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The comparison of charcoal activation processes using methylene blue adsorption- Removal percentage and surface coverage area.

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Abstract: A series of activation processes was performed on charcoal waste to absorb and remove methylene blue(MB) from polluted waters. The results were used to calculate the MB removal percentage and the surface coveragearea. Both aspects are important indication of the activation process efficiency. The activated process with potassium chloride, potassium carbonate and water stream showed high adsorption efficiency with removal percentage of 90, 84 and 79 % respectively and 24.5 , 24.0 and 18.9 of $m^2\ g^{-1}$ of surface cover area (θ) such surface area increment was considered an important aspect to evaluate the promising properties of activated charcoal to be use in water treatment plant.

Keywords: adsorption, dye, charcoal activation, methylene blue

Introduction

Since ancient times the textile industry has been using dyes and pigments to color and improve their products. There are more than 100.00 commercially available dyes in the market and over 7.105 tones of different kinds of dyes are produced annually. The water discharge of these dyes has been representing acute and chronic problems to the ecological systems due their high toxicity, carcinogenic properties. The comparison of different activation processes was performed to optimizing the adsorption processes of water pollutants. Different activation processes were indicated in literature, most of them using: Potassium Chloride, Water Steam, Potassium bicarbonate, zinc chloride, phosphoric acid and others, Table 1.

Table 1. In literature, some different coal activation processes.

Activation Agent	References
K_2CO_3	MESTRE *et al* (2011)
Steam	ALTENOR *et al* (2009)
H_3PO_4	ALTENOR *et al* (2009)
$ZnCl_2$	KHALILI, N. R. et al (2000)

The calculation of surface coverage area (θ) of the activated charcoal can be performed using the adsorbed methylene blue quantity proportional of the total charcoal activated area. The methylene blue surface coverage area is approximately constant and amounts 200-245 m^2/g indicating an area of 2.080 nm^2 covered per methylene blue adsorbed molecule.

Material and Methods

The activation processes were performed using 30 g of milled eucalyptus charcoal (diameter < 0.074 mm) mixed with the activation agent in water and the suspension was kept mixing in rotational shaker for 6 hours. Afterwards the suspension was filtrated and dried at 90°C for 24 hours. The adsorption processes were studied using MB solution in different

initial concentrations with 1,0g of activated charcoal. The adsorption processes were followed by the collection of aliquots each 30 minutes of stirring time, the system equilibrium time were obtained after 120 min of continuous stirring. All aliquots were centrifuged for 15 minutes on 1500 rpm and the spectrophotometer UV-Vis VARIAN E1 was used to measure the MB absorbance. The analytical curve was preparing using MB standards. MB is a potent cationic dye with maximum spectrophotometric adsorption of light around 630 nm. The MB adsorbed mass is an important indication of the surface coverage area (θ) of activated charcoal. The activation with zinc and the phosphoric acid were not considered due their high toxicity as zinc is toxic metal, and high commercial cost for phosphoric acid.

Results and Conclusions

The results were used in surface coverage area calculations for different activated processes (Gleysteen, 1959). The activated charcoal with potassium chloride, potassium carbonate and water steam showed the higher MB removal percentages 90, 84 and 79 % and surface coverage area were 24.0, 24.0 and 18.9 m^2g^{-1} respectively, Table 2.

Table 2.The removal percentage and surface coverage area for different activation processes.

Activation Processes	Removal %	qe (mg g^{-1})	Θ (m^2g^{-1})
KCl	90	0.100	24.5
$KHCO_3$	84	0.098	24.0
Water Steam	79	0.077	18.9

Table 2 shows the efficiency of the KCl activation process in comparison with potassium carbonate and water steam. The potassium chloride and water steam shows promising aspects to be used as charcoal activation agent with higher MB removal percentage and coverage surface area. Such properties can be improved using the charcoal raw material with lower particle size, as indicated in literature. Raw starting material with low particle size also represents cost of charcoal waste previous treatment. In spite of such difficulties, the charcoal activation processes can be considered promising in toxicological aspect, low cost, high efficiency and increasing coverage surface area.

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