

RESEARCH ARTICLE

Properties Improvement of activated Carbon Prepared from Hit Natural asphalt by Phenol Formaldehyde Polymer Waste

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ABSTRACT:

This study was suggested for the possibility of producing activated carbon from natural asphalt (very large quantities in our country at Abo-Aljeer fault in Anbar, west of Iraq). The resulted activated carbon then mixed with waste condensation polymers widely used in factories and homes as a thermal insulator to improve its properties. Pyrolysis product of natural asphalt and phenol formaldehyde polymer waste was chemically activated with potassium hydroxide, and dilute hydrochloric acid was used to remove any trace of polluter. The effect of preparation conditions on the produced activated carbon characteristics as an adsorbent was measured with the iodine adsorption (internal porosity) and methylene blue (surface area). This method has an economic and environmental advantages.

KEYWORDS: Natural asphalt, condensation polymeric waste, Activated carbon, adsorption.

INTRODUCTION:

Activated carbon, a widely used adsorbent in industrial processes, due to its homogenous structure, highly developed internal surface area, porosity and large capacity for adsorbing chemicals, gases and liquids [1, 2]. Activated carbon adsorption has been cited by the US environmental protection agency (USEPA) as one of the best available environmental pollution control technologies [3].

Natural asphalt materials include a large range of heavy hydrocarbons as an organic mixture of various chemical elements and compounds [4]. These materials were formed by the rush of crude oil to the surface of the earth by the internal pressure of the tank, where most of its light components were lost and oxidized by air oxygen [5]. An additives used for Natural asphalt modification include polymers, carbonaceous materials, and other materials of various origin [6]. New studies was focused on various ways to overcome the problems of large quantities of waste polymers, However, the increase in cost, environmental concerns, and the decreasing space for landfills make alternative treatment options desirable, different alternative methods have been proposed in order to process the plastic wastes [7-11].

Activated carbon was prepared using sodium hydroxide at 550°C with very high adsorption properties [12]. Activated carbon was prepared the from natural asphalt after treating with lignin at different rates and then activating by chemical method [13].

Activated carbon was prepared using physical activation under the layer of charcoal in high temperature furnace and the carbonization of acrylic fibrous waste was performed at different temperatures (800°C, 1000°C, and 1200°C) with heating rate of 300°C/h and at different holding time [14].

One of modified methods for activated carbon preparation is by using (Asphalt: waste Polymer) system [2]. In recent years there has been considerable research in the area of activated carbon production from plastic wastes and products with high surface areas and pore volumes have been produced [15].

The activated carbon has been prepared by treated asphalt with two kind of waste polymer in presence of sulfur, under fixed laboratory conditions of temperature and time and polymers additives, used potassium hydroxide to process primary carbonization and solution (10%) hydrochloric acid to remove any trace of the ions and reduction of the metal components [16].

MATERIALS AND METHODS:

The precursors used in this study were phenol formaldehyde polymer waste and Hit natural asphalt collected from Abo-Aljeer fault (Anbar, west of Iraq). The proximate and ultimate analysis of the precursor materials was carried out according to ASTM standard techniques, and the results are given in table 1.

Activated carbon preparation:

This study involve the preparation of activated carbon from natural asphalt without additive and natural asphalt with (1% and 2%) waste polymer.

One gram of asphalt was extracted with n- hexane (1:40) hexane: natural asphalt for 3 hours at 0°C with continuous stirring to and the asphalt % was calculated [5]. The waste polymer of phenol formaldehyde was treated thermally at 350°C for one hour, then it was mechanically crushed by ceramic mortar.

To prepare activated carbon, a certain weight of extracted asphalt was distilled under a low pressure of 20 mm (vacuum pump) to get rid of the light components, the distillation residues were treated with a thermally fractured polymer of 1% and 2%. The mixture of extracted asphalt and the waste polymer of phenol formaldehyde heated at 200°C for mixture homogenization.

A chemical reactivation method was performed with mixture: KOH (1:1.5) respectively [17,18], and then thermally treated at 450°C for 3 hours. The resultant washed up with continuous stirring by distilled water followed by 15% HCl for 2 hours to neutralize pH to 7 and removing the metal ions and impurities and dried at 120°C for 1 hour.

The carbon yield of the each sample was calculated using following equation [19].

$$\text{Yield (\%)} = (W1 / W0) \times 100\%$$

Where, W1 is the dry weight (g) of the final activated carbon and W0 is the dry weight (g) of the precursor material(extracted asphalt and polymer).

Measurement of Surface of adsorption by methylene blue:

The value of the Methylene blue is defined as the number of mg of Methylene blue dye from its water solution on the outer surface of activated carbon when 1g of activated carbon is used. A 0.1g of activated carbon is weighed in a conical flask, then 100 ml of 20ppm methylene blue dye was added with continuous stirring for 24 hours at room temperature.

The solution was centrifuged and UV-Visible absorption spectrum measured at the maximum wavelength 665nm, the absorbed amount of the dye on activated carbon is calculated [20, 21].

Measurement the Internal porosity of adsorption by iodine number:

A 10 ml of 5% hydrochloric acid solution was pipetted to dried activated carbon 1g in a250ml conical flask, then the contents was heated until it boils for 30 seconds and leaves to cooled to room temperature, after that 100 ml (0.1N) iodine solution was by pipetted with continuous stirring for half an hour. The contents of the beaker shall be filtered by a dry and clean filter paper. The filtrate solution stand for 24 hours, then titrated with sodium thiosulfate 0.1N using starch indicator, the weight of iodine adsorbed from the activated carbon surface is calculated using the following equation [22, 23]:

$$I_n = \frac{x}{m} \cdot D$$

Where:

m= the weight of the activated carbon in gram

x= A – [2.2B × ml of sodium thiosulfate solution used]

A= N1 × 12693, N1= Normality of iodine solution (0.1N)

B= N2 × 126.93, N2= Normality of sodium thiosulfate solution (0.1N)

D= correction factor

Measurement of Bulk Density:

A certain amount of activated carbon was filled into the previously weighed bottle, then the bottle was weighted by a sensitive balance and the density was calculated using the following equation:

$$\text{Density (gm/cm}^3\text{)} = \text{mass (gm)} / \text{volume (cm}^3\text{)}$$

Measurement of humidity content:

1 gm of activated carbon taken with ceramic container and put in an electric oven at 110 °C for 1 hour and then leave to cool at room temperature in a desiccator, then weighted and calculated the percentage of humidity.

Measurement of the percentage of ash content:

1 g of activated carbon is placed in a ceramic container and placed in an electric oven at 950°C for one hour. It is then left to cool in the desiccator and then weighted. From the weight difference, the percentage of ash calculated [24].

RESULT AND DISCUSSION:

The carbonation of the base material with high carbon content is to force the creation of various pores by eliminating the hydrogen and some atoms involved in the composition of the original material. Potassium

hydroxide was used at a constant rate of 75% for the necrosis and the transformation of the form of the material used. On the surface of the earth and the natural bitumen treated with polymer residues, as these types of activated carbon free of sulfur, nitrogen and various toxic substances, and after purification of the prepared models and remove any traces of metals and pollutants using thermal escalation with 10% hydrochloric acid, the results of the measurements were as shown in the table below:

PPFP=Poly Phenol Formaldehyde Polymer:

The data show that activated carbon samples have a good adsorption capacity by observing the adsorption of the methylene blue samples, which reflect the surface area of the activated carbon, if the results show that the best ratio of polymer residues as a bituminous agent was 1% was the optimal ratio of the interaction with this type of bituminous material and at the added increase to 2% decrease the carbon ability of adsorption and the reason for the non-interaction of bitumen with the increase of polymer added, which worked on the spread of this increase between the carbon mass of the outer surface and is the cause of the loss of some pores through the spread or adsorption on the surface of activated carbon, see table 1, figure 1 and figure 2.

Table 1: The Ratio of additive, Iodine No., Methylene blue, Ash%, Density and Humidity% of the prepared samples of activated carbon

Sample	PPFP %	Iodine No. mg/g	Methylene blue mg/g	Ash %	Density g/cm ³	Humidity %
H ₀	0	651	66	2.9	0.09	6.2
H ₁	1	653	87	2.1	0.20	8.1
H ₂	2	668	73	0.9	0.31	7.5
B. D. H		908	90	3.2	0.325	0.8

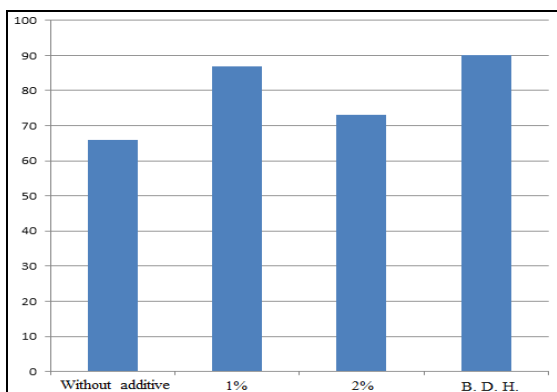


Figure 1: Showed measurement of methylene blue adsorption.

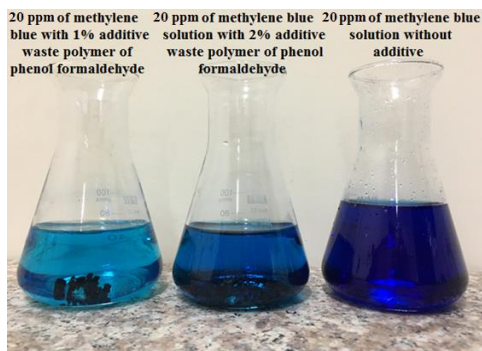


Figure 2: Adsorption of 20 ppm methylene blue without additive and with 1%, 2% additive waste polymers of phenol formaldehyde

oscillation in the adsorption value was greater than that of the laminar dye. The spread of the added polymer was on the outside without being affected by the form of stents or deposited inside the activated carbon model, see table 1, figure 3 and figure 4.

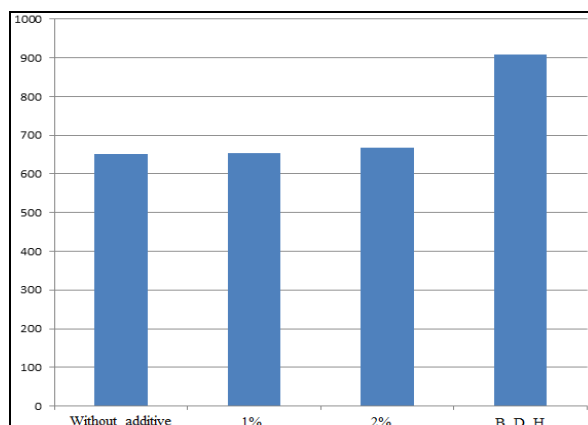


Figure 3: Showed measurement of Iodine number adsorption

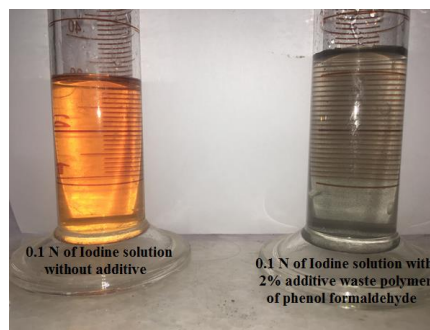


Figure 4: Adsorption of 0.1N iodine solution without additive and with 2% additive waste polymers of phenol formaldehyde

It is noted that the prepared models gave acceptable adsorption values for the iodine solution, which expresses the internal surface area of the activated carbon, and that 2% of the additive gave the best adsorption process for the iodine solution 0.1N, and the

The measurement density was in the height of the prepared models. This is due to the increase in the weight of the material formed. This is evident in note 3, but all models remained within the acceptable limits of activated charcoal density compared to B. D. H. Water was different in each model and model 2 remained the highest retention for the amount of water absorbed, see table 1 and figure 5.

It was observed when measurement humidity that the second sample humidity ratio was higher than the rest of the samples, but the first model without additives was less humidity compared to the remaining samples, the observed variation in humidity measurement of activated carbon samples is clear evidence of the activated carbon activity indicated in these ratios, where the more humidity, this is clear evidence of the presence of many porous that help to withdraw water molecules and therefore the second sample is the best in terms of possession of more porous, see table 1 and figure 5.

The higher content of the ash indicates the presence of non-carbonated components in the prepared models. Two degrees of heat and a temperature of less than 450 °C were used. The content of ash was higher than the use of a higher temperature of 550 °C to be the ash content within the specifications of the comparison model B. D. H., see table 1 and figure 5.

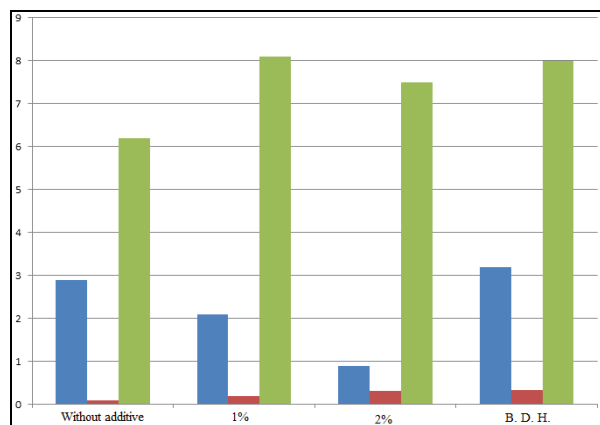


Figure 5: Showed measurements of the Density, Ash and Humidity. Where: (Blue) Ash; (Red) Density; (Green) Humidity

CONCLUSION:

This research proved the possibility of preparing activated carbon from natural asphalt for the unit and the possibility of improving the specifications of adsorption by adding waste polymer and this research showed that activated carbon in both cases has good adsorption properties monofilament and can be used as an alternative to activated carbon prepared from other sources higher and higher cost in operations preparation.

ACKNOWLEDGEMENTS:

Thanks to everyone who has provided a helping hand for this research to appear in the best form to be published. Special thanks Todr. Ayad Al-Mamoori from University of Babylon-college of sciences. Thanks to college of applied sciences-Hit and College of Sciences -University of Anbar.

REFERENCES:

1. B. Thomas and S. George, Production of Activated Carbon from Natural Sources, *iMedPub Journals*, 1(17); 2015: 1-5..
2. O. Ramadhan and A. Hamdon, Production of Activated Carbon by Grafting of Lignin with Oxidized Asphalt via Fused Carbonization and Chemical Activation, *National Journal of Chemistry*, Vol. 31; 2008: 377-382.
3. J. Martin (USEPA), Federal Register, 77(58); 2012).
4. M. Bostancioğlu and Ş.Oruc, Optimizing activated carbon size and ratio in bitumen modification, *GRADEVINAR*, 69(3); 2017: 215-220.
5. A. Al-Dabouni, L. Ali, "Oil, Origin, Installation and Technology". University of Mosul, 1986: 63.
6. S. Chebil, A. Chaala and C. Roy, Use of softwood bark charcoal as a modifier for road bitumen, *J. of Fuel*, 79;2000: 671-683.
7. A. Bazargan, G. McKay and D. Hui, Porous Carbons from Plastic Waste, *AdvPolymSci*, 12; 2013: 1-26, Springer-Verlag Berlin Heidelberg.
8. K. Zia, H. Bhatti and I. Bhatti, Methods for polyurethane and polyurethane composites, recycling and recovery, a review. *React FunctPolym.*, 67(8);2007: 675-692.
9. G. Howard, Biodegradation of polyurethane, A review. *Int. Biodeterior Biodegradation*. 49(4)2002: 245-252.
10. S. Al-Salem, P. Lettieri and J. Baeyens, Recycling and recovery routes of plastic solid waste (PSW): a review, *Waste Manage.*, 29(10); 2009: 2625-2643.
11. C. Nnamchi, J. Obeta and L. Ezeogu, Isolation and characterization of some polycyclic aromatic hydrocarbon degrading bacteria from Nsukka soils in Nigeria. *Int J Environ SciTechnol*, 3(2);2006: 181-190.
12. T. Yamaguchi, "Preparation of activated carbon and light oil from petroleum asphaltene an attempt for the utilization of heavy oils", *J. Fuel*, 59(6);1980: 444,445.
13. O. Ramadhan, A. Hamdoon and K. Ahmed, Production of activated carbon by grafting of lignin with oxidized asphalt via fused carbonization and chemical activation, *National J. of Chemistry*, 31; 2008: 377-382.
14. M. Naeem, S. Javed, V. Baheti, J. Wiener, M. Usman, S. Zameer U. Hassan, A. Mazari and J. Naeem, Adsorption Kinetics of Acid Red on Activated Carbon Web Prepared from Acrylic Fibrous Waste, *Fibers and Polymers*, 19(1); 2018: 71-81.
15. A. Bazargan, C. Hui and G. McKay, Porous Carbons from Plastic Waste, *Polymer*, 266; 2013: 1-25.
16. M. Rabeea, R. Muslim and A. Younis, Preparation Activated Carbon from Biji Refinery Asphalt Treated with Sulfur and Waste Polymers, *International Journal of Applied Engineering Research*, 12(24); 2017: 14783-14788.
17. S. Hirunpraditkoon, N. Tunthong, A. Ruangchai and K. Nuihitikul, Adsorption Capacities of Activated Carbons Prepared from Bamboo by KOH Activation, *International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering*, 5(6); 2011: 477-481.
18. X. Li, Q. Xu, Y. Fu, and Q. Guo, Preparation and characterization of activated carbon from Kraft lignin via KOH activation, *Environmental Progress and Sustainable Energy*, 33(2); 2014: 519-526.
19. T. Mi, L. Chen, S. Xin and X. Yu, Activated Carbon from the Chinese Herbal Medicine Waste by H₃PO₄ Activation, *Journal of Nanomaterials*, 1; 2015: 1-9.
20. J. Nasr, N. Hamdi and F. Elhalouani, Characterization of activated carbon prepared from sludge paper for methylene blue adsorption, *Journal of Materials and Environmental Sciences*, 8(6); 2017: 1960-1967.
21. V. Jha and K. Subedi, Preparation of Activated Charcoal Adsorbent from Waste Tire, *J. Nepal Chem. Soc.*, 27; 2011: 19-25.
22. M. Martin, A. Artola, M. Balaguer and M. Rigola, Activated carbons developed from surplus sewage sludge for the removal of dyes from dilute aqueous solutions. *Chem. Eng. J.*, 94(3); 2003: 231-239.
23. A. Bacaoui, A. Yaacoubi, A. Dahbi, C. Bennouna, R. Luu, F. Maldonado-Hodar, J. Rivera-Utrilla and C. Moreno-Castilla, Optimization of conditions for the preparation of activated carbons from olive-waste cakes, *Carbon*, 39(3); 2001: 425-432.
24. S. Anisuzzaman, C. Joseph, W. Daud, D. Krishnaiah and H. Yee, Preparation and characterization of activated carbon from Typhaorientalis leaves, *Int. J. Ind. Chem.*, 6; 2015: 9-21.