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Comparison on Electrocoagulation process with Aluminum and mild steel electrode to treat the waste water of match box industry

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Abstract: Nowadays, one of the major problems facing industrialized nations is the contamination of the environment by hazardous chemicals. Among the industries involved are petroleum refining, organic chemicals, synthetic industries, milling, coal conversion, pulp and paper manufacturing, and textile processing industries. A large number of publications reporting its effects and damages to human health, animals and the environment. There is still a need for advanced techniques to remove these pollutants. The Electrocoagulation process has proved to be rather effective in the degradation and mineralization of single organic toxicants and the mixtures of various organic wastes. Wastewater treated by EC gives palatable, clear, colorless and odorless water. It can able to remove metal ions and/or hydroxides from synthetic solutions, groundwater or industrial wastewaters. Typically, high or complete removal could be obtained when treatment parameters (voltage, electrolysis duration, pH, inter electrode distance, stirring speed) are optimized. Aluminum, iron and combination electrodes can be used in the EC system. It can also able to remove organic material from industrial wastewaters or synthetic solutions. In general, iron electrodes give higher organic matter removal, whereas higher color removal is obtained with aluminum electrodes. Purification of surface waters from natural organic matter, inorganic pollutants or microbes can be achieved. Aluminum electrodes are more commonly used than iron electrodes in these applications.

Index Terms

Match box, Waste water, Electrocoagulation

1.Introduction

Nowadays, one of the major problems facing industrialized nations is the contamination of the environment by hazardous chemicals. Among the industries involved are petroleum refining, organic chemicals, synthetic industries, milling, coal conversion, pulp and paper manufacturing, and textile processing industries. A large number of publications reporting its effects and damages to human health, animals and the environment. There is still a need for advanced techniques to remove these pollutants. The Electrocoagulation process has proved to be rather effective in the degradation and mineralization of single organic toxicants and the mixtures of various organic wastes.

2. MATCH BOX INDUSTRY

Matchbox industry demands a large amount of water and generates large quantities of wastewater. It is highly located at Kovilpatti, Tuticorin, Sivakasi, Sattur etc., Characteristics of the effluent consist of large amounts of suspended solids, nitrogen in several chemical forms and oils, phosphorus, and chlorides. In the matchbox industry wastewater, it is highly effective in the electrocoagulation process.

2.1Types of matches:

a) Safety matches: It can only produce fire when struck against the specially prepared surface on the matchbox.

b) Strike-anywhere matches: It can produce fire when struck against any frictional surface. Being the commoner type and the cheaper to produce, the first type will be discussed here.

3. EFFECTS OF MATCHBOX INDUSTRY WASTEWATER ON ENVIRONMENT

The pollutants discharged from the matchbox industry affect all aspects of the environment such as water, air and land. The untreated wastewater affects health and causes diarrheal, vomiting, headaches nausea and eye irritation on children and workers. Nitrogen and red phosphorus in the soil, soil bulk density had decreased. And nitrogen and red phosphorus also decrease the ground water. The consumption of fresh water can seriously harm habitat near mills, reduce water levels necessary for fish and alter water temperature, affect the groundwater recharge, bad smell produced on air, affect the soil and human body health, a critical environmental factor for fish. They also increase the amount of phosphorus substances in the water, causing death to the zooplankton and fish, as well as profoundly affecting the terrestrial ecosystem.

4. COLLECTION OF WASTEWATER

Matchbox industries are located at Kovilpatti, Tuticorin, Sivakasi, Sattur etc., In this project we collected the wastewater from kovilpatti matchbox industry.

4.1Materials used:

- ✓ Pair of aluminum electrodes (anode and cathode).
- ✓ DC power supply
- ✓ Magnetic stirrer
- ✓ Beaker.

5. EXPERIMENTAL METHOD

The experimental setup is shown in Fig. 5.1. The glass beaker is chosen with the dimensions 65mm×65mm×110mm.Pair of aluminum electrodes are used. One is Anode and another one is cathode of same dimensions (12.5*2.5*0.4cm). Effective area of electrode is 12.2cm^2 and the spacing between electrodes was 1cm.The electrode pair was immersed in wastewater to a depth of 5cm.. The electrodes were connected to a digital dc power supply. The voltage of experiment is 7.5V and stirring speed of 300rpm and the electrolysis duration of 60min are performed. All the runs were performed at constant temperature of 25°C Before each run, the electrodes were washed with acetone to remove surface grease, and the impurities on the aluminum electrode surfaces were removed by dipping for 5min in a solution freshly prepared by mixing 100cm3 HCl solution (35%) and 200cm3 of hexamethylenetetramine aqueous solution (2.80%) . At the end of the run, the electrodes was washed thoroughly with water to remove any solid residues on the surfaces. The removal efficiency of COD, total suspended solids (TSS), and turbidity were carried out according to the Standard methods. In this experiment we have chosen mild steel electrodes. In the upcoming semester we have to do the experiment by using AL electrodes. By comparing the removal efficiency of these two electrodes best electrode will be decided.

Fig 5.1 Experimental setup

Table 5.1 Initial Characteristics of MBI waste water

S.No	Characters	Values
1	Ph	4.5
2	Electrical conductivity(mS/cm)	34.48
3	COD (mg/L)	253
4	Turbidity	595 NTU
5	Color	Brown
6	Chlorides(mg/L)	693
7	Sulphate (mg/L)	2954.57
8	Total solids (mg/L)	6560
9	Total dissolved solids (mg/L)	4280
10	Total suspended solids (mg/L)	2280
11	Total fixed solids(mg/L)	3040
12	Total volatile solids(mg/L)	3520
13	Acidity(mg/L of $CaCO_3$)	480
14	Alkalinity(mg/L of $CaCO_3$)	250

Table 5.2. Characteristics of sewage disposal effluent standards (As per TNPCB)

S.No	Characters	Values
1	pH	6.5-9
2	COD (mg/L)	20 mg/L
3	Turbidity	<10
4	Chlorides(mg/L)	250
5	Sulphate (mg/L)	250
6	Total solids (mg/L)	700
7	Total dissolved solids (mg/L)	650
8	Total suspended solids (mg/L)	50
9	Acidity(mg/L of $CaCO_3$)	100
10	Alkalinity(mg/L of $CaCO_3$)	100

Table 5.3 Various Parameters

S.NO	PARAMETERS	RANGE
1	pH	3-7
2	Voltage	4.5-12 V
3	Stirring speed	300-700 rpm
4	Contact time	30-150 mins
5	Electrode spacing	1-5 cm

TABLE 5.4 EFFECT OF PH ON TURBIDITY REMOVAL

Initial turbidity 595NTU

S.No	PH	Turbidity (NTU)	Removal efficiency(%)
1.	7	13	97.81
2.	6	9	98.48
3.	5	5	99.15
4.	4	3	99.49
5.	3	5	99.15

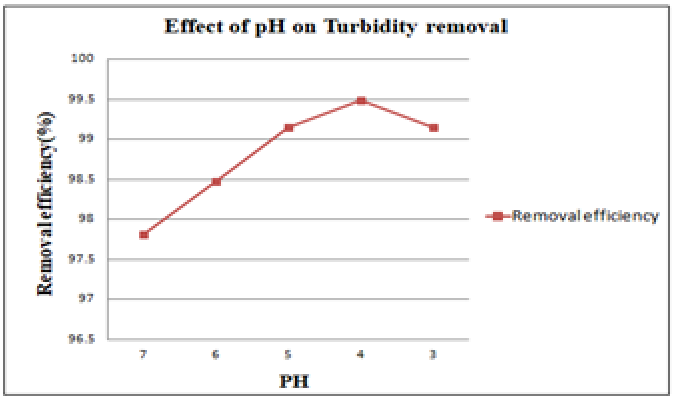

Fig 5.2. Effect of pH on turbidity removal

Table 5.5 Effect of pH on COD removal

Initial COD-253mg/l

S.No	PH	COD (mg/l)	Removal efficiency(%)
1.	7	112	62.16
2.	6	80	72.97
3.	5	56	81.08
4.	4	32	89.18
5.	3	48	83.78

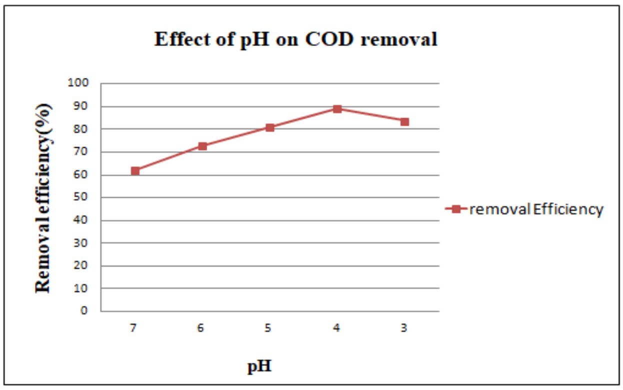

Fig. 5.3 Effect of pH on COD removal

Table 5.6 Effect of voltage on turbidity removal

Initial Turbidity-595NTU

S.No	Voltage (V)	Turbidity (NTU)	Removal efficiency (%)
1.	4.5	19	96.80
2.	6	13	97.81
3.	7.5	5	99.15
4.	9	3	99.49
5.	12	6	98.99

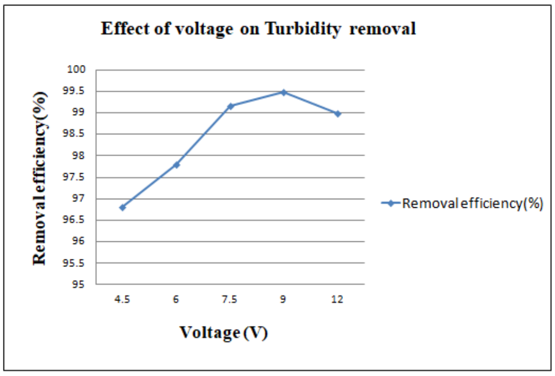

Fig 5.4 Effect of voltage on turbidity removal

Table 5.7 Effect of voltage on COD removal

Initial COD-253mg/l

S.No	Voltage (V)	COD (mg/l)	Removal efficiency (%)
1.	4.5	128	56.75
2.	6	96	67.56
3.	7.5	56	81.08
4.	9	32	89.18
5.	12	56	81.08

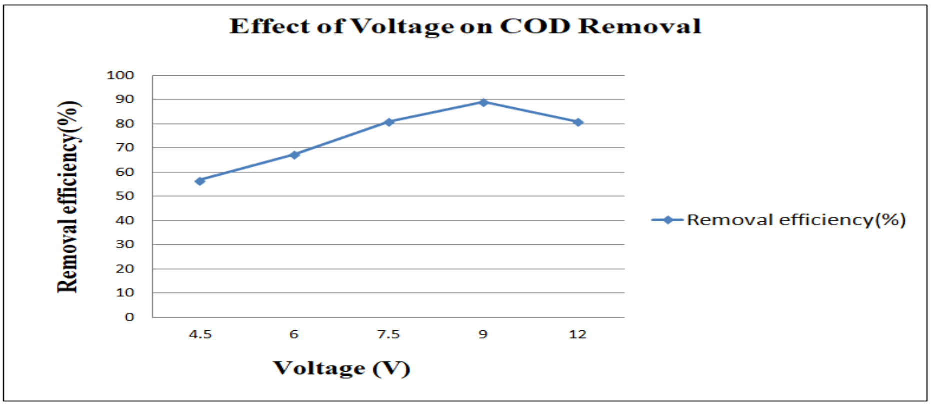

Fig 5.5 Effect of voltage on COD removal

Table 5.8 Optimum value of parameters

S.No	Parameters	Optimum Values
1	Ph	4
2	Voltage(v)	9
3	Electrolysis duration(mins)	90
4	Inter Electrode Distance(cm)	2
5	Stirring Speed(rpm)	400

Table 5.9 Final removal efficiency of Aluminium Electrode

S.No	Characters	Initial	Final	Removal efficiency(%)
1	Electrical conductivity(mS/cm)	34.48	20.3	-
2	COD (mg/L)	253	24	91.89
3	Turbidity	595 NTU	2 NTU	99.66
4	Color	Brown	Yellow	-
5	Chlorides(mg/L)	693	296	57.28
6	Sulphate (mg/L)	2954.57	241.32	91.83
7	Total solids (mg/L)	6560	560	91.46
8	Total dissolved solids (mg/L)	4280	190	95.56
9	Total suspended solids (mg/L)	2280	370	83.77
10	Total fixed solids(mg/L)	3040	240	92.10
11	Total volatile solids(mg/L)	3520	320	90.90
12	Acidity(mg/L of $CaCO_3$)	480	100	79.96
13	Alkalinity(mg/L of $CaCO_3$)	250	50	80

Table 5.10 Final removal efficiency of mild steel Electrode

S.No	Characters	Initial	Final	Removal efficiency(%)
1	Electrical conductivity(mS/cm)	34.48	31.34	-
2	COD (mg/L)	253	16	94.59
3	Turbidity	595 NTU	43 NTU	92.77
4	Color	Brown	Green	-
5	Chlorides(mg/L)	693	348	49.63
6	Sulphate (mg/L)	2954.57	396.48	86.58
7	Total solids (mg/L)	6560	640	90.24
8	Total dissolved solids (mg/L)	4280	160	96.26
9	Total suspended solids (mg/L)	2280	480	78.94
10	Total fixed solids(mg/L)	3040	180	94.07
11	Total volatile solids(mg/L)	3520	460	86.93
12	Acidity(mg/L of $CaCO_3$)	480	120	75
13	Alkalinity(mg/L of $CaCO_3$)	250	70	72

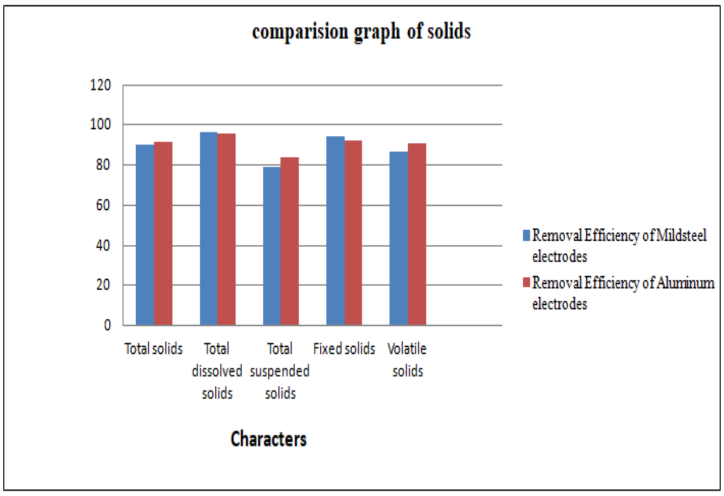

Fig 5.6 Comparison between aluminium and mild steel electrodes

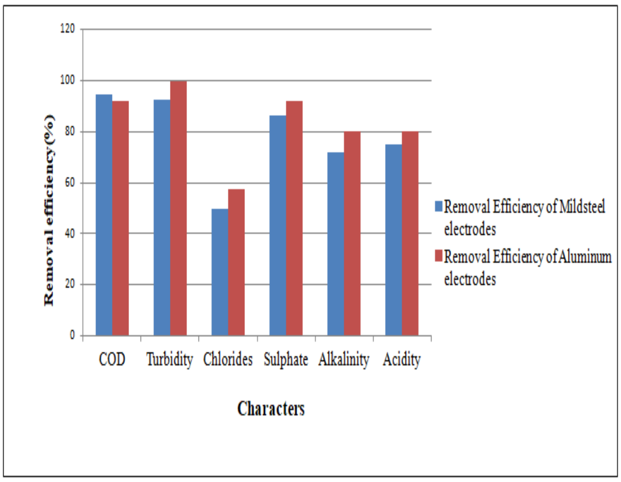

Fig 5.7 Comparison between aluminium and mild steel electrodes

Table 5.11Comparison between sewage disposal standards and mild steel electrode performance

S.No	Characters	Effluent Standards	Final
1	COD (mg/L)	20	24
2	Turbidity	<10 NTU	2 NTU
3	Chlorides(mg/L)	250	296
4	Sulphate (mg/L)	250	241.32
5	Total solids (mg/L)	700	560
6	Total dissolved solids (mg/L)	650	190
7	Total suspended solids (mg/L)	50	370
8	Acidity(mg/L of $CaCO_3$)	100	100
9	Alkalinity(mg/L of $CaCO_3$)	100	50

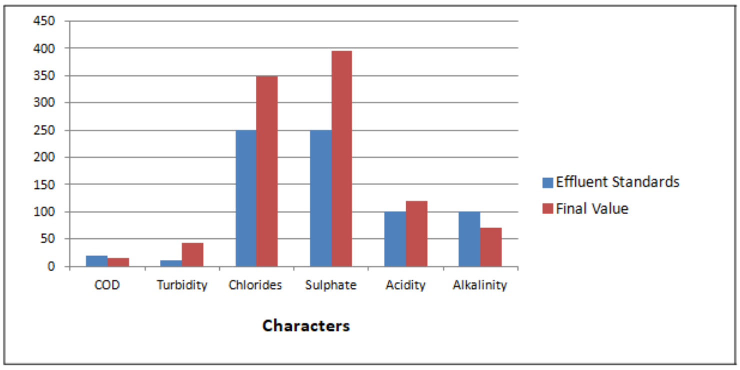

Fig 5.8Comparison between sewage disposal standards and mild steel electrode performance

6. CONCLUSION

In this study, it has been found that electrocoagulation is the appropriate process for the matchbox industry wastewater. In turbidity, chloride, sulphate, COD, TS, TSS, TDS, FS, VS, acidity, alkalinity experiment, we can got a maximum removal efficiency of 99.66%, 57.28%, 91.83%, 91.89%, 91.46%, 83.77%, 95.56%, 92.10%, 90.90%, 79.96%, 80% respectively using aluminum electrodes. For mild steel electrodes that are 92.77%, 44.59%, 86.58%, 94.59%, 90.24%, 78.94%, 96.26%, 78.94%, 94.07%, 86.93%, 75%, 72% respectively. When we compare these two electrodes, maximum removal efficiency of turbidity, chloride, sulphate, TS, TSS, VS, alkalinity, acidity obtained at aluminum electrodes and maximum removal efficiency of COD, TDS, FS obtained at mild steel electrodes. When comparing these two electrodes aluminum electrodes plays a major role to remove maximum no of parameters at high removal efficiency. So electrocoagulation process with Al-Al electrode combination gave a better result.

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