ELECTRO COAGULATION TREATMENT

Electro-coagulation is the latest Technology used in treating the Waste water. This technology is successfully used in textile dyeing waste water treatment apart from other applications such as sewage treatment, ship washing, tannery effluent and food processing. ZDT Electro-coagulation system is based on the following scientific principles.

Electro-coagulation (EC), the passing of electrical current through water, has proven very effective in the removal of contaminants from water. Electro-coagulation systems have been in existence for many years using a variety of anode and cathode geometries, including plates, balls, fluidized bed spheres, wire mesh, rods, and tubes. There has been a quantum leap in refining the EC process to increase removal rates and to lower capital and operating costs.

Clarifier referred as solids contact units or up flow tanks, contains the process of mixing flocculation and sedimentation. For good flocculation, anionic poly electrolyte added as a coagulant aid. Clear water over flows to the filter feed sump.

“The Electro coagulation process is based on valid scientific principles involving responses of water contaminants to strong electric fields and electrically induced oxidation and reduction and...
reactions. This process is able to take out over 99 percent of some heavy cat ions and also precipitate charged colloids and remove significant amounts of other ions, colloids and emulsions. When the system is in place, the operating costs including electric power, replacement of electrodes, pump maintenance and labor can be less than $1 per thousand gallons for some applications.

Potential applications to agriculture and quality of rural life include removal of pathogens and heavy metals from drinking water and decontamination of food processing wash waters.

Coagulation is one of the most important physiochemical operations used in water treatment.

This is a process used to cause the destabilization and aggregation of smaller particles into larger particles. Water contaminants such as ions (heavy metals) and colloids (organics and in organics) are primarily held in solution by electrical charges. Coagulation can be achieved by chemical or electrical means. Chemical coagulation is becoming less acceptable today because of the higher costs associated with chemical treatments (e.g. the large volumes of sludge generated, and the
hazardous waste categorization of metal hydroxides, to say nothing of the costs of the chemicals required to effect coagulation).

"Chemical coagulation has been used for decades to destabilize suspensions and to effect precipitation of soluble metal species, as well as other inorganic species from aqueous streams, thereby permitting their removal through sedimentation or filtration. Alum, lime, and/or polymers have been the chemical coagulants used. These processes, however, tend to generate large volumes of sludge with high bound water content that can be slow to filter and difficult to dewater. These treatment processes also tend to increase the total dissolved solids content of the effluent, making it unacceptable for reuse within industrial applications".

Electro-coagulation can often neutralize ion and particle charges, thereby allowing contaminants to precipitate, reducing the concentration below that possible with chemical precipitation, and can replace and/or reduce the use of expensive chemical agents (metal salts, polymer).

"Although the electro-coagulation mechanism resembles chemical coagulation in that the cationic species are responsible for the neutralization of surface charges, the characteristics of the electro-coagulated flock differ dramatically from those generated by chemical coagulation. An electro-coagulated flock tends to contain less bound water, is more shear resistant, and is more readily filterable".

Electro-coagulation has reduced contaminated water volume by 98%; and lowered the treatment cost by 90% for bilge water containing heavy metals and oil emulsions.

Although electro-coagulated water may vary because of the individual chemistry of process waters, a few examples of water treated by electro-coagulation include.

- The reduction of bacteria from 110,000,000 (standard plate count) in sewage waste water to 2,700 bacteria per milliliter;
The contaminants in oily waste waters from steam cleaning operations, refineries, rendering plants, and food processors are generally reduced 95 to 99%;

Dissolved silica, clays, carbon black, and other suspended materials in water are generally reduced by 98%;

Heavy metals in water such as arsenic, cadmium, chromium, lead, nickel, and zinc are generally reduced by 95 to 99%.

NOTE: Heavy metals processed with sufficient activation energy precipitate into acid resistant oxide sludge like NiFe$_2$O$_4$, that pass the Toxic Classification Leaching Procedure (TCLP) which allows the sludge to be reclassified as non hazardous.

Electro coagulation reaction chamber produces several distinct electrochemical results independently. These observed reactions may be explained as:

A. **Seeding** resulting from the anode reduction of metal ions that become new centers for larger, stable, insoluble complexes that precipitates as complex metal oxides;

B. **Emulsion breaking** resulting from the oxygen and hydrogen ions that bond into the water receptor sites of oil molecules creating a water in soluble complex separating water from oil, driller’s mud, dyes, inks, etc.;

C. **Halogen complexion** as the metal ions bind themselves to chlorines in a chlorinated hydrocarbon molecule resulting in a large insoluble complex separating water from pesticides, herbicides, chlorinated PCB’s, etc.;

D. **Bleaching** by the oxygen ions produced in the reaction chamber oxidizes dyes, cyanides, bacteria, viruses, biohazards, etc.
E. Electron flooding of the water eliminates the polar effect of the water complex, allowing colloidal materials to precipitate, and the increase of electrons creates an osmotic pressure that ruptures bacteria, cysts, and viruses;

F. Oxidation - Reduction reactions are forced to their natural end point within the EC chamber which speeds up the natural process of nature that occurs in wet chemistry

G. EC induced pH swings toward neutral. The process is optimized by controlling reaction chamber materials (iron, aluminum, titanium, graphite, etc.), amperage, voltage, flow rate, and the pH of the water. The technology handles mixed waste streams (oil, metals, and bacteria), very effectively. Variables such as temperature and pressure have little effect on the process. The best way to understand what will happen with specific water is to test that water in the EC reaction chamber.

The electro coagulation process has been successfully used to:

- Harvest protein, fat, and fiber from food processor waste streams.
- Recycle water, allowing closed loop systems.
- Remove metals, and oil from wastewater.
- Recondition antifreeze by removing oil, dirt, and metals.
- Recondition brine chiller water by removing bacteria, fat, etc.
- Pretreatment before membrane technologies like reverse osmosis.
- Precondition boiler makeup water by removing silica, hardness, TSS, etc.
- Recondition boiler blow down by removing dissolved solids eliminating the need for boiler chemical treatment.
Remove Color and solids from Textile Dyes Effluent.

- Remove BOD, TSS, FOG, etc., from wastewater before disposal to POTW, thus reducing or eliminating discharge surcharges.
- De-water sewage sludge and stabilize heavy metals in sewage, lowering freight and allowing sludge to be land applied
- Condition and polish drinking water
- Remove chlorine and bacteria before water discharge or reuse

The operating costs of electro coagulation vary dependent on specific water treated. For example, municipal sewage water was treated for $0.24/1,000 gallons, and steam cleaner water containing crude oil, dirt and heavy metals was treated for $0.05/gallon.

DISSOLVED AIR FLOTATION (DAF) SYSTEM

Dissolved Air Flotation is a liquid/solid separation process in which microscopic air bubbles (10-100μ) become attached to solid particles suspended in liquid, causing the solid particles to float. In a DAF system air is dissolved into liquid under pressure. The dissolved air remains in solution until the pressure is released to atmospheric pressure, causing the air to come out of solution in the form of microscopic air bubbles. The bubbles are mixed intimately with the wastewater and become attached to the solids in the waste stream causing the air solids agglomerate to float to the liquid surface where a solids (float) blanket is formed. Surface skimmers then remove the float blanket.
ADVANTAGES OF DISSOLVED AIR FLOTATION (DAF) SYSTEM

Dissolved air flotation (DAF) has gained widespread usage over the last forty years for the removal of suspended solids (TSS), oils and greases (O&G), and biochemical oxygen demand (BOD) from wastewater and other industrial process streams. DAF systems are frequently used to provide wastewater pretreatment, product recovery, and thickening of biological solids in industries ranging from food processing to pulp and paper to petrochemicals. Years of experience in specifying DAF systems for industrial applications has shown that many engineers, designers, and end users have come to rely on DAF design information from common reference materials, such as engineering handbooks. Such reference materials base specification of DAF systems on parameters such as recycle rate and pressure, air-solids ratio, hydraulic loading, and surface loading. However, the values provided in common references for these parameters tend to be outdated or inadequate when compared to data from actual operating systems.

In other words, the reliability and performance of DAF systems have improved with increased use of this technology, but there has not been a corresponding change in the standard design criteria for these systems.
DAF OVERVIEW

While DAF units come in many forms, the systems most commonly produced today are Circular-shaped units using recycle pressurization to provide dissolved air to encourage flotation. As illustrated in Figure 1, a DAF system consists of the following primary components:

1. Contact cell or coagulation chamber. Provides for the mixing of dissolved air with flocculated particles in the influent to allow for attachment of bubbles to particles. Also provides even distribution of flow across the width of the unit.
2. Flotation cell. Provides surface area for the flotation of air and flocculated particles (float).
3. Surface skimmer. Provides the means for removal of float from the flotation cell for transfer to dewatering or other handling. The most Commonly-used system involves a series of flights pulled by a chain drive system with variable-speed, timer-operated drives.
4. Bottoms skimmer or auger. Provides for the removal of settled solids in the bottom of the unit.
5. Effluent discharge baffle and chamber. Provides for physical separation of clarified water from flocculated particles and bottoms prior to discharge from the unit through weirs or similar structures.

6. Air saturation (whitewater) system. Provides the required amount air in the proper form (bubble sizes in the range of 10-100 m), ideally using minimum recycle flow. The whitewater system uses pump pressurization to force air into solution with either the influent stream or a clarified effluent recycle stream. The air-water solution is then injected into the incoming wastewater stream to encourage bubble-solid contact and flotation.

ELECTRO COAGULATION SYSTEM

1. START UP WITH MANUAL OPERATION:
   - Close the drain valve & open the feed valve
   - Switch ON the EC feed pump
   - Give the desired flow to the EC skid by adjusting drive of the feed pump
   - Ensure water over flow in the skid
   - Switch on the EC system
   - Check the clarity of EC outlet
   - If any colour or tint appear increase the power of EC system
   - Every half an hour once give air in the EC skid for 1 or 2 min

2. SHUT DOWN PROCEDURE:
   - After few minutes switch off EC feed pump
   - Give air up to five min
   - Drain the EC drain valve while system is stopped
   - Flush the EC skid by fresh water

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POLYMER PREPARATION AND DOSING

- Use 0.1 percent of Anionic polymer
- Add slowly in the polymer mixer tank
- Switch on the Polymer mixer
- Mix the water up to the water level mark
- Do not stop the Polymer mixer
- Switch on the Polymer Dosing pump and give the flow in the Flash mixer.
- Give the Polymer Dosage of 0.5 PPM to 1 PPM to the Flash mixer

ACID PREPARATION FOR ACID DOSING

- Measure 10 percent of Concentrated Sulfuric or hydrochloric acid
- Fill of water in the Acid Dosing tank
- Add Concentrated Sulfuric Acid or hydrochloric acid slowly in the Acid Dosing tank
- Mix the water with acid
- Switch on the Acid Dosing pump and give the required flow to maintain the pH 7 to 8 in the effluent

EC CLEANING PROCEDURE

- Give air and Fresh water for 5 minutes during when the plant going to stop
- Weekly once or the outlet water is not clear or the current taken is more than the optimized level Clean by acid Solution. For Acid cleaning follow the following steps
- Make 2 to 4% of concentrated acid solution in the Acid cleaning tank
- Stop the plant and close all inlet feed valve
- Open the Acid cleaning valve
- On the Acid Cleaning pump
- 2 minutes run the cleaning solution and allow the overflow from the EC skid to equalization tank
- 15 minutes the acid cleaning solution will be re-circulated to the Acid cleaning tank
• Stop the acid cleaning pump and close all the valve. The cleaning solution will be choked in the EC system for 10 minutes
• Open the valves and on the pump, again re-circulate the solution for 10 minutes
• Ensure all the metal oxide coating will be removed. If not continue the same process until to remove all metal oxide
• After that drain the cleaning solution and the EC system ready to operate