Piston diaphragm metering pumps have been indispensable for many years in the wastewater treatment process.

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Advanced development of a classic product – piston diaphragm metering pumps now monitor themselves

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Piston diaphragm pumps are often the first choice for metering liquids in industrial processes. They are extremely sturdy, resistant to wear and need little maintenance. They have been used for decades in areas as varied as power stations, the chemical or paper industry as well as for water and wastewater treatment. Up to now, they have been monitored through central system control. More recently, they have been able to monitor themselves thanks to their own control systems. This means that it is possible for CE declarations of conformity to be issued not only for individual units but also for complete metering stations.

The piston diaphragm metering pump was developed in the 1980s, mainly for dispensing chemicals, which can be both highly viscous and aggressive and/or abrasive. This type of pump is an oscillating positive displacement pump. These combine the high metering precision of a reciprocating pump with the optimum sealing characteristics of a diaphragm pump. Large-area, diffusion-proof diaphragms guarantee the long service life of the metering pumps. Up to now, different sensors have been attached to the pump for monitoring and control. They delivered their data to a control unit for checking and evaluation. This monitoring and control was the task of a higher-order control system for which the pumps were just a few of the many units in a large system. The correlations were linked in the control system. This way, it could be determined whether a pump was running correctly or where the problems were.

Of late, however, it has become possible to take the task of monitoring the pump away from the control system, thus reducing its load. The reason for this is that the pump is no longer controlled externally, but at the pump itself. A control unit with operating terminal is attached to the pump for this purpose. The device makes intelligent monitoring possible, which evaluates and displays all sensor data for the pump on the spot. The result of the internal evaluation is the only data transmitted to the external control system.

Fast integration and simple interfaces

This largely independent pump control has two decisive advantages. Firstly, such an intelligent system can be integrated very quickly and easily into an existing system. Very little programming has to be done in the higher-order control system to monitor a new pump. The required IT effort is minimal because the pump only signals the operating data and status to the control system. The second advantage is the simplification of the interfaces. The pump manufacturer is familiar with its devices and the sensors installed in the pumps. It knows how the pumps work correctly and how they can be monitored. By contrast, the higher-order control systems are developed by other companies. They are experts in programming, IT or control, but they are not specialists in different pump types and different sensors. Communication is thus greatly reduced at the interface through the in-pump control, since the pump monitors itself.

Piston diaphragm metering pumps combine the high metering precision of a reciprocating pump with the optimal sealing characteristics of a diaphragm pump.

Flexible control

The dispensing capacity of the piston diaphragm metering pumps with the new control can be specified by changing two manipulated variables. Adjusting the stroke length changes the volume of hydraulic fluid displaced per stroke in the dispensing piston. Adjustment of the stroke volume takes place linearly from 0-100% at standstill or during operation. In addition, the stroke frequency is changed as the second manipulated variable through the motor speed.

The controller mapped in the software controls the motor frequency by comparing the setpoint delivery rate with the actual flow. If the stroke length is adjusted, the controller adapts the

Source: Alltech Dosieranlagen

Fig. 1: Piston diaphragm metering pump with a new type of control

frequency to prevent a change in flow. If the motor frequency becomes too large or too small, this is countered by adjusting the stroke length. An optimum range is defined for the frequency. Shortly before the system moves out of this range, stroke length adjustment reacts until the frequency is back in the centre of the optimum range. The stroke length is changed electrically by the control via an actuator motor. The current position is recorded by a sensor. This allows precise settings to be made in advance using software.

The actuator motor carries out the very fine steps. Thus a high setting range and precise settings are guaranteed. The new control also monitors excess pressure and negative pressure, as well as numerous performance parameters. The piston diaphragm metering pump independently controls the specified metering quantity and monitors system pressure. All operating and fault messages are displayed, saved and signalled digitally. Since the new control has two analogue inputs, regulation of the metering capacity for phosphate precipitation, for example, can take place on the basis of the waste water quantity or the phosphate load.

Alternatively, only one analogue input can specify the setpoint value. An additional ß value can be set via the dosing pump display to evaluate the ratio. Flow is either calculated internally or can be attributed by an external MID (magnetic-inductive flowmeter).

The pressure in the piston is measured by a pressure sensor. The number of strokes, the current stroke length and the pump data stored in the control unit are monitored and the current flow is displayed. This is used as the actual value for the controller. In addition, the dispensing pump can also be adjusted for batch mode, where the quantity (delivery rate and pump output) and batch duration can be selected individually. In batch mode, the actual value of the flow is integrated after the start command until the set quantity (delivery rate and pump output) is reached. Once this is the case, the metering pump is switched off. It then waits for the next batch to start.

Source: Alltech Dosieranlagen

Fig. 2: Chemical storage and metering station for municipal and industrial wastewater treatment

Clear operation

The new control has a control panel for menu operation and parameter setting. The settings menu is divided into individual submenus to make simple and clear parametrisation possible. The control can work in both manual and automatic modes. In manual mode, for example, the required flow quantity can be set by pressing the enter key with the up and down keys. in automatic mode, the two operating modes “Flow” and “Batch” can be selected.

In “Flow” mode, the setpoint value for the delivery rate is either entered by hand, specified externally via up to two analogue inputs or optionally communicated via field bus. If both analogue inputs are selected, the resulting

delivery rate is calculated by the software. Release is via either the digital inputs or the field bus. In "Batch" mode, the user can enter a delivery rate and pump output per batch by hand.

The classical piston diaphragm metering pump is a pump suitable for universal use. It is characterised by high metering precision and a very high degree of operational safety. Depending on the industrial environment, users focus on different criteria.

Metering precision determines the consumption of chemicals

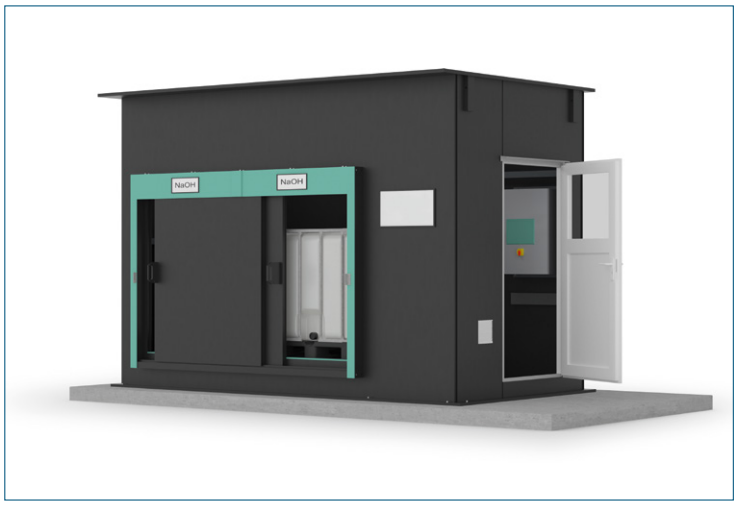
It goes without saying that the metering precision of the metering pump (better than +/–1%) determines the effectiveness of chemicals used in the production process. With the piston diaphragm metering pump, the stroke can be adjusted gradually and linearly from 0-100% during operation and at standstill. This enables precise metering of chemicals. At the same time, the metering setting is reproducible. Piston diaphragm metering pumps used in the chemical industry, for example, have to withstand corrosive and abrasive media. The temperature of the pumped medium or the ambient temperature of the metering pumps must be taken into consideration by the design. Monitoring equipment is essential in the chemical industry in particular, which makes high demands on operational safety.

The piston diaphragm metering pump independently controls the specified metering quantity and monitors system pressure.

Use in the paper industry

Thanks to their high metering precision, piston diaphragm metering pumps with their own control unit play a major role in the paper industry. This is because a wide range of different chemicals are used for manufacturing paper and corrugated cardboard. Precise metering of these is decisive for production. If there are deviations in the quantities of chemicals dispensed, this may impair the quality of the product. This will result in expensive faulty batches and could even lead to production coming to a standstill.

A wide spectrum of chemicals is used: sodium hypochlorite is used for manufacturing cellulose, for example, to remove the lignin which



Source: Alltech Dosieranlagen

Fig. 3: Storage and dispensing station for a neutralisation system with caustic soda, installed in a walk-in protective enclosure made of polyethylene

causes lignification of the cell from the wood fibre. Sodium hypochlorite is also used as a bleach to remove undesired colour from the raw material (pulp). Hydrogen peroxide removes printing ink from paper fibre and is therefore used for recycling used paper. Exactly metered dispensing leads to the correct concentration of chemicals dissolved in water and is the basis for optimum production results.

If there are deviations in the quantities of chemicals dispensed, this may impair the quality of the product. This will result in expensive faulty batches and could even lead to production coming to a standstill.

Polymers are also used for manufacturing paper. Polymers improve the retention properties in the dewatering process. Better retention properties lead to higher production quantities and reduce the energy costs during drying. Polymers also improve the addition of pigments and process chemicals to the cellulose fibre. The water used in the production cycle for paper production must be kept as clean as possible. Here, hypochlorite or biocide is used for disinfecting the water in the production cycle, for example. Numerous special chemicals are also used to influence the paper properties. These can be somewhat problematic for metering pumps in that they have a high viscosity or are highly corrosive or abrasive. However, the versatile and adaptive piston diaphragm metering pumps can be adapted specially to these difficult requirements.

Safety and reliability

Piston diaphragm metering pumps meet the high demands made on operational safety and reliability in industrial processes. One of the safety elements is a pressure relief valve in accordance with DIN EN 809 which is integrated in the hydraulic unit of the metering pump. This pressure relief valve only comes into contact with the hydraulic fluid, thus guaranteeing safe and reliable function long-term. Blocking or soiling of the valve by the medium pumped is thus excluded. If the intake or delivery side of the pump becomes blocked in the event of a fault, the pressure relief valve opens so that an excess load on the pump and pipeline system is guaranteed to be avoided.

Source: Alltech Dosieranlagen

Fig. 4: Metering station for sulphuric acid for use in the power station sector

Alongside functional safety, this special structure also means safety for operating staff, operating equipment and the environment. As soon as the pressure relief valve opens, the operator receives an acoustic signal or an additional electric alarm. Another advantage of this special pressure relief valve is that errors/faults on the intake side are also indicated. A double diaphragm system is an additional safety feature. This protects both the pump and production. Should the diaphragm rupture, the pump can be stopped and a fault message is generated – optically and electrically.

Use in power stations

For power station operators, the focus is on reliability of the metering technology and thus process reliability. Piston diaphragm metering pumps with intelligent control can thus often be found and in many different places in the power station sector – for cooling water handling as well as wastewater treatment and the purification of smoke gas. Metering stations for the metering of acids and alkalis are used in ion-exchanger systems for treating boiler supply water, for example. The chemicals are drawn from storage tanks with the aid of sturdy piston diaphragm metering pumps. The metering heads and diaphragms are made of acid- and alkali-resistant materials. The diaphragm metering pumps have a built-in safety valve and diaphragm rupturing signal systems.

With the mobile container solution, the pump is delivered completely prefabricated with all peripheral devices and can be set up at exactly the point in a system where it is required.

Metering stations in containers

The new independence of the piston diaphragm metering pump from higher-order control systems thanks to its own control makes the further development of the complete metering station possible: a mobile container solution. The pump and all peripheral devices are installed in a metal container. It is delivered completely prefabricated and can be installed exactly where required in a system. Modification or adaptation of the system infrastructure is thus unnecessary. This is a major advantage, in particular in complex systems such as those found in the

Approval in accordance with the Federal Water Resources Act (WRA) can be obtained for the whole unit, i.e. the independent metering station, including chemicals storage.

Source: Alltech Dosieranlagen

Fig. 5: Mother tank installed in a container with piston diaphragm metering pump

chemical industry, because retooling is very complicated and expensive in such operations. One example already in practical use: a client in the petrochemical industry relies on a tailor-made solution for metering chemicals for polyaluminium chloride for in-house wastewater treatment. This solution was manufactured and tested including a mother tank in a 20-foot container. The complete package was delivered; from planning to installation, including commissioning and training. There was no need to convert the infrastructure on the refinery grounds.

A mother tank is an integral component of a metering station. It is used for safely setting up and emptying IBCs (intermediate bulk containers) – standardised transport containers – and equipped with a safety bund. The mother tank has been approved by the German Institute for Construction Engineering (DIBt) and may be used for the pressure-less storage of substances hazardous to water. Mother tank and safety bund also have product certification from the Swiss technical inspection body (SVTI) of compliance with the rules of the Swiss Conference of the Heads of Cantonal Environmental Protection Offices (KVU).

The IBCs are placed directly on the tank by a forklift truck and then emptied completely into the mother tank. Even with a liquid reserve of 10–50%, the volume of the tank can accommo-

The functional principle of the piston diaphragm metering pump

- The drive and hydraulic unit are filled with a hydraulic fluid for hydraulic power transmission.
- The hydraulic power transmission between the drive and the metering diaphragm is set up via the hollow-drilled pistons of the hydraulic unit.
- The piston is not firmly connected to the drive cam and is returned to its zero position by the piston spring after the intake stroke.
- As a consequence, the pump drive is not damaged if the intake flow is blocked.

Source: Alltech Dosieranlagen

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Fig. 6: Piston diaphragm metering pumps on console in WRA-certified safety bund

date the contents of a new IBC. Hereby a continual supply of the dosing system can be ensured, which in turn implies a further advantage: the timing of the refilling process does not require permanent monitoring.

The metering station has been equipped with a detachable spray guard for special use in the refinery. This provides operating staff with additional protection against contact with chemicals. An important customer requirement was ease of operation of the system. For this reason, the metering station was equipped with flushing connections, calibration vessels and MIDs.

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