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Removal of silver from wastewater using cross flow microfiltration

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Abstract. Removal of silver from wastewater was investigated using continuous cross flow microfiltration (MF) technique hollow fiber membranes with a pore size 0.2μm, with sorbent coated material Al_2O_3/$SDSH_2Dz$ particle size (8 μm). The coating investigated was dithizone (Diphenylthiocarbazone) in 0.005M ammonia solution. In the filtration of silver ion solutions, the effects of the permeate flow rate and cross flow velocity on the absorption of silver ion solutions, and since the pore size of membrane (=0.2 μm) is smaller then that of the (Al_2O_3), no need to consider the variation of (Al_2O_3).rejection as it can be considered to be 100%. The amount of silver absorbed into sorbent material Al_2O_3/$SDSH_2Dz$ was (25.35, 39.68 ppm) for the cross flown velocity of 5, 2.5 L/hr respectively, and were the results as function of permeate flow was (25.35, 39.68 ppm) for the velocity of 5, 2.5 L/hr respectively.

Key words: silver, crossflow microfiltration, aluminum oxide, dithizone, filtration.

Introduction

The removal of metal ions from wastewater is an important process in water treatment Cimino and Caristi (1990) and a potential source voluble of metal. The most common methods of removing metal ions is by the use of precipitation, coagulation, ion exchange, floatation, reverse osmosis, membrane filtration, solvent extraction (Quintelas et al.,2009) and metal recovered as insoluble salt after sedimentation. The increasing use of silver in water purification, industrial processes and components, medicine, and photographic Absalan and Goudi (2004) and it potential environmental impact means that silver should be removed and recovered, there is an important to improve the technological new and cost effective methods for silver recovery Ajiwe and Anyadiegwu (2000).That allows recovering of wastes one promising approach is high affinity absorption process when selective binding allows the concentration of recovery from dilute process streams. Sorption can occur on particles a variety of surfaces, but only few materials are known to possess adsorptive efficiencies or reactive surfaces sufficiently favorable for adsorbing metal ions such as silver ions. Adsorption on solid surface is a promising method for removing the metal ions from waste water. The most widely used material as an adsorbent for metal ions, Al_2O_3 loaded with dithizone.

Microfiltration membranes are being increasingly employed for wastewater treatment because they are a highly effective physical barrier to suspended particulate matter. Our research where therefore to investigate the retention profile of metal ions as a function of filtration factor in the presence of sorbent material Al2O3/$SDSH_2Dz$.

Material and Methods

Materials Preparation

Aluminum oxide (Al_2O_3, CAS # 1344-28-1) and Silver standard solutions ($AgNO_3$, CAS #7761-88-8) were purchased from Sigma-Aldrich. The metal ion solutions were prepared from distilled water.

Preparation of Dithizone coated alumina, 30 mg of SDS the concentration of SDS should be lower than critical micelle concentration (CMC) which ($8*10^{-3}$ M) [24], and 1 g of Al_2O_3 particles in 100ml water was shaken for one hour and the pH was adjusted to 2 with 0.5M nitric acid. The supernatant solution was discarded and the remaining solid was dried. To this solution 10 ml of dithizone solution 50 mg/100ml of (0.005M ammonia solution) was added to form Dithizone (H_2Dz) impregnated ad-micelles on Al_2O_3 particles while shaking the suspension with a stirrer. After mixing for one hour at room temperature, the supernatant solution was discarded and the remaining sold was dried, to form coated Al_2O_3/SDSH_2Dz.

Crossflow Microfiltration

Crossflow microfiltration had a feed volume of 20 L of solution. During the experiments the feed solution contained the known concentration of silver ions was pumped through the crossflow filtration rig. Meanwhile the desired amount of the sorbent material Al_2O_3/SDSH_2Dz was added into the reservoir tank contained 5L distilled water. Process was operated at crossflow velocity (0.05 to 0.25 L/s), transmembrane pressure (0.2 bar), pH (6.5) of the solution, permeate flow rate (5L/hr for all experimental runs. The temperature of the solution was kept constant at 25 ^{o}C by using the heat exchanger. The desired transmembrane pressure was maintained by two manually operated valves. The permeate flow rate was controlled by the permeate pump (5l/hr). Permeate flux was determined using a numerical differentiation method. The permeate samples were also collected at regular time intervals for the analyses of silver concentration.

Evaluation of the efficiency of the sample was carried out using Atomic Adsorption Spectroscopy. The equipment used was PerkinElmer Instruments LLC (AAnalyst200) equipped with hollow cathode lamp as the radiation source was used for determination of silver. The wavelength was 328.1nm, lamp current was 4.0mA and the acetylene flow rate was 2.0 Lmin^{-1}. The slit width was 0.5nm with an air flow rate 13.5 Lmin^{-1}.

Results and Discussion

The effect of cross flow velocity on absorption of silver ions into coated material.

The effects of the crossflow velocity on the silver absorption into the coated material Al_2O_3/SDSH_2Dz are shown in figure 1. It is seen form figure 1 that the silver ions absorption into the coated material Al_2O_3/SDSH_2Dz increases with increasing cross flow velocity, the amount of silver absorbed into sorbent material Al_2O_3/SDSH_2Dz was (25.35, 21.65 ppm) for the velocity of 0.25, 0.05 L/s respectively.

The effect of the permeate flow rate on the absorption of silver ions into coated material.

Figure 2 shows that the effects of the permeate flow rate on the absorption of silver ions into the coated material (Al_2O_3).it is clears from figure 2 that the adsorption of the silver ions into the sorbent material decrease with increasing the permeate flow rate. The amount of silver absorbed into sorbent material Al_2O_3/SDSH_2Dz was (25.35, 39.68 ppm) for the velocity of 5, 2.5 L/hr respectively.

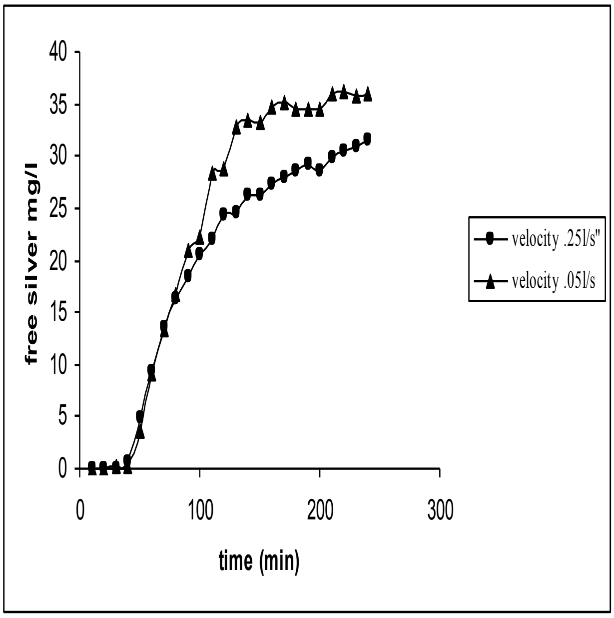

Fig. 1. The effect of cross flow velocity on the absorption of silver ions into the sorbent material Al_2O_3/SDSH_2Dz as a function of time the initial concentration of silver ions 45ppm.

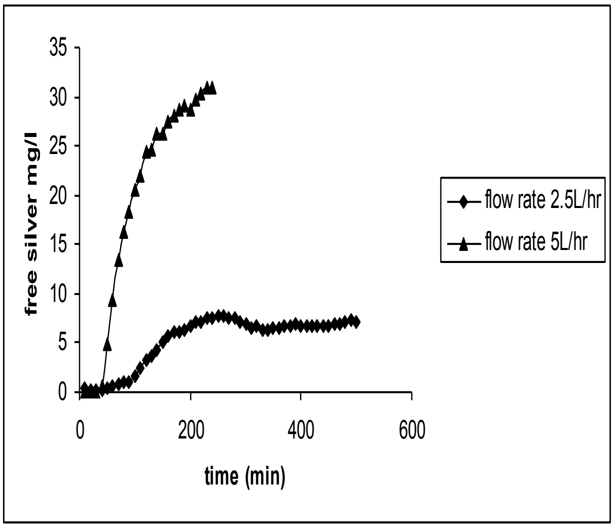

Fig. 2. The effect of the permeate flow rate on the absorption of silver ions into the sorbent material Al_2O_3/SDSH_2Dz as a function of time the initial concentration of silver ions 45ppm.

Conclusion

From the results it was observed that the silver ions be effectively removed from wastewater using cross flow microfiltration. The mount of silver ions absorption into the coated material Al_2O_3/SDSH_2Dz is strongly depended on cross flow velocity and permeate flow rate. It was observed that the silver ions absorption into coated material was increase with increasing cross flow velocity and were decrease with increasing permeate flow rate.

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