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Application Of Activated Candlenut Shell Using Potassium Hydroxide For Iron Reduction (Fe TO FeSO4)

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Key Words : *Adsorbent, Freundlich, Langmuir, FeSO $_4$ solution ,Candlenut Shell.*

Inti Sari

Penelitian ini bertujuan untuk mempersiapkan karbon dari tempurung kemiri dengan proses karbonasi dan aktivasi KOH 1M yang digunakan untuk menjerap Fe2+ pada larutan. Proses aktivasi menghasilkan perubahan struktur dan gugus fungsi pada karbon aktif. Penelitian ini mempelajari pengaruh suhu karbonasi 800 oC dengan konsentrasi aktivator yaitu KOH 1M dengan waktu aktivasi 24 jam. Konsentrasi awal larutan mempengaruhi kapasitas adsorpsi karbon aktif, semakin besar konsentrasi awal larutan yaitu pada 5 mg/L maka kapasitas adsorpsi semakin besar. Adsorpsi optimum terjadi pada pH 7 dengan memberikan peningkatan penyerapan Fe2+ sebesar ± 7 mg/g dan waktu kontak 120 menit. Tinjauan kesetimbangan yang digunakan menggunakan model isoterm Langmuir dan Freundlich, dimana kesetimbangan yang paling cocok adalah model Isoterm Freundlich dengan nilai R2 = 0,9848 ; KF = 4,427; n = 3,475. Dapat disimpulkan bahwa karbon aktif tempurung kemiri mampu menyerap logam Fe2+ dalam larutan FeSO4.

Abstract

This study aims to prepare carbon from candlenut shell by carbonation and activation of 1M KOH which is used to adsorb Fe 2+ in solution. The activation process produces changes in structure and functional groups on activated carbon. This study studied the effect of carbonation temperatures of 800 o C with the concentration of activator is KOH 1M with 24 hours activation time. The initial concentration of the solution affects the adsorption capacity of activated carbon, the greater the initial concentration of the solution which is at 5 mg/L, the greater the adsorption capacity. Optimum adsorption occurs at pH 7 by providing an increase of Fe 2+ absorption of ± 7 mg/g and contact time is 120 minutes. The equilibrium review is used using the Langmuir and Freundlich isotherm models , where the most suitable equilibrium is the Freundlich Isotherm model with a value of R 2 = 0.9 848 ; K F = 4,427 ; n = 3,475 . It can be concluded that the activated carbon from the candlenut shell is able to absorb Fe 2+ metal in FeSO 4 solution.

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PENDAHULUAN

Heavy metal contamination in the environment is one of the major problems in the world today. Contamination of heavy metal ions that pollute the environment, most of which can be carried through the food pathway, this process occurs faster when entering the human body through the food chain. The content of Fe is a type of pollutant found in almost all wastes origining from industry. The main sources of iron entering the environment come from industrial wastes such as the battery industry , electroplating industry and other chemical industries (Sudarmadji, et al., 2006).

The adsorption process is one of the most commonly used methods for removing toxic metals in wastewater (Mahiti, 2008). Adsorption method has several advantages including relatively simple process , effectiveness and efficiency is relatively high and does not provide side effects in the form of toxic substances (Volesky, et al., 2005). Adsorption is a physical-chemical process in which the adsorbate, in this case pollutants, accumulates on the surface of solids called adsorbents. The adsorption process is suitable for wastewater with low metal concentrations and industries with limited costs.

The challenge of the current adsorption technology is the selection of economical and efficient adsorbent alternatives to minimize operational costs in developing countries (Yusoff et al, 2014). One of the waste that has not been widely used as an adsorbent is the candlenut shell waste. The candlenut shell waste can be used as activated charcoal which can be used as an adsorbent because it has a large surface area.

EXPERIMENTAL METHOD

Preparation of Raw Materials

Preparation of raw materials is done by cleaning the candlenut shell waste by washing and drying then reducing the size of the process to 100 mesh to facilitate the carbonation process .

Carbonization Process

Candlenut pieces are included in a closed crucible, then carbonated using a furnace at a temperature of 800 ^oC with a carbonation time of 2 hours.

Activation Process

The activation process is done by contacting activated carbon in KOH solution with a ratio of 1:3. After that, the strirring process is carried out for 10 minutes and left for 24 hours. After 24 hours, the screening process is carried out and washed use distilled water to carbon active so that it becomes neutral . Then it dried on temperature 100 ˚ C in oven until obtained mass constant .

Test Ability Adsorption

The process of testing the adsorption ability begins with the manufacture of standard solutions Fe with a concentration of 60, 70, 80, 90, 100 ppm. Each adsorbent with the mass of 1 gram of was contacted with 50 ml of Fe solute and stirred with *shaker* for 2 hours. After that, filtering is done with filter paper. The filtered solution was analyzed for its iron content using AAS.

HASIL DAN PEMBAHASAN

Effect of pH solution to Capacity Adsorption Carbon Active for Absorb Fe^{2+}

To obtain Optimum pH, adsorption is carried out by activated carbon with a variation of pH 6; 6.5; 7; 7.5; 8. Based on Figure 3.1, it can be seen that the increase in pH from pH 6 to pH 7 gives an increase of about ± 7 mg/g to the amount of Fe 2+ that is absorbed, but after pH 8 it decreases by about ± 10 mg/g along with the increasing pH of the solution. At pH 6, the adsorption ability of activated carbon for Fe 2+ metal showed low results, because in acid conditions there was competition between H + and Fe 2+ to interact with the surface of the adsorbent, so that repulsion of Fe 2+ with the surface of the adsorbent caused increasing H + ions (titin et al., 2016). While in alkaline conditions (pH 8) the adsorption process is decreased due to the hydrolysis reaction in the solution, so that under these conditions metal ions can form hydroxide precipitates which causes the adsorption process to difficult occur (Nurhasni, 2012).

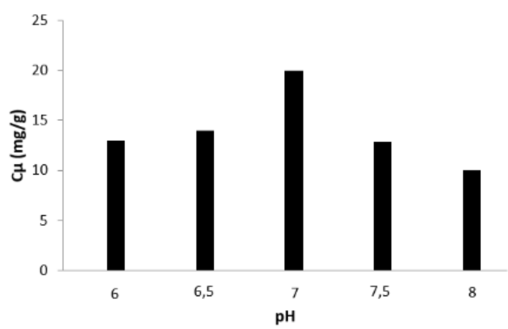

Figure 1 The Effect of pH on Active Carbon Absorption Capacity

The graph in figure 1 shows that it can be seen that the pH of the solution is the most optimal, at pH 7. This is indicated by the high value of percent (%) removal at pH 7 to metal ions Fe2 +. At pH 6 the absorption value of Fe2 + metal ions is low, this is because the low pH (acid) surface of the adsorbent is surrounded by H + ions due to the competition of absorption of ionic charge with Fe2 + to bind to the OH- group. Because the excess H + charge replaces Fe2 + to bind to the OH- group, or it can be said that the refusal of the load between the surface of the adsorbent and it is known that Fe2 + metal ions are positively charged so their absorption ability becomes low. At pH 7, the absorption of Fe2 + metal ions increases and reaches the optimum condition at pH 7, this means that the condition of Equilibrium for iron occurs at pH 7.

Influence Concentration Early to Capacity Adsorption

In order to determine the effect of initial concentration on the adsorption ability of activated carbon to absorb Fe 2+ , as much as 1 gram of activated carbon is inserted into Fe 2+ solution with concentration of 60, 70, 80, 90, 100 mg / liter, respectively. The mixture is then stirred using a shaker with a speed of 200 rpm with a time of 120 minutes. After 120 minutes the mixture was filtered and the filtrate was analyzed its concentration of Fe 2+ using AAS, the results presented in Figure 2.

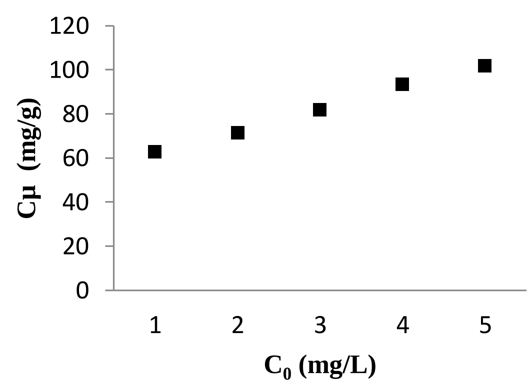

Figure 2 Effect of initial concentration on adsorption capacity.

The graph in Figure 2 shows that an increase in the initial concentration of the solution gives an increase in the amount of Fe 2+ that is absorbed. This happens because the higher the adsorbate concentration, the greater the force of the driving force so that the movement of the adsorbate molecule causes the mass transfer rate (surface diffusion) from the solut phase (adsorbate) to the faster adsorbent (Zou, 2013).

However, if the adsorbate is saturated, the amount of Fe 2+ that is absorbed will tend to be constant.

Isotherm Adsorption

In the design of the adsorption process, adsorption capacity data is needed, which can be known through the adsorption isotherm model. In this study, Langmuir and Freundlich isotherm models were used, the results of which were presented in Figure 3 and Figure 4. Based on the graphs in Figures 3 and 4, it can be seen that Freundlich's isotherm has a greater correlation (R2) than Langmuir isotherm.

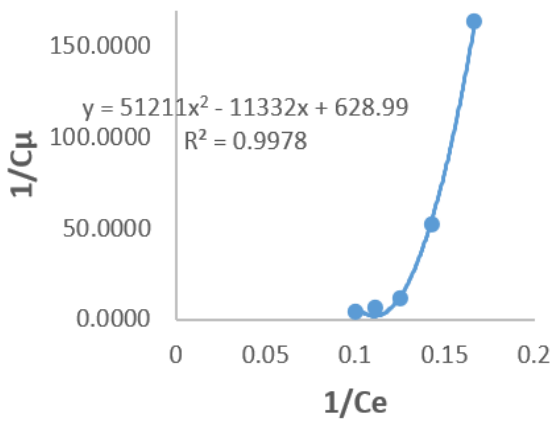

Figure 3 Langmuir Adsorption Isotherm

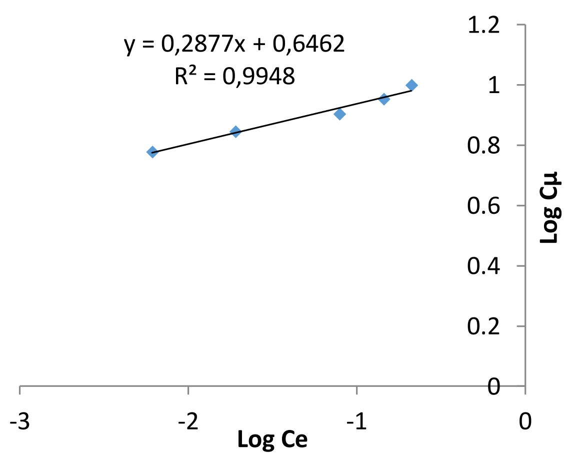

Figure 4 Adsorption isotherms Freundlich

Table 1 Parameters for the adsorption of Fe^{2+} ions reviewed Langmuir and Freundlich isotherms.

Parameter	Langmuir	Freundlich
k_L	0.0095	
k_F		4,427
N		3,475
q_m	2,506	
R^2	0.944	0.99 48

Information:

k_L = Langmuir Adsorption Equilibrium

k_F = Freundlich Adsorption Equilibrium

n = Heterogeneity factor

q_m = Maximum Absorption Capacity

R^2 = Relationship coefficient

Based on the data in Table 1, there is comparison relation coefficient (R2) of the two models, Langmuir and freundlich isotherms can know where the equilibrium equation model that can represent this study. The R2 value of the freundlich model is closer to one than langmuir. At this equilibrium means that the adsorption of Fe 2+ by activated shell shell charcoal is in accordance with the freundlich adsorption isotherm model. Its absorption is physical and multilayer. This identify that absorption is more physically dominant, where Fe metal sticks to the Van der Walls style compared to activated charcoal pores.

As a comparison, some of the results of adsorption studies that have been carried out by other researchers have obtained the results that the adsorption equilibrium between Fe and activated charcoal from bagasse with KOH activator is in accordance with Freundlich's equilibrium (Astandana, 2016). The equilibrium of Fe adsorption with coalactivated charcoal is also consistent with Freundlich's equilibrium model (Vitasari, 2009)

CONCLUSIONS

1) Carbon active shell candlenut worth it made as adsorbent for absorb Fe^{2+} metal ions in $FeSO_4$ solution artificially , because water content and levels the ashes no exceed limits set SII.
2) Optimum conditions for adsorption metal Fe^{2+} use adsorbent shell candlenut this is at pH 7, time 120 minute contact and concentration Fe metal is 80 ppm.
3) The most suitable equilibrium model for adsorption metal Fe^{2+} use adsorbent shell candlenut this is an equilibrium model Freundlich with the value of R^2 = 0.9 9 48 and K_F value = 4,427 ; n = 3,475 .

RECOMMENDATIONS

1) Further study regarding to the equilibrium model adsorption with other models is needed.
2) It is necessary to continue Fe metal adsorption research using the candlenut shell adsorbent for electroplating industry waste in the field.

REFERENCES

Astandan, y. 2016. Kesetimbangan Logam Fe Menggunakan Karbon Aktif dari Ampas Tebu Sebagai Adsorben. Jurnal Fteknik Vol 3. Pekanbaru.

Nurhasni, 2012. Pengaruh pH terhadap Kemampuan Adsorpsi Fe^{2+} dalam Pelarut Air. Jurnal Mipa-Kimia Vol.VI.No.3,2012

Mahiti, 2008. *A Generalized Ono-Kondo Lattice Model For High Pressure on Carbon Adsorben*, Ph.D Dissertation, Oklahoma State University

Sudarmaji, J.M., dan Corie, I.P., 2006, Toksikologi Logam Berat B3 dan Dampaknya Terhadap Kesehatan, *Jurnal Kesehatan Lingkungan*, Vol. 2 No. 2, 129-142

Sudarwin. 2014. *Analisis Spasial Pencemaran Limbah Logam Fe Pada Sumber Air*. Semarang: Tesis Kesehatan Lingkungan.

Suhadak, Akhmad. 2015. Sifat Arang Aktif Dari Tempurung Kemiri. *Jurnal Penelitian Hasil Hutan* 25(4): 291 – 302.

Titin, AZ. dan Intan, S. 2016. Adsorpsi Fe (II) dengan Arang Kulit Buah Kakao (*Theobroma cacao L.*) Teraktivasi Asam Klorida. Pontianak. *Jurnal Teknologi Terpadu No.2 Vol.5(2)*" ISSN 2303 – 1077.

Vitasari, D. Lysttanto, P.A. 2009. Kesetimbangan dan Termodinamika Adsorpsi Fe dengan Adsorben Karbon Aktif dari Arang Batu Bara. Jurnal Tkimia Universitas Muhammadiyah Surakarta. Surakarta.

Kim, Ji yun, dkk., 2009. *Mining and Identification Of A Glucosidase Family Enzyme With High Activity Toward The Plant* Extract *Indican*. Journal of Molecular Catalysis B: Enzymatic. 57: 284–291

Volesky, B., and Naja, G., 2005, *Biosorption Application Strategies, In: Proceedings of the 16th Internat, Biotechnol, Symp. (S.T. L.Harisson; DE. Rawlings and J Petersen) (eds.)* IBS Compress Co., Capetown South Africa: 531542.

Yusoff dkk, 2014. *Encyclopedia of Chemical Technology*. Vol.5. Interscience Encyclopedia. Inc. New York.