STUDY ON THE APPLICATION OF MELALEUCA CAJUPUT ACTIVATED CARBON IN THE TREATMENT OF WASTE WATER FOR TEXTILE INDUSTRY

Phan Dinh Tuan, Nguyen Tran Huyen Anh
University of Technology, VNU-HCM

1.INTRODUCTION

It has been found that melaleuca cajuput wood is a good material for activated carbon [1]. Nevertheless, to identify the suitability of the activated carbon to practical uses, it is necessary to study the adsorption characteristics of different species in corresponding media [6,8]. The investigations deal with some types of dyestuffs which are considered harmful to environment: Sulfite Red S3B, Procion yellow HE-XL and Sulzol Blue R. The suitability of the activated carbon to the contaminated components could be evaluated by the adsorption capability, which is judged by isotherm curves, and the adsorption speed, which is judged by kinetics investigations.

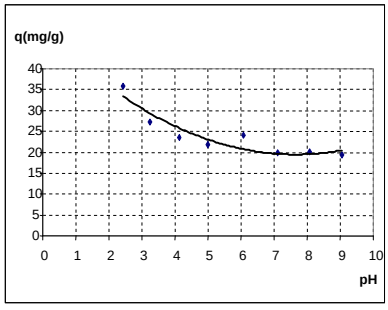
2.MATERIALS AND METHODS

Melaleuca cajuput activated carbon is self produced based on the procedure described in [1]. Its specific surface area is evaluated by BET method. The Sulfite Red S3B, Procion yellow HE-XL and Sulzol Blue R dyestuffs are supplied by the Institute for Textile and Fashion. Compositions of the dyestuffs in liquid media are identified by chromatography (UV-VIS DR Hatch 5000).

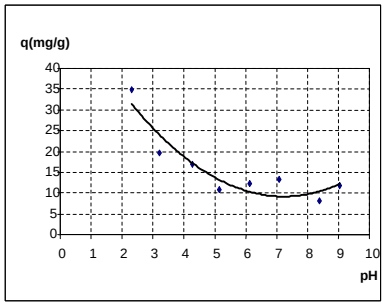
3.RESULTS AND DISCUSSION

3.1.Influence of pH

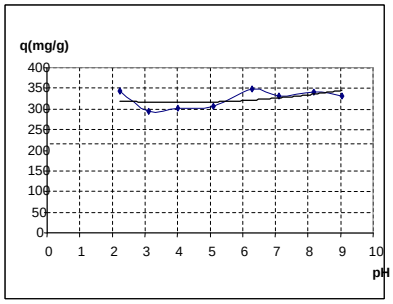
Batch tests have been done to identify the influences of pH on the adsorption capability of the activated carbon. The data are displayed in Figure 1. It is pointed out that at low pH values, the adsorption capability of the Sulfite Red S3B and Procion yellow HE-XL dyestuffs on the activated carbon are higher than at neutral media (pH = 5 -8), while the adsorption capability of the Sulzol Blue R does not change much . Thus, the adsorption to remove those dyestuffs is more effective in light acid media waste water.



a)



b)



c)

Figure 1. Influence of pH on the adsorption capability on the activated carbon
a) Sulfite Red S3B 150%-VL b) Procion Yellow HE-XL-VL c) Sulzol Blue R-VL

3.2.Isotherm equilibriums

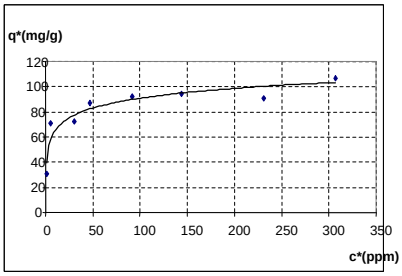
Isotherm equilibriums to the dyestuffs are determined at room temperature as the treatment temperature of most waste water resources. Different volumes with determined initial concentrations of dyestuffs and different determined amounts of activated carbon have been brought to contact in batch tests. The concentration changes of dyestuffs during the contact have been samples, analyzed until pseudo plateaus are observed. The received data are used for the isotherm equilibriums creation. The experimental data are plotted on Figure 2.

It is assumed from the experiments that the Langmuir's isotherms [2,3,4,7] could be used to illustrate the data:

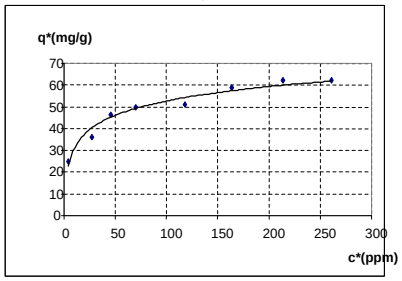
$$q^* = \frac{QK_L c^*}{1 + K_L c^*} \quad (1)$$

in which Q (mg/g) is the maximum concentrations of adsorbate in the activated carbon, KLis an equilibrium constant,(1/ppm), q*(mg/g) and c*(ppm) are the concentrations of the adsorbate in the activated carbon and in the solution, that are in equilibrium with each other.

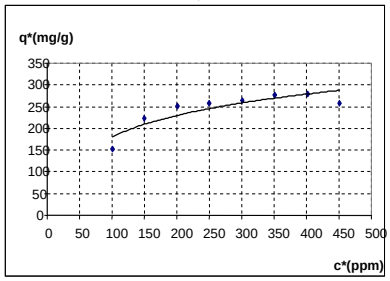
By logarithmizing the equation (1) and plot the calculated values on graphs, it is easy to find out the corresponding values of Q, Kc for the used dyestuffs as shown on the Figure 2.



a)



b)



c)

Figure 2. Isotherm of the dyestuffs adsorption on the activated carbon at room temperature and pH ≈ 2.
a) Sulfite Red S3B, Q = 93.46(mg/g), K_L= 0.473(1/ppm)
b) Procion Yellow HE-XL, Q= 54.64(mg/g),K_L = 0.187(1/ppm)
c) Sulzol Blue R, Q= 277.78(mg/g), K_L= 0.240(1/ppm)

3.3.Kinetics investigation

Each volume of 1500 ml with determined initial concentration of dyestuffs is prepared for the kinetics investigations. Two concentrations of the dyestuffs (20ppm and 40ppm of each type) and two different amounts of the activated carbon (ca. 0,3gr and 0.6gr) are used for these investigations. Samples are taken during the adsorption process and analysis has been done to figure out the change of adsorbate concentrations in the solution. The concentrations of the adsorbate in solid phase (activated carbon) are calculated on the base of material balances.

Three types of kinetics models have been used to evaluate the flow of the process: the outer mass transfer [3], the pseudo 1st order and the pseudo 2nd order [4]. By plotting the experimental point and the calculated theoretical lines on the same graphs, it has been found that the pseudo 2nd order kinetic equation fitted rather well the experimental results (Figures 3,4 and 5). This agrees well with the suggestions made by Y.S.Ho and G.McKay [5].

4.CONCLUSION

Based on the study, it is pointed out:

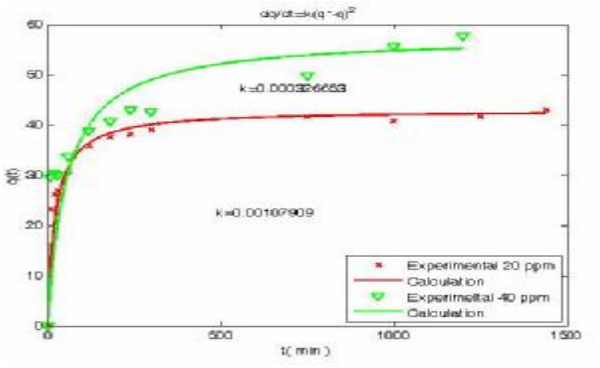
- Melaleuca cajuput steam-activated carbon could be effectively used to treat dyestuffs of the textile wastewater. When the concentration of dyestuffs in waste water is about 250ppm, the

activated carbon could adsorb 100, 60, 250 mg/g for the dyestuffs Sulfite Red S3B, Procion Yellow HE-XL and Sulzol Blue R, respectively.

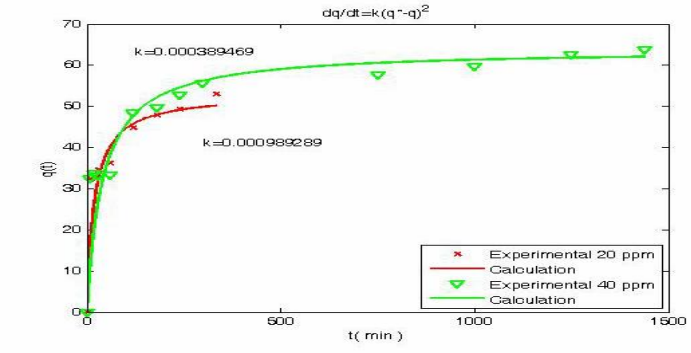
- Equilibrium isotherms of the adsorption processes could be described by Langmuir's equation.

- Kinetics characteristics of the processes could be well described by pseudo-2nd order equations. The theoretical equation with experimentally determined coefficients can be used for process calculation.

- For practical applications, column tests should be done with different types of dyestuffs.

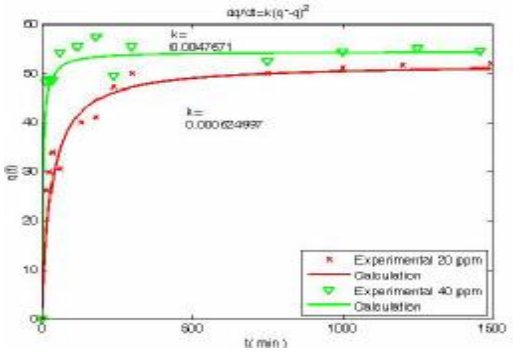


a)

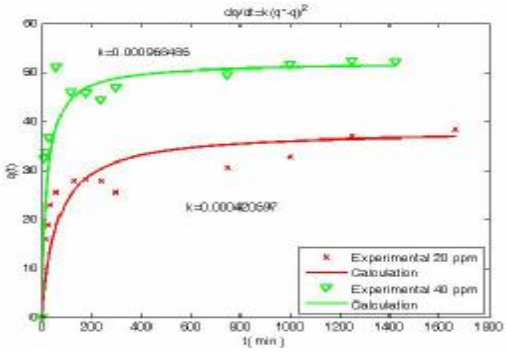


b)

Figure 3. Kinetic behaviours of the Sulfite Red S3B adsorption on activated carbon with initial solution concentrations of 20ppm and 40ppm.
a) Weight of activated carbon: ca. 0,3gr b) Weight of activated carbon: ca. 0,6gr

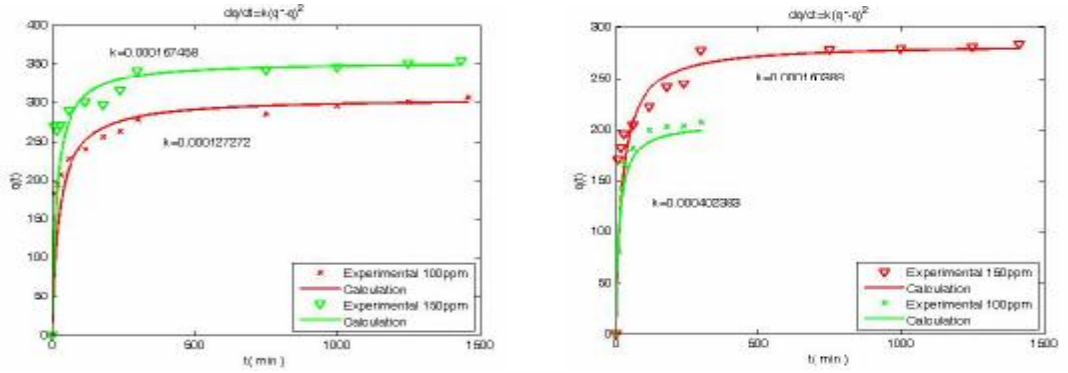


a)



b)

Figure 4. Kinetic behaviours of the Procion Yellow HE-XL adsorption on activated carbon with initial solution concentrations of 20ppm and 40ppm.
a)Weight of activated carbon: ca. 0,3gr b) Weight of activated carbon: ca. 0,6gr



a) b)

Figure 5. Kinetic behaviours of the Sulzol Blue R adsorption on activated carbon with initial solution concentrations of 20ppm and 40ppm.
a) Weight of activated carbon: ca. 0,3gr b) Weight of activated carbon: ca. 0,6gr

REFERENCES

[1]. Đặng Thị Yến Nhi, *Nghiên cứu công nghệ sản xuất than hoạt tính từ cây tràm cừ*, Luận văn thạc sĩ, Trường Đại học Bách Khoa TpHCM, (2007).

[2]. Nguyễn Thị Kim Dung, *Nghiên cứu khả năng khử màu nước thải dệt nhuộm bằng phương pháp hấp phụ trên bentonite*, Luận văn tốt nghiệp Đại học,Trường Đại học Bách Khoa TpHCM, (2007).

[3]. Roop Chand Bansal Meenakshi Goyal, *Activated Carbon Adsorption*, CRC Press, Taylor & Francis Group, (2005).

[4]. Harry Marsh, Francisco Rodriguez-Reinoso, *Activated carbon*, Elsevier Science and Technology Books, (2006).

[5]. Y.S.Ho and G.McKay, *Kinetic model for Lead (II) sorption on peat*, Multi-Science Publishing CO.LTD.,p. 1-7,

[6]. Milan SmiŠek, RNDr, Slavoj ČernÝ RNDr,. CSc, *Activated carbon –Manufacture properties and Application*, Institute of Physical Chemistry, Crechslovak Academy of Science, Prague (Czechoslovakia), (1970).

[7]. Duong D. Do, *Absorption Analysis: Equilibria and Kinetics*, Department of Chemical Engineering University of Queensland, Australia, (1998).

[8]. Mr.Kakuta, *Types of carbon Adsorpbents and their productions*, Science Ceremony in Japan, p.1-41, (2007).