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Study on the Kinetics of Co-pyrolysis of Wet Blue Leather Shavings and Straw

Zhengzhou University

Zonghui Zhang, Jie Liu *, Keyong Tang *

School of Materials Science and Engineering, Zhengzhou University, Zhengzhou 450001, P. R. China

Abstract

In this work, the kinetic behavior and evolution characteristics of the mixture of straw (ST) and wet blue leather shavings (WLS) during the co-pyrolysis process were studied. The ST was blended with WLS in three blending ratios: 75 wt.%, 50 wt.% and 25 wt.%, and then heated from 35 to 600 ℃ at 10, 30 and 50 ℃/min under N_2 atmosphere with a flow rate of 40 ml/min. The initial decomposition temperature of ST was lower than that of WLS, but the maximum pyrolysis rate of straw was much higher than that of the WLS. The residual material of ST after pyrolysis was lower than that of WLS, and the residual material of the three blending ratios were between the two components. The co-pyrolysis could improve the pyrolysis performance of both components. The pyrolysis curves of the TS/WLS blends in different proportions could be simulated by utilizing the pyrolysis data of ST and WLS. It was found that the simulated data and the experimental data had the best fit when the straw ratio was 50 wt.%. Two iso-conversional methods of Ozawa–Flynn–Wall (OFW) and Modified Kissinger–Akahira–Sunose (MKAS) were used to calculate the activation energy. A lowest average activation energy was obtained when the weight ratio of ST was 75 wt.%.

Introduction

From raw hides to finished hides, there will be a complicated production process, during which a large amount of waste scraps will be produced. One type of solid waste generated from the leather industry is wet blue leather shavings (WLS); This product is mainly composed of protein collagen and chrome and poses a serious threat to the environment[1]. Properly treating WLS is an urgent problem. Biomass is an alternative renewable energy source and one of the most common energy sources in the world[2]. At the same time, agricultural straw utilization has become a big concern in many countries with abundance of the production. This paper studies the pyrolysis process of a blend composed of wheat straw(ST) and WLS particles in thermogravimetric analysis.

Methods

Crush the WLS and ST separately, and dry and store at room temperature. The samples are mixed with wet blue chrome leather shavings and straw in different proportions, namely 75W25S, 50W50S and 25W75S, and the pyrolysis parameters of WLS and ST are compared.

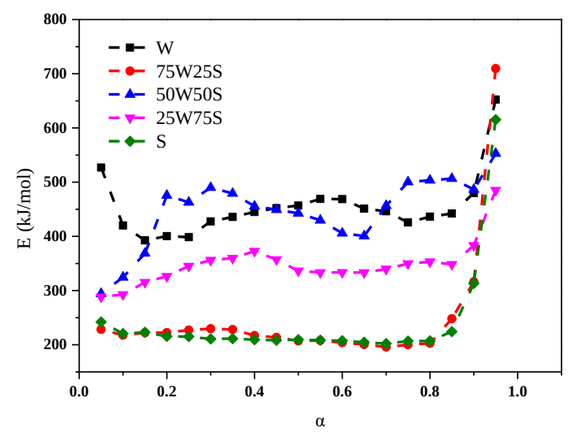

Figure 2 Activation energy calculated by OFW method.

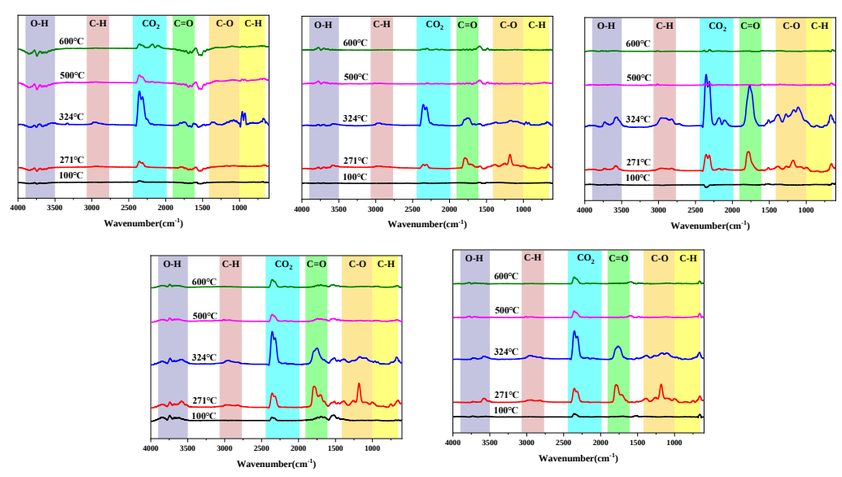

Figure 3 FTIR spectra of WLS and ST at different temperature.

Results and discussion

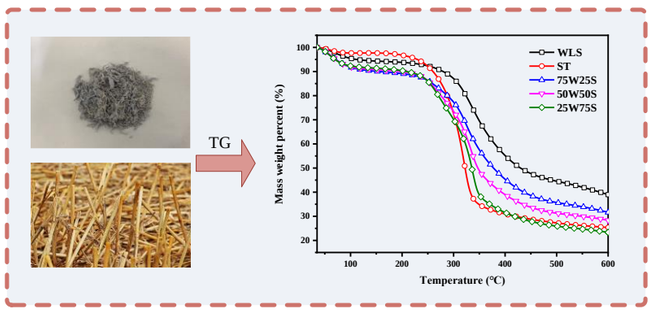

Figure 1 TG curves of wet blue leather shavings (WLS) and wheat straw.

Table 1 Characteristic parameters for all samples heated at the heating rate of 10 ℃ /min.

Sample	T I(℃)	T max(℃)	T_f(℃)	DTG_{max}(%/s)	$R_{600℃}$(%)
WLS	254.85	337.01	466.49	0.07114	38.96
75W25S	250.36	324.96	472.27	0.07982	34.40
50W50S	234.25	333.93	453.85	0.10805	32.04
25W75S	229.57	336.93	427.87	0.16573	25.87
ST	227.86	320.56	398.10	0.2059	25.35

Conclusions

The simulated data and the experimental data had the best fit when the straw ratio was 50 wt.%. Two iso-conversional methods of Ozawa–Flynn–Wall (OFW) and Modified Kissinger–Akahira–Sunose (MKAS) were used to calculate the activation energy. A lowest average activation energy was obtained when the weight ratio of ST was 75 wt.%.

References

[1] Pati A, Chaudhary R, Subramani S. A review on management of chrome-tanned leather shavings: a holistic paradigm to combat the environmental issues[J]. Environ Sci Pollut Res Int. 2014;21:11266-82.

[2] Kluska J, Turzyński T, Ochnio M, et al. Characteristics of ash formation in the process of combustion of pelletised leather tannery waste and hardwood pellets[J]. Renewable Energy. 2020;149:1246-53.