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REMOVAL OF PHENOL FROM HOSPITAL WASTEWATER USING MANGGIS HUSK

Edison Munaf*, Refilda, Rahmiana Zein, Deswati and Venny Oktasari

Laboratory of Analytical Environmental Chemistry, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang 25163, Indonesia.

ABSTRACT

The ability of manggis husk to remove phenol substance from hospital waste water has been investigated. Phenol concentration was measured by using 4-aminoantipyrine as coloring agent and detected at 506 nm using a visible spectrophotometer spectronic 21. Several parameters that can affect phenol uptake such as particle size, pH and concentration of reagents were examined. Under the optimal conditions, phenol substance removal from aqueous solution is *ca.* 94 %.

INTRODUCTION

In recent years there has been an increased awareness of the potential impact of toxic pollutants such as heavy metals, ammonia and phenol substances. Various methods such as ion exchange, carbon adsorption, precipitation and electro deposition[1] have been successfully applied for toxic pollutants removal from wastewater. On the other hand, the use of agricultural product and by-product as material for the removal of toxic pollutants has received considerable attention and many materials have been examined due to their numerous functional groups and low capital cost[2,3].

Phenols are well-known environmental pollutants. The waste water from coke manufactures, paper mill, coal conversion, oil shale and plywood industries contain phenols up to several grams per litter. Although a number of materials such as moss[4], peat[5], wood[6], coconut husk[7] and rice husk[8] have been investigated to removal heavy metals from wastewater, scarcely any authors have described the removal of phenol using biosorbents[9,10].

Manggis husk, is readily available in great abundance in Indonesia. It is generally discarded as a waste. The cell walls of husk consist mainly of cellulose, and lignin[11] and they have a lot of hydroxyl groups in their structures, where the ion-exchange properties of the husk are due to the

presence of various functional groups. These polyfunctional biosorbents exhibit unique toxic pollutants adsorption abilities.

The aim of the present work is to study the capability of manggis husk for the removal of phenol from hospital waste water. The phenol concentration is determined by using a spectrophotometric method.

MATERIAL AND METHODS

Treatment of manggis husk

Manggis husk was washed with an excess of purified water, dried at room temperature for one day. Then, the husk was ground and screened to obtain particle sizes of 150, 180, 250 and 425 μm. A 5 g amount of the husk was boiled with water to remove the color dyes, and than rinsed with 20 mL of 1% hydrochloric acid for 1 day, followed washing with 50 mL deionized water. After the washing solution was removed, the husk was dried at room temperature for one day before use.

Chemicals and apparatus

All reagents employed in this work were of analytical reagent grade or better, and obtained from E. Merck (Darmstadt, Germany), unless otherwise noted. Phenol standard solution, 4-aminoantipyrine, ammonium hydroxide, ammonium chloride, potassium ferricyanide were used as the reagent. Phenol concentrations in the initial solution and effluent were analyzed by using a UV-Vis spectrophotometer spectronic 21.

Procedure

Determination of phenol concentration

Phenol solution (5 mL) was placed in a clean dry 50 mL volumetric flask. To the solution was added 20 mL of purified water and 2 mL of 4-aminoantipyrine, followed by addition of 1 mL potassium ferricyanide. The solution was then added with ammonium hydroxide, mixed well, and fixed to 50 mL with addition of purified water. The final solution pH was adjusted to around 10 with ammonium hydroxide and buffer solution. The absorbance of the solution at 506 nm was measured against the reagent blank.

Removal of phenol

A 3 g amount of treated manggis husk was inserted into the baker glass. Than added with 20 mL of 50 mg L^{-1} phenol and than shaking for 30 min. The solution was than filtered. The initial concentration of phenol present in hospital wastewater and the final concentration in the filtrate solutions were determined as described above.

RESULTS AND DISCUSSION

Selection of color forming conditions

The pH and concentration of reagents play an important role in the color forming of the substance. Therefore, precise control of pH and reagent concentration was found to be crucial to provide better sensitivity and repeatability. The reaction mechanism of phenol with 4-aminoantipyrine is shown in Figure 1. The detail procedure and optimal conditions for the color forming of phenol with 4-aminoantipyrine was desribed previously[10].

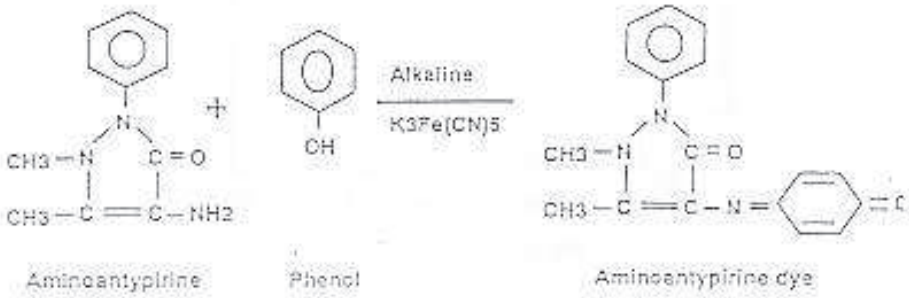

Figure 1. Reaction mechanism of the 4-aminoantipyrine dyes formed with phenol.

Selection of adsorption conditions

Effect of the particle size on phenol adsorption

The adsorption capacity of manggis husk strongly depends on the surface activity like other synthetic ion exchangers, viz., specific surface area available for solute-surface interaction, which is accessible to the solute[12]. Consequently, it is expected that the adsorption capacity increases with increasing surface area of the husk. In other words, the sorption material having smaller particle size could adsorb more phenol.

Figure 2 shows the plots of the percentage of phenol uptake versus the particle size of the manggis husk. Although the phenol uptake was optimum (94.8 %) for the husk with 180 μm, the results indicated that for

other size of manggis husk the sorption was still satisfactory, e.g., 90 - 93 %. From the results 180 µm husk was selected for the further experiment.

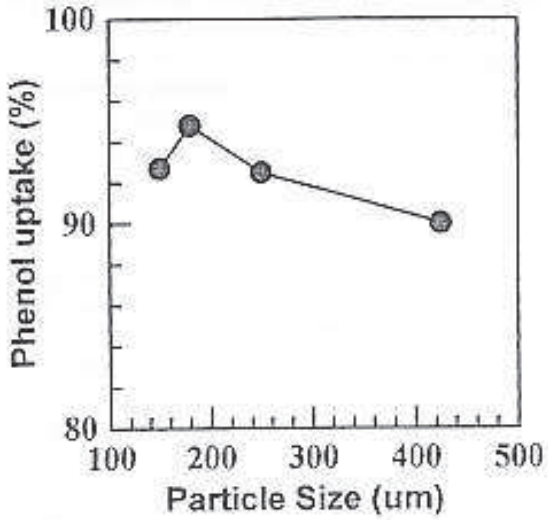

Figure 2. Effect of particle size of husk on the phenol uptake.

Effect of heat treatment on phenol adsorption

The effect of heat treatment on the sorption of phenol onto manggis husk was examined. Phenol uptakes obtained on fresh and dried (up to 120 °C) of the husk were compared based on the same dry weight. The results indicated similar capacity of phenol uptake (93-96%). Therefore, it is concluded that the heat treatment does not affect the binding capacity of sorption sites for phenol.

Effect of contacting time on phenol adsorption

Figure 3 shows the percentage of phenol adsorb versus contacting time between phenol solution and manggis husk.The result indicate that the optimum adsorption of phenol (92%) by manggis husk is occurred at 30 min contacting time. Therefore 30 min was selected as the contacting time of phenol and manggis husk.

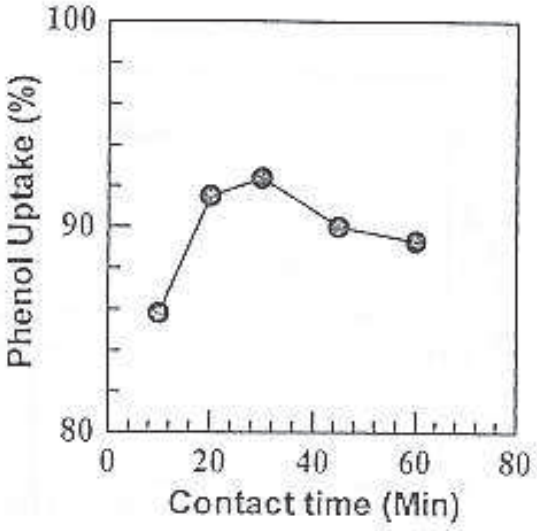

Figure 3. Effect of contacting time of husk on the phenol uptake.

Langmuir isotherm

The distribution of the solute (phenol) between the liquid phase and the solid phase can be described by several mathematical relationships such as the standard Langmuir model[13]. The Langmuir model assumes that uptake occurs on an homogenous surface by monolayer sorption without interaction between sorbed molecules. The sorption results obtained at equilibrium can be used to determine the maximum amount of phenol that can be sorbed by manggis husk using a modified Langmuir isotherm:

$$Ce/Ne = 1/N^*b + Ce/N^*$$

where Ce [mg L^{-1}] is the concentration of phenol solution at equilibrium, Ne [mg g^{-1}] is the amount of phenol sorbed per unit weight of manggis husk at equilibrium, b is a Langmuir constant related to the energy of sorption [mg L^{-1}] and N^* is the maximum sorption capacity of rice husk. Plots of Langmuir isotherms for the phenol-manggis husk system is shown in Figure 4. From the figure it is seen that the maximum sorption capacity for phenol is 34.8 mg per g manggis husk.

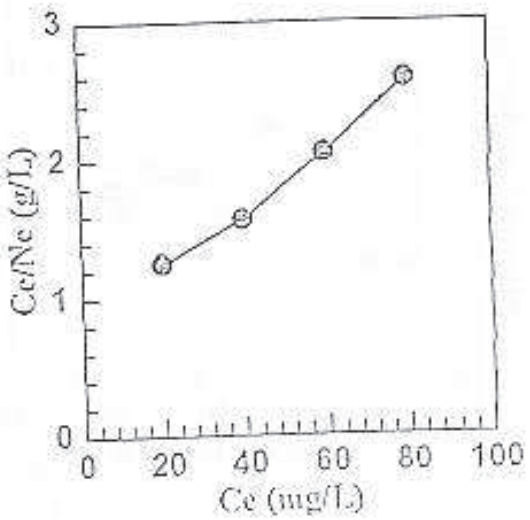

Figure 4. Langmuir isotherm for phenol-manggis husk system.

Removal of phenol from waste waters

In order to verify the capability of the manggis husk for the removal of phenol present in real wastewater samples, the present method was applied to remove phenol contained in hospital wastewater. The wastewater samples were filtered prior to use to remove solid particles. The volume of each sample used was 250 mL and inserted to the baker glass contained 3 g of manggis husk.

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