Using charcoal micronized carbon (MEC) to methylene blue adsorption – the isotherm calculations

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Abstract: A comparison of different isotherm calculations was performed using micronized eucalyptus charcoal (MEC) absorbing methylene blue. The dye wastewater could affect in large scale the surface water quality and the metabolism of many species. The micronized charcoal was able to remove about 75% for the dye accordingly with Langmuir, Freundlich and Redlich-Peterson isotherm calculations suggesting a promising new, efficient and low cost water treatment process.

Keywords: adsorption, micronized charcoal, methylene blue, Redlich-Peterson

Introduction

The adsorption process has been one of the most important techniques used in water treatment before discharge in water courses. The presence of dyes such as methylene blue may causes eutrophication and secondary dangerous products due to chemical reactions. The eucalyptus charcoal used in adsorption process was obtained as a solid waste with low cost and particle size, the surface area can be improved using the milling micronization processes.

The adsorption processes were studied reaching the equilibrium condition and performing the calculations of Langmuir isotherm, Freundlich isotherm and Redlich-Peterson isotherm, equations I, II and III respectively (SAMPRANPIBOON, 2014) (Ho et al, 2005).

$$C_e/q_e = 1/Q_0 b + C_e/Q_0, \qquad \text{I}$$

$$\log q_e = \log K_f + 1/n \log C_e \qquad \text{II}$$

$$\ln (C_e/q_e) = g \ln C_e - \ln K_r \qquad \text{III}$$

Where: C_e = equilibrium concentration (mgL^{-1}); q_e = the amount adsorbed at equilibrium ($mg.g^{-1}$); Q_0 and b are Langmuir constants; Q_0 indicates the adsorption capacity of the material and b indicates the energy of adsorption. K_f and n are Freundlich constants. K_f indicates the adsorption capacity of the material and n indicates efficiency of adsorption. K_r and g are Redlich-Peterson constants; K_r indicates the adsorption capacity and g is the exponent between 0 and 1.

Material and Methods

A $5mgL^{-1}$ methylene blue solution was prepared as stock solution and after the experiments was diluted for different initial concentrations. The MEC (diameter < 500 mesh) mass was 0.1 g and it was added to the methylene blue solution at reaction chamber. The suspension was stirred continually for 3 hours. The suspension aliquots were collected each 30 min and the systems reached the equilibrium after 120 min. After collected the aliquots were centrifuge at 1500 rpm for 20 minutes. The supernatants were measured at UV-Visible Spectrophotometer Cary 1E at λ = 663 nm. The adsorbance was converted to methylene blue concentration using an analytical curve prepared with dye standard.

Results and Conclusions

The results were used to perform the isotherm calculations, Figure 1. The isotherm constants for Langmuir, Freundlich and Redlich-Peterson can be observed at Table 1.

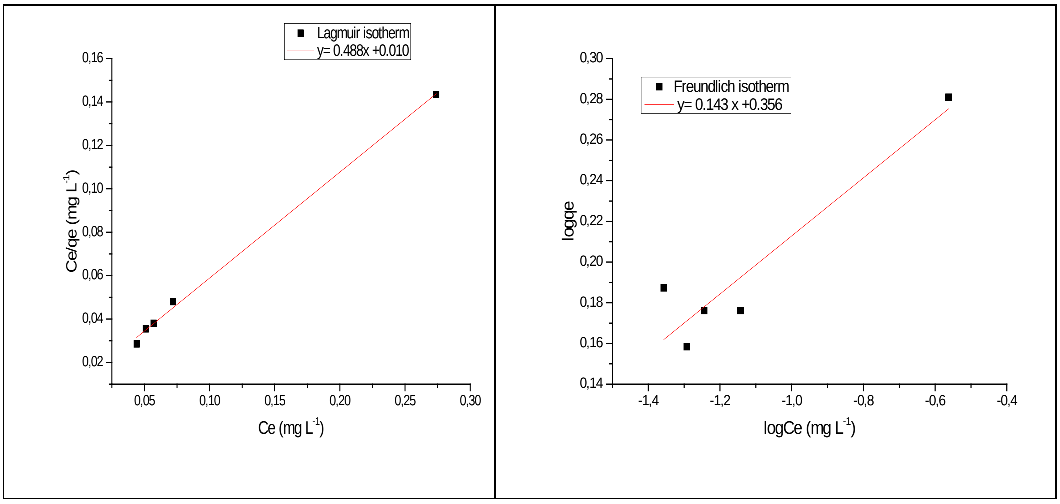

Figure 1: The Langmuir isotherm and the Freundlich isotherm line equations.

Table 1: Langmuir, Freundlich and Radlich-Peterson constants and parameters.

Langmuir	**Q_0 (mg/g)**	**b (mL/mg)**	**Removal %**	**RL**
	0.49	0.021	74	0.996
Freundlich	**K_f ($L.g^{-1}$)**		**n**	
	2.27		7.14	
Redlich-Peterson	**K_r($L.g^{-1}$)**		**g**	
	0.05		0.02	

The RL values were in the interval from 0 to 1, accordingly with Langmuir isotherm system. The Freundlich isotherm constant n was also in the interval of 2<n<10, the results indicate the adsorption process in agreement with Freundlich model with equal adsorption heating and Redlich – Peterson parameters were also promising.

References

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