Treatment of Waste Water Produced by Electronic Industry by Electrocoagulation Process
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Abstract:
There are two fundamentals reasons of waste water viz. prevention pollution and thereby protecting the environmental and protecting the public health by safe guarding waste supplies and preventing the spread of water born diseases. When untreated industrial waste water is discharge it will contaminate the natural water body i.e. river, lake with hazardous chemicals. It is absolutely necessary to study the characteristic of industrial waste water, to ensure its safe disposal. These study will help in determination the degree the type of treatment required to given waste water this avoid the pollution of sources of it disposal. Waste water produced from electronics industry is from pre-treatment process. Company having an In-house facility of 10 tank process for phospheting of panel for purpose of degreasing, oxidation and oil removal. The waste water treatment plant it has been designed with Electrocoagulation treatment unit.

Keywords: Prevention, Diseases, waste water, Hazardous, Pollution, Disposal, Electrocoagulation treatment unit.

1. INTRODUCTION
During the last century huge amounts of industrial waste water was discharged in to rivers, lakes and coastal areas. This resulted in serious pollution problems and caused negatives effects to the ecosystem and human’s life. Industrial wastewater treatment describes the processes used for treating waste water that is produced by industries as an undesirable by product. After treatment, the treated industrial water may be reused for domestic purpose i.e. gardening, flushing etc. For checking the quality of treated water physical and chemical impurities must be in permissible limit as per IS 10500:2017 i.e. colour, turbidity, temperature, odour, pH, total solids (suspended and dissolved), hardness, chemical oxygen demand (COD) For complete treatment of waste water produced by industry we adopted Electrocoagulation process. EC unit with aluminum electrodes at low value of current density is most economical process.

2. BACKGROUND
Tushar Prabhakar, Rohan S Gurav, (2019)- This paper is the extended study of previous paper “Powder coating industry Wastewater Characteristics and its effect on environment”. This paper explains about the treatment of Powder Coating Industry waste water and the best possible treatment method and its parameters. Electrocoagulation method or technique is one of the promising techniques available for the treatment of this type of wastewater. The experiments were conducted with aluminum electrodes with various combinations of connections. Parameters such as pH, TDS, Colour, Turbidity, Phosphate and Chromate removal is showed using Aluminum electrode with the efficiency of 95.5% is found out. The electrical usage power required has also been calculated for the designed test treatment unit.

Gunatilake S. K. November – (2015), Methods for treating industrial wastewater containing heavy metals often involve technologies for reduction of toxicity in order to meet technology-based treatment standards. This article was focused on the recently developed and newly applicable various treatment processes for the removal of heavy metals from industrial wastewater. Physico-chemical removal processes such as; adsorption on new adsorbents, ionex change, membrane filtration, electro dialysis, reverse osmosis, ultra filtration and photo catalysis were discussed. Their advantages and drawbacks in application were evaluated. Biological treatments are eco friendly, best removal and low cost methods. Lot of bio adsorbents can be found in nature. Physical and other most common chemical methods are produced toxic sludge which is unable to settle within industries. Although chemical cost is high chemical treatments is one of the most suitable treatments for toxic inorganic compounds produced from various industries which cannot removed from any biological and physical techniques.

Ahmed Samir Naje (2015)- Contemplated Treatment Performance of Textile Wastewater Using Electrocoagulation (EC) Process under Combined Electrical Connection of Electrodes .In this paper The effect of a few working parameters, for example, bipolar anode component (Fe or Al), electrolysis time (RT), momentum power (I), pH, concoction bolster, between terminal separation (IED), and mixing speed (Mrpm) were analyzed.
M.A. Barakat 21 July 2010- Over the past two decades, environmental regulations have become more stringent, requiring an improved quality of treated effluent. In recent years, a wide range of treatment technologies such as chemical precipitation, adsorption, membrane filtration, electro dialysis, and photo catalysis, have been developed for heavy metal removal from contaminated wastewater. Although many techniques can be employed for the treatment of wastewater laden with heavy metals, it is important to note that the selection of the most suitable treatment for metal-contaminated wastewater depends on some basic parameters such as pH, initial metal concentration, the overall treatment performance compared to other technologies, environmental impact as well as economics parameter such as the capital investment and operational costs. Finally, technical applicability, plant simplicity and cost-effectiveness are the key factors that play major roles in the selection of the most suitable treatment system for inorganic effluent. All the factors mentioned above should be taken into consideration in selecting the most effective and inexpensive treatment in order to protect the environment.

3. IDENTIFICATION OF PROBLEM

Company has powder coating unit, for which the material has to pass through various tanks including dissolved chemicals in water. Companies have In-house facility of 10 tank processes for phospheting of panel for purpose of degreasing, oxidation, oil removal. They have powder coating unit as well as well painting facility. Through the process of pre-treatment waste water generated. Waste water generally content Rusto kem 2A, Bonderite AK 5055, Kemkote 312, Fixodine 50CF etc those chemicals are use for degreasing, derusting, passivation, phosphating. To remove all hazardous chemical mixed with water we introduced an Electrocoagulation unit. Generated waste water from industry cant disposed in natural stream as per orders and by rules of MIDC. But by using electrocoagulation unit oil and grease, colour, chemical present in water Removed up to permissible limit, and treated water easily disposed in natural stream or it may be reuse for domestic purpose.

4. PROPOSED METHODOLOGY

Great quantities of harmful wastewater are produced during the production process of electronic products and components. If factories were to discharge wastewater into river or any natural stream. It would cause the serious harm to ecological recourses in the surrounding which can be very fatal. Wastewater treatments not only changed poisoned substance in non-poisoned substances, but also recycle wastewater so they can be reuse again. Because of many chemicals use in electronic industry for numerous processes, wastewater generation is quite high in industry. Waste may included organic and inorganic wastes, Acid and alkalis, heavy metals, oil and grease, biological waste, etc. organic waste collected separately from wastewater system. Acid and alkalis are sending to onsite wastewater treatment facilities. In our study treatment of electronic industry wastewater include only an electrocoagulation unit. This consists of pair of aluminum plate in parallel, which act as monopolar electrodes. It further more required a direct current power source, a resistance box to regulate the current density and a multimeter. Electrocoagulation (EC) is well established technology for treatment of industrial waste water without the need for process chemicals such as Ferric, PAC or polymers. A wide range of pollutant can be efficiently removed up to 98% including heavy metal, COD, BOD, suspended and colloidal solids, bacteria, viruses.

Typical Contaminant Removal Performance using EC Technology

The removal rates for the contaminants listed below are typical and are intended to provide a guide. Most wastewater is complex products and it may only single contaminants that need removal to meet discharge or re-use standard. The EC unit can remove multiple contaminants from wastewater or target specific elements and this is done by selection of electrodes material, residence time and current density applied. In our case for treatment of wastewater produced by electronic industry we use aluminum plate, and residence time is up to 120sec per batch. In one batch approximately 600 lit wastewater is going too treated. EC unit having a capacity of 50m³/hr

**Table 1. Analysis of Impurities**

<table>
<thead>
<tr>
<th>Parameters (Physical and Chemical)</th>
<th>Before treatment (By EC process)</th>
<th>After treatment (By EC process)</th>
<th>Max. permissible limit(as per IS 10500:2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>colour</td>
<td>25</td>
<td>5</td>
<td>15-20 (Cobalt Scale)</td>
</tr>
<tr>
<td>Turbidity</td>
<td>10</td>
<td>5</td>
<td>5-10 NTU</td>
</tr>
<tr>
<td>Temperature</td>
<td>28.7°C</td>
<td>12.5°C</td>
<td>10-15°C</td>
</tr>
<tr>
<td>Odour</td>
<td>Nil</td>
<td>NS</td>
<td>Nil</td>
</tr>
<tr>
<td>pH</td>
<td>8.89</td>
<td>6.82</td>
<td>6.6-8.6</td>
</tr>
<tr>
<td>Total suspended solid</td>
<td>239 ppm</td>
<td>89 ppm</td>
<td>100 ppm</td>
</tr>
<tr>
<td>Total dissolved solid</td>
<td>589 ppm</td>
<td>188 ppm</td>
<td>500</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>5.48</td>
<td>7.57</td>
<td>40% of the saturation value, or 3mg/lit whichever higher.</td>
</tr>
<tr>
<td>Hardness</td>
<td>850</td>
<td>100</td>
<td>75-115</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>7.289</td>
<td>1.251</td>
<td>0.1</td>
</tr>
<tr>
<td>COD</td>
<td>267.33</td>
<td>76.33</td>
<td>75-100</td>
</tr>
</tbody>
</table>

Figure 2. Sample of electronic industry wastewater
The Electrocoagulation process
Electrocoagulation (EC) is the process of applying a direct current voltage to the wastewater to be treated using submerged electrodes which act as the anode and cathode. Typically, these electrodes are made from mild steel and aluminum. A DC voltage is applied to the electrodes and due to the conductivity of water passes between the electrodes. The electrical current acts on the suspended particles in water, neutralizing their charges and allowing the very fine solids to precipitate and settle. The electrical current also makes the electrodes sacrificial and in doing so, they give up their metal ions into solution in water. These iron acts a similar manner to the chemical coagulants used in DAF system. Suspension and emulsion are destabilized, solids coagulate and separate out and hydrocarbons. The EC reaction time is typically between 20 and 120 seconds depending upon the contaminants being treated. The consumable are electricity and the sacrificial electrodes. Both these directly affect the EC operational cost. Energy consumption is typically 1.0 kw/hr per cubic meter (1000 liters) treated with metal electrodes consumption of between 5 and 20 grames per cubic meter treated. Compared with chemical doasing systems, EC produces significantly less sludge with much lower sludge handling cost. Unlike chemically produced sludge, EC produces a broadly neutral pH, easy to dewater and non-leaching, oxide sludge.

Electrocoagulation – Electrical Description
EC requires a DC voltage to be applied to the submerged electrodes in the reaction chamber. The incoming voltage is AC and therefore needs rectifying before it can be applied. The incoming electrical supply is typically 400V three phase but for smaller EC plants 230V single phase can be used. A 1:1 isolation transformer for safety and then the AC supply is converted to DC via a fully configurable and controllable digital DC drive. This delivers a fully variable DC voltage to the electrodes from 0- 480V DC. The EC process depends upon the electrical current density (CD) applied to the electrodes and the available surface areas of the electrodes. The EC plant provides a very large electrode surface area relative to the flow rate meaning the CD can be minimized for the specified reaction time. The current drawn is dependent on the conductivity of the water which can vary extensively. The EC reaction chamber is configured using a bipolar electrical connection and multiple; close spaced electrodes to reduce the resistance in the chamber. This make the energy consumption very efficient because no excess voltage used as this would lead to wasted heat. Because the operator of the EC plant is able to fully tailor the voltage applied, the absolute minimum electrical energy and metal electrodes are consumed.

Objective of the study
The main objective of study is to calculate the design parameters which affect the efficiency of the wastewater treatment system in the electronic industry. Working of these parameters will point out the environment management system to be adopted for the treatment of waste.

Parameters considered in the experimental study
- pH
- Colour
- Turbidity
- Temperature
- Odour
- Total solid (suspended and colloidal)
- Dissolved Oxygen

5. DESIGN WORK
The EC system was a batch type reactor (50Lit capacity) it is consisted 17 electrolytic cell and the electrodes were square with a rectangular flange the dimension of electrodes are given in fig. The electrodes had a thickness of 5mm: the cathode was made up of aluminum. The cell consisted of 4 areas, Sedimentation, flotation, reaction and circulation. The electrodes were arranged in parallel (20mm spacing) to lower the potential difference between the electrodes and they were connected in series. The entire anode was connected at single point and all the cathode were connected at another point. The reaction area was where the electrical transfer between the electrodes and solution occurred. The sedimentation is allowed flogs to precipate and accumulates without clogging the reaction area. Bubbling occurred in the circulation area and caused water circulation between the electrodes Lab-scale experimental was conducted with cylindrical vessels using a laboratory direct current (DC) power supply. All of the experiments were performed at room temperature.
Sampling and EC experiments
The sample was collected after drain-out the pre-treatment tank. Whole drained water is not possible to treat in a single batch. The initial characteristics are presented in table 2. To evaluate EC efficiency the experiment was conducted with the EC prototype. The water volume was 50Lit and tests were done at room temperature. Electrodes gaps were 20mm, the current densities were 11A/m² and the reaction time 15 min, after the reaction time the sample were allowed to settle for 60min.

6. MODEL ESTIMATION
Model estimation is necessary for effective benefits, it depend upon consumption of water in industry generally for pre-treatment process, cleaning, sanitary purpose and gardening etc. Near about 20,000 lit waste water and 25 Kg sludge generated per week. In electrical industry RS.60,050Required as water charges.

Operational cost

<table>
<thead>
<tr>
<th>Per month</th>
<th>Before adoption of EC unit</th>
<th>After adoption of EC unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>80,000 lit</td>
<td>RS.60,050</td>
<td>RS.2560</td>
</tr>
</tbody>
</table>

The estimated monthly operating cost saving using Electrocoagulation is RS.57, 490 per month.

Construction cost
80,000 lit waste water generated monthly from industry.
Construction cost for 1000 lit = 9, 64, 438 RS
Construction cost recovery: - 3 year 9 month.

7. CONCLUSION
1. The prototype Electrocoagulation system demonstrated a significant level of efficiency. The model generated made it possible to removal of physical and chemical impurities effectively. Efficiency of removal of impurities is up to 91%.
2. The optimum operating condition was a current density 7A/m² to 11A/m² and a 15-mm electrodes gap.
3. Treatment plant is capable of removing chemical impurities completely.
4. Electrocoagulation unit is suitable to any small scale industry.

8. FUTURE SCOPE AND BUSINESS POTENTIAL
- Treated water use for domestic purpose i.e. gardening, cleaning, and sanitary purpose.
- Water charges may get reduces which beneficial to industry.

9. REFERENCE
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