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Determination of zero charge point of a biosorbent which origin is vegetable

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ABSTRACT

During this work, we proceeded to the study of the chemistry of surface of a biosorbent produced by a forest waste «bark of eucalyptus » by a potentiometric study. Thus, several techniques are exploited namely the monitoring of pH changes biosorbent of suspensions based on contact time (pH = f (Tc)).

Keywords: Eucalyptus bark, potentiometric, PZC, Biosorbent.

INTRODUCTION

The use of biosorbent materials in the treatment of chemical effluents made the object of a particular attention by directing the researches to the use of these not expensive and recyclable products as the bark of eucalyptus.Surface chemistry plays a crucial role in the process of interaction involved in the biosorption process [1-2-3] . The surface of the absorbent substrate is described by electrochemical parameters such as the point of zero charge (PZC) and the isoelectric point (IEP) [4]. Indeed The pH, for which the surface charge is zero in other words the total of positive charges equals that of negative charges is of particular interest, as there is no electric aversion between the various particles. The pH values at PZC or the IEP vary due to specific adsorption of cations or anions to the particle surfaces or because of the presence of heterogeneous or surface impurities [5]. A point of zero charge PZC characterizes the sorbent-sorbate interaction. This point determines the ease with which a substrate can adsorb harmful pollutants [6-7-8-9].

MATERIALS AND METHODS

This part contains the experimental techniques used. Specifically, protocols and conditions of substrate preparation from the bark of Eucalyptus and analysis methods that have allowed the characterization of the PZC.The chemicals used in this study are analytical in nature and have not undergone any previous treatment.

3 .1. Experimental protocol for preparation of eucalyptus bark

3.1.1. Physical Preparation

The bark used is that of boxwood which is a short clear fibrous bark gray finely reticulated or obliquely furrowed surface. The bark is washed with tap water to remove dust and suspended solids. Then, it is dried in the open air, crushed and sieved. The preparation is carried in Laboratory of Radiochemistry of the Faculty of Sciences in Rabat-Morocco.

3.1.2. Chemical Treatment

The untreated barks strongly color the solutions because of the solubilization of organic substances as tannins, which are toxic compounds, which presents a major drawback for their employment without preliminary chemical treatment. To remedy this problem, the bark is used after washing with different acids. We can cite for example hydrochloric acid that is both effective, available and affordable to implement the treatment. Other acids such as sulfuric acid, nitric acid, phosphoric acid may also be employed in this case. The bases used in this context is sodium hydroxide. In the present work, the bark is heat treated initially with sodium Hydroxide (2M) and a second time with phosphoric acid (1,4M). This process continues until the washings become colorless.

3.2 Study of the chemistry of surface of a biosorbent

The surface chemistry study of the material biosorbent is led by the potentiometric technique.The acido-basic titrations are realized on suspensions of masses between 5 and 25g/l. The sorbent is put in suspension in solutions HCl or NaOH 0,05N. Following the procedure, the volume of the suspension is 20 or 50 ml. The reactions protonation– deprotonation involved in acid-base behavior of the substrate are performed by the following reactions:

$$\overline{>SOH} + H^+ \leftrightarrow \overline{>S(OH_2)^+}$$

$$\overline{>SOH} \leftrightarrow \overline{>SO^-} + H^+$$

The determination of the constants of acidity of a material can be realized by modeling Potentiometric titration curves of this biosorbent.

RESULTS AND DISCUSSION

We realized at various initial pH (pHi) the follow up the pH of a suspension of 20 g / l of bark of eucalyptus according to Tc. The volume of the examined suspension is equal to 50 ml.

The figure 1 illustrates pH = f (Tc).

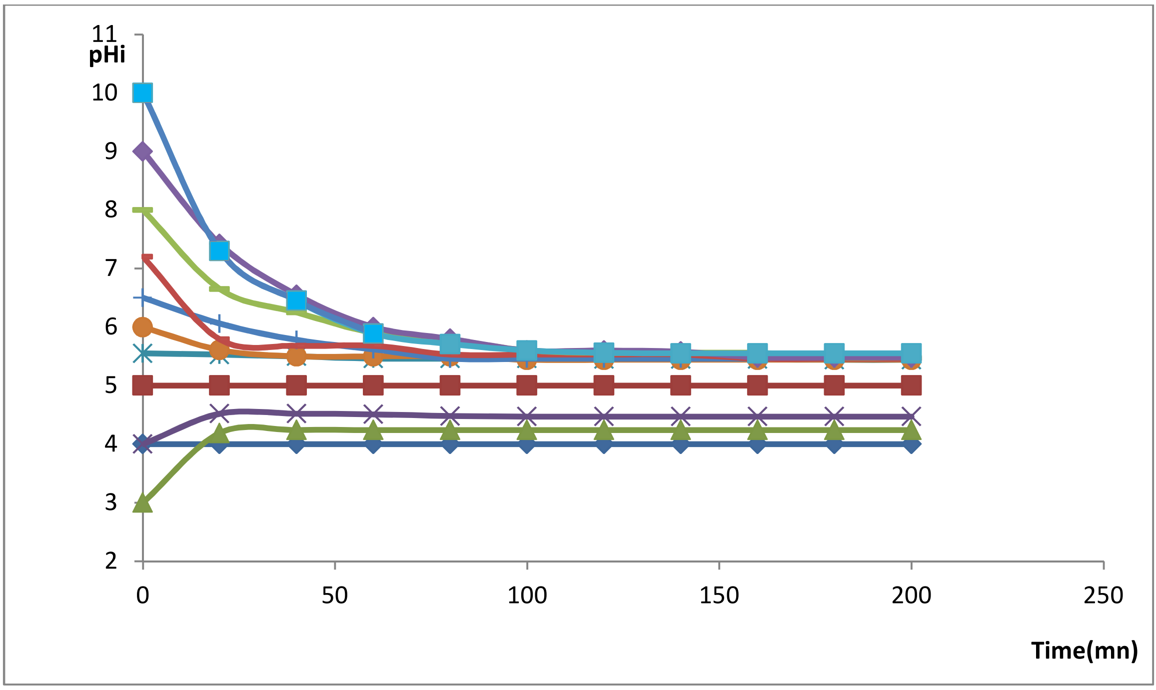

Figure 1: Variation in pH = f (Tc) of a suspension of the biosorbent 20g / l obtained at pHi = {10 -9 -8 -7 -6, 5 -6 - 5, 5 - 3 – 4} and two blank tests to pH = 4 and 5

The results indicate, in all cases examined, a change in pH which is accentuated during the first 20 minutes. When time continues to increase, the pH stabilizes after 100 minutes. This change in pH is generally due to the exchange of H^+ or OH^- functional groups from > SOH present on the surface of the biosorbent. Indeed, when pHi is upper than 5.5, the variation of the acidity of the suspension becomes less significant as far 4.45 <pH <5.5. This result is due to the effect of the surface charge, which contributes to the stability of the pH, when it is nearby of zero. Consequently, we can suppose at first, that the value of the PZC of the studied barks is between 4, 4 and 5, 5. These results are comparable to the bibliographical data concerning the barks of eucalyptus [10-11]. Moreover, when the pH is adjacent to the PZC, there is a buffer suspension behavior. Nevertheless, these results seem insufficient in this case, since solutions whose pH is less than 5 also show a buffering effect. To this end the method for measuring pH = f (Tc) must be coupled with another technique in order to achieve accurate values of PZC. So, we tried to bring out other physico-chemical parameters in order to identify the points which correspond to a minimal pH variation of the examined suspension.

These parameters can be obtained only from the derivative of the function pH = f (Tc). This is why the titration curves are smoothed by polynomial equations.

The figure 2 presents f (pHi) =$\frac{dpH}{dTc}$.

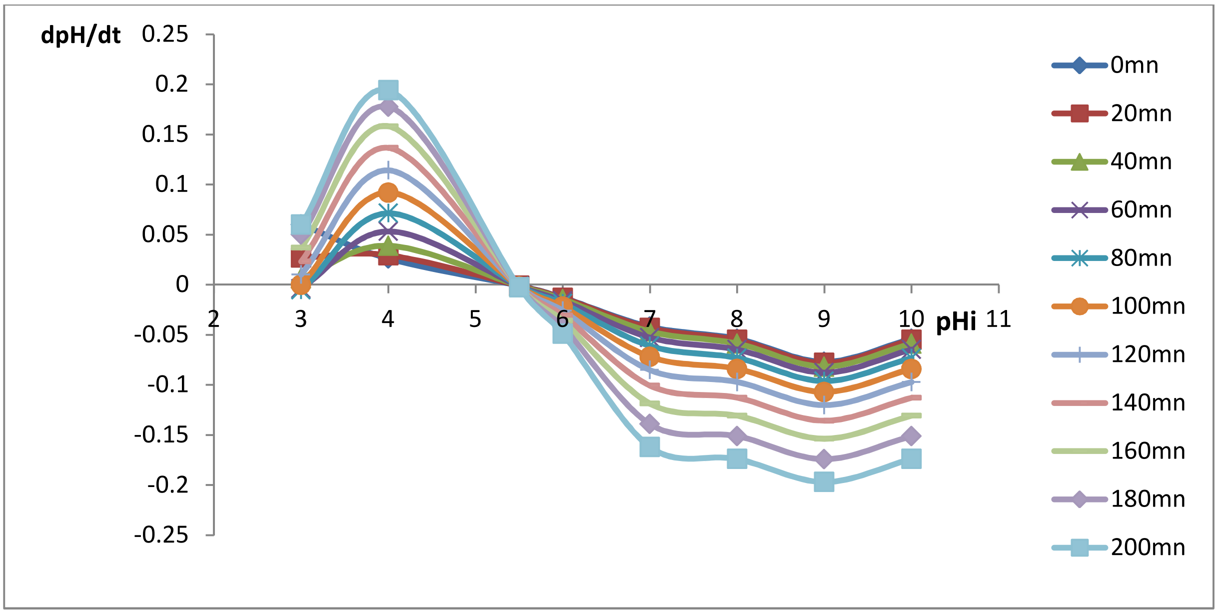

Figure 2.Variations f (pHi) =$\frac{dpH}{dTc}$ obtained for a substrate suspension of 20g / l

These variations show a cross point (pH = 5.5, 0). The overlap observed in $\frac{dpH}{dTc}$ equal zero, to conclude that PZC = 5.5. These values are in agreement with literature data [10].

The maximum $\frac{dpH}{dTc}$ observed at pH = 4 indicates an acid-base behavior change sites > S_1OH.

This behavior is described by the reaction:

$$> SOH + H^+ \ {}_2\rightleftarrows^1 > SOH_2^+$$

CONCLUSION

In this study, we have process to determine the zero charge point of eucalyptus bark used as biosorbent in the cleanup of releases. Therefore, the technical monitoring pH changes biosorbent of suspensions as a function of hydration time (pHi = f (Tc)) indicates that the value of the PZC of this material is between 4,4 and 5,5. For clarification, the first order derivative curves pHi = f (Tc) smoothed by polynomial equations allowed to calculate the PZC = 5.5 of this biosorbent.

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