Experimental Investigation for reduction of reaction time in Electrocogulation process by the addition of Moringo Olifera

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ABSTRACT:

Textile industry is one of the most polluting industries as the dyeing process uses large quantity of water and various kinds of dyes. Electrocoagulation has become one of the most promising methods for the treatment of dyeing waste water. In this paper electrocoagulation with iron electrode has been carried out for 40 litres of simulated Blue CA dye (0.04%). The major parameter considered was the reaction time. To reduce the reaction time moringo olifera was added in the process. Initially Electrocoagulation process using iron electrode after 2, 3, 4 and 6 hrs of reaction time shows upto a colour removal efficiency of 99% after 6 hrs. The experiments showed that when moringo olifera was added to the electrocoagulation process the reaction time has been reduced and the colour removal efficiency was 99% immediately after 3hrs of the reaction time.

Keywords: *Electrocoagulation, colour removal*

INTRODUCTION:

The textile industry is one of the largest industries in the world in terms of production. This industry continues to be the second largest employment generating sector in India. Textile processing generates many waste streams, including liquid, gaseous and solid wastes, some of which may be hazardous. The main environmental problems associated with textile industry are water body pollution caused by the discharge of untreated effluents. This can cause damage if not properly treated before being discharged into the environment. Dyeing is the process of adding colour to textile products like fibres, yarns and fabrics. Tirupur in Tamil Nadu excels in knitted readymade garments. The bleaching and dyeing units use large quantities of water, but most of the water used by these units is discharged as effluents containing a variety of dye and chemicals. Water level in the bore wells are lowering due to the large scale exploitation of ground water for industrial application. Generally, the water is not suitable for drinking. The river Noyyal which was non perennial earlier now flows throughout the year because of the effluent discharge from the industries. Different physical methods such as membrane filtration processes and adsorption techniques are widely used. The major disadvantages of the membrane process is that it has a limited lifetime before membrane fouling occurs and the cost of periodic replacement must thus be included in any analysis of their economic viability. Chemical method includes coagulation or flocculation combined with flotation and filtration. These techniques are often expensive and although the dyes are removed, accumulation of concentrated sludge creates a disposal problem. Recently, other emerging techniques known as advance oxidation process have been applied with success for the pollutant degradation. These methods are very costly and commercially unattractive. Biological treatment is the most economical alternatives when compared with other physical and chemical process but fouling is one of the problems. Biodegradation methods such as fungal decolourisation, microbial degradation and bioremediation systems are commonly applied to the treatment of industrial effluent. Moreover, although many organic molecules are degraded, many others are unmanageable due to their complex chemical structure.

ELECTROCOAGULATION METHOD

Electro coagulation is a technique used for waste water treatment, industrial processed water and medical treatment. Electricity based Electro coagulation technology removes contaminants that are impossible to be removed by filtration or chemical treatment system. An EC system essentially consists of pairs of conductive metal plates in parallel, which acts as mono polar electrodes. It furthermore requires a direct current power source, a resistance box to regulate the current density and a multimeter to read the current values. The conductive metal plates are commonly known as “sacrificial electrodes”. The sacrificial anode lowers the dissolution potential of the anode and minimizes the passivation of the cathode. The sacrificial anodes and cathodes can be of the same or of the different materials. During electrolysis, the positive side undergoes anodic reactions while on the negative side cathodic reactions are encountered. Consumable metal plates, such as iron or aluminium, are usually used as sacrificial electrode to continuously produce ions in the water. The released ions neutralize the charges of the particles and thereby chemical reaction and precipitation, or by causing the colloidal materials to combine, which can or other contaminants move through the applied electric field, there may be ionization, electrolysis, hydrolysis, and free-radical formation which can alter the physical and chemical properties of water and contaminants. As a result, the reactive and excited state causes contaminants to be released from the water and destroyed or made less soluble.

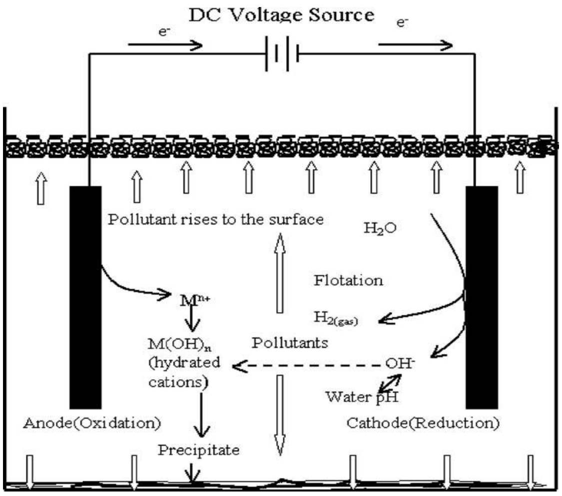


Fig. 1.Schematic diagram of electro coagulation cell.

Decolourisation of the waste water from the textile industry is achieved through 1. Optimisation of the operating parameters for colour removal efficiency. 2. Usage of different types of electrodes. 3. Electrocoagulation combined with other processes. 4. Modification in various parameters. Most of the colour removal was due to adsorption and complexation. The presence of NaCl reduces the power consumption, Chen-Lu Yang & Jared McGarrahan (2005). NaCl electrolyte was found to be the best suited electrolyte for the electrocoagulation process, Senthilkumar et al (2010). pH is an important operating parameter that affects the efficiency of the process. As the pH increased greater than 9 the efficiency of the process decreased. Both the energy and electrode consumption increased with increasing the operating time, Kobya M et al., (2006). With increase in the dye concentration the colour removal percent decreases. Also when the pH is maintained between 6- 8 the colour removal is high, Kashefialasi M et al., (2007). Ozone can accelerate the rate of colour removal by Electrocoagulation process. Current density could be limited to certain extent to avoid excessive oxygen evolution and heat generation, Shuang Song et al (2007). Electrocoagulation is found to be more economic compared to electro oxidation, Ashtoukhy E.S, Amin (2010)

NATURAL COAGULANTS

Naturally occurring coagulants are usually presumed safe for human health while there is a fear by using aluminum salts that may induce Alzheimer's disease. Some studies on natural coagulants have been carried out and various natural coagulants were produced or extracted from microorganisms, animals or plants. Extracts from the seeds of Moringa oleifera can be used, the trees of which are widely present in Africa, the Middle East and the Indian subcontinent. Moringa oleifera is one of the most wide spread plant species that grows quickly at low altitudes in the whole tropical belt, including arid zones. It can grow on medium soils having relatively low humidity. Moringa oleifera seeds are an organic natural polymer. Moringa oleifera is a coagulant used at home to clear the turbid Nile water Jahn (1984). Later, many researchers have reported on the various uses of Moringa oleifera seeds as coagulant and coagulant aid in the last 20 years. Moringa oleifera coagulant has been found to have high coagulation activity only for high turbidity water.

EXPERIMENTAL PROCEDURES AND METHODS:

The EC unit consists of a glass container of 15x60x60 cm with an electric stirrer arrangement, a D.C. power supply and two electrodes. Fig. 1 shows the experimental setup containing: Glass container; DC power supply; Electrode pair; Electrical stirrer. Iron Electrodes were vertically disposed and dipped in 40 Liters of the wastewater. Blue CA dye was prepared with Sodium Chloride (NaCl) as electrolyte, and then were diluted according to the desired concentration (0.1g/L) in 40 Liters. Experiments with same concentration and same applied current (2.26 A) were conducted. To obtain optimum results, tests were conducted for 2, 3, 4 and 6 hours of reaction time and stirring with 120 grams of NaCl, after which the process is left 30 minutes to settle. The process was continued with the addition of 90 grams of Moringa Powder. Dye concentration was measured using UV/vis Spectrophotometer (V-670, Jasco) at a wavelength 588nm. The calculation of color removal efficiency, (CRE (%)) after electrocoagulation treatment was calculated using the formula:

$$CRE(\%) = \frac{(Abs_0 - Abs_1)}{Abs_0} \times 100$$

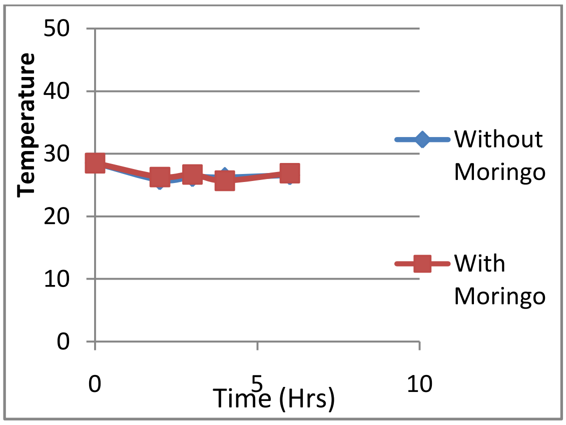
dissociation rate also decreases.

Where, ‘Abs_0’ and ‘Abs_1’ are the absorbance values of dye before and after electrocoagulation process respectively.

RESULTS AND DISCUSSIONS

With the help of the various experiments, better results of color removal efficiency (CRE) were obtained using Iron electrode, electrocoagulation process along with the addition of moringo olifera.

Fig 2. Effect of Time on Temperature



There is no significant change in the temperature when the reaction time increases, during the electrocoagulation process and along with the addition of Moringo olifera Electrical Conductivity increases for the initial three hours and at the end of the reaction time it remains constant for both cases. It may be due to the dissociation rate in the initial stage and thereinafter as the reaction time increases the

Fig 3. Effect of Time on Electrical Conductivity

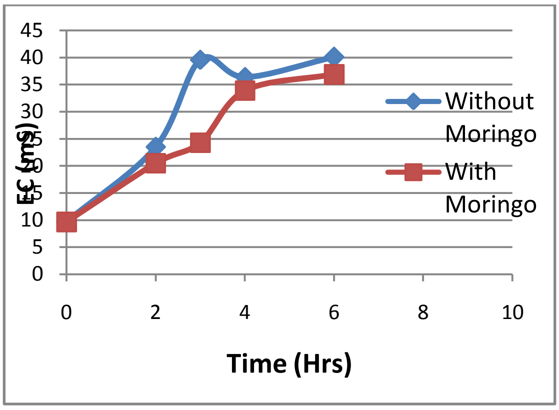
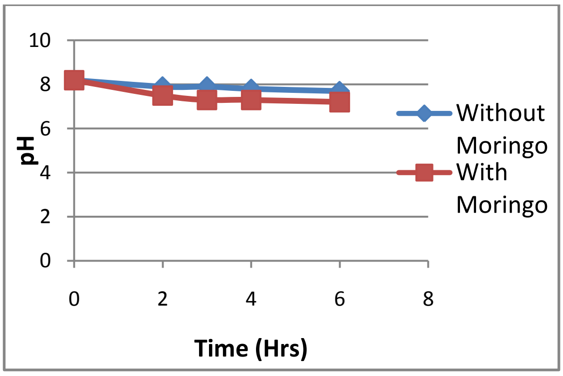
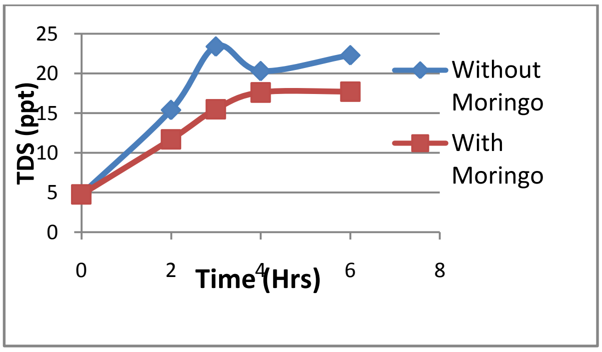


Fig 4:Effect of Time on pH



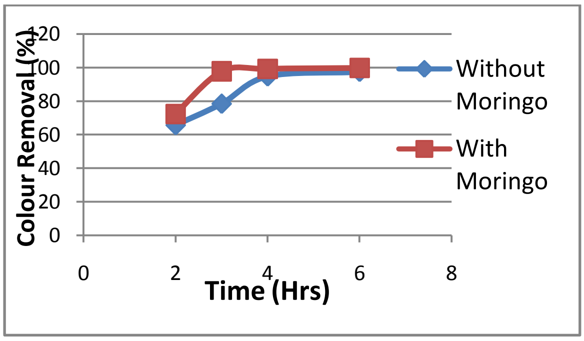
pH remains constant during the reaction process and it is found that the pH ranges between 7-8 as the Fe $(OH)_3$ reacts with hydroxide ion and produces $Fe(OH)_4^-$.

Fig 5. Effect of reaction time on TDS



Total dissolved solids gradually increase with the increment of time and after a certain period of time it remains stable. After addition of moringo there is no much increase in the Total dissolved solids. The increase in the solids may be due to the addition of electrolyte and in the later case may also be due to the powder moringo.

Fig6. Effect of time on colour removal efficiency.



The colour removal efficiency increases as the time of reaction increases. This is because the reaction time determines the rate of production of Fe^{2+} or Fe^{3+} ions from the electrode. It is also proved in the earlier studies that the reaction time has a linear relation with the energy consumption. Hence it is of great importance to optimise the operating time so as to make the process economical. This study clearly proves that upon addition of moringo powder to the electrocoagulation process the reaction time can be reduced upto 50 %. Experiments show that immediately after the process time of 3 hrs the colour removal efficiency was maximum. This is because the moringo powder acts as a good coagulant itself, thereby removing the dye molecules from the waste water.

Fig 6. Spectrum obtained for dye absorbance after 2, 3, 4, and 6 hours of Fe Electrocoagulation

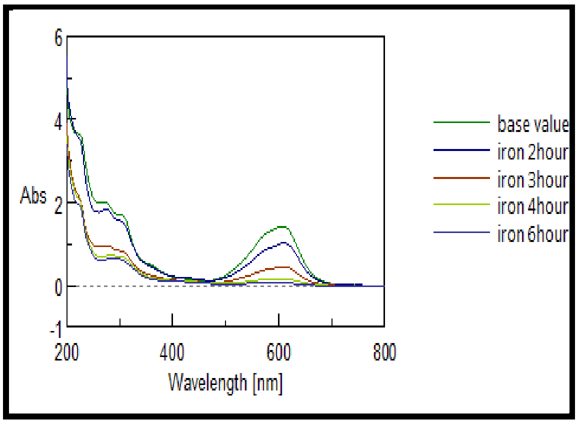
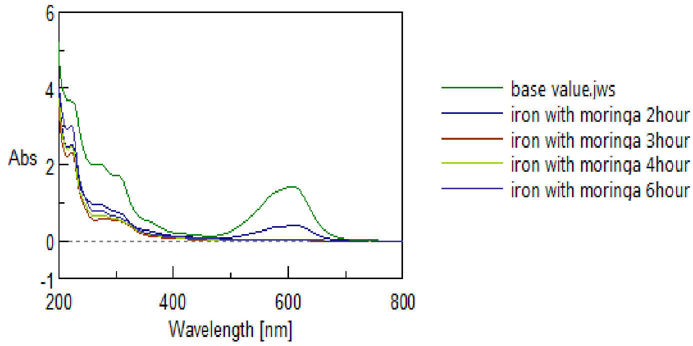


Fig 7. Spectrum obtained for dye absorbance after 2, 3, 4, and 6 hours of Fe Electrocoagulation with Moringo.



CONCLUSION:

After the of Fe electrocoagulation process with and without the addition of moringo results prove that the reaction time can be reduced upto 50 percentage when moringo is added to electrocoagulation process. The parameters like temperature and pH does not show much variation when the reaction time increases. But the electrical conductivity and total dissolved solids increases in the initial stage. After three hours of reaction time there was neither increase or decrease.

- The usage of Moringa Powder increases the Colour Removal Efficiency.

The method used in this work was the process of Iron electrode with assistance of the natural coagulant Moringa Powder, reaching a result of almost 100 % of color removal showing that the junction of chemical and biological methods is the best and most economic way to reach a low-cost and high-effect treatment against the contamination of water and soil .At different increased process time the rate of removal is higher. Finally it can be concluded that electro coagulation method is a safe, reliable, efficient and cost effective method for removal of colour. Also the results showed that electro coagulation is a faster and more effective process than other methods.

For better results of CRE work may be carried out with real scale and continuous flow circumstances.

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