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Advancing grate-firing for greater environmental impacts and efficiency for decentralized biomass/wastes combustion

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Abstract

Biomass power is an important routine to source more energy needs from renewables and to mitigate global warming. This paper presents an overview of all the key technologies currently used for direct biomass co-firing for combined heat and power production, among which grate-firing is regarded to well suit decentralized biomass and municipal/industrial wastes combustion. This paper discusses with concrete examples how to advance grate-firing for greater efficiency and environmental impacts, e.g., use of advanced secondary air system, flue gas recycling and optimized grate assembly, which are of great interest and relevance for further development of this technology.

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Keywords: Biomass; municipal and industrial wastes; direct co-firing; grate-firing; CFD

1. Introduction

Biomass is the largest renewable energy resource. Among various biomass conversion technologies, biomass power prevails. For example, for bioenergy-based transportation, the two leading technologies (i.e., cellulosic ethanol *vs*. electric vehicle batteries) are compared. Bioelectricity is found to outperform ethanol across a range of feedstocks, conversion technologies and vehicle classes [1]. Compared to the use of other renewable energy sources, biomass co-firing is normally significantly cheaper and can be implemented relatively quickly [2]. For European power generators, the current economic circumstances also greatly favor a change to biomass co-firing: an annual

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growth of 9-10% per year until 2020 has been projected. So far, biomass co-firing has been applied in over 240 plants worldwide. To further boost biomass power, the combustion technologies need to be advanced for greater efficiency, environmental impacts, and flexibility in terms of both the fuel range and operation range.

Abbreviation

BFB	bubbling fluidized bed	PA	primary air
CFB	circulating fluidized bed	PF	pulverized fuel
CFD	computational fluid dynamics	PVC	polyvinyl chloride
CHP	combined heat and power	RDF	refuse-derived fuel
EU	European union	REF	recovered fuel
FBC	fluidized bed combustion	RFG	recycled flue gas
FGD	flue-gas desulfurization	SA	secondary air
MSW	municipal solid waste	SCR	selective catalytic reduction
OFA	over-fire air		

2. Assessment of the three main biomass co-firing technologies

Figure 1, extended from [3], compares the fuel ranges of the three main combustion technologies, i.e., suspension-firing (or PF-firing), fluidized bed combustion (FBC) and grate-firing. Their key features, pros and cons in biomass/waste-firing for combined heat and power (CHP) are summarized in Table 1.

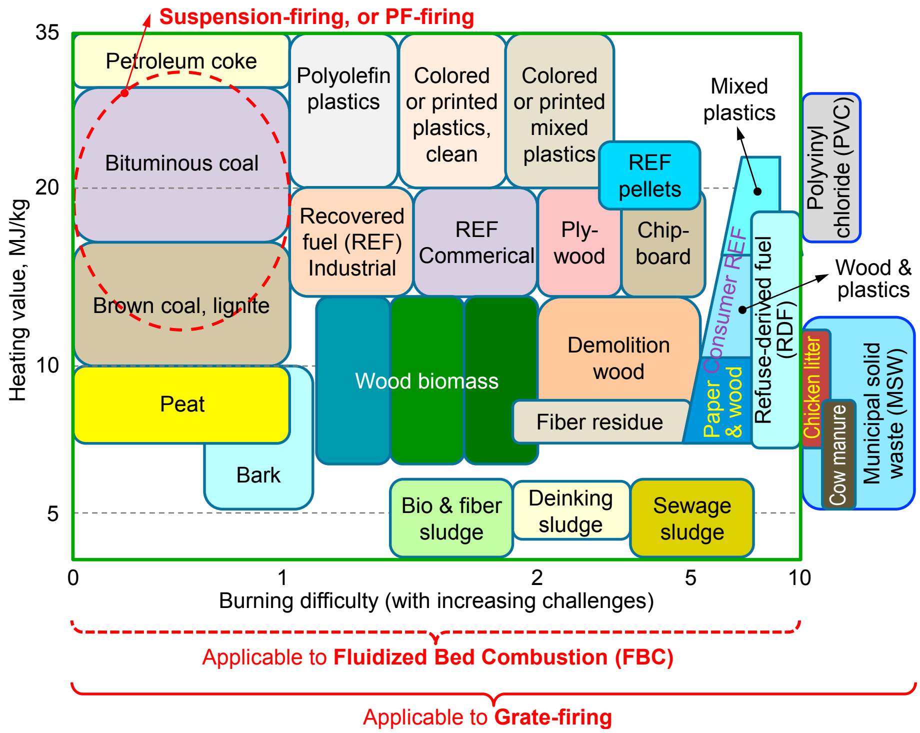

Fig. 1. Fuel range comparison of the three combustion technologies: PF-firing *vs*. FBC *vs*. grate-firing.

An evaluation of biomass co-firing in Europe shows that PF-firing is the most widely used direct co-firing technology, followed by BFB, CFB and grate-firing [2]. PF-firing has witnessed great success in co-firing of woody