# ADSORPTION OF MELANOIDIN BY ACTIVATED CARBON FROM CANE BAGASSE

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## Introduction

Cane bagasse is a by-product in the manufacture of raw sugar and is readily available in Southeast Asia. It has a potential as a resource material for the preparation of activated carbon because of its fibrous characteristics. Activated carbon is widely used to remove organic compounds from wastewater. Melanoidin is a nitrogenous brown colored polymer present in sugar industry wastewater that is formed through the interaction between amino acids and carbohydrates. It prevents the entry of sunlight into the rivers and lakes receiving this wastewater affecting the photosynthetic activities of marine plants eventually killing aerobic marine animals.

The purpose of this paper is to study the adsorption of melanoidin from sugar industry wastewater using activated carbon from cane bagasse. It also presents the results of the characterization studies of activated and regenerated carbons.

## Experimental

Raw Materials: Sugar cane bagasse obtained from the Philippines was used as the source of activated carbon. Previous studies[1,2] showed that the bagasse is a suitable source because of their low ash content.

Preparation of Melanoidin Solution: Melanodin was prepared in the laboratory by dissolving 4.5 g glucose, 1.88 g glycine, and 0.42 g $NaHCO_3$ in 200 ml distilled water and heating for 7 hr at 95°C.

Preparation of Activated Carbon: The activated carbon was prepared from Philippine bagasse by carbonizing with $N_2$ gas at 300°C for 1 hr and activating with steam at 800°C in a ceramic boat inside a horizontal furnace consisting of a 70-cm length and 3.5-cm i.d. batch reactor.

Adsorption Equilibrium Experiment: The adsorptive capacity of the activated carbon was determined using melanoidin solution. Known weights (0.1 g) of activated carbon were contacted with a given melanoidin solution (0.015 l) in flasks. The flasks were agitated for 3 days at 25°C to assure equilibria using a thermostat shaker. Samples were filtered and the amount adsorbed was determined from the initial and final concentrations of the adsorbate by measuring the transmittance using a Hitachi 330 UV Spectrophotometer. The adsorptive capacities, expressed in $q^*$, were determined by adsorption isotherms and Langmuir plots.

Determination of Surface Area: Surface areas were determined in the laboratory using the BET Single Point Method[3]. This was verified using the Cranston-Inkley (CI) Method by Menabe Chemical Engineering Co. Nitrogen gas was used for the adsorption.

## Results and Discussion

**Table 1** shows the results of the characterization study of the activated carbon. The yield, Y, is the mass in gram of activated carbon produced per gram of cane bagasse. The numbers in the sample name stand for the activation time [hr]. From the table, it can be seen that yield decreases as the activation time increases. On the other hand, the adsorptive capacities and surface area increase as the activation time increases. Based from the values of $Yq^*$ the optimum activation time for the preparation of the activated carbon is 1 hr. The iodine number of B-0.10 was determined and a value of 730.3 mg/g was obtained.

**Table 1. Characteristics of Activated Carbon**

| Sample | Y [-] | $q^*$ [g/g-C] | $Yq^*$ | [a]Surface Area [$m^2$/g] | [b]Surface Area [$m^2$/g] | Pore Volume [ml/g] | Pore Diameter [ml/g] |
|---|---|---|---|---|---|---|---|
| A-0.5 | 0.15 | 0.71 | 0.106 | 682 | 339 | 0.171 | 20.22 |
| B-1.0 | 0.13 | 2.37 | 0.308 | 951 | 458 | 0.278 | 24.26 |
| C-1.5 | 0.10 | 2.60 | 0.248 | 957 | 491 | 0.231 | 18.84 |
| D-2.0 | 0.07 | 3.23 | 0.226 | 974 | 508 | 0.339 | 26.72 |

[a]Calculated using the BET Single Point Method
[b]Calculated using the CI Method

A commercial activated carbon was also used to adsorb melanoidin and a value of 2.85 g/g-C as its adsorptive capacity was obtained. Also, commercial carbons have surface areas around 400$m^2$/g and pore volumes above 0.20 ml/g. It is worth to mention that sample B-1.0 favorably compares to a commercial one.

The activated carbon that has adsorbed melanoidin (B-10) was dried and regenerated for 3 cycles at the same condition used for carbonization and activation. The surface areas of the regenerated carbons after the first cycle regeneration were determined using the BET Single Point Method. The results are included in **Table 2**.

**Table 2. Properties of Regenerated Carbon**

| Adsorptive Capacity, Yield and Surface Area | First Cycle | Second Cycle | Third Cycle |
|---|---|---|---|
| $q^*$ [g/g-C] | 2.79 | 3.46 | 3.00 |
| Y [-] | 0.14 | 0.13 | 0.12 |
| $Yq^*$ | 0.38 | 0.45 | 0.36 |
| [a]$A_s$ [$m^2$/g] | 974 | nd | nd |
| [b]$A_s$ [$m^2$/g] | 813 | nd | nd |

[nd] not determined

The table indicates that after two regeneration cycles, the adsorptive capacity was improved. There was an increase in the values of $q^*$ of the regenerated carbon. The product of Y and $q^*$ increased after two regeneration cycles but decreased after the third regeneration. Note that there was an increase in the yield (Y) of activated carbon after the first regeneration. The yield corresponds to the amount of regenerated carbon produced per gram of bagasse. This increase in yield proves that the adsorbed melanoidin could be a source of activated carbon. However, after the second and third regenerations, the yield slightly decreased. The loss of carbon happens during the gasification stage due to entrainment of the carbon in the moving gas stream. The decrease in $q^*$ after three regeneration cycles could be due to the clogging of the pores of the fine regenerated carbon after being used three times for the adsorption of melanoidin.

## References

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