhydrous liquids (HFD), which have a higher density than mineral oil and are flame retardant. Examples include

Fig. 2: Sealing challenge for fuels with bio content

phosphoric acid esters (HFD-R), anhydrous chlorinated hydrocarbons (HFD-S) or a mixture of HFD-R and HFD-S, and anhydrous other compositions (HFD-U) comprising fatty acid esters. However, both biodegradable and synthetic hydraulic fluids attack conventional elastomeric sealing materials. A high-performance FKM compound must also be usable in all the areas mentioned without any issues and for the long term.

Carburettor fuel E10

Despite the fact E10 fuel has already been around for some time, discussions remain ongoing about the 10% ethanol blend in commercial petrol (E10) - both among users and seal manufacturers. Elastomer seals that end up in permanent contact with the E10 carburettor fuel are not only found in cars of trucks powered by said fuel, but throughout the periphery of the production and transport chain of the same. Both manufacturers and logistics companies alike are plagued with problems due to the E10 carburettor fuel. In some cases, the maintenance intervals are extremely short, because the seals used to date lacked sufficient resistance.

Impact on sealing materials

Conventional sealing materials that have not been specifically designed to withstand contact with biogenic media can be adversely impacted in various ways when in permanent contact with these fluids. The physical properties of these sealing materials are prone to change, in volume for example (swelling) or the degree of hardness. Chemical resistance (e.g. through hydrolysis) may also be drastically reduced. Changes like these all cause the sealing properties to decline, considerably in some cases and will eventually lead to leakage and/or require premature seal replacement.

New FKM material for use in biogenic media

The independent manufacturer C. Otto Gehrckens GmbH (COG) has developed an FKM sealing material called "BF 750" tailored for such applications, which has proven its worth on numerous occasions. This material concerned is a 3rd-generation high-fluorine polymer based on fluororubber (FKM). This compound was specially developed by COG Compound Development to meet the most stringent demands of use in biogenic media, as well as being tested in an independent laboratory. Results exceeded all expectations – normal use saw practically no material changes occur. So the testing scope was extended to also include more unusual and extreme situations. Here too, the FKM BF 750 material performed admirably, achieving results far below any tolerance limit, as exemplified by the data below. The study also encompassed corresponding fuel blends with conventional fuels as well as purely biogenic fuels.

As well as exceptional resistance to hot water and steam, the manufacturer claims this FKM material can also withstand all conventional fuels and many other media, like alcohols and acids. The BF 750 material developed can be deployed wherever sealing materials come into contact with the above-mentioned media. The applicable scope thus includes hydraulic components, pipes, lines, valves, petrol station dispensing systems and their peripherals, pumps, motors, couplings, vacuum pumps, boilers, autoclaves, hose seals among others. In other words, numerous and wide-ranging applications.

After storage for 72 h at 23 °C

Medium		B100	B5	E85	Vegetable Oil	Ethanol	Fuel C
Change in hardness	Pts.	0	0	-1	0	-1	-1
Change in tensile strength	%	0	0	0	0	0	0
Change in elongation	%	0	0	0	0	0	0
Change in weight	%	0,0	0,0	+0,3	0,0	+0,2	+0,1
Change in volume	%	0,0	0,0	+0,7	0,0	+0,5	+0,1

After storage for 72 h at 70 °C

Medium		B100	B5	E85	Vegetable Oil	Ethanol	Fuel C
Change in hardness	Pts.	-1	-2	-7	0	-5	-5
Change in tensile strength	%	-11	-10	-20	-5	-19	-17
Change in elongation	%	-6	-8	-9	-3	-10	-9
Change in weight	%	+0,5	+0,4	+3,1	+0,1	+2,2	+1,9
Change in volume	%	+0,8	+0,9	+7,3	+0,1	+5,5	+5,3

Conclusion

So is the proposed deployment of biological media more likely to solve problems or only spark new issues? Yes to both – at least the perspective is what counts. Using biological fluids to a greater extent delivers a whole host of advantages, but the downsides need to be noted too. Clear pluses include scope to reduce environmental pollution and similarly cut CO_2 emissions. But successfully weaning users off their dependence on oil is also a huge positive.

Conversely, however, the clearly negative effects on various components in ongoing contact with such media cannot be ignored and must be considered disadvantageous. Many sealing materials that were previously used without any issues may prove incompatible with the changed environment. Costs also spiral when the need to use higher-quality materials arises. However, in the long term, whether materials cost will actually increase substantially remains in question.

The ball is in the manufacturers' court to adapt to the respective application and roll out new and special materials. These must be tested for the contact media in question and conform to the most stringent of requirements. Only this approach can help guarantee that they will function safely in the long term. The optimal solution for the user, as the example of a special FKM material shows, is a universally suitable sealing material compatible with biogenic media and offering unbeatable safety.

Fig. 3: The independent manufacturer C. Otto Gehrckens GmbH (COG) has developed an FKM sealing material called "BF 750" tailored for such applications

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VEGA sensors ensure reliable supply

Copper is the new gold

The processing of copper scrap involves many precisely coordinated processes. This is the only way to ensure that the recycled copper can be used effectively later on. When it comes to level instrumentation, Montanwerke Brixlegg relies on radar technology from VEGA.

Very few companies can look back on over 550 years of company history. The Brixlegg copper-silver smelter appeared in documents for the first time in 1463. Copper and silver ores were mined there and refined into pure metals up until the 20th century. Since 1890, secondary materials containing copper have been increasingly used as raw materials instead of ores. "While the challenges back then were for the most part exclusively mining problems, today they are much broader. We are now responsible for maintaining a positive interplay between people, the environment and the economy," explains the Head of Electrical Engineering at Montanwerke Brixlegg in Tyrol.

Fig. 1: Highly reliable: VEGAPULS radar sensors for continuous level measurement. (All photos VEGA Grieshaber KG)

Today, with more than 350 employees, the company is a 100 % upcycling operation and one of the most important industrial operations in western Austria. The plant in Brixlegg is considered a specialist in copper recycling and the associated copper refining. But there is more to it: The Tyrolean company is also rushing ahead in the area of climate protection – the world's most climate-friendly copper is produced here. The plant generates the lowest CO_2 emissions of any comparable industry, and uses 100 % recycled raw materials as well as 100 % renewable energy for electricity requirements. "In this way, we are not only doing pioneering work for today's needs, but as the first in the value chain, we are laying the groundwork for absolutely climate-neutral manufacturing in the future," says the Head of Electrical Engineering.

Scrap turns into valuable raw materials

The raw materials used are copper-bearing dust, ash, shredded materials, sludge and return slag with a copper content of between 15 and 60 %, as well as alloy scrap such as brass, bronze and gunmetal with a copper content of between 60 and 80 %. Refined materials and chopped and sorted electrical cables have a copper content of around 80-99 %. High-purity scrap retrieved from semi-finished product manufacturing, on the other hand, is used directly in the foundry without refining. Beside these solid raw materials, copper chloride solutions from the electronics industry are also processed.

In addition to copper, numerous other metals such as nickel, zinc, tin and precious metals are extracted from the raw materials. The copper cathodes, round billets, rolled plates and precious metals produced in this way become valuable raw materials for various applications in the electrical and construction industries, in mechanical and plant engineering, in the high-tech sector as well as in electroplating and agriculture.

The sensor withstands harsh ambient conditions

Without reliable and robust measurement technology, the finely tuned production processes would not be possible. VEGA instruments have been in use here for a long time already; however, collaboration between the two companies has intensified greatly since 2016. "In my opinion, VEGA's specialisation in pressure and level measurement has brought huge benefits. We're absolutely thrilled with the quality and handling of the sensors, which is why we rely on VEGAPULS for continuous level measurement," says the Head of Electrical Engineering. "Since the market launch of the compact sensor series in 2020, we've installed almost 50 of the units." These are used in various sensitive chemical applications, like the measurement of acids, alkalis, milk of lime, etc. One example is the continuous measurement of acidic liquids in the electrolysis sector, which is of utmost importance for optimal use and control of the pumps.

Fig. 2: A radar sensor monitors the uniform feed of the scrap packages in the combustion chamber.

Numerous level switches of the 61 and 63 series have also been installed as overfill protection. Recently, more NAMUR versions have been installed, as the periodic function test using the test key on the control-

Fig. 3: The conditions around the shaft furnace are harsh. However, the radar sensors are not impressed by dust or the high temperatures.

ler makes things significantly easier. With NAMUR electronics, not only is very simple wiring possible, but also the test of the sensor via the test key on the control unit in the control cabinet. It is therefore no longer necessary to climb up to the top of the vessel; dismounting the instruments for testing is also a thing of the past. This in turn saves a lot of time and increases the safety of personnel. The level switch detects limit levels in the vessel and forwards them to the controller. The measured value is adapted to the specific conditions of the measuring point through an adjustment in the controller. Readings are shown on the display and outputted via the integrated current outputs. This means that the point level signals can also be used for simple control tasks. What is more, the signal circuit is monitored for line interruption and short-circuit.

Monitoring the level in the shaft furnace

A very special place of application for continuous level measurement is the shaft furnace. Packages of scrap are fed into this furnace via a conveyor. Beside the high ambient temperatures, the process heat itself as well as dust and vibration constantly create new challenges for the deployed measurement technology. Until December 2021, a radiometric measuring system for min/max monitoring was used at this site, but it did not deliver reliable readings. And this method was very limited in scope – it only allowed point level detection. For this reason, and because of the ever-present danger of the radiation source, the company wanted to replace it with something better.

"We have to monitor the level precisely in order to maintain the optimal filling volume," explains the Head of Electrical Engineering further. A steady inflow of product mix is extremely important for the entire process. The special situation: There must always be product in the combustion chamber, otherwise the fire could flash back and cause great damage. Here, continuous measurement with VEGA sensors makes it possible to feed in the scrap packages evenly. He goes on to emphasize this point: "Before this measuring system was installed, the shaft furnace was repeatedly emptied too much and it was damaged as a result of the excessive temperatures."

Now, the radar sensor keeps the level in the shaft furnace exactly at the optimal point. With the help of a 45° mirror, the level inside the shaft furnace is measured by the externally mounted, and thus well protected, radar sensor. The sensor was installed and commissioned by the Head of Electrical Engineering and his team at the end of December 2021. Fine adjustment was carried out by a VEGA engineer.

The radar sensor is hardly affected by the harsh conditions, even the deposits on the shaft walls do not interfere with the measurement. This is due to the sensor's very small beam angle of 4°. As a result, the sensor can be used reliably even in narrow shafts with internal installations or buildup on the walls, because the measuring beam simply travels right past such obstacles.

Eliminating false signals

Two aspects played a role in selecting the sensor. The first: The radar sensor can cope with extremely high temperatures. The process temperature inside the furnace is approx. 200 °C and the ambient temperature outside the furnace, approx. 50 °C, is still quite hot. And the second: The sensor is optimised for measurement at close range. Special processing of the reflections in the close range makes it possible to reduce the influence of interference signals directly in front of the antenna system. The tight focusing of the transmitted signal offers further advantages. The most important is that the actual measurement signal can be separated quite well from interference signals, allowing even the smallest reflected signals to be picked up. And last but not least, the sensor is non-sensitive to buildup on its own surfaces – extremely important in the harsh environment of the furnace.

Beside the advantages in the process

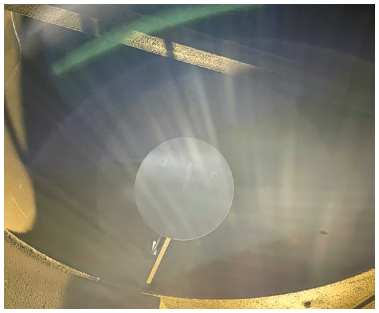

Fig. 4: With the aid of a 45 degree mirror the filling level in the shaft furnace is measured.

and the high measurement accuracy, there were also very practical considerations that convinced the Head of Electrical Engineering from the Tyrolean company and his engineering team that VEGA technology was the right choice. These included the simple installation and maintenance, the price and the customer service. The sensors can also be conveniently adjusted via a smartphone with Bluetooth, which makes them ideal for harsh environments, Ex areas or measuring points that are difficult to access. Thanks to Bluetooth and the intuitive adjustment structure, the team was able to install the radar sensor in the shaft furnace and get it up and running in no time. What is more, they can now instantly retrieve all relevant information about the instrument just by entering its serial number. This greatly facilitates maintenance work carried out later.

VEGA Grieshaber KG,
Schiltach, Germany

Yield doubled

Flottweg Tricanter® in bioethanol production at Glacial Lakes

Bill Griffiths

Glacial Lakes Energy LLC operates four bioethanol plants in South Dakota in the Northwest U.S., and has more than 20 years of experience in bioethanol production. During the production of bioethanol, the American company also produces corn oil as a by-product, which can be resold as a valuable raw material. In order to improve the yield and quality of the corn oil, the company chose to use a Flottweg Tricanter® in two plants. The new separation technology has made it possible to achieve higher yields and to produce an extremely high-quality oil. At the same time, operating times have been increased with less maintenance.

From corn to Bioethanol

Glacial Lakes Energy operates four bioethanol plants in South Dakota: Aberdeen, Huron, Mina, and Watertown. All four facilities are managed by one managing director, and are located within a two-hour driving radius of each other. Each plant has an operations manager, production manager, and maintenance manager responsible for the maintenance and operation of each individual plant.

The Watertown facility started operations in August 2002 and originally delivered a nominal capacity of 40 million gallons per year (MMgy), equivalent to around 150 million liters per year. In 2007, the plant was expanded, and currently produces more than 130 MMgy of bioethanol. The Mina facility was commissioned in June 2008 to produce around 110 MMgy, and now operates at a capacity over 140 MMgy. In December 2019, GLE acquired two additional bioethanol production plants in Aberdeen and Huron, South Dakota. Today, the Aberdeen plant produces around 50 MMgy, while Huron produces 40 MMgy of bioethanol. Overall, the bioethanol plants purchase more than 125 million bushels of corn annually and produce over 360 MMgy of ethanol, 918,000 tons of animal feed products/distillation meal, and 51,000 tons of corn oil per year.

Corn oil as a valuable by-product of bioethanol production

Bioethanol is fast becoming a sustainable alternative to fossil fuel. Various renewable raw materials, such as sugar beets, corn, or potatoes, serve as the basis for the production of bioethanol, with corn being the most important source of raw materials. Conventional bioethanol facilities produce ethanol, solids, and a residual syrup, which is created by evaporating and drying the thin stillage. An increasing number of plant operators are taking advantage of another innovative method of raw material extraction, which uses a 3-phase decanter centrifuge from the Vilsbiburg specialist in separation technology in order to obtain another valuable product from the thin stillage: corn oil. This corn oil can then be used as

Fig. 1: GL LLC is using Flottweg's Tricanter® in in two of their plants.

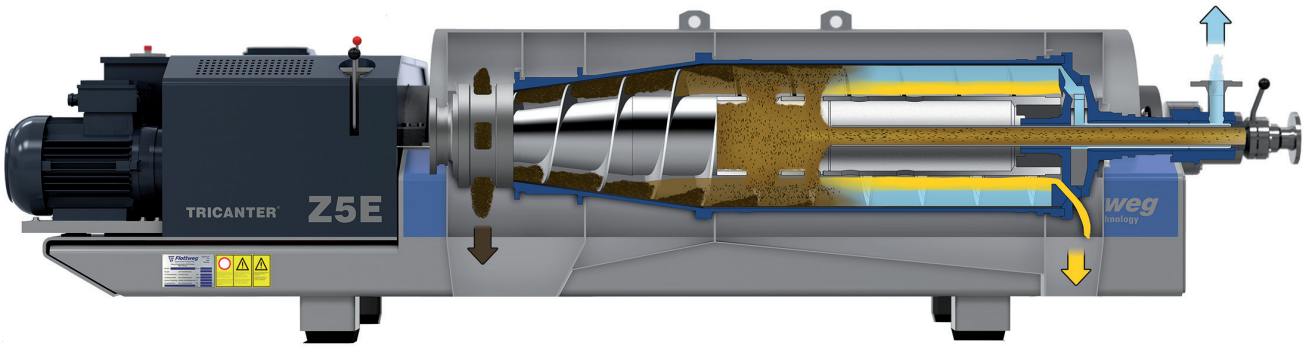

Fig. 2: Flottweg's 3-phase decanter separates the thin stillage to preserve the corn oil as a valuable resource.

a feed additive or for the production of biodiesel.

The design and function of the 3-phase decanter centrifuge is similar to that of a decanter (two-phase separation). The decisive difference between these two machines lies in the discharge of the liquid. A Tricanter® separates three phases – the solid material and two liquid phases: a "heavy" liquid phase (higher density and discharged under pressure) and a "light" liquid phase (lower density and discharged without pressure). Based on this principle, the oils are separated from the thin stillage and an additional raw material is obtained. Thanks to the adjustable impeller (skimmer), it is very easy to adjust the 3-phase decanter to changes in product conditions in order to guarantee an optimal separation result and the highest product quality. An increased oil yield ensures a fast return on investment.

Low oil yield and an Ill-sized machine: The challenges at Glacial Lakes Energy LLC

Previously, GLE used a disc separator to recover and separate oil in Aberdeen. However, since the machine was too small, had a poor recovery rate, and provided low oil yield, they decided to look for another option. The managing director was convinced from the very beginning that production could be increased with an upgraded plant. After extensive research, two separation solutions made the final cut: "Ultimately, the question for us was whether to install another separator or to switch to another technology, such as three-phase separation," he explains. "Both technologies are good when you look at things just in terms of oil separation. But when it comes to recovering corn oil from bioethanol production, we gravitated strongly towards three-phase separation. That's why we opted for a Tricanter®." The first results with the decanter then cemented complete satisfaction in Aberdeen and Hogan: "After using it, we saw a significant increase in capacity."

At the start of 2021, the plant in Mina found itself in a situation similar to Aberdeen's original predicament: The separators did not produce high-quality oil and offered a low oil yield. "We were once again faced with the decision to either upgrade the system or start using three-phase separation," explains the operations manager. "We finally went with two Tricanter®s again and achieved a great result. After installing them, we were able to double the oil yield." Since the two separators were still fully functional, the managing director decided to leave a machine in Mina as a back-up for weekly CIP procedures.

Solving problems

Although the 3-phase decanter from the Bavarian supplier was slightly more expensive to purchase than the separator, there were several key advantages in favor of it. The way the machine handles was a very important consideration for the managing director: "The main reason I ultimately chose this machine is that it is much easier to use," he explains. "Aside from being easy to operate, it is much less prone to malfunctions than the old separators. The cost/effort required to maintain a 3-phase decanter is therefore much lower than for a separator. When the machines are cared for properly, annual maintenance is sufficient. Separators, on the other hand, require quarterly maintenance in addition to large-scale maintenance work every year." In terms of cleanability, a 3-phase decanter is much easier to handle than separators, which need to be rinsed with water several times daily in addition to being cleaned weekly.

From the managing director's perspective, these major advantages justify the cost of purchasing the 3-phase decanter: "We have some really good people looking after the separators in our plants. Thanks to their experience, they make handling separators and the work involved look simple. I also know, however, that these plants can cause a lot of headaches if you don't give them 100 % of your attention and not all processes are running smoothly," he clarifies. "That's where the decanter makes things much easier; it is just more user-friendly."

In the future, the managing director would still choose Flottweg's separation technology and, in particular, their product. "I would opt for three-phase decanters again because they work right from the get-go. You install them, look after them properly, and then the machines just perform. That's the most important thing for me."

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Significant CO_2 reduction

Heidelberg Materials expands sustainable concrete portfolio in Germany under EcoCrete brand

- **EcoCrete offers up to 66 % CO_2 reduction per cubic metre of concrete**
- **This high reduction is achieved on a strictly technical basis and without compensation measures**
- **The expansion of local, sustaiable product portfolios in the Group countries is a key element of Heidelberg Materials' climate strategy**

The German subsidiary Heidelberger Beton is now offering a broad portfolio of sustainable concretes under the EcoCrete brand. Depending on the application, the sustainable concrete offers between 30 and 66 % CO_2 reduction per cubic metre of concrete compared to the reference value of the industry. This reduction is achieved on a strictly technical basis and without compensation measures. In addition, the eco concrete range is available in particularly resource-saving types with at least 10 % of recycled content. Also, part of the concept are the one-hundred-percent use of green electricity, the use of recycled water, and the complete recyclability of the concrete in the case of subsequent deconstruction.

"Expanding local, sustainable product portfolios is a key element of

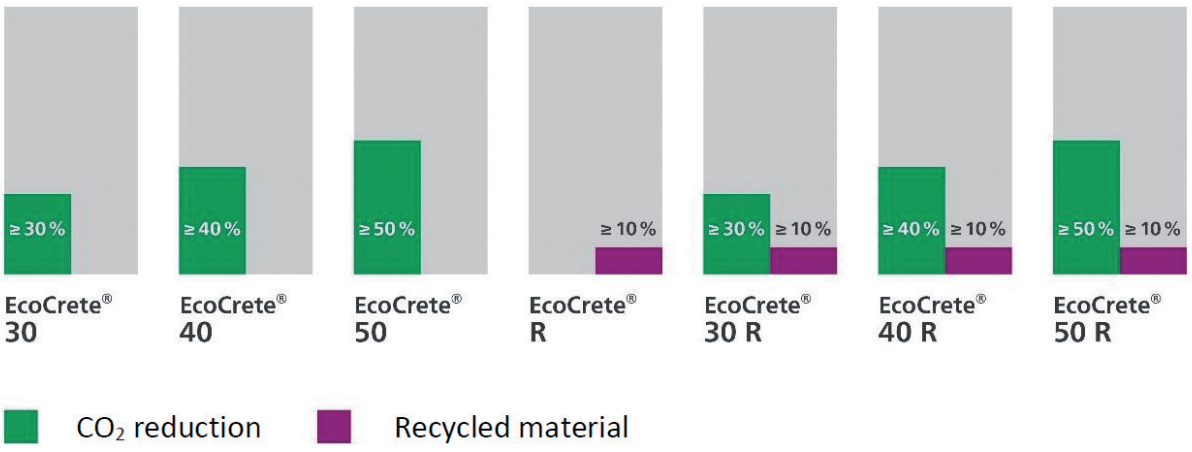
the manufacturer of building material's climate strategy," said the Chairman of the Managing Board of the German subsidiary. "The launch of EcoCrete in the German market is representative of the ambitious CO_2 roadmaps we are implementing at all levels of the company and in all Group countries".

"We are committed to regionally produced, CO_2-optimised building materials that push the limits of what is technically feasible today in terms of sustainability. Our cements and concretes are also being continuously developed to reduce the ecological footprint even further in the future – over the entire life cycle," explains the Chief Sustainability Officer and member of the Managing Board of the company.

A significant part of HeidelbergCement's research and development activities focuses on minimising energy use and CO_2 emissions through innovative products and process improvements. The company has set itself the goal of reducing its CO_2 emissions by 30 % by 2025 compared with the reference year 1990 and achieving climate neutrality by 2050 at the latest. The company is a global leader in the building materials industry in the development and application of innovative technologies for carbon capture and utilisation. With its increasing involvement in concrete recycling, the company also contributes to the circular economy.

HeidelbergCement,
Heidelberg, Germany

EcoCrete: up to 66 % CO_2 reduction



Valve industry already on hydrogen course

The energy market is facing a major transition as hydrogen will have a significant impact on the fields of electricity, heat and mobility. Hydrogen could also significantly reduce CO_2 emissions in processes of the chemical and steel industries, as well as in refineries. Sophisticated valves are needed to cope with the specific challenges of this medium. The valve industry is already on course to handle this – and the market seems to be booming.

Some states are already setting the course for the use of hydrogen. Germany, for example, has already recognised its potential and formulated the National Hydrogen Strategy about two years ago, providing also subsidies. These can also contribute to environmental protection. "Flexible energy carriers are indispensable for the energy transition and open up new markets for German companies", explains the German Ministry of Education and Research. In taking this step, Germany is pursuing a systematic approach thinking about production, transport, storage, distribution and use of hydrogen – including an international dimension.

Power-to-gas plants are needed to generate green hydrogen: In these plants, wind and solar energy are used to produce hydrogen via electrolysis from electricity and water. Power-to-gas plants are already in operation in Germany, as well as in Scandinavia and other European countries such as Switzerland, Austria, France, Italy and Hungary. On a global scale, these plants are used in China, Canada and Argentina, as well as in other countries.

A demanding medium

The process is particularly challenging as electrolysis produces not only hydrogen, but also oxygen. Both are very demanding media, with completely different requirements for corresponding valves and their materials", Hartmann Valves explains. For hydrogen valves used in power-to-gas plants, the requirements are comparable to other gas applications.

A pressure test with hydrogen shows whether the limit values are complied with and fugitive emissions are minimised. Photo: Hartmann Valves

The right choice of materials is crucial, in particular to avoid for example hydrogen embrittlement. Design-engineering measures are also crucial in order to guarantee the tightness of the valves against the small-molecule hydrogen in the long term. For this reason, Hartmann Valves offers gas-tight metal-seated ball valves with long service lives, which, if required, have also multiple barriers in pressure direction to further increase safety in the plant. For absolute certainty and security, material suitability tests and hydrogen emission tests are essential. "These provide the plant operator with the additional security of being able to predict actual emissions regarding the hydrogen medium that will be used later."

Hydrogen can be stored in caverns that are hermetically sealed against the medium. Wellheads are used at the interface between above-ground plant facilities and underground storage, Hartmann Valves explains. In addition to wellheads, ball valves are used for pipelines and compressor stations.

Avoiding explosive concentration

Also the Waldemar Pruss Armaturenfabrik fully focuses on dealing with the challenges connected to hydrogen valves. A particular risk for highly loaded pressure-bearing components is 'hydrogen embrittlement'; a material fatigue caused by the penetration of hydrogen into the metal lattice, which leads to the formation of cracks. The company emphasises that this is "a risk to be taken seriously". Hydrogen is also the chemical element with the lowest density and diffuses comparatively easily through materials. Pruss says that "this requires special solutions for spindle and housing seals".

Pruss advises particular caution because hydrogen is both odourless

Thyssenkrupp has expanded its manufacturing capacities for water electrolysis to a gigawatt scale. According to their own statement, the group can already today put into practice complete value chains – starting with the large-scale production of hydrogen arriving at the subsequent production of sustainable commodity chemicals such as ammonia or methanol. Photo: thyssenkrupp

and tasteless and, depending on the concentration, can react explosively with the ambient air. "When selecting materials, we therefore take great care to check their suitability for use in terms of hardness values, explosive decompression and ductility", the company explains.

Round sealing seats

In order to enable absolute tightness, müller quadax works with the 4-fold eccentric construction principle for its valves. The butterfly valves have a round sealing seat with a uniform wall thickness all around. "The design differs significantly from the common triple eccentric designs which have an elliptical sealing seat", the company explains. Material expansions have a homogeneous effect on the entire sealing surface due to high temperature fluctuations "and thus ensure optimum sealing tightness", the company continues. In addition, the Quadax® H_2 valve is equipped with a special sealing ring made of a dedicated material that "functions perfectly even at these extremely low temperatures".

Safety valves for hydrogen filling stations

Goetze KG supplies high-pressure safety valves for electrolyser manufacturers as well as safety valves for hydrogen filling stations – because in addition to the energy grid and industry, focus is also on mobility. Goetze sees an increasing international demand for hydrogen technology and supplies safety valves with up to 1000 bar to Chinese and Spanish plant manufacturers. China is already putting a particular emphasis on this and the world's largest hydrogen filling station was built in Beijing last year. "Eight hydrogen fuel pumps are ready to refuel up to 600 vehicles on a daily basis", Goetze reports. This is possible thanks to the large volume of up to five tonnes production capacity, embedded in a 200,000 square metre hydrogen park.

Demanding technical challenges

The technical requirements for hydrogen filling stations are higher than for conventional ones, emphasises Herose: At these stations, the gas is stored in low-pressure storage tanks at about 20 bar. In car fuel tanks, however, the hydrogen must be compressed considerably more because of the necessary energy density. "Compressors first compress the gas to 1000 bar and then store it temporarily in high-pressure tanks. To prevent the gas from heating up too much during refuelling, it passes through a pre-cooler", the company explains. The refuelling process is controlled electronically, and the pressure in the tank is regulated at 700 bar. "If the pressure drops unexpectedly, the safety valve opens and allows the excess pressure to escape unhindered into the atmosphere." As hydrogen is thirteen times lighter than air, it escapes upwards and is not dangerous. Valves with highest safety standards are required for the passage from petrol station storage tanks to car fuel tanks.

And how might hydrogen use look in the future? In Fraunhofer IFF's view, "systemically integrated hydrogen production" is a valuable concept. Not only the hydrogen produced during electrolysis would be used, but also oxygen; i.e. for welding processes or for ozonation of sewage treatment plants. "Problematic micropollutants such as pharmaceuticals, pesticides or cosmetics can be removed from wastewater by adding ozone", Fraunhofer IFF explains. Another possible use is in agriculture, where the oxygen could be used for desulphurisation of biogas plants. These are more uses that show further, promising prospects.

Innovations related to industrial valves and fittings can be seen at VALVE WORLD EXPO from Nov. 29 to Dec. 1, 2022, in Halls 1 and 3 of the Düsseldorf Exhibition Center.

Valve World Expo
www.valveworldexpo.de

Optimizing efficiency through filtration

The insider tip for clean and efficient processes

Environmental protection and productivity do not have to be a contradiction in terms: Companies that consistently reduce their carbon footprint and optimize the eco-balance of their processes and products can grow in a climate-friendly way. However, it is crucial for holistic efficiency optimization to consider all areas of the operation. In this context, it can also be worth-while to look at filtration and separation processes. FILTECH visitors will gain insights into all areas of filtration and separation of all types of media. The combination of trade fair and congress offers everything they need for efficient separation technology in their processes. FILTECH will next be held from February 14 to 16, 2023.

Clean ambient air, safe products, efficient processes: Filtration and separation processes play an indispensable role in ensuring smooth operations that have no negative impact on people or the environment. This importance is particularly obvious in the energy supply and production sectors: Wherever indispensable combustion processes take place for the time being, operators must take care to comply with applicable limit values and environmental regulations. The emission of pollutants can also be effectively prevented by filter technology.

Filtration technology plays a more inconspicuous, but no less important role for the efficiency of operations – and thus also for the eco-balance of the entire company – in the primary processes of production. In beverage production, for example: Users who rely on backwashable filters simplify cleaning, increase system service life, and achieve high-quality results in a resource-saving and sustainable manner. In other areas of the process industry or in manufacturing processes, too, modern filter systems can provide economic and ecological benefits that pay off for operators in the long term.

Equipment and components, services and know-how for the energy and the manufacturing industry are offered by the exhibitors at FILTECH. At the combination of trade fair and congress, visitors receive industry-specific expertise and opportunities for personal exchange on filtration and separation of all types of media.

Fig. 1 + 2: Expertise and personal exchange: At FILTECH, visitors can find out about current trends in research and development and experience a wide range of products and services. Source: FILTECH Exhibitions Germany

Focused trade fair with over 440 exhibitors

From February 14 to 16, 2023, FILTECH will again open its doors to visitors at the Cologne exhibition center – less than a year after the previous date in spring 2022. Due to the Corona pandemic, it was necessary to deviate from the usual one-and-a-half-year interval. "The innovative power of the filtration industry is very strong," explains Suzanne Abetz from organizer FILTECH Exhibition Germany. "At FILTECH 2023, the trade audience will again be presented with numerous innovations – also from many new exhibitors who will be taking part for the first time."

Visitors to FILTECH 2023 will again be able to experience a wide range of products and services: In addition to separation and separation technology, the program also includes measuring technology, analytics, and laboratory supplies, as well as news from science and research. Industry leaders such as ANDRITZ and MANN+HUMMEL will be represented, as will specialists such as Haver & Boecker and Lehmann & Voss. In addition, there will be numerous research and development institutes.

Operators from the food and beverage industry will benefit from the presence of suppliers for both solids separation and solid-liquid separation, as well as manufacturers from the solid-gas separation sector.

As the desire for clean, hygienic ambient air in production and administrative areas has risen sharply since 2020, many exhibitors are also focusing on products such as stationary air purifiers and systems in a wide range of dimensions. HVAC systems from exhibitors achieve capture rates of over 99.9 percent and can help operators with energy-efficient solutions for all HVAC applications in factory buildings.

Whether air purification or filtration processes in production: The fact that the demand for new products and services remains high is also proven by the large number of exhibitors. according to the current status, the organizer is already expecting over 440 companies at FILTECH 2023 – more than ever before.

Personal exchange at the heart of the congress

Traditionally, the FILTECH exhibition area is also complemented by a strong congress. Visitors thus not only have the opportunity to experience the latest products and services live but can also find out about current trends in research and development in the congress area. The FILTECH Scientific Advisory Board, chaired by Dr. Harald Anlauf (Karlsruhe Institute of Technology) and Prof. Eberhard Schmidt (Bergische Universität Wuppertal), guarantees the high quality of the presentations: Experts from international universities, research institutions and companies review the submitted contribution proposals and compile a program that guarantees valuable information from all areas of the industry. The organizer expects more than 200 presentations for FILTECH 2023.

The congress at the event is divided into units covering all relevant topics. Seven thematic areas will be in focus:

- Solid-liquid separation
- Solid-gas separation
- Filter media
- Testing, instrumentation, and control
- Simulation and modeling
- product related processes
- Membrane processes

In addition, the congress at FILTECH 2023 will be dedicated to current industry trends such as selective separation, microprocess technology and nanofluidics, mist and droplet separation, and biological waste gas treatment with biofilters. Two focused day-long courses will be held on February 13, 2023, the day before the exhibit area opens, and will also specifically address engineers, scientists, managers and other technical personnel who need applied knowledge on topics related to solid-liquid separation and fine particle removal.

Filtration processes for safety and efficiency

Environmental impact, energy prices, employee protection – there are many good reasons to take a close look at filtration and separation processes in operation and identify optimization potential. At no other trade event will visitors receive such comprehensive and in-depth expertise on separation processes as at FILTECH: In the exhibition area, plant operators will find the right products and services. At the congress, they can exchange ideas with experts on current trends and gain a decisive edge in knowledge. For successful planning of the visit, interested parties can find a list of exhibitors, an overview of focus topics and industries as well as the extensive conference program at filtech.de.

FILTECH
www.filtech.de

Hammelmann expands the performance spectrum of the HAMPRO® series

As part of the first ACHEMA since the revival of face-to-face trade fairs, Hammelmann GmbH, Oelde, presented its newly developed HAMPRO® 1600 high-pressure process pump, which complements the established HAMPRO® series and further expands the power range and flowrate capabilities.

With a drive power of up to 1600 kW, a working pressure of 3,000 bar can be achieved with the high-pressure pump working at a flow rate of 258 l/min. (15.4 m^3/h). The maximum flow rate of 4,266 l/min. (256 m^3/h) is achieved at an operating pressure of 200 bar.

Like the other pumps in the HAMPRO® series, the HAMPRO® 1600 is extremely variable in terms of the pumped media and is used wherever high performance, pressure and reliability are required. The materials used and the design of the system are optimized for continuous operation. The upright design minimizes the mechanical stress on the components in combination with the pump head made of stainless steel with no alternating pressure loads to ensure low wear and extremely smooth running. Ten plungers move the conveyed medium through the machine with almost no pulsation and an efficiency of up to 95 %.

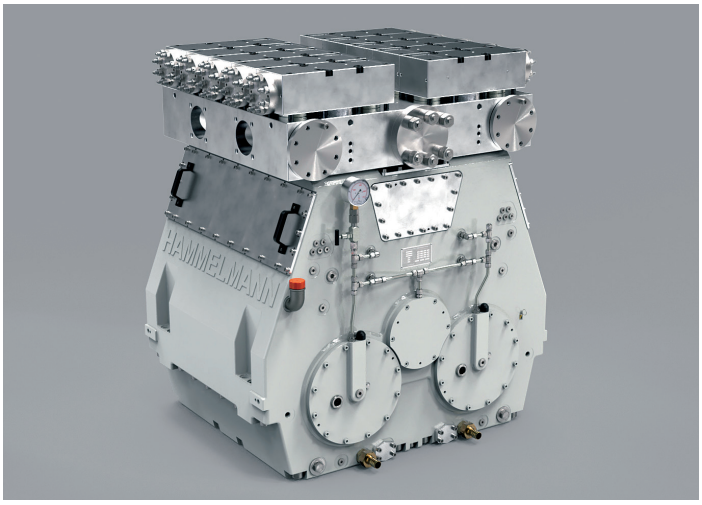


Fig. 1: HAMPRO® 1600 – the newest addition to Hammelmann's extensive line of process pumps

The HAMPRO® 1600 can be used for descaling steel, pumping ammonia and other chemicals, injecting water into natural gas reservoirs, flushing conveyor lines and many other industrial production processes. In the "Zero Emission" design version, the medium is completely separated from the environment, so that the pumped medium cannot escape to the outside in any operating state.

Comprehensive solutions for tank and flange cleaning

The company covers every imaginable requirement for tank and container cleaning with the Aquamat and Aquarex® series. Tank cleaning units from S to XXL are available. Special solutions in ATEX design or for pumping chemicals are also part of the product range, as are very compact designs for use in small containers, such as IBCs, or high-performance solutions for cleaning of large containers.

Tank cleaning devices of the Aquarex® series are adapted to individual requirements. The range of solutions extends from mobile reel systems to gas-tight lance and reel systems to permanently installed, fully automated systems.

Fig. 2: The Aquamat tank cleaning systems cover the most diverse requirements with a variety of sizes and specifications.

To increase occupational safety when cleaning pipe flanges, the Oelde based company will be showing a flange cleaning system. Mounted on the pipe, the unit utilizes the adjustable working position and the constant rotation by compressed air to offer many areas of application on the pipe flange and nozzle and ensure the intensive cleaning of material. The flange cleaner uses a Masterjet rotary nozzle and is also suitable for polished high-pressure flanges, since the working position is always the same, ensuring a safe distance from the flange.

The resulting recoil forces are completely absorbed while the operator steers from a safe distance.

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AS-Schneider will present the new Digital Valve Kit, valves for hydrogen applications as well as valves for use with fugitive emissions at the Valve World 2022: Solutions for a sustainable and digital future

A highlight from the AS-Schneider Group at the Valve World at booth B20 in hall 03: Expanding on the static digital twin valve solution Digital Product Pass, AS-Schneider presents the new dynamic digital twin solution, the so-called Digital Valve Kit. The new Digital Valve Kit, providing plant operators with remote access and remote control of their valves, as well as indicating the current health status of the installed valves. In addition, the specialist for industrial valves will present valves

and manifolds as well as the DBB ball valves for hydrogen applications and for use with fugitive emissions (TA-Luft 2021).

Digital Product Pass (DPP)

Every year, technicians install millions of mechanical components in brown- and greenfield plants - a large proportion of which are valves and valve manifolds. To take advantage of the IIoT, suppliers, plant engineers and operators should include these valves in the digital twin

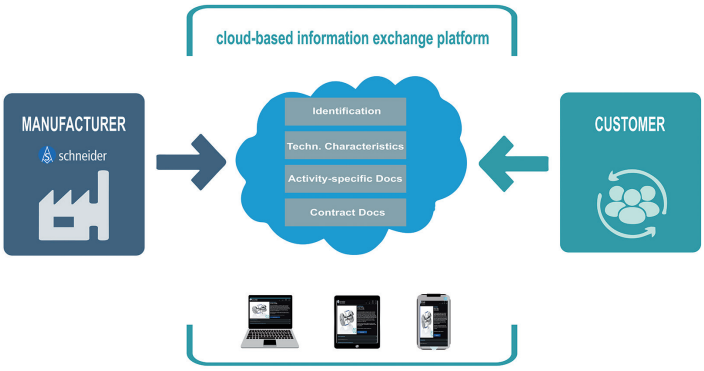

Fig. 1: AS-Schneider norms the data according to VDI 2770 and provides the data package via 3rd platform (so-called cloud-based information exchange platform). (all Pictures by: Armaturenfabrik Franz Schneider GmbH + Co. KG)

of the plant. This is exactly where the AS-Schneider Group comes in, developing valve solutions that can be easily integrated into the global and digital industrial infrastructure of the future.

Starting a few years ago, AS-Schneider has been offering its customers the so-called Digital Product Pass for valves, which fulfills the requirements of DIN SPEC 91406 (IEC 61406). The E Series Valves and Manifolds, Monoflanges, VariAS-Blocks and DBB Piping Ball Valves are marked with a unique QR code. The user can scan this or enter the individual serial number at www.qr4v.de. That QR-code provides easy access to static product information like technical specification, activity - specific docs, individual drawings, certificates, and spare parts.

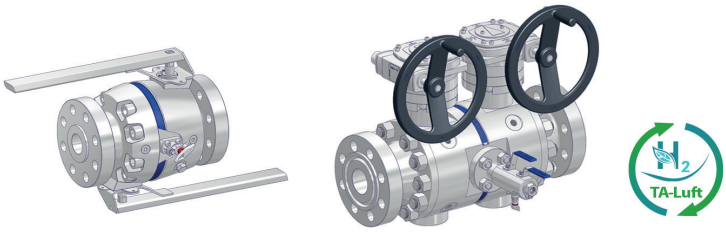

Fig. 2: Hydrogen and TA-Luft compliant DBB piping ball valves can also be used safely in natural gas applications with, for example, a 20% hydrogen blending.

Having joined the Digital Data Chain Consortium (Digital Data Chain) recently AS-Schneider will now move this to the next level by norming the data according to VDI 2770 and providing the data package via 3rd platform (so-called cloud-based information exchange platform). The first insights are shared by AS-Schneider at booth B20 in hall 03.

Digital Valve Kit (DVK)

In addition to the static Digital Product Pass, AS-Schneider is currently working on a dynamic solution to sense or capture data, the so-called Digital Valve Kit.

The Digital Valve Kit provides plant operators with remote access and remote control of their valves as well as indicates the current health status of the installed valves. The DVK provides all alerts to the maintenance team in a timely manner. This enables them to react in time and initiate further measures at an early stage. The system is compliant with all industry-relevant standards (e. g. NAMUR standard).

A live demo of this can be seen daily at Valve World at 11 a.m., 02 p.m. and 04 p.m. at the AS-Schneider booth B20.

Valves for hydrogen applications

AS-Schneider's valves have been successfully used for hydrogen for more than 20 years – all valves and manifolds as well as the DBB ball valves are suitable for this purpose. The instrumentation and piping valves can also be used safely in natural gas applications with, for example, a 20 % hydrogen blending. This feature is particularly interesting for natural gas plant operators and gas network operators who want to convert their natural gas pipelines for hydrogen.

AS-Schneider recommends austenitic stainless steel 316 or 316L as the optimum material for instrumentation and pipeline valves in the hydrogen industry. Other materials are also possible.

Those responsible should ensure on top that non-metallic valve materials such as seals and lubricants are compatible with the hydrogen medium. There are lists of these in the standards and norms (Sandia, ISO/TR, SAE).

Fig. 3: Hydrogen compliant instrumentation valves from AS-Schneider have been successfully used for hydrogen for more than 20 years and meet the requirements of the TA-Luft amendment.

When the user selects the appropriate valve head unit, he must first check whether the operating environment is closed or open. If the environment is open, he can use the standard valve head unit from AS-Schneider. If the valve is mounted in a closed, non-ventilated environment – which could be a protective enclosure or a container - then increased tightness requirements. Those will be covered with special valve inserts (Fugitive Emission Standards like TA-Luft or bellow sealed valves). Plant operators can get advice from the hydrogen experts at Valve World to find the right material and valve head units for their specific requirements.

Valves for use with fugitive emissions - meets specifications of the TA-Luft amendment

Strict legal requirements force certain industries to capture and reduce fugitive emissions by using emission control equipment.

In such cases, we recommend plant operators and plant builders to use industrial valves with special valve head units and sealing

systems that are type-tested according to ISO 15848-1 or meet the requirements of the TA-Luft amendment.

The valves from AS-Schneider meet the requirements of the new TA-Luft, which came into force on December 1, 2021 as the amended Technical Instructions on Air Quality Control. It sets stricter limits for pollutant emissions from plants requiring approval. The most important change in the specifications is the adoption of the ISO 15848-1 standard, which clarifies how a valve is to be tested and specifies the parameters for classification. After the end of the transition period in 2025, valves must comply with this standard. For plants in the planning or installation phase, it is important to ensure that valves, pumps, compressors or even flange connections directly comply with the specifications of the TA-Luft amendment.

AS-Schneider is very experienced in this field and was actively involved in working out the amendment.

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Kyocera's high-performance components work reliably – even in the most demanding environments

Hydrogen is an upcoming energy carrier regarding future solutions in many fields, Kyocera's components' excellent mechanical robustness and hermetic sealing technologies can offer the right solution for various applications. In order to present the newest innovations and possibilities in this field, Kyocera exhibited its ceramic parts at the fair Hydrogen 2022, which was held in Bremen on October 19 and 20.

Due to the fact that hydrogen is projected to be the energy carrier of the future and that the demand for hydrogen and corresponding investments is rising accordingly, Kyocera is furthermore setting standards in order to reach the aim of a more efficient future with their ceramic components. Kyocera's ceramics therefore have the appropriate characteristics to function reliably in the demanding environment and can be used in various hydrogen applications.

Fig. 1: Feedthroughs

Hydrogen as the energy carrier of the future

Hydrogen is a highly flexible energy carrier. Owing to its quite difficult handling and transportation, special solutions using ceramic materials present new possibilities to overcome related challenges. If it is produced with renewable energies, it is also climate-friendly. Beside the advantages concerning the climate as well as the security of supply, hydrogen technologies and solutions have the potential to reach the global market and create future places of employment.

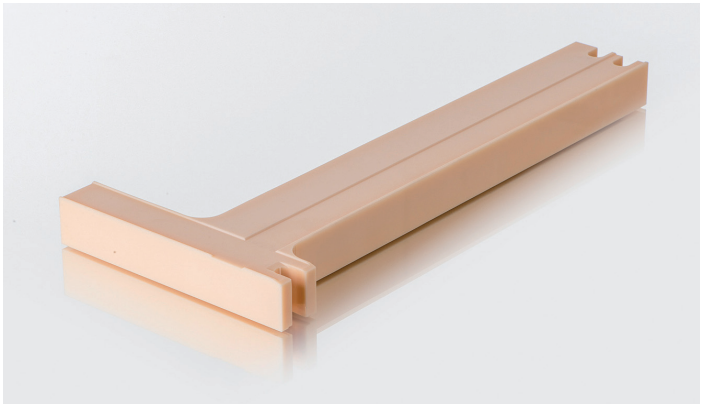

Fig. 2: Dielectric rail for fuel cells

CO_2-free production of Hydrogen

Generally, one can distinguish between green, blue and turquoise hydrogen. Especially green hydrogen produced by electrolysis with water, is becoming significantly more important in the near future. Green hydrogen is the major measure in order to reach the goals of the Paris Climate Agreement. Besides this fact, green hydrogen stands out with its diversity of uses in different fields of application. For example, it is the only way to make certain processes in the chemical industry and the most practical way to replace coal in the steel industry. In the so-called electrolysis process, the water is broken down into hydrogen and Oxygen with the help of electricity. The electricity required for the process comes exclusively from renewable energies. Furthermore, this means that the used energy as well as the production of hydrogen are CO_2-free. Due to the special chemical properties of hydrogen, safety and performance must be ensured throughout the entire value chain, i. e. production, transport and storage.

Ceramic in Hydrogen applications

Kyocera can supply high-performance ceramic materials showing high performance in harsh environment conditions, like in hydrogen processes. The excellent mechanical robustness and hermetic sealing technologies can offer the right solution for various applications. By identifying the specific needs of your application, Kyocera is able to select or develop the most suitable material to provide the right custom solution for your needs.

Full assemblies based on individual customer's requirements

In total, Kyocera not only provides ceramic components, but fully customized solutions. Thanks to a big variety of shaping methods, many years of experience in brazing technology and a wide portfolio of coating technologies, Kyocera is able to provide full assemblies based on their customers' requirements and needs. Kyocera's electric feedthroughs are hermetically sealed and suitable, even for UHV applications. With a big range of available metal- and brazing materials, they can be adapted to be usable under different conditions such

as corrosive environment, mechanical load/high pressure and high temperatures.

Fig. 3: One-layer SiC heat exchanger

Kyocera at Hydrogen 2022
To showcase the advantages of ceramics for hydrogen operation, Kyocera participated in the Hydrogen Fair 2022 in October in Bremen. This year's theme was "Technologies & Solutions for a Low Carbon Hydrogen Future".

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Wide range of applications for energy-efficient high-pressure pumps

Whether in power generation, in the chemical, food and heavy industries or in process technology: high-pressure plunger pumps work highly efficiently and around the globe in a wide variety of applications.

The individuality and the spectrum of possible uses of high-pressure pumps can be demonstrated with a few examples. Due to their efficiency and possible applications, the pumps make a decisive contribution to improving our environmental conditions.

Fig. 1: Application diversity of URACA products around the globe

Initially, the focus will be on an industrial project from the current thematic world around the topic of mobility, in particular hydrogen: Gas tanks for the automotive industry are usually operated with a filling pressure of about 700 bar. Since these – like any other fuel tank – are to be refilled countless times, it is important within the scope of quality testing to ensure the property of pressure resistance with sufficient test cycles. For this purpose, special pressure test units are used which, by means of the reproducibility of the results over a large number of test cycles, make it possible to demonstrate the pressure resistance and thus the safety of the tanks in continuous use on exemplary tests for the respective production batches.

Cyclic pressure testing is economically and ecologically advantageous for the tank manufacturer, since the average power consumption of these systems is only about 50 percent compared to other technical solutions, such as a system with a pressure converter.

The cycle test describes an increasing, thresholding pressure load on the test object between a variably adjustable upper and lower limit. The set pressure is approached reproducibly with a tolerance of ±10 bar at maximum pressure and ±5 bar at minimum pressure. Shortly before reaching the set maximum value, the pressure increase rate is adjusted to achieve the sinusoidal characteristic. The pressure is held in the range of the maximum value. After a freely definable holding time, the pressure is reduced again via the relief time, which can also be set, and is also held for a certain time after the lower pressure level has been reached. Holding time and pressure relief can be defined in 0.1 second increments. The system reaches a maximum pressure of Pmax = 1,300 bar, while the minimum pressure can be set to Pmin = 10 bar. A total of 50,000 - 150,000 cycles per test object are run, whereby the maximum number is limited to 10 cycles per minute depending on the container size. The energy input is limited to the short, time-limited phases of pressure build-up; no significant pump power is required for all other phases.

A DP724 pump unit is used for cyclic pressure testing. The heart of the system is a high-pressure plunger pump of type KD724, driven by a frequency-controlled electric motor. The unit is able to display a sinus-like pressure curve and – depending on the medium – delivers reproducible results for up to 150,000 test cycles. The pressure can be flexibly adjusted up to 1,300 bar. By means of a valve station installed in the unit, the required pressure increase and pressure decrease curves are realized. In addition to the unit, the complete system includes a water tank with booster pump for independent supply and a recooling system for the test medium used in the closed circuit. Installed in a sound-insulated container, the pressure test unit can be used flexibly. The electrical control system, which can be integrated into the operator's system, allows individual and flexible setting of the test parameters.

Key data at a glance	
Test pressure max.:	1,300 bar
Test pressure min.:	10 bar
Plant power:	110 kW
Number of test cycles:	50,000 – 150,000
Pressure curve per cycle:	Sinusoidal
Test medium:	Water

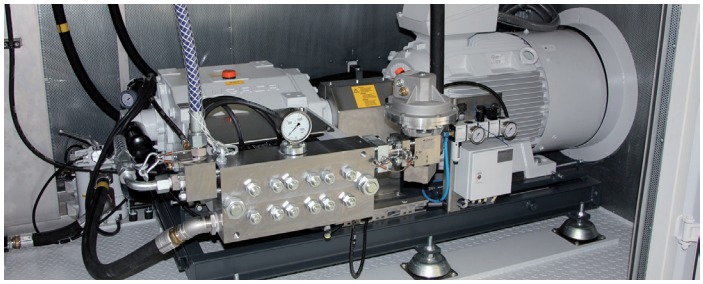

Fig. 2: High pressure pump unit KD724E for cyclic pressure testing

Fig. 3: Flexible applicable pump unit as container design

A second example from the field of new, climate-friendly energy sources is the production of biodiesel: a fuel with many challenges.

High-pressure pumps make an essential contribution towards the production of these environmentally friendly fuels. Biodiesel or fatty acid methyl ester (FAME) is a fuel that is equivalent in use to mineral diesel fuel. The chemical industry obtains biodiesel by transesterifying vegetable or animal fats and oils with monohydric alcohols such as methanol or ethanol. During production, the fatty acids contained in the oil are split off from the glycerol with the aid of a catalyst and chemically converted with methanol, i. e. esterified. In various steps, this process produces the fuel "biodiesel" as the main product and the by-product "glycerol", which is used as a food additive and in medicine. The methanol is recycled back into the reactor.

In today's industrial, patented processes, so-called supercritical processes, various reactions take place simultaneously and within a few minutes. They achieve maximum yield and, thanks to the special process parameters, no longer require catalysts. For this purpose, high-pressure pumps are used to pump methanol and fatty acids against high pressures. Depending on the production plant, pump capacities of up to several hundred kilowatts are required for these applications. The particular challenges for the high-pressure pumps lie in the properties of the pumped media: methanol, for example, has hardly any lubricating properties, while other media tend to crystallize early, which can severely disrupt pump operation and lead to reduced service lives.

Local conditions, such as use in hazardous areas or particularly high or low temperatures, also place enormous challenges on the pump units and thus on their manufacturers. Compliance with local regulations, standards and certificates round off the requirement profile for the pump supplier.

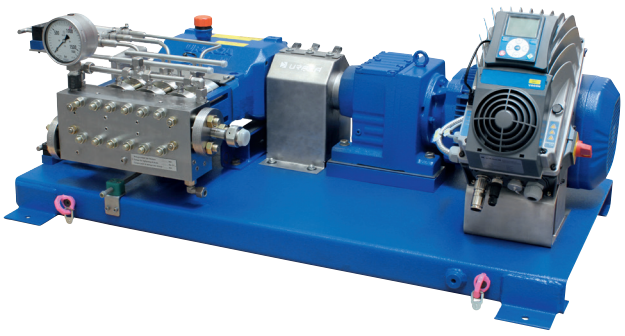

Fig. 4: High-pressure pump unit for conveying supercritical CO_2 for extraction

The many years of experience, the high level of expertise and the design refinements therefore characterize the robust and long-lasting pumps from URACA to the satisfaction of the customers.

Other examples in the field of liquefied gas include CO_2 extraction and the injection of CO_2 into reservoirs.

In the extraction of active and valuable substances, aromatic and flavouring substances, the food and pharmaceutical industry is forced to make high demands concerning quality and economy of the extraction process. The CO_2-method is therefore preferably used in the extraction of primary vegetable products. The optimal sequence of the process depends on the quality and the controllability of process data in the high-pressure section. Efficient industrial utilization of this method requires high reliability and functionality of the most important technical system components. The pumps for increasing the pressure of the liquid CO_2 therefore play a key role in the process, because these pumps can be reliably adapted to the CO_2-conditions.

The main advantages of extraction with the help of CO_2 are, on the one hand, the gentle treatment of the substances and, on the other hand, the cleanliness of the end product, i.e. extracts do not contain any solvent residues. Apart from this, the method enables high selectivity of the extraction. By using suitable process parameters (pressure and temperature), even different active substances can be extracted from the same raw material. This property of CO_2 demands that the parameters process pressure, process temperature and flow volume of the extraction system are maintained almost exactly at a level that matches the required nominal values.

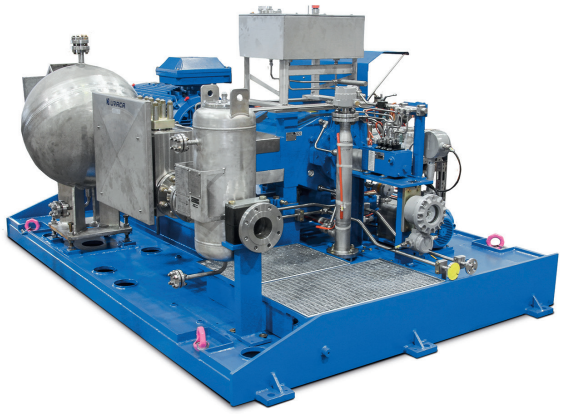

Fig. 5: Electrically driven pump unit for the production of biodiesel

Pressure generation and volumetric flow control is preferably accomplished by a positive displacement pump, which is able to meet the high demands concerning controllability and constant flow volume and can therefore be very well adapted to the properties of CO_2. By minimizing the dead space, an oscillating positive displacement pump is able to achieve a very good volumetric efficiency, despite the high compressibility of liquid carbon dioxide. Due to the high process pressures and the relatively low flow volumes, this pump type is particularly suitable for CO_2-extraction.

Positive displacement pumps therefore are the only pump type, which, in combination with a good rate of efficiency, achieve the demanded process data and guarantee exact compliance with the parameters most economically. This stability results from the excellent proportionality of rotary speed and flow volume and its almost complete independence from the process pressure.

The following requirements concerning the rating of the pump, which is intended to deliver the CO_2 for the extraction process, must be met. The pump must first be compressed to the required supercritical pressure to be able to transform the CO_2 into the supercritical condition. Compared with water, liquid carbon dioxide has a considerably higher compressibility. Density value essential for the flow quantity (suction and pressure side) can be taken from the table of thermodynamic state variables.

Special attention must additionally be paid to the requirements concerning high durability of components and cavitation free delivery at a high overall efficiency of the pump. High demands are thereby placed on sealing of the plunger and the leak tightness of suction and pressure valves.

The requirements on fluid contacting parts can only be met by highly specialized designs in connection with the use of special materials. The only standard element of such a pump is the power end with crosshead and crank drive. It is precisely these properties that also predestine the high-pressure pumps for injecting CO_2 into underground reservoirs.

With an increasing variety of applications and growing requirements, the development of new products is of elementary importance. Based on this motivation, URACA has added compact pumps to the power ranges of 700 kW and 1200 kW with the two new pump types P3-85 and P5-85 and created a new pump series in the upper range.

Fig. 6: Plunger pump P5-85 for the process industry

This adds two extremely compact plunger pumps to the product portfolio, the main features of which are their short design as well as the integrated gearbox. With a stroke of 100 mm and a rod load of 280 kN, the average piston speed can be kept relatively low. The Px-85 series enables an increase in performance compared to long-stroke machines of corresponding performance classes while at the same time complying with the API 674 limitation on average piston speed.

The short design, the elimination of external gears and the simultaneous optimization of performance with respect to comparable gearless types enormously expand the range of applications to the benefit of the user. As a result, not only can several pumps be replaced by one in individual cases, the new series also opens up areas of application that previously had to be served by long-stroke and very slow-running types. In addition to saving space, these possibilities also lead to a reduction in costs compared to the complete ensemble with gearbox, converter and similar additional units.

Key data at a glance:	P3-85	P5-85
Power P_{max}	700 kW	1,200 kW
Stroke	100 mm	
Rod load	280 kN	
Flow rates up to approx.	2,100 l/min	3,500 l/min
Gearbox	integrated or with long shaft	

Decades of experience in the development and construction of high-pressure plunger pumps, state-of-the-art technology and highest manufacturing quality with maximum vertical integration have made URACA a leading company in the industry. The newly developed high-pressure pumps are continuing this successful course.

In petrochemical production, specifically in the cracking processes, the central building blocks of a refinery, the basic products for the production of fuels, colors and plastics, pharmaceuticals, detergents, and many other products are produced.

The pumps used in these applications demand the highest expectations in design and features. They not only need to operate under high pressures, they also need to operate under high temperatures while providing maximum reliability and durability.

Various procedures can be used to process residual oil, which is accrued after refining heavy oil, bitumen or normal crude oil. It is then compressed to around 150-250 bar, mixed with hydrogen and fed into the hydrogenation reactor at up to 450°C. This critical process uses pure hydrogen, so system failure, particularly in the feed pumps is not acceptable. Otherwise, extremely critical operating conditions may arise. As a result, redundant solutions with standby capacity for the pumps are usually used. When in use, each pump is also monitored with adapted instrumentation to detect possible faults early and react to them accordingly, so that it does not become a hazardous situation.

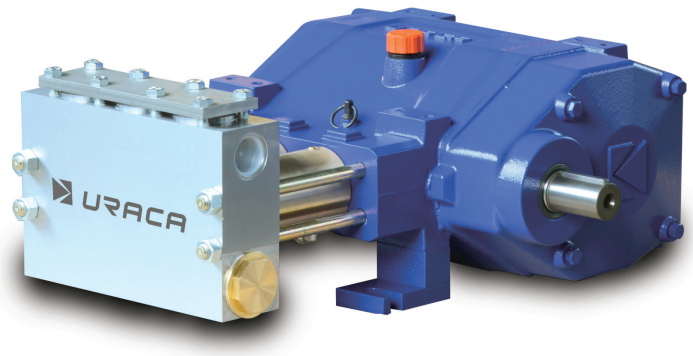

Fig. 7: High-pressure plunger pump P3-70 for hot oil

Oil as a pumped medium is usually non-problematic and easy to handle. However, residual oil may contain a number of aggressive and corrosive elements. Hydrogen sulphide and sulphur (particularly at high temperatures) are the worst culprits here. At moderate temperatures, sulphur still possesses positive properties in terms of lubricity between the plunger and mechanical seal. But at high temperatures, it behaves in a negative way and can cause heavy corrosion. Sulphur attacks metallic materials that come into contact with the pumped medium here. The challenge for pump suppliers is in choosing and using high-quality alloys to prevent corrosion.

High operating temperatures also mean that the components expand when exposed to heat. Finding constructive ways to take account of these conditions and ensure that the pumps work flawlessly, even in hot conditions, requires a wealth of experience and specialist knowledge.

For decades URACA pumps have proven themselves in the processes of refineries around the world. New refineries also rely on URACA high pressure pumps, especially for applications or processes requiring pumping hot oil and wash water. These highly sensitive processes require pumps capable of providing the exact pressure and flow demanded of them whether new or many years old. The demand for reliability stays the same for the life of the equipment. Is a high pressure pump the ideal choice for this application? The high quality of URACA pumps are, especially after many years of use, the right choice based on reliability, durability, ease of maintenance and design. URACA pumps offer long run times, low energy consumption due to high efficiency, long maintenance intervals, and leading designs based on many years of experience making URACA pumps the ideal choice for customers calculating the life cycle costs of a pump.

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TEC artec GmbH supplies 4 control ball valves 12" class 1500 as main inlet and outlet control valve in natural gas caverns

Caverns are cavities created underground in salt rock by flushing out with water (so-called leaching), which are usually filled with natural gas, crude oil or air for storage purposes. They serve to compensate for seasonal fluctuations in demand, supply bottlenecks and optimize the commercial conditions of procurement and thus serve the overall security of supply of the European energy market. In the future, underground storage of regeneratively produced hydrogen will play a greater role.

In addition to the underground facilities, the aboveground facilities include the compressors, filters, control stations, measuring facilities, drying facilities, cooling- and preheating facilities. On the valve side, control valves play a decisive role in addition to the various shut-off and safety valves.

Since the natural gas in the salt caverns is usually injected and discharged again via the same pipeline, the control valves in these pipes play a special role.

They should:
- regulate the quantity when the natural gas is pressed into the cavern and the discharging quantity when it is withdrawn with a constant pressure change gradient.
- ensure largely pressure-loss-free operation in the fully open state (with similar pressure ratios between the cavern and the network pipeline).
- avoid overshooting and pressure shocks.
- cover a wide flow range, which brings conventional control valves to their performance limits.

Of the total of 75 operated caverns in the East Frisian municipality of Etzel (Friedeburg), 51 are used to store natural gas.

For 4 of these caverns, which have already been in operation for years, a high-pressure control valves specialist the manufacturer TEC artec GmbH from Oranienburg near Berlin, has supplied control ball valves in the last two years.

Fig. 1: Control ball valve 12" cl1500 as main feed-in and withdrawal control valve for natural gas cavern storage in Etzel (with trace heating without insulation in the installation phase)

The plant operator originally had two control valves at each cavern, directly between the cavern head and the above-ground facilities. The two control valves of different sizes are used to cover the wide control range. The smaller of the two covers the smaller load scenarios, while the larger of the two valves controls the large load cases accordingly.
A split-range operation cannot not be realized in this application due to the extreme design scenarios with the compressible media natural gas under changing pressures. In addition to the internal pressure of

Fig. 2: Cavern storage aerial view

the natural gas cavern, the pressure change gradient and the temperatures prevailing in the cavern also have an influence on the safe operation and service life of a cavern.

Due to the positive experience of neighboring cavern operating companies with control ball valves and the limited selection of other suitable control valves, TEC artec was initially awarded the contract for the supply of one control ball valve. This was to be put through its paces under real operating conditions.

After successful commissioning and the convincing performance tests, the delivery of another 3 identical control ball valves for the other caverns was also ordered from TEC artec.

The valves for the gas storage operator in Etzel are equipped with a 2-stage pressure reduction for the control at high pressure differences. At smaller pressure differences and the associated larger opening positions of the valve, the mode changes smoothly to a 1-stage pressure reduction. From approx. 50% opening, regulation takes place with a barely measurable pressure difference.

The 2-stage pressure reduction at higher pressure differences reduces the icing problem due to the Joule-Thomson effect. In addition, the control discs with the bores directed parallel to the pipeline create a uniform flow with low turbulence, which also has a positive effect on noise emissions.

With leakage rate A according to EN12266-1, the control ball valves supplied meet the significantly higher tightness requirements for shut-off valves.

Technical data of the control ball valves

Flange:	ANSI B16.5: 12“/ cl1500/RTJ
Material:	1.0566 / ASTM A350LF2
Seat:	Pure metal, DBB, DPE
Leakage rate:	EN12266-1: A
Design pressure:	210bar
Design temperature:	-20 ... +50°C
Medium:	Natural gas
Hydrogen suitability:	yes
Cvs-value:	1000m³/h
Control Curve:	Equal percentage, modified
Control ratio (measured)	463:1
Flow direction	Bi-directional
Actuation	AUMA with AUMATIC (Ex)

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Impressum

Publisher
Dr. Harnisch Verlags GmbH in cooperation with Prof. Dr.-Ing. Eberhard Schlücker as scientific advisor and editorial board of PuK

Responsible for content
Prof. Dr.-Ing. Eberhard Schlücker
Silke Watkins

Publishing company and reader service
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Eschenstr. 25
90441 Nuremberg, Germany
Tel 0911 2018-0
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E-Mail puk@harnisch.com
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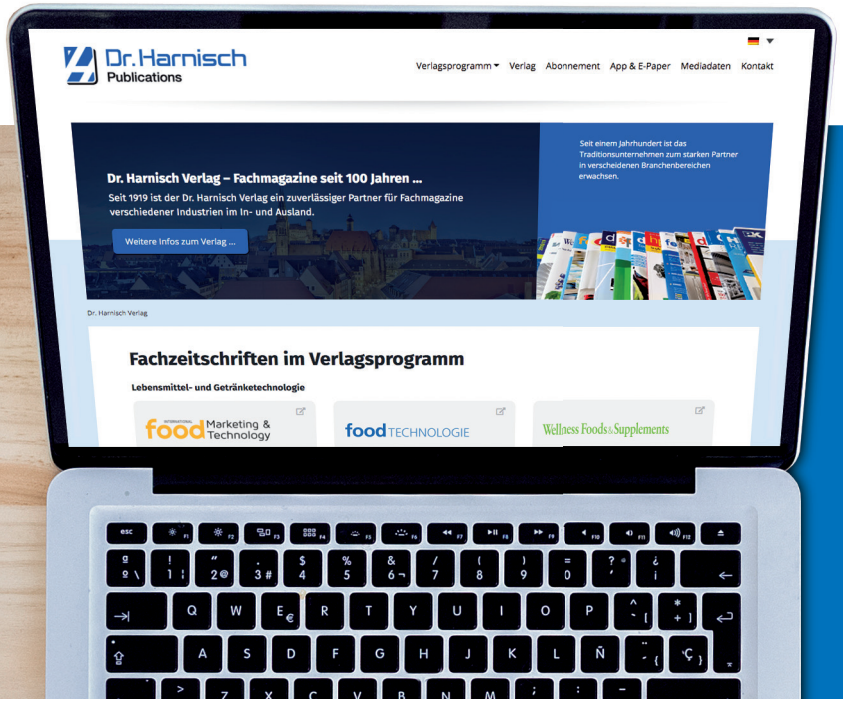

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