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TSS Water Course

Module 11

Waste Neutralization

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Module 11 WASTE NEUTRALIZATION

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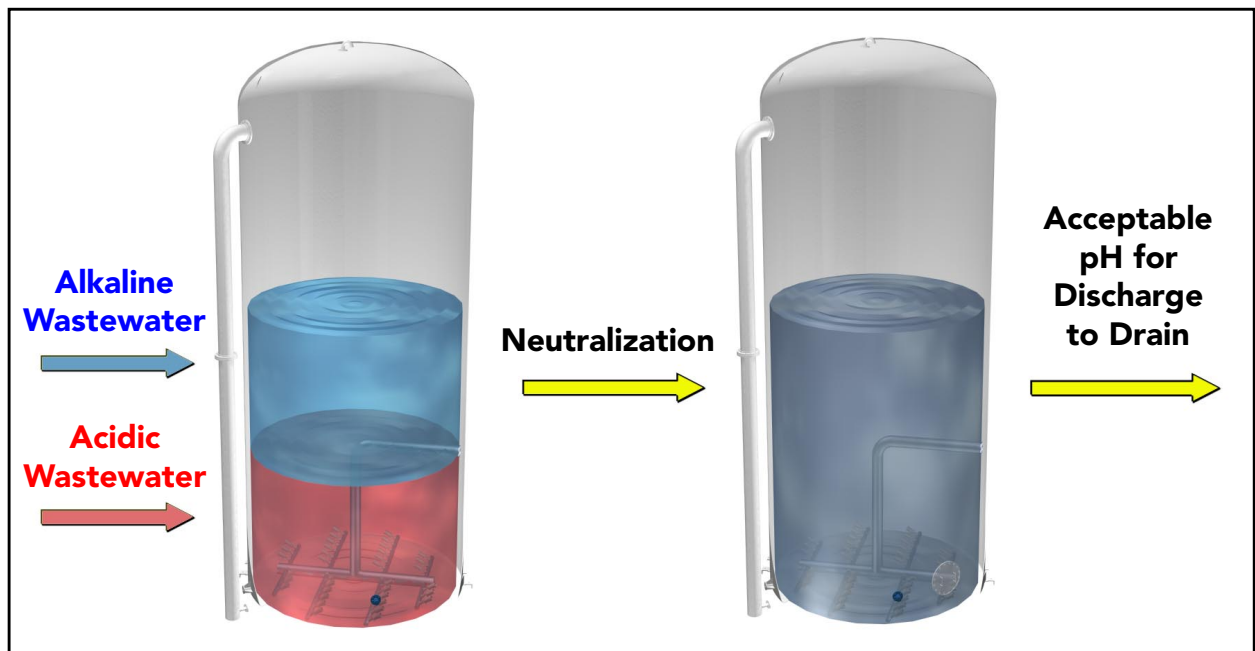


Figure 11.1-1: Acidic and Alkaline Wastewaters Neutralize Each Other



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11.1 Fundamentals

Neutralization involves adjusting the pH of a liquid to approach the “neutral” pH of 7.0 (neither acid nor base). The concept of pH is discussed in detail in Module 2, Section 7. Generally, neutralization involves the use of an acid (pH less than 7) to lower the pH of a tank of basic (or alkaline) liquid (pH greater than 7), or the use of a base (or alkali) to raise the pH of a tank of acidic liquid.

In the water treatment industry, wastewater is generated from the regeneration of the resins used in cation, anion, and mixed bed ion exchange systems. The chemicals used to regenerate the resins have extreme pH levels. For example, sulfuric acid, with a pH of 1-2, is used for regeneration of cation resin and sodium hydroxide, with a pH of 13-14, is used for regeneration of the anion resin. After the regeneration process, the water containing these chemicals must be disposed of. Due to its extreme pH, the wastewater cannot be sent directly to drain, as this will typically violate local regulations regarding the pH of wastewater discharge. For example, the NPDES (National Pollutant Discharge Elimination System) standard for stream discharge pH is 6-9. The acceptable pH of the discharge varies by location and the destination of the discharge (such as a stream, a well or a sewer leading to a municipal waste treatment plant).

To neutralize the highly acidic wastewater from a cation resin regeneration, a supply of alkaline liquid is needed. An anion resin regeneration is usually performed at the same time, and its wastewater is alkaline. When these two wastewater streams are combined, the pH is “neutralized” and approaches 7. If the resulting pH of the combined liquids is not within the acceptable range for discharge, an additional amount of either acid or base must be added to shift the pH into the acceptable range. **Figure 11.1-1** on the opposite page shows this concept. Generally, the chemicals used to adjust the wastewater are the same chemicals used to regenerate the resins in the ion exchange systems.

The regeneration of resin from a mixed bed ion exchange system generates both highly acidic wastewater and highly basic wastewater. The total amount of wastewater generated is generally a lower volume than the combined wastewater streams from a pair of cation and anion ion exchange systems. Regardless of the volume, the two wastewater streams resulting from the regeneration of a mixed bed system can be combined to nearly neutralize each other.



Figure 11.2-1: Batch Neutralization Tank



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11.2 Process and Operation Overview

The process of neutralization involves the following:

- Collection of wastewater resulting from the regeneration of various ion exchange systems
- Combining and mixing wastewater streams
- Measuring the pH of the combined wastewater streams
- Adjusting the pH of the wastewater so it is within acceptable limits for discharge to drain

11.2.1 Wastewater Collection

The wastewater remaining at the conclusion of an ion exchange resin regeneration cycle generally has an extreme pH and cannot simply be sent to drain. Instead the wastewater is directed to a “batch neutralization” tank. **Figure 11.2-1** on the opposite page shows a typical batch neutralization tank. The purpose of the tank is to hold the wastewater streams in one location. Once collected, the goal is to use the wide variations in pH of the streams and cause them to neutralize each other.

11.2.2 Wastewater Mixing

For complete neutralization to occur in a reasonable amount of time, the acidic and alkaline waste volumes in the batch tank must be thoroughly mixed. There are several mixing approaches that can be considered.

A motor-driven mixer on a shaft can be used to mix the contents of the tank. The tall tanks often used in this application necessitate the use of long shafts that require careful balancing with submerged bearings to keep the shafts in place. Mounting the mixer assembly on the side of the tank removes these requirements but adds an underwater seal. The maintenance for either of these approaches can be difficult.

Mixing can also be achieved by blowing air into the bottom of the neutralization tank. This method avoids the use of moving parts and the associated maintenance concerns, but requires a suitable supply of air. This procedure usually requires a large set of blowers to produce the volume and pressure of air required to mix a full tank of water.



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Another mixing method lets centrifugal pumps recycle the wastewater in the tank. This approach provides a fast and efficient mix with a relatively low-maintenance piece of equipment. Only one pump operates, and any additional pumps are for redundancy. **Figure 11.2-2** below shows a pair of recycle pumps.

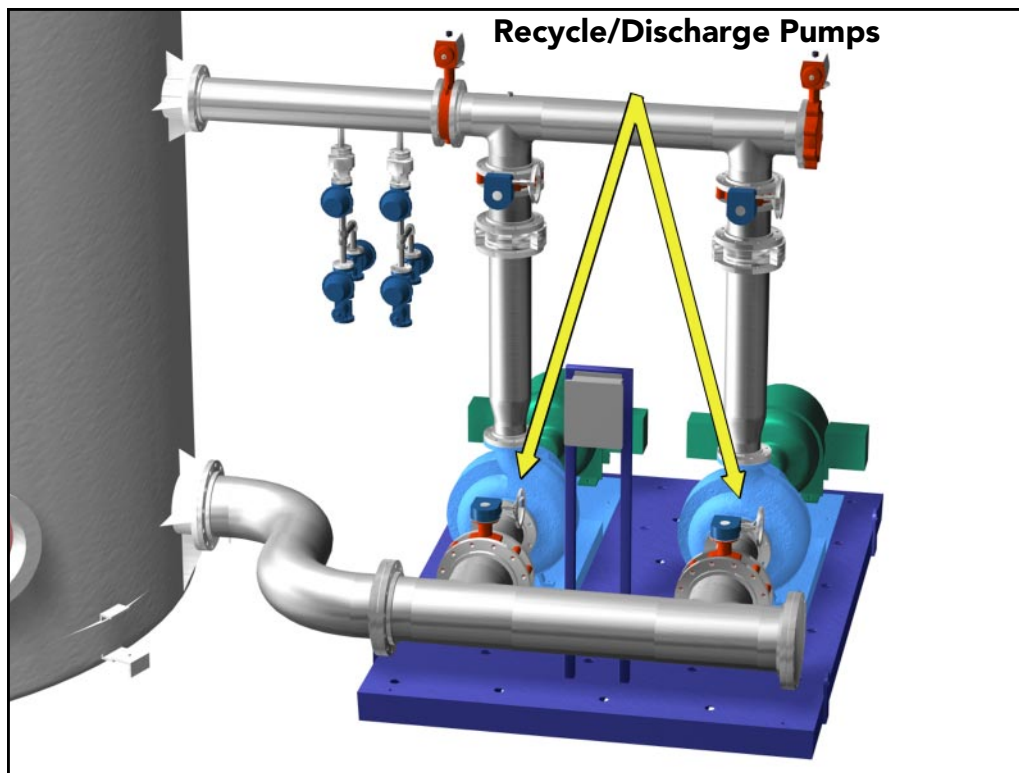


Figure 11.2-2: Recycle / Discharge Pumps

In a recycle mixing design, water flows from the bottom of the neutralization tank and proceeds to the suction of the operating recycle pump. After being discharged from the pump, the water is directed back into the batch tank. The time required to pump the entire contents of the tank one time is the “turnover rate.” This can be measured in turns per hour, with one turn being equal to the volume of the batch tank flowing through the pump one time.

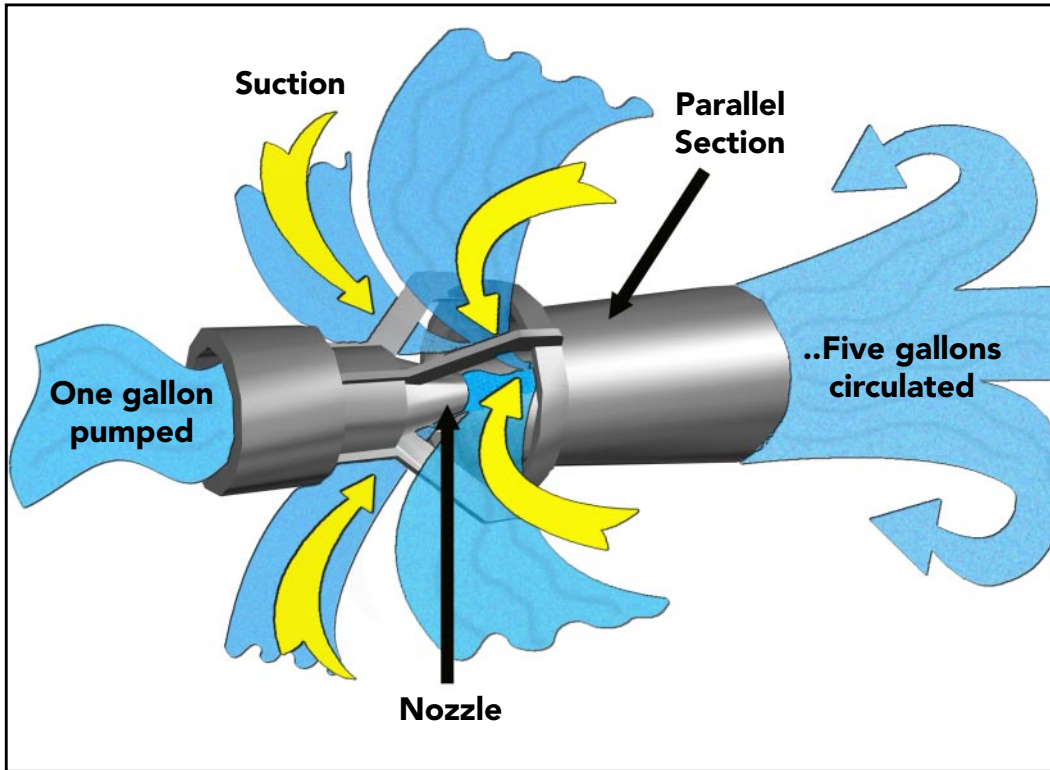


Figure 11.2-4: Principle of Tank Mixing Eductor



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As it enters the tank, the water passes through an “eductor” that mixes water from the pump (the motive fluid) and water from another part of the tank (the entrained fluid). The batch tank contains a series of eductors, equally spaced on laterals, to thoroughly mix the tank’s contents. **Figure 11.2-3** below shows the arrangement of eductors inside the batch tank.

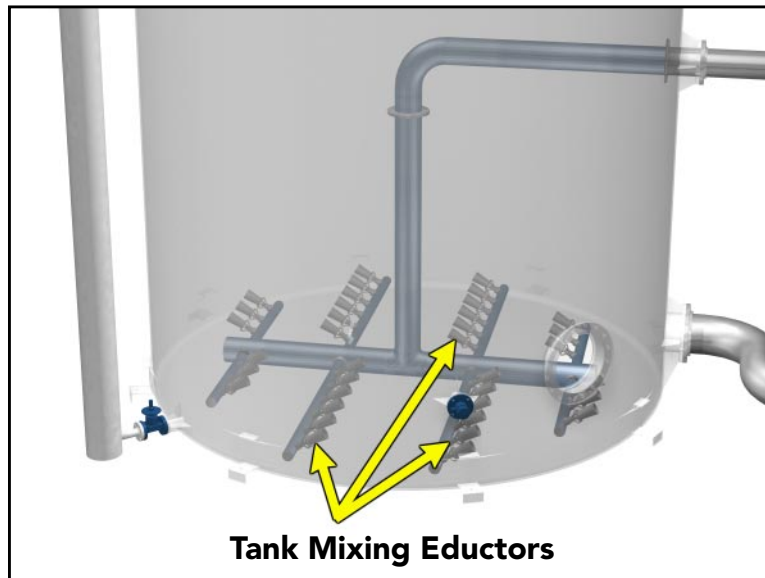


Figure 11.2-3: Tank Mixing Eductors

The flow of water from the recycle pump through an eductor creates suction that pulls in approximately four times the amount of water being pumped. For every gallon pumped into a single tank mixing eductor, five gallons are discharged, which significantly reduces the turnover rate. **Figure 11.2-4** on the opposite page shows a schematic of how an individual eductor functions. The agitation caused by the discharge stream also encourages mixing of the tank contents, especially when using a series of eductors arrayed through the batch tank.

11.2.3 pH Measurement

While the wastewater is being recycled, an inline sensor continuously monitors its pH. As the wastewater in the tank is being mixed, the pH is checked to verify that it is within acceptable limits for discharge. If the pH of the batch is acceptable, the water is sent to drain. If the pH of the batch is outside the acceptable range, additional chemicals are added to bring the pH to a desirable level before it is discharged.



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11.2.4 Wastewater pH Adjustment

If the batch of mixed wastewater from a cation resin regeneration and an anion resin regeneration does not yield an acceptable pH for discharge, then the batch must be adjusted. Based on the pH measurement, an algorithm in the control system determines the amount of acid or caustic that must be added to the batch tank.

Figure 11.2-5 below shows where the chemicals are added. If the pH of the batch is too high, acid is added. If the pH of the batch is too low, caustic is added. The amount added should be sufficient to bring the pH of the batch tank contents into the acceptable range. The chemicals used are commonly the same chemicals used for cation or anion resin regeneration.

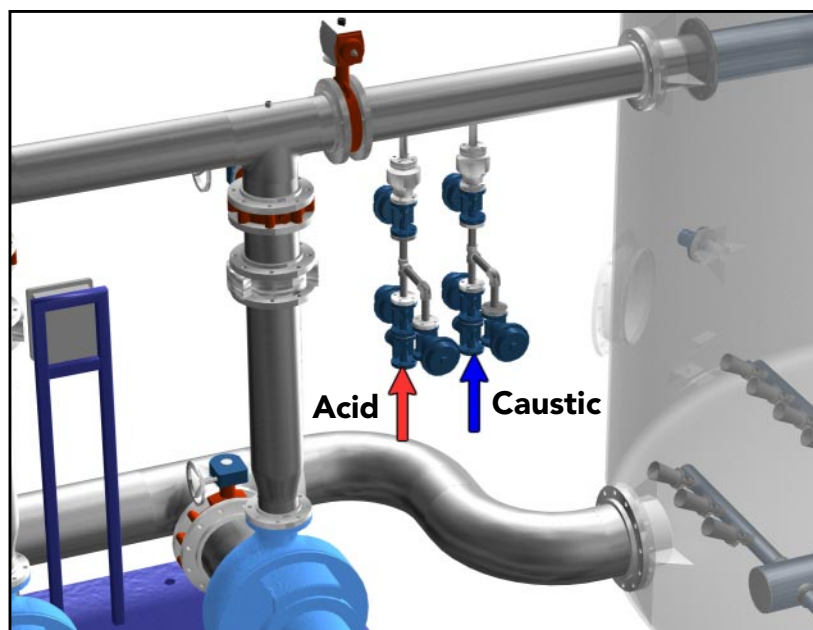


Figure 11.2-5: Location of Chemical Additions

After the adjustment chemical is added and the contents of the tank are thoroughly mixed, the pH of the wastewater batch is measured again to confirm that it is within the acceptable range. If the pH is acceptable, the contents of the batch neutralization tank are sent to drain. If the pH is not acceptable, another adjustment cycle is executed until the pH of the batch is acceptable.