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Experimental studies on charging and electric field characteristics of biomass/coal co-combustion ash

Jianyi Lu [a,*], Bingyi Xu [a], Yihai Lu [a], Xiaochuan Deng [a], Eric Eddings [b]

[a] School of Environmental Science and Engineering, North China Electric Power University, Baoding 071003, China
[b] Department of Chemical Engineering and Institute for Secure and Clean Energy, University of Utah, Salt Lake City 84112, USA

HIGHLIGHTS

- The electric field characteristics of co-ash were systematically studied.
- Increased biomass ratio enhances particle-charging characteristics of co-ash.
- Increased biomass ratio results in a more optimal volt-ampere characteristic.
- Biomass ratio has little effect on plate current density distribution.

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ABSTRACT

This paper mainly studied charging and electric field characteristics of different proportions of biomass/-coal co-combustion ashes (co-ash) in a self-designed high-voltage electrostatic field, including an evaluation of charging, volt-ampere and plate current density distribution characteristics of co-ash. In addition, the mechanisms that influenced charging and electric field characteristics were discussed by analyzing the morphology, chemical composition and specific resistance of co-ash. The research results showed that with an increase of biomass ratio in the co-combustion fuel, the charge-mass ratio of co-ash displayed a rising trend to a certain extent, and gradually enhanced particle-charging characteristics. The co-ash in an electric field manifested a property of being easier to charge, so a more optimal volt-ampere characteristic was obtained. Simultaneously, the results also indicated that the plate current density distribution of co-ash showed limited change with an increase of biomass ratio in co-combustion.

1. Introduction

Coal is an important energy source, one which promotes rapid economic development, but the environmental pollution problems caused by coal burning are more and more of widespread concern. At the present time, China is faced with the dual challenge of energy shortage and environmental pollution. Optimizing its energy portfolio by fortifying the renewable energy portion is a significant objective of China's energy development, one attractive approach to take advantage of biomass to partly offset of the utilization of coal in energy production [1–3]. Biomass fuel has broad potential for utilization, as it is a green, renewable and abundant energy resource. Currently, purely biomass-combustion-based power generation has seen broad application in many countries of the world; however, many problems have been observed such as serious fouling, slagging and corrosion in these biomass power plants, such that many power plants have chosen to implement biomass/coal co-combustion technology in existing units as a means for reducing the severity of these problems. In addition, due to the advantage of reducing coal utilization and thus environmental pollution, biomass/coal co-combustion technology has become an important topic in the field of biomass energy research and development.

In recent years, many scholars have extensively studied biomass/coal co-combustion technology. Naiema [4] experimentally studied wood chips and oats with coal co-combustion in a circulating fluidized bed boiler, and experimental results indicated that the addition of biomass played an important role in the reduction of particulate matter, PAH and greenhouse gas CO_2 emissions. Sung et al. [5] studied NO_x emissions from biomass/coal co-combustion, and it was found that biomass/coal co-combustion can have an important influence on NO_x emission reduction. Lu et al. [6] studied the physicochemical properties and slagging

* Corresponding author.
E-mail address: lujianyi@tsinghua.org.cn (J. Lu).

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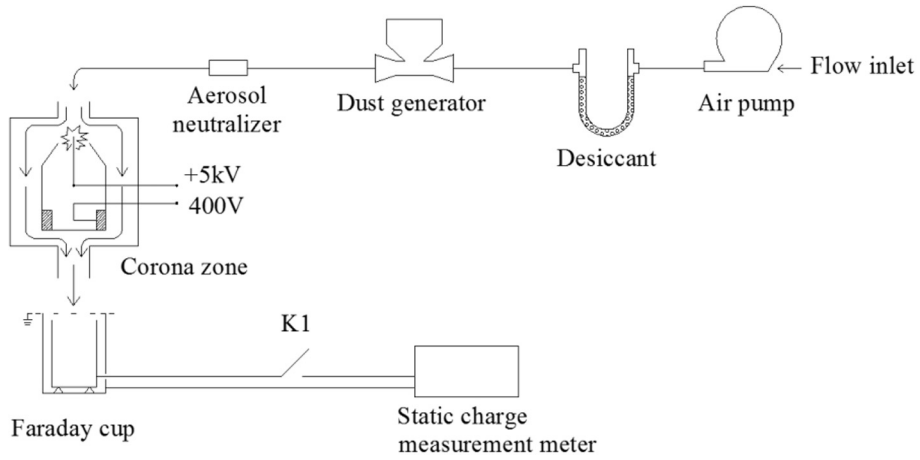

Fig. 1. Schematic diagram of total charge-mass ratio of ash measurement system.

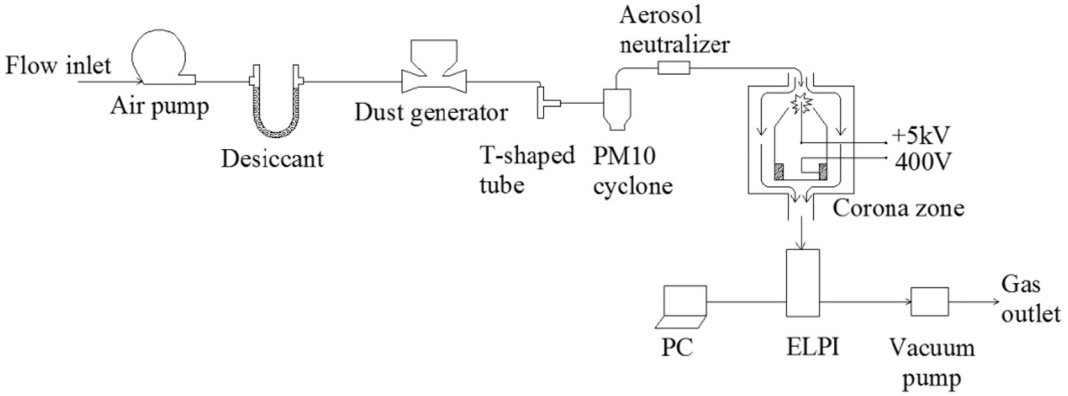

Fig. 2. Schematic diagram classified charge-mass ratio of co-ash measurement system.

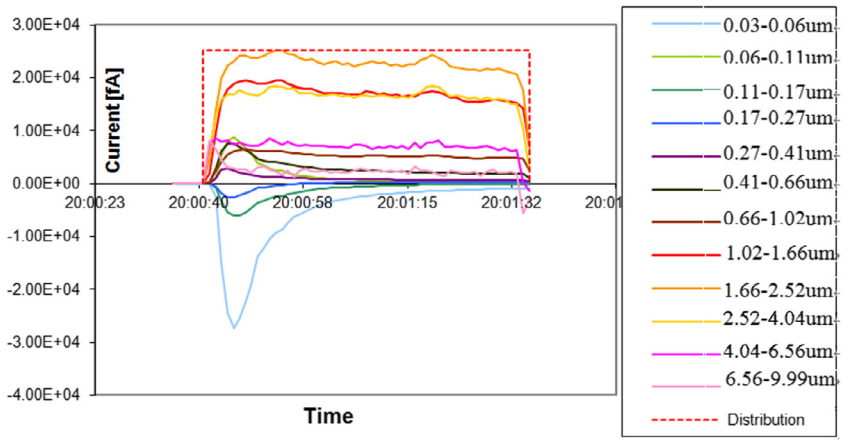

Fig. 3. ELPI registrogram of biomass/coal co-ash charge characterization.

characteristics of co-ash, and experimental results showed that the biomass ash exhibited a slagging tendency, with increases in biomass/coal co-combustion ratio leading to an increasing slagging trend. Their studies indicated that both the acidic oxides and alkaline oxides in the ash would directly affect the melting temperature. Niu et al. [7] studied the slagging characteristics of biomass combustion in power plant boilers, and their experimental results showed that all biomass ash from their fuels exhibited slagging characteristics, and the more alkaline metals led to a greater degree of corrosion on the boiler walls, since it would penetrate the protective film on metal surfaces to accelerate corrosion.

But so far, the charging and electric field characteristics of biomass/coal co-ash in electrostatic fields have been rarely studied. Due to some differences in physical-chemical properties and com-