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ScienceDirect

Energy Procedia 66 (2015) 197 – 200

Energy Procedia

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

ANAEROBIC PYROLYSIS CHARACTERISTICS OF MUNICIPAL SOLID WASTE UNDER HIGH TEMPERATURE HEAT SOURCE

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Abstract

This study proposed a new pyrolysis technique for municipal solid waste under anaerobic environment with regenerative radiant tube as the high-temperature heat source within a rotating bed reactor. To obtain the optimum condition of this technique, the effect of heating source temperature, arrangement and bed thickness on the distribution, composition and yield of products was experimentally studied. A three-dimensional transient mathematical model was established to describe the pyrolysis process characterized with simultaneous fluid flow, heat and mass transfer in a rotating bed reactor. The simulation model parameters were also modified based on experimental data. Results showed that this new technique has commercial viability due to the possibility to effectively avoid the problem of tar congestion and obtain high caloricity clean gas.

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

Keywords: Municipal solid waste; Pyrolysis; Regenerative radiant tube; Rotating bed reactor; Clean gas

1. Introduction

The problem of solid waste disposal is growing throughout the world, as a result of industrialization and population growth [1]. At present, the total amount of municipal solid waste in China reached 1.5 billion tons, increasing at a rate of 5.0%/yr [2]. Land filling had been by far the dominant approach for municipal solid waste treatment. However, two-thirds of cities in China are surrounded by garbage and many landfills are near the end of their design life [3]. Compared with the conventional land filling of municipal solid waste, incineration is almost always used for power generation or heating systems. However, incineration still can't get rid of the problem of dioxin pollution [4]. Pyrolysis is the thermal degradation of organic material in an oxygen deficient atmosphere producing gas, liquid and solid products. Pyrolysis can avoid the problem of dioxin pollution from the principle and is an effective way to realize harmlessness, reduction and resource utilization with high energy conversion efficiency [5]. It has great significance to accelerate China's energy-saving emission reduction.

2. Heat-Carrier-Free Rotary Hearth Furnace Pyrolysis Technology

Peer-review under responsibility of the Engineering Department, Lancaster University
doi:10.1016/j.egypro.2015.02.019

Shenwu's new heat-carrier-free regenerative rotating bed pyrolysis process is recognized as the first in global. This technology can gasify and liquefy part of municipal solid waste without adding hydrogen and oxygen under normal pressure, yielding with high purity and high calorific value fuel gas and solid carbon. The charger will continuously convey the material from bin to rotating bed. In rotating bed pyrolysis furnace, the roof and wall are fixed, while material will rotate with furnace hearth. The solid carbon generated from material pyrolysis via the heating by regenerative radiant tube combustor will be discharged from discharging port in a sealed way. High temperature solid carbon will be cooled by water spray. The pyrolysis gas generated in furnace will enter into cooling tower via gas pipe. The fixed gas after cooling will be purified and transferred to gas storage tank. The cooled oil water will separate in separation tower, and the oil will be stored in oil tank.

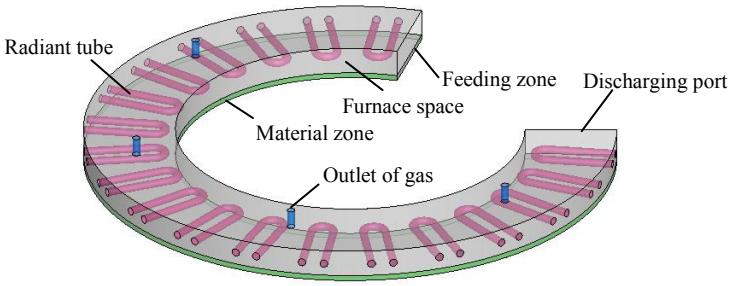

Figure 1. Physical model of heat- carrier- free regenerative rotating bed

3. Experiment

3.1 Materials

Beijing municipal solid waste was taken as raw material. The component analysis of municipal solid waste was shown in Table 1. The industrial and element analysis of municipal solid waste were shown in Table 2.

Table 1. Composition of Beijing municipal solid waste

Composition	kitchen	Fabric	plastic	paper	metal	glass	stone
Volume ratio /%	27.69	1.01	12.15	39.01	0.51	19.0	0.63

Table 2. Industrial and element analysis of municipal solid waste (air dried)

Industrial analysis (wt%)				Element analysis (wt%)			
Moisture	Ash	Volatile	Fixed carbon	C	H	N	S
3.80	25.14	63.75	7.31	25.10	2.78	1.89	0.26

3.2 Operating conditions

To explore optimum pyrolysis condition of regenerative rotating bed and obtain high calorific value gas, the heating temperature and material thickness was investigated experimentally. The experimental condition was shown in Table 3.

Table 3. Experimental condition

Number	Thickness (mm)	Rotating speed (r/min)	Heating temperature (℃)
1	150	90	750
2	150	150	650
3	150	80	850
4	100	80	750
5	200	150	750

Table 4. Distribution of pyrolysis products

Number	Carbon (wt%)	Liquid (wt%)	Gas (wt%)
1	50.37	2.67	46.96
2	48.93	3.80	47.27
3	48.40	1.90	49.70
4	5 .00	3.10	45.90
5	47.73	5.70	46.57

3.3 Results and discussion