Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 66 (2015) 297 – 300

Energy Procedia

*The 12th International Conference on Combustion & Energy Utilisation – 12ICCEU

Thermal Behaviour of Corn/Cotton Stalk Blends during Co-pyrolysis

XING Xianjun , LI Hui , MA Peiyong*, SUN Yadong, HU Yunlong, LI Tao

Department of Mechanical and Automotive Engineering, Hefei University of Technology, Hefei 230009, China

Abstract

The pyrolysis behaviors and pyrolysis kinetics of corn straw（YM）, cotton stalk(MG) and blends at different proportion were studied by TG-DSC technique. The results indicate that two kinds of biomass straw can be mixed fully. The pyrolysis process with its blend ratio is not a linear relationship and solid product reduced compared with single-stalk. In addition, the major pyrolysis process of mixture within the main range can be well described by a two-dimensional diffusion model with Malek method. Among the tested samples, the 40:60 MG/ YM blend shows the lowest activation energy of 51.7 KJ/mol. Besides corn straw plays a dominant role on the course of the thermal conversion. The experimental results may provide useful data to promote the application of biomass thermochemical conversion technology of biomass mixture.

Peer-review under responsibility of the Engineering Department, Lancaster University

Keywords: Pyrolysis，Mixture proportion，Cotton stalk，Corn straw

1. Introduction

As a renewable source, biomass has become increasingly important for the production of energy. Over the last two decades, current energy consumption of biomass accounts for about 14% of total word energy consumption, second only to oil, coal, and nature gas [1]. The mixing techniques study of the biomass pyrolysis is relevant as it is the initial step of biomass combustion, pyrolysis, briquetting technology and other major routes of biomass utilization technology. As an important step of gasification, liquefaction, carbonization and combustion, the pyrolysis behavior and characteristics play an extremely important role in the design, behavior prediction and operation parameters specification of the reactor [2]. However, the mutual influence study of typical biomass has been a controversial issue. Presently, there are no systematical researches reported about pyrolysis of mixture of corn straw and cotton stalk. In this paper, some pyrolysis experiments of blends were conducted by simultaneous thermal analyzer. The study described in this paper was focused on interaction, thermal properties and reaction kinetics of biomass straw blends.

* Corresponding author. Tel:153-7538-5975
E-mail address: mapeiyong@163.com

Peer-review under responsibility of the Engineering Department, Lancaster University
doi:10.1016/j.egypro.2015.02.062

2. Experimental

Typical agricultural straw in the Anhui China, corn straw and cotton stalk were chosen for investigation. The materials were milled twice for more tiny particles (more than 90% were particles below 80 mesh) in a laboratory mill after being mixed with their different mixture ratios. After being sieved on a vibration sieve for 15 min, the milled powder between the screen of 80 mesh and 120 mesh was collected. All analyses were performed three times. Ultimate and proximate analyses of the samples are shown in Table 1.The experiments were performed from ambient temperature up to the maximum temperature of 1173 K at the constant heating rate of 20 K/min. The sweeping gas was 70ml/min nitrogen (99.999%).

Table 1. Analysis data of corn stalk and cotton stalk

	Proximate analysis				Chemical composition analysis			Ultimate analysis			
	M	V	A	FC	Cellulose	Hemicellulose	Lignin	N	C	H	S
MG	8.37	62.9	13.6	21.9	42.0	24.0	15.0	1.09	41.8	5.7	0.11
YM	8.31	80.9	11.99	13	41.7	27.2	20.3	0.69	43.0	5.9	0.06

3. Results and discussion

3.1 Experimental results

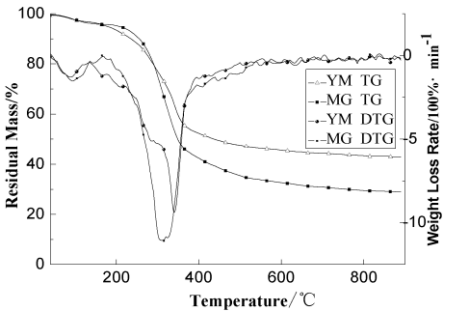

Fig 1. TG-DTG curves of cotton stalk and corn straw

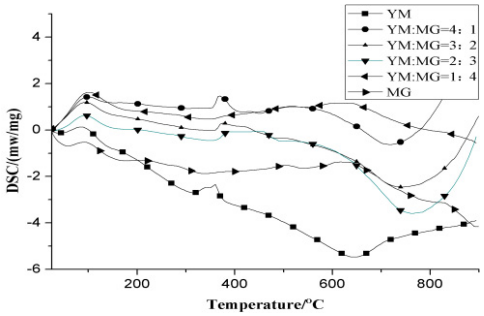

Fig 2. DSC curves of blends under different proportion

Fig 1 shows TG and DTG curves drawn using recorded experimental data of corn straw, cotton stalk. Comparison of TG and DTG curve shows that the whole process can be divided into the well-known four stages: Drying of biomass, Heating of biomass, Degradation of biomass, Heating and aggregation of char.

Table 2. Characteristic parameters of pyrolysis of blends under different proportion

Samples	$(dx/dt)_{max}$	T_{max}	Ts	M
MG	11.2	307	260	28.80%
20%MG+80%YM	10.6	332	245	29.70%
40%MG+60%YM	11.8	337	250	29.30%
60%MG+40%YM	9.2	340	243	38.10%
80%MG+20%YM	11.4	338	237	30.90%
YM	9.3	341	232	43.50%

$(dx/dt)_{max}$（wt.%/°C）:The maximum weight loss rate , T_{max} (°C) Corresponding temperature of the maximum weight loss rate, Ts(°C) Initial pyrolysis temperature , M(100%): Residual mass.

From Fig 1 and Table 2, great differences are found among the pyrolysis behaviors of the samples. Corn straw starts its decomposition easily, with the weight loss mainly happen at 220-315°C. It gets the maximum mass loss rate 9.3% at 307°C, and there is still 55.6% solid residue left even at 900°C. Cotton stalk pyrolysis is focused at a higher temperature range with the maximum weight loss rate 11.2% at