pH Control Systems

This technical article describes six basic types of pH control systems. it will help you identify the correct application and choice of pH instrumentation.

Batch Processing (System A)

This type of system uses an ON/OFF relay controller for “batch” processing. The system operates as follows:

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

In this system, level sensing of some type is very desirable 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. if mixing is poor, a repeat-cycle timer is recommended. The OFF time of the cycle will give the system some time to mix and reduce any eventual 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 in the system, the less the delay and/or overshoot will be.

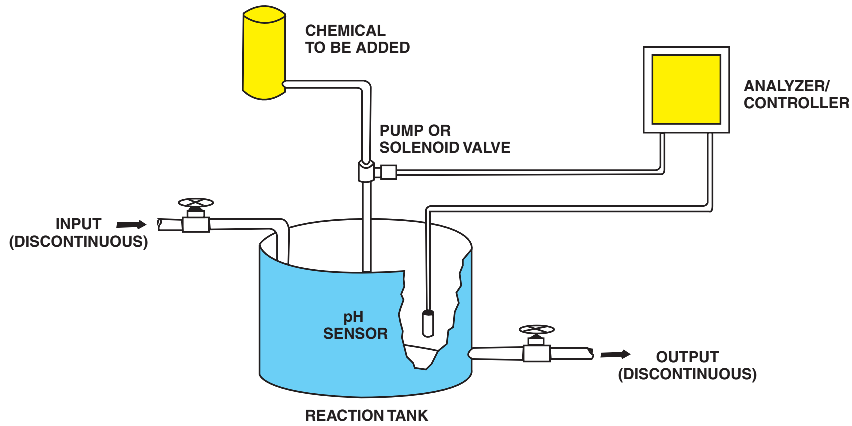
This simple system has one disadvantage: it does not easily handle a continuous flowing process.

Continuous with Tank (System B)

This type of system is very similar to SYSTEM A, but allows for continuous input. With continuous process 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 than without deadband. This results in smooth operation without rapid cycling.

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.

BATCH PROCESSING (System A)



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 invaluable. In many cases, it may be necessary to use two final control elements, each delivering different amounts of chemical and having different setpoints. For example, one valve may deliver 1 GPM of caustic below 3 pH and another may deliver 0.1 GPM of caustic below 4 pH.

Good mixing is very important in these systems, and the mixer or agitation method should not be undersized. The retention time of the system (tank volume divided by GPM inflow) should be greater than 10 minutes. if it is much longer, a repeat-cycle timer can reduce overshoot.

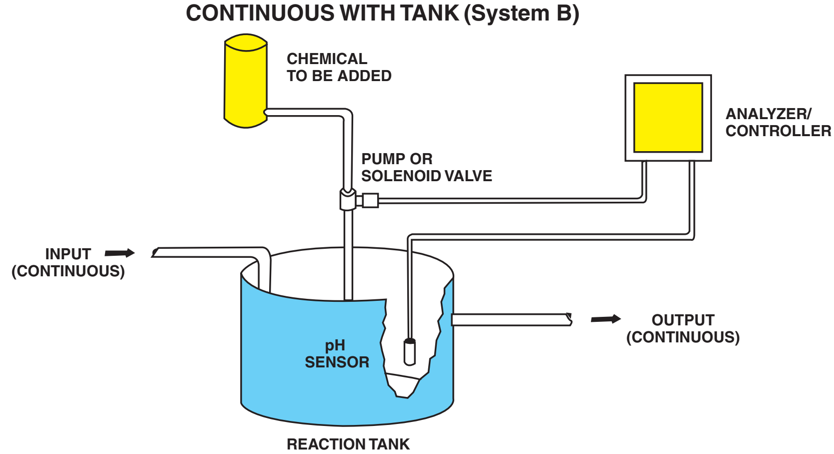
This type of system can be fairly accurate, but in general it does not produce smooth outputs. The pH will tend to cycle between levels.

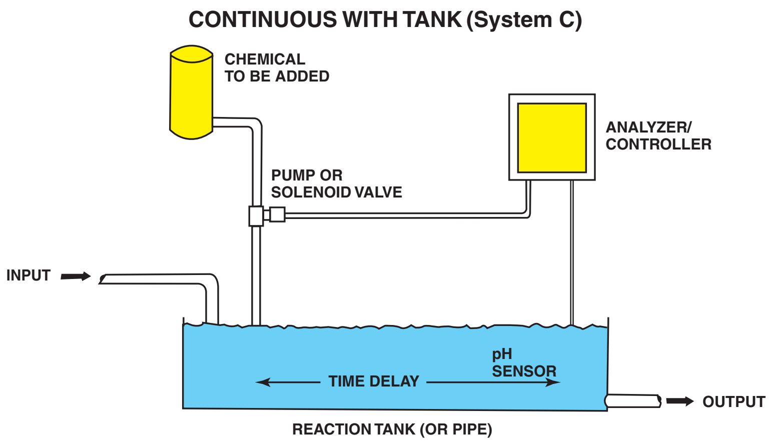
Continuous with Tank (System C)

This type of 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 might 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 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 a series of “shots” of chemical. If not enough chemical is being added, the controller output will affect the cycle timer to lengthen the “ON” time and shorten the “OFF” time.

CONTINUOUS WITH TANK (System B)





The cycle time should usually be less than the delay time of the system so that a series of shots are in the tank and gradually mixing. By the time chemical reaches the sensor, it should be mixed enough so that the sensor does not measure large variations in pH.

The final control element should be sized so that it cannot deliver more than five times the amount of chemical required at the maximum system load.

Continuous, On-line Control (System D)

This type of system uses a PROPORTIONAL GAIN controller with an ANALOG OUTPUT for two general types of pH control where the pH is to be adjusted only slightly or to a value away from 7 pH (less than 4 pH or more than 10 pH). The system consists of the following elements:

1. A pH sensor which senses the pH of the final product.
2. An analyzer/controller which provides an analog control signal.
*3. A transducer that produces a pneumatic signal proportional to the analog control signal.
*4. A pneumatic valve which delivers reagent to the process.
5. A mixing device placed between the chemical delivery point and the pH sensor.

* The transducer and pneumatic valve can be replaced by an electrically controlled pump or valve.

Two very important points of this system are the mixing and the delay time between adding chemicals 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 about the desired setpoint.

When solution is flowing through a pipe, an excellent mixing device to consider 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 system is that the actual controller pH setpoint will not be the same as the desired process pH value. The difference may not be large, but there will be some difference.

System E

This type of 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 there is doubt about the proportional gain controller’s performance.

The integral (reset) function of the two-mode controller will try to adjust the process to the desired setpoint if it is physically possible to do so.

The two-mode controller also has a sample/hold feature (transmit time) that allows it to control a process with as much as 8 minutes of delay time from chemical addition point to actual sensing.

System F

This type of 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 1 to 8 minutes exist and the chemical to be added is abrasive or tends to clog small openings (lime slurry, for example). For this reason, an ON/OFF valve is preferred over the proportional valve, to avoid erosion of its internal parts and to provide more reliable reagent addition.