Whitepaper

Chemical Feed Systems: Everything You Would Like to Know About Them

Cannon Water is one of the leading suppliers of wastewater and water treatment equipment, chemical feed system, water test equipment. We provides the complete solution for water filtration treatment.

CANNON WATER TECHNOLOGY INC.

www.cannonwater.com

Water treatment is one of the essential requirements for various industry segments like wastewater treatment plants, chemical facilities, and so on. These industry segments produce a huge amount of wastewater through its processes, which when released directly into the nearby water bodies may pollute the water and invite the wrath of regulatory authorities. Thus, the water is treated before releasing it to the environment. This treatment involves various types of chemicals, which are fed to water streams using chemical feed systems. A well-designed chemical feed system is an important aspect of any water treatment program.

An Overview of Chemical Feed Systems

Chemical feed systems are designed for automated injection of chemicals into the water to be treated. These systems release chemical reagents to the water through dosing. They dose a precise amount of chemicals to the water to maintain consistency. Today, you can find pre-engineered chemical feed systems with customizable features to meet diverse water treatment requirements. The chemical feed systems comprise different components that contribute to their functioning. The components and the system in its entirety is designed to withstand chemical-laden environments.

Uses of Chemical Feed Systems

Chemical feed systems are mainly employed for the following types of water treatment:

- Disinfection
- Flocculation and Coagulation
- Nutrient Removal
- Sludge Conditioning
- Odor Control
- Alkalinity Supplementation
- Corrosion Inhibition

Types of Chemicals Used by Chemical Feed Systems

There are basically three types of chemicals used by chemical feed systems. They are:

- Dry Chemicals: These chemicals get their name from their dry, powdered form. Sodium bicarbonate, calcium hypochlorite, calcium chloride, algaecides, and soda ash are a few popular types of dry chemicals. Dry chemicals may or may not be mixed with liquids.
- Liquid Chemicals**:** As the name indicates, these chemicals are in liquid form and are commonly used in chemical feed systems due to the ease of use. Aluminum sulfate or liquid alum, 50% sodium hydroxide, and caustic soda are a few liquid chemicals used regularly.
- Gaseous Chemicals: Chlorine gas is one of the most common forms of gaseous chemicals used in industries. Its addition serves many purposes in wastewater treatment. Chlorine is fed into wastewater plants for algae control, sludge bulking control, disinfection, slime, and odor control.

Key Components of a Chemical Feed System

A chemical feed system is made of several components like the ones mentioned below:

- Delivery Systems: Feed pumps serve as delivery systems; thus, they form an integral part of any chemical feed system. These pumps carry chemicals for dosing. Metering pumps are the most common types of feed pumps used in a chemical feed system. There are different types of chemical metering pumps based on their construction and way of operation. The following are a few popular types:
    - Diaphragm Pumps: These pumps use a reciprocating action of a diaphragm, a rubber, or the valves present on either side of the diaphragm to feed the chemical. The diaphragm used in these pumps is made of Teflon or thermoplastic. These pumps are widely used for wastewater treatment due to their accuracy and efficiency. Diaphragm pumps can handle any type of chemicals, as well as sludges and slurries with ease, which is why they find applications in harshest environments. Diaphragm pumps are one of the important types of positive displacement pumps. Nowadays, solenoid and motor-driven mechanical diaphragm metering pumps are gaining popularity. Although their designs may vary across brands, mechanical metering pumps are equipped with microprocessor controls. These microprocessor controls help assure accurate speed control in sensitive applications. Solenoid metering pumps can pump at high pressures up to 600PSI are equipped with automation features as mechanical pumps. Mechanical pumps are available at low prices than solenoid metering pumps.
    - Peristaltic Pumps: These pumps are also known as roller pumps because it uses a set of rollers to pump the fluid. The chemical fluid to be pumped is contained in a flexible tube, which is positioned inside a pump casing. The rotors equipped with rollers compress the tube, thereby forcing the fluid to move towards the pipe. The pump comes to its original position after the fluid moves out. This whole process is known as peristalsis. The design of this pump helps prevent backflow. Stenner, SEKO, MEC-O-MATIC, Chem-Tech, and Knight Equipment are a few popular brands offering peristaltic pumps. Peristaltic pumps are suited for applications requiring small feed rates of < 0.1 gallons per hour.
    - Packed Plunger Pumps: The pumps of this type can assure high discharge pressures. This is why they are widely used for chemical treatment in boiler systems. The pumping action of these pumps is produced by a plunger or a direct-acting piston that moves forward and backward creating a reciprocating motion. The piston makes the fluid inside the chamber to move out. Stroke length or motor speed of these pumps can be easily adjusted to meet the application requirements.
    - Liquid Gravity Feeders and Jet Pumps (Eductors): Liquid gravity feeders work on the principle of gravity feeding, which gains its driving force from the difference between the level of chemical in the tank and the point of application. Against this, jet pumps or eductors use the kinetic energy of the liquid that is moving. Both these types are rarely used due to challenges posed during the feed transfer.

  All the above-mentioned pumps are used for transferring liquid chemical feeds. However, for dry chemicals the following types of feeder systems are used:

    - Volumetric Feeders: These feeders dispense an accurate amount of powdered material. Volumetric feeders are generally used for feeding dry chemicals such as lime slaking, lime feed, clay feed, dry polymer, and so on.

- Gravimetric Feeders: The feeders feed chemicals by weight. Gravimetric feeders assure accuracy within 1-2%.

Gaseous chemicals are transferred using gas feeders, which are now largely extinct. This is because chlorine being a real gas is covered under safety regulations. To ensure safety, these gas systems are used under vacuum. To use these systems, special equipment and arrangements need to be done. Self-contained breathing equipment, special containment chorine rooms, chlorine gas detectors, as well as chlorine air room scrubbers are some of the requirements.

- Chemical Storage Systems**:** Solution tanks are the chemical storage systems used for holding chemical solutions to be fed into the water. There are three types of chemical storage systems used:
  - Bulk Storage: The storage tank of this type can hold liquid chemicals in bulk. The chemicals for treatment are delivered by a carrier or a vendor truck. The tank is usually positioned near the feed system.
  - Semi Bulk Storage: This type of storage is ideal for applications that do not use chemical feeds regularly. Semi bulk storage tanks are designed in such a way that the tanks can be stored easily by stacking above one another when not in use.
  - Drum Storage: This was one of the most popular methods of chemical storage until a few years back. Safe disposal of drums after the end of their lifespan was one of the key challenges faced by users. To avoid this, nowadays, business owners use reusable containers.

- Accessories**:** Although tanks and pumps form the body of any chemical system, they are not enough. You will require one or more of the following accessories to support their functions.
  - Tank/Pump Packages: As the name suggests, these may include everything that you may require to set up a chemical feed system. The package may include valves, pumps, gauges, strainers, relief valves and mixers. All these equipment contribute to the preparation of chemical solution, as well as mixing and pumping. Let's analyze each of these components individually.
  - Mixers: Impellers are the most common type of mixers used in chemical feed systems. Speed reducers and air-driven recirculation pumps may also be used for mixing. Of these, speed reducers are most commonly used for chemicals that comprise high molecular weight polymers. However, air-driven or electrical recirculation pumps are used for applications where there are high chances of air entrapment in chemicals.
  - Timers: They are used to control the function of mixers, as well as the feeding of chemicals.
  - Alarms: A chemical feed system is made of different components, which may stop working when certain variables exceed the required proportions. Alarms are nowadays used as monitoring systems. They can be set to monitor tank levels, chemical feed rates, pump status, and changed operating conditions. This will help industrial users to reduce damages caused due to dry running or change in operating variables, or some unspecified conditions.
  - Injection Nozzles: These nozzles are one of the key accessories of the chemical feed system. They are used to inject chemicals into the tanks. There are two types of injection nozzles – high-pressure injection nozzles and low-pressure injection nozzles. Of these, high-pressure injection nozzles are used in various vapor systems. On the other hand, low-pressure injection nozzles are used for injecting chemicals into a liquid stream.

- Level Gauges: As the name indicates, these devices are used to monitor the level of chemicals in tanks. They can be used for on-site monitoring as well as remote monitoring.

Types of Chemical Feed Systems

Chemicals are fed into the water stream in different ways based on the required feed rate and feed pump output. The chemicals can be fed in any of the following ways:

- Continuous Feed: This system is commonly used for liquid chemicals, which are continuously fed into the water tank. This feed system is commonly employed for deposit control in once-through systems, as well as domestic water chlorination. The continuous feed may be provided by a gravity drip feed, where the feed rate is regulated by a needle valve.
- Shot Feed: The chemical is shot-fed by an on-off control on a feeder pump. It may also be discharged from a measuring chamber or a calibrated pump. This type of feeding is widely used in bio-oxidation basins or cooling systems with high system volume to blowdown ratio.

The above-discussed feed systems are appropriate for liquid chemicals. However, the following feeds are developed for gaseous chemicals.

- Solution Feed: This type of feeding can be noticed in vacuum-type feeders, where gas is drawn to the piping system by vacuum. If there is any leak in piping then it leads to vacuum loss, and as a result, the system is shut down for supply. The vacuum feeders use ejectors to create a vacuum required for operation.
- Direct Feed**:** In this feed, gas is fed into the flow stream to be treated. This involves the direct injection of gas under high pressure. This type of feeding is usually restricted to small applications, which have no regular water supply for solution feed.

Dry chemicals more or less follow the same feeding techniques as liquid chemicals, but with little variations.

- Manual Feed: These feed systems are manually batched at routine intervals into solutions prior to feeding as slurries or liquids. However, for implementing this type of feed, the rate and batch strength must be known.

Know About Different Chemical Control Systems or Dosing Pump Controls

Chemical control systems are part of an effective chemical feed system. They have a dramatic effect on program results and overall operational costs. Hence, it is important to choose the right control systems. The following are a few popular types of chemical control systems.

- Manual Controls: This is one of the simplest, yet popular controls employed by wastewater plants. The output of the pump is set manually using dials or knobs, and the pump is put on or off using a manual switch. Sometimes, the power supply on the pump is put on or off for operating or closing the pump.
- External Pacing Control: In this type of control, the pumps receive signals from a dry contact flow monitoring device such as a flow meter regarding turn on, turn off, and dosing. The Stenner PCM Pump

Control module is one of the brilliant examples of this control. The module features a time adjustable controller that sends commands to the pump. Generally, this module works well for pumps with a fixed output. It is operated along with a pulsing dry contact meter that signals the PCM, which commands the pump to deliver a fixed dose of chemical based on the volume of water.

- Feedforward Controls: These pump control systems can detect increased or decreased demand for chemicals and compensate accordingly. Generally, feedforward controls work only when a system error is detected. These controls are used for controlling the feed rate of coagulants, chelants, and corrosion inhibitors.
- On-off Constant Rate Mode: In this type of pump control, the pump on and off is automated. This control is more apt for cooling towers or other similar applications that do not require a continuous or regular feed of chemicals. In short, it is most suitable for controlling acid feed rates at low or high pH setpoints.

Problems Incurred Due to Poor Chemical Control

If a chemical feed system is not designed properly then you may experience several problems. The chemical control will not meet objectives of the water treatment program and the results may vary. The following are a few common problems incurred due to poor chemical control:

- Increased Operational Costs: This may be due to factors like the overuse of chemicals. The chemical overuse not only adds to direct costs of chemicals but also hinders the performance of systems and may lead to high energy costs, too.
- Increased Maintenance Costs: Increased use of chemicals may incur high maintenance costs. As said before, most chemical feed systems possess rugged construction, still, the continuous use of chemicals in large amounts may accelerate corrosion rates, and regular equipment maintenance, repairs, and replacements. All these add to maintenance costs
- Downtimes and Increased Labor Costs: Sometimes systems may undergo widespread damage due to poor control of chemical feed. This would lead to costly production downtimes, thereby costing productive hours for facilities where water treatment is very essential for regular operation. Also, increased use of chemicals may demand operator attention, thereby adding to labor costs.

Important Terms You Should Know

- Active Chemical Strength: A term used to refer the active strength of the chemical. It is usually expressed in pounds per gallon. The specific gravity of a chemical is used for describing its active strength.
- Alkalinity Supplementation: Alkalinity of wastewater is maintained to assure the effectiveness of wastewater treatment. Alkalinity may change during some wastewater treatments such as nitrification. This may affect the pH values. Thus, chemicals are added after alkaline-consumption treatment processes to maintain the alkalinity of water. Some chemicals used for improving alkalinity include lime, baking soda, soda ash, caustic soda, and magnesium hydroxide.
- Batch Strength: It refers to the number of pounds of chemicals dissolved in water. The water by gallons is considered to identify batch strength.
- Coagulation: In this process, chemicals are added to water to promote the aggregation of colloidal and heavier or non-settleable particles into larger and easily settleable particles. Due to the common electric charges of non-settleable particles, they repel each other. The chemical added to the water stream helps

neutralize their charges, and promote destabilization of suspended particles. Aluminum or magnesium hydroxide and lime are a few examples of coagulants.

- Corrosion and Scaling Control: Efficiency of chemical feed systems depend on flow rate and other factors. These factors may be affected due to scales or rust that forms on the interior of equipment or component. To avoid this, corrosion and scale inhibitors are widely used. Corrosion and scale inhibitors are types of chemicals that help remove scaling or rust from these equipment.
- Disinfection: In the wastewater industry, various types of chemicals are used for treating wastewater prior to its release to the water stream. This is known as disinfection. Some popular chemicals used include ozone, sodium hypochlorite, bromine, and chlorine gas.
- Feed Rate: This term may be used in two situations:
    - The amount of chemical required to change the effect of water. It is indicated in pounds/day. It can be used to calculate the chemical needed for a larger batch or for a single day.
    - The amount of chemical fed from a feeder.

  It is calculated as feed rate = flow rate (MGD) x 8.34 #/gallon x chemical dosage (mg/l)
- Flocculation: This process follows coagulation, where large particles are formed from the matter that is coagulated. The flocculation promotes inter-particle contact in particles that are destabilized during coagulation. Synthetic or organic polymers are used as flocculants.
- Flow Rate: This refers to the amount of water that is treated at a wastewater facility every day. This is indicated in millions of gallons per day (MGD).
- Nutrient Removal: Chemicals like phosphorus are removed from wastewater before discharging it into the water stream. This is accomplished using chemical addition to the wastewater stream. Ferric sulfate, aluminum sulfate, ferric chloride, and ferrous sulfate are popular chemicals added to the wastewater stream.
- Odor Control: Wastewater streams produce a foul odor due to the presence of certain nutrients. Chemicals are added to such streams to neutralize the odor of nutrients. Odor control is accomplished by adsorption or neutralization.
- Sludge Conditioning: When the sludge is conditioned for further processing such as dewatering, the process is referred to as sludge conditioning. Generally, flocculants and coagulants are used for the purpose.
- Sludge Stabilization: In many processes, sludge undergoes biological decomposition, which produces a foul odor. Chemicals are added to the sludge to inhibit any biological decomposition, and this process is known as sludge stabilization. Lime is the most common chemical used for sludge stabilization.

Conclusion

When employed correctly, chemical feed systems can bring effective results for water treatment facilities using them. They have a direct and in-direct impact on the process outcomes and productivity. Hence it is recommended to consult some top manufacturers or suppliers before investing in chemical feed systems for your business. Cannon Water Technology, Inc. offers one of the largest selections of chemical feed systems in the US. The company offers chemical feed system components and chemicals from industry-leading brands. For more information, please visit https://cannonwater.com/.

Reference URLs

https://burtprocess.com/systems/chemical-feed-systems

http://files.dep.state.pa.us/Water/BSDW/OperatorCertification/TrainingModules/ww07_chem_feed_wb.pdf

https://www.suezwatertechnologies.com/handbook/chapter-35-chemical-feed-systems

http://www.purewaterproducts.com/chemical-feed-pumps

http://www.neptune-pumps.com/pcfsys.htm

http://www.gwindustrial.com/neptune_chemical_feed.html

http://www.veoliawatertech.com/our-expertise/standard-products/chemical-feed-canada/

https://www.pumpsandsystems.com/why-single-source-best-chemical-feed-systems

https://www.psgdover.com/docs/defaultsource/neptune/brochures/packaged_chemical_feed_systems.pdf?sfvrsn=dda0fa3f_11+

Contact US

233 Technology Way Suite 9

Rocklin, CA 95765

United States of America

csd@cannonwater.com

916-315-2691