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№ 8769

Study of the Breakthrought Curves of Chromium Elimination onto Activated Carbon

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August 31, 2022

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ABSTRACT

The present work aims the study of chromium elimination from industrial sources in a fixed-bed column of activated carbon. The experiments were carried out at natural pH and temperature with a flow rate (5, 10, and 20 mL/min) and bed height (3.5 cm). Breakthrough curves for feed concentrations (0.01, 0.03, and 0.05 mol/L) were investigated. The results indicated a marked decrease up to 99%. The value of the flow constant for the Thomas model decreased with the increase in the concentration of the incoming substance, but increased with the increase in the flow rate. This is the template and instructions for extended abstracts. Authors are advised to read the extended abstract guidelines carefully and follow them strictly.

Keywords:
Chromium
Adsorption
Breakthrought Curve
Activated carbon

1. Introduction

Various physical, chemical and biological methods of processing heavy metals have been developed and tested. These processes include flocculation[1], precipitation, ion exchange, membrane filtration, irradiation and ozonation. However, most of these technologies are expensive, especially when applied to high-throughput effluents. Therefore, the adsorption technique on abundant natural materials such as clay, selected raw or modified minerals, and activated carbons, is reliable and inexpensive [2-3].

The present work aims to study the removal of hexavalent chromium by adsorption on fixed bed of activated carbon. Dynamic behaviour of fixed-bed column was described in terms of breakthrough curve.

2. Materiel and Methods

The use of columns in the dynamic adsorption study is a relatively fast and reproducible analytical method. In this system, continuous flow adsorption study was conducted in columns made of Pyrex glass tube, with an inner diameter of 2.5 cm and a height of 20 cm, supplied by a peristaltic pump with Chromium (VI) solution. The treated solution is collected for analysis and tested at room temperature of 25 °C, activated carbon bed depth (3.5 cm), flow rates (5, 10 and 20 mL/min), and Cr(VI) concentration (0.01, 0.03, and 0.05 mol/L).

3. Results and Discussion

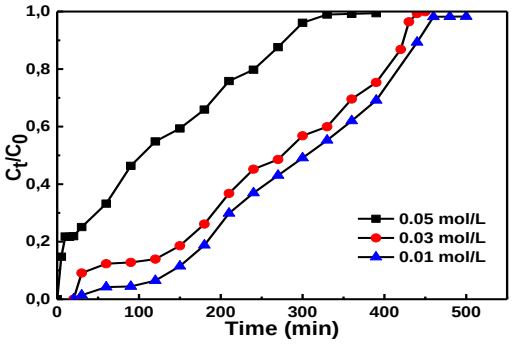

Figure.1 Breakthrough curves for Cr (VI)

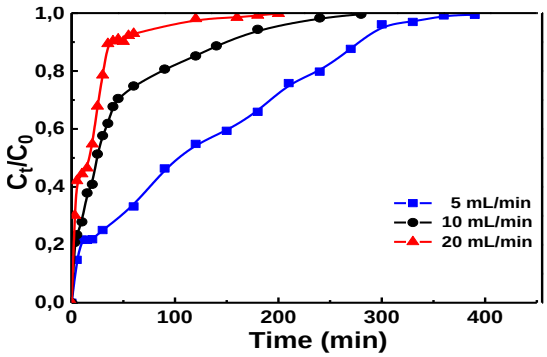

Figure.2 Effect of influent Cr(VI) concentration on the breakthrough curve of Cr(VI).

3.1 Effect of flow rate on breakthrough curves

The breakthrough curves were obtained for the adsorption of Cr(VI). Normalized hexavalent chromium concentration (C_t/C_0) versus time at different flow rates is shown in Figure. 1. The shape of the breakthrough curves is identical for the three flow rates (5, 10 and 20 mL/min). It was found that the breakthrough occurred faster with a higher flow rate, the curves have two parts, the first one characterizes the retention, where the efficiency is maximum, so the concentration at the column outlet in solute is low; the second part characterizes the decrease in GAC bed efficiency, which indicates the beginning of saturation of the adsorbent. However, it is noted that the operating conditions have an influence on the adsorption capacity. In fact, the saturation time of the GAC decreases with the increase of the flow rate. The fix bed saturation is quickly reached for the fastest flux, and the saturation time decreases from 330 min to 140 min with an increase in flow from 5 mL/min to 20 mL/min. Adsorption was rapid at lower flow rate due to the availability of reaction sites near the surface of particles capable of capturing Cr(VI) [3]

Therefore, there is not enough time for adsorption equilibrium to be reached, which results in lower bed utilization, and the adsorbate solution leaves the column until the equilibrium is reached [4].

3.2 Effect of influent Cr(VI) concentration on breakthrough curve

The effect of influent Cr(VI) concentration on the breakthrough curves is presented in Figure.2. It was observed that more concentrated feed solutions provided earlier bed saturation. It is illustrated that the breakthrough time decreased with the increase of influent Cr(VI) concentration. At a lower concentration, the breakthrough curve was dispersed and breakthrough occurred slower, the total removal rate of Cr(VI) was found to be 99% after 460 min, 430 min and 330 min, at Cr(VI) concentration of 0.01 mol/L, 0.03 mol/L and 20 mL/min, respectively. These results demonstrated that higher initial influent concentrations led to a higher driving force for mass transfer, hence the adsorbent achieved saturation more quickly, which resulted in a decrease of exhaust time and adsorption zone length [5,6].

4. Conclusion

In this paper, the removal of Cr(VI) by activated carbon was investigated. From the findings presented here it was concluded that:

- All the breakthrough curves had a similar shape.
- The breakthrough curves shifted to the origin with an increasing flow rate, and an earlier breakthrough.
- The measured concentrations of Cr(VI) decreased with an increase in the influent concentration.

5. References

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