Kinetic Study of Adsorption Active and Non Activated Carbon from Chocoa Skin in Methyl Violet Solution

Tri Hartono1,*, a, Hastami Murdiningsih1,*,b, Amri,1,*,c, Nurhayati1,*,d, Ramadhani F.1,*,e
1) Chemical Engineering Department, State Polytechnic of Ujung Pandang
Jalan Perintis Kemerdekaan KM. 10, Tamalanrea, Makassar 90245, Indonesia
*Corresponding Author : trihartono@poliupg.ac.id

Abstract - Methyl violet solution has particular color and mostly used to coloring in textiles industry and traditional cloth making. The liquid wastes containing this color can be reduces or removed by several methods, one of which is by adsorption using carbon as an adsorbent. The chocoa plant is abundant in Indonesia while its fruit consists of 60.67% lignin, 36.47% selulosa and 18.90% hemiselulosa [1]. Hartono et al. [2 &3] reported cassava’s skin contain protein, cellulose and crude fiber can be used as basic material (similarly with chocoa skin) of producing active carbon. This research is to develop more on reducing methyl violet (as particular color) containing in liquid waste by adsorbent from chocoa skin with variation of reaction time between active carbon and non-activated carbon for constant particle sizes of 48 Mesh (-425/+250 μm), and also to study the kinetical reaction of chocoa skin active carbon and non-activated carbon for adsorbing methyl violet in term of Freundlich and Langmuir isotherm equations. The result shows the kinetical adsorption of both active and non-activated carbon from chocoa skin as adsorbent follows Langmuir isotherm equation with adsorption capacity of 579.91 mg/g and 338.94 mg/g respectively.

Keywords: Chocoa Skin Wastes, Carbon, Adsorption, Kinetical Study.

I. Introduction
Chocolate industry generally produces by-product in the form of chocoa skin solid waste containing 70% from their fruit. These solid wastes is mostly disposed, in fact it can be converted into carbon and hence has more added values. Carbon or graphite is widely used as adsorbent for removal organic acid and anorganic matter [4, 5, 6 & 7].

Most of textiles industry also produces liquid waste containing organic and anorganic pollutant. Therefore this pollutant in liquid waste must be treated before dispose it to environment. One of several dyes color pollutant in the liquid waste is deep violet color. To reduce or remove this color, adsorption method using adsorbent can be applied.

Based on previous experimental result [2 & 5], active carbon derived from solid waste (by-product) is able to decrease organic and anorganic matters in liquid waste. Similarly, carbon derived from chocoa skin is highly possible to be applied as an adsorbent.

In this work, we report an investigation of adsorbent (non activated carbon and active carbon from chocoa skin) for removal violet color in industrial liquid waste and to find its maximum adsorption capacity through Freundlich or Langmuir isotherm equations.

II. Research Methodology
A. Producing charcoal from solid waste of chocoa skin and activating it into active carbon.
Chocoa skin was oxysdised by burning without excess of oxygen and activated using KOH of 0.5N solution for 24 hours. The product was filtered out and neutralized by washing it with distilled water until neutral pH, dried in an oven for 100 °C, grinded and sieved to obtain particle size of 48 Mesh.

B. Preparing liquid waste containing methyl violet
1 litre of methyl violet solution with concentration of 2N was made and diluted to be 0.5N in concentration as simulated liquid waste.

C. Adsorption tests
1g gram of non-activated carbon with particle size of 48 Mesh was placed into each six 250 ml erlenmeyer flasks. 50 ml simulated sample (concentration of 30

DOI : http://dx.doi.org/10.31963/intek.v10i1.4347
ppm) was added into each flasks and shaked it for 5, 10, 15, 45, 75, and 105 minutes. Each solution was then filtered out from the solid using filter paper and each filtrate is determined its adsorptivity using Uv-Vis Spectrophotometer and finally its final concentration was calculated. The similar procedure is repeated but using active carbon as an adsorbent with particle size of 48 Mesh.

Kinetic reaction model of adsorption [7] given by the following equations:

Langmuir isotherm:

\[ Q = \frac{b \cdot K \cdot C_e}{1 + K \cdot C_e} \]  
(1)

Freundlich isotherm:

\[ Q = K \times C_e^{1/n} \]  
(2)

III. Results and Discussion

A. Reaction time optimization for both non-activated and activated carbon an as adsorbent in simulated liquid waste (methyl violet solution)

Table 1 Calculation data of adsorptivity for non-activated and activated carbon

<table>
<thead>
<tr>
<th>t (min)</th>
<th>Methyl Violet Concentration (ppm)</th>
<th>Active Carbon</th>
<th>Non Activated Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Final Adsorbed</td>
<td>Final Adsorbed</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>30.0</td>
<td>0.0</td>
<td>30.0</td>
</tr>
<tr>
<td>1</td>
<td>0.146</td>
<td>29.854</td>
<td>9.131</td>
</tr>
<tr>
<td>3</td>
<td>0.176</td>
<td>29.824</td>
<td>8.342</td>
</tr>
<tr>
<td>5</td>
<td>0.288</td>
<td>29.712</td>
<td>6.745</td>
</tr>
<tr>
<td>10</td>
<td>0.193</td>
<td>29.807</td>
<td>6.870</td>
</tr>
<tr>
<td>15</td>
<td>0.164</td>
<td>29.836</td>
<td>6.063</td>
</tr>
<tr>
<td>45</td>
<td>0.336</td>
<td>29.664</td>
<td>6.941</td>
</tr>
<tr>
<td>75</td>
<td>0.300</td>
<td>29.700</td>
<td>5.369</td>
</tr>
<tr>
<td>105</td>
<td>0.431</td>
<td>29.569</td>
<td>5.505</td>
</tr>
</tbody>
</table>

Table 1 and Fig.1 show adsorptivity between active and non activated carbon (adsorbent) in simulated liquid waste containing methyl violet solution with reaction time. Active carbon determines higher adsorptivity compared to non-activated carbon. This indicates of active carbon porosity is getting bigger after being activated. The optimum reaction time occurs at about 5 minutes for both active and non activated carbon.

B. Adsorption Capacity Determination

Table 2 shows the equilibrium adsorption of active and non activated carbon from chocoa skin at different final concentration of methyl violet solution.

<table>
<thead>
<tr>
<th>Final Conc., Ce (ppm)</th>
<th>Equal adsorption, Qe (mg/g)</th>
<th>Ce/Qe</th>
<th>log Ce</th>
<th>log Qe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active C</td>
<td>Non Activ. C</td>
<td>Active C</td>
<td>Non Activ. C</td>
<td>Active C</td>
</tr>
<tr>
<td>0.146</td>
<td>9.131</td>
<td>588.0</td>
<td>411.0</td>
<td>2.48E-04</td>
</tr>
<tr>
<td>0.176</td>
<td>8.342</td>
<td>587.4</td>
<td>426.6</td>
<td>2.99E-04</td>
</tr>
<tr>
<td>0.288</td>
<td>6.745</td>
<td>585.2</td>
<td>458.0</td>
<td>4.93E-04</td>
</tr>
<tr>
<td>0.193</td>
<td>6.870</td>
<td>587.0</td>
<td>455.5</td>
<td>3.30E-04</td>
</tr>
<tr>
<td>0.164</td>
<td>6.063</td>
<td>587.6</td>
<td>471.4</td>
<td>2.79E-04</td>
</tr>
<tr>
<td>0.336</td>
<td>6.941</td>
<td>584.2</td>
<td>454.1</td>
<td>5.75E-04</td>
</tr>
<tr>
<td>0.300</td>
<td>5.369</td>
<td>584.9</td>
<td>485.1</td>
<td>5.13E-04</td>
</tr>
<tr>
<td>0.431</td>
<td>5.505</td>
<td>582.4</td>
<td>482.4</td>
<td>7.40E-04</td>
</tr>
</tbody>
</table>

Figure 1. Adsorptivity between active and non activated carbon in methyl violet solution with time

DOI: http://dx.doi.org/10.31963/intek.v10i1.4347
At different liquid waste concentration, the equilibrium adsorption is shown in Table 2. Both Freundlich and Langmuir isotherm equation (1 & 2) can be mathematically converted into equation (3 & 4) as following:

**Langmuir isotherm:**
\[
\frac{C_e}{Q} = \frac{1}{K \cdot b} + \frac{1}{b} C_e
\]  
(3)

**Freundlich isotherm:**
\[
\log Q = \log K + \frac{1}{n} \log C_e
\]  
(4)

Plotting equation (3) and equation (4) will determine the fit between Freundlich and Langmuir isotherm and hence its maximum adsorption capacity can be calculated.

- **Analysis of adsorption capacity of adsorbent (active carbon)**

Applying equation (3) will result a linear line (Fig. 2) and this indicates that Langmuir equation fit to the adsorption isotherm for active carbon from cassava skin. From this equation, the calculated adsorption capacity of active carbon in methyl violet solution is 579.91 mg/g.

- **Analysis of adsorption capacity of adsorbent (non-activated carbon)**

Similarly, Applying equation (3) will result a linear line (Fig. 3) and this indicates that Langmuir equation fit to the adsorption isotherm for no-activated carbon from cassava skin. From this equation, the calculated adsorption capacity of non-activated carbon in methyl violet solution is 338.94 mg/g.

On the other hand, plotting equation (4) for both active and non-activated carbon does not show linear line (Fig. 4 & 5). This indicates adsorption freundlich equation does not fit with this equation.

**Figure 2.** Adsorption capacity of active carbon with Langmuir isotherm

**Figure 3.** Adsorption capacity of non-activated carbon with Langmuir isotherm

**Figure 4.** Adsorption capacity of active carbon with freundlich isotherm
IV. Conclusion

Both adsorbent (active and non-activated carbon from chocoa skin) can be used to decrease the amount of methyl violet contained in liquid waste with time reaction of only 5 minutes and they follow to Langmuir equation. The adsorption capacity of active carbon and non-activated carbon from chocoa skin is 579.91 mg/g and 338.94 mg/g respectively.

Acknowledgement

Authors would like to thank to our student Nurhayati and Ramadhani who have assisted this experimental research. Finally, authors would also like to thank to Politeknik Negeri Ujung Pandang for providing the fund and laboratory facilities to conduct this research.

References

[1] Loppies, J.E. 2016 Karakteristik Arang Kulit Buah Kakao yang dihasilkan dari Berbagai Kondisi Pirolisis. Industri Hasil Perkebunan. 11(2) : 99-100