Importance of Ageing in MSWI Bottom Ash Utilization.

Bhattarai, Sneha
2019

Importance of Ageing in MSWI Bottom Ash Utilization

Student: MSc. Sneha Bhattarai
Supervisor: doc. Ing. Michael Pohořelý, Ph. D.
Supervising Expert: Ing. Michal Šyc, Ph. D.

Municipal solid waste incineration (MSWI) bottom ash, as a non-combustible by-product from the incineration plants, contains several valuable metals and minerals which can be utilized in metallic as well as construction industries. The recovery and utilization of the metallic and mineral fractions from bottom ash is not only ecological but also economical. Prior to its utilization, bottom ash needs to be stabilized as it is unstable in the atmospheric conditions. MSWI bottom ash is thus subjected to a phenomenon known as ageing/weathering which is a combination of CO_2 uptake from the atmosphere and the chemical reactions following contact with water. Under the influence of several factors such as pH, redox potential, temperature, humidity as well as the presence of atmospheric CO_2, ageing occurs naturally in the incineration residues. Complex processes such as hydrolysis, hydration, oxidation/reduction, carbonation, sorption, dissolution/precipitation, etc. which occur during ageing aids in the reduction of bottom ash reactivity. Moreover, this simple yet effective phenomenon termed ageing helps in overcoming the major hindrance in bottom ash utilization which is heavy metals leachability.

The aim of this abstract is to describe in brief the phenomenon of ageing and to focus on the various changes that occur in the bottom ash matrix during this process, which makes bottom ash utilization beneficial from both ecological as well as economical point of view. Also, the effect of weathering on the trace element mobility has been researched.

The research has shown that slow structural and mineralogical changes occur in the bottom ash matrix as a consequence of aging, which may alter its physical and chemical characteristics. Physical changes like change in temperature, moisture, pore cementation, changes in grain size and pore size distribution might alter the hydrological characteristics of bottom ash whilst, chemical changes such as decrease in pH are likely to affect the leaching of major and trace elements in bottom ash. pH plays a vital role in leaching of heavy

metals which is controlled by solubilities of these secondary minerals. In the pH range of 7–12, due to precipitation/dissolution, solid Cr_2O_3 seems to control the leachability of Cr whereas, in the pH range of 3–7, surface complexation affects the Cr leachability where it was absorbed by hydrous ferric oxide (HFO). Similarly, in case of Cu, at pH 5–7, Cu precipitates mainly as $Cu_2CO_3(OH)_2$ and for pH above 7, Cu precipitates as CuO. Besides pH, temperature, humidity/moisture and pressure also seem to affect the ageing phenomenon.It has been found that humidity of 15% is optimum for bottom ash ageing process to occur. In general, the higher the carbonation temperature, the lower the leaching. Also, the duration for the entire carbonation varies depending on the CO_2 partial pressure.

References

1. T. Sabbas; A. Polettini; R. Pomi; T. Astrup; O. Hjelmar; P. Mostbauer; G. Cappai; G. Magel; S. Salhofer; C. Speiser; S. Heuss-Assbichler; R. Klein; P. Lechner. Management of Municipal Solid Waste Incineration Residues. *Waste Manage. (New York, N.Y.)* **2003,** *23*, 61–88.
2. Jeannet A. Meima; Rob N. J. Comans. Geochemical Modeling of Weathering Reactions in Municipal Solid Waste Incinerator Bottom Ash. *Environ. Sci. Technol.* **1997,** *31*(5), 1269–1276.
3. E. Rendek; G. Ducom; P. Germain. Carbon Dioxide Sequestration in Municipal Solid Waste Incinerator (MSWI) Bottom Ash. *J. Haz. Mat.* **2006,** *128*, 73–79.
4. T. Van Gerven; E. Van Keer; S. Arickx; M. Jaspers; G. Wauters; C. Vandecasteele. Carbonation of MSWI-bottom ash to decrease heavy metal leaching, in view of recycling. *Waste Manage.* **2005,** *25*(3), 291–300.
5. Hua Zhang; Pin-Jing He; Li-Ming Shao; Xin-Jie Li. Leaching behavior of heavy metals from municipal solid waste incineration bottom ash and its geochemical modeling. *J. Mater. Cycles Waste* **2008,** *10*(1), 7–13.