Laundry Wastewater Treatment Using Electrocoagulation/Flotation and Electro-Fenton Processes

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Received: April, 2013 Accepted: June, 2013

Abstract
Several laundry houses throughout Tehran consume a large amount of water each day and discharge the resulting wastewater into septic tanks or municipal sewage system without any suitable pretreatment. This would result in severe contamination and other serious environmental issues. In the present study, performance of electrocoagulation/flotation process with aluminum and iron electrodes is compared with electro-fenton process for the simultaneous removal of chemical oxygen demand (COD), phosphate and turbidity from laundry wastewaters. The effects of operative chemical and electrochemical variables such as initial pH and hydrogen peroxide concentration, electrode arrangement, current density and electrolysis time on removal efficiency of COD, phosphate and turbidity were also investigated and optimized. During the optimization of effective parameters in these processes, energy consumptions and removal efficiencies were considered simultaneously.

Introduction
Electrocoagulation/flotation process is an electrochemical method for treatment of polluted water or wastewater. Through the applied electric current to aluminum sacrificial anodes, aluminum corrodes produce coagulation agents in solution (such as aluminum hydroxide). The produced coagulation agent sticks to pollutants in the water or wastewater and form large size flocs that can be sedimentated. Besides, released hydrogen gas at the cathode which appears as fine bubbles binds suspended particles and float them to the top of the electrochemical reactor. In electro-fenton method hydrogen peroxide was added into electrcoagulation system, so fenton reaction was formed in the process.

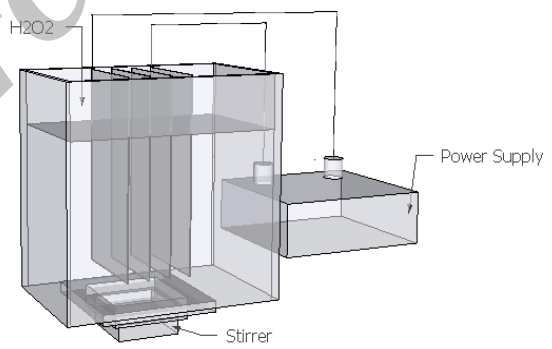

Fig. 1. The schematic experimental setup in the study

Materials and Methods
Experiments were carried out in a 3.6dm3 electrochemical reactor mobilized with a magnetic stirrer for better solution mixture. Aluminum and iron plates were used as anodes and cathodes. The dimensions of plates were 180×90×1mm and the effective area of each electrode submerged in wastewater was 117cm2. Inter electrode spacing was 2cm. The electrodes were connected to a D.C. power supply (0-5A and 0-60V). The batch experimental setup is schematically shown in figure 1.

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The pH of wastewater was adjusted by adding either sodium hydroxide or sulfuric acid and measured by a 691 Metrohm pH meter. In the electro-fenton method, hydrogen peroxide was applied externally into the electrochemical system. The electrochemical cell was fed by wastewater daily collected from Taleghani laundry house in Tehran.

Results and Discussion

At first, the effect of pH (in the range of 2-10) on the electrocoagulation/flotation processes with aluminum and iron electrodes were investigated. After adjusting pH, the experiments were carried out using five different types of arrangements with optimized pH to determine the best arrangement. In the next step the optimum values of current density (from 0 to 21.36mA/cm^2) for both processes were determined. In the electro-fenton process, the effect of pH and the optimal initial amount of H_2O_2 was chosen by adding 0, 150, 300, 450 and 600 mg/lit H_2O_2 to the feed. In the final step, to find the optimal value of electrolysis time, its effect on removal efficiency of COD was assessed. Other parameters such as pH, current density, electrode arrangements and H_2O_2 concentration were remained constant. The results, as illustrated in figure 2, demonstrate the COD concentration as a function of electrolysis time in electrocoagulation/flotation and electro-fenton processes.

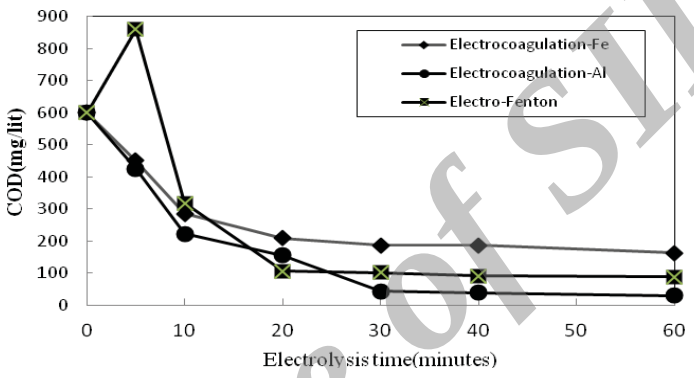

Fig. 2. Effect of Electrolysis Time on COD Concentration in electrocoagulation/flotation and electro-fenton processes

As it can be seen in figure 2, both electrocoagulation/flotation and electro-fenton processes are efficient to remove pollutants from laundry wastewater. Under the optimal parameters such as four aluminum electrodes in parallel connection, pH of 5, electrolysis time of 30 minutes and current density of 12.82 mA/cm^2 (1.5A), the proportions of COD, phosphate and turbidity removal efficiencies were obtained about 92.8%, 98.6% and 89.2%, respectively, and energy consumption was calculated as 3.1 kWh/kgCOD. During the experiments in the electrocoagulation/flotation process with iron electrodes, the neutral pH with the optimized arrangement of electrodes (four monopolar plates in series), electrolysis time of 30 minutes and current density of 4.27mA/cm^2 (0.5A) were chosen as optimal values, whereas in the peroxi-electrocoagulation process the optimum pH, current density and electrolysis time were 3, 4.27mA/cm^2 and 20 minutes, respectively. The best arrangement was similar to that of iron electrodes. The optimal amount of H_2O_2 for the efficient COD removal was obtained 150 mg/lit H_2O_2.

Under these optimal conditions, the COD removal efficiency and energy consumption of electrocoagulation/ flotation and electro-fenton processes were calculated as 69%, 3.4 kWh/kgCOD and 82.3%, 1.64 kWh/kgCOD, respectively. Therefore, adding hydrogen peroxide with 150 mg/lit concentration results in greater values for COD removal efficiency and lower values for electrolysis time.

Conclusion

This study indicates that in these processes, i.e. Electrocoagulation/flotation and electro-fenton, there is a possibility of laundry wastewater treatment with acceptable efficiency. These methods can be used in large scale industrial facilities as well as in-situ laundry houses, as a wastewater pretreatment process.

Keywords: COD removal, electrocoagulation/flotation, electro-Fenton, laundry wastewater, phosphate.