pH Control Systems

Introduction
Different types of applications require different pH operating principles of each. It is intended to help control systems. This technical bulletin describes six match applications with the most suitable pH control basic types of pH control systems and outlines the system.

Control System A: Batch Processing (Discontinuous Input)
This type of control system uses an on/off relay controller for "batch" processing. The system operates as follows:

1. Process solution is pumped into a tank until full.
2. Agitation or mixing begins and chemical is added until desired pH is reached. The relay controller switches the chemical addition pump (or solenoid valve) on/off.
3. Process then flows out or is pumped out of tank.

In this control system, it is desirable to employ some type of level sensing system to signal when the tank is full and empty, and to lock out the mixer and pH control when the solution is not at the proper level. Also, if mixing is poor, a repeat-cycle timer is recommended. The resulting off time of the cycle provides the system extra time to mix and reduce any eventual pH overshoot.

When sizing the final control element, note that there will be some delay between adding chemical and sensing the resulting pH change. If the final control element is oversized, the system will have unacceptable overshoot. The faster the mixing is, the less the delay and/or overshoot will be.
This simple pH control system has one disadvantage—it does not easily handle a continuous flowing process.

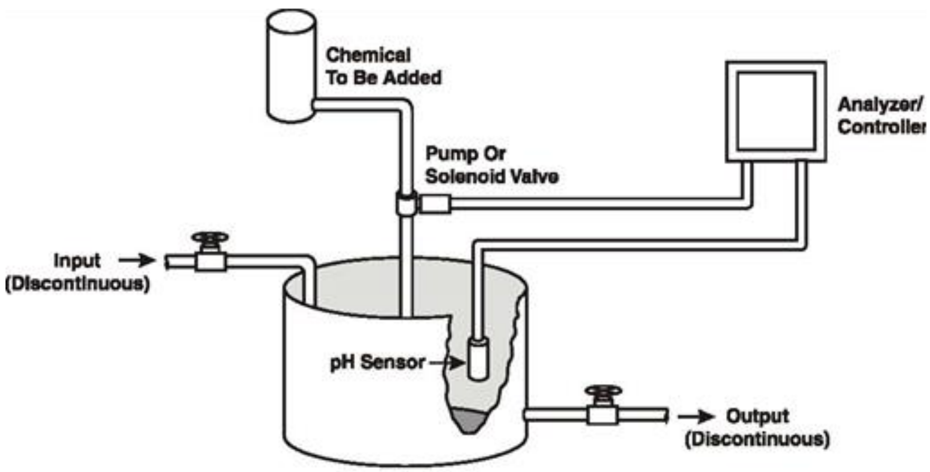

Figure 1: Control System A: Batch Processing with Discontinuous Input

Control System B: Batch Processing (Continuous Input)
This type of control system is very similar to System A, but allows for continuous input. In batch processing applications with continuous input, an on/off relay controller with latching or deadband is required. The deadband will hold the final control element on for a longer time, resulting in smooth operation without rapid cycling.

Control System B does not require as much level control and monitoring as System A, since the reaction tank outlet can be sized large enough and placed in the tank wall to make tank overflow unlikely.

The final control element can be a pump or an on/off valve. Sizing of the final control element is complicated and depends on many factors. This is one situation where a titration curve can be very useful. In many cases, it may be necessary to use two final control elements, each one delivering a different amount of chemical and having a different setpoint. For example, one valve may deliver 1 GPM (gallon per minute) of caustic below 3 pH and the other may deliver 0.1 GPM of caustic below 4 pH.

Good mixing is very important in these types of systems and the mixer or agitation method should not be undersized. The retention time of the system (tank volume divided by GPM in-flow) should be greater than 10 minutes. If it is much longer, a repeat-cycle timer may reduce overshoot. This type of control system can be fairly accurate, but it generally does not produce smooth outputs. The pH will tend to cycle between levels.

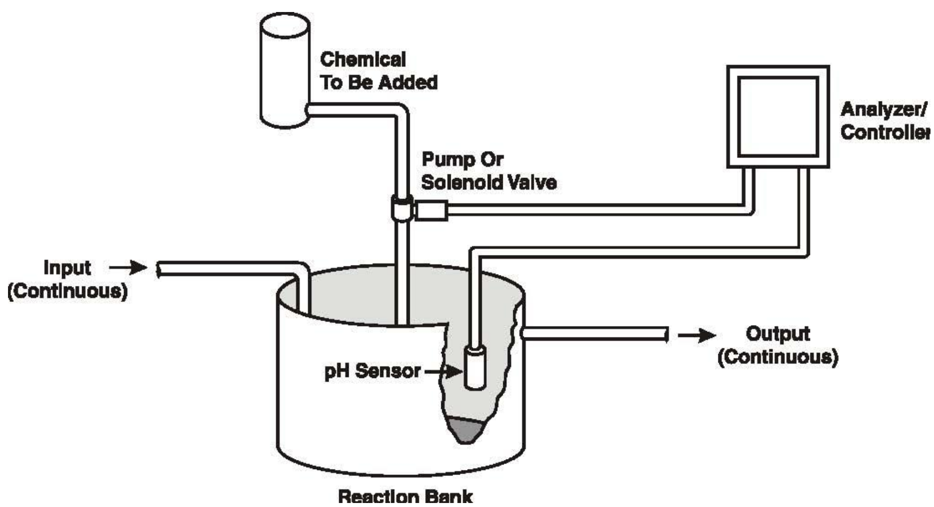

Figure 2: Control System B: Batch Processing with Continuous Input

Control System C: Batch Processing (Continuous Input and Delay Time)

This type of control system uses a proportional gain controller with time proportioning (% cycle) output for applications like those of System B, except that the delay time between chemical addition and sensing is at least one minute. This type of situation may occur where the solution flows through a long tank, a trough or a series of tanks.

The time proportioning (% cycle) output is a switch closure that activates a solenoid valve or pump. The controller's analog output is fed to an electronic "percent of cycle timer" to electrically adjust the on time from 0 to 100%. The time base of the cycle timer is electrically adjustable from a few seconds to a few minutes. The chemical delivery to the system is through a series of "chemical shots." If the system is not receiving enough chemical, the controller output will affect the cycle timer to lengthen the on-time and shorten the off-time.

The cycle time should usually be less than the delay the sensor does not measure large pH variations. The time of the system, so that a series of shots are in the final control element, should be sized so that it cannot tank and gradually mixing. By the time chemical deliver more than five times the amount of chemical reaches the sensor, it should be mixed enough so that required at the maximum system load.

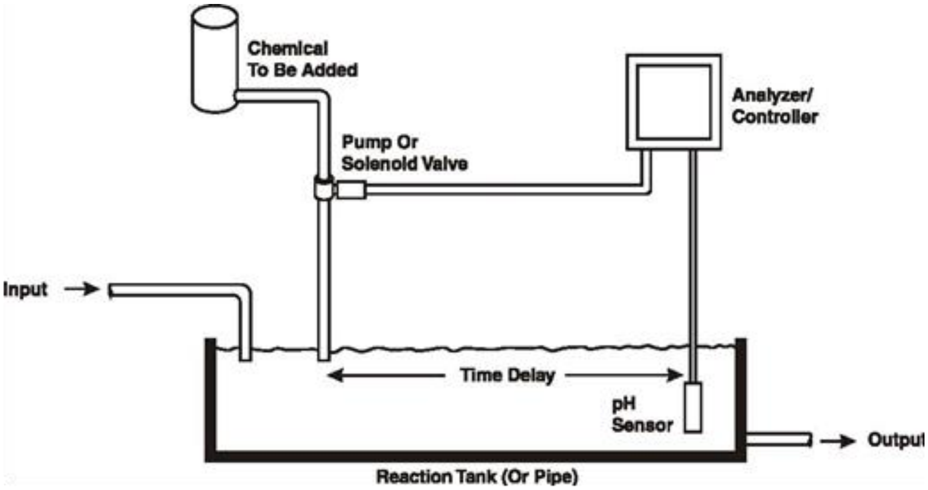

Figure 3: Control System C: Batch Processing with Continuous Input and Time Delay

Control System D: Continuous, On-line Control

This type of control system uses a proportional gain controller with analog output for two general types of pH control where the pH is to be adjusted: a) only slightly, or b) to a value away from 7 pH (less than 4 pH or more than 10 pH).

This control system usually consists of these elements:

1. pH sensor to measure the final product
2. Analyzer/controller to provide an analog control signal
3. Transducer* to produce a pneumatic signal proportional to the analog control signal
4. Pneumatic valve* to deliver reagent to the process
5. Mixing device to be placed between the chemical delivery point and the pH sensor.

Two very important points of this system are the mixing and delay time between adding chemical and sensing the result of the addition. The mixing must be thorough and the delay time should not be more than a few seconds. A long delay time will result in the process pH cycling back and forth through the desired setpoint.

When solution is flowing through a pipe, an excellent mixing device to consider using is a "static mixer." This device provides good mixing in a very short time. By injecting chemicals at the mixer input and placing the pH sensor at the mixer output, the two most significant problem areas of this type of system are eliminated.

An inherent characteristic of this control system is that the actual pH setpoint used for the controller will not be the same as the desired process pH value. The difference may not be large, but there will be some difference.

If a time delay exists between chemical addition point and sensor, System E described on the next page applies.

* Transducer and pneumatic valve may be replaced by an electrically controlled pump or valve.

Control System E: Continuous, On-line Control with Two-Mode Controller

This type of control system is the same as System D except that it uses a two-mode controller in place of the proportional gain controller. The two-mode controller is much more complex than the proportional gain (one¬mode) controller and should be used if the performance of the proportional gain controller is unacceptable.

The integral (reset) function of the two-mode controller will adjust the process to the desired setpoint if it is possible. The two-mode controller also has a sample/hold feature to compensate for transit time, allowing it to control a process with up to eight minutes of delay time from chemical addition point to pH sensing point.

Control System F: Hybrid Control

This type of control system uses the two-mode controller of System E with the on/off control element of System C. This hybrid system is recommended for applications:

- Where accuracy of control is important
- Process delay times of one to eight minutes exist
- The chemical to be added is abrasive or tends to clog small openings (lime slurry, for example).

For these reasons, an on/off valve is preferred over the proportional valve to avoid erosion of its internal parts and to provide more reliable reagent addition.

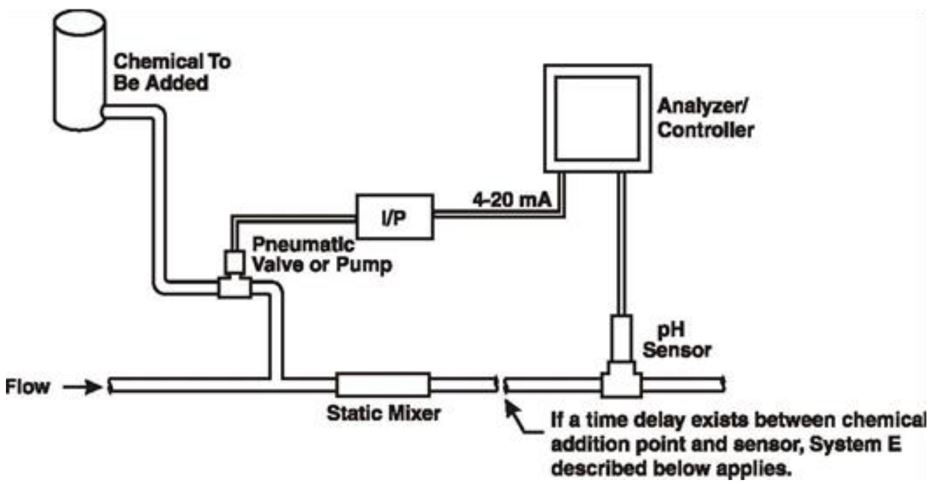

Figure 4: Control System D: Continuous, On-Line Control

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