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Study on pyrolysis and gasification of wood in MSW

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Abstract: In order to develop municipal solid waste(MSW) pyrolysis/gasification and melting technology with low emission and high efficiency, it was planed that all the main components in MSW and some typical kinds of MSW were pyrolyzed/gasified to propose an expert system for raw MSW. In this paper, wood, which was a prevalent component in MSW, was pyrolyzed and gasified in fluidized-bed reactors at different apparent excess air ratios (EARs), temperatures and fluidizing velocities. For pyrolysis, with temperature increasing from 400℃ to 700℃, the yield of pyrolysis char decreased while that of pyrolysis gas increased (in this paper respectively from 28% to 20% and from 10% to 35%), and when temperature was 500℃, the yield of pyrolysis tar reached the highest, up to 38% in this paper. It was the optimum for gasification when temperature was 600℃ and apparent EAR was 0.4. Under the experimental conditions of this paper, gasification efficiency achieved 73%, lower heat value(LHV) reached 5800 kJ/(Nm^3) and yield of syngas was 2.01 Nm^3/kg. Lower fluidizing velocity was useful to upgrade gasification efficiency and LHV of syngas for wood gasification. Based on the results, the reactive courses and mechanism were analyzed respectively for wood pyrolysis and gasification.
Keywords: wood; pyrolysis; gasification; municipal solid waste(MSW)

Introduction

Nowadays, the quantity of municipal solid waste (MSW) has increased evidently, especially in developing countries. For example, in China, the disposed volume of MSW was about 137×10^6 t in 2002 (Complied by National Bureau of Statistics of China, 2003). With the requirement of environment protection, pyrolysis/gasification and melting technology is proposed to be one of the most efficient means to dispose MSW with less pollutant emissions, especially including PCDD/Fs and heavy-metals which are strongly concerned by public.

By far, some technologies have been proposed and industrialized: (1) Siemens/KWU Schwel-Brenn technology: it consists of a rotating pyrolysis drum indirectly heated by recirculation flue gas and a high temperature combustionand melting furnace(Malkow, 2004; Kawai and Taguchi, 2000). (2) Thermoselect process: it consists of a rotating degasification channel indirectly heated by circulation of hot medium and an oxygen-blown gasification and melting furnace (Malkow, 2004; Calaminus and Stahlberg, 1998). (3) Von Roll RCP technology: it consists of an oxygen-blown grate-type gasification chamber, an oxygen-blown combustion and melting furnace and an oxygen-blown CFB burner (Malkow, 2004). (4) Fluidized bed gasification and swirl-flow melting process: it consists of a fluidized-bed gasifier, and a swirl-flow combustionand melting furnace (Malkow, 2004; Suzuki and Takahashi, 2002; Tame and Taniguchi, 2002). (5) MSW direct melting system: it is a rich-oxygen-air blown furnace which consists of three parts, drying zone, reaction zone and combustionand melting zone (Osada *et al.*, 2000; Osada and Osada, 2002). (6) The Korea Institute of Machinery and Materals (KIMM) process: it consists of a stoker furnace used as a pyrolysiser/gasifier and melting furnace modified from glass melting furnace (Kim, 2004). The above pyrolysis/gasification and melting technologies are suitable for the treatment of MSW with high calorific value in developed countries.

In order to develop MSW pyrolysis/gasification and melting technology for changeful MSW in developing countries, it was planed that all the main components in MSW and some typical kinds of MSW were pyrolyzed/gasified to propose an expert system, which could forecast the suitable technology and operating conditions for MSW disposal there. The mass percentage of woody garbage in MSW is about 4%—12%, as showed in Table 1 (Patumsawad and Cliffe, 2002; Plaza *et al.*, 1996; Sukrut *et al.*, 2002; Nakamura *et al.*, 1996; Mastro and Mistretta, 2004). As the predominant ingredient, wood was selected to be pyrolyzed/gasified in fluidized-bed reactors. And the characteristics of pyrolysis and gasification would be analyzed and introduced as one of important parameters into the expert system.

Actually, wood pyrolysis/gasification is involved in many other technologies, like MSW gasification and co-combustion (Larson *et al.*, 1996; Scott and Stanley, 1998; Morris and Waldheim, 1998), wood gasification united with gas turbines or engine (Kim, 2004; Larson *et al.*, 1996; Wu *et al.*, 2002; Bridgwater *et al.*, 2002; Babu, 1995; Chen *et al.*, 2003; Drift *et al.*, 2001), wood gasification by steam/air/CO_2(Lucas *et al.*, 2004; Tsai *et al.*, 2001), biomass IGCC(Babu,

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