Essential cleaning process monitoring

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Monitoring the performance of cleaning-in-place (CIP) processes is an important tool for effective cleaning management and ensures the efficiency of this critical activity. Within the range of monitoring targets turbidity is a parameter that is playing an increasingly important role next to conductivity in cleaning and phase separation.

A means of measuring turbidity and conductivity is indispensable when the solid material content needs to be measured and the presence and levels of alkalis, acids and water, or where un-dissolved soiling must be detected. A combination of turbidity and conductivity allows individual cleaning stages to be separated, permits reliable separation of production and cleaning when pressing out the contents of the product pipe-work, and also allows individual products to be distinguished.

You will find the use of phase separation in various areas of the dairy or liquid product processing:

- CIP-return line to separate the phases of flow of the cleaning solutions and the rinse waters.
- When draining (flush-out) a production plant for switching over between product tank and feed tank and/or waste water and other media.
- For separating milk and rinsing water in the return line.

In these main areas there are basically four options for phase separation:

- Manually by way of a sight glass (only possible under certain conditions).
- Automatically by way of a time control.
- Automatically by way of volume acquisition.
- Automatically by means of conductivity and turbidity.

There are a number of advantages and disadvantages with these alternatives,

Manual switch-over and time control, for example, require lower investment but they can involve considerable losses in the subsequent costs of plant operation duration of 10 years. For example if only 10 litres of product is lost per phase change and there are four phase changes per week, a total of more than 10,000 litres of product will be written off over five years.

A system with a nominal pipe width of DN65 will contain 10 litres in 3m of pipe and a flow velocity of 1.0m per second means that 10 litres disappear in just about three seconds.

With the change-over by means of time control a certain safety time interval must be given due consideration in order to prevent too much water from getting into the product tank.

Better results in terms of product loss are achieved with change-over using volume acquisition than with the time controlled method. Depending on the plant, however, the volume acquisition system has to be very sophisticated and consequently more expensive.

Particularly in larger installations where several tanks are connected up to one production plant, the emptying of a plant with water and the change-over as soon as the plant is empty is complicated to calculate because the piping routes and the tank volumes are different.

Moreover, possible inclusions of water still in the plant are not recognised.

Left, the itm-2 relative turbidity meter and, right, the ilm-2 inductive conductivity meter. Each has a matching EHG measuring point.

A cleaning station with eight CIP-lines. By using Negele's ilm-2 conductivity meter, a sure separation of different cleaning solutions is possible.

Cost-optimal solution

The use of conductivity and turbidity sensors to control phase separation is a cost-optimal solution. The sensors, which are mounted at a short distance upstream of the switch-over valve, switch over exactly and precisely at the pre-set product concentrations. Water inclusions are identified immediately.

Planning and start-up costs are low because the switch-over point is independent of volume and time.

This also ensures maximum safety and reliability and prevents unwanted water in the product.

On the CIP return line during the phase separation of the cleaning media, the most important point is to identify the media flowing back from the plant and to direct them into the correct storage tank (lye, acid, water).

Based on their respective conductivity, these media can be differentiated. Depending on the conductivity of the medium in the return line, the medium in the piping can be identified and the subsequently arranged valves are set in such a way that the lye is sent into the lye vessel, the acid into the acid vessel and the water into the stack tank.

A most important factor for a low-loss operation is the reliability of the switch-overs always happening at the same point in the flow cycle. This means that good reproducibility of the conductivity measuring unit as well as a rapidly functioning temperature compensation based on the various medium temperatures is essential.

The degree of mixing of the various cleaning media and, therefore, the consumption of expensive cleaning concentrates depend on these two factors.

The user can save hard cash by selecting the right monitoring equipment in a cleaning installation,

The points of the greatest importance for phase separation in a CIP system are, without doubt, high reproducibility and the shortest possible device response time. Without these it is not possible to guarantee reliable cleaning or save expensive cleaning agents.

The ilm-2 conductivity meter from

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Negele, for example, completely satisfies these requirements. The absolute conductivity of all liquids changes with temperature, and for this reason conductivity meters initially calculate back from the conductivity actually measured at the sensor, using a factor that depends upon the particular medium, to obtain the relative conductivity at a temperature of 25°C. This factor is known as the temperature coefficient (TK).

It describes the percentage change in conductivity of a medium for each Kelvin degree, as a proportion of its conductivity at 25°C. Water and other watery liquids have a figure of around 2%/K, which corresponds to the basic setting of the ilm-2.

It follows from this that any conductivity meter requires a temperature sensor in order to compensate for the temperature response of the medium concerned. A temperature sensor of this sort is already integrated into the ilm-2 conductivity meter.

When switching between two cleaning phases, the speed of this temperature compensation is the factor of the greatest importance.

If the device reacts here very slowly, then the process of switching between two media at different temperatures takes an unnecessarily long time, and incurs costs. The ilm-2, with an average 50% response time of just 1.2 seconds, saves the user hard cash.

For example in a typical phase change from rinsing water (at 20°C) to alkali (at 80°C), a slower compensation for temperature difference would give a conductivity reading lower than it should be and the return to an accurate indication of the actual conductivity of the alkali would be delayed (Fig. 1).

If the measurements of such changes are rapid it is easy to see that the quicker switching of processes makes it possible in this example, to use less cleaning agent.

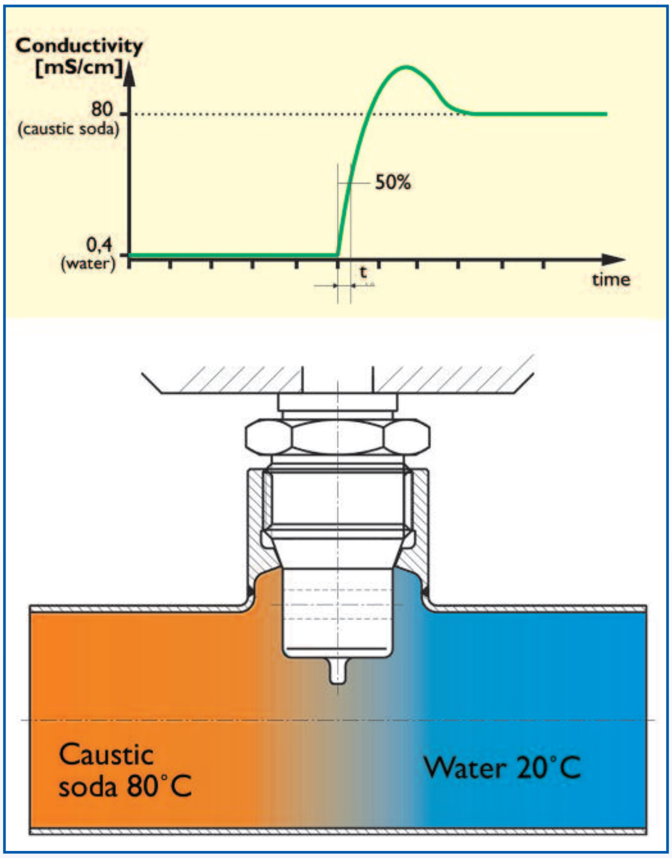

Fig. 1. Diagram illustrating the change in the conductivity at a phase change.

Consistent reproducibility

Consistent reproducibility is also an important factor because it guarantees reliable phase separation so that the changeover always takes place at the same point ensuring that the cleaning performance is maintained.

This reduces the need for re-cleaning resulting in further potential savings in cleaning agent.

This kind of meter provides further potential savings by using more cleaning agent. This may seem to be a conflicting statement, but the ability of the meter to measure the conductivity and thereby the strength of cleaning agents enables addition of precise quantities of highly concentrated cleaning medium to the existing mixture. This again ensures first time effective cleaning. A conductivity meter such as the ilm-2 can be used to automate this process which makes the reproducibility of the device again very important.

The system's dosing response to measured changes are only as good and as consistent as the measurements themselves.

With its 11 measuring ranges, and a reproducibility of <1% this unit offers the means of achieving a smooth, economical, and optimum operation of a CIP process.

In contrast to some alternative conductive measuring systems the inductive measuring method employed here has the advantage that the measuring tip is not exposed to the wear, tear and erosion caused by the pipe contents.

This sensor is fitted directly into the CIP pipeline through just one hygienic, welded G1" socket and its unique design ensures a clean, smooth junction within the pipe.

If, as well as separating different cleaning phases (alkalis/acid/water) it is necessary to separate the flow phases according to suspended solids, or to detect solid material, then the installation of a turbidity meter is very effective.

This is of particular value if product residues or other forms of soiling need to be detected in the cleaning agent, or if filters are to be monitored. When pigging or pressing out the product from the pipelines before cleaning the change from product to water can be detected reliably by means of a turbidity meter.

In all of these cases, reproducibility of the measurements is more important than the absolute measured value itself. It is of much greater importance that there is a consistent reading level which will always switch the process at the same point; the absolute value at the point where switching takes place is not, on the other hand, relevant.

Consistent reproducibility is the most important criterion for reliably achieving high quality standards and for working economically.

For this kind of relatively straightforward measuring task it is not therefore necessary to use expensive absolute instruments working with standardised units of measurement such as the 'NTU'.

It is sufficient here to use an economical relative measuring device offering high reproducibility, such as the itm-2, which uses an infra-red backscattering process to take measurements in units of %.

Reliable combination

A combination of turbidity and conductivity allows the user to acquire all the parameters relevant to the cleaning process, and therefore to optimise the cleaning process while reducing costs.

A particularly straightforward and economical solution is for example achieved by the combination of Negele's ilm-2 conductivity meter and the itm-2 turbidity meter.

It allows individual cleaning stages to be separated, permits reliable separation of production and cleaning when removing the contents of the product lines with water, and also allows individual cleaning products to be distinguished and measured.

A quick, economical, and high quality technique for fitting the two devices uses the EHT pipe T-pieces (Fig. 1) that can be easily integrated into the existing pipe work through an orbital welding technique.

This method of fitting is particularly useful for small pipe diameters where it may be otherwise difficult to weld in a cylindrical socket.

The ilm-2 can thus be integrated, as a pre-assembled measuring point, and the itm-2 turbidity meter can, using this type of fitting, be installed into a pipe diameter of just DN 25.

Retrofitting into milk pipes is also quick and economical with the aid of a wide spectrum of available adapters such as Varivent, TriClamp and many others.

Significant savings

The combination of conductivity and turbidity has demonstrated its value in practice over a long period and installations in CIP stations with eight lines is not unusual.

In such installations the conductivity meters reliably measure and control the phase separation of the different cleaning media.

The turbidity meters distinguish between the various products such as milk or yoghurt and cleaning solution and, therefore, provide the process with an important switching criterion for distinguishing between the production phase and the cleaning phase, as well as between the individual products.

A case study based on an initial loss of 20 litres per phase change for a weekly rate of four changes shows a potential payback on investment within eleven weeks and a £28,000 saving of product loss over five years. Both devices were developed with the intention of achieving the highest possible reproducibility from a measuring technique that does not generate sensor wear and are, therefore, ideally suited, either individually or as a combination, for any cleaning plant.

The fact that both devices can be fitted easily, using just one hygienic welded socket each, means that assembly too is not unnecessarily difficult and valuable time is saved.

In addition, the significant reduction in servicing costs arising from wear and ageing of the sensors are an important cost element alongside acquisition and commissioning costs when selecting this equipment. n

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