Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 31 (2016) 514 – 519

Procedia Environmental Sciences

The Tenth International Conference on Waste Management and Technology (ICWMT)

Study on heavy metals conversion characteristics during refused derived fuel gasification process

Xianchao Zhou, Wei Liu, Peng Zhang, Wei Wu*

School of Materials and Metallurgy, Northeastern University, Shenyang City 110819, China

Abstract

RDF (Refused Derived Fuel) is recognized as one of the most promising renewable energy due to low heating value fuel of hydrogen-rich synthesis gas can be generated during its gasification process. But the main problem related with the use of RDF gasification processes is the heavy metals conversion. The objective of this study is to investigate the heavy metals conversion characteristics during RDF's pyrolysis and gasification process. Experiments were carried out by a two-stage reactor under a temperate range from 600 °C to 750 °C. The effect of oxygen presenting and catalyst using on heavy metals conversion was studied. The results showed that with the increase of temperature, the heavy metals migrate into tar and liquid products, leading to the decrease of the heavy metals residue in char. The residual of Cd in char are less than Cr, Cu, Pb and Zn. Moreover, the addition of oxygen makes more heavy metals fixed in char. The study also found that the Ni-Ca catalyst supported by γ-Al_2O_3 can absorb the heavy metals effectively, which reduce the amount of the heavy metals emission.

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

*Keywords:*Heavy metal; Refused Derived Fuel; Gasification; Reforming; Catalyst

1. Introduction

With the development of economy, the amount of MSW (Municipal Solid Wastes) has continuously increased in last decades[1]. And these MSW which harms the environment took up too much land. The traditional treatment methods are the sanitary landfill, waste incineration and biological treatment, but all of these methods exists

* Wei WU. Tel.: +86-024-8367-0467; fax: +86-024-8367-0467.
*E-mail address:*wuwei@smm.neu.edu.cn

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.070

different disadvantage[2,3]. Therefore, the treatment of MSW has become a big problem all over the world.

RDF has been recognized as one of the most attractive ways to dispose of MSW[4]. In the recent years, scientists focus on the exploitation of RDF as source of energy, but the main difficulty is how to convert RDF into hydrogen-rich synthesis. Gasification is a popular and high efficient conversion method, and this thermo-chemical method can convert carbon-based materials into hydrogen-rich synthesis gas(H_2; CO; CH_4, et. al)[5-8]. So, RDF is regard as the most promising renewable energy in the future.

However, there are several unsolved problems. The gasification technology of RDF may generate by-product contains organic pollutants, sulfur oxides and nitrogen oxides. The most important problem is heavy metals transfer when conducting pyrolysis or gasification. The heavy metals (Cu; Pb; Cr, et. al) tend to migrate into air, water and soil and bioaccumulate in ecosystem, which can pose serious threats to the environment[9]. Therefore, it is necessary to figure out the conversion characteristics of heavy metals during gasification.

The objective of this study is to investigate the heavy metals conversion characteristics during pyrolysis and gasification process at high temperature. The pyrolysis, gasification and gasification-reforming experiments were carried out by adjusting operating parameters: temperature, ER and catalyst.

2. Experimental Method

2.1. Raw material

The RDF was used as raw material and premade by urban garbage. The RDF production process is showed in Fig.1.The MSW undergoes a series of treatments. First, the metal and inorganic non-combustible materials are removed. Second, the organic components are shredded by multifunctional disintegrator and mix with CaO. Finally, RDF is manufactured by extrusion molding machine. The average length of RDF pellet is 15 mm to 20 mm, diameter is 7 mm.

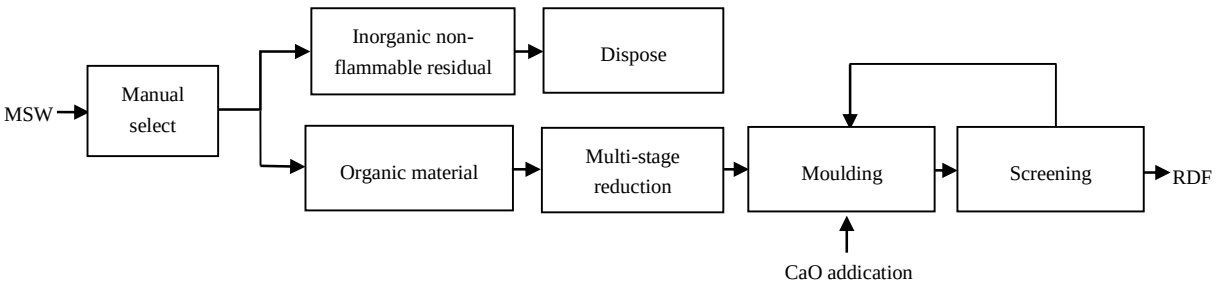

Fig.1 The process flow diagram of RDF

The proximate analysis and ultimate analysis of RDF are showed in Tab.1.The main composition of RDF is 3.16 wt% of inorganic non-flammable material, 61.17 wt% of kitchen, 4.89 wt% of plastic and rubberand13.31wt% of paper. The average moisture content is 54.5wt%, the LHV(Low Heating Value) is 7658MJ/kg. After forming process, the average humidity is 2 wt% and the LHV is 16.7MJ/kg.

Table 1. The proximate analysis and ultimate of RDF.

Ultimate	Amount	Proximate	Amount
Moisture	2.0 wt%	H	6.4 wt% dry
Volatiles	74.7 wt% dry	C	45.4 wt% dry
Fixed carbon	12.9 wt% dry	O	34.4 wt% dry
Ash	12.4 wt% dry	N	1.1 wt% dry
HHV	18.6 MJ/kg	Cl	0.4 wt% dry
LHV	16.7 MJ/kg	S	0.1 wt dry