

PREPARATION OF ACTIVATED CARBON FROM THE BY-PRODUCTS OF AGRICULTURAL INDUSTRY

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Summary

Activated carbons with appropriate adsorptive properties were produced from sawdust and seeds of a stone-fruit. The carbonaceous raw materials were carbonized and activated by steam. Starting with sawdust a decolourizing powdered carbon with low density could be produced. The seeds of the stone-fruit investigated could be converted to a product of high density suitable for water purification. By proper selection of the agricultural by-products a great variety of activated carbons can be obtained.

Introduction

Activated carbon is an important ingredient of chemical industry and it is essential in the potable water and waste water treatment [1]. Theoretically any type of carbonaceous material can be converted to activated carbon, but a product of good quality needs a proper raw material.

In countries having rich coal resources, the main raw material is coal of low inorganic content whose processing results in activated carbons with a sufficient structural strength. If no coal of good quality is available, the lignin and cellulose containing by-products of sawmills and canning industry can be taken into consideration as raw materials for producing activated carbon.

Applying modern technology, the carbonaceous material is subjected to dry distillation, it is charred in the absence of air, and the carbonized intermediate is oxidized with activating agents at a temperature of 850–1000 °C. The more generally used agents are steam and carbon dioxide. The activation process results in a large specific surface area and a certain type of pore structure which yield the desired adsorptive properties of activated carbon. If, besides carbonization and activation, no other supplementary technological steps are involved, the raw material determines the structural properties of the product [2].

To find the parameters of the carbonization, the data of thermal analysis are very helpful. Carrying out the investigations of the raw materials in an inert atmosphere and air, the moisture content, volatile matter, the quantity of

combustible material and the ash content can be measured. The residue of heating in inert atmosphere is composed of the charred product (fix-carbon) and the ash content.

The quantity of the volatile matter determined from the TG curve refers to the number and dimensions of those supplementary equipments which should be taken into consideration if designing a technology for processing or annihilating the volatile products of thermal decomposition. The ash content determined by thermal analysis decides the applicability of a given raw material for producing activated carbon.

The temperature interval belonging to the weight change helps to determine the final temperature of the carbonization. The decomposition heat shown by the DTA curve presents a basis for the estimation of energy requirement of the carbonization.

Experiments and discussion of results

Sawdust, available in large quantities and seeds of a stone-fruit were converted to activated carbon.

The curves of thermal analysis of the raw materials recorded in argon are shown in Fig. 1. The characteristic exothermic peaks of the decomposition of

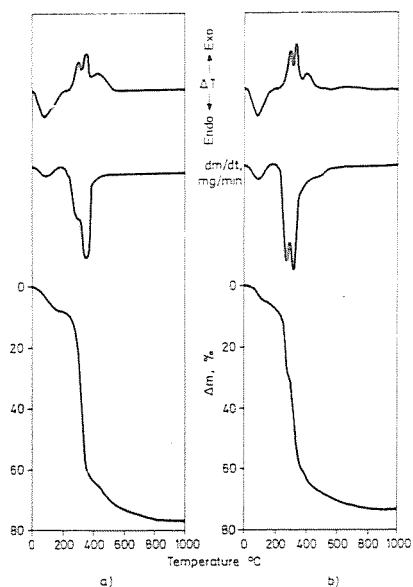


Fig. 1. TG, DTG and DTA curves recorded in argon
a) sawdust; b) seeds of a stone-fruit

cellulose and lignin can be identified very well on the DTA curves. The TG curves show, according to the expectation, a high volatile content.

The data of technological importance obtained by thermal analysis are summarized in Table 1.

In the carbonization process the thermal decompositions are accomplished and the gases and liquids formed are driven away. To distill the tar products a higher temperature is necessary.

Table 1

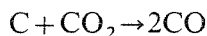
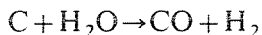
Composition of the sawdust and the seeds of a stone-fruit determined by thermal analysis

Raw material	Carbon %	Volatile matter %	Ash %
Sawdust	25.5	73.0	1.5
Seeds of a stone-fruit	28.7	71.0	0.3

According to the TG curves a carbonization temperature of 600 °C can be applied for both raw materials.

The carbonizations were carried out, with the exclusion of air, in an iron vessel equipped with an inlet for the inert gas and an outlet for the sweeping out the volatile by-products.

The activation is taking place in the interphase between the solid carbon and the activating agent.



The products take their origin from both phases, for this reason the activation process belongs to the family of heterogeneous reactions.

The replacement of reactants converted in the reaction phase and the removal of the products take place by mass transport processes. This means that depending on the experimental conditions the reaction rate can be influenced considerably by the diffusion. Consequently, the type of reactor, the temperature, the composition and flowing conditions of the fluid phase, the ratio of the solid and fluid phases, the dispersion of carbon solid all have influence on the time of activation resulting in a product of desired quality.

The carbonized samples (10 g) with a grain size of 0.8–1.0 mm were activated with steam (18 g/h) at 900 °C in a rotary quartz reactor (Fig. 2) using nitrogen as an inert sweep gas. The reaction time was varied from 20 to 60 minutes.

The adsorptive properties of the products were determined by measuring the iodine number and methylene blue adsorption [3].

The yields of activations and the corresponding adsorptive properties belonging to different activation times are summarized in Table 2.

The iodine number is the amount of iodine adsorbed in mg/g of carbon when the equilibrium concentration is 0.02 mol/l, and it gives information

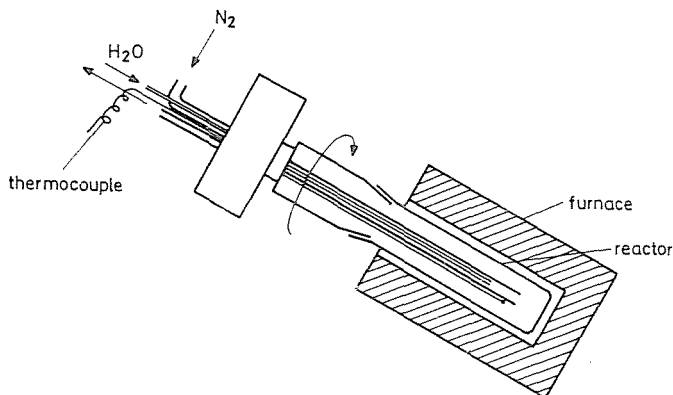


Fig. 2. Rotary quartz-reactor

Table 2

Adsorptive properties of activated carbons obtained by different activation times

Raw material	Activation time min	Yield %	Iodine number mg/g	Methylene blue adsorption g/100 g	Bulk density g/l	Ash %
Sawdust	20	70	610	8.7	330	
	30	56	950	15.5	290	
	40	43	1150	18.7	260	11.8
Seeds of a stone-fruit	30	78	750	4.0	470	
	45	70	880	7.3	420	
	60	61	1050	14.5	380	1.8

about the internal surface of activated carbon. An empirical rule states that 1 mg of iodine adsorbed represents 1 m² of surface area measured by the BET method. The quantity of the methylene blue adsorbed reveals the adsorptive properties of a carbon towards larger molecules.

The data of Table 2. show that both raw materials can be converted to activated carbon of good quality, if the activation time is properly chosen.

The char produced from sawdust reacts faster with steam than the carbonized seeds of the stone-fruit. Consequently, between the structures of raw materials there must exist differences. The charred seeds of stone-fruit are more compact and they have a satisfactory structural strength. These facts are supported by the values of bulk densities.

By grinding the product made of sawdust a decolourizing powdered carbon can be produced.

Activated carbon manufactured from the seeds of stone-fruit investigated with a suitable particle size can be used in columns for water treatment.

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