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STUDY OF REMOVAL OF HEAVY METAL BY ELECTROCOAGULATION PROCESS IN THE TREATMENT OF SUGAR INDUSTRIAL WASTE WATER

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ABSTRACT

A vast number of publications have delved the operation of the electrocoagulation (EC) process in heavy essence ions junking from sugar wastewaters. Utmost of these studies were simple lab-scale using synthetic wastewater with the absence of a holistic and methodical approach to considering the process complexity. This comprehensive review considers the abecedarian aspects of EC processes similar as mechanisms, kinetic models, and an isotherm model used by different exploration errs. Likewise, the impact of the main design and process functional parameters on the junking effectiveness is bandied and anatomized. Numerous concluding reflections and perspectives are stated to give perceptivity for possible unborn examinations.

Keywords: electrocoagulation (EC), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), polyaluminium chloride (PAC).

1. Introduction: Sugar diligences have an important place in Indian profitable development. Still, the wastewater generated from these diligences bears a high degree of pollution cargo. Sugar diligence in India induces about L of wastewater for one ton of sugar club crushed. Wastewater from the sugar assiduity, if discharged without treatment, poses pollution problems in both submarine and terrestrial ecosystems. In this review, the sugar assiduity wastewater generation sources, characteristics, recent advancements in aerobic, anaerobic, and physicochemical treatment technologies, and the areas demanding farther exploration have been explored. The possibility of treated wastewater exercise was also delved. Utmost of the exploration work for sugar assiduity wastewater treatments has been carried out by anaerobic treatment processes. Still, canvas and grease aren't fluently degraded by anaerobic processes. Also, an anaerobic process incompletely degrades nutrients whereas, aerobic processes consume advanced energy. Anaerobic-aerobic combined systems can remove organics fully. Unfortunately, veritably many studies are available for anaerobic-aerobic combined systems, and further work is demanded in this field. The sugar assiduity is one of the diligence that produce a high quantum of adulterants since its wastewater contains a high quantum of organic material, Biochemical Oxygen Demand (Duck) and Chemical Oxygen Demand (COD). Still, it can beget problems to submarine life and the terrain, If this waste is discharged without proper treatment into the watercourse. For the primary treatment process, sugar wastewater can be treated by using the chemical rush system which involves a coagulation process. Presently, ferric chloride has been used as the coagulant but it consumes further alkalinity and is sharp. In this study, the suitable coagulant to be used to treat the wastewater from the sugar assiduity and the optimum conditions to achieve high chance junking of COD was determined. The specific of the wastewater was originally determined. Also, the most suitable coagulant to be used for the treatment was studied by determining their effectiveness to reduce COD and TSS in the wastewater at different tablets. Aluminium sulphate (alum), ferric chloride and poly aluminium chloride (PAC) were chosen to be studied for suitable coagulants. The optimum condition of the coagulant (pH, coagulant lozenge, fast mixing speed) was determined by using Design-Expert software. Results showed that alum can be used to effectively remove42.9 of COD and 100 of TSS at high lozenge (50 mg/ l). The optimum condition of alum was at pH5.2, 10 mg/ l of alum and 250 rpm of mixing speed. This shows that at optimum conditions, alum can be used to treat wastewater from the sugar assiduity. The sugar assiduity is one of the largest agro-based diligences as sugar is one of the essential substrates for mortal salutary consumption and it's an important product for mortal life. The effluent produced from the sugar assiduity if it isn't duly treated before releasing it into the water sources can beget pollution to the terrain (1). The wastewater produced in the sugar manufacturing process has a high content of organic material and latterly high Biochemical Oxygen Demand (Duck), particularly because of the presence of sugars and organic material in the beet or club. In sugarcane processing, the typical situations of Duck are 1700 – 6600 ppm in the undressed effluent, the Chemical Oxygen Demand (COD) is from 2300 to 8000 ppm the total suspended solids are over to 5000 mg/ L, and the ammonium content is high. Multitudinous systems have been recommended by experimenters to treat sugar assiduity wastewater similar as adsorbent

(2), electrochemical anaerobic natural treatment, biochemical oxidation etc. The wastewater treated by the below styles isn't meeting the discharge limit; it needed revision either in individual treatment or independently. The chemical rush system adopts the coagulation and flocculation process and it's proven to be suitable to remove a remarkable quantum of adulterants in the wastewater

(3). Coagulation and flocculation is a process of adhesion and contact whereby the dispersed colloid patches form Page 1 of 2 flocks or large clusters and enables them to be removed from water fluently by settling, flotation or filtration. In the coagulation and flocculation process, numerous types of coagulant can be used to destabilize the patches and wad the patches into flock form so that they can latterly be deposition and separated from the liquid.

(4). Alum can achieve high organic junking This statement can be supported by where the junking effectiveness of COD reached up to 48 to 87 in addition to the TSS of the wastewater can be reduced up to 94.

(5). in another study, the chance of COD and TSS junking was59.9 to84.5 and92.4 to95.9 independently. Meanwhile, 62 to 80 of COD junking and 75 to 90 of TSS junking also can be attained.

(6). Ferric chloride, ferric sulphate and ferrous sulphate gave the stylish performance at too acidic conditions. Still, using ferric chloride as a coagulant at around neutral pH can give 44 to 67 of chance junking of COD and 71 to 76 chances junking of TSS.

(7). Likewise, by using FeCl3 as a coagulant, it can reduce65.3 to71.1 of COD and75.5 to 85 of TSS. Polyaluminium chloride (PAC) allows the conformation of floc briskly compared to another coagulant as it has a high positive electrical charge so it can neutralize the charges of the colloidal fluently and reduce the repellent between patches therefore allowing the patches to form larger flocs.

2. Main factors: *ELECTROCOAGULATION PROCESS* Electrocoagulation is one of the most promising processes gaining attention to a researcher in the present era due to its high contamination removal efficiency. It is used for both water and wastewater treatment. In the electrocoagulation process, oxidation occurs on sacrificial anode and reduction occurs at the cathode in an aqueous solution when current is applied. Aluminium and iron electrode material are most commonly used due to their various advantages such as availability, their low cost. The coagulant/precipitates, such as iron and aluminium hydroxides are formed in situ during the process, are non-toxic, and have high contaminants removal efficiency. In the electrocoagulation process, electrode material and their area, solution pH, current density and treatment time play a significant role, whereas, the presence of electrolytes and distance between electrodes also can affect the process.

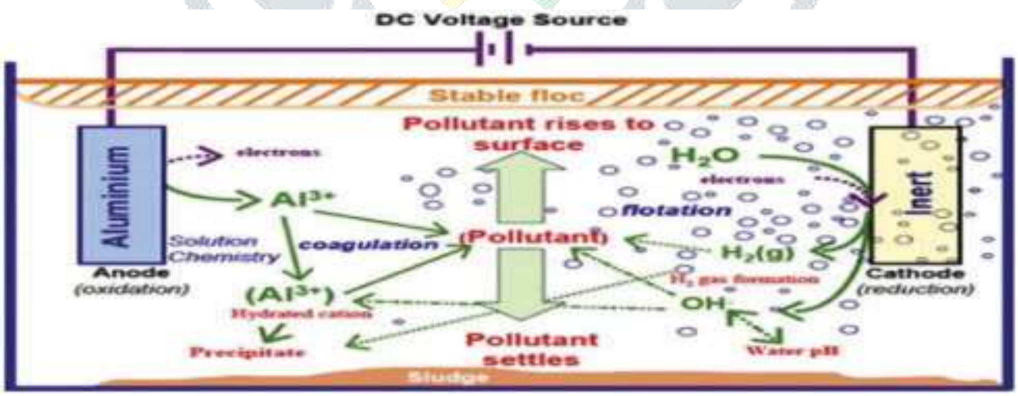

Figure 1.1: electrocoagulation process

2. EXPERIMENTAL METHODOLOGIES:

MECHANISM OF ELECTROCOAGULATION Medium OF ELECTROCOAGULATION The medium of electrocoagulation isn't completely known because of its complex response. The result to be treated by electrocoagulation is filled in the reactor. Electrodes of analogous or different material are dipped into the result and classified as anode and cathode. These electrodes are connected to the power source, through which the current is passed into the result. When current is passed through aluminium and iron anodes Al3 and Fe2 ions, independently, are formed. At cathode hydrogen gas and hydroxide ions are released at the same moment of time. These hydroxide ions combine with the Al3 and Fe2 ions in result and formed aluminium and iron hydroxides, independently, which act as a coagulant. Aluminium and iron are generally used electrodes in electrocoagulation process. In the iron electrode, two mechanisms have been proposed.

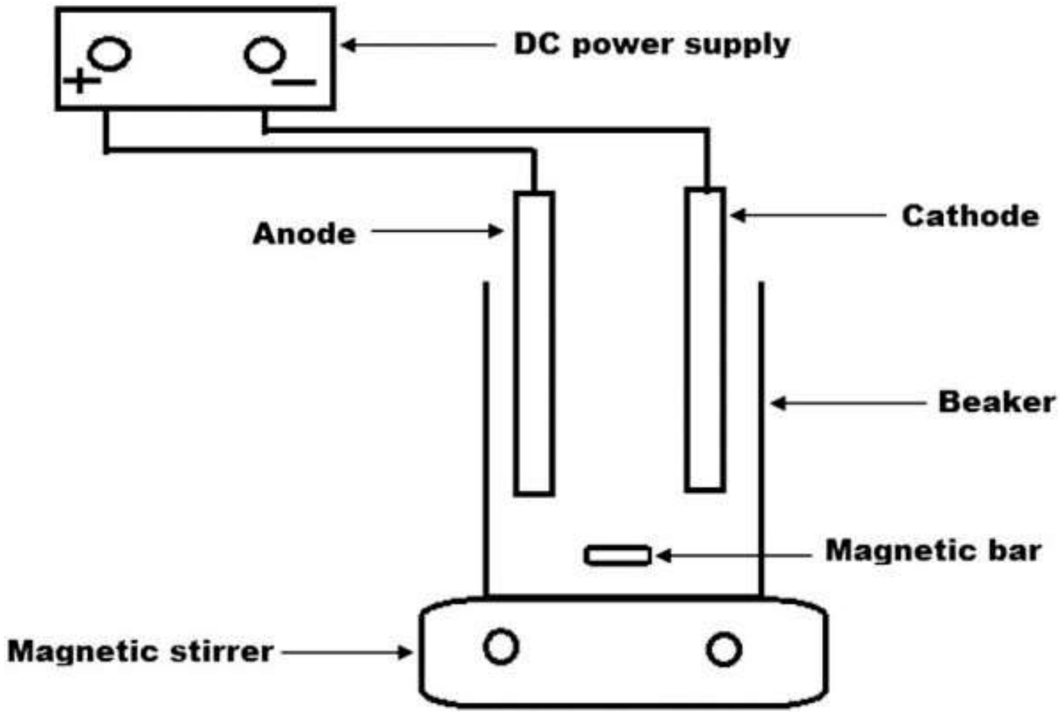

Fig. 2.1: Schematic Setup of Electrocoagulation System

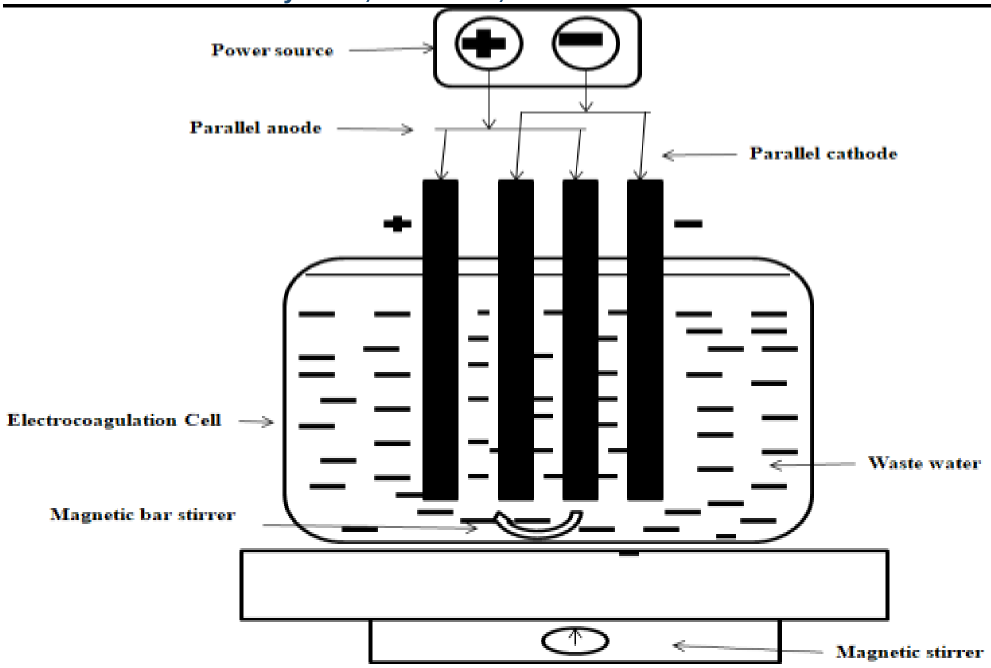

Figure 2.2. Schematic diagram of the experimental setup used for the electrocoagulation study

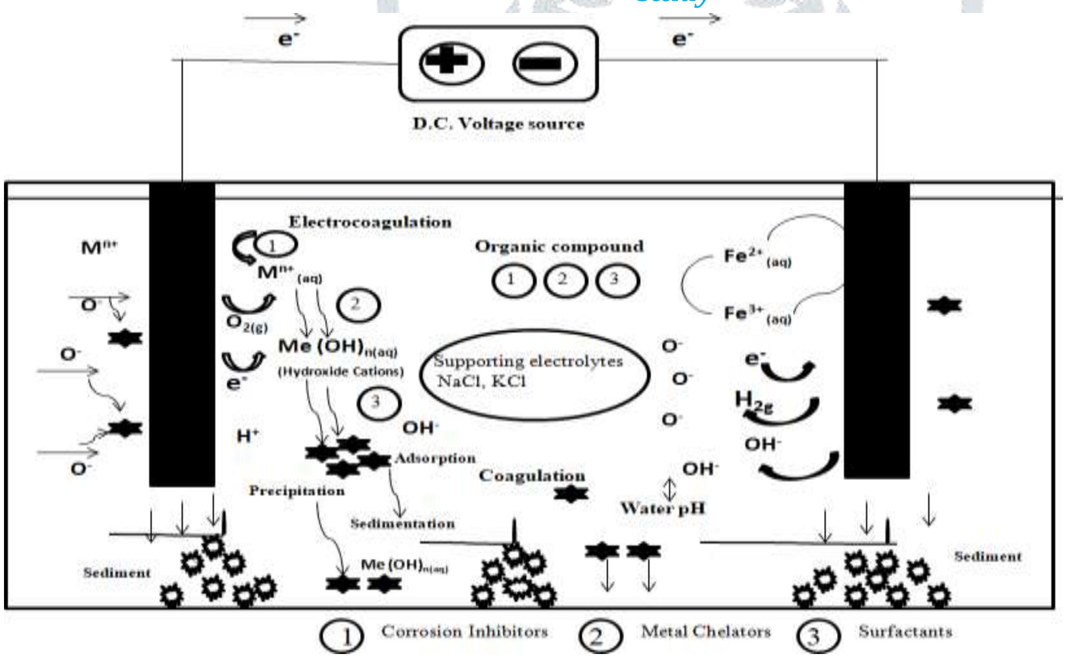

Fig. 2.3 Diagram showing complexities and interactions in an electrochemical reactor.

Mechanism 1:

Anode: $4Fe(s) \rightarrow 4Fe^{+2}(aq) + 8e^{-}(aq)$

$4Fe^{+2}(aq) + 10H2O\ (l) + O2\ (g) \rightarrow 4Fe\ (OH)\ 3(s) + 8H^{+}\ (aq)$

Cathode: $8H^{+}\ (aq) + 8e^{-} \rightarrow 4H2\ (g)$

Overall: $4Fe^{2+}(s) + 10\ H2O\ (l) + O2\ (g) \rightarrow 4Fe\ (OH)\ 3(s) + 4H2\ (g)$

Mechanism 2:

Anode: $Fe(s) \rightarrow Fe^{+2}(aq) + 2e^{-}$ $Fe^{+2}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2 (s)$

Cathode: $2H_2O (l) + 2e^{-} \rightarrow H_2 (g) + 2OH^{-}(aq)$ Overall: $Fe(s) + 2 H_2O (l) \rightarrow Fe(OH)_2(s) + H_2 (g)$

In case of iron electrodes various form of monomeric ions such as Fe (OH)3 and polymeric hydroxyl complex such as Fe(H2O) 3+, 6 5 Fe(H2O)2+, Fe(H2O)4(OH)2+, Fe (H2O) 8(OH) 4 + and Fe2 (H2O) 6(OH) 4+ are generate in an electrolyte system. In the case of aluminium electrode reactions are as follows: Anode: Al(s) → Al + (aq) + 3e- Cathode: 3H2O (l) + 3e- → 3/2 H2 (g) + 3OH- 3

Al3+ions further react to hydroxyl ion and formed aluminum hydroxides and poly hydroxides such as $Al(H_2O)^{3+}$, $Al(H_2O)_5OH^{+}$, $Al(H_2O)(OH)^{2+}$ etc. 6 2

Metal ions produced at the anode and hydroxide ions

produced at the cathode react in the aqueous media to produce various hydroxides species depending on the pH such as Fe(OH)2, Fe(OH)3, Fe(OH)2+, Fe(OH)2+ and Fe(OH)4−. The iron-hydroxides coagulate and precipitate to the bottom of system.

To determine theoretical dissolved mass of iron from anode, Faraday's law can be used.

$m = l \times t \times M / (z \times F)$

where m is the quantum of anode material dissolved (g), I is the current (A), t is the electrolysis time (sec), M is the molecular weight (g/ spook), z is the number of electrons involved in the response, and F is the Faraday's constant Riyad delved that EC for junking of heavy essence by using iron electrodes material. This study delved the performance of a new nonstop- inflow, perforated tube EC system for treating synthetic results containing zinc, bobby, nickel, trivalent chromium, cadmium and cobalt using iron anodes accoutrements. In an attempt to achieve a advanced junking capacity, several working parameters like pH, current viscosity and heavy essence ions attention were studied. For the junking of heavy essence, a simple and effective treatment process is basically necessary. A reactor consists of a graduation series of twelve figures of electrolytic cells, each cell containing pristine sword cathode and iron anode in the nonstop inflow EC system. The study investigates the treatment of synthetic results containing Zn2, Cu2, Ni 2, Cr 3, Cd2 and Co2. Results attained with synthetic wastewater revealed the following The most effective junking capacities of studied essence were achieved when the pH was kept at 7 Charge lading was plant to be the only variable that affected the junking effectiveness significantly. An increase of charge lading was observed for all essence ions when the current viscosity was varied in the range0.27-1.35 mama/ cm2. The junking edge of all studied ions increased with charge lading (Qe). The junking rate has dropped upon adding original attention. The quantum of iron delivered per unit of the contaminant removed wasn't affected by the original attention. Longer electrolysis times were necessary for chromium, cadmium and cobalt junking. Lower effective junking of chromium compared to zinc, bobby and nickel and the less effective junking of cadmium and cobalt. The result show that iron was veritably effective as sacrificial electrode material for heavy essence junking effectiveness and cost points.

3. *RESULT & DISCUSSION PARAMETER AFFECTED ON ELECTROCOAGULATION*

Following are the effect of different functional parameters on junking effectiveness of heavy essence from wastewater samples attained from different diligence was delved to determine the operating optimum conditions which have been published in journals.

Effect of pH

The original pH of a result is one of the important factors affecting the performance of electrochemical processes as refocused out by several authors. PH is a critical operating parameter impacting the performance of the EC process. PH of the medium changes throughout the process, depending on the type of electrode material and original PH. The EC process exhibits only some buffering capacity, substantially in alkaline medium, that prevents large changes in pH and a drop of the contaminant junking effectiveness. In acidic media, advanced junking edges are attained.

Effect of Current Viscosity

The effect of current viscosity is an important parameter for contaminant junking within the electrocoagulation (EC) process that affects the essence hydroxide attention formed during the system. High current viscosity especially results in the corruption of the electrode material. With the increase of the current viscosity advanced values of junking, edge were attained. The advanced effectiveness of junking of pollutants with increased current viscosity was because of the advanced quantum of ions produced on the electrodes that promote destabilization of the contaminant motes and the aggregation of the convinced flocks while adding hydrogen elaboration. Still, the increase of the current viscosity Page 1 of 2 causes advanced consumption of the anode material. Current viscosity influences coagulant lozenge as well as bubble conformation rate, their size and the flock's growth. Current viscosity is an important factor that influences the electrocoagulation (EC) process. It's plant that the junking effectiveness of TS, COD and FC are increased snappily up to a current viscosity of 20 mama/ cm2. This is explained by the fact that the coagulant product on the anode and cathode increases at the same time as increase the current viscosity. But, at advanced current viscosity (25 – 30 mama/ cm2), the junking of TS, COD and FC are nearly constant.

Effect of Electrode Material

The most generally used electrode accoutrements for EC are aluminium and iron. They're cheap, readily, available and effective. Electrode material defines which electrochemical responses are within the EC system. Optimal material selection depends on the adulterants to be removed and the chemical parcels of the electrolyte. In general, aluminium seems to be superior compared to iron in utmost cases when only the effectiveness of the treatment is considered. Aluminium electrodes were most effective in removing the colour of the wastewater, whereas iron electrodes removed COD and phenol from the wastewater more effectively than aluminium electrodes. A common arrangement of aluminium and iron electrodes removed colour, COD and phenol with high effectiveness. Iron electrodes and a combination of iron and aluminium electrodes gave the loftiest arsenic junking edge. From essence plating wastewater analogous results were attained for bobby, chromium and nickel junking.

Effect of EC Time

Response time is one of the most significant functional parameters for all electrochemical treatment processes as with the increase of response time, erosion of electrodes releases advanced quantities of coagulant ions in the result, an increase in response time bettered the effectiveness of phosphate junking. An increase in electrolysis time leads to an increase in coagulant attention that have been reported to reduce the flock viscosity, also reduce their settling haste. The EC time is an important parameter that's influential on the electrocoagulation (EC) process. Electrolysis time is of vital significance in the performance EC process. It's plant that junking effectiveness of TS, COD and FC increases with adding electrolysis time over to 15 min, later junking effectiveness is observed nearly constant. The junking effectiveness increased with settling time.

Effect of Electrolyte (NaCl) Attention

It's important to probe the effect of electrolyte attention since factual wastewater generally contains a certain amount of hearties as the electrolyte attention increases, the junking effectiveness increases due to the proliferation of the electrical conductivity reaching the maximum value. Still, with the increase in NaCl attention, the junking effectiveness diminishments. Sodium chloride is generally employed to increase the conductivity of the water or wastewater to be treated. Electrical Energy and Electrode Consumption Electrical energy consumption is a significant provident parameter in the electrocoagulation process. It can be seen that the longer the contact time of the system applied, the weight of the electrode consumed in the simple EC process has been increased. The variation of electrical energy consumption increased proportionally with contact time.

Effect of Applied Voltage

In all electrochemical processes, the applied voltage is the most significant parameter for controlling the response rate within the electrochemical reactor. It's well known that this variable determines the product rate coagulant, adjusts also bubble product, and hence affects the growth of formed flocks. The Effect of Inter Electrode Distance The distance between the electrodes is an important variable to optimize operating costs. According to the characteristics of the effluent, the process effectiveness is constantly bettered by varying the distance between the electrodes.

Effect of Operating Temperature

Is another important operating condition that will affect adulterant junking effectiveness in wastewater treatment the turbidity junking effectiveness from an abattoir wastewater in the EC process increased by adding result The results show that adding temperature damages junking. Still, it should be noted that the operation of the electrocoagulation (EC) process at an advanced temperature significantly reduced electrical energy consumption and fluid conductivity increases. Therefore, the product of hydroxide species increases swiftly also enhances pH value. Wastewater generated during ultimate of the processes may contain several organic and inorganic chemicals, which can't be discharged directly into water bodies or on land or into sewers. Due to analogous various countries regulate the amount and quality of the backwoods. Therefore, pollution abatement and environmental protection are now the policy statements of large enterprises. These programs encourage the minimization of brackish use. Various Processes analogous as wet oxidation

(1) Thermolysis Coagulation

(2) Absorption and membrane separation have been reported to treat various artificial backwoods. All these processes have their limitations. Electrocoagulation (EC) is one of the better options for the treatment of various artificial backwoods.

(3). the current challenge is the financially realistic performance of new and largely effective but cost and energy ferocious, treatment technologies. Advanced wastewater treatment goes beyond the position of conventional secondary treatment to remove significant amounts of nitrogen, phosphorus, heavy substance, biodegradable organics, bacteria and contagions.

(4). Electrocoagulation is a fashion used for wastewater treatment, industrially reused water and medical treatment .

(5). The electrocoagulation process removes adulterants that are generally more delicate to remove by filtration or for Page 1 of 2 chemical treatment systems analogous as emulsified oil, petroleum hydrocarbons, refractory organics Suspended solids and heavy substance .

(6). Electrocoagulation has been used primarily to treat wastewater from the pulp and paper sedulity

(7) Mining and substance processing industriousness. In addition, Electrocoagulation has been applied to treat water containing foodstuff waste .

(8) Canvas waste Colorings Public conveyance Organic matter from tip leachates.

(9) De fluoridation of water.

(10) Synthetic cleaner backwatersetc. During the last numerous decades, the environmental sector has shown a truly high interest in the treatment of different types of water and wastewater by the electrocoagulation process. This work aims to review former studies on the wide range of operations of electrocoagulation employed in the treatment of wastewater expiring from different industriousness analogous as cloth, makeup, pulp and paper, food, tannery and electroplating industriousness.

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