



Experimental results of gasification of waste tire with air in a bubbling fluidized bed gasifier

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HIGHLIGHTS

- ▶ Lower ER values result in higher CH₄ concentration and LHV.
- ▶ Four bed materials are tested to verify the change of LHV with ER.
- ▶ Bed temperature significantly changes the LHV.
- ▶ The LHV–ER relation is different for various ER regions.
- ▶ Three correlations are produced to find LHV in the ER range of 0.15–0.60.

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ABSTRACT

Waste tire can be thermochemically disposed to solve environmental problems and to produce energy. Gasification is one of the methods to obtain a product gas with a high calorific value. The product gas is a potential resource for electrical energy production. This paper presents the experimental results of gasification of waste tire in a fluidized bed under air atmosphere. The effects of equivalence ratio (ER), gasification temperature and bed material particle size on the composition of the product gas are investigated. The equivalence ratio is varied in the range of 0.15–0.45. The composition of the product gas is determined with an online gas analyzer which measures CO, CO₂, CH₄, H₂ and O₂ components. The lower heating value (LHV) of the product gas is calculated by using the gas composition measurements. Lower ER values result in lower CO₂ concentrations, higher CH₄ and H₂ concentrations and higher LHVs. This study shows the importance of gasification temperature at low ER values, produces data points for four bed material particle sizes to verify the relation between LHV and ER, and proposes generalized correlations for different ER ranges.

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1. Introduction

Waste tires need to be disposed in order to eliminate significant environmental problems. Waste tire has higher heating value, higher volatile content and lower ash content than coal and biomass. Therefore, scrap tire is a good candidate for a thermal disposal application. Among different thermochemical conversion techniques, gasification process is used to obtain a gaseous product from solid fuel. The gaseous product is called product gas or synthesis gas. The product gas can be used to generate electrical energy by using a fuel cell, gas turbine or gas engine. In addition to the product gas, a solid product is also generated during the gasification of waste tire. The solid product, which is also called char yield, can be used as a carbon source in industrial process and synthesis.

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Many researchers studied various aspects of different methods, such as combustion, pyrolysis and gasification, on the disposal of waste tire. Singh et al. [1] performed experiments in a down fired combustion facility to reburn and co-fire the pulverized tire rubber together with pulverized coal. They found that the reburning of tire reduced NO emission up to 80%. They also found that the co-firing of tire with a lower volatile coal provided greater NO removal than that with a higher volatile coal. Ko et al. [2] performed design and economic analysis of a processing facility to produce activated carbon for two different feedstocks: Waste tire and coal. They found that waste tire was better than coal to produce activated carbon.

Williams et al. [3] pyrolyzed scrap tire in a fixed bed reactor under nitrogen atmosphere. They studied the effects of pyrolysis temperature and heating rate on the compositions and properties of the derived gases, pyrolytic oils and solid char. Lee et al. [4] investigated the effects of different parameters on pyrolysis of waste tire in a fluidized bed reactor. The feed rate of tire did not affect the pyrolysis performance. However, the oxygen concentration,