

Experiment-4

OBJECTIVE:

Operation of pH control system of a bioreactor and evaluation of response of the controller to different control settings.

INTRODUCTION:

One of the most important chemical variables in the fermentation processes is pH because both, the specific growth rate, and product formation rate depend on the pH. Therefore, it is of utmost importance that the pH be controlled in a desirable manner for proper understanding of the fermentation process. Though, the shake flask media are highly buffered (high buffering salt concentration), the media pH may not remain constant throughout the fermentation. Fermentor media are poorly buffered (low buffering salt concentration) as the pH control system can take care of changes in pH during fermentation.

DESCRIPTION:

The pH control system comprises of the following:

- 1) Sensing unit: It is a combined glass pH sensor with the reference electrode housed in the same assembly. A glass bulb at the bottom serves as measuring element of pH in a sample. A white colored ceramic plug enables flow of ions from the sample to the reference electrode. The electrical output is of the order of few milli-volts (mV).
- 2) Monitoring unit: It is an amplifier (AMP) capable of accepting mV signal from a pH sensor. The three potentiometers (POTS), are available on the front panel, namely,
 - a) Temperature compensation POT enables us to adjust the AMP for different sample temperatures
 - b) Asymmetry POT is used for calibration of the AMP at pH 7
 - c) Slope POT for calibration at pH 4
- 3) Control Unit: The control accepts measured value of the pH from the monitoring unit and gives out corrective signal to alkali-pump or the acid pump depending upon the nature and magnitude of error. It comprises of
 - a) Set point POT
 - b) P-band POT (Proportional –band POT)
 - c) T-on POT
 - d) T-off POT
 - e) Alarm POT
 - f) Manual/Auto mode selector switch

By a suitable setting of pots (iii)-(b) to (d), different control actions can be implemented. The dead-band for the controller is 10% of the P-band value. The output of the PID-controller is time dependent ON & OFF to acid/ alkali pumps (constant speed type). So long as the error is out of P-band range, control signal is at maximum i.e., OFF time is zero and ON time is infinite. In other words the pump remains continuously ON. As soon as the error comes within the P-band range, the pump is switched ON and OFF automatically by the controller. The OFF-time duration increases and the ON-time duration decreases as the measured value moves towards the set value. The time durations, set on the T-ON and T-OFF POTS, are the ones, which the controller will use at output signal when error is in the middle of the P-band range.

- 4) Constant speed acid / alkali delivery pumps. They are actuated by the signals from the controller unit.

CALIBRATION:

1. Connect the pH sensor with the pH amplifier (the monitoring unit).
2. Ensure switch “Manual/ Auto” mode selector (iii-e) manual position.
3. Switch on the power and wait for 15 minutes to let the amplifier stabilize.
4. Set POTS (iii)–b & c to their middle positions.
5. Dip the electrode tip in pH 7 buffer solution ensuring that ceramic plug of the reference electrode is also dipped .Set pot (ii)-a to a temperature of the buffer. Wait for 1-minutes for the pH reading on the monitoring unit to stabilize. Adjust POT-(ii)-b till the meter displays 7 pH.
6. Take put the sensor from pH 7 buffer solution and wash its tip with distilled water. Wipe out adhering water gently by touching the glass bulb with a tissue paper. Do not rub the paper as it may damage the glass bulb.
7. Dip the electrode-tip in pH 4 buffer solution and set POT (ii)-a to temperature of the buffer. Wait for 2-minutes for the ph reading on the monitoring unit to stabilize. Adjust POT (ii)-c till the meter displays 4 pH. Repeat the step number 6. The probe is now calibrated.
8. Fit the sensor through a port on the top plate of the bioreactor and set POT (ii)0 –a to temperature of the medium in the bioreactor.

CONTROL SETTINGS:

Connect the acid/base delivery tubes through the pumps on to one of the ports on the top plate of the bioreactor. Put their suction ends in the respective storage bottles. Fill the tubes by manually actuating the pumps from the controller. Set POT (iii)-a to a desired pH set point. Try out the following settings on the controller. Record measured pH value with time when the control action begins till the time when measured pH value to come to the dead band around the set value.

S. No.	T-ON (Sec)	T-OFF (Sec)	P-band (pH)
1	0.5	20	0.5
2	20	0.5	0.5
3	20	0.5	0.1
4	5	5	0.5

DISCUSSION :

Attach graphical response plots, and write a discussion on your observations.