Better process control

Improve Dairy Processing and Quality Control

InPro X1 In-Line pH Measurement
A History of pH Measurement

- 1910s: first glass pH electrodes
- 1950s: Dr. Werner Ingold combined reference and measuring electrode
- Steady development of tailored solutions based on glass
- Solution based on enamel
- IsFet technology
- 2022: The X-Chip – A completely new technology
Challenge: Measuring pH in Dairy Applications

Is it possible to decrease maintenance costs while also lowering the risk of off-spec product or recall?

How will our daily CIP procedure affect an in-line pH sensor’s performance and lifetime?

How can I further improve process yield and product quality?

Is it possible to implement safe in-line pH measurement and eliminate grab sampling?
Actual Situation

How is pH measurement used today

The importance of pH is so high that inline sensors are used

- Glass sensor: accepting the risk of losing a batch in case of breakage
- IsFet sensor: either accepting the loss of the sensor after cleaning or using a retractable housing
- Enamel sensor: accepting high cost and slow recovery after CIP

Standard procedure, pH is measured in a sample, at line, or in the lab

- The sample varies in temperature
- Fermentation might go on in the sample
- Oxidation might impact the pH
- Separation is happening
Differentiation between process automation and quality controls

- The effort to measure pH inline so far was high
- If the process control really needed the pH information, some used IsFet technology or even took the risk to use glass sensors
- The majority chose to take samples and try to improve their process based on this information
- It is important to differentiate between Quality Control and Process Control
  - Quality control checks the final result of a process and releases the product if it is fine, based on a sample. Improvement is only at the next batch possible. If the quality is bad, costs arise to rework or dump the product.
  - Process control is a closed loop with the target to detect deviations immediately and react to them. Inline measurement helps to avoid rework, losses, and slow processing.
- With a new technology dairy companies can achieve real inline process control and automation
Test: InPro X1

酸度基準：1.33～1.37%

発酵開始時
発酵終了時
R-1バルクスターター 添加率2%
11月10日培養 T512(凍結菌LOT:230523)
## Specifications and Certificates

### Technical data of the InPro X1 HLS

<table>
<thead>
<tr>
<th>Measurement Parameter</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISM (Digital) or Analog</td>
<td>ISM (Digital)</td>
</tr>
<tr>
<td>pH Sensing Technology</td>
<td>Composite X-Chip</td>
</tr>
<tr>
<td>pH Range</td>
<td>0 – 14</td>
</tr>
<tr>
<td>Reference System</td>
<td>Pre-pressurized liquid electrolyte,</td>
</tr>
<tr>
<td></td>
<td>ceramic diaphragm, Argenthal® cartridge</td>
</tr>
<tr>
<td></td>
<td>with silver-ion trap</td>
</tr>
<tr>
<td>Operating Temperature (for</td>
<td>0 – 80 °C (100 °C) / 32 – 176 °F (212 °F)</td>
</tr>
<tr>
<td>cleaning)</td>
<td></td>
</tr>
<tr>
<td>Operating Pressure</td>
<td>0 – 4 barg (0 – 58 psig)</td>
</tr>
</tbody>
</table>

### Ordering Information

<table>
<thead>
<tr>
<th>pH Sensor</th>
<th>Shaft Length</th>
<th>Order Nr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>InPro X1 HLS-N200-K120</td>
<td>120 mm</td>
<td>30 389 700</td>
</tr>
<tr>
<td>InPro X1 HLS-N200-K225</td>
<td>225 mm</td>
<td>30 389 701</td>
</tr>
</tbody>
</table>
InProX1 HLS: Innovative Sensor Design

**Unbreakable X-Chip Technology Eliminates the Risk of Glass Contamination**

InPro X1 HLS has an **unbreakable design** and **passed the drop test according to** U.S. military standard **MIL-STD-810H**

- **Composite X-Chip pH-sensing technology**
- **Life science grade PEEK shaft**
- **Pressurized liquid electrolyte**
- **Argenthal cartridge reference system**
- **Ceramic diaphragm**
- **Grade 2 titanium protective cap & solution ground**
- **FKM O-ring and flat gasket**
- **ISM* board with self-diagnosis functionality**

*Intelligent Sensor Management*
How Does the X-Chip Work

X-Chip pH Sensing Technology vs Conventional Glass pH Electrodes

The X-Chip measures the proton activity of the X-chip against the reference
Developed for F&B

The First Food-Safe, In-Line pH Sensor That Withstands Cleaning

- InPro X1 HLS has a **hygienic design** and meets all major food regulations including EHEDG, 3A and supplies Food Contact Material according EC1935/2004, FDA, GB 4806 and similar.

- Contrary to available glass-free pH technologies such as ISFET, the InPro X1 is **resistant to clean-in-place (CIP)** procedures. Using a static InFit housing, the sensor is cleaned with the process CIP.

**Usability:**

- Digital integration has no limits on cable length
- Compliance with Food Contact materials
- The sensor can remain in the system until ACT or DLI calls
- CIP cleaning is appreciated
- Simple steady holder
pH Measurement in Dairy Processes

Milk Reception → Raw Milk Tank → Heat Treatment → Standardisation → Cream

Raw Milk Tank
Heat Treatment
Standardisation
Cream

Skimmed Milk

Sour Milk → Rennet

Milk → UHT
Fresh
ESL
Condensed
Packaging

Cheese
Fresh
Soft
Semi
Hard

Butter
Sweet
Mild Sour
Sour

Fermented
Yoghurt
Sour Cream
Curd

Powder
Skimmed Milk
Whole Milk

Clean-in-Place CIP
pH as a Quality Parameter

Detecting Undesired Growth of Microbes/Foreign Cultures

Why pH measurement:

- The continuous inline measurement of pH allows to track the entire volume that is downloaded and used inside a dairy plant
- Bacteria-caused pH drop is early detected with in-line pH measurement
- Protection of each step avoids unnecessary treatment and improves performance, e.g., of heat exchangers
- The product quality can be monitored and recorded continuously

Typical conditions: pH: 6.7, process temperature: 4 °C, CIP: 80 °C, 2% caustic, 1% acid, hygienic design, pressure: atmospheric in vessel, 2-5 bar in pipes, flow: up to 2m/s
pH in Monitoring Starter Culture

**Speed and Value of pH Drop Indicates Performance of the Starter Culture**

**Why pH measurement:**
- Define the actual status of self-propagation cultures
- Ensure ideal starting conditions for dried or frozen starter cultures
- Increased production and reduced batch times by pointe controls
- Greater stability of product quality
- Improve the operation time and equipment utilisation

**Typical conditions:**
- pH: 4.2, process temperature: 37 °C, CIP: 80 °C, 2% caustic, 1% acid, hygienic design, pressure: atmospheric in vessel, 2-5 bar in pipes, flow: up to 2m/s
Key Value Messages and Approach

- **Our Approach/Focus:**
  - We supply the sensor for continuous pH control of the milk before rennet dosing to improve the coagulation/renneting.
  - We ensure that all milk that reaches the vat is within the defined specification, ready to host the starter culture best possible, improving speed and consistency of the process.
  - Fast and efficient thickening helps to produce consistent quality.

- **Benefits of the Solution:**
  - Stands CIP cleaning and SIP sterilization
  - Certified hygienic design, 3A and EHEDG
  - Food contact materials according international regulations
  - Simple handling ISM supported calibration installation, operation and maintenance
  - Robust, hygienic and easy to operate holder
Key Value Messages and Approach

- **Our Approach/Focus:**
  - We can offer the sensors that monitor whey quality all along the cutting and pressing for undesired microbes growth that would lower the pH.
  - The customer can safely separate infected whey early before it spoils the next process, saving time and rework.
  - The X1 sensor ensures that the pH is at the correct level in membrane and ultrafiltration systems, protecting the membranes.

- **Benefits of the Solution:**
  - Simple handling
  - Robust sensor
  - No danger of glass
  - Fast and efficient cleaning with CIP and control of the CIP conditions.
Example: Fermentation in Yogurt Production

Fermentation in single or multiple Vessels

Why pH measurement:
- Recognition of the raw milk condition
- Inline detection of the culture performance with the opportunity to redosing more culture if necessary
- Protection against foreign microbes for product safety
- Fast fermentation saves energy, time and increases productivity
- Inline measurement will define the end of fermentation always at the same pH
- Multi-channel Transmitter support smart systems in large tank farms

Typical conditions: pH: 4.4, process temperature: 43 °C, CIP: 80 °C, 2% caustic, 1% acid, hygienic design, pressure: atmospheric in vessel, 2-5 bar in pipes, flow: 2m/s
Hygienic Process Connection and Controls

**InFit 761e and ISM Transmitter M300/400/800**

- Standard static process connection
- EHEDG certified, the sensor is always at the same status as the rest of the system
- Minimum insertion
- No extra effort for the operation and maintenance of a retractable holder
- Intelligent Sensor Management (ISM)
- Digital integration
- Plug and measure
- Software-supported calibration without transmitter
- DLI supports operation and maintenance planning
- ACT supports calibration planning
- Full traceability of all calibrations
Questions or remarks?