Powell Water – The Electrocoagulation Process

Electrocoagulation (EC) is a process that has been in existence for decades with the first patent issued in 1906. However, it has been only recently that the process has been fully commercialized as a result of technical advancements specific to overcoming the deficiencies of previous units.

30 gpm EC Power Supply and Chamber

Electrocoagulation (EC) will significantly reduce BOD, TSS, TKN, phosphate, silica, heavy metals, and other contaminants from aqueous solutions. With the use of clean electricity, electrocoagulation efficiently removes a wide range of contaminants with a single system. The EC makes constituents in the water "separable". Heavy metals are converted from ion forms to oxide forms, allowing them to be disposed in a non-hazardous landfill. Because electrocoagulation utilizes methods that precipitate out large quantities of contaminants in one operation, the technology is the distinct economic and environmental choice for industrial, commercial and municipal waste treatment. The capital and operating costs are usually significantly less than chemical coagulation.

Powell Water is the industry leader and the world's largest supplier of industrial electrocoagulation (EC) systems has more than 150 installations worldwide. The EC chamber consists of flat metal blades placed parallel to each other. Untreated water is introduced into the bottom of the chamber and is dispersed evenly as it moves upward through the blades. Direct current is applied to the first and last blade. The liquid then becomes a conductor, allowing the current to pass freely throughout the chamber. This results in a flood of electrons into the water, neutralizing charged particles, causing them to precipitate out of solution. In addition, the metal blades react to the current by releasing charged metal ions that act similar to chemical coagulants. The unit also contains an automated clean-in-place (CIP) system and an air purge system that fluidizes precipitates and reverses polarity in order to extend metal blade life and prevent contaminants from coating the blades. No chemicals are required for the treatment process. The acid solution used in the automated cleaning cycle is recycled and, when exhausted, is routed through the EC system for final disposal. EC has become recognized as a very effective means for economically treating a wide variety of challenging water treatment applications and are available in sizes ranging from 1 gpm to multiples of 2,500 gpm.

30 gpm EC Chamber with Metal Blades Prior to Wastewater Flow

Powell Water

Sundine Enterprises

Recycle, Reuse, Rethink!

720-363-0548

SPECIFICATIONS

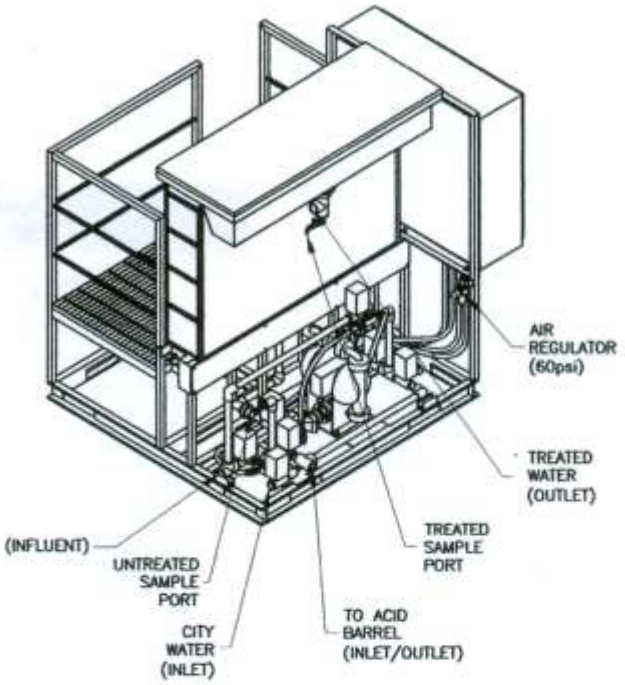
FLOW RATE:
30 GPM

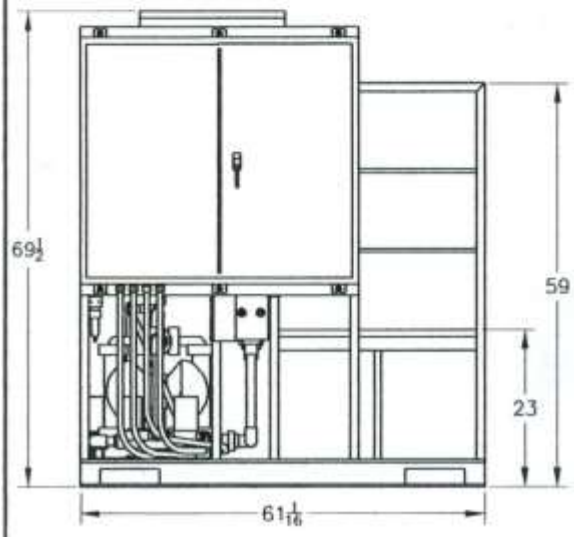
ELECTRICAL:
460V 3ø, 120A

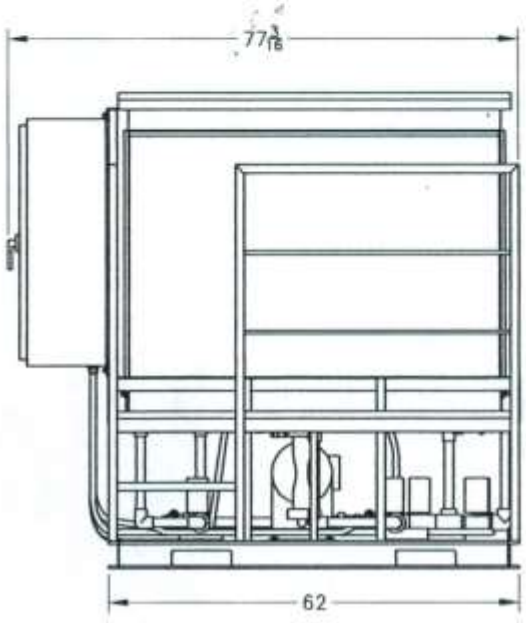
AIR:
60psi REGULATED

PLUMBING:
1" SUPPLY AND FEED LINES
2" TREATED LINES
SCH 80 PVC

SHIPPING WEIGHT:
SKID – APPROXIMATELY 800 lbs.
STEEL BLADES – APPROXIMATELY 1800 lbs.
ALUM. BLADES – APPROXIMATELY 650 lbs.







Powell Water 30 GPM Electrocoagulation

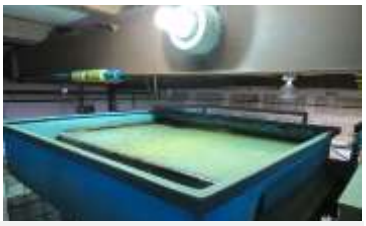
Powell Water EC - Effective, Economical Wastewater Treatment

Applications:

- Aquaculture
- Aquifer regeneration
- Coal
  - Colloids
- Commercial laundry
- Cooling towers
  - Silica
- Food processing
  - Beef, chicken, pork slaughter houses
- General industrial
- Ground water clean up
- Mining – active/closures
  - Heavy Metals
- Pre-treatment to R.O.
- Municipal Sewage:
  - BOD
  - Cold water ammonia
  - FOG
  - Micro pollutants
  - Pathogens
  - Pesticides
  - Pharmaceuticals
  - TSS
  - Viruses
- Oil and gas
- Plating
- Potable water
- Produced water
- Radioactive isotopes
- Semi-conductors
- Swimming pools

30 gpm EC Chamber, Power Supply, and Observation Deck

30 gpm Carbon Steel Blade with Cathode and Anode Posts



30 gpm EC Chamber with Contaminated Water Flowing through Sacrificial Metal Blades

APEX Advantages

No Process Chemicals Required - The treatment process requires no chemicals. The system is periodically cleaned with an acid solution that is recycled.

Minimal Operator Requirements – Even the largest systems can be operated with only 1 or 2 operators. Operator training is straightforward. The simple design ensures the system is very reliable and cannot be damaged by operator error or process upset.

Minimal Maintenance – Maintenance is limited to periodic replacement of the flat blade electrodes which consist of generic plate that can be purchased locally.

Low Operating Cost – Besides manpower, the only operating costs are power and periodic metal blade replacement. Power consumption is typically 4 kwh/1,000 gallons, and metal blade consumption is about 0.20 lbs. /1,000 gallons treated.

Minimal Waste Disposal – Most contaminants are precipitated as oxides which render them non-hazardous and able to pass the TCLP test. Since no additional chemicals are added, the waste volume is minimal and can typically be discharged into dumpsters for haul-off or non-hazardous landfill.

Treats Wide Range of Contaminants – Treats a wide range of items including suspended solids, colloidal solids, emulsions, fats, grease, bacteria, viruses, heavy metals, hardness, silica, boron, selenium, and organics.

Powell Water Systems, Inc.
Summary of Contaminant Removal Efficacy
Utilizing Electrocoagulation Technology

Biologicals

Contaminant	Before	After	% Removal
Bacteria	110,000,000 cfu	2,700 cfu	99+
Coliform	318,000,000 cfu	ND (<1) cfu	99+
E. coli	>2,419.2 mpn	ND (<0.01) mpn	99+
Enterococcus	83 mpn	ND (<10) mpn	82
Total Coliform	>2,419.2 mpn	ND (<0.1) mpn	99+
Cyanotoxin	67.7 ug/l	2.2 ug/l	97

Dyes

Contaminant	Before (NTU)	After (NTU)	% Removal
Ref. 006-691	125.1	12.1	90
Ref. 006-692	129.4	2.2	98
Ref. 006-854	68.30	0.68	99+
Ref. 006-851	2,340	4.5	99+

Hydrocarbons

Contaminant	Before (mg/l)	After (mg/l)	% Removal
Benzene	90.1	0.3590	99+
Ethyl Benzene	428	0.372	99+
MP-Xylene	41.6	0.057	99+
MTBE	21.58	0.0462	99+
O-Xylene	191	0.416	99+
PCB	0.0007	ND (<0.0001)	85
Petroleum Hydrocarbons	72.5	ND (<0.2)	99+
Toluene	28,480	0.227	99+

Nutrients

Contaminant	Before (mg/l)	After (mg/l)	% Removal
Ammonia	49	19.4	60
Nitrate	11.7	2.6	77
Nitrite	21	12	42
Nitrogen TKN	1,118.88	59.08	94
Phosphate	28	ND (0.2)	99+
Potassium	200	110	45
Sulfate	104	68	34

Pesticides

Contaminant	Before (mg/l)	After (mg/l)	% Removal
Aldrin	0.063	ND (0.001)	98
Chlorpyriphos	5.87	ND (0.03)	99+
Cypermethrin	1.3	0.07	94
DDT	0.261	0.002	99+
Diazinon	34	0.21	99+
Lindane	0.143	ND (0.001)	99+
Propetamphos	80.87	0.36	99+

Metals / Minerals

Contaminant	Before (mg/l)	After (mg/l)	% Removal
Aluminum	224	ND (0.7)	99+
Arsenic	0.076	ND (<0.002)	97
Barium	0.014	ND (<0.001)	93
Boron	4.86	1.41	70
Cadmium	0.125	ND (<0.004)	96
Calcium	1,321	21.4	98
Chromium	139.	ND (<0.1)	99+
Cobalt	0.1238	0.0214	82
Copper	0.7984	ND (<0.0020)	99+
Cyanide (free)	723	ND (<0.02)	99+
Fluoride	1.1	0.415	62
Gold	5.72	1.38	75
Iron	68.34	0.19	99+
Lead	0.59	0.0032	99+
Magnesium	13.15	0.04	99+
Manganese	1.061	0.018	98
Mercury	0.72	ND (<0.003)	98
Molybdenum	0.35	0.029	91
Nickel	183	0.07	99+
Platinum	4.4	0.68	84
Selenium	68	38	44
Silicon	21.07	ND (0.10)	99+
Silver	0.0081	0.0006	92
Tin	0.213	ND (<0.020)	90
Vanadium	0.262	ND (<0.002)	99+
Zinc	221	0.140	99+

Synthetic Organic Compounds/Organics

Contaminant	Before	After (mg/l)	% Removal
BOD_5	1,050 mg/l	14 mg/l	98
NTU	35.38 mg/l	0.32 mg/l	99+
TSS	1,560 mg/l	8 mg/l	99+
PFOS	140 ng/l	3.1 ng/l	98
PFOA	44 ng/l	5.0 ng.l	89

Radioisotopes

Contaminant	Before	After	% Removal
Americium-241	71.99 pCi/l	0.57 pCi/l	99+
Plutonium-239	29.85 pCi/l	0.29 pCi/l	99+
Radium	1093 pCi/l	0.10 pCi/l	99+
Uranium	0.13 mg/l	0.0002 mg/l	99+

Abbreviations:

mg/l = milligrams per liter or parts per million
pCi/l = picocuries per liter
cfu = colony forming unit
mpn = most probable number
ND = not detectable at the reporting limit
NTU = nephelometric turbidity units

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August 7, 2010

Dear Mr. Hamilton,

The purpose of this letter is to inform you of the results we have recently obtained from our tests of the Powell Water Systems Electrocoagulation unit for removal of biological pathogens and indicators from sewage.

We performed a trial using a single sample of raw sewage obtained from a municipal wastewater treatment facility in southwest Florida. Samples were tested to determine the abundance of two types of bacteria and four types of viruses before and after treatment with the electrocoagulation unit. The electrocoagulation process resulted in significant decreases in the concentration of all microorganisms tested, and in several cases reduced the concentration of the pathogens to below the detection limits of our assays. Electrocoagulation led to an approximately 4 log reduction in the concentrations of both fecal coliforms and Enterococci (approximately 99.999% decrease). Concentrations of phages (viruses that infect bacteria) infectious for *Eschericia coli* and *Bacillus subtilis* decreased from several thousand plaque forming units (pfu) per milliliter to less than one pful per milliliter. In addition, concentrations of human polyomaviruses were reduced from approximately 10,000 copies per milliliter to below assay detection limits, demonstrating that electrocoagulation removed human pathogenic viruses.

In addition, we determined the efficiency of electrocoagulation for removing *Pepper mild mottle virus* (PMMoV), which is a plant pathogen that has recently been found at extremely high concentrations in human sewage. PMMoV was found in the raw sewage at approximately 60,000 copies per milliliter and electrocoagulation reduced the PMMoV concentrations to below detection limits. This is extremely encouraging since we typically see PMMoV concentrations in excess of 10,000 copies per milliliter in final effluent from most commercial treatment plants.

My laboratory has spent several years studying the types of viruses and bacteria present in raw sewage and treated wastewater, with the goals of identifying pathogens that present a risk to public health as well as effective indicators that can be used for water quality testing. In our preliminary experiment, the Powell Electrocoagulation unit reduced all the tested biological agents (including both bacteria and viruses) with greater efficacy than current wastewater treatment practices.

Thank you for facilitating this trial, and I hope that we can continue to work together in the future to further evaluate this very promising treatment process.

Sincerely,

Mya Breitbart

Dr. Mya Breitbart