WHITEPAPER

Reduce Maintenance Costs – CIP Cleaning 4.0!

Whether in the beverage industry or the pharmaceutical industry, "Cleaning in Place" (CIP) is one of the standard cleaning methods for production plants. With fully automatic CIP cleaning, companies can reduce costs at many levels and therefore produce more economically. Optimizing the plants by using robust pH electrodes leads to lasting cost reduction.

CIP cleaning (Cleaning in Place) has been considered a standard cleaning method in the beverage industry for years. The basic principle for the cleaning process is optimized coordination of mechanical, timing, and chemical factors. Detergents and rinsing solutions are applied to the surfaces of plant components using a spray nozzle integrated in the plants. The movement of the spray nozzle ensures that the detergents completely coat all surfaces and therefore clean them.

The CIP cleaning process

Altogether, a CIP plant includes a concentrate tank, application tank, measurement and dispensing technology, and a heat exchanger. Acid is contained in a concentrate tank (e.g. 65 % nitric acid); lye is contained in another (e.g. 55 % caustic soda). Both concentrates are adjusted to the concentration of the application solution using water (e.g. 2.5 % for caustic soda) in so-called application tanks. The viscosity of lye increases as the temperature decreases – a feature that can become particularly inconvenient for the cleaning process during the winter. This is why the alkali tank is connected to a heat exchanger to maintain the temperature. In addition, tanks with water for rinsing and – depending on the application – one each containing disinfectants (e.g. peracetic acid), highly-purified water, or the option to use steam sterilization as a final process are also included in the CIP plant.

The cleaning process is divided into several process steps; different factors must be taken into account during each step. These include the pollution degree in the production plant and the manufactured product. Problems can occur, for example, due to cross-contamination during batch changes.

Measuring the conductivity and also the pH value is the focus during CIP cleaning. Depending on the application under certain conditions, inline pH electrodes are built into the process. These need to be able to stand up to CIP cleaning. The situation becomes interesting when, at the end of the cleaning process, steam sterilization of the plant occurs.

The role of pH value during CIP cleaning

The measuring priorities change depending on whether CIP cleaning is non-circulatory or stacked. In non-circulatory cleaning, all detergents and rinsing solutions are disposed of after cleaning. The conductivity in the return flow plays a less important role in this case as the pH value measurement has a higher priority. This is significant because the costs for water disposal depend on the pollution degree of the wastewater.

Furthermore, companies that dispose of wastewater in municipal sewage treatment plants are required to neutralize it. As a high pollution degree prevails in the collection tanks under certain circumstances and pH values and temperatures are likely to change, the electrodes used there are subject to extreme stress.

Moreover, there are also pH value measurement points in the process that must be replaced during CIP cleaning, depending on the application. So, for example, a process may require that the pH value in a fermentation tank is monitored but the tank is steam sterilized at the end of CIP cleaning. If a standard pH electrode is then installed there, it will demonstrate a much shorter operating life due to the regular extreme stress.

Glass electrode design

A pH electrode is designed as a combination electrode that unites a construction of glass with reference electrodes. On the glass electrode, hydrogen ions form a potential dependent upon the pH value while the potential of the reference electrode remains constant. The difference between both potentials, the measuring chain voltage, causes the sensor's electrical signal. A pH electrode must always be adjusted to the process conditions.

Factors like the production medium, temperature, pressure, and of course the expected pH value play a large role here. The individual components (membrane glass and diaphragm) of a pH electrode are selected according to these factors. JUMO tecLine electrodes are high-quality sensors for professional applications in process and industrial measuring technology. They are implemented as combination electrodes and are available in many variants for a wide range of applications. The new heavy-duty version of the JUMO tecLine HD pH is particularly robust and can be used even in difficult processes involving elevated pollutants and toxins or in oil-containing media at temperatures up to 135 °C and 13 bar pressure.

A newly developed and extensive PTFE ring diaphragm with improved structure enables a quick response time while simultaneously being largely impervious to greater pollution loads. The double-chamber architecture is a standard feature; its extended diffusion path prevents electrode failure in the event of penetrating electrode poisons. A large salt reserve in the reference system enables measurements with long-term stability.

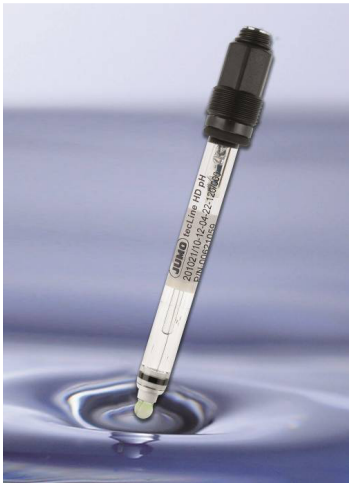

Fig. 1: JUMO tecLine HD – robust electrodes in a heavy-duty version

Intelligently combined – the analysis unit

The constantly increasing demands on more efficient and low-maintenance cleaning as well as fulfillment of hygienic requirements and environmental standards make high process reliability and its monitoring imperative. Using a multichannel measuring device, all CIP cleaning tasks are combined in one device.

The JUMO AQUIS touch S multichannel measuring device is characterized by the feature that all important parameters to be measured can be recorded with one device. In this manner, the JUMO AQUIS touch S has four analysis inputs that can be allocated to measuring conductivity in the flow and pH value in the return flow during CIP cleaning. The level of the storage tank and the turbidity of the return flow as well as the flow, for example, can be monitored using additional analog inputs. The multichannel measuring device has many binary inputs and outputs that can be used for such functions as to control flow using frequency measurements, monitor limit values, take over PID controls, and switch alarms. In this manner it is definitely possible for the device to take over controlling the valves for the individual cleaning steps depending on the measurement parameters.

The proven integrated calibration timers ensure trouble-free plant operation and reduce maintenance costs. Two wash timers are used to clean pH electrodes in regular cycles. Certain functions can be initiated repeatedly at an interval that can be pre-determined. Wash timers, for example, can actuate binary outputs to activate a cleaning process in the plant. As high a measurement certainty as possible is guaranteed through regular cleaning of the sensors. The calibration timer regularly reminds the operator to recalibrate the sensors. Corresponding alarms and event list entries can be individually configured. A calibration logbook in which all successfully completed calibration processes are recorded along with the date, time, and numerous other details is available for analog inputs IN 6 to IN 12. In this way, the plant operator always has an overview of the calibration history of the analysis sensors.

All measurement data can be recorded and saved with the additional recording function. The great advantage is that the device can also fulfill official reporting obligations in this way. Using both the JUMO PCC and JUMO PCA3000 software packages, the registered data can be transmitted via Ethernet to a database and saved there.

The standard practice is to control all data in a central PLC. This is often not designed for the large amounts of data and reaches its performance limits over time. Using a multichannel measuring device also provides advantages here because it removes the burden from the PLC, increasing its performance.

Fig. 2: JUMO AQUIS touch S with process screen for CIP cleaning

Summary

The use of robust JUMO tecLine HD pH electrodes for CIP cleaning can increase the service life and reduce maintenance costs. A pH electrode must meet the respective requirements of its operating location to deliver reliable values. The selection of membrane glass and diaphragm are of vital importance in this respect. The interaction between the pH electrode and the intelligent JUMO AQUIS touch S multichannel measuring device provide an optimized, all-encompassing solution for controlling the entire CIP cleaning process as a result. The intelligence of the device helps the user to analyze and optimize his process in detail, reducing costs in the long term.

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