Hospital Waste Water Treatment By Electro Fenton Process

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ABSRACT

Electro Fenton process is a relatively economical method other AOPs and both iron and hydrogen peroxide are relatively cheap and safe. The reactions are efficient at low pH-levels. Electro Fenton Process for waste water treatment shows better results over the conventional method. Electro Fenton process can be used as a tertiary treatment to waste water. The other parameters such as TDS, Color, COD and SS shows effective changes over conventional method. Effect of distance between the electrodes on the removal efficiency of TDS, Color, COD and SS. Distance between the electrodes in this method is selected between 3 cm and 3.5 cm which causes a 4% increase in the removal efficiency and gives rise to energy consumption and operational cost of the method. Optimum value of 12-30 V DC after that rate of degradation reduced. Value of DC voltage should be less than 40V DC supply. As per experimental studies optimum reaction time is 120-150 minutes in which maximum removal of TDS, Color, COD and SS. There is complete mineralization of organic matter. There is no need for any processing units on the surface. This process reduces organic loading in terms of chemical oxygen demand and done the removal of recalcitrant and toxic pollutants thus allowing for further conventional biological treatment.

Keywords – Hospital Waste Water Treatment, Color, TDS, SS Removal, Electro Fenton Process, DC Current.

Introduction

Hospital wastewater has been discharged into the sewage network without any primary treatment or there is no any conventional wastewater treatment facility provided for the treatment of collected wastewater is not able to meet wastewater originate from domestic, industrial, commercial, agriculture activity may create threat to human life. Waste water which generated from the Municipal and hospital usually conveyed in combined sewer or sanitary landfill and treated at wastewater treatment plant.

Types of Hospital waste

Radio-Active Waste

Radio-active waste may be solids, liquids and gases used for analytical procedures, body organ imaging and tumor localization and treatment.

Chemical Waste

This type of waste may be hazardous, toxic, corrosive, flammable, reactive or genotoxic.

Pharmaceutical Agents

This is the main source of the hospital waste which enters because there were surplus stock, spillage or contamination was detected or the expiry date over.

Sources of Hospital Waste

1. Drug treatments.
2. Surgery.
3. Radiology.
4. Operation room.

5. Laundry.
6. Chemical and biological laboratories.
7. Medical services.
8. Research activities.

Electrochemical (Electro-Fenton) Process

Electrochemical oxidation process is also called as Electro Fenton Process which is the combination of Electro Coagulation and AOPs Fenton Process. Electrochemical reactions include in Electro-Fenton methods situ generation of their agents used for the Fenton reaction and generated reagents depend on solution conditions, cell potential and nature of electrodes. Production of Ferrous ions oxidative dissolution of anodes such as iron metal or by reduction of ferric ions at an inert cathode such as platinum and H_2O_2 may be produced by dioxygen reduction at the cathode.

Advantages of Electro Fenton Process

1. Main advantage of this process is environmental compatibility.
2. Clean reagent is used
3. Can control various parameters like COD, BOD, TDS, Turbidity, Color removal etc.
4. Less Effluent produced
5. Wastewater can be reuse for process.
6. Cost of reagents are lower
7. This treatment process can be used at ambient temperature.
8. Complete mineralization of organic matter
9. Very effective at removing resistant organic compounds
10. Produce less harmful by-products
11. Less maintenance required

Applications of Fenton Process

1. Water Reclaim Process of various types of waste water
2. Chemical Industry
3. Pharmaceutical Industry
4. Pulp and Paper Industry
5. Textile Industry
6. Food Industry
7. Landfill Leachates
8. Biomedical Application
9. Dye-Process Industrial Waste
10. Pre-treatment to wastewater, sludge, or contaminated soil
11. Organic pollutant destruction
12. Toxicity reduction
13. Biodegradability improvement
14. BOD / COD removal
15. Odor and color removal

Literature Reviews

Electro Fenton process can be used as a tertiary treatment to waste water. The other parameters such as TDS, COD, SS shows effective changes over conventional method. For this treatment process the optimum values of parameters such as reaction time 120 Min , pH value between 4-5 , DC voltage 6-18 V and the distance between two electrode will be 3-3.5 cm. By adjusting all the parameters the results of this process will effective.[5]. **Study of efficiency of AOPs by Vineetha et al. (2013)** the photo degradation of effluent in the presence of solar radiation and the result shows 79 % color removal under the optimum conditions of H_2O_2, pH and catalyst. for the treatment of effluent, They also observed AOP combined with electro coagulation process more effective for COD, SS, TDS and

Color removal from waste water. Electro Fenton process can be used as a tertiary treatment to waste water. The other parameters such as TDS, COD, SS shows effective changes over conventional method. [10]. **Electro Fenton process is a relatively economical method other AOPs** and both iron and hydrogen peroxide are relatively cheap and safe. The reactions are efficient at low pH-levels 3-4 which is difficult to maintain. For this AOP process iron and hydrogen peroxide are two major chemicals determining operation costs as well as efficiency and the dosage of H_2O_2 depends on initial COD. If COD is higher the requires more H_2O_2 and as value of COD lower than the less H2O2 required. The optimum amount of H_2O_2 obtained is 600-900 mg/l of waste water treated. Amount of excess hydrogen peroxide is harmful to many microorganisms and will affect the overall efficiency. [16]

MATERIAL AND METHODOLOGY

Characteristics of Raw Hospital Waste Water

Sr. No.	Parameters	Quantity (mg/l)
1	pH	7.5(-)
2	TS	640
3	TDS	515
4	SS	125
5	COD	678

Materials

Hydrogen Peroxide (H_2O_2)

This is the strong oxidant and its application in the treatment of various inorganic and organic pollutants is well established. H_2O_2 consist of two hydrogen molecules and two oxygen molecules.

Fenton's Reagents (Fe salt/ $FeSO_4$ Solution)

Metal salts (e.g. iron salts) which are strong oxidants that is the Fenton's process. Fe^{+3} and Fe^{+2} are used to oxidation of H_2O_2 which decompose or cause of degradation of waste water. The amount of this Fenton reagent based on amount used of H_2O_2.

Acid or Alkali

H_2SO_4 acid or NaOH alkali to be used for pH maintain of waste water. The optimum Value of pH necessary for the Fenton process.

Electrodes

Iron or Aluminum electrode are used for the electro Fenton process

EXPERIMENTAL ANALYSIS

Electro Fenton Treatment Procedures

Treatment procedure of waste water was carried out at ambient temperature in the following sequential steps.

1. Calculate various parameters of hospital waste water like pH, SS, COD, Color and TDS.
2. Waste water sample was put in a reaction vessel and stirred for mixing.
3. The scheduled Fe^{2+} dosage was achieved by adding the necessary amount and Fenton Agent add 1:1 proportion of H_2O_2.
4. A known 200-900 mg/l volume of 35% (w/w) H_2O_2 solution was added in a single step.
5. Start the DC current supply. (readings can take at DC supply 12 & 24 V)

6. Check SS, Color and TDS of sample per 30 mins interval.
7. In between continuous stirring process will require

RESULTS AND DISCUSSION

Effect of 12V DC on SS, Color and TDS

After collecting the samples of waste water and giving treatment from all the three methods for every 30 minutes interval following are results obtained for all the parameters values. Table 5.1 represents the % reduction of SS, Color and TDS with various time of intervals at 12 V DC current. As contact time increase rate of reduction of SS, TDS and SS also increase. The maximum reduction in SS, TDS and Color at 120-150 mins time of contact or reaction time.

Time Min	% SS Reduction	% Color Reduction	% TDS Reduction
30	42	30	32
60	48	38	40
90	56	48	52
120	60	58	64
150	64	58	66

Effect of 12Volts DC on SS, Color and TDS

Effect of 24V DC on SS, Color and TDS

After collecting the samples of waste water and giving treatment from all the three methods for every 30 minutes interval following are results obtained for all the parameters values. Table 5.2 represents the % reduction of SS, Color and TDS with various time of intervals at 24 V DC Current supply. The maximum reduction in SS, TDS and Color at 120-150 mins time of contact or reaction time.

Time Min	% SS Reduction	% Color Reduction	% TDS Reduction
30	44	46	48
60	62	60	64
90	70	66	72
120	82	74	84
150	86	88	88

Effect of 24V DC on SS, Color and TDS

Effect of Various Parameters on Electro Fenton

Effect of pH value

Different pH values results found that low pH has effective for the best removal efficiency is obtained at a pH = 3-4. At the lower value of pH is better to remove SS, TDS and Color from waste water as they can scavenge hydroxyl radicals. At high pH formation of Fe (II) complexes with the buffer occurs inhibiting the formation of free radicals Precipitation of ferric oxy hydroxides inhibits the generation of ferrous ions and the oxidation potential of hydroxyl radical is known to decrease with increase in pH.

Effect of Reaction Time

Reaction time is the important factor for treatment process. As per experimental studies optimum reaction time is 90-120 minutes demonstrated. Ferrous iron and hydrogen peroxide with the production of hydroxyl radical was almost complete in 120-150 minutes. Between the 120-150 min

contact time maximum removal of SS, TDS and Color from the hospital waste water.

Effect of H_2O_2 Addition

For this AOP process iron and hydrogen peroxide are two major chemicals determining operation costs as well as efficiency and the dosage of H_2O_2. As per experimental study optimum amount of H_2O_2 obtained is 600-900 mg/l of waste water treated. Amount of excess hydrogen peroxide is harmful to many microorganisms and will affect the overall efficiency and hydrogen peroxide present in large quantities acts as a scavenger for the generated hydroxyl radicals.

Effect of Fe2+ Addition

Usually the rate of degradation increases with an increase in the concentration of ferrous iron but an enormous increase of ferrous iron leads to an increase in the unutilized quantity of ferrous irons, which will contribute to an increase in the TDS content of the effluent stream.

Effect of Voltage

As applied voltage increase the rate of photolysis of H_2O_2 increase. Optimum value of 12-30 V DC after that rate of degradation reduced. Value of DC voltage should be less than 40V DC supply.

Effect of the distance between the electrodes

Effect of distance between the electrodes on the removal efficiency of Color, SS and TDS. Distance between the electrodes in this method is selected between 3 cm and 3.5 cm which causes a 4% increase in the removal efficiency and gives rise to energy consumption and operational cost of the method. The minimum distances should be selected. The distance between the electrodes is an important operation condition for the electrodes which affects the removal of pollutants.

CONCLUSION

Electro Fenton can also be an effective pre-treatment step by transforming constituents to by-products that are more readily biodegradable and reducing overall toxicity to microorganisms in the downstream biological treatment processes. Electro Fenton appeared to be the most promising method, in terms of cost effectiveness and ease of operation. Electro Fenton's oxidation is very effective method in the removal of many hazardous organic pollutants from wastewaters. Effect of distance between the electrodes on the removal efficiency of SS, TDS and Color. Distance between the electrodes in this method is selected between 3 cm and 3.5 cm which causes a 4% increase in the removal efficiency and gives rise to energy consumption and operational cost of the method. Optimum value of 12-30 V DC after that rate of degradation reduced. Value of DC voltage should be less than 40V DC supply. As per experimental studies optimum reaction time is 120-150 minutes in which maximum removal rate for SS, TDS and Color. There is complete mineralization of organic matter. There is no need for any processing units on the surface. This process reduces organic loading in terms of chemical oxygen demand and done the removal of recalcitrant and toxic pollutants thus allowing for further conventional biological treatment. Electro Fenton process is a relatively economical method other AOPs and both iron and hydrogen peroxide are relatively cheap and safe. The reactions are efficient at low pH-levels. At low pH value maximum removal of SS, TDS and Color

from waste water. Electro Fenton Process for waste water treatment shows better results over the conventional method. Electro Fenton process can be used as a tertiary treatment to waste water. The other parameters such as TDS, Color, SS shows effective changes over conventional method. The % reduction of various waste water characteristics Color , SS and TDS vs Time in Min. The increase the % reduction with time in min at 12 and 24 V DC current 120-150 min shows the optimum value of reduction of various parameters by using the electro Chemical Oxidation Process.

SCOPE AND BENEFITS

Future Scope

1. Electro Fenton (Chemical) can be adopted to treatment of waste water.

2.To improve the efficiency of conventional method.

3.Electro Fenton can be used as an additional treatment to treat waste water.

4. Electro Fenton process can make waste water for reusable.

System Capabilities

• Removes Heavy Metals.
• Removes suspended and colloidal solids.
• Destabilizes oil and other emulsions.
• Removes fats, oils and grease.
• Removes complex organics.
• Destroys and removes bacteria, viruses and cysts.

Benefits

• Treats multiple contaminants.
• Sludge minimization.
• Capital cost significantly less than conservative technologies.
• Operating cost significantly less than conservative technologies.
• Low power requirements.
• Low maintenance.
• Minimal operator attention.
• Consistent and reliable results.

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NOMENCLATURE

AOP - Advanced Oxidation Process
BOD – Biological Oxygen Demand
COD – Chemical Oxygen Demand
E.A. - Extended Aeration
FBR - Fluidized Bed Reactor
HWW – Hospital Waste Water
MBR - Membrane Bio-Reactor
SBR - Sequential Batch Reactor
SS – Suspended Solids
TDS – Total Dissolved Solids