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Co-combustion of unburned carbon separated from lignite fly ash

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Abstract

This paper is focused on developing methods of characterization and the technical possibility of co-combustion of unburned carbon separated from lignite. For this aim, sieving technique was developed and a demonstration plant was installed on a 370 MW unit, located at Bełchatów Power Station. Three different size fractions of unburned carbon particles separated from fly ash (B08, B10 and B15), raw lignite (WB) and their blends were analysed.
Studies indicate that it may be expedient to recycle the smallest fraction of unburned carbon (B08) and further co-combust it with lignite, while largest fractions (B10 and B15) may be considered as valuable materials for preparation of briquettes/pellets and/or activated carbon for flue gases purification. Moreover, performed analyses prove that co-combustion of even 40% contribution of unburned carbons will not considerably deteriorate ignition behaviour, flame stability, fuel burnout, NO_X and SO_2 emissions and will not increase slagging and fouling risks.

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Keywords: unburned carbon; co-combustion

1. Introduction

The Bełchatów Power Plant, being a part of the PGE Polska Grupa Energetyczna S.A., is one of the world's largest lignite-fired thermal power stations. It consists of 13 units, including 12 units with nominal capacity of 370-390 MW each and one unit with nominal capacity of 858 MW. After a retrofit in September 2015, the total installed capacity reached 5,420 MW.

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The lignite supplied to the power station comes from the nearby opencast mine, exploring two coalfields i.e. the Bełchatów field and the Szczerców field. From the geological point of view, both fields are similar due to the fact that they are a part of the same coal seam. Petrographic analysis indicates, that the main lithotype texture distinguished is xylo-detric coal, containing up to 36.5% of xylite, including in some cases even to 3.6% of fibrous xylite [1].

The presence of fibrous xylite plays a crucial role in coal crushing and processing, hindering the grinding process due to its flexibility. Furthermore, the reactivity of xylite is lower than for detritic coal, thus it is mainly responsible for the presence of unburned carbon in the ash. The rise of the unburned carbon loss in ash (Loss Of Ignition – LOI)) has a negative impact on power plant performance, decreasing its overall energy efficiency, the effectiveness of dust collection equipment, the purchase cost of coal and hamper possibilities of further fly ash reuse [2,3].

Modernization of plant's units, including, among others the installation of longitudinal afterburning grate, reduced the presence of unburned carbon in bottom ash, while the fly ash issue remains unresolved. The main objective of the work was to design technical method to separate unburned carbon from fly ash and to develop possible methods of its reuse. This paper is focused on the technical possibility of co-combustion of separated unburned carbon with lignite, hence presented material covers characterization of physicochemical properties of unburned carbons and experimental results of its combustion at laboratory-scale research stands.

2. Methods of separation of unburned carbon from fly ash

The main purpose of separating unburned carbon from fly ash is to obtain high quality fly ash for concrete applications. In general, all developed techniques are based on mechanical separation of unburned carbon grains from fly ash, i.e. sieving, gravity separation, electrostatic separation, magnetic separation and froth flotation.

For the purpose of this study, sieving technique was developed and a demonstration plant was installed on a 370 MW unit, located at Bełchatów Power Plant. The fly ash was collected from fly ash hoppers placed under the 2nd pass chamber and rotary air heater (Fig. 1a). Applied technique enables to possess about 0.5 t/h of unburned carbon, divided into three different size fraction streams: below 1.0 mm (hereafter marked as B08), from 1.0 mm to 1.5 mm (B10) and above 1.5 mm (B15).

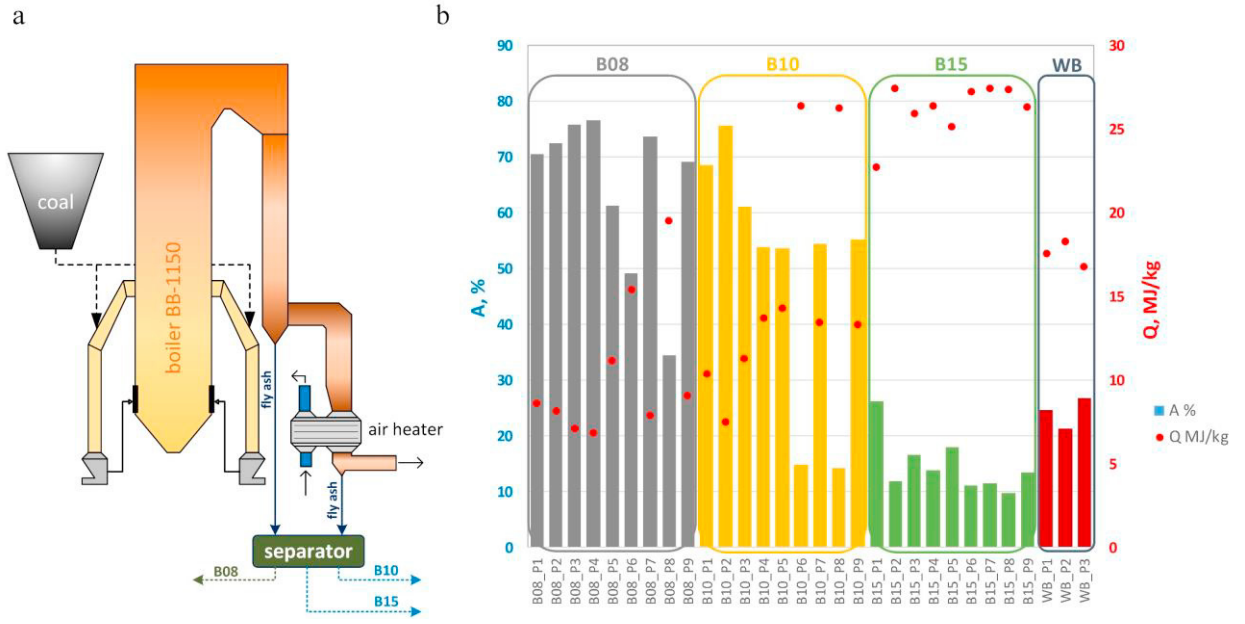

Fig. 1. (a) Demonstration plant for separating unburned carbon from fly ash; (b) Changes of physicochemical properties of investigated samples.