Removal of Pesticides from Water through Electrocoagulation Unit Using Stainless Steel and Iron Electrodes

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***Abstract*: The purpose of the present study to investigate the removal efficiency of two pesticides: Imidacloprid and Chlorpyrifos from aqueous solution through electrocoagulation treatment unit. Electrocoagulation acts to be one of the best operative methods. The removal efficiency was investigated at variable conditions of operating parameters. The best removal efficiency obtained for Imidacloprid and Chlorpyrifos was 94% and 90% respectively, with initial pH 6.5, the initial pesticide concentration of 30 mg/ L, and current density of 5A after 60 minutes by using combined iron and stainless steel electrodes. Batch flow system was used for operation of reactor. The study concludes that the electrocoagulation treatment process using combined iron and stainless steel electrodes is the efficient and simple method for the removal of Imidacloprid and Chlorpyrifos from aqueous environment.**

***Keywords*: Electrocoagulation; Iron; Stainless Steel; Imidacloprid; Chlorpyrifos.**

I. INTRODUCTION

Water is one of the important component to sustain the life on earth. However with increasing population and industrial development, its resources become limited. One of the globally persistent challenge in the 21st century is the provision of sufficient fresh water supply that is free from contaminants [1]. One of the most important problem among all is water contaminants by pesticides were studied over the years [2]. Pesticide substances are considered very harmful, most pesticide substance have harmful effects on human health and cause environmental problems. Pesticide polluted water considered as globally environmental problem, the main sources are agricultural runoff and effluents from pesticide manufacturing industries [3]. It is not amazing that there is a rising concern in emerging new technologies that are simple, easy, cost effective and highly efficient in the removal of contaminants from water, Current treatments biological and chemical approaches, the biological are effective, but require long treatment times, large treatment services are expensive. The chemical methods, which involve adding of chemicals to remove or precipitate the contaminants, are very effective in removing the contaminants, but the chemicals can cause secondary contaminants and large amount of sludge [1]. Pesticide removal are examined through various emerging techniques classified as physical, chemical and biological methods, like; absorbent techniques, Oxidation [4], Ozonation [5], Nano-filtration[6], Photo catalytic degradation[7,8], adsorption [9,10], hollow fiber liquid-liquid membrane extraction [11], photo-phenton [12], photo catalytic process combined with peroxide & hydroxide [13], biological processes [14],electrochemical and electrocoagulation processes [2,3]. All process has some advantages and disadvantages. Electrochemical techniques are, in this case, favorable because of their flexibility, safety, selectivity, pliability to mechanization and environmental compatibility [15]. Among these methods electrocoagulation is considered simple, economical and more efficient.

Electrocoagulation uses electricity to treat the pesticides polluted water [16]. Electrocoagulation process encompasses the use of current to cause the metal ions that form the coagulant in the solution. Whereas electrocoagulation commonly working mechanism are including coagulation, adsorption, precipitation and floatation, the electrocoagulation process utilize electrodes as cathode & anode to produce flocks by reaction at anode and cathode followed by electrolysis. Electrocoagulation is simple, efficient & cost effective method for the treatment of various water and waste water, in latest years many studies have been specifically concentrated on the use of electrocoagulation owing to the increase in environmental limitations on discharge waste water. [17].

Present study aims to study the possibility of using stainless steel and iron electrode material for subtraction of Chlorpyrifos and Imidacloprid pesticides from water through electrocoagulation process. Determine the combined effect of electrode on the pesticide removal efficiency. Moreover the effect of various operating parameters at variable conditions were studied.

II. MATERIALS & METHODS

A. Reactor Design

The batch electrocoagulation unit were used for this study, for the removal purpose of Pesticides from water, the electrocoagulation unit consists the raw water tank of 20 L for the purpose of storing raw water, after that the main reaction tank is placed in the center of unit, which consists of the iron electrode as anode and stainless steel as cathode with size 6” by 6” and 3mm thick. Electrodes are positioned vertically parallel to each other, the electrocoagulation reaction tank is connected with storage tank and receive raw water from storage tank through inlet and outlet valves. The reaction tank also comprise mixing pump as supporting purpose to steadies the water equally. The electrodes are connected to DC power supply. The water after contacting with electrodes in reaction tank is treated and after treating flowed to secondary tank through outlet valve and where water is settled and the settled water is send from secondary tank and receives by filtration unit and filtered water was tested for pesticide residues and physiochemical parameter analysis. Setup as shown in figure 01.

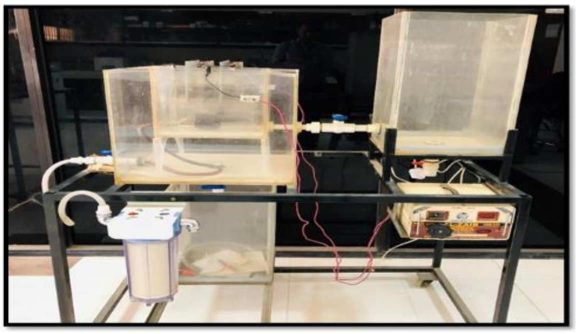

Fig 01: Electrocoagulation treatment unit setup

B. Sample preparation

In the present work Stock solution of pesticide 500 mg/ L of Imidacloprid and 1000 mg/ L Chlorpyrifos were prepared by dissolving accurate quantity of pesticide in distilled water and diluted properly. For making stock solution the quantity of pesticide required were calculated by using following equation [19].

$$M1 \times V1 = M2 \times V2 \qquad (1)$$

Where, M1, M2, V1, and V2 are the initial concentrations, final concentrations, initial volume and final volume.

Various different solutions of pesticides with concentration ranges 30-150 mg / L was prepared to measure its removal at variable conditions. The conductivity of solutions were raised either by using NaCl, and 0.1 HCl or 0.1 NaOH was used to adjust the pH of solution at desired values..

C. Operating conditions and Analysis

The experiments was carried out at variable operating conditions such as pH 4.5 to 8.5, current 1- 5A with variable retention time of ranges 15 to 75 minutes. The main parameter were analyzed and studies in this work is the removal efficiency of electrocoagulation unit, the remaining pollutant concentration (mg/ L). Remaining contaminants of Imidacloprid and Chlorpyrifos were measured through double beam UV-visible spectrophotometer at λ max = 270 nm and 307 nm respectively using calibration curve with standard error ±0.5%.
The pesticide residue removal efficiency in experiment is calculated through this equation;

$$E = [(Ao - A) / Ao)] \times 100 \qquad (2)$$

Where Ao and A are absorbance values of pesticide solutions before and after treatment with respect to their λmax [20].

III. RESULTS

Removal of Imidacloprid and Chlorpyrifos

The electrocoagulation treatment unit operation for the Imidacloprid and Chlorpyrifos removal from laboratory prepared synthetic water. The removal is carried out at different conditions, one condition keep variable and all remaining conditions kept constant. The samples were examined at different concentration of solutions having pesticides 30, 50, 100, 150 mg/L. increasing the initial pesticide concentration results in decreasing the removal efficiency, the best removal efficiency for both pesticides were obtained at initial concentration 30 mg/ L. As shown in figure 02 that efficiency decreases from concentration 30 ppm to 150 ppm. A series of experiments was carried out at pH ranges (4.5-8.5). The best removal efficiency were obtained at pH 6.5 with variable current density and time, as shown in figure 03. The removal efficiency of the pesticide is low in acidic and alkaline medium, meanwhile, in slightly acidic as neutral, the removal efficiency is much higher as it is proved in obtained results. A series of experiments were carried out with the current density varied from 1-7 ampere. The best removal efficiency were obtained at Current density 5Amp as shown in figure 4. Increasing current increases the removal rate because bubble generation and coagulants rate increases with increasing current that cause more number of H2 bubbles and decrease bubble sizes resulting as increases in adsorption rate that cause faster removal of pesticide [21, 22] .The removal is carried out at variable time interval such as 15, 30, 45, 60 and 75 minutes. The best removal efficiency was obtained at 60 minutes. Figure 5 displays the removal efficiency at different time intervals.

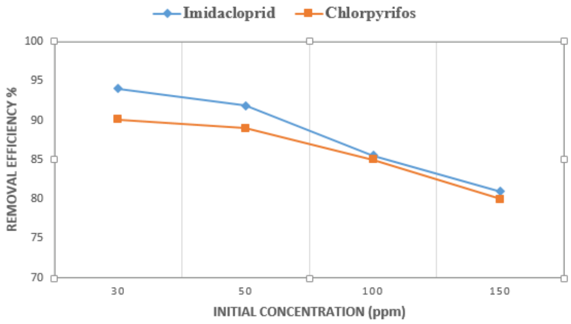

Fig 2: Removal efficiency at pH 6.5, current density 5A, and time 60 minutes

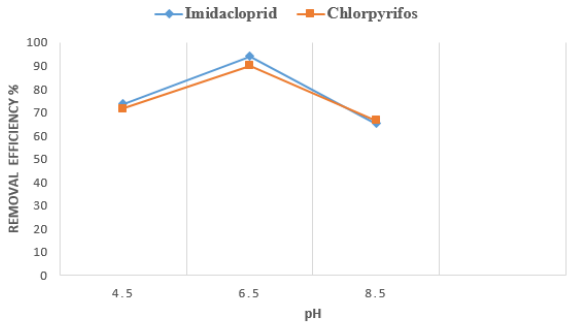

Fig 3: Removal efficiency at initial concentration 30ppm current density 5A, time 60 minutes

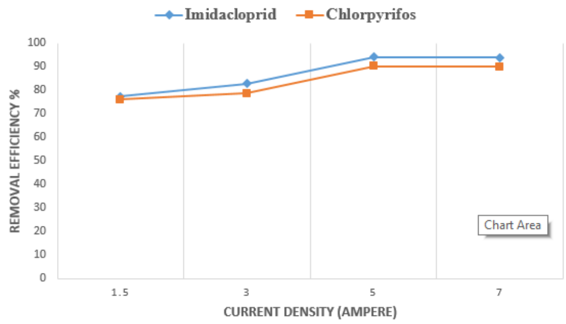

Fig 4: Removal efficiency at pH 6.5, initial concentration 30ppm, time 60 minutes

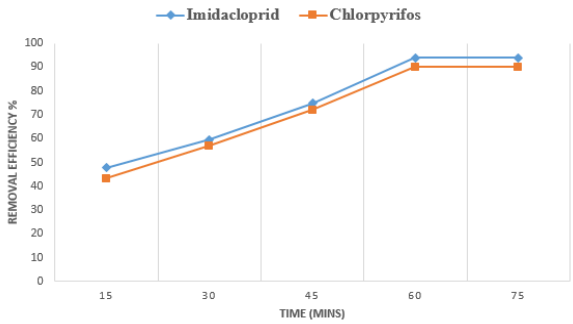

Fig 5: Removal efficiency at pH 6.5, initial concentration 30ppm current density 5A, time 60 minutes

IV. CONCLUSIONS

The present work focuses to remove the Imidacloprid and Chlorpyrifos pesticides from simulated water and investigate the applicability of Electrocoagulation process by using iron and stainless steel electrodes combined. The removal was observed with variable condition such as initial pH, current density, initial pesticide concentration. The best removal of Imidacloprid and Chlorpyrifos was obtained 94% and 90% at variable operating parameters: current density of 5Ampere, an initial pH 6.5, and reaction time 60 minutes and initial pesticide concentration 30mg/ L, by using iron and stainless steel. The electrocoagulation process is easy, fast, effective and clean process for the removal of pesticides from water.

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