

Production of Activated Carbon from Agriculture & Paper Industry Wastes: Result, Evaluation & Discussions

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Abstract - Activated carbon has been there with us for hundreds of years. It has large purposes in quite a lot of industries e.G. Within the water-cure, dye, sugar refining, among others. All the activated carbon on hand in Kenya is imported. Therefore creation of activated carbons in the community and from locally on hand materials can be one of the moneymaking and atmosphere-pleasant solutions to this as it might change into poor-valued wastes to useful materials. For that reason, the primary objective of this study used to be to prepare activated carbons from paper mill slug using a two-step method, and to establish.

I. ANALYSIS AND DISCUSSION

Premiere conditions of creation. The carbonization process was once carried out at 520°C for forty five minutes, and physical activation applied at 850oC for a variety of soaking occasions of 30, 60 and seventy five minutes.

Table 1: Weight Loss Analysis

TIME (MINUTES)	TEMPERATURE	WT LOSS(gm.) (°C)	BEFORE(gm.)	AFTER(gm.)
30	460	103	64.26	38.74
	520	103	57.27	45.73
	580	103	51.81	51.19
45	460	103	45.83	57.14
	520	103	40.92	62.08
	580	103	34.92	68.08
60	460	103	37.87	65.13
	520	103	35.46	67.54
	580	103	30.94	72.06

The activated carbon was all set beneath restrained provide of oxygen from paper mill slug because the precursor. The paper mill slug. Three distinct pyrolysis temperatures were considered with every three one of a kind soaking times investigated. Then also three special activation temperatures have been used. The result of the exclusive activation stipulations used to be investigated via

comparing absorbance of Methylene blue in samples which had passed through the one of a kind condition.

II. RESULTS, EVALUATION AND DISCUSSION

1. Pyrolysis information evaluation earlier than pyrolysis was once carried out, all the nine samples had been first weighed making use of an electronic stability and the samples set to 103gm. After pyrolysis and activation the samples have been reweighed.

In order to calculate the load loss during pyrolysis, the following formula was once used;

$$*+ '&)) = W_{\text{beforepyrolysis}} - W_{\text{afterpyrolysis}}$$

When the above equation was once utilized after pyrolysis, the next desk was once accomplished:

Table 2: % Yield after 30 Minutes

Temp (°C)	% Yield
460	62.388
520	55.602
580	50.301

Definition of Activated carbon

Activated carbon includes a large variety of amorphous carbon-situated materials prepared to showcase a excessive degree of porosity and an elevated interparticulate surface field. It is also a long-established term used for a bunch of adsorbing components of crystalline kind, having colossal developed interior pore buildings that make the carbon more adsorbent[10].

The percentage yield was once then calculated utilizing the following method;

$$\text{Yield \%} = \frac{W_{\text{after}}}{W_{\text{before}}} \times 100$$

For example, a sample calculation at 460oC, 30 minutes soaking time; % 388%The above was once performed for the entire soaking times and information tabulated as

follows. Graphs were additionally plotted to provide a transparent snapshot of the editions. For 30 minutes the following table was once then completed with the aid of % Yield equation

A graph of yield against temperature was plotted for various duration of time as follows

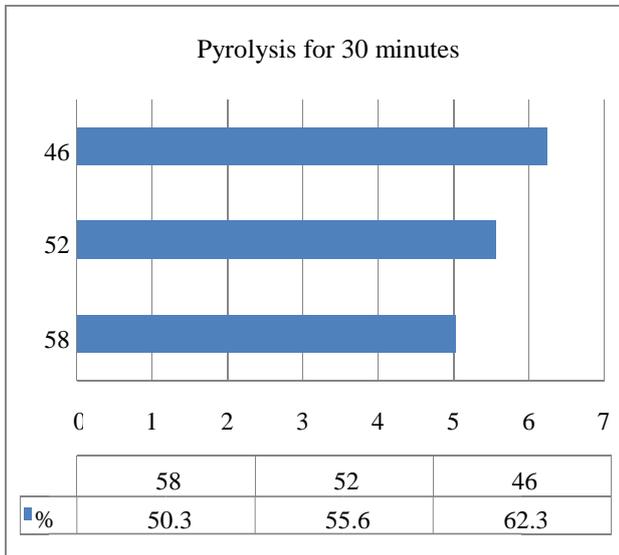


Figure 1: Chart of % Yield after 30 minutes

ii. For 45 Minutes

Table3: % Yield after 45 Minutes

Temp (°C)	Yield
460	44.495%
520	39.728%
580	33.369%

A graph of yield against temperature was plotted for various duration of time as follows

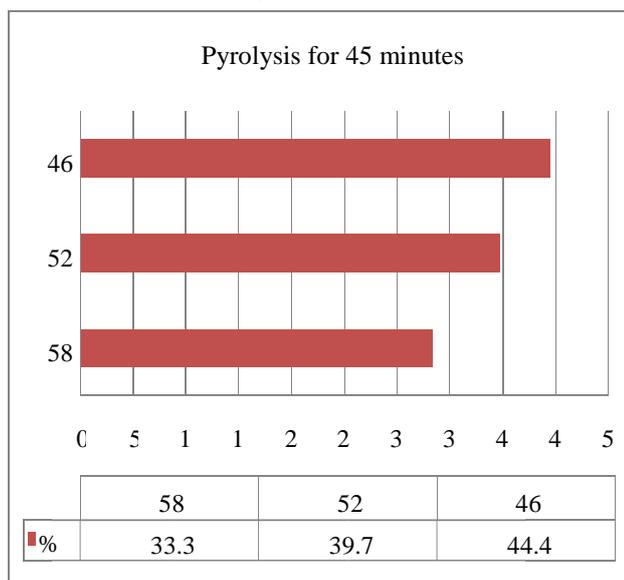


Figure 3: Chart of % Yield after 45 minutes

iii. For 60 Minutes

Table 4: % Yield after 60 minutes

Temp (°C)	Yield
460	36.767%
520	34.427%
580	30.039%

A graph of yield against temperature was plotted for various duration of time as follows

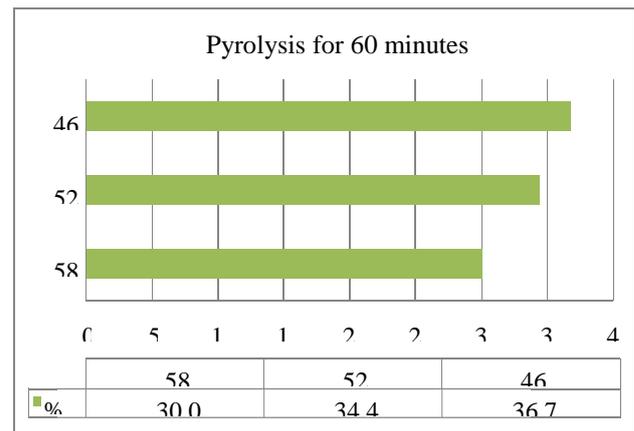


Figure 2: Chart of % Yield after 60 minutes

III. PYROLYSIS TEMPERATURE AND WEIGHT LOSS

There was a need to determine the variation of weight loss with pyrolysis temperature hence graphs of weight loss against pyrolysis temperature were plotted as shown below

For 30 minutes:

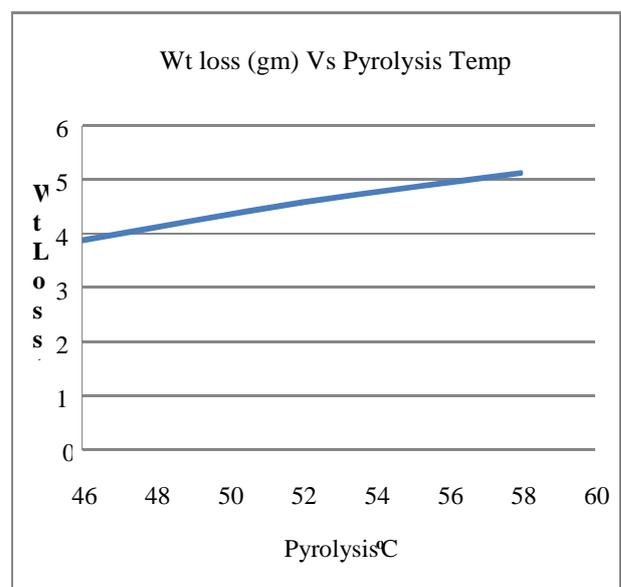


Figure 4: Graph of Weight Loss against Pyrolysis T

For 60 minutes:

From the above graphs, it is evident that for a specific soaking time, weight reduction in pyrolysis elevated with expand in temperature. At slash temperatures e.G. At 460oC, weight reduction was once quite low. This might be in view that not all the risky matter used to be pushed. For the samples, a variety of loss was once within the 580oC. This was once due to extra volatiles being driven out on the high improved temperatures and likewise because of probably the most carbon being oxidized through the oxygen in the beginning present/trapped within the airtight crucible.

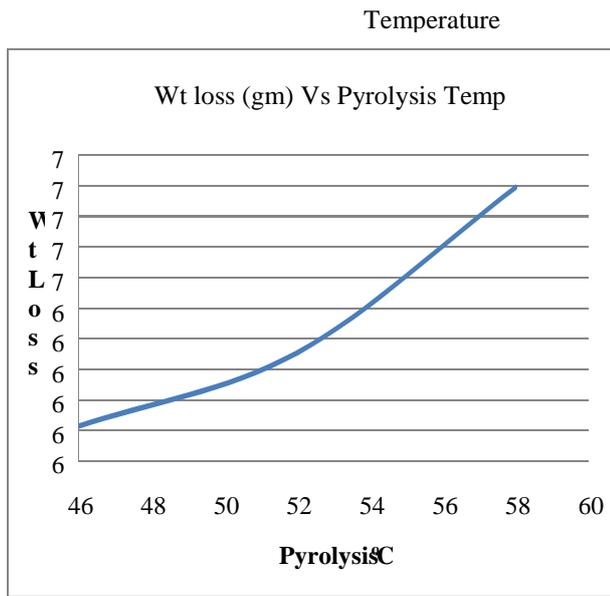


Figure 5: Graph of Weight Loss against Pyrolysis T
For 45 minutes:

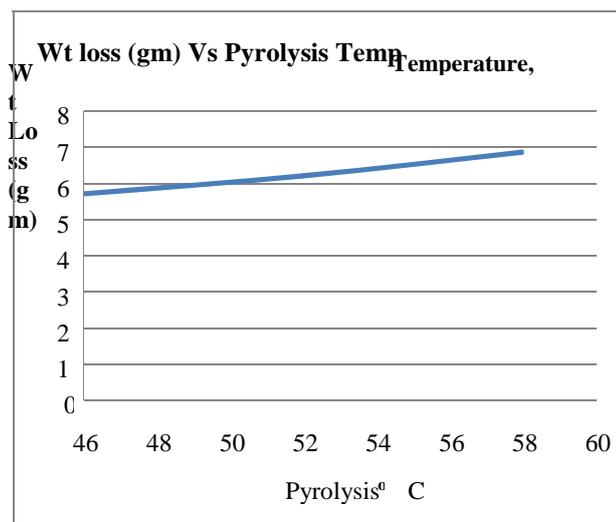


Figure 6: Graph of Weight Loss against Pyrolysis T

The gases produced in pyrolysis mainly include hydrogen, CO₂, CO, CH₄, ethane (C₂H₆) and different hydrocarbons. At expanded temperatures, the related vigour supplied makes the molecules of these gases

crumble and for this reason escape. The 520oC pattern is a compromise between the two extremes; no longer much risky matter closing and no longer so much weight reduction. This was the sample taken to the next move of activation. Indeed that is in step with the previous stories' recommendations and in addition from more than a few texts on activated carbon.

The trend discovered in pyrolysis temperature versus weight reduction was once also seen in pyrolysis soaking time in opposition to weight reduction. Weight loss elevated with soaking time. This is attributable to the truth that accelerated soaking time gave ample time for probably the most closing unstable matter to flee, and in addition one of the vital carbon to be oxidised. Again, the ultimate time was once the compromise between the two extremes i.E. Forty five minutes. The sample then chosen to proceed to the next move of activation was the one made underneath 520oC pyrolysis temperature and soaking time of forty five minutes.

Four.2. Methylene Blue Adsorption outcome

4.2.1. Calibration curve

with the intention to get the quantity of Methylene blue adsorbed by way of the all set samples, a calibration curve of absorbance against attention used to be plotted. To obtain this curve, the Methylene blue was all set at one of a kind concentrations as explained prior. The results bought from the spectrophotometer have been as follows; it's important to notice that the zero values correspond to distilled water which acts as reference point, having adsorbance of zero. These values have been plotted to give the following graph;

Figure 1: Graph of Absorbance against concentration The plot of absorbance towards attention gave a straight line via the starting place as proven above. This used to be used along side the various samples' absorbance values of 664.5nm-wavelength light.

The samples had been then tested utilising the UV spectrophotometer and the results have been as follows;

Table 6: Calibration Curve Values

1.791	0.0000583
1.081	0.0000352
1.104	0.0000359
1.243	0.0000379
0.476	0.0000148
0.627	0.0000171
1.358	0.0000435
0.584	0.0000187
0.746	0.0000238

Table 7: Variation of Absorbance with Activation Temperature and Time

Activation Time (Minutes)	Temperature (°C)	Absorbance
30	750	1.791
	850	1.081
	950	1.104
60	750	1.243
	850	0.476
	950	0.627
75	750	1.358
	850	0.584
	950	0.746

The above absorption values, with the calibration curve, were then used to learn off the corresponding awareness of the samples. This was once tabulated as follows

Table 8: Concentration of Samples from Calibration Curve Absorption Concentration (moles) of Methylene Blue

The above concentration values for Methylene Blue have been that remaining after mixing it with the Activated Carbon samples. To be able to get the amount of Methylene Blue that was once truly adsorbed by means of the carbon, we have to apply the next equation;

$$1 + h^3(4(5^6(70) \& 89(\text{zero} = : \text{four} / + / ; ' < \& 4 = (4 + 8 ; + / \& 4 > : < ? - @ / 4 ; ' < \& 4 = (4 + 8 ; + / \& 4 > @ < ?$$

E.G. At 750oC, half-hour, for initial quantity of moles = 0.0001 ready,

$$70) \& 89(0 \% \& ') = 0.0001 - \text{zero.0000583} = \text{zero.0000417}$$

When the above equation used to be applied, the moles adsorbed had been received for the relaxation of the samples as;

Absorption Moles Adsorbed (I.C – F.C)
Mg/2g Adsorbed

Table 9: Concentration Adsorbed by Activated Carbon Sample

2.2. Affect of Activation Temperature on Adsorption

utilizing this set of moles adsorbed, the adsorption will also be got from the calibration curve. It will now be grouped in step with the samples activated as;

A graph of moles of Methylene Blue adsorbed versus Activation temperature was once plotted.

From the above graph, it is proven that the adsorption of Methylene blue increases with the develop of activation

temperature unless a maximum worth then drops. The maximum adsorbance temperature is the best value of adsorption, and is obtained to be 850oC. In all of the three line graphs, highest absorbance occurs at 850oC i.E. For the activation time of half-hour, adsorbance is 1.982, for 60 minutes, adsorbance is 2.613 and finally for 75 minutes adsorbance used to be 2.492. This worth is an indication of the measure of activation of the carbon derived from the paper pulp shells. A greater value of adsorbance shows better activation and hence a greater pore progress. This interprets to a greater surface field bought with the aid of activating the carbon. 4.2.3. Have an impact on of Activation Time on Adsorption yet another graph of Methylene Blue adsorbed versus Activation time was plotted and is as proven beneath.

Table 10: Sample Adsorbance Values

	30 minutes Activation	
Sample	Temperature (°C)	Adsorption
1	750	1.288
2	850	1.982
3	950	1.957
	60 minutes Activation	
	Temperature (°C)	Adsorption
4	750	1.894
5	850	2.613
6	950	2.543
	75 minutes Activation	
	Temperature (°C)	Adsorption
7	750	1.727
8	850	2.492
9	950	2.336

From the above graph, it's noted that with increase in activation time, absorbance of Methylene blue increases. However this development does no longer go on indefinitely; it peaks at 60 minutes, then phases off and drops. At soaking time of 60 minutes the adsorbance values are the highest i.E. For an activation temperature 750oC it is 1.894, for 850oC it's 2.163 and lastly for 950oC it's 2.543.

The cause for that is that with improved activation time, one of the vital volatiles initially in the carbon structure are pushed of thus of accelerated steam activation thus the adsorption surface is increased. With additional broaden in activation time, the steam penetrated deeper inside the particles than with short time.

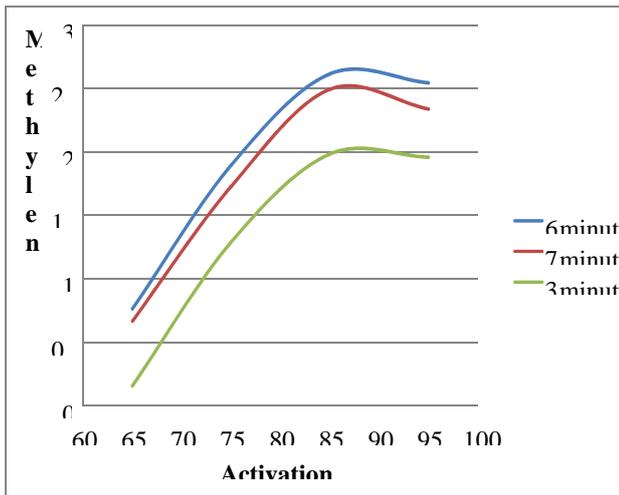


Figure 14: Graph Methylene Blue Adsorbed against Ac

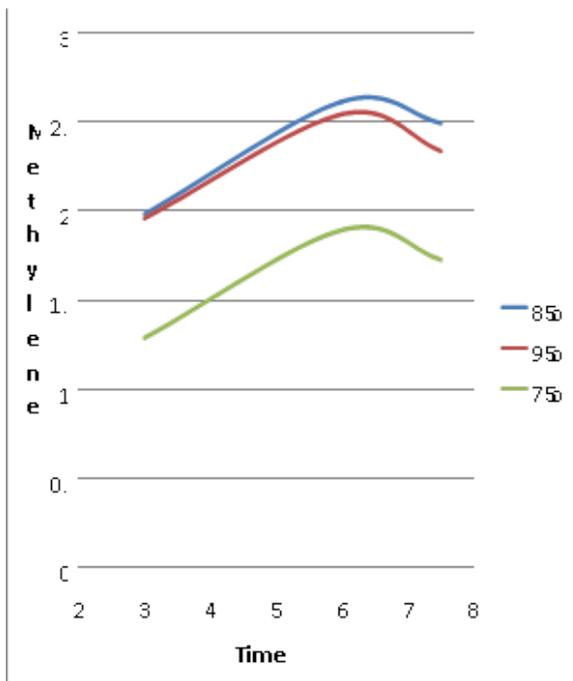


Figure 15: graph of methylene blue Activation

The motive for the levelling off and dropping of adsorbance after peaking at 60 minutes is that probably there was once persevered activation which favoured formation of micropores, and because the Methylene blue experiment would no longer notice a lot of the change.

IV. CONCLUSION

The outcome of this study exhibit that it is feasible to organize activated carbons with moderately excessive surface areas and pore volumes from paper mill slugat the optimum stipulations arrived at above by way of bodily activation with steam. These conditions are: a pyrolysis temperature of 520oC with soaking time of 45 minutes, and an activation temperature of 850oC with soaking time of 60 minutes. The pyrolysis temperature of 520oC used to

be arrived at with the intention to economize the cost of construction and time. High pyrolysis temperature translates to high power charges coupled with low carbon yields at growing temperatures.

Future Scope of study

1) Broad investigation should be implemented to provide ACs with even better surface characteristics by means of specific routes comparable to bodily activation, two stage activation and microwave heating etc and will also be when put next with the results obtained with chemical activation.

2) Utilization of AC to deal with more than a few other pollution present in water streams must be undertaken.

3) Approach financial system most commonly will depend on the decision of uncooked fabric and approach of practice of AC. Thus the rate estimation must be carried out to evaluate the skills software of the adsorbent in specific observes.

4) Designated investigation of desorption of Cr (VI) and regeneration of spent AC is essential to evaluate the affectivity of the process which wants an immediate attention.

5) The effectivity of AC produced by using phosphoric acid activation can be accelerated extra at impartial pH by way of modifying the surface practical groups.

6) Column reviews should be carried out to test the suitability of ready AC as adsorbent in water purification techniques.

7) Most of the activated carbon as good as different adsorbents have shown effectiveness in putting off chromium species from the waste move at low pH. Nonetheless the presence of chromium in the trace amount in consuming water is a fundamental assignment. As a result to fight this predicament wide investigation wants to be applied to advance an adsorbent and show its knowledge to treat the contaminated ingesting water at neutral pH.

8) Solid waste management is a nice environmental trouble that is launched and disposed with the aid of the industries and the agricultural sectors. Hence research endeavor is wanted to utilize the solid waste or convert it to a useful product.

REFERENCES

- [1] Aber, S., Khataee, A., Sheydaei, M. Optimization of activated carbon fiber preparation from Kenaf using K_2HPO_4 as chemical activator for adsorption of

- phenolic compounds. *Bioresource Technology*, 100 (24), 2009, 6586-6591.
- [2] Acharya, J., Sahu, J.N., Mohanty, C.R., Meikap, B.C. Removal of lead (II) from wastewater by activated carbon developed from tamarind wood by zinc chloride activation. *Chemical Engineering Journal*, 149, 2009, 249-262.
- [3] Acharya, J., Sahu, J.N., Sahoo, B.K., Mohanty, C.R., Meikap, B.C. Removal of chromium(VI) from wastewater by activated carbon developed from Tamarind wood activated with zinc chloride. *Chemical Engineering Journal*, 150 (1), 2009, 25-39.
- [4] Adhoum, N., Monser, L. Removal of phthalate on modified activated carbon: application to the treatment of industrial wastewater. *Separation and Purification Technology*, 38, 2004, 233239.
- [5] Adinata, D., Daud, W.M.A.W., Aroua, M.K. Preparation and characterization of activated carbon from palm shell by chemical activation with K_2CO_3 . *Bioresource Technology*, 98, 2007, 145-149.
- [6] Agarwal, G.S., Bhuptawat, H.K., Chaudhari, S. Biosorption of aqueous chromium(VI) by *Tamarindusindica* seeds. *Bioresource Technology* 97, 2006, 949- 956.
- [7] Ahmad, M.A., Alrozi, R. Removal of malachite green dye from aqueous solution using rambutan peel-based activated carbon: Equilibrium, kinetic and thermodynamic studies. *Chemical Engineering Journal*, 171 (2), 2011, 510-516.
- [8] Ahmadpour, A., Do, D. The preparation of activated carbon from macadamia nutshell by chemical activation. *Carbon*, 35, 1997, 1723-1732.
- [9] Ahmadpour, A., Do, D.D. The preparation of active carbons from coal by chemical and physical activation. *Carbon*, 34, 1996, 471-479.
- [10] Ahmaruzzaman, Md. Adsorption of phenolic compounds on low-cost adsorbents: A review. *Advances in Colloid and Interface Science*, 143 (1-2), 2008, 48-67.
- [11] Al-Duri, B. Introduction to adsorption. In: McKay, G. (Ed.). *Use of adsorbents for the removal of Pollutants from Wastewaters*. Boca Raton, FL: CRC Press, 1996, 1-6.
- [12] Akgerman, A., Zardkoohi, M. Adsorption of phenolic compounds on fly Ash. *Journal of Chemical and Engineering Data*, 41 (2), 1996, 185-187.
- [13] Aksu, Z., Kutsal, T. A bioseparation process for removing lead(II) ions from waste water by using *C. vulgaris*. *Journal of Chemical Technology and Biotechnology*, 52, 1991, 109-118.
- [14] Alaerts, G.J., Jitjaturant, V., Kelderman, P. Use of coconut shell based activated carbon for Cr(VI) removal. *Water Science and Technology* 21, 1989, 1701-1704.
- [15] Alamansa, C., Molina-Sabio, M., Rodriguez-Reinoso, F. Adsorption of methane into ZnCl₂activated carbon derived discs. *Microporous and Mesoporous Materials*, 76, 2004, 185-191.
- [16] Allen, S.J., Gan, Q., Matthews, R., Johnson, P.A. Comparison of optimized isotherm models for basic dye adsorption by kudzu. *Bioresource Technology*, 8, 2003, 143-152.
- [17] Amin, N.K. Removal of direct blue-106 dye from aqueous solution using new activated carbons developed from pomegranate peel: adsorption equilibrium and kinetics. *Journal of Hazardous Materials*, 165 (1-3), 2009, 52-62.
- [18] Antony, J. *Design of Experiments for Engineers and Scientists*, Butterworth-Heinemann, New York, 2003.
- [19] Arami-Niya, A., Daud, W.M.A.W., Mjalli, F.S. Comparative study of the textural characteristics of oil palm shell activated carbon produced by chemical and physical activation for methane adsorption. *Chemical Engineering Research and Design*, 89 (6), 2011, 657-664.
- [20] Arenas, L.T., Lima, E.C., Santos, A.A.D., Vagheti, J.C.P., Coasta, T.M.H., Benvenuti, E.V. Use of statistical design of experiments to evaluate the sorption capacity of 1,4diazoniabicyclo[2,2,2]octane silica chloride for Cr(VI) adsorption. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 297, 2006, 240-248.
- [21] Ariyadejwanich, P., Tanthapanichakoon, W., Nakagawa, K., Mukai, S. R., Tamon, H. Preparation and characterization of mesoporousactivated carbon from waste tires. *Carbon*, 41, 2003, 157164.
- [22] Arriagada, R., Garcia, R., Molina-Sabio, M., Rodriguez-Reinoso, F. Effect of steam activation on the porosity and chemical nature of activated carbons from Eucalyptus globules and peach stones. *Microporous Materials*, 8 (3), 1997, 123-130.
- [23] Aworn, A., Thiravetyan, P., Nakbanpote, W. Preparation and characteristics of agricultural waste activated carbon by physical activation having micro and mesopores. *Journal of Analytical and Applied Pyrolysis*, 82 (2), 2008, 279-285.
- [24] Aworn, A., Thiravetyan, P., Nakbanpote, W. Preparation of CO₂ activated carbon from corncob for methylene glycol adsorption. *Colloids and Surfaces A: Physicochemical Engineering Aspects*, 333, 2009, 19-25.
- [25] Ayranci, E., Hoda, N. Adsorption kinetics and isotherms of pesticides onto activated carbon cloth. *Chemosphere*, 60 (11), 2005, 1600-1607.