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avivid

WATER TECHNOLOGY llc

Putting a new spin on water treatment.

Produced Water Treatment with Electrocoagulation

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Produced Oil Water
Case Studies

Oil & Gas Water Treated with TurboCoag® Processing

Avivid's tests on contaminated water from produced oil water sites in CO, NM, TX, PA, and WV have shown that TurboCoag® can successfully treat these oil waters. Treatment with TurboCoag® is an excellent alternative to deep well injection disposal of treated produced oil water, while also reducing operational costs and preserving resources.

Significant differences are observed between produced oil water and frack water. Optimum results are only obtained after testing to determine the correct dosage levels. These dosage levels are easily controlled by automatically adjusting the anode current levels and flow rates.

The Colorado water sample pictured at the right was given a nominal treatment, but contaminant removal results were not lab tested. This was solely for visual demonstration purposes.

Note: TurboCoag® does not remove salt, but it can be used as a pretreatment step before reverse osmosis if desalination is desired and will increase the longevity of RO membranes.

Avivid's O&G Treatment Process

The process displayed in the figure below broadly describes the operation for cleaning contaminated pond or lake water but can also be applied to agricultural manure lagoon ponds as well. The system would be composed of a "pod" of TurboCoag® reactors in mobile CONEX containers, created for ease of mobilization/demobilization and scaled to the on-site water volume requirements.

Principal advantages:

- Very clean effluent
- Controlled treatment levels
- Small footprint for the volume treated
- Does not use evaporation ponds and processes all water on-site directly for reuse

Dewatering equipment would be external to this multi-trailer system.

Optimum pH for TurboCoag® is 6 to 8, with a minimum salinity level of 1000 PPM. The process creates a precipitate which takes a few minutes to form and settle out. The precipitate is then separated from the water, while the clean water can be discharged into a stream, and the sludge—which passes the toxicity characteristic leaching procedure (TCLP)—can be disposed of in any landfill or may be land applied as a fertilizer depending upon the effluent constituents.

TurboCoag® V

The TurboCoag® V reactor (TCV) is our 5th generation reactor design that integrates all Avivid's lessons learned from field trial and customer testing experience. The TCV is supplied with patented rotating electrodes and an innovative housing design that eliminates the maintenance concerns of legacy electrocoagulation systems. This reactor is capable of 50 to 200 GPM depending on the level of contaminants in the water.

Single Reactor Specifications:

- **Power: 35 to 60 kW, @ 2500 to 5000 Amps**
- **Flow: 25-200 GPM /reactor**
- **Dimensions: 109" L x 43" W x 57" H**

Use Case: Frack Pond Water in West Virginia

Frack water from a storage pond in West Virginia was treated on April 15th through April 17th, 2019 and tested on April 15th and April 18th.

The water was initially treated with the TurboCoag® 1-GPM bench scale reactor to determine appropriate treatment levels and polymer dosages. Water was then treated at different dosage levels using the larger reactor in the pilot trailer known as TurboCoag® IV. The treated water was held in four 1500-gallon storage tanks. The water from each tank was tested for residual iron levels, which were compared to the iron levels in the untreated water.

The following tables provide data from these treatments.

TURBOCOAG® TREATMENT				
Water Sample	**Treatment Level Al^{+++}**	**pH**	**Iron (PPB)**	**Removed**
RAW	-	6.56	45500	
Bench Test	**74 PPM**	7.73	470	98.97%
Sample 1	**74 PPM**	7.73	2580	94.33%
Sample 2	**55 PPM**	7.82	2280	94.99%
Sample 3	**37 PPM**	7.45	5580	87.74%

Note: All tests performed with Hach FeroVer assay using Hach 890 spectrophotometer. Accuracy is +/- 10%.

The picture to the right shows the unfiltered samples from the above table. The water samples shown were decanted from the tanks (pictured below, left) about 18 inches above the sludge line.

Left to right: Sample 1, 2, 3, and RAW

The settling tanks, shown below left, hold the treated water from which the above samples were taken. These tanks are 116 inches high containing 1500 gallons each.

The picture to the right, above, shows the amount of sludge visible after settling.

Pictured at left is TurboCoag® IV, the electrocoagulation unit used to treat the fracking water at the WV demonstration site. The raw water was collected from the storage pond shown to the right.

The TurboCoag® unit above is for purposes of this demonstration only. This single reactor in the trailer is capable

of 5 GPM to 50 GPM, depending on the contamination level of the water. At these flow rates, the aluminum dosage levels are between approximately 150 ppm to 15 ppm. For most waters, larger doses are not required. The 15 ppm is about the lowest dosage that has been observed to be effective for any water treated.

The following table shows lab test results after the water samples taken from the storage tanks after settling.

AFTER SETTLING					
Water Sample	**Treatment Level Al^{+++}**	**pH**	**Turbidity (NTU)**	**Iron (PPB)**	**Removed**
RAW	-	6.23	21.0	29200	
Bench Test	**74 PPM**	8.03	6.0	62	99.79%
Sample 1	**74 PPM**	7.73	3.5	168	99.42%
Sample 2	**55 PPM**	7.82	2.9	201	99.31%
Sample 3	**37 PPM**	7.45	3.9	268	99.08%

The jars shown in the photo below are the same sample jars shown on page 10, after additional settling occurred.

Left to right: Sample 1, 2, 3, and RAW

Avivid's Electrocoagulation Advantages:

- Continuous water treatment
- Low maintenance system
- Oxidizes and precipitates heavy metals
- Kills bacteria, molds, spores and viruses, unlike chemical coagulants
- Creates micro-bubbles for flotation cells
- Removes suspended and colloidal solids without sludge buildup
- Removes fats, oil, grease and other complex organics
- Few or no chemicals required
- Substantial reduction in residual sludge resulting in reduced disposal costs
- Most sludge is inert creating TCLP[1] sludge suitable for ordinary landfill
- Effective preprocess for RO[2] and ED[3] systems by prolonging membrane life

[1] Toxicity characteristic leaching procedure (**TCLP**) is a soil sample extraction method for chemical analysis employed as an analytical method to simulate leaching through a landfill.
[2] Reverse Osmosis (**RO**) a process by which a solvent passes through a porous membrane in the direction opposite to that for natural osmosis when subjected to a hydrostatic pressure greater than the osmotic pressure.
[3] Electrodialysis (**ED**) is a membrane-based separation process in which ions are driven through an ion-selective membrane and separated and concentrated under the influence of an electric field.

Historical Issues with Electrocoagulation

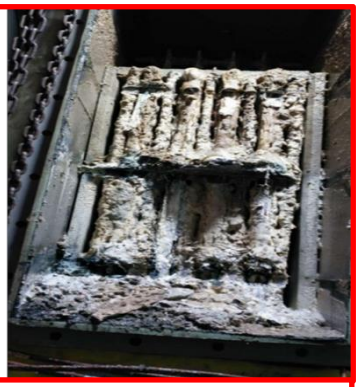
Electrocoagulation has been an "emerging technology" since the late 19th century, when many electrical and magnetic treatments were attempted. Significant ongoing worldwide work on the science of EC consistently supports the potential efficacy and efficiency of the process. However, EC is not widely used because developing an EC reactor into a robust industrial process requires resolving serious issues.

The most important of these issues are electrode fouling (passivation) and sludge accumulation. Electrode fouling is primarily oxidation of the anode which creates an insulating layer that impedes or stops the current flow. Fouling can also occur with sludge buildup between the anodes and cathodes, creating flow and electrical problems.

Typical electrocoagulation reactors still struggle with the engineering problems of passivation and sludge buildup as illustrated in the photos below, which were provided by a potential customer.

Traditional EC with Fixed Anodes

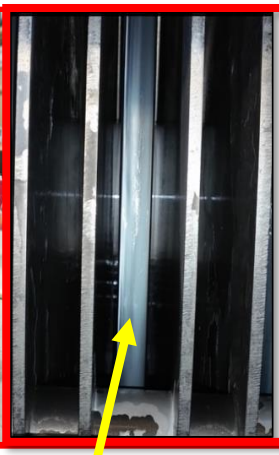
Passivation Limits Operation



Reactor Sludge Buildup

TurboCoag® vs Traditional EC Technology

Commercial Sized Reactor



New Aluminum Anodes width: 0.75"

Anodes after 40 days of 24/7 operation: 0.04"

Rotational anodes were fully consumed after 40 days of 24x7 operation without passivation and without sludge buildup within the reactor.

- TurboCoag® provides a unique water treatment system that can displace chemical treatments.
- TurboCoag® reduces OPEX for the operator sludge in three distinct ways:
    - **sludge disposal by 30-70%**
    - **chemical consumption by 70-100%**
    - **biocide consumption by 100%**
- Maintenance can be accomplished within two hours by replacing the anode cartridge. Design life of the cartridge is 30-60 days depending upon inlet water quality, flow rates, and treated water requirements.

With the development of TurboCoag®, Avivid Water Technology has created a solid technical response to the design, operation, and reliability challenges of traditional electrocoagulation. The company's TurboCoag® reactor dramatically removes the important limitations of traditional EC reactor designs.

For further information please contact us. Feel free to visit our facility for a demonstration.