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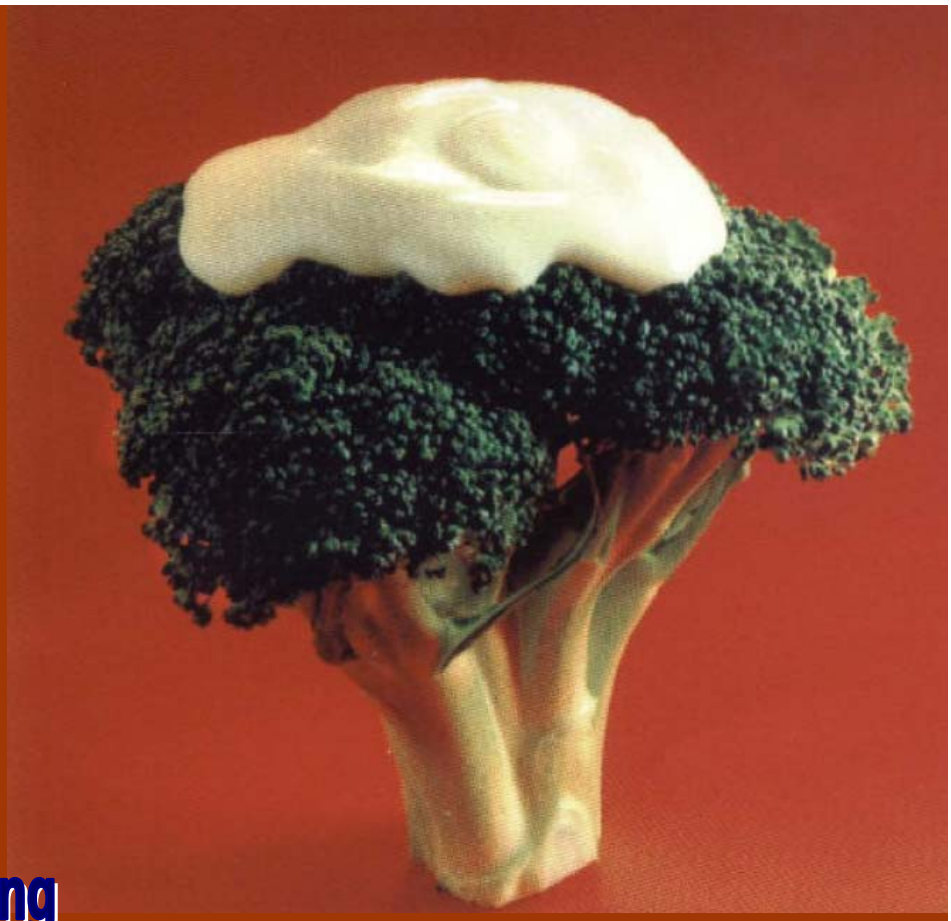

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Glassless pH analysis using Isfet sensors

Optimum texture using starches which swell in cold water

Plus SPECIAL FEATURE HYGIENIC DESIGN

No Glass

Online analysis of milk using ISFET Sensors

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Durafet II is a pH sensor suitable for use in industrial applications. Measurement is based on an Ion-Sensitive Field Effect Transistor device as an alternative to traditional glass style pH electrodes. The advantages of this sensor over glass pH electrodes are a faster response time even at low temperatures, greater robustness due to the fact that it contains no glass, and also negligible acid and base errors. With these characteristics, the sensor is evidently suited to use in milk processing.

In the manufacture of milk products, measurement of the pH value of the raw milk at the process intake is a key parameter. In this specific case, the milk is delivered every half an hour and pumped into large storage tanks. Previously, a "grab" sample has been taken from each delivery and tested in the laboratory to determine its pH value. Owing to the inevitable time lag between the sample being taken and the results of the analysis being available, the whole quantity in storage must be discarded if the measured pH value lies outside the permitted acceptable limits.

Here the implementation of online pH measurement presents clear ad-vantages. Online measurement makes It possible to validate the quality of incoming milk pH values prior to use in the process. Another benefit of direct benefit of direct in line measurement is that the workload involved in carrying out pH analyses in the laboratory is reduced to a reasonable level. There are essen-tially two obstacles to online analysis in this application using con-ventional pH sensors. Since measurements are taken directly from the milk, the use of glass is out of the question – in the event of a sensor being defective or breaking, there would be too great a risk of the milk being contaminated by splinters of glass. The milk is also delivered at low temperatures at which conventional glass sensors have slower response times.

Illus. 1: pH measurement point with Durafet II sensor in casing

Illus. 2: Sanitary pH sensor in casing

Advantages of the Durafet II ISFET sensor

These obstacles can be circumvented using Honeywell's Durafet II pH sensor. A semiconductor chip functions as the pH-sensitive measuring element - there is no need to use glass in the sensor. In addition to this unique design feature, the measurement system adopted has additional advantages that are due primarily - in comparison with conventional glass sensors – to the difference in chemical interactions between the sensor and the medium to be analysed.

These interactions can best be explained if one considers the measurement system used in an ISFET pH sensor. In conventional field effect transistors (FETs), the current between drain and source is controlled by the application of an applied voltage at the gate. In a FET intended for use in pH measurements, the gate is used as an electrically insulating, ion-selective film. This film is in direct contact with the medium to be analysed. With this arrangement, the medium itself acts as the gate. The FET is activated, and a varying electrical potential is generated based on the electrical potential of the media being analysed. In summary, the ISFET junction responds to pH of the media analogous to that of glass pH electrodes. As an example, if solution pH increases by one pH unit the potential at the gate / solution interface becomes more negative by approximately 60 millivolts.

With conventional sensors there is also the effect of the deterioration of the pH electrode glass envelope, often resulting in frequent pH sensor replacement. In high alkaline applications, errors caused by the interference of other Ions in the media (typically Sodium Ion) can also present a problem for the end user. The nature of technology used in ISFET pH measurement significantly reduces interference of this type. Marked changes in the temperature of the medium and the relatively low temperature of the milk do not adversely affect the accuracy of the

measurement, or the electrode response time.

Non-glass pH electrode technology facilitates direct on line / in line / in process pH measurement with very little risk of process contamination.

Hygienic design

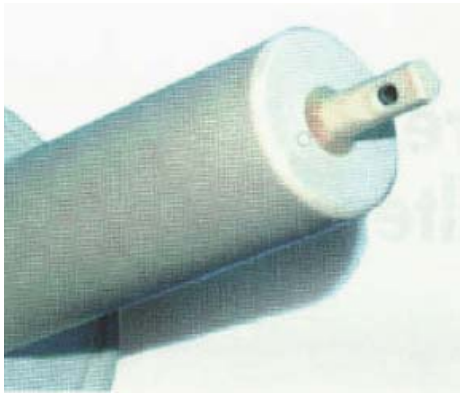
To meet hygiene requirements and to minimise changes to the existing process, the customer selected Honeywell's model 7794 Sanitary Durafet II pH sensors with a 1.5" diameter process flanges. These sensors are made of high-performance food-grade polysulphone plastic. The process flange forms an integral part of the electrode body. The body (whose surface roughness is less than 0.8 µm) is designed specifically to meet hygienic requirements to 3A standards.. Honeywell's unique method of sealing the ISFET measuring electrode and also the ceramic reference junction into the electrode body ensure that the integrity of the sensor maintained.

The only change implemented by the customer was to install T-pieces with 1.5" tri-clamp flanges on the existing stainless steel pipes that transport the milk. The sensors are placed directly in the stream of the medium, typically under pressures of approx. 6 bar. The sensor signal is analysed by the DirectLine DL 421 pH transmitter. The DL421transmitter module enables a simple and cost – effective method of converting measured pH values to 4-20 milliamp signals for end user monitoring and control.

Operated with just three buttons

The DirectLine DL421 pH transmitter uses 2-wire technology together with the latest digital technology. The robust and watertight plastic casing with IP 66 protection can easily be installed in small areas owing to its compact size. The DL412's output is in the form of a 4.20 mA electrical signal, which is not vulnerable to interference. The parameters are set, and the module operated, using just three buttons mounted on the transmitter front face. Settings and operational status are indicated by an LCD display also mounted on the transmitter front face.

When configuring the unit, messages are displayed on the LCD indicating the status of the required operating parameter. Inbuilt software allows for



Illus. 3: The measurement surface on the Durafet II sanitary sensor

sensor problem diagnosis.

Integral buffer recognition values enable calibration to be carried out quickly and simply. After each successful calibration of the sensor, the display shows the offset and percentage theoretical slope of the sensor. This diagnostic information makes it easy to assess the integrity of the sensor performance.

The ease of calibration and the convenient user interface with only three buttons in particular, were decisive factors leading the user to choose this solution. For simplicity of calibration, the DirectLine pH transmitter is mounted directly beside the sensor using a din style remote mount bracket supplied with the unit. The transmitter is connected electrically (4-20 milliamps) to the customers control system by a loop-powered cable.

For the purposes of regular checking and calibration in this particular application, the sensor is taken out of the process and taken to a calibration station along with the attached sensor cable along with the DL 421 pH transmitter. This needs to be done because, given the confined spaces, the sensor cannot be inspected directly at the measurement point.

It may be that in other applications at this customer site, the conventional method of on-the-spot calibration and cleaning will be carried out.

The Model 7794 pH electrode remains in the pipeline when process cleaning is carried out.

Because of this, consideration needs to be given to the electrodes resistance to highly acid or alkaline cleaning products at relatively high temperatures. CIP (clean in place) cleaning puts the greatest wear and tear on pH sensors, since typical CIP solutions at temperatures around 85º C not only corrode conventional glass electrodes but also markedly affect the lifetime of ISFET pH sensors.

There are to ways to achieve acceptable sensor lifetimes. On the one hand, the sensor can be taken out of the process during cleaning, by means of a manual or automatic device. This means however, that the sensor is not cleaned together with the process – a separate cleaning procedure needs to be carried out. The second option is to make the Semiconductor chip even more resistant –considerably so– to chemicals such as NaOH. This is amore technically demanding approach.

Positive experience in day-to-day operation

Online pH analysis has been in use with this customer for over one year. The user's expectations have been confirmed by their experiences gained over this period. The sensor responds quickly to changes in the process pH and shows good values for electrode slope and zero point. The ease with which the Model 7794 Durafet II sanitary pH can be installed and removed combined with easy-to-use DirectLine DL421 with its integral display and function keys, won over the customer.

Illus. 4: DirectLine DL421 pH value measurement converter