**Fluidics Move the World — What Makes Fluidics Move?**

*Natural gas pipelines, hydrogen, drinking water or CO2 capture — you can't do it without pumps, valves and compressors. At the same time, fluid systems have a reputation for being energy- and maintenance-intensive cost traps. With fluid technology becoming networked and the threat of a PFAS ban looming, the industry is looking for new approaches.*

Pumps — and, of course, compressors — are energy-hungry units: it is estimated that around a quarter of industrial electricity is used to pump fluids. In terms of global electricity production, this represents 10% of the world's total — meaning that one in ten power stations is in operation just to provide the energy needed to move liquids from A to B.

This is not always efficient: in particular, improperly dimensioned, worn or poorly controlled pumps, as well as inefficient compressors and compressed air leaks, are known to be huge energy wasters. In addition, pumps are often oversized due to ignorance or uncertainty. As a result, the units operate outside their optimum efficiency, have to be throttled and wear out more quickly. However, the consistent use of modern speed control systems could help to save 7.5 terawatt hours of energy and 4 million tonnes of CO2 emissions in Germany alone. Thanks to the lower energy consumption of controlled drives, improved impeller geometries or smaller clearances, the extra cost of new equipment is quickly amortised.

Another factor to consider is the enormous burden of high energy prices, particularly for companies with a high degree of upstream integration: Production processes such as the casting of machine parts or the testing of large pumps are expensive, with energy requirements in the megawatt range and huge costs for electricity and gas, experts warn — and point out that, unlike consumers, industrial companies do not benefit from fixed price guarantees. Energy and cost optimisation will therefore not only be part of the product development specifications for pump manufacturers in 2023, but also at the heart of their own manufacturing processes.

**Connectivity Continues to Be in Demand: Is Connected Fluidics the Next Big Thing?**

The prevailing influence of energy efficiency is also reflected in the fact that the German Engineering Federation (VDMA), for example, sees the greatest potential for digital tools in this area. After all, a lot is happening in Fluidics 4.0: the asset administration shell finally brings the concept of the digital twin to life. Pumps, compressors, vacuum pumps and even connected fittings can now be specified in such a way that this information can be read and used by everyone involved in the process. OPC UA Companion Specifications are also available to ensure interoperability between components from different manufacturers.

Digital solutions also score when it comes to leak detection: Acoustic cameras combine ultrasonic sensors with optical imaging to detect leaks in pipelines or compressed air systems. Manufacturers such as FLIR are taking this a step further by integrating gas analysis into so-called gas cameras. These cameras not only detect leaks, but also identify the corresponding gas. Today, such cameras are small enough to be available as handheld devices, but they can also be permanently installed.

**A Danger Foreseen Is Half Avoided**

In addition to efficient drives and precise controls, more and more suppliers are using methods such as software-based anomaly detection, in which an algorithm examines current operating conditions. Based on these values, the software can make predictions about future malfunctions or anomalies and suggest appropriate measures. According to the VDMA, predictive maintenance can prevent around 70% of unplanned shutdowns. There are growing calls for the integration of condition monitoring — even for relatively simple components such as valves and even seals. This is not easy when the necessary sensor technology also has to work in the Atex area, for example. Even mechanical seals are making the leap into the digital world with products such as EagleBurgmann's wireless Smart Seal sensors.

Operators are increasingly unwilling to take risks, especially when dealing with explosive or environmentally hazardous substances. Sealless magnetically coupled pumps are therefore in great demand, especially because manufacturers such as Richter Chemie-Technik supply them with wetted parts or linings made of PFA or PTFE. However, because the magnetic force can only transmit a certain amount of torque, a full-length shaft is sometimes essential — this can be made even tighter, for example with leak-free mechanical seals from EagleBurgmann. The nitrogen-flushed sealing solutions are used in compressor stations for natural gas pipelines, where they prevent the escape of the greenhouse gas methane.

**Hydrogen and Carbon Capture: New Media for the Energy Transition**

Of course, pumps & co. will also be needed in the energy and raw materials value chains of the future: hydrogen, for example, as the smallest molecule in the periodic table, places special demands on pumps and compressors. The gas is highly volatile and can penetrate the crystal lattice of metallic materials, leading to hydrogen embrittlement.

It is therefore important to take a close look at the components used — from the pump to the fittings. After all, requirements such as specific materials and surface qualities are often not specified. For this reason, pump manufacturers such as KSB are currently drawing on their expertise from "classic" hydrogen projects in the chemical industry, even though not every detail has yet been clarified. For example, developers complain that there are still unresolved questions about hydraulic balancing or the operation of pumps in different hydrogen processes.

This also applies to the size of future hydrogen projects: While typical modular container plants currently produce around 10 m³ per hour, large world-scale plants can produce 800 m³ and more — as can the operating pressure, which can range from 6 to 40 bar. Depending on the size, sealless standardised chemical pumps, diaphragm valves or butterfly valves made of corrosion-resistant materials or with appropriate coatings are used.

Also on the pumping experts' agenda are processes for CO2 capture and utilisation or storage (CCS or CCSU). For these processes, pumps must cover a wide range of applications, be ready for use in a short time and be able to withstand very high pressures and temperatures, the manufacturers explain. Then there are the challenges of CO2 as a medium, such as its volatility — carbon dioxide exists as a gas phase at ambient pressure — which requires a suitable seal.

However, these challenges can be overcome: This is demonstrated by the column internals for amine scrubbing that fluidics specialists such as Sulzer are supplying for large-scale demonstration projects for CO2 capture, as well as the high-pressure pumps and valves — such as double-eccentric butterfly valves, cage-guided single-seat control valves and diaphragm valves — that KSB, among others, offers for handling liquid CO2. Lewa, for example, uses diaphragm pumps for the injection of carbon dioxide or hydrogen sulphide, as the toxic H2S in particular is difficult to pump due to its high vapour pressure and poor lubricating properties.

**Exploiting Energy and Efficiency Potential**

Then there is LNG: in the short term, liquefied natural gas is expected to satisfy Europe's hunger for energy and compensate for the loss of supplies from Russia. At $27 billion worldwide, more than ten times as much money will be invested in gas projects and terminals in 2022 as in 2020. This also includes the corresponding fluidics, especially since the extreme conditions of the cryogenic medium require high-performance components.

For example, gas terminals and refuelling stations are just as dependent on cryogenic pumps and valves as ship refuelling. The components must be able to withstand temperatures below -160°C and safely contain the explosive vapours produced during evaporation. Single or multi-stage centrifugal pumps are used for this purpose, but the extreme conditions make seal-less designs such as canned motor pumps more suitable.

For good reason, explosion protection and Atex certification place high demands on the components used. LNG regasification in particular requires suitable safety valves due to the extreme pressures involved. For fluctuating flow rates, side channel pumps designed for low-viscosity media, such as those from Sero Pump Systems with their wide speed ranges, are best suited. With the right components — and as production becomes more connected and digitally supported — operation and maintenance can be streamlined and run with less manpower, say fluid experts.

After all, the process industry is now also concerned about whether there will be enough skilled workers in the future and whether companies will be able to pay them. Particularly in the labour-intensive service sector, but also in manufacturing and increasingly in development, more and more companies are complaining about the difficulty of filling positions. Although the number of employees in the mechanical engineering sector recently rose slightly by 1.7% to a total of 1.02 million, the German Engineering Federation (VDMA) estimates that there are still 1,400 vacancies at its member companies.

**PFAS Ban: How to Deal with the Sword of Damocles?**

In fact, no one doubts that pumps, valves, actuators and compressed air components will continue to be needed in the future. Industrial pumps alone have a global turnover of around $70 billion a year — a figure equivalent to twice the GDP of Estonia. But whether they will be as reliable and safe in the future as they are today is by no means a foregone conclusion — at least in Europe: the EU's planned ban on so-called persistent chemicals or PFAs (perfluorinated and polyfluorinated chemicals) covers much more than outdoor clothing, cosmetics, Teflon pans or pesticides. ECHA's proposed ban covers all substances containing at least one CF2 or CF3 group. FKM and other fluorinated elastomeric plastics such as PTFE, FFKM, FEPM, PFA or FEP are also PFAS by definition and are therefore likely to be banned from 2026.

As a result, some of the most important materials for seals could disappear from the market. If this ban goes ahead as planned, the consequences would be dramatic: there are currently no alternative materials that could replace PFAS seals. The impact on industry and society would be significant: it is estimated that around 80% of industrial production would be affected. Not only that, but water and energy supplies, as well as the health sector, would also suffer massive problems. As a result, insiders expect the law to be watered down, if at all. However, it is virtually impossible that ECHA will back down completely. Regardless of how the PFAS issue develops, the fluid handling industry cannot ignore it.

The only option for manufacturers is to take the bull by the horns: suppliers want to become less dependent on the chemical industry by offering a diversified range of products. But this will also require innovation and ideas that go beyond fluidics, which is already highly developed. This includes digital services as well as customised solutions to meet market and regulatory requirements close to the customer.

**Caught Between Order Backlog, Supply Bottlenecks and Energy Shock**

Energy price shock, stalled supply chains and the war in Ukraine: things are not going well for the European industry. So it comes as something of a minor miracle that the German Engineering Federation (VDMA) says 2022 has been “much better than expected” for manufacturers of pumps, valves and fluid technology. But that can mean a lot: The raw figures in the VDMA report "Pumps and Compressors for the World Market 2023" show that, despite the optimism, orders (-3%) and sales (-2%) were down on the previous year. At the same time, the order backlog built up during the Corona years is slowly disappearing — an advantage for operators, but one that leaves suppliers dependent on new orders.

But business as usual is becoming less and less an option: even hitherto reliable markets such as China seem unable to keep up with the tremendous pace. While the Chinese are once again demanding more pumps (+8%), more and more suppliers from the country are entering the German and European markets with high-quality products. As a result, pump imports to Germany increased by a respectable 12%. The picture is similar for compressed air technology, with exports to China up 17% and imports up 14%.

**Faltering Supply Chain: Electronic Components Continue to Cause Problems**

While in previous years incoming orders exceeded actual sales — a typical indicator of supply bottlenecks — these are beginning to fade into the background. Standard parts such as lids or sheet metal are largely back on the market, but electronic components such as chips or semiconductors are still a cause for concern. This is not so much the case for ball and butterfly valve manufacturers, but certainly for actuator suppliers — especially as the trend towards digitalisation, connectivity and modularisation continues unabated. Companies such as Samson, for example, are taking advantage of the extension of the Ethernet standard to include the Advanced Physical Layer (Ethernet-APL) to equip positioners with Ethernet-based Profibus communication with integrated valve diagnostics.

However, this kind of added intelligence will only work if the sought-after electronic components, especially semiconductors, are available in time. Experts do not expect this to happen before the end of 2023, which poses a challenge for pump manufacturers in particular, who have high hopes of integrating their equipment into cyber-physical systems.

There is little doubt that the fluidics of the future will evolve beyond mere components such as pumps or compressors to digitally enabled system solutions. Whether it is AI helping to design pumps, algorithms enabling condition-based maintenance, or 'pump as a service' subscriptions complementing current business models, a future without pumps, valves or compressors is unthinkable.

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