Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 125 (2017) 56–62

Energy Procedia

www.elsevier.com/locate/procedia

European Geosciences Union General Assembly 2017, EGU Division Energy, Resources & Environment, ERE

Metallic Elements Occurrences in The Municipal Waste Incineration Bottom Ash

Piotr Rafał Kowalski[a,]*, Monika Kasina[a], Marek Michalik[a]

[a]*Institute of Geological Sciences, Jagiellonian University, Gronostajowa 3A, 30-387 Kraków, Poland*

Abstract

Bottom ash (BA) samples from a municipal waste incinerator in Poland were collected to investigate metallic components. Numerous metal-rich phases were present in the BA as a part of the incombustible waste fraction, concentrated and modified during thermal treatment. Metallic components in the BA occurred as heterogeneous assemblages of elements with various oxygen content. Fe- and Al-rich occurrences prevailed other types of compositions (e.g. Cu-, Zn- and Ti-rich). Elements in metal-rich phases co-occurred with each other (e.g. Fe occurred with Si, Ca, P, Al and Ti; Al occurred with Fe, Si and Ca; Zn occurred with Ca, Al and Si).

Peer-review under responsibility of the scientific committee of the European Geosciences Union (EGU) General Assembly 2017 – Division Energy, Resources and the Environment (ERE).

Keywords: waste incineration; MSWI bottom ash; metallic fragments; inclusions

1. Introduction

The increasing need for raw materials forces the mining industry to use low grade ores and allows the consideration of materials previously treated as waste, as a resource. In modern waste management, waste incineration residues represent significant volume of materials that need to be managed or landfilled (this is not recommended due to environmental and legislative issues). The main aim of using waste thermal treatment is to reduce its mass and volume with its simultaneous sanitization [1]. Waste thermal treatment allows additionally to recover thermal energy from the incineration. It is used to reduce incineration costs through production of electricity

* Corresponding author. Tel.: +48-663-307-850; fax: +48-12-664-43-05.
E-mail address: p.kowalski@doctoral.uj.edu.pl

1876-6102
Peer-review under responsibility of the scientific committee of the European Geosciences Union (EGU) General Assembly 2017 – Division Energy, Resources and the Environment (ERE).
10.1016/j.egypro.2017.08.060

or using heat in the technological processes or as additional source in a district heating. On average 30% of the waste mass remain in the form of solid post-process residues [2]. The BA is produced in the highest quantity and it is the main reservoir of the metallic elements taking into account its mass and elements absolute content [3].

The global trend in waste management is to recover or reuse as much as possible of valuable waste components to extend their lifetime and to follow the policy of Zero Waste. Selective waste collection and recycling is effective for these used products which are composed of pure metals or when it is easy to separate metallic components from others non-metallic parts. They often need cleaning and other purification steps before further use. Recovering of metals entrapped in the BA looks promising because of their concentration by flammable components removal during incineration. However, after incineration metals might be covered by ash material and/or oxidized, thus making it further processing more difficult. Incineration also significantly reduce the amount of waste which need to be processed for metallic elements recovery [4].

The BA from municipal solid waste incineration (MSWI) is a heterogeneous material composed of ash fraction (formed during the thermal treatment) and residual components barely affected in the furnace. The residual components are mostly composed of fragmented glass and ceramics and fragments of metal products (from few mm up to 3–5 cm in size). The BA chemical and mineral composition is to some extent diversified and mostly related to the composition of the waste in the incinerator operational area but also other factors (e.g. boiler characteristic, incineration temperature, used waste preparation technologies) [5-7]. That makes important the studies on the BA valuable components and their distribution in the material, in terms of their further processing.

The MSWI BA is an easily accessible material which can be used as a resource (e.g. mentioned metallic components) or as a raw material. The concentrations of some elements (e.g. Cu, Zn, Mg) in the BA were reported as comparable to low- and medium-grade ores [8]. By using valorization or extraction techniques it is possible to extend the range of its possible application [9]. The techniques of ferrous metal products separation using simple magnets and non-ferrous metal products using eddy current separators are widely used. To increase efficiency of the separation, techniques of grains size reduction should be applied (e.g. crushing, high voltage fragmentation) [10].

The aim of this study is to investigate metallic components of the BA to determine its usefulness as a resource of the metallic elements. Studies were based on the metallic components description: their chemical composition, sizes, distribution within the BA and characteristic of the metallic elements co-occurrences. The BA was characterized using chemical and mineralogical methods with quantitative determination of the amorphous and crystalline phase.

2. Materials and analytical methods

2.1. Bottom ash samples

To investigate distribution of metallic elements within metallic components in the BA, eight samples were collected in 2015 and 2016 (totally ca. 100 kg, 6–14 kg each sample). Material from municipal waste thermal treatment was obtained in the incineration plant in Poland situated in a big city (over one million of inhabitants), which incinerates 48 000–55 000 tons of waste per year. Three types of solid residues are produced there: the BA (Fig. 1a), the air pollution control residues (APC) and the fly ash (FA). Their ratio (wt%) is 91.5 / 7 / 1.5.

Fig. 1. (a) fresh BA stored on a heap; (b) metallic products separated from the BA using hand picking and magnetic separator.