

# Study on Thermal Conversion of the Waste Oil Absorbin Activated Carbon

Qing Mao<sup>1</sup>, Shouyu Zhang<sup>1\*</sup>, Menghao Zhao<sup>1</sup>, Yunlong Yao<sup>1</sup>, You Li<sup>1</sup> and Jingning Yang<sup>1</sup>

<sup>1</sup>School of Energy and Power Engineering, University of Shanghai for Science and Technology, Shanghai, China  
Corresponding Email: zhangsy-guo@163.com

**Abstract.** The pyrolysis and combustion characteristics of a waste oil absorbing activated carbon were investigated using a thermogravimetric analyzer under heating rate of 10°C/min from 25°C to 1000°C. The activated carbon sample was used to adsorb waste oil. The results obtained, indicates that DTG curves of the pyrolysis process of the sample has three peaks at 106°C, 190°C and 249°C. The four peaks are observed in the DTG curves of the incineration process. The first peak at 110°C is caused by water emission. The second peak corresponds to the temperature of 190°C that is consistent with the second peak temperature of the pyrolysis process of the sample. The third peak at 240°C which is 9°C lower than the third peak temperature of the pyrolysis process. The second and third peaks maybe caused by the emission of the waste oil absorbed in the activated carbon. The fourth peak temperature is 516°C and the weight loss within the range of 400°C ~ 560°C is more obvious. The weight loss is caused by the residue char combustion.

**Key words.** Waste oil absorbing activated carbon, thermal conversion, pyrolysis, incineration.

## 1 Introduction

Activated carbon, because of the thermal treatment, which removes the moisture and the volatile matter contents of the biomass, the remaining solid char shows different properties than the parent biomass materials [1]. These changes in the properties usually lead to high reactivity, and hence, an alternative usage of char as an adsorbent material becomes possible [2]. Therefore, activated carbon is a specially treated carbon, with numerous small voids, high surface area, and it not only has a strong physical and chemical adsorption function, but also has the role of detoxification, so widely used [3-4]. However, when an activated carbon reached its saturation limit, it was simply discarded, generating a secondary source of pollution. Moreover, concern about environmental protection has increased over the years from a global viewpoint, and the spent activated carbon has to be considered a hazardous waste in itself, so it requires special treatment [5-6].

At present, the research on thermal decomposition of the spent activated carbon has been reported rarely. In this paper, the thermal decomposition characteristics of the waste oil absorbing activated carbon were studied by thermal conversion. The TG-DTG curves of the waste oil absorbing activated carbon at the atmosphere of air and nitrogen were researched, respectively. These experimental results helped to reveal the reaction process of the spent activated carbon decomposition.

## 2 Materials and methods

The materials used for the experiment was the spent activated carbon, which had been used to adsorb oil. In addition, the sample was ground and a particle size fraction of 0.3-0.45mm was used for the studies. What's more, the proximate analyses of the samples are listed in Table 1.

Thermal gravimetric method is a technique to measure the relationship between the mass and the temperature under the programmed temperature. If a differential unit is attached to the analyzer, it can simultaneously be recorded the derivative thermogravimetric curve, namely the function of the mass change rate with temperature or time.

Pyrolysis and incineration was carried out with a thermogravimetric analysis (TA/TGA Q500, America). About 1mg of the sample was pyrolysed (or burned) under 40mL/min N<sub>2</sub> (or air) flow at heating rate of 10°C /min from 25°C to 1000°C. The atmosphere was also maintained during the heating up and cooling-down intervals. This flow rate ensures a suitable atmosphere on the sample during the run, while the small amount of the sample and the slow heating rate ensure that the heat transfer limitations can be ignored. From these assays, the evolution with temperature of weight loss (TG) and the weight loss rate (DTG) for the samples studied were obtained.

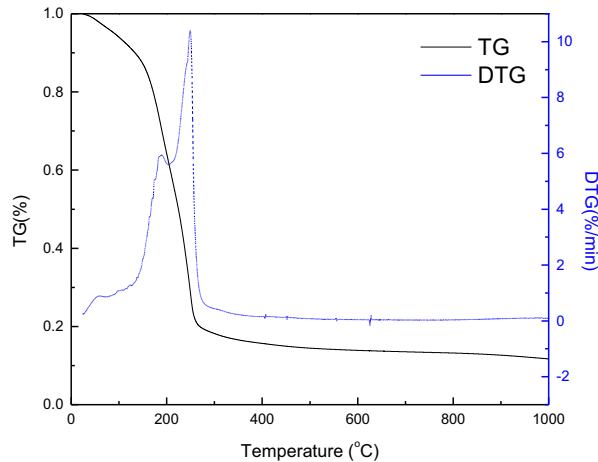
Table 1. Proximate analyses of samples.

Name	M <sub>d</sub> /%	A <sub>d</sub> /%	Q <sub>d</sub> / (MJ/kg)
------	-------------------	-------------------	--------------------------

Value	21.8	6.9	12.21
-------	------	-----	-------

### 3 Results and discussions

**Pyrolysis Characteristics.** Pyrolysis is one from of energy recovery process, which has the potential to generate char, oil and gas product [2]. Figure 1 shows the TG and DTG pyrolysis profiles of the sample [6].

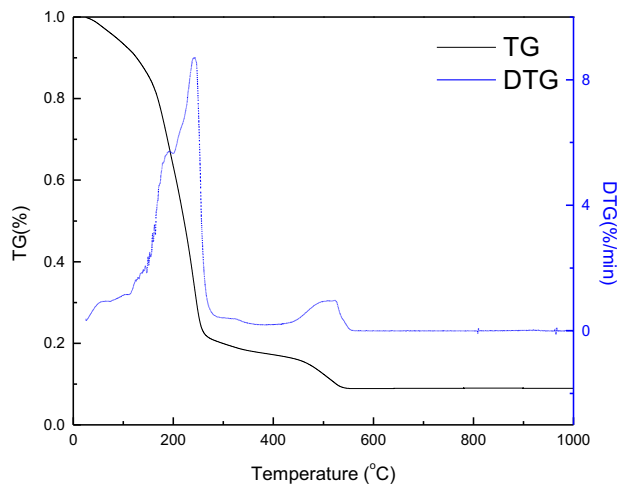


**Fig. 1.** TG and DTG pyrolysis profiles of the sample.

The TG-DTG curves showed that the decomposition proceeds through few well-defined steps with DTG peaks closely corresponding to the weight loss obtained. From Figure 1, the weight loss of the sample increased with temperature increasing (TG curve), and the whole process is divided into three distinct and successive steps can be deduced (DTG curve). Namely, the first weight loss step is from 25°C to 106°C, it is associated with water emission. It is well known that some of the water in the sample and the boiling point of the water is relatively low. What's more, the second step is from 106°C to 190°C, this step maybe can be considered as the emission of the waste oil absorbed in the activated carbon. Because the sample is the waste oil absorbing activated carbon. In addition, the third step, it is followed by a second step, between 190°C and 249°C, which corresponds to the decomposition of inorganic minerals.

**Combustion Characteristics.** The TG-DTG curves of the sample in air at heating rate of 10°C/min are shown in Figure 2.

The three peaks at 106°C, 190°C and 249°C in Fig.1 (DTG curve) can be observed. However, the four peaks were observed in Fig.2 (DTG curve). The DTG peaks closely corresponding to the weight changes observed on the TG curves. The first peak in the low temperature region is 110°C, in other words, the first weight loss step is from 25°C to 110°C, it is also related to water emission. Because some of the water in the sample and the boiling point of the water is relatively low. The second peak corresponds to the temperature of 190°C that is consistent with the second peak temperature of pyrolysis. The third peak at the temperature of 240°C which is 9°C lower than the third peak temperature of pyrolysis. Scilicet, the second and third weight loss maybe also associated with the emission of the waste oil absorbed in the activated carbon. Because the sample is the waste oil absorbing activated carbon. it is as same as the second weight loss step of the pyrolytic process. The fourth peak temperature is 516°C and the weight loss within the range of 400°C ~ 560°C is more obvious, and the reason of the weight loss is the residue char combustion [7-8].



**Fig. 2.** TG and DTG Incineration profiles of the sample.

## 4 Conclusions

From the DTG profile of the waste oil absorbing activated carbon, the pyrolytic process is divided into three stages can be found, while the incineration process of the waste oil absorbing activated carbon is in four phases. For the incineration process, the first weight loss step is related to water emission. It is well known that some of the water in the sample and the boiling point of the water is relatively low. The second and third weight loss step maybe caused by the emission of the waste oil absorbed in the activated carbon. Because the sample is the waste oil absorbing activated carbon. The fourth weight loss step corresponds to the residue char combustion.

In another case, for the Pyrolytic process, the first weight loss step is also related to water emission. The second step maybe can be considered as the emission of the waste oil absorbed in the activated carbon. The third weight loss corresponds to the decomposition of inorganic minerals.

When an activated carbon reached its saturation limit, it was simply discarded, generating a secondary source of pollution. However, the spent activated carbon can be regarded as a kind of energy, especially the waste oil absorbing activated carbon. Therefore, this kind of energy should be greatly utilized in the future.

## Acknowledgements

This research was supported by the National Science & Technology Pillar Program during the Twelfth Five-year Plan Period (Grant NO.2012BAA04B01).

## References

1. IOANNIDOU O, ZABANIOTOU A: Agricultural residues as precursors carbon production: a review. *Renewable and Sustainable Energy Reviews* Vol 11(2007), 1966-2005.
2. Putun AE, Ozbay N, Onal EP, Putun E: Fixed-bed pyrolysis of cotton stalk for liquid and solid products. *Fuel Process Technol* Vol 86(2005), 1207–19.
3. R M Suzuki, A D Andrade, J C Sousa, et al: Preparation and characterization of activated carbon from rice bran. *Bioresource Technology* Vol 98(2007), 1985-1991.
4. PAUL T W, ANTON R: Reed pre-formed activated carbon matting derived from the pyrolysis of biomass natural fibre textile waste. *J Anal Appl Pyrolysis* Vol 70(2003), 563-577.
5. FOO K Y, HAMEED B H: Recent developments in the preparation and regeneration of activated carbon by microwaves. *Advances in Colloid and Interface Science* Vol 149(2009), 19-27.
6. ANIA CO, MENENDEZ J A, PARRA J B, et al: Pyrolysis of activated carbons exhausted with organic compounds, *J. J Anal. Appl. Pyrolysis* Vol 74(2005), 518-524.

7. Zhan D, Cong C J, Diakite K, et al: Kinetics of thermal decomposition of nickel oxalate dehydrate in air, *J. Thermochemica Acta* Vol 430(2005), 101-105.
8. Marisamy M, Tomoaki N, Kunio Y: Characteristics of co-combustion and kinetic study on hydrothermally treated municipal solid waste with different rank coals: A thermogravimetric analysis, *J. Applied Energy* 87(2010), 141-148.