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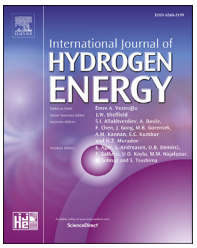

Electrochemical treatment of wastewater: Selectivity of the heavy metals removal process

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ABSTRACT

Electrochemical processes have been known as a very efficient method for the industrial wastewaters treatment, especially for the removal of heavy metal ions. In this work, we would like to provide a method that not only effectively treats heavy metal ions but also carries out the process with a notable selectivity rate. An electrochemical cell with conductive carbon fibers cloth cathode and Platinum coated titanium panel anode (5 × 5 cm), low voltage supply energy of 10 V, and pH value of 6.8 is designed to remove Coppers, and Nickels out of the solutions contains Nickel Sulfate and Copper Sulfate (0.06 M).

There are modifications applied to the electrode to improve its conductivity and durability, the two factors that may effect directly on the efficiency of the whole process. The result we obtained shows a good and promising data with high removal efficiency (up to 97%) during the 20 h working time. Together with the removal process, the properties of electrode materials are also well investigated. With the conductive carbon cloth shows its superiority, the electrochemical cell in this work become a very versatile system. In that manner, we provide a system which is not only can treat the wastewater, but also creating energies such as hydrogen and oxygen, collecting of heavy metals in hydroxide form, and can be easily improved to a continuous process with higher efficiency and larger application.

Furthermore, the affection of electrode arrangement is carefully studied and revealed its properties, providing a chance applying the method to actual industrial purpose. With a close, medium and far distance of the two electrodes we arrange, the result of removal heavy metal ions is differently achieved (97, 96.5 and 71%). Technical problems appear during the process seems to be minor and could be solved quickly by a simple solution which will be described in the later part. However, a single effective process to treat the wastewater we introduced here is just the beginning. A continuous system which can be operated for a longer time, more effective and creating a decent amount of energies would be welcome to investigate.

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Introduction

Water pollution caused by heavy metals is a global problem and should have received worldwide attention. Since the late 20th Century, wastewater treatment has become a very critical task needs to be taken care of, due to the public expectation of producing waters that are clean, free of color, turbidity, taste, odor, and other harmful metal ions. Heavy metals containing water should be managed properly, or it could lead to serious damage to the environment which will result in long term effect on human and other living creature health [1].

Electrochemical processes have gained lots of attentions and interests in recent years as a cost efficient and accomplished technology for the treatment of industrial wastewaters. Electrochemical systems offer several advantages over others [2] such as operation at ambient temperature and pressure as well as robust performance and capability to adjust to variations in the influent composition and flow rate. The method itself is considered to be capable of degrading a notable wide range of contaminants, including refractory carboxylic acids [3,4] and perfluoro carboxylic acids [5,6]. The nature of the electrochemical process is the applying of electricity to pass a current through an aqueous metal bearing solution, which also contains a cathode plate and an insoluble anode. The treatment is the precipitation of the heavy metals in a weakly acidic or neutralized electrolyte as hydroxides. In that manner, the choice of the electrode material does not only provide specific application options but also play a significant role in improving the method proficiency against various type of contaminated compounds. Furthermore, the quality of the treated wastewaters would depend on the amount of produced ions or charged loading, the product of current and time [7], so that any factor that effect on the charge loading during the process may also impact on the final efficiency of the whole process.

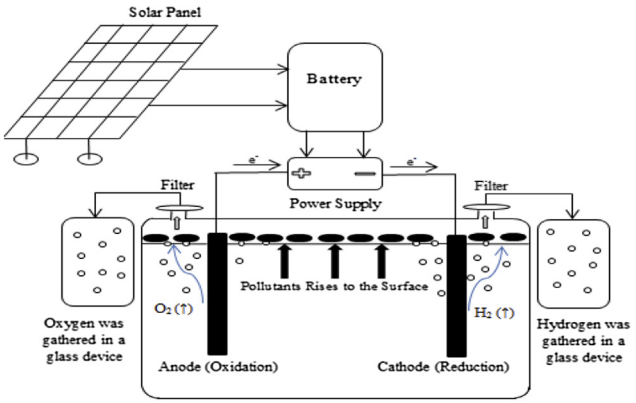

Fig. 1 – Schematic diagram of the electrochemical cell.

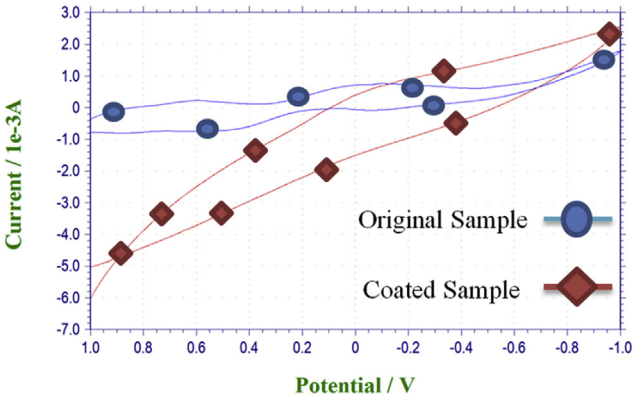

Fig. 3 – Cyclic voltammetry measurement comparison of the coated cathode and the original cathode.

The conductive carbon fiber clothes are widely used as reinforcement material in polymer composites, offering a stronger specific strength and modulus among all reinforces fibers [8–11]. Accordingly, it should be very interesting to use the conductive carbon fiber cloth as an electrode in an electrochemical process to investigate its properties carefully. In this work, the electrochemical method has been used to treat heavy metal containing solution with a notable selectivity rate, which is a result of the sequence removal of both coppers and nickels out of the wastewater. Furthermore, we also indicate the behavior of the removal process and its relationship between the electrode properties, the charge loading value and the electrochemical performance of the process.

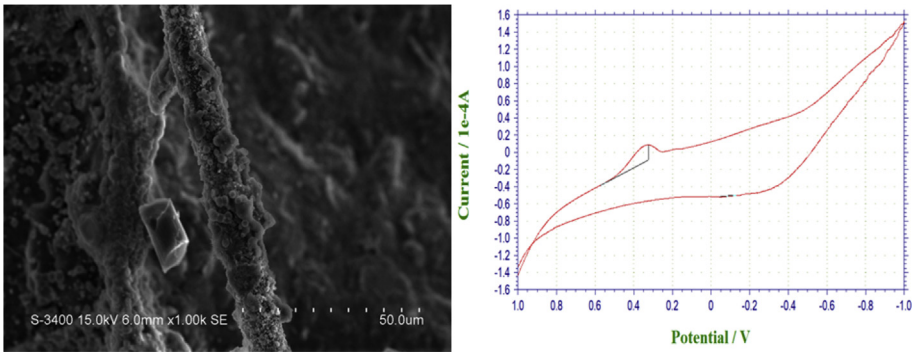

Fig. 2 – CV measurement describes the electrical conductivity of the coated conductive carbon fiber cloth cathode and a SEM photograph which indicates the cathodes coated surface.

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