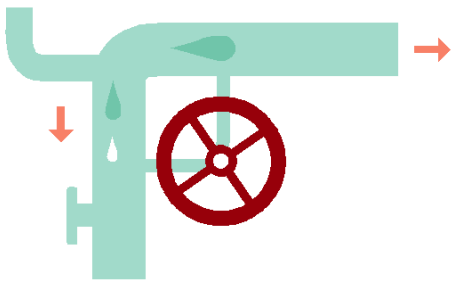


chapter 10  
PRODUCED  
WATER  
TREATMENT





## 10 A

### Introduction.

Enviro Watertek LLC is a Water Company committed to environmentally clean water remediation.

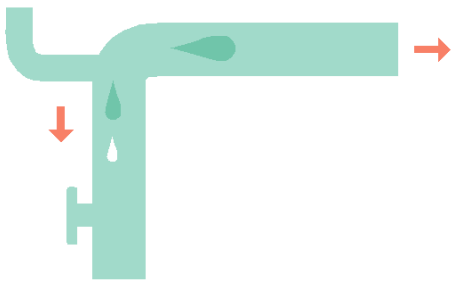
Water management has always been a vital step in the development and production of oil/gas resources. Clean water's importance has increased dramatically with emergence of wide-scale development of shale resources for oil and gas production.

Fracking requires large volumes of water as an input into the well (volumes vary, but typical jobs are often in the 750,000-1.2 Million Barrels range).

#### Services and advantages

- ✓ Treat produced water onsite to control bacteria, scale, biofouling and corrosion.
- ✓ Chemical free process, fully automated, greatly reduces waste to a small dry amount.
- ✓ Scalability, no bag filter waste and uses 100% of water.
- ✓ Recycle 100% of produced water from oil and gas drilling operations, flowback and wastewaters to be reused in current and future operations.
- ✓ Reduce or eliminate water acquisition, transportation, treatment and disposal costs.
- ✓ Eliminate the use of toxic chemicals, further eliminating health, safety and environmental issues associated with chemical consumption, transportation and handling.
- ✓ Preserve vital natural water resources for current and future generations.





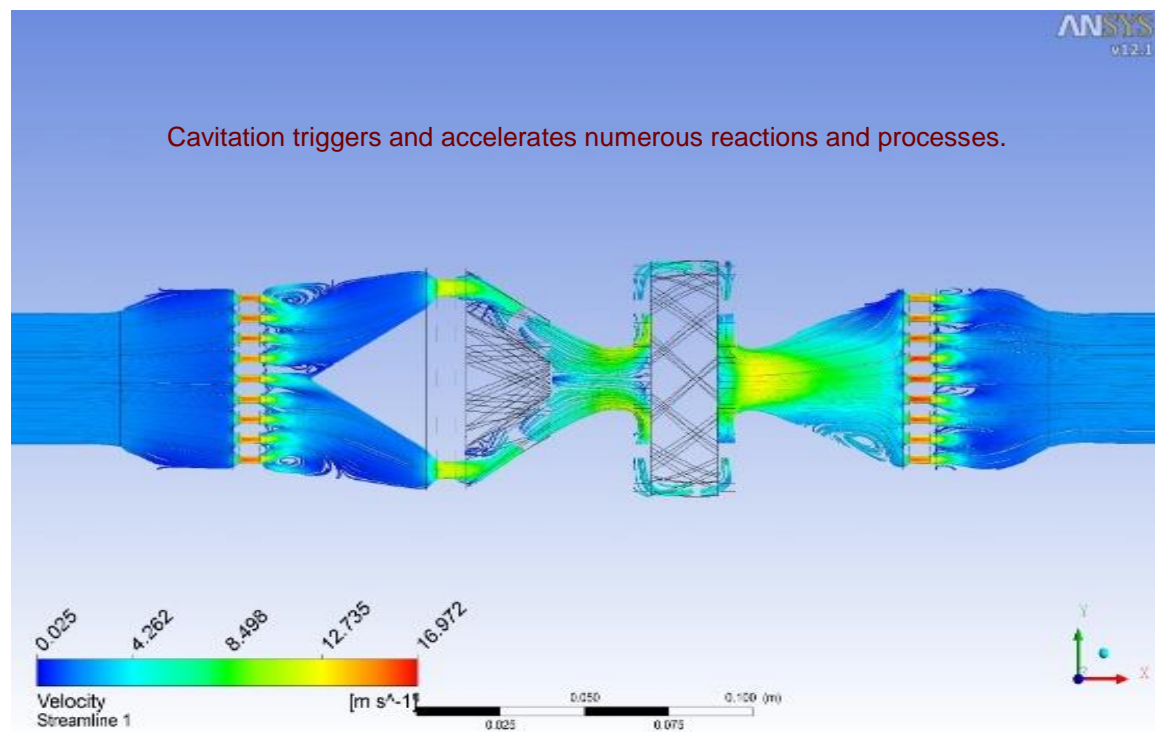
## 10 B

Patented technology under exclusive license.

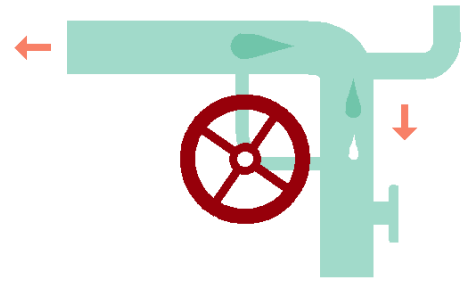
### Hydrodynamic Multistage - Flow Through Cavitation

Cavitation is a process by which a void (bubble) is produced in fluid stream and immediately implodes. Inertial (or transient) cavitation occurs when the pressure in the fluid stream decreases below the saturated vapor pressure of the fluid, creating a void where the matter phase has changed from liquid to gas.

This effect is usually localized since the bubble created within the stream needs a surface to nucleate – such as the sidewall of a container, the tip of a pump impeller vane, solid impurities in the liquid, or undissolved microbubbles.



Hydrodynamic cavitation comprises the nucleation, fluid's vaporization, growth, pulsation, and collapse of bubbles which occurs in a flowing fluid as a result of a decrease and subsequent increase in its static pressure. The collapse of the bubbles results in a localized significant increase in pressure and temperature. The combination of elevated pressure and temperature, along with vigorous mixing supplied by the hydrodynamic cavitation, triggers and accelerates numerous reactions and processes.



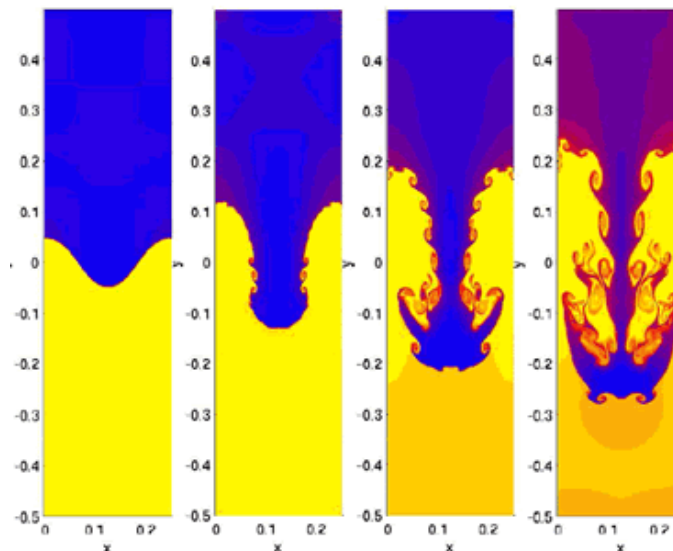
## 10 C

### Initiatives undertaken in the past five to ten years.

#### Cavitation/Advanced Oxidation

The shockwave released by many bubbles continuously collapsing also can be heard as the telltale “flowing gravel” sound in a pump, pipe, or valve, which is indicative of cavitation.

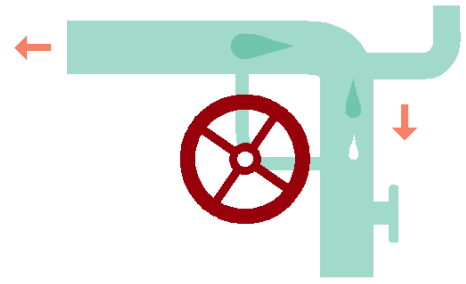
These forces can cause multiple chemical reactions, one of which is the dissociation of water into hydrogen and hydroxyl radicals. Hydroxyl radicals are powerful oxidizers and can be used to destroy organic constituents such as hydrocarbons.



While the supercritical effect is localized to the area of bubble collapse, there are three unique traits of supercritical cavitation in the water that can be used in produced water treatment: organic phases become completely soluble; oxygen is completely soluble and behaves as a strong oxidizer; and inorganic constituents become largely insoluble.

#### Quality Control

Accuracy in the online analysis of processed water allows to monitor the functionality and effectiveness of a production facility to be drawn. The right measuring technique enables the fast detection of parameters and provides the opportunity to take countermeasures.



## 11 A

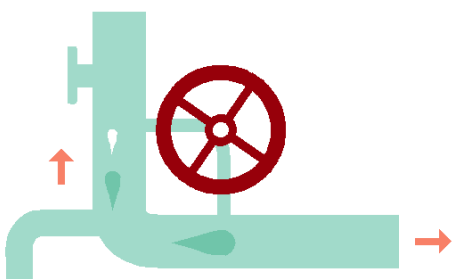
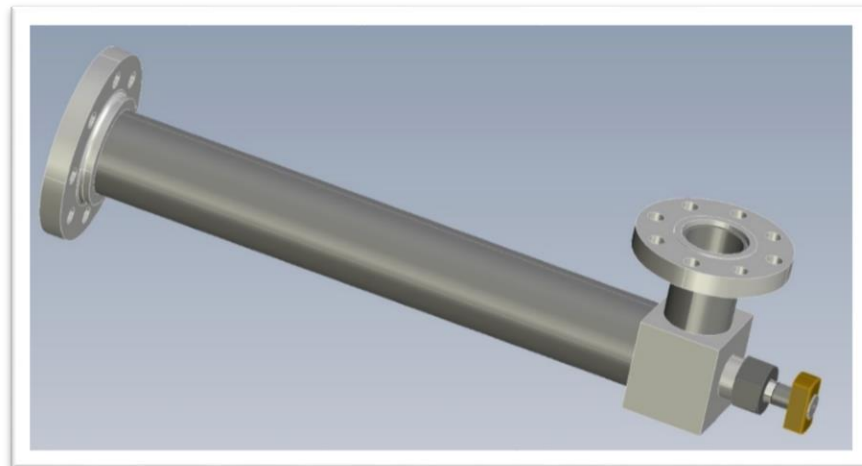
# Multistage Cavitation Reactor

### Patents

**MULTI-STAGE CAVITATION DEVICE** - The flowthrough cavitation device is provided for mixing and manipulating fluids that comprises feeding a fluidic mixture in a multi-stage flow-through hydrodynamic cavitation system, subjecting said fluid to a controlled multi-stage cavitation and continuing the treatment for a period of time sufficient for obtaining desirable changes in the physical and/or chemical properties and generating upgraded products Patent # 20100290307

**CAVITATION GENERATOR** - A method and device are provided for mixing and manipulating fluids that comprises feeding fluid in a multi-stage flow-through hydrodynamic cavitation system, subjecting said fluid to a controlled multi-stage cavitation and continuing the treatment for a period of time sufficient for obtaining desirable changes in physical and/or chemical properties and generating upgraded products. Patent # 20100103768

**HIGH-THROUGHPUT CAVITATION AND ELECTROCOAGULATION APPARATUS** - The invention relates to a cavitation and electrocoagulation reactor comprising a hollow cylindrical cathode having a cylindrical anode coaxially disposed therein to form an annular interelectrode gap between the contact surfaces. The method for removing contaminants from a contaminated fluid flow involves the simultaneous application of hydrodynamic cavitation and electrocoagulation to the contaminated fluid flow US Patent No. 8,673,129.







11 B

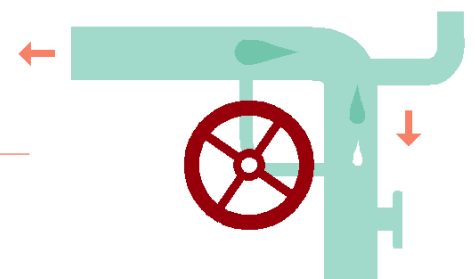
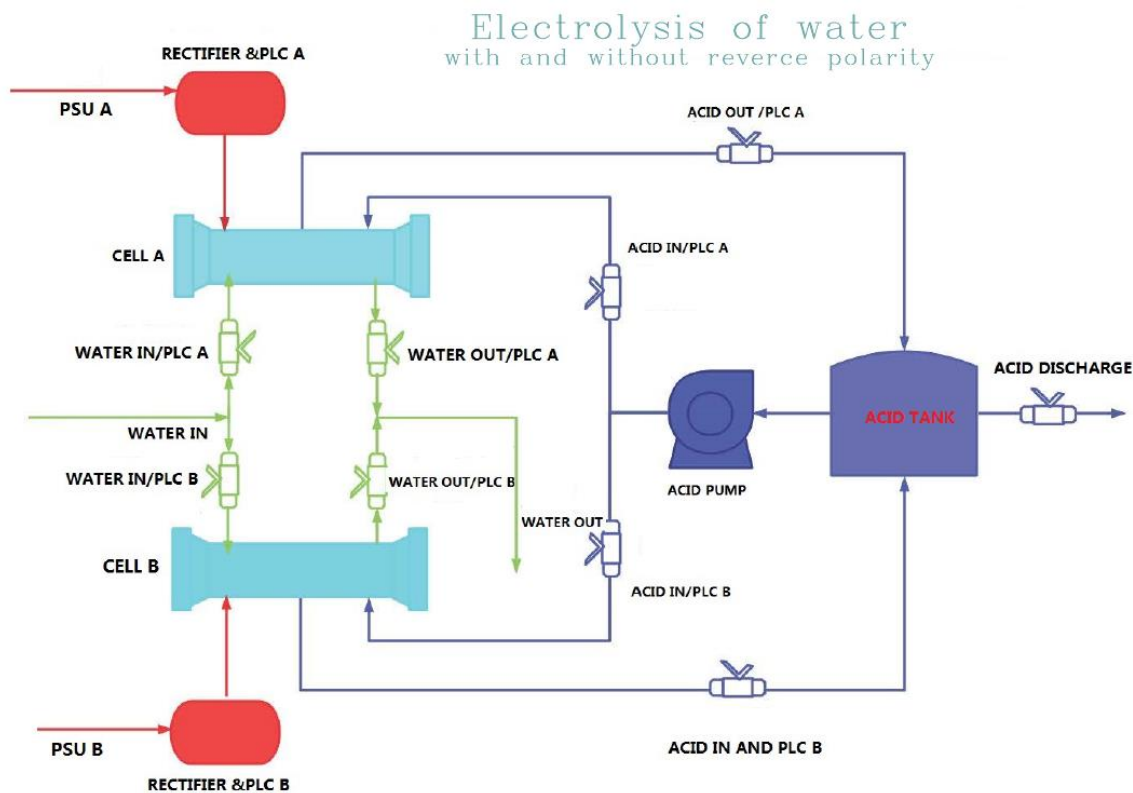
## Water Electrolysis Technology – Electrooxidation (EOx)

Disinfection of water by direct electrolysis is a kind of oxidative treatment of water, but is fundamentally different from the common methods of disinfection in that the oxidizers are made from the water itself, and are not introduced from the outside and, having fulfilled its function, go back to the previous state. The effectiveness of water disinfection by direct electrolysis is several times higher compared to chemical methods. Direct electrolysis of water helps to remove chromaticity, hydrogen sulfide, ammonium of the source water.

Chlorine, which is necessary to prevent secondary bacterial contamination of water in distribution networks, is activated from natural mineral salts in water passing through the electrolyzer and instantly dissolves in it. Direct electrolysis destroys chloramines, converting them into nitrogen and salt.

The difference between "direct electrolysis" and "production and accumulation of sodium hypochlorite" is that the use of special electrodes makes it possible to produce ozone and hydrogen peroxide from water.

During direct electrolysis, when the source water passes through the electrolyzer, oxidizers such as oxygen, ozone, hydrogen peroxide, sodium hypochlorite are synthesized, instantly showing their oxidative properties. In the case of the production and accumulation of sodium hypochlorite, when it is dosed into the treated water from oxidizers, only sodium hypochlorite remains.

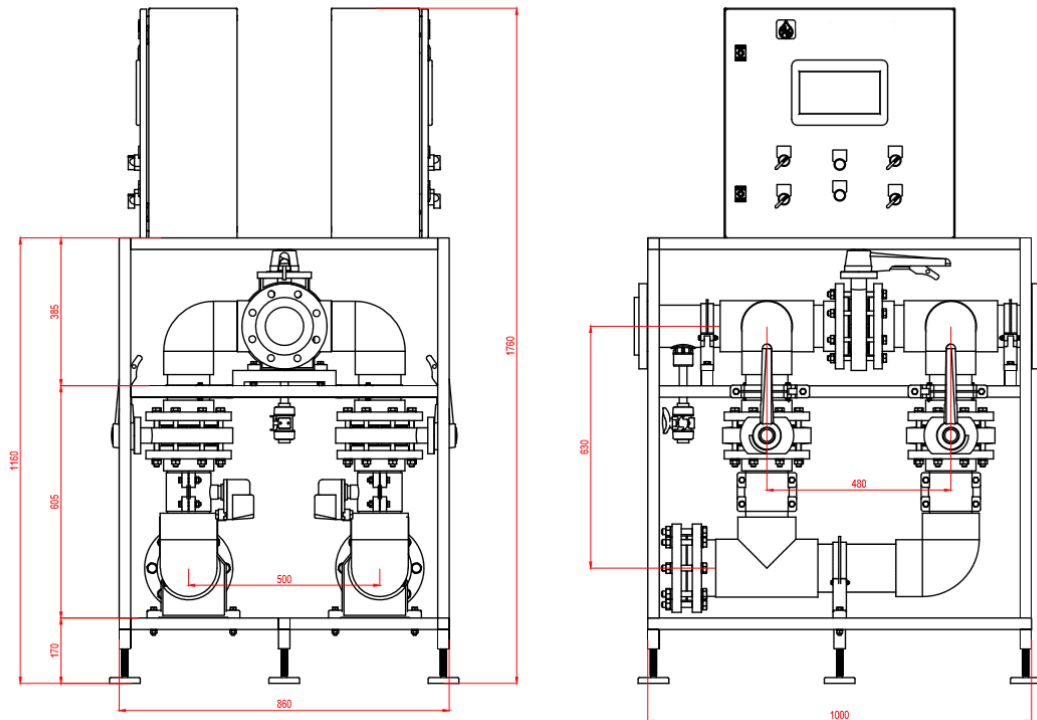


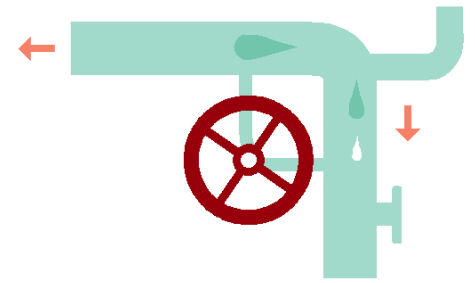


# 11 C

## Electrolyzer

Water management has always been a vital step in the development and production of oil/gas resources. Clean water's importance has increased dramatically with emergence of wide-scale development of shale resources for oil and gas production. We use high quality industrial mixed metal oxides (MMOs) anodes for both oxygen and chlorine evolution in order to address needed quality of water and the specific needs of our customers





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## Electrocoagulation

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Electrocoagulation (EC) utilizes soluble metal (like Al and Fe) electrodes to form metal hydroxides by using current between immersed metal electrodes in wastewater, and these metal hydroxides serve as coagulants and/or adsorbents to remove inorganic and organic pollutants and pathogens. Electrocoagulation mechanisms may involve oxidation, reduction, decomposition, deposition, coagulation, adsorption, precipitation, and flotation.



Our patented technologies have the capability to eliminate trucking costs, enhance production yields, reduce disposal costs, mitigate environmental risks and ensure regulatory compliance. Enviro Watertek Wate Technologies can facilitate reduction of iron, copper, zinc, turbidity, sulfide, barium, TPH, E.coli and more from flowback and produced waters before reuse or discharge.

**Electrocoagulation** (EC) may be an alternative to the use of coagulants like polyelectrolytes in the precipitation systems. Consider the following advantages

**Advantages:**

- Simple to operate
- Solids produced have low water content, are more easily settled or filtered
- Flocs are much larger, contain less bound water and separate from water faster
- Lower TDS, since no chemicals are added
- Effective on colloidal wastewater
- No “chemical” cost, storage or handling





## Advantages of Combined Electrocoagulation and Electrooxidation Treatment of Waters

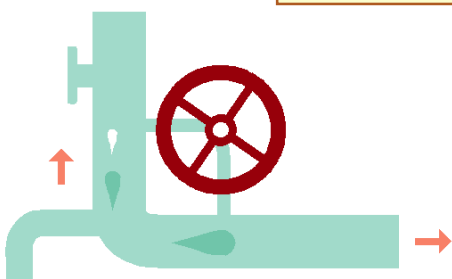
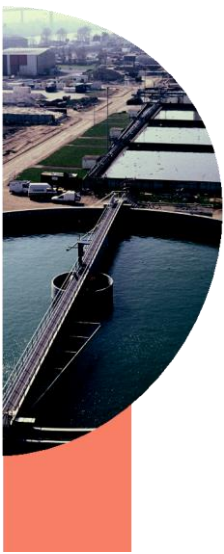
High pollutant removal yield from treated waters achieved by using electrocoagulation method without adding any chemical coagulant or flocculants, thus reducing the amount of sludge. However, electrocoagulation (EC) is an inefficient method for the removal of stable and dissolved organic pollutants. Electrooxidation (EOx), which is the most effective technologies for the treatment of waters containing soluble organic compounds, can directly and indirectly oxidize small organic pollutants. Since EC is fast but incomplete process and EOx is a complete but slow process, combining the two processes offers a practical hybrid.

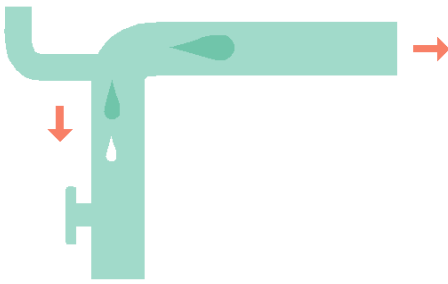
The most common inorganic water pollutants are heavy metals, nitrates, sulfates, phosphates, fluorides, and chlorides, which have serious hazardous effects.

The organic pollutants found in wastewaters may be generalized as insecticides, herbicides, fungicides, polycyclic aromatic hydrocarbons, phenols, biphenyls, halogenated aromatic hydrocarbons, formaldehyde, detergents, oils, greases, normal hydrocarbons, alcohols, aldehydes, ketones, proteins, lignin, and pharmaceuticals. These pollutants remain either in dissolved, in colloidal, or in suspended form.

Strengths of EC method can be summarized as follows; it requires equipment and operating conditions and does not require additional chemicals; treated water is colorless, odorless, and clear; the amount of the sludge formation is low which can be easily stabilized and dehydrated; compared with chemical coagulation, the effluent contains less total dissolved solids; and the gas bubbles produced in the cathode allow the pollutants to be separated easily by floating them to the surface.

The EOx can completely degrade many harmful organic pollutants before they reach the receiving environment. The EOx is based on in situ production of oxidants either directly at the surface of the electrodes.





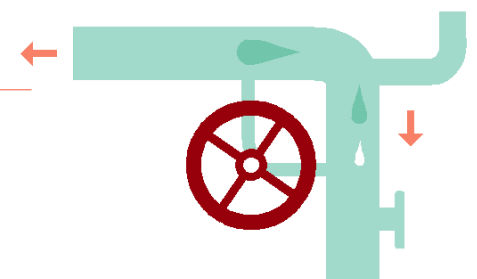
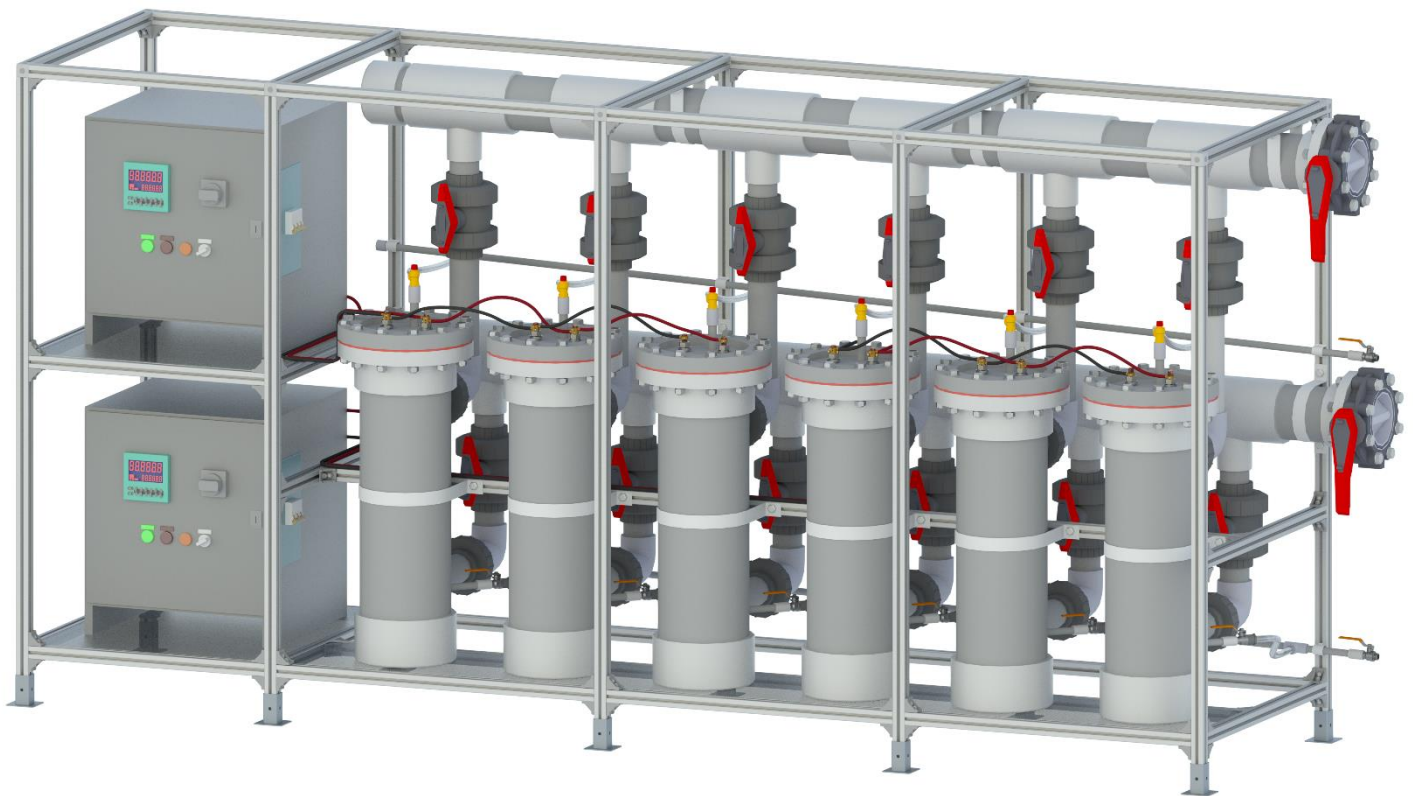
## 12 B

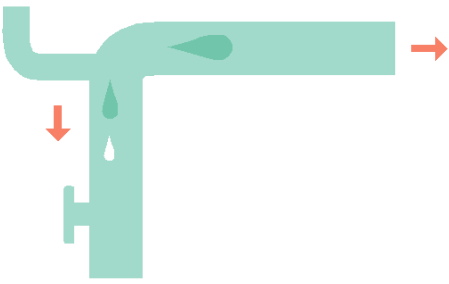
### Electrocoagulation (EC) Design

The removal of heavy metals from industrial waste has become one of the most essential applications in wastewater treatment in terms of protection of health as well as the environment. These heavy metals are known to be among the most common pollutants found in industrial wastewaters, pose serious health hazard, and are environmentally-unfriendly because they are not biodegradable and tend to accumulate in living organisms

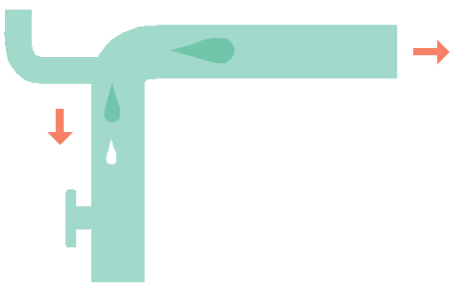
The EC has been used for the treatment of various types of wastewater and effluents containing algae, phosphate, sulfide, sulfate, sulfite, fluoride and heavy metals ions such as;  $\text{Fe}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Cd}^{2+}$

EC is a simple and efficient process where the production of the coagulating agent is managed in situ by means of electro-oxidation of a sacrificial anode.





**AVAILABLE CAPACITY**  
FROM 250GPM to 1000GPM

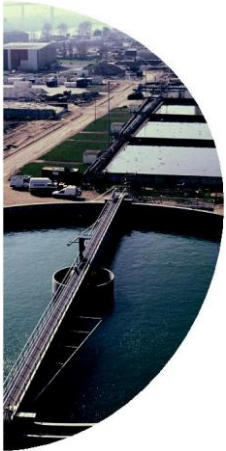


## 12 C

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### Enviro WaterTek water process

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The Enviro Watertek process includes proprietary technologies, unique stand -alone water treatment processes, hybrid configurations of commercial packages and patented systems developed for treatment of oil and gas produced water. This process includes pretreatment, post-treatment and concentrated waste disposal to meet the required water quality standards. Eliminating waste and harsh chemicals, reduces operational and man-power cost.

#### We Service Your Industry

##### OIL AND GAS

“Produced water” is the oil and gas industry term for any water that comes out of the oil or gas reservoir as part of the production process. Oil reservoirs often contain large volumes of water, while gas reservoirs typically have smaller quantities.

Due to increasing environmental awareness and regulations, disposal to surface waters and evaporation ponds is becoming less prevalent. Produced water is considered an industrial waste, subject to standards defined and issued by the U.S. Environmental Protection Agency.

##### INDUSTRIAL

Treatment solutions for lower costs and higher quality. Industrial water — water drawn from wells, surface and municipal sources to be used for heating, cooling, washing, rinsing and other processes — must often be treated in order to protect equipment and keep costs down. Minerals and bacteria in source water can reduce the efficiency and operating life of boilers and other systems. And if water is used in production processes, impurities can directly affect product quality.

##### AGRICULTURAL

Ensuring operational stability and future profitability in a volatile marketing climate means employing a cost-effective water and wastewater management program that optimizes the use of every drop of clean water.

Solution for the treatment and reuse of the large amounts of wastewater generated from agricultural processing operations. Enviro technology can solve the most challenging agricultural related wastewater challenges.



