Application Data Sheet
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pH Control In Fermentation Plants

BACKGROUND

A typical batch fermentation process starts with sterilization so that all micro-organisms found in the mash and reactor are completely destroyed. The mash is heated in the fermenter or a special cooking vessel by injecting live steam or by means of steam coils set in the vessel. Holding the temperature at 121°C (250°F) for 30 minutes is usually adequate to destroy all living organisms in the mash. However some processes require higher temperatures. As shown in Figure 1, a heating/cooling jacket maintains the temperature of the fermentor.

A fermentation cycle can be divided into two phases: (1) the growth phase and (2) the production phase. Initially during the growth phase, cells grow very slowly while adapting to the reactor environment. After the adaptation period, the cell culture grows exponentially, releasing enzymes as a byproduct of the metabolic process. During the production phase, the molecular products are formed through a series of chemical reactions catalyzed by the enzymes. For many fermentation processes, these two phases are concurrent.

pH CONTROL

pH is one of the most important chemical environmental measurements used to indicate the course of the fermentation process. It detects the presence of specific chemical factors that influence growth, metabolism, and final product.

For example, the pH of commercial mash of P. chrysogenum (penicillin production) must be closely monitored and controlled in both the growing phase and the production phase. Early in the growth phase, the pH of the mash is carefully maintained between 4.5 and 5.5, depending on the mash formulation. The range is set to ensure the most favorable condition for growth. The metabolism of glucose and rapid consumption of ammonia during this phase adversely affect the medium by lowering the pH. If the medium is not adjusted, growth may be inhibited and the fermentation may take a long time to reach the optimal range required for penicillin production.

In the production phase, the organism starts to metabolize other sugars (lactose) and amino compounds because of the depletion of glucose. The liberation and accumulation of ammonia from the metabolism of amino compounds will cause the pH to slowly rise. The pH is allowed to rise to about 7 and is controlled at this point until the end of production. Depending on the culture and several other factors, it has been found that the optimum range for penicillin production lies between 6.8 and 7.8. The pH is carefully monitored and controlled in this range by the addition of sulfonic acid. Finally, at the end of the fermentation, the pH rises and production stops. Figure 1 depicts the pH control loop implemented on a standard fermentor.

INSTRUMENTATION

The Rosemount™ 1056 pH/ORP transmitter and 1066 Two-Wire transmitter are well suited for fermentation applications by virtue of their ease of use. Each has fully descriptive diagnostic capabilities. Temperature compensation is often not required because many applications operate near pH 7, which is the isopotential point of the measurement.

In applications where there is a significant change in the measured pH with temperature change, a separate RTD (Pt 100) can be used with either instrument to provide a temperature compensated pH measurement. When using the Rosemount analyzers, temperature compensation is not limited to conventional electrode compensation, but can also include compensation for changes in actual solution pH with temperature change leading to more precise pH control.

The pH sensor of choice for fermentation applications is the Rosemount Hx338 Steam Sterilizable pH sensor. Designed to withstand repeated sterilizations to 140°C (284°F) and mounted in industry standard hardware, the Hx338 features improved reference technology that resists the effects of poisoning or fouling, and has been designed for long life at high temperatures.

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INSTRUMENTATION

Rosemount 1066 transmitter

- HART® communications
- Continuous diagnostic monitoring of sensor performance
- Easy to use menu structure
- Easy to read display

Rosemount 1056 pH Transmitter

- Single or dual pH input.
- NEMA 4X (IP65) weatherproof, corrosion-resistant enclosure.
- Two Isolated current outputs.
- Easy access diagnostic screens for troubleshooting

Rosemount Hx338 pH sensor

- Provides biotechnology and pharmaceutical processes with Tri-Triple reference technology.
- The three overall reference junctions work together to maintain a drift-free pH signal and fight poisoning ions

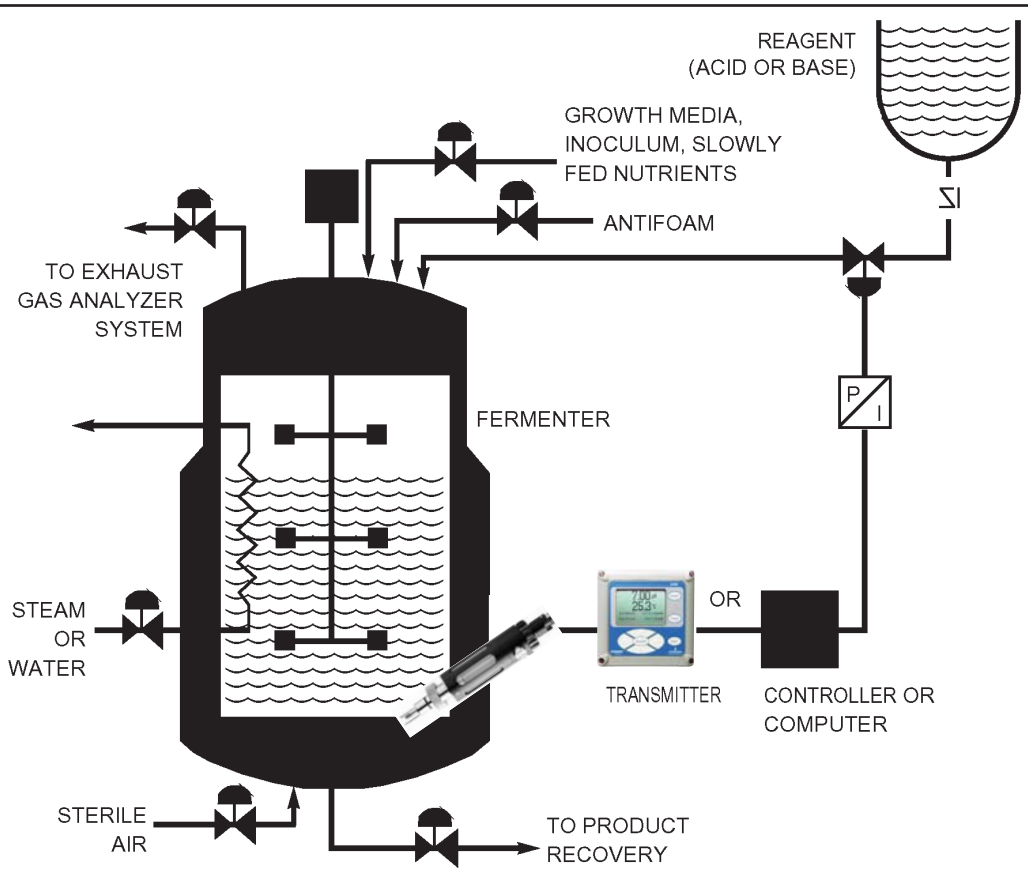

FIGURE 1

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