Flexible Measuring and Control in Reverse Osmosis Systems:

What advantages do modular multi-channel controller for central tasks in water treatment have

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Reverse osmosis systems play a central part in water treatment. In industrial applications, for example, reverse osmosis is used for purifying process water, producing drinking water and desalinizing seawater or for producing ultra pure or pharmaceutical water. In addition to these processes, which aim at reducing the concentration of the substances dissolved in the water, the beverage industry also uses reverse osmosis systems for increasing concentrations, e.g. in the manufacture of fruit juice concentrates or for concentrating the must in wine production.

Osmosis, a central active principle in nature, enables the regulation of water in cells and plants. If two fluids with different concentrations of dissolved particles are separated by a semi-permeable membrane, the difference in concentration is equalized by the physical process of diffusion until the concentration of the dissolved molecules is the same on both sides. Since the membrane allows only the solvent, generally water, but not the dissolved substances to pass, the osmotic pressure causes the solvent to move in the direction of the higher concentration of dissolved particles through the semi-permeable membrane.

Reverse osmosis makes use of this principle, but reverses the process. In a

concentrated solution which is surrounded by a semi-permeable membrane, a pressure is created which is higher than the natural osmotic pressure. This reverses the osmosis effect and the water is forced out through the membrane. The dissolved substances, which cannot pass the membrane, remain inside in a high concentration.

The membranes used in reverse osmosis are very thin, but have to be able to withstand high pressures – up to 80 bar in seawater desalinization, for example. Therefore, they are applied to a fluid-permeable carrier layer which can absorb the high pressure. The resulting unit is provided with a separating layer and rolled up to increase the density and ensure an optimal yield with minimum volume. The rolled “membrane cartridge” is then inserted into a tubeshaped pressure vessel. In large industrial reverse osmosis systems several of these membrane cartridges are usually used in combination, since the size of the units is limited due to design considerations.

General requirements in industrial reverse osmosis systems

To prevent the membranes from becoming clogged with solid substances floating in the water, these substances are removed by means of pre-filtering. Once a membrane cartridge has become clogged with accumulations of solids, it normally cannot be cleaned and has to be replaced. In addition, oxidation elements such as chlorine have to be removed prior to reverse osmosis, to prevent damage to the membrane by these chemicals. The chlorine compounds are used in the preliminary phase of reverse osmosis systems to prevent biological growth. Prior to the reverse osmosis process, they are removed by means of active carbon filters, after which the ORP value is measured. Compliance with specified pH values should also be monitored during the preliminary phase to prevent further chemical attacks on the membranes and undesired effects such as scaling or fouling. To prevent the precipitation of solids during the concentrating process, chemicals for antiscaling or acids are added by means of a ratio controller or pH controller.

Customized solution for monitoring and control tasks

Especially for these applications, the Fluid Control Systems specialist Bürkert developed the MultiCELL 8619 multi-channel controller. In reverse osmosis systems, the controller can be used for monitoring functions as a flow indicator, to measure the ORP value or percentage retention value. The 8619 MultiCELL can also be used for control tasks, such as regulation of the pH value and the dosing of chemicals and ratio control. The modular controller is adapted at the factory to the particular application and customer specifications. The standard version includes the user interface, the mainboard and AC adapter, two analog and digital outputs and two digital inputs. Six slots are available for connecting additional boards. The large, configurable graphic display with backlighting can display up

Back side of the Bürkert MultiCELL 8619 controller with SD card slot, mainboard (orange), signal input card for pH/ORP (white), signal input card for conductivity (green) and signal output card (black). The three free slots are protected by the metal plate

to four readings simultaneously. Further parameters and user-specific pages can be displayed by “scrolling”. The digital and analog signal outputs enable the transfer of process data and status signals. If more than two of these are needed, an output card with two additional digital and two additional analog outputs can be installed. All process values can additionally be stored on SD cards by means of an optional data logger package for computer analysis using any standard software package.

The blacklight display can display up to four readings simultaneously

“The modular design of the new controller makes it possible to implement numerous customized configurations for reverse osmosis systems,” explains Volker Erbe, Product Manager Sensors at Bürkert. “The uses range from single-channel measurement to complete monitoring of the water quality in reverse osmosis systems.” The best way to illustrate this is to describe a few typical applications.

Flow transmitter or controller

To begin with, the 8619 MultiCELL controller can be used as a mere flow transmitter. For this purpose, the only hardware needed is the mainboard; if required, an additional PID control can be implemented via software. The two digital signal inputs of the mainboard are used as pulse inputs for flow rate measurement. Depending on the task, the flow rate can either be simply measured and displayed or sent to a PLC via the signal outputs. With the optional PID controller software function, however, flow rate control is possible with two independent control loops. The two digital or analog signal outputs then serve as control signals for pumps or control valves.

Single-channel analysis transmitter

For use as a single-channel analysis transmitter the mainboard is equipped at the factory with a signal input card for pH/ORP or conductivity. If several values are to be processed, an additional input card is required for each value.

A typical application for single-channel controllers is pH neutralization in industrial waste water treatment. Depending on the set-point deviation, either acid or alkali is added. In addition to the mainboard, the controller requires a signal input card for the pH value. The flow rate measuring function is not activated, but this can be achieved by means of an optional supplement to the PID controller software. The two controller outputs for acid and alkali are generally implemented in the form of pulse frequency modulation via the digital outputs. The pulse frequency is adjusted as the set-point deviation increases. The controller function can be configured as a P controller (for static processes) or PI or PID controller (for dynamic processes).

The Bürkert MultiCELL 8619 is a versatile module for central monitoring and control tasks in water treatment systems

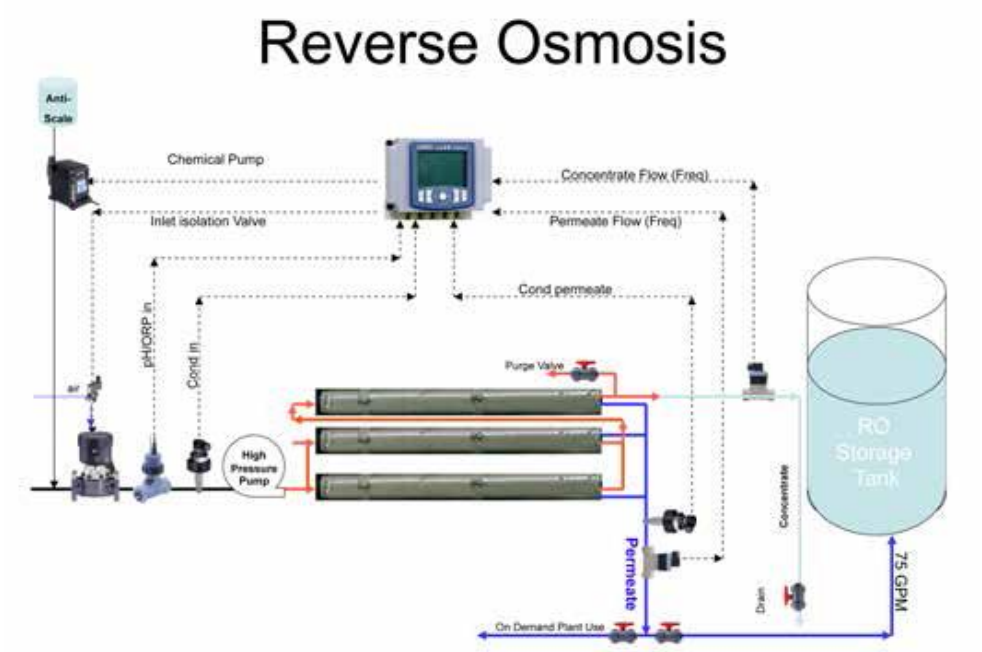
Conductivity measurement in ultra high purity water systems

A typical “ultra pure water skid” consists essentially of a reverse osmosis unit and an EDI module. For monitoring the water quality, a conductivity measurement is necessary upstream and downstream of the RO module and downstream of the EDI module. In addition, the temperature is measured downstream of the EDI module to ensure uncompensated conductivity monitoring with a separate temperature display in compliance with the USP standard if required. For this application the 8619 requires three signal input cards for conductivity and, for transfer of the signal to a PLC, one additional signal output card. Therefore, all parameters can be sent as analog signals. The temperature compensation often required for ultra pure water is already a standard feature of the unit.

Monitoring water quality

In industrial reverse osmosis systems, very high demands are placed on the water quality. Less than optimal quality, for example in beverage production, directly affects the flavour of the end product. Accordingly, numerous central parameters in the system have to be monitored and controlled. Especially important is the ratio of permeate to concentrate, the ion retention capacity of the unit, the pH value in the feed water and a minimum amount of chlorine in the supply. This means that the flow rate of permeate and concentrate, the conductivity of the feed water and permeate, as well as the pH and ORP values of the feed water have to be monitored.

For these extensive tasks the 8619 MultiCELL is expanded by adding two signal input cards for conductivity and two signal input cards for pH/ORP. If the process values are to be sent to a higher-level PLC, two additional signal output cards are also needed. The required software functions are flow rate measurement and the PID function.



Design of a reverse osmosis system with the Bürkert MultiCELL 8619 controller

The ratio of permeate to concentrate frequently is set manually by means of a manual control valve in the concentrate pipe. This can also be implemented as an automatic flow control, e.g. with a Bürkert control valve with top control, type 8802 continuous. The concentrate flow rate is then adjusted based on the feed water flow rate. The MultiCELL controller also monitors the ion retention capacity (% reject). If a value drops below the lower limit, the system has to be inspected. By adding acid the pH value is adjusted to a value which minimizes scaling and the danger of chemical attack on the membrane. Finally, the controller monitors the chlorine content of the water by means of an ORP measurement. If the value drops below a threshold, the active carbon filter function has to be checked and the filter in the preliminary phase of the system may have to be replaced.

Economical, flexible and universal

The multi-parameter 8619 MultiCELL can be used to execute practically all central control tasks in reverse osmosis systems with only one modular controller, which can be equipped with additional functions for the particular application. “The reduced parts range within the control and monitoring of reverse osmosis systems is advantageous in terms of maintenance, storage and employee training,” says Volker Erbe. If several units need to be configured identically, the configuration and parameter data can be optionally stored on SD cards for easy transfer to other units. This facilitates commissioning and also saves time.

The continuous control of all essential parameters in a reverse osmosis system ensures consistently high quality and an optimal service life of the membrane cartridges. That not only reduces the costs for the membranes themselves, but also prevents the unnecessary production downtime required for replacement.

Contact

Do you have questions or can we help you to optimise your systems with our modular multi-channel controllers? Than just contact us:

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