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Gas-pressurized torrefaction of biomass wastes: Co-gasification of gas-pressurized torrefied biomass with coal

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HIGHLIGHTS

- Co-gasification of GP torrefied biomass and coal was studied in detail.
- Synergistic effect occurred significantly.
- Combustible gas production was promoted.
- The kinetic model of RPM was most fitting for the co-gasification.
- GP torrefied biomass reduced the activation energy of coal gasification.

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ABSTRACT

Co-gasification of coal and biomass offers a relatively cleaner utilization way of fossil fuel. The fuel property improvement of biomass can not only improve the property of syngas but also enhance the synergistic effect during the co-gasification. In our previous work, a novel gas-pressurized (abbreviated as GP) torrefaction was proposed to effectively upgrade the biomass under mild condition. In this work, the co-gasification of GP torrefied biomass and coal were conducted to explore the synergistic effect and kinetics. Significant synergistic effect during the co-gasification was proved. The CO yield of co-gasification increased to as high as 70.70 mol/kg, resulting from the promotion of carbon in coal converting into CO by GPRS. Furthermore, the kinetic model of RPM was most fitting for the co-gasification, and the activation energy of co-gasification was reduced. Thus, the coal gasification was promoted significantly by GP torrefied biomass through obvious synergistic effect during the co-gasification.

1. Introduction

The co-gasification of coal and biomass can not only realize the utilization of renewable energy, but also reduce the emissions of SO_x, NO_x, and other air pollutants (Hu et al., 2017; Zhang et al., 2017). Moreover, it was found that the synergistic effects between biomass and coal occurred during their co-gasification and improved the gasification reactivity and efficiency (Krerkkaiwan et al., 2013; Xu et al., 2014). So, in recent years, more and more attention has been paid to the co-gasification of biomass and coal. The potential mechanism of the synergistic effects was proposed by some researchers. The biomass with a high H/C ratio produces a large number of free radicals (˙H, ˙OH, etc.), H_2, and light hydrocarbons during its thermal decomposition, which can promote the thermal decomposition and gasification of coal during their co-gasification (Hu et al., 2017). Besides, the alkali and alkaline earth metals in biomass, such as Na, K, Ca, and Mg can also catalyze the thermal decomposition and gasification of coal (Wei et al., 2016; Zhang et al., 2016).

The synergistic effect actually occurs at the stage of biomass char and coal char co-gasification, because the temperature and speed of volatile matter (VM) release of biomass is completely inconsistent with those of coal (Vuthaluru, 2004). But the fixed carbon (FC) content of the raw

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