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Abstract - Textile industries release large amounts of wastewater at risk of toxicity. Shells could be alternative adsorbent materials both economic and less polluting. To highlight the process of adsorption of dyes on Mytilus Edulis shells, a model, based on an analytical method was applied to the case of spherical samples. The theoretical, results fo the kinetics of dye transfer were in good agreement with the corresponding experimental ones. The Spherical model exhibited a significant dye transfer, controlled by diffusion with different diffusivity an a coefficient of matter transfer characterizing the retardation in the transfer on the surface.

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I. Introduction

Synthetic organic dyes are compounds used in many industries such as automotive, chemical especially the textile sector, or any range of shades and chemical families are represented. The affinities between textiles and dyes vary the chemical structure of dyes and fiber type on which they are applied. It is not uncommon to find that during the dyeing process from 15 to 20% of the dyes, and sometimes up to 40% for sulfuric dyes and reagents, are evacuated with effluents liquids that are mostly directly discharged into rivers without treatment.

Coloured discharges pose a cosmetic problem, but also health because many of these dyes are toxic. Like all organic compounds hazardous to humans, synthetic dyes require specific treatments. Many kinds of adsorbents have been developed for various applications [1–3]. However, the conventional method used by treatment plants wastewater is difficult and sometimes not even suitable for the remediation of these pollutants biocides.

A processing technique suitable for discharge from the textile industry must first achieve performance when citrate is a mixed effluent. It is why the adsorption process (multi adsorption) on activated carbon, is the method most used and recommended for the treatment of wastewater in industries textiles.

Despite its effectiveness, Charbon is an expensive material asset and mostly imported, and the material asset and mostly imported, and the search for new products that come from a source cheap and available, is useful.

We are interested in the properties of the adsorbed shells of mussels that could be used in the treatment of discharges from the textile industry. The use of shells in a new treatment process within a framework of sustainable development, the social aspect and environemental, but we must also consider the economic the general interest objective in the long term is threefold: reduce pollution, promote recycling and waste waters.

II. Theoretical And Experimental Part

a) Assumptions

The following assumptions were made: (i) The sample was spherical in shape, (ii) The spherical sample was not modified during the test, as shown by experiments, (iii) The de transfer was controlled by diffusion under transient conditions, with a constant diffusivity, (iv) The liquid transfer into the sample was not considered, and (v) a coefficient characterizing the dye transfer through the liquid-sample interface was introduced in the paper.

b) Mathematical Treatment

Fick's laws describing the matter transfer by diffusion were considered, for the case of a spherical sample with a constant diffusivity [4]:

$$j = -D.\frac{\partial C}{\partial x}$$

$$\frac{\partial C}{\partial t} = D\left[\frac{\partial^2 C}{\partial r^2} + \frac{2}{r}.\frac{\partial C}{\partial r}\right] \qquad (1)$$

$$= \frac{1}{r^2}.\frac{\partial}{\partial r}\left[D.r^2.\frac{\partial C}{\partial r}\right] \qquad (2)$$

III. Results And Discussions

After having determined the data useful for calculation, i.e. the diffusivity and the coefficient of

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matter transfer at the surface of the sample, the model was built and then tested by comparing the kinetics of dye transfer into the support obtained either from experiment or from calculation.

a) Determination of KInetic Parameters

It was difficult to determine the diffusivity corresponding with the transfer of drug by using short tests [8] because of the presence of the coefficient of matter transfer. So, we calculated this parameter by using the data obtained from experiments for very long times and the Equation 5.

The initial and boundary conditions were described by equations 3 and 4:

$$t=0 \quad 0 \leq r < R \quad C=0 \tag{3}$$

$$t> 0 \quad 0 \leq r \leq R \quad C=C_{éq}=C_0 \tag{4}$$

Analytical solutions could be found for the simple case when the diffusivity was constant, and the concentration of dye on the surface of sample was zero as soon as it was soaked in the liquid [5,6].

$$\frac{M_\infty - M_t}{M_\infty} = \frac{6}{\pi^2}.\sum_{n=1}^{\infty}\frac{1}{n^2}.\exp(-\frac{n^2.\pi^2.D.t}{R^2}) \tag{5}$$

Where M_t and M_∞ was the amount of dye released at time t and at infinite time, respectively, R was the radius of the sphere, n was an integer.

The series shown in equation 5 was available for long and short tests, for very short tests, a simple equation was used [7].

$$\frac{M_t}{M_\infty} = \frac{1}{6}.(\frac{D.t}{\pi})^{0,5} \tag{6}$$

b) Methylene Blue Diffusivity

To test the validity of the expression of the intra-particle diffusion already demonstrated, the evolution of Ln [1 / (1-F ^{2} t)] versus time was plotted. In all cases, the plot of Ln [1 / (1- F ^{2} t)] versus time applied properly to methylene blue dye diffusion is shown at figure 1. The results of simplified model application.

c) Indigo Carmine Diffusivity

In the same, to test the validity of the expression of the intra-particle diffusion already demonstrated, the evolution of Ln [1 / (1-F ^{2} t)] versus time was plotted, the plot of Ln [1 / (1- F ^{2} t)] versus time is applied properly to indigo carmine dye diffusion is shown at figure 2.

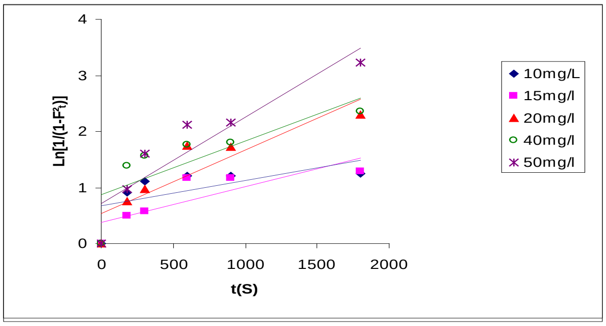

Figure 1 : Vermeulen intraparticle model for methylene blue adsorption onto Mytilus Edulis shells

Table 1 : Results of application of the simplified model of internal diffusion Vermeulen for methylene blue adsorption onto Mytilus Edulis shells

C_0 mg/l)	r²	$K_V(s^{-1}) = (\pi^2 D/R^2)$	$D(m^2.s^{-1})$
10	0,9833	0,0273	2,42. 10^{-12}
15	0,9806	0,0381	3,38. 10^{-12}
20	0,8	0,068	6,03. 10^{-12}
40	0,9174	0,071	6,3. 10^{-12}
50	0,8359	0,0925	8,2. 10^{-12}

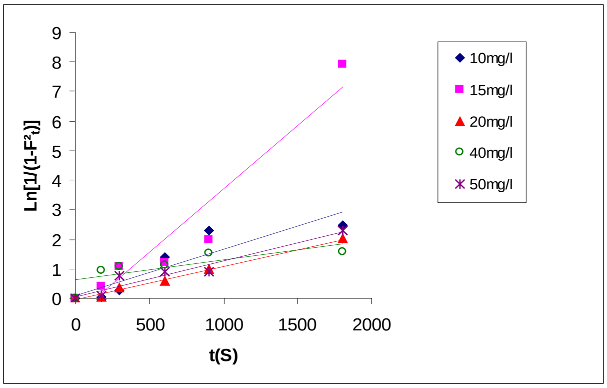

Figure 2 : Vermeulen intraparticle model for indigo carmine adsorption onto Mytilus Edulis shells

Table 2 : Results of application of the simplified model of internal diffusion Vermeulen for indigo carmine adsorption onto Mytilus Edulis shells

C_0 (mg/l)	r²	$K_V(s^{-1}) = (\pi^2 D/R^2_a)$	$D(m^2.s^{-1})$
10	0,8221	0,0939	8,3. 10^{-12}
15	0,9201	0,0958	8,5. 10^{-12}
20	0,9918	0,1685	1,49. 10^{-11}
40	0,8978	0,1704	1,51. 10^{-11}
50	0,9331	0,1728	1,53. 10^{-11}

IV. CONCLUSION

We have shown in particular that it was possible to adsorb dyes in the shells of mussels Mytilus Edulis previously untreated.

A model, based on a numerical method with finite differences, was built by considering that the samples were spherical in shape. The dye transfer was found to be controlled by diffusion under transient conditions with different diffusivity and with a coefficient of matter transfer at the liquid- material interface.

$K_V=\pi^2D/R^2a$ increment depends on the concentration of the colored solution $D = f(C_0)$, it increases with increasing concentration and diffusivity·

The kinetics of dye transfer obtained by experiments and calculation were in good agreement, proving the validity of the model.

References Références Referencias

1. S. Wang, H. Lee, Dye adsorption on unburned carbon:kinetics and equilibrium, J. Hazard. Mater. B 126 (2005) 71–77.
2. O. Hamdaoui, Batch study of liquid-phase adsorption of methylene blue using cedar sawdust and crushed brick, J. Hazard. Mater. B 135 (2006) 264–273.
3. V.K. Gupta, I. Ali, Suhas,D.Mohan,Equilibriumuptake and sorption dynamics for the removal of a basic dye (basic red) using low cost adsorbents, J. Colloid Interf. Sci. 265 (2003) 257–264.
4. J. Crank, 1975, The matematics of diffusion, 2nd edition, clarendon Oxford.
5. W.W. Moshleu and R.E. Martin, 1988, Diffusion equation solutions in experimental wood drying, wood Sci., 1, pp. 47-57.
6. E.T.Choong, 1965, Diffusion coefficients of softwoods by steady-state and theoretical methods. For. Prod. J.15:21-27.
7. M. Elkouali and J.M. Vergnaud, 1990, Modelling the process of absorption and desorption of water and below the fiber saturation point, wood. Sci. Technol. 25:327-339.
8. J.L.Tarverdet and J.M.Verrgnaud, (1984), Study of transfer process of liquid into and plasticizer out of plasticized PVC in using short tests, J. appl. Polym.SCi., 29, 3391-3400.

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