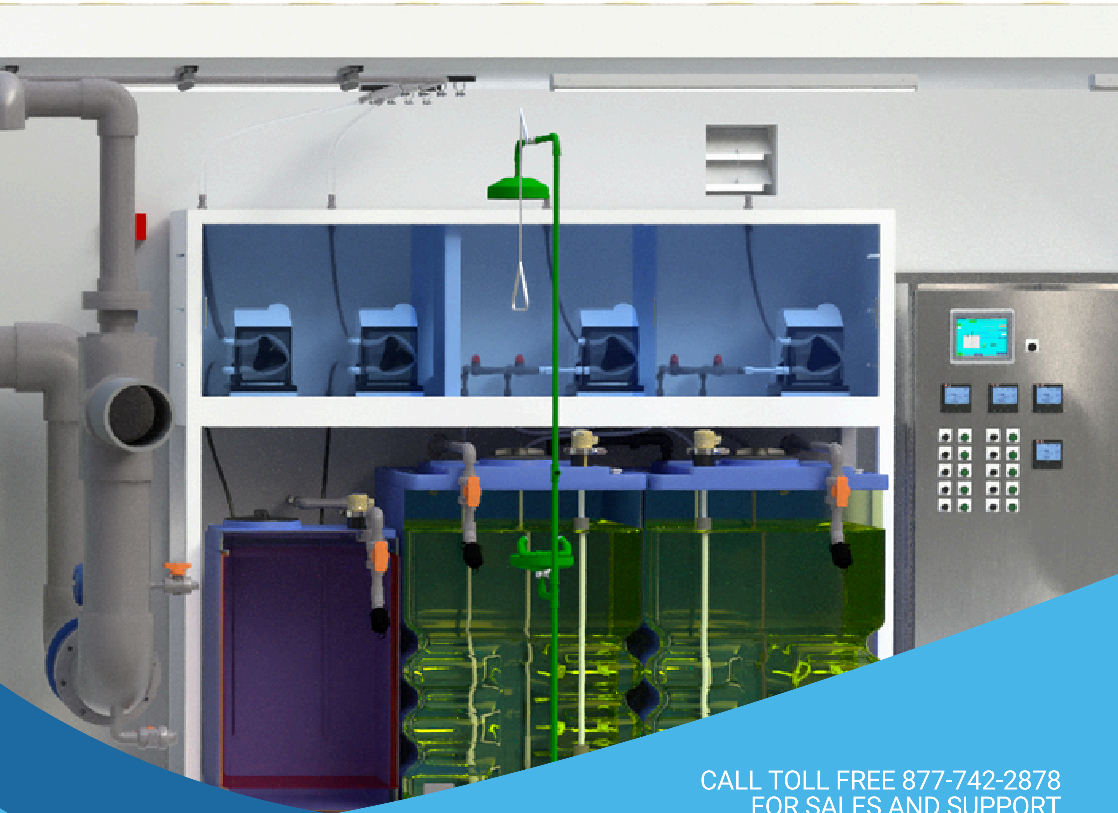
Defining pH Neutralization Systems



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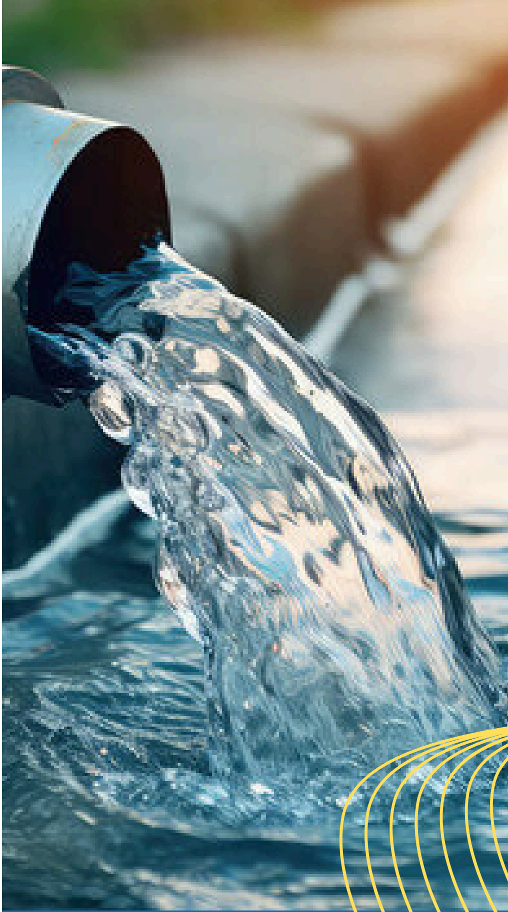
pH Neutralization Systems

The requirement for pH adjustment or neutralization is a common demand that spans various industries including manufacturing facilities, research laboratories, food processing, bottling plants, schools, and universities. While discharge pH limits vary from region to region, the side effects of discharging outside these limits are the same, possible fines and damage to the environment in some cases.

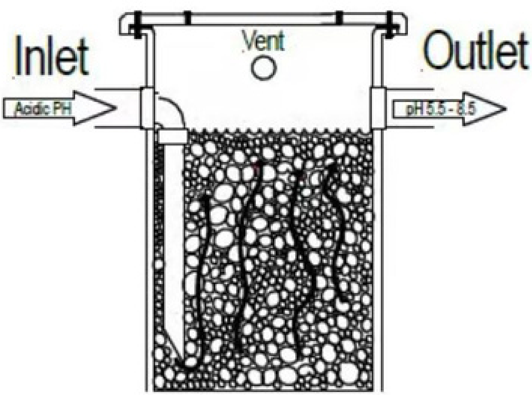
There are several different treatment schemes and equipment that can be applied to prevent effluent excursions. These include limestone chip tanks, batch treatment systems, and single, dual, and three stage continuous flow systems.



A properly operating pH neutralization system depends on the correct assessment of the conditions and the design.

Limestone Chip Tank System

Limestone chip tank systems function on a flow through basis and generally involve a vertical cylindrical tank, which is filled with calcium carbonate, more commonly known as limestone. The limestone chips will raise the pH of acidic waste streams. The chip tank has an inlet fitting and downpipe to direct influent to the bottom of the tank. The tank is filled almost to the top with limestone chips and the influent percolates up through the chip bed until it reaches the overflow fitting on the opposite side of the tank. Often, the discharge tank fitting will be plumbed to a U-trap assembly with a pH sensor for effluent monitoring.



These systems are most seen in lab settings, and they are sized based upon the number of sinks connected to the system. As a rule of thumb, the tank volume (gallons) is 3-4 times the number of sinks. For example, if you have 50 sinks, the tank would be 175 gallons. Limestone is available in 50-pound bags, each occupying 0.5 cubic ft. Knowing that 1 cubic ft is 7.481 gallons of water, we can determine that 13.4lbs of limestone are required per gallon. In our example, that would result in over 2,300 lbs of limestone! Unfortunately, the limestone breaks down over time and needs to be replaced. There are advantages and disadvantages of this, the most basic pH adjustment system.

Advantages of Limestone Chip Tank

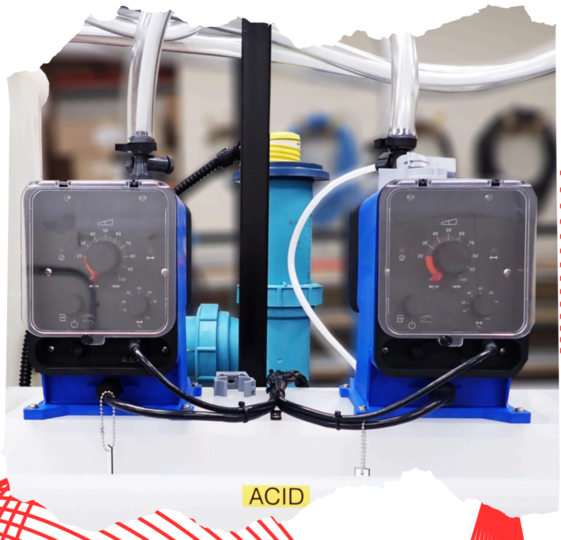
The main advantages of these systems are that they are inexpensive and can be designed to handle multiple low flow waste streams. Disadvantages include that it is only a **one-way pH system** (cannot handle high pH streams), it cannot handle concentrated waste dumps, the tank may foul and generate bacterial growth and odor, and finally, maintenance (cleaning the tank or changing out the limestone) is costly and requires a system shutdown.

Basic Batch System

The preferred method for pH neutralization of waste streams is by the automatic addition of acid or caustic. The ideal set-up is a batch neutralization module. A **basic batch system** includes a treatment tank with a mechanical agitator (mixer), an in-tank pH sensor, an in-tank level control, metering pumps for acid and caustic injection, an automated drain valve or pump for the effluent, and a control panel.

In a **batch cycle**, the treatment tank fills until it reaches its start point where the mixer is energized, and acid or caustic is proportionally added until the pH is within the desired range. At this point, the tank goes through a **dwell cycle** of a few minutes to ensure the pH is maintained and then the tank is dumped via an automatic drain valve or pumped down.

Once the tank has emptied, it is ready for a new cycle. This is the ideal scheme in that you are sure the discharged waste has reached the desired pH range and eliminates chances of pH excursions.



Downsides of Batch Systems

First, unless the waste is generated in batches itself, some provision must be made to store incoming waste when the system is in a batch cycle. Depending upon the speed that the tank can be drained upon completion of a batch, it may take between 15-45 minutes on average to process a batch. Looking at an example with a 25 gpm flow rate, this would require a **surge or collection tank** that would be over 1,125 (25 gal/min x 45 min) gallons just to keep up with the batch system. In addition, the **surge tank** would require automated pumps/valves and a level control to interlock with the batch tank to transfer waste on demand. Not only are additional controls required, but the system, requires a large amount of floor space, which is generally at a premium.

Flow Through Systems

The next type of pH adjustment is a **continuous or flow through system** where wastewater is pumped, or gravity drained into the treatment tank and is automatically adjusted as it flows through the tank.

This set up uses the same mixer, **pH sensor**, and **metering pumps**, but does not require the automated discharge valve/pump or the level control to run the system. A continuous flow system can handle large flows, up to and over 1,000 gpm. This style system is designed for a retention time of 20-30 minutes, depending upon the make-up of the waste stream.

For example, a 100 gpm flow would require 100 gpm x 25 minutes = 2500-gallon tank. Often flow through systems are designed in multiple stages to reduce the tank size. Using the same 100 gpm example, a dual stage system would employ two 1250-gallon tanks, each with a 12.5-minute retention time. **Multiple stages** are also used if the pH of the influent is greater than two pH units from the desired discharge range (two pH units being the maximum adjustment range per stage on a flow through basis). In this case, the first tank serves as a course adjustment, and the second stage serves as a fine adjustment of the pH.

In addition, an **equalization tank** may be provided upstream of the pH tanks. This is useful when multiple streams are being treated of varying pH or if some streams are at elevated temperature. The equalization tank provides some self-neutralizing of the pH (reducing chemical usage and cost) and equalizes the temperature of incoming varied streams.

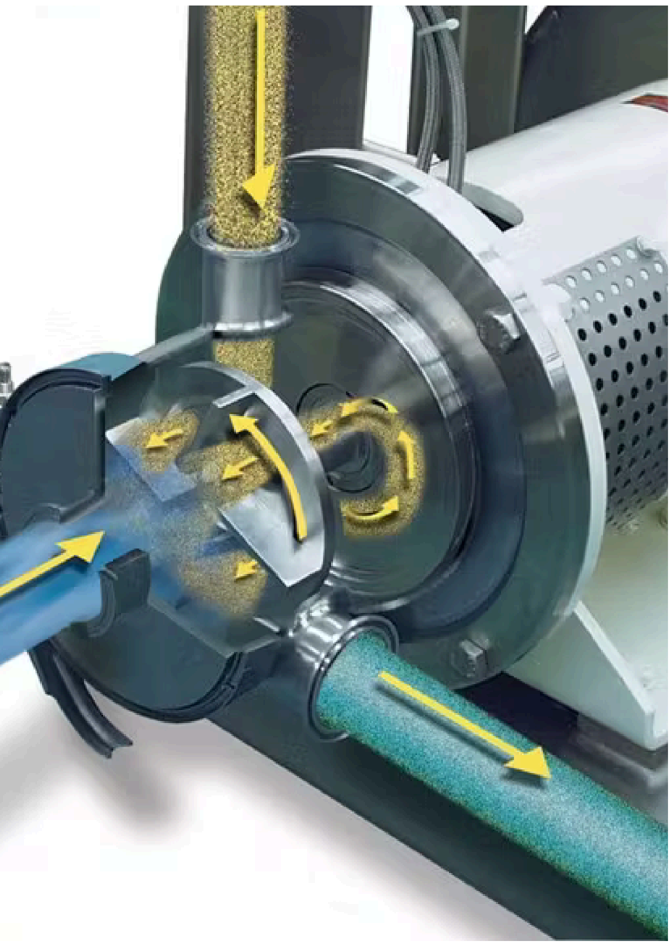
Disadvantage of Flow System

The main disadvantage of a **flow through system** is that the effluent pH is not guaranteed to be within specification. If careful analysis is not done up front and the system not properly sized or the waste profile changes, excursions can occur. In addition, equipment failures such as probes or metering pumps, or even not replacing reagent will not prevent the discharge of out of spec. waste, as it would in a **batch system**.

What do the Systems all Share?

The **treatment tanks** are constructed from thermoplastics, either HDPE (high density polyethylene) or natural polypropylene, or sometimes stainless steel or fiberglass. In smaller systems where temperature is not an issue, a molded HDPE tank is most economical for volumes < 500 gallons. Larger tanks can be fabricated in polypropylene up to 2,000 gallons. Over that size, **fiberglass tanks** are recommended due to the tank weight and structural reinforcements required. **HDPE tanks** have a temperature limit of 140 degrees F, polypropylene is suitable up to 180 degrees F, and fiberglass can be used with solutions seeing spikes of over 200 degrees F with the appropriate resin. Whichever material is used, the tanks share the same features.

An **inlet downpipe or baffle** is used to direct flow to the bottom of the tank. Installed in this baffle are the chemical injectors from the metering pumps. Most systems utilize solenoid driven electronic diaphragm metering pumps, which are supplied with their own spring-loaded injector valve. These are installed near the bottom of the tank via tubing connections. Installation in the inlet baffle eliminates the chance of the tubing being caught in the mixer prop. The tanks include a cover, either bolt-down or welded with a vent fitting and access manway.



The cover also includes guide rails, generally epoxy coated carbon steel for the mixer support. The **mixer** itself is either a direct drive or gear driven unit with T316LSS wetted parts. The mixer should be designed for a tank turnover rate between 1.5-2 turnovers per minute. This ensures rapid mixing of the incoming waste and the reagent being added. Failure to achieve proper mixing can result in stratification in the tank and effluent excursions. The mixer should also be positioned facing the inlet.

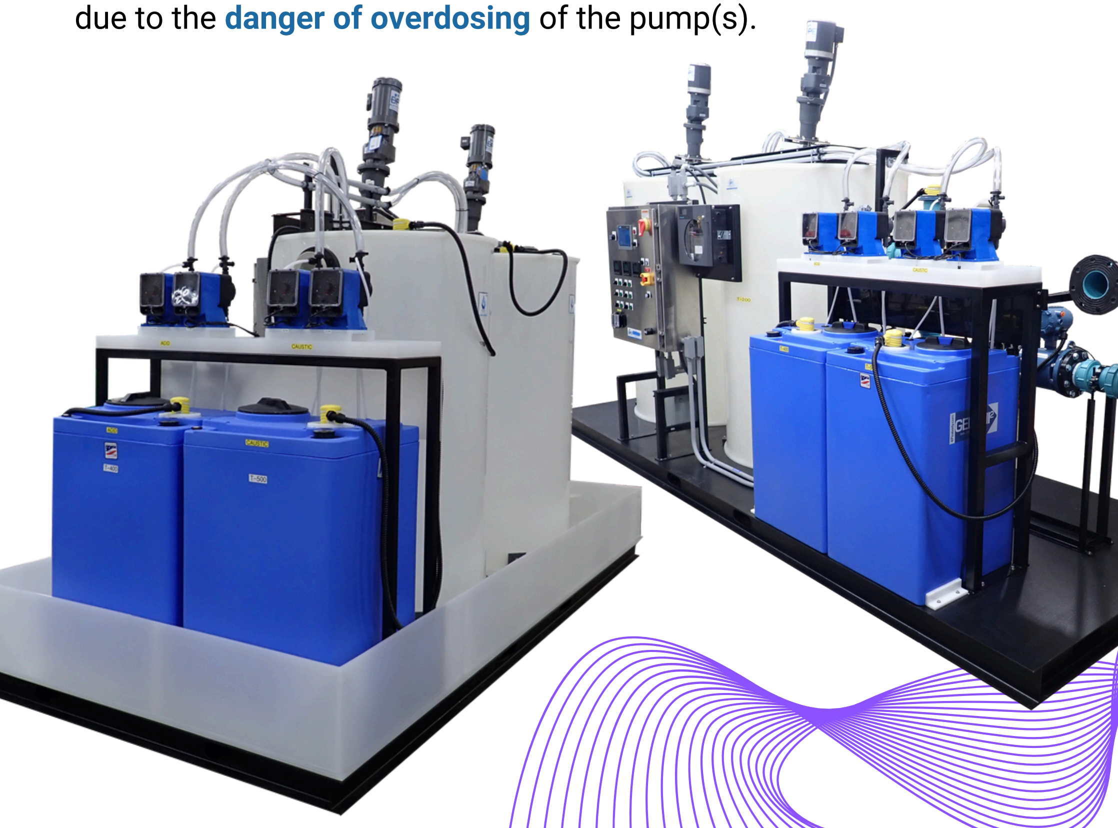
In **vertical cylindrical tanks** the tank can be vertical mounted with anti-vortex baffles installed inside the tank, or if it has an angle bracket (generally 10-15-degree pitch) it can be mounted 1/6 of the tank diameter off center. Various mixer configurations and mixing rates are available to meet the needs of varying tank sizes. In addition, mixers are available with sealed flanged connections for applications where odor may be an issue.

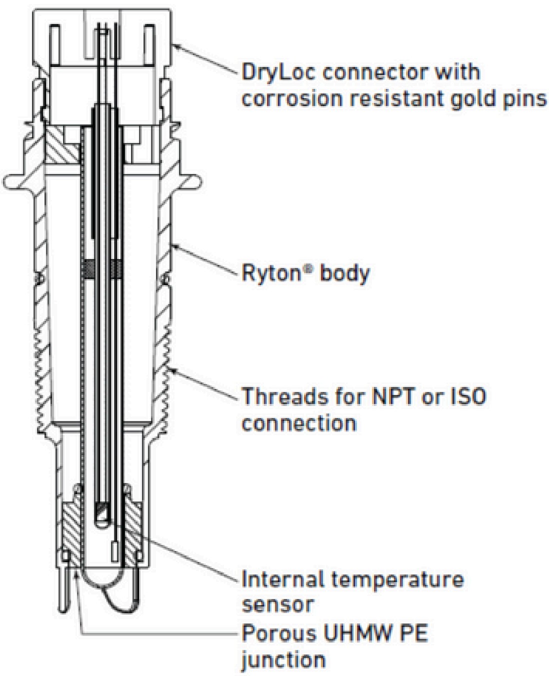
The **standard adjustment chemicals** are sodium hydroxide (to raise the pH) and sulfuric acid (to lower the pH). Sodium hydroxide can be used at concentrations between 20% and 50% and sulfuric acid is generally used at concentrations of 50% and up. The exact concentrations may be determined by the fact that one or both chemicals may already be in use at the facility. If not, a 50% concentration of each is recommended.

The [metering pumps] should include a proportional control input for the frequency, or speed of the pump. This input can be either a proportional pulse or a 4-20mA signal depending upon the pump brand. The input to the pump is set such that the pump runs at full speed as the pH is furthest away from the setpoint and slows down as it approaches the setpoint. This prevents overshoot on the pH and prevents the system going into an oscillation created by the system itself.

Guide to System Design and Maintenance

Care must be taken not to overlap the control points for the acid and caustic addition just for that reason. **Metering pumps** are available in various sizes, from units in the gpm output range to the gph output range. Ideally, the metering pump sizing should be based upon a titration with the actual waste and the reagents to be used. Over sizing a metering pump is just as dangerous as under sizing due to the **danger of overdosing** of the pump(s).





pH sensors are generally mounted on the top of the tank and should be inserted to approximately 60% of the depth of the tank. They should include an automatic temperature compensation circuit and be mounted in such a way that they can be easily removed for cleaning and calibration, which is required at least once per month.

On large tanks, pH sensors can be mounted through a sidewall fitting with a wet-well retraction assembly to facilitate maintenance. The **retraction assembly** allows the sensor to be removed under pressure. Systems may also include two or three probe setups for alarming and automatic switch over if one of the probes fails. On a single pH probe system, a failed probe can cause the system to possibly overdose chemistry and create a pH excursion on the discharge.

The options for [pH neutralization systems] range from a basic limestone tank to a batch treatment system to a multi-stage continuous flow unit. **Limestone systems** are still used in low flow acidic lab waste streams where inexpensive one-way treatment is required. **Batch systems** are employed where concentrated or widely varying pH streams exist and where space allows. **Higher flow systems** utilize continuous flow units, designed in one, two, or three treatment stages in series. Whichever treatment mode is used, the more upfront data that can be gathered on the expected waste flow rates, temperatures, and waste stream constituents, the better the final system will operate.

A properly operating pH neutralization system depends on the correct assessment of the conditions and the design of the equipment. Burt Process Equipment can assist in determining the wastewater profile and establishing a neutralization system design for a **wide range of applications.**

Burt Process Equipment

pH Neutralization System Application Questionnaire

	Customer and Contact Information
Date	
Company Name	
Contact Name	
Phone	
Fax	
Address	
Additional Contact Info.	
	Solution Information
Chemical Composition	
Temperature Range (°F)	
Solids in Suspension (PPM)?	
Specific Gravity	
Oil and Grease Present (PPM)?	
	Available Utilities
Electrical (Voltage, Frequency, phase)	
Compressed air (psig, SCFM)	
	Service Conditions (Batch Treatment Only)
Total Accumulated Flow/batch (gallons)	
Batch Frequency (# batches/day or week)	
	Service Conditions (Continuous Treatment Only)
Average Flowrate (gpm)	
Maximum Flowrate (gpm)	
pH Range of Influent (min-max)	
Desired Effluent pH Range (min-max)	
	Service Conditions (Batch Treatment Only)-continued
List Any Concentrated Dumps to the System	

Chemical Composition	
Concentration (%)	
Volume (gallons)	
Frequency of dumps (dumps/day, week, month)	

Please list any additional comments here that would assist in engineering the proper design of the system: