Technology Section

Pak. j. sci. ind. res., vol. 32, no. 4, April 1989

ACTIVATED CARBON FROM INDIGENOUS INFERIOR WOODS
Part I. Impregnation Ratio Influence

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(Received December 10, 1988; revised March 13, 1989)

The effect of zinc chloride in different impregnating ratios on the properties of activated carbon prepared from indigenous inferior woods has been studied. The activity of carbon has been determined against iodine, methylene blue and molasses. It has been found that product activity is optimum against low molecular weight substances at comparatively lower ratio of activating agent whereas for high molecular weight compounds, higher ratio of activating agent is desired. Activated carbon suitable for any particular industrial requirement may be prepared by variation in ratio of impregnating agent.

Key words: Activated carbon, Inferior woods, Impregnation ratio.

INTRODUCTION

Activated carbon is assuming increasing importance in the control of air pollution, in purifying and controlling the general chemical environment, in certain biomedical applications and for the removal of organic matter from water and wastewater [1]. It may be prepared by any of the two processes developed by Ostrejko [2]. The properties of an activated carbon depend on the nature of the raw material used, the conditions of carbonization and the nature of the activation process. It has been well established that among the conventional activating agents used, zinc chloride is the most appropriate [3].

In an earlier work [4], a study on activated carbon from different indigenous agrowastes has been described and now these studies have been extended to indigenous woods. These woods may be used as a raw material for the production of activated carbon.

The present studies describe preparation of activated carbon by low temperature chemical activation process of indigenous inferior woods, like (*Acacia arabica*) Babul, (*E. camaldulensis).* Eucalyptus (*Ficus lacon buch*), Pakar, (*Picea morinda*), Partal (*Acacia albida*), Keekar, (*Albizzia spp.*) Siris and (*Populus ciliata*) Poplar. A comparative study of the different physical and chemical characteristics of these carbons has been done. The results obtained provide some useful information about the utility of these products in different industrial purification processes.

EXPERIMENTAL

The debarked wood samples were first dried in an electric oven at 105° and then ground to 80 mesh.. All the unextracted wood samples were then analysed for their α-cellulose, klason lignin, EtOH-benzene extractives and ash content by standard methods [5].

The powdered raw materials (1 kg) were mixed with 0.5, 1,2 and 3 kg of $ZnCl_2$ dissolved in just enough quantity of water for through mixing and dried. The dried mass was then carbonized in a muffle furnace out of contact with air at a temperature of 650-750° for 6 hours. The carbonized material was washed with 10 % hydrochloric acid and distilled water, then dried and powdered.

The bulk and true density of these samples were determined by standard method [5]. Pore space per 100 g. of carbon (Vp) was also calculated [6]. The ash and matter soluble in acid of the activated carbon samples were determined [5]. The iodine number of these samples was determined to measure the relative adsorptive power of different activated carbons [7]. The methylene blue [8] and molasses values [9] of these samples were also determined.

RESULTS AND DISCUSSION

A series of seven indigenous inferior woods namely babul (W_1), eucalyptus (W_2), keekar (W_3), pakar (W_4), partal (W_5), poplar (W_6) and siris (W_7) have been selected for these studies. It was established earlier that chemical treatment with zinc chloride prior to carbonization of any cellulosic raw material is a pre-requisite for producing good quality activated carbon [4]. The effect of impregnating ratio variation of zinc chloride on the activity of charcoal has also been studied.

Table 1 shows chemicals analysis of different woods utilized for the preparation of activated carbon. It show that percentage of α-cellulose (48-57 %) in all of the samples is appreciably greater than that of lignin (24-30 %). According to the theory of Burrage [10] these woods are suitable raw material for activated carbon as cellulose is the

main component which is being reacted or dissolved by zinc chloride during the process of activation whereas lignin etc. remain unreacted.

Table 1. Chemical analysis of indigenous woods*.

S. No.	Type of wood	α-Cellulose (%)	Klason lignin (%)	Extractives (EtoH-benzene) (%)	Ash (%)
1.	W_1	54.54	25.37	8.68	3.35
2.	W_2	50.23	30.58	4.80	1.39
3.	W_3	58.52	24.15	7.85	2.15
4.	W_4	48.74	28.52	5.01	1.40
5.	W_5	57.60	30.00	2.90	0.60
6.	W_6	50.00	24.20	3.20	0.40
7.	W_7	54.25	26.85	9.22	0.79

*W_1 = Babul, W_2 = Eucalyptus, W_3 = Keekar, W_4 = Pakar, W_5 = Partal, W_6 = Poplar, W_7 = Siris.

Table 2 shows different characteristics i.e. ash and matter soluble in acid of activated carbons R_1, R_2, R_3 and R_4, prepared with different impregnating ratios of activating agent and a standard activated carbon of E-Merck. It may be seen here that there is a marked decrease in the ash content [4] with the increase in the amount of the activating agent which is most prominent in the case of R_2 to R_3 whereas in the case of R_3 to R_4 this ash reduction is rather low, The matter soluble in acid of these carbon samples also show a gradual decrease with an increase in the amount of zinc chloride and it is within the recommended limit of 3.5 % [11] in all of the cases and is very low in the case of W_3 and W_5.

Table 3 shows a detailed pattern of the true and bulk density and resultant pore space per 100 gm of the activated carbon samples prepared with different proportions of activating agent. It shows that bulk density decreases and true density increases with the increase in the impregnation ratio. Their pore space gradually increases and this increase is very pronounced in the samples, R_1 to R_2 and R_2 to R_3 but very little in the case of R_3 to R_4. It is evident from the above data that the increase in the impregnating ratio results in an increase in the pore space of the activated carbon samples. This increase seems to be closely related to the increased adsorptive power of these samples [6] as shown in Table 4. The activity of these carbons and a standard carbon (E.Merck) has been determined against iodine, molasses and methylene blue which are the three main tests used for determining the empirical characteristics of liquid phase carbons. It will be seen in Figs. 1 and 2

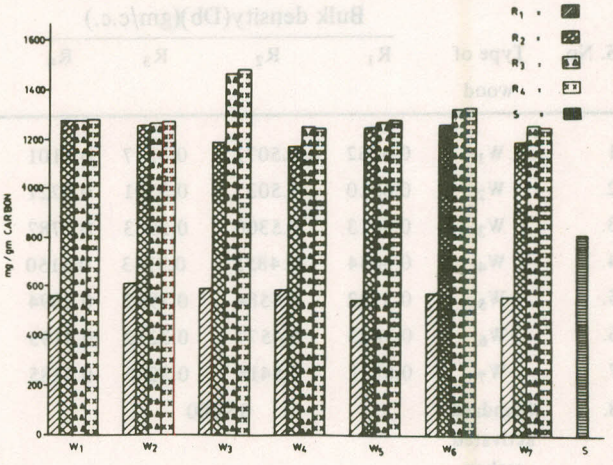

Fig.1. Iodine adsorption,

Table 2. Different characteristics of activated carbons.

S. No.	Type of wood	Ash content (%)				Acid solubles (%)			
		*R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
1.	W_1	3.55	3.29	1.71	1.65	0.62	0.59	0.53	0.50
2.	W_2	1.26	1.13	0.63	0.59	0.85	0.82	0.75	0.76
3.	W_3	3.12	2.77	1.26	1.18	0.21	0.18	0.14	0.11
4.	W_4	3.21	3.06	1.47	1.39	0.45	0.42	0.34	0.30
5.	W_5	1.29	0.93	0.63	0.58	0.17	0.15	0.11	0.10
6.	W_6	1.17	1.05	0.87	0.78	0.36	0.32	0.30	0.28
7.	W_7	1.92	1.71	0.96	0.90	0.62	0.55	0.31	0.29
8.	Standard activated carbon (E. Merck)			5.99				2.0	

*R = Impregnating ratio, R_1 = 1:0.5 R_2 = 1:1, R_3 = 1:2 R_4 = 1:3

that all samples of activated carbon have attained their optimum activity in the case of iodine and methylene blue when prepared with impregnation ratio 1 : 1 (R_2). The samples W_3 and W_5 have shown comparatively better adsorption capacity in the case of iodine and methylene blue respectively. In the case of molasses value, an entirely different pattern has been observed as may be seen in Fig. 3. The optimum level of adsorption in this case is

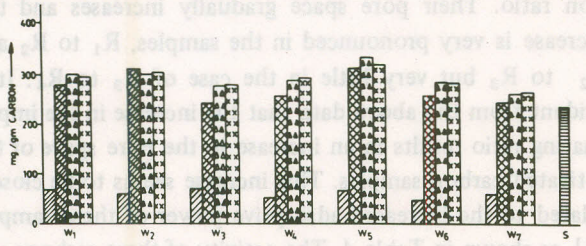

Fig. 2. Methylene blue adsorption.

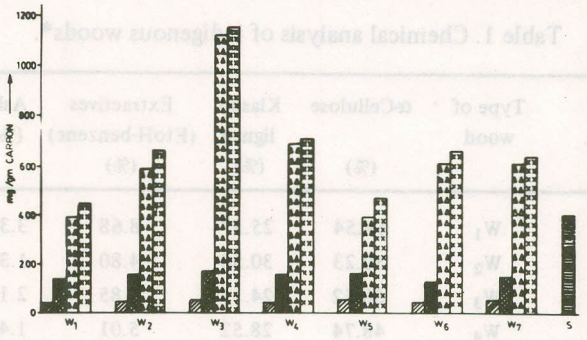

Fig. 3. Molasses value.

Table 3. Pore space of different activated carbons.

S. No.	Type of wood	Bulk density(Db)(gm/c.c.)				True density(Dt)(gm /c.c.)				Pore space(c.c./100gms.)			
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
1	W_1	0.6262	0.5071	0.3317	0.3101	1.47	1.52	1.76	1.81	91.67	131.45	244.66	267.26
2.	W_2	0.6310	0.5037	0.3391	0.3221	1.45	1.59	1.94	1.96	95.58	135.64	243.35	259.45
3.	W_3	0.6613	0.5300	0.2963	0.2787	1.41	1.48	1.81	1.84	80.29	121.11	282.25	304.46
4.	W_4	0.6054	0.4855	0.3343	0.3150	1.67	1.71	1.77	1.80	105.30	147.49	242.64	261.90
5.	W_5	0.5732	0.4584	0.2992	0.2894	1.39	1.47	2.21	2.24	102.52	150.12	288.97	300.89
6.	W_6	0.5623	0.4577	0.3212	0.3195	1.72	1.80	1.90	1.95	119.70	162.93	258.70	261.70
7.	W_7	0.6721	0.5415	0.3245	0.3185	1.63	1.70	1.83	1.85	87.44	125.85	253.52	259.91
8.	Standard activated carbon (E.Merck)		0.9400				1.84				149.73		

Table 4. Adsorption characteristics of different activated carbons.

S. No.	Type of wood	Iodine No.(mg/gm)				Molasses value(mg/gm)				Methylene blue No.(mg/gm)			
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
1.	W_1	560	1274	1275	1281	40	138	390	450	68	278	298	287
2.	W_2	612	1258	1270	1275	50	157	594	664	59	309	297	302
3.	W_3	595	1194	1475	1490	56	173	1124	1155	72	238	274	277
4.	W_4	587	1177	1259	1255	46	162	691	709	48	256	284	291
5.	W_5	547	1259	1283	1291	59	164	391	472	67	312	330	317
6.	W_6	573	1268	1333	1340	45	127	613	660	45	256	282	279
7.	W_7	558	1200	1269	1257	53	151	611	635	57	240	257	262
8.	Standard activated carbon (E Merck)		820				400				255		

obtained in samples with impregnation ratio 1 : 2 (R_3). Sample W_3 has again showed a remarkable degree of increase in activity against molasses as in iodine adsorption.

It may be seen from the above data that with the increase in the ratio of impregnating agent, the pore space and resultant adsorptive capacity of the activated carbons prepared also increase. It may be due to the increased dissolution of cellulose [10] and the increased number of complex ions $[ZnCl_2(OH)_n]H_n$ formed [12] in concentrated zinc chloride solution. Another view about the action of zinc chloride during the carbonization is that it provides a skeleton on which carbon is deposited and bonded by adsorption forces [13]. At lower concentration of zinc chloride (R_1), a poor activity pattern has been observed in all of the cases which corresponds to the above fact.

In the case of iodine and methylene blue, optimum level of adsorption in all of the cases has been attained by sample R_2 (impregnation ratio 1:1) whereas in molasses this level is attained in sample R_3 (impregnation ratio 1:2). This different behaviour may well be explained by the fact that the nitrogenous compounds and lyophillic colloids [14] present in the molasses are unable to reach part of internal structure through ultrafine entrances in sample R_2 and results in lower molasses value. Correspondingly with the increase in zinc chloride concentration (R_3) these pores are enlarged [15] and the above compounds are easily adsorbed which give rise to a remarkable increase in their molasses value. The above adsorption pattern of the three adsorbants in our studies is further supported by the fact that iodine number, methylene blue number and molasses number correlate with the surface area in pores greater than 10Å, 15Å and 28Å in diameter respectively [16].

The yield of chemically activated carbons obtained from different inferior woods have also been determined. It shows that the average yield of the product ranges between 28–33 %.

It is concluded from these studies that inferior woods may economically be utilized in producing good quality activated carbon. It has also been inferred that in the case of iodine and methylene blue i.e. for lower molecular weight compounds, carbons predigested with zinc chloride in the ratio of 1:1 have gained their optimum activity whereas in the case of molasses i.e. for higher molecular weight compounds, this activity is attained when impregnated with zinc chloride in the ratio 1:2. The adsorption data of these carbons also lead to the conclusion that they have the ability to adsorb a fairly wide range of molecules from small to large size which impart taste, odour and colour such as those required in water and sugar purification requirements.

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