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Thermogravimetric studies of active carbons from lignocellulosic materials

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Abstract: *Thermogravimetric studies of active carbons from lignocellulosic materials.* Thermoanalytical methods were applied in investigation of active carbons (ACs) from waste agricultural products, e.g. peach stones and hornbeam wood. The study was performed on twelve samples of ACs from lignocellulosic materials. The precursors were pyrolysed at the temperature of 600°C, 700°C and 800°C. Carbonizates were activated with sodium hydroxide at a temperature about 150°C higher than the temperature of carbonization for 15 and 30 min in nonporous ceramic reactor. Effects of activation processes has been described.

Keywords: peach stones, hornbeam wood, carbonization, active carbons, TG analysis

INTRODUCTION:

Activate carbon (AC) is one of the most widely used adsorbents because of its high adsorptive capacity. Therefore, it has been widely used as adsorbent, in catalysis or in separation processes. As a result, the demand for activated carbon is increasing. However, activated carbon is expensive which limits its large-scale application. Presently, low cost forest and agricultural wastes are considered promising adsorbents for adsorption applications. Besides, they are cheaper and readily available materials. In recent years, a lot of research has been reported on activated carbons from agricultural wastes, such as pictacchio shell, cotton stalks, bagasse and rice husk, rice bran, coffee husks, olive kernels, cherry stones, olive stones, walnut shells, sugar cane bagasse and sunflower seed hull, wood particle board wastes etc. (Saka 2012). Activate carbon is a promising material for contaminant adsorption because of its efficiency, stability, and potential for reuse. However, the extensive use of activated carbon was restricted due to the high cost. The textual and chemical characteristics of the activated carbon depend on the nature of the precursor used as well as the methods and conditions of production. Previous studies showed that NaOH could be successfully used to develop activated carbons. The most important advantages over KOH are lower price and less corrosive behavior (Sun et al. 2012). The literature reported of the process of preparing high surface area microporous-activated carbon with a BET specific area of 2746 m2/g. Some researchers have found that the reaction mechanism of NaOH is similar to that of KOH and that the same high surface area activated carbon could be obtained using NaOH activation as KOH activation (Tseng 2006).

The main objective of this study was applied of thermogravimetric analysis to studies active carbons obtained from hornbeam wood and peach stones.

MATERIAL AND METHODS

Sample preparation: The peach stones were cleaned with distilled water and dried at 105°C for 24 h. Next step was grounding peach stones and then hornbeam wood in a roller mill, sieving and manually select only shells of stones. The crushed materials were subjected to pyrolysis and carbonization. These processes have been carried out in a chamber reactor in oxygen free atmosphere by heating to 600°C, 700°C or 800°C at the temperature rate of 3°C/min and then, holding in stable conditions for 1 h. Carbonizates after grinding were activated with sodium hydroxide at mass ratio 1:4 in argon atmosphere at a temperature about 150°C higher than the temperature of carbonization for 15 and 30 min in nonporous ceramic

reactor. ACs were extracted with 1% hydrochloric acid and then, with deionized water to the neutral pH.

Thermogravimetric analysis: The analysis of active carbons was carried out on a Labsys^{TM} thermobalance of the Setaram Company in the following conditions: final temperature - 1200°C, rate of temperature increase - 5 deg/min, atmosphere – helium flowing at the rate of about 2 dm³/h.

RESULTS AND DISCUSSION

Thermogravimetry (TG) is a technique for measuring of weight loss of samples as a function of temperature or time and is often used to study the thermostability of organic and inorganic compounds. This technique is also used to investigate surface and adsorption properties of porous materials (Pawlicka el al. 2012).

Figures 1-3 presents thermogravimetric curves of active carbons from peach stones and hornbeam wood. It was found that the products obtained from the hornbeam wood are more thermal stable than activates from peach stones. However, in the case of ACs from hornbeam wood prepared at the temperature 950°C, in the range of 700°C - 800°C can be observed decomposition of carbon groups.

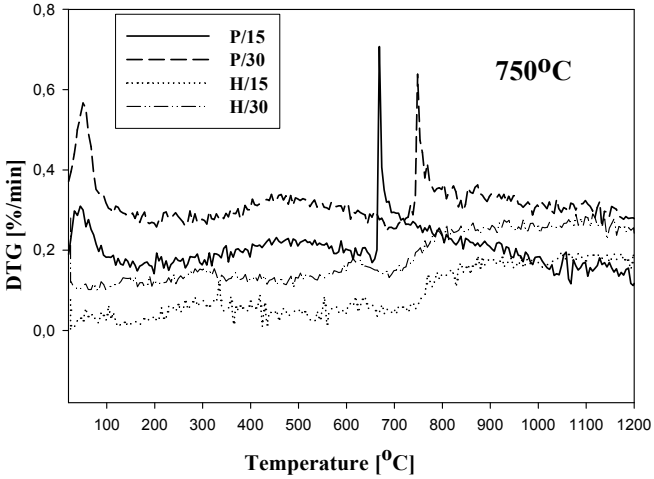

Fig. 1 DTG curves of carbonizates from peach stones (P) and hornbeam wood (H) actived with sodium hydroxide in temperature 750°C

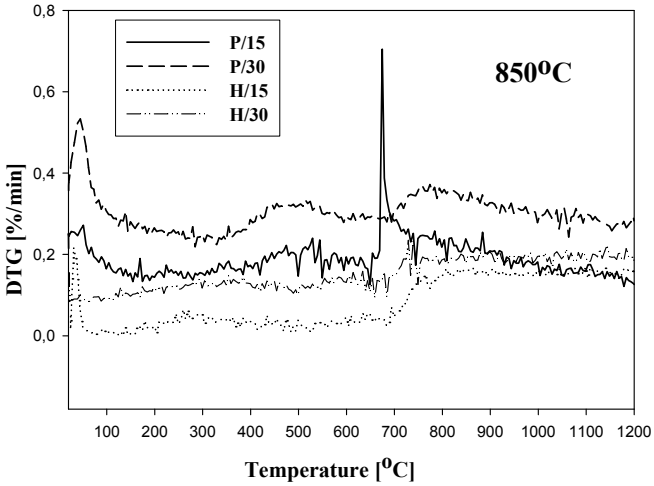

Fig. 2 DTG curves of carbonizates from peach stones (P) and hornbeam wood (H) actived with sodium hydroxide in temperature 850°C

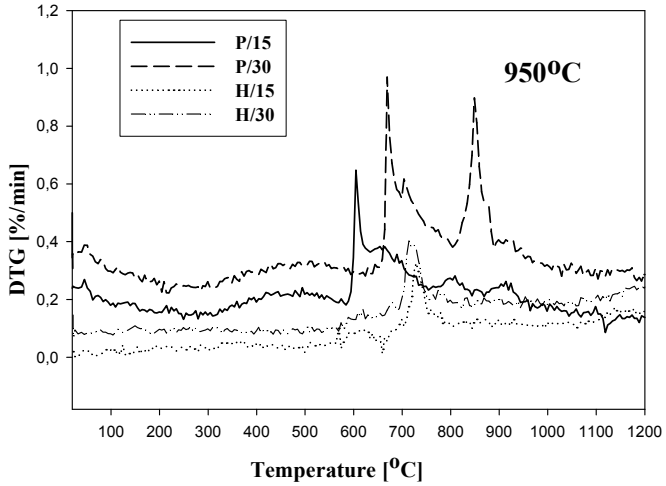

Fig. 3 DTG curves of carbonizates from peach stones (P) and hornbeam wood (H) actived with sodium hydroxide in temperature 950°C

Weight loss determined for each active carbons are presented in Table 1. Lowest weight loss was obtained for hornbeam wood in activation process carried in a 850°C for 30 minutes and amounted 16.46%. For peach stones lowest weight loss was 44.72% and it was noticed at activation process at 850°C for 15 minutes. Activate carbons from hornbeam wood have almost three times lower weight loss than the activate carbons from peach stones. In addition, in the case of ACs from hornbeam with increasing duration of activation weight loss has been is reduced. For the activate carbons from peach stones relation is reversed. The data showed that it is preferred to carry out the activation process at 850°C for both materials.

Tab. 1 Weight loss of active carbons determined by thermogravimetric

Sample	Weight loss [%]		
	20-150°C	200-1200°C	Total
P/750/15/NaOH	5,26	40,83	47,70
H/750/15/NaOH	0,61	20,64	21,45
P/750/30/NaOH	6,68	41,98	50,43
H/750/30/NaOH	0,19	18,32	18,69
P/850/15/NaOH	5,24	37,97	44,72
H/850/15/NaOH	0,40	18,28	18,84
P/850/30/NaOH	6,76	39,50	47,93
H/850/30/NaOH	0,36	15,81	16,46
P/950/15/NaOH	5,50	42,89	50,02
H/950/15/NaOH	0,32	18,56	19,17
P/950/30/NaOH	5,99	50,95	58,55
H/950/30/NaOH	0,38	17,74	18,36

Samples have been named according to the following scheme - P/750/15/NaOH or H/750/15/NaOH, where “P” means peach stones and “H” means hornbeam wood. Next numbers sequentially present temperature and time of activation and type of used activator.

CONCLUSIONS

Results of our investigations concluded that:

1. It was found that the products obtained from the hornbeam wood are more thermal stable than activates from peach stones.
2. Activate carbons from hornbeam wood have almost three times lower weight loss than the activate carbons from peach stones.
3. Lowest weight loss was obtained for hornbeam wood in activation process carried in a 850°C for 30 min. For peach stones lowest weight loss was noticed at activation process at 850°C for 15 minutes.

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Streszczenie: *Badania termograwimetryczne węgli aktywnych uzyskanych z materiałów lignocelulozowych.* W pracy otrzymano węgle aktywne z łupin pestek brzoskwini oraz z drewna grabu. Procesy karbonizacji prowadzono do temperatury końcowej 600°C, 700°C oraz 800°C. Karbonizaty aktywowano przy udziale wodorotlenku sodu w czasie 15 oraz 30 minut, w temperaturze o 150°C wyższej niż temperatura karbonizacji. Do analizy otrzymanych materiałów węglowych wykorzystano termograwimetryczne techniki pomiaru i określono procentowe ubytki masy w funkcji temperatury. Wyniki badań wskazują, że węgle aktywne z drewna grabu wykazują 2 – 3 krotnie wyższą odporność termiczną niż bliźniacze węgle z łupin pestek brzoskwini, niezależnie od temperatury i czasu trwania aktywacji. Stwierdzono, że węgle aktywne z drewna grabu otrzymane w procesie aktywacji w temperaturze 850°C w czasie 30 minut charakteryzują się najmniejszym ubytkiem masy. W przypadku aktywatów z łupin pestek brzoskwini zależność ta występuje przy temperaturze aktywacji 850°C w czasie 15 minut.

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