Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 125 (2017) 34–40

Energy Procedia

www.elsevier.com/locate/procedia

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

Seasonal changes in chemical and mineralogical composition of sewage sludge incineration residues and their potential for metallic elements and valuable components recovery

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

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

Abstract

The incineration products composition is dependent on the incineration technology, operating conditions and also on the waste feed composition, which can change seasonally, depending on the temporal growth of the population due to tourism, micro-industry seasonality, intensity of atmospheric precipitation and other factors. Seasonal variations in potentially valuable elements concentrations in incineration products are visible but their overall content is low, therefore this material should not be considered as a source of valuable elements. Due to high content of phosphorus (7.5 wt%) only the fly ash can be considered as a potential source of this critical raw material.

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: sewage sludge; thermal treatment residues; seasonal changes; mineralogical and chemical composition

1. Introduction

Waste thermal treatment (waste incineration) is one of the accepted, by the EU Commission, ways to restrict the excess waste. The EU Member States have committed themselves to reduce significantly the amount of waste produced and landfilled, as well as, to use their energetic and raw materials potential. Waste incineration leads to

* Corresponding author. Tel.: +48-12 664-43-80; fax: +48-12 664-43-05.
E-mail address: monika.kasina@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.2017.08.049

formation of incineration products such as bottom ash, fly ash, air pollution control residues, exhaust gas with suspended dust and wastewater.

Due to the population growth the amount of sewage sludge produced as a result of wastewater treatment increases. That brings the challenges to its proper management. Municipal wastewater is a mixture of household, small industrial plants, trading and service firms sewage and rainfall water [1] and therefore sewage sludge obtained as a result of wastewater processing can be treated as a sink for different contaminants. Due to the fact that sewage sludge can easily accumulate metals, harmful elements and toxic organic substances [2] its landfilling is not recommended [3]. Nevertheless, in developing countries this way of waste treatment is still active. In Poland, landfilling was significantly reduced (74% in 2010 down to 57% in 2014) however still dominating and the higher amount of sewage sludge is thermally treated (increase from 0.4% in 2010 up to 15% in 2014) [4,5]. Even though the sewage sludge thermal treatment has advantages such as volume reduction or lower disposal costs it is not a complete method [6] (still ca. 3% of the solids remain as thermal treatment residues) it aims to minimize the future landfill, or completely avoid it (zero-waste-policy).

As a result of sewage sludge thermal treatment solid residues such as fly ash (FA) and air pollution control (APC) residue are produced. In addition this process leads to volume and mass reduction that causes concentration of elements. The goal of this study was to characterize FA and APC residue from a sewage sludge incineration plant to describe seasonal variation in chemical composition based on main elements (Si, Al, Fe, Ca, P and C_{tot}) and economically valuable trace elements with a focus on: Zn, Pb, Cu, Ni, Cd and Cr as well as to describe mineral composition of incineration residues and the possibility of metallic elements extraction.

2. Material and Methods

2.1. Fluidized bed incineration

Dewatered sewage sludge was incinerated in the fluidized bed boiler using Pyrofluid™ technology, which is characterized by high turbulence of the fluidized bed at operating temperature in the range of 850-900º C, ensuring complete incineration of organic matter, a longer life time of the boiler and the effective reduction of NOx emission. In addition the heat exchange area within the fluid bed allows to reduce the size of the installation. A thermal utilization station is equipped with a heat exchanger, responsible for pre-cool of flue gases and the production of saturated steam to power the drying node. A detail description of incineration technology is presented in [7,8].

2.2. Fly ash (FA) and air pollution control (APC) residue characterization

FA, classified as non-hazardous waste (waste code: 19 01 14) [9], and APC residue (classified as hazardous waste; waste code: 19 01 07*) [9] were sampled quarterly from winter 2015 until autumn 2016, from one of the Polish sewage sludge incineration plants located in a ca. 1 million inhabitants city in Poland. For each sampling 10 kg of averaged FA, and 5 kg of APC were collected from the silo during chutes to the transporting trolleys.

FA was reddish, fine material, which contained over 30% of fine fraction (0.25-0.63 mm particle size) and low content of water soluble fraction, whereas APC was grey, very fine material which contained over 99% of 0.25-0.63 mm fraction, and the content of water soluble fraction exceeded 95% [8]. After removal of the water soluble fraction in the reaction with deionized water (20 L of water was used to filtrate 1000 g of the material) an additional mass reduction of 98% was noted.

2.3. Methods

In order to determine the content of major and trace elements multi-element chemical analysis using inductively coupled plasma mass spectrometry (ICP-MS) and inductively coupled plasma optical emission spectroscopy (ICP-OES) were performed in the Bureau Veritas Minerals (former AcmeLabs Analytical Laboratories) in Vancouver, Canada. The C_{tot} and S_{tot} content was measured using a LECO combustion analysis and loss on ignition (LOI) was obtained using thermal methods.