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# MASS EFFECT OF SALAK SKIN ACTIVATED CARBON WITH ZINC CHLORIDE CHEMICAL ACTIVATION AND ITS APPLICATION ON PHENOL ADSORPTION

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**Abstract**. Activated carbon can be from various organic and inorganic raw materials. One organic material that has potential as a raw material is salak skin. Salak skin is modified in manufactured of activated carbon by treatment in the sun, in the roast, and the oven. Activated carbon was then activ with a $ZnCl_2$ activator, and the adsorbing power of this salak skin-activated carbon was against phenol reduction. The most adsorbent material that reduces the concentration of phenol is the roasted adsorbent material with a final phenol concentration of 2.15 mg/L with an absorbed phenol concentration of 297.85 mg/L at a mass of 1.5g. Based on the analysis results, it can seen that each variation of the type of activated carbon material will experience a decrease in concentration along with an increase in adsorbent mass. The greater the mass of the adsorbent, the adsorption ability will increase. Each type of activated carbon material also experienced an increase in percent removal along with increasing adsorbent mass. The results of research on the effect of activ carbon mass also show that the value of adsorption capacity decreases with increasing adsorbent mass.

**Keywords:** Salak, Adsorbent, Phenol, $ZnCl_2$

## 1. Introduction

Activated carbon is a carbon-containing material with a large internal surface area and complex porous structure and widely utilized in industrial applications and waste treatment [1]. Activated carbon can absorb volatile compounds, pesticides, benzene, chlorine, and various type metals [2].

In recent years, the importance of agricultural waste as a source of renewable raw materials for activated carbon production has been realized such as date seeds, corn cobs, coconut shells, cassava peels, peanut shells, and many other agricultural materials. Salak skin is also one of the agricultural wastes that have the potential as a usable activated carbon (Chadrudee Sirilamduan, 2011). Salak (Salacca edulis Reinw) is native to Southeast Asia and has an egg-like shape with brown fruit skin covered with scales. After peeling the skin becomes a waste that contains carbon elements, so it has the potential to become activated carbon raw material [3].

The process of making activated carbon is divided into two, physics and chemistry [4]. One chemical process that used is the activation method. Research on the manufacture of active carbon by activation process with $ZnCl_2$ activator has been done. Coconut fiber with a $ZnCl_2$ activator produces an effective adsorbent to remove nitrate from the solution [5]. Sodeinde (2012) made activated carbon from coconut shells with a $ZnCl_2$ activator


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and concluded that the activated carbon catalyzed the reduction of cobalt (III) hexamine. Conversion of cobalt (III) hexamine increased in the presence of activated carbon [6].

In the absorption of activated carbon, the adsorption process occurs, which is a process of absorption of substances to be removed by the surface of the activated carbon. Many studies have studied the benefits and uses of activated carbon that can absorb organic and inorganic compounds. The increasing need for activated carbon is due to the increased number of applications of activated carbon that apply to the industry. In general, activated carbon is used in the medicine, food, beverage, water purification, pharmaceutical, and chemical industries with the increasing demand, it encourages researchers to look for other alternative materials that can be used as activated carbon [7].

Based on the above description, the researcher wants to explore salak wedi peel waste in Bojonegoro as an activated carbon material. This research aims to provide an alternative for the manufacture of activated carbon by utilizing salak wedi skin. The salak wedi skin was modified by treatment in the sun, in the roast, and in the oven in the manufacture of activated carbon which was then activated with $ZnCl_2$ activator and then tested the adsorbing power of this salak skin activated carbon against phenol reduction.

## 2. Research Methods

### 2.1 Carbon Preparation

This study conduct three treatments in the manufacture of salak skin-activated carbon, namely in the sun, in the roast, and in the oven. First of all the salak skin obtained was washed with running water until clean. In the first sample, the salak skin is dried in the sun for 5-7 days until the skin is complete dry and the weight is constant. In the second sample, the salak skin was roasted using a small fire for 1.5-2 hours until it became charcoal and a weight was obtained. And in the third sample, the salak skin is baked in an oven at 110℃ for 2 hours until a constant weight is obtained. Furthermore, these three samples were mashed, and chemical activation was carried out on the three samples of salak skin carbon using a $ZnCl_2$ activator.

### 2.2 Activated Carbon Activation

Chemical activation carried out in a ratio of 1: 1.5 so that every 100 mL of aqua DM will react with 20 grams of carbon and 30 grams of activator. The Chemical activation out in two stages, the first stage put distilled water and the activator into a glass beaker and heat it for 1 hour. The second stage carbon powder into the solution for 2 hours. The mixed solution of the activator and carbon powder was then heated using a hot plate with a temperature of 100℃ and stirred using a magnetic stirrer at 300 rpm for 2 hours. After chemical activation is complete, precipitation and washing then carried out. Precipitation is done by letting the sample sit for one day until a precipitate forms at the bottom of the glass beaker. So that the liquid in the sample is discarded until only the precipitate remains. The precipitate obtained was then washed by giving aqua DM repeatedly until it reached a neutral pH. After neutralization was complete, the sample was dry using an oven at 110℃ for 2 hours. After drying, the sample return to the form of carbon powder.

### 2.3 Testing Activated Carbon against Phenol

Activated carbon with different activators is put into each of 3 Erlenmeyer with a mass of activated carbon as much as 500 mg, 1000 mg, and 1500 mg then each activated carbon is added with 200 mL of phenol solution with a concentration of 300 mg / L and then shaken at 200 rpm for 1 hour, after which it is allowed to stand for 30 minutes to settle

and then filtered to separate the filtrate, and the residue then measured the filtrate with UV-Vis spectrophotometry at a wavelength ($\lambda$) 270.0 nm [8]. After that, the phenol absorption efficiency was calculated.

## 3. Results and Discussion

### 3.1 Activated Carbon Moisture Content

One of the chemical properties of activated carbon that affects the quality of activated carbon is water content. The water content is tested by heating the activated carbon in an oven at 105oC. for 1 hour and then weighed until it reaches a constant weight [9]. The moisture content of salak skin-activated carbon can be see in Table 1.

**Table 1**. Activated Carbon Moisture Content

| Sample | Water Content before Activation (%) | Water Content after Activation (%) |
|---|---|---|
| Sun-dried | 2,57 | 2,78 |
| Oven | 2,42 | 2,65 |
| roasted | 2,35 | 2,52 |

Overall, the moisture content of the results of this study is relatively small and meets the quality standards of activated carbon based on SII 0258-88, which is a maximum of 15% for powder-form activated carbon [10]. This shows that during carbonization the water bound to the raw material comes out before activation. The decrease in water content is closely related to the hygroscopic properties of the activator. The binding of water molecules on activated carbon by activators causes the pores on activated carbon to get bigger. The larger the pores, the more the surface area of activated carbon increases. This increase in surface area results in increased adsorption ability of activated carbon. Increasing the adsorption ability of activated carbon, the better the quality of the activated carbon [11].

### 3.2 Effect Of Mass and Type of Activated Carbon on Phenol Adsorption Ability

In determining the concentration of phenol adsorbed used phenol simulation waste with an initial concentration of 300 ppm, the mass variation of each type of activated carbon material. The concentration of phenol adsorbed by salak skin-activated carbon can be seen in Table 2.

**Table 2**. Phenol adsorbed on Salak Bark Carbon

| No | Sample | Massa (g) | Adsorbent | Absorbed Concentration (mg/L) | Final Concentration (mg/L) |
|---|---|---|---|---|---|
| 1 | Sun-dried | 0,5 | 1,1362 | 275,3 | 24,97 |
| | | 1 | 0,7622 | 283,25 | 16,75 |
| | | 1,5 | 0,3392 | 292,55 | 7,45 |
| 2 | In the oven | 0,5 | 0,9332 | 279,49 | 20,51 |
| | | 1 | 0,5531 | 287,84 | 12,16 |
| | | 1,5 | 0,2319 | 294,91 | 5,09 |
| 3 | Roasted | 0,5 | 0,6432 | 282,19 | 17,81 |
| | | 1 | 0,2234 | 295,1 | 4,9 |
| | | 1,5 | 0,0981 | 297,85 | 2,15 |

Based on the research that has been done, the results obtained as in Table 3.2. Here can be seen data on the concentration of phenol adsorbed by salak skin activated carbon on variations in mass and type of samples. The effect of the mass and the type of activated carbon on the ability of phenol adsorption shown in Figure 1 below.

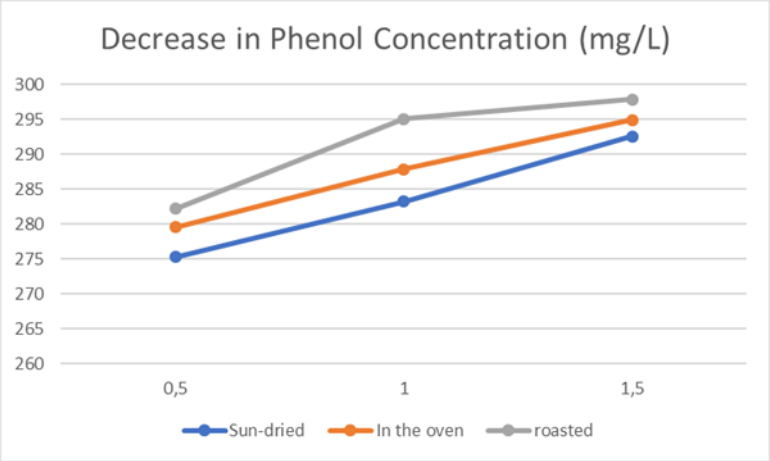


**Figure 1.** Decrease in Phenol Concentration

Description:

X: Mass of adsorbent (g)

Y: Concentration of phenol adsorbed (mg/L)

Figure 1 shows the results of phenol concentration reduction from variations in the type of activated carbon material and adsorbent mass. Based on graph 3.1, it can seen that each type of activated carbon material will experience an increase in percent removal along with an increase in adsorbent mass. The results of research on the effect of activated carbon mass also shows that the adsorption capacity value decreases with increasing adsorbent mass. This is because when there is an increase in adsorbent mass, there is an increase in the percentage value of adsorption efficiency and adsorption capacity [11].

### 3.3 Adsorption Ability of Salak Skin

In determining the efficiency of adsorbed phenol absorption, simulated phenol waste with an initial concentration of 300 ppm was use. The following results are mass variations of each exploration of activated carbon materials. The efficiency of phenol absorption that can be absorbed by activated carbon salak wedi peel can be seen in Table 3. The method used to reduce the concentration of phenol is the adsorption method because addition to being easy to do, the effectiveness is high, and the costs required are relatively cheap. In the adsorption process, activated carbon from various methods of making activated carbon with $ZnCl_2$ activator is mix with phenol simulation waste with a concentration of 300 ppm. In this study, phenol is used as an adsorbate because phenol waste is very dangerous for life, and usually this waste produced from small industries to large industries. The process is stirring for 1 hour and filtering so that there is a separation between the filtrate and the residue. The resulting filtrate was then analyzed with a UV-Vis spectrophotometer [8].

**Table 3**. Sorption Efficiency and Adsorption Capacity of Phenol

| No | Sample | Massa (g) | Final Concentration (mg/L) | Efficiency Absorption (%) | Capacity Adsorption (mg/L) |
|---|---|---|---|---|---|
| | | 0,5 | 24,97 | 91,68 | 110,01 |
| **1** | Sun-dried | 1 | 16,75 | 94,42 | 56,65 |
| | | 1,5 | 7,45 | 97,51 | 39,01 |
| | | 0,5 | 20,51 | 93,16 | 111,79 |
| **2** | In the oven | 1 | 12,16 | 95,95 | 57,57 |
| | | 1,5 | 5,09 | 98,3 | 39,32 |
| | | 0,5 | 17,81 | 94,06 | 112,87 |
| **3** | Roasted | 1 | 4,9 | 98,36 | 59,02 |
| | | 1,5 | 2,15 | 99,28 | 39,71 |

In this study, the fixed variables used were the type of activator, adsorbate concentration, stirring time, activation pH, and activation time while the independent variables were the types of activated carbon material and adsorbent mass. Based on table 3, the absorption efficiency graph can be as follows.

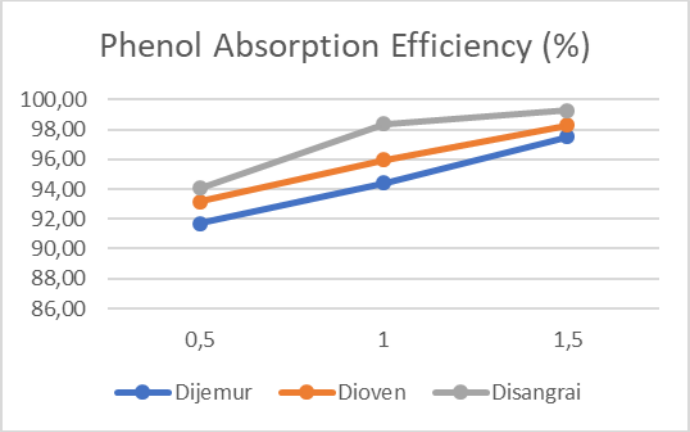


**Figure 2.** Phenol sorption efficiency

Description:

X: Adsorbent mass (g)

Y: Absorption efficiency (%)

The graph shows the absorbance results from variations in the type of activated carbon material and adsorbent mass. The adsorbent material that most reduces the concentration of phenol is the roasted adsorbent material with a final phenol concentration of 2.15 mg/L so that the concentration of phenol absorbed is 297.85 mg/L at a mass of 1.5 g. Based on the graph, it's known that each variation in the type of activated carbon material will reduce the concentration of phenol. Based on the graph, it can see that each variation of the type of activated carbon material will experience a decrease in concentration as the mass of the adsorbent increases. The greater the mass of the adsorbent, the adsorption ability will increase. This is because the additions of adsorbent mass will increase the total amount of surface area and the number of pores used to bind the adsorbate in the adsorption process [7].

Percent removal is the amount of phenol concentration absorbed by activated carbon per initial concentration of phenol adsorption capacity is the amount of adsorbate that can be adsorbent per gram of activated carbon. The results obtained from this study are the type of activated carbon material whose highest absorption efficiency is the type of activated carbon material roasted at 99.28% with a mass of activated carbon 1.5 g and inversely proportional to its adsorption capacity which only reaches 39.71 mg/g at the same mass.

## 4. Conclusions

- The adsorbent material that reduces the concentration of phenol the most is the roasted adsorbent material with a final phenol concentration of 2.15 mg/L, so the concentration of phenol absorbed is 297.85 mg/L at a mass of 1.5g. Based on the results of the analysis, it can see that each variation of the type of activated carbon material will experience a decrease in concentration as the mass of the adsorbent increases. The greater the mass of the adsorbent, the adsorption ability will increase.
- Each type of activated carbon material will experience an increase in percent removal with an increase in adsorbent mass. The result of research on the effect of activated carbon mass also shown that the adsorption capacity value decreases with increasing adsorbent mass. This is because when there is an increase in adsorbent mass, there is an increase in the percentage value of adsorption efficiency and adsorption capacity.

## References

1. Victor Manuel Perez Lozano, Development Of Novel Adsorbents And Catalysts Based On Activated Carbon, SGITT-OTRI, http://sgitt-otri.ua.es.html, diakses pada 7 Januari 2014.
2. J. Ray Gillespie, Home Water Treatment Using Activated Carbon, Cooperative Extension Service Michigan State University, http://www.baycounty- mi.gov, diakses pada 7 Januari 2014.
3. Farhana Binti Mohamed Wazir, Skripsi, Faculty of Applied Science Universiti Teknologi Mara, Mara, 2012.
4. Satish M. Manocha, Sadhana journal. 28,2003.
5. C. Namasivayam, D. Sangeetha, Indian Journal of Chemical Technology. 12, 2005.
6. Sodeinde O. A, International Journal of Chemical Engineering and Applications. 3, 2012.
7. Pambayun, Gilar. S, dkk. "Pembuatan Karbon Aktif dari Arang Tempurung Kelapaa dengan Aktivator ZnCl2dan Na2CO3 sebagai Adsorben untuk mengurangi Kadar Fenol dalam Air Limbah". Jurnal Teknik Pomits, vol. 2, no. 1 (2013): h. 116-120
8. Dwi Putranto, Ari dan M. Razif. "Pengaruh Aktivasi Arang Tempurung Kelapa dengan Asam Sulfat dan Asam Fosfat untuk Adsorpsi Fenol". Jurnal Purifikasi, vol. 6. No. 1 (2006): h. 37-42.
9. Budiono, Ari dkk. "Pengaruh Aktivasi Arang Tempurung Kelapa dengan Asam Sulfat dan Asam Fosfat untuk Adsorpsi Fenol", (2008): h. 1-12.
10. Asbahani. "Pemanfaatan Limbah Ampas Tebu sebagai Karbon Aktif untuk Menurunkan Kadar Besi pada Air Sumur". Jurnal Teknik Sipil Untan, vol. 13, no. 1 (2013): h. 105-114
11. Nurhasni, dkk. "Penyerapan Ion Aluminium dan besi dalam Larutan Sodium Silikat Menggunakan Karbon Aktif". Valensi, vol. 2, no. 4 (2012): h. 516-525.