EFFICIENCY OF PROCESSES FOR THE CARBONATION OF MUNICIPAL SOLID WASTES BOTTOM ASH

Kanjo, E.I.[1], Courard, L.[1], Hubert, J.[1]

[1]University of Liege, Urban and Environmental Engineering, Building Materials (Belgium)
Email: Luc.Courard@uliege.be

Abstract

Municipal solid waste incinerated bottom ash (MSWI-BA) is a byproduct from waste incineration process, which is used mainly as replacement of sand and natural aggregates in road foundations and concrete pavements. Usually, MSWI-BA undergoes a maturation treatment before being used by exposing it to the atmosphere for a period of minimum 18 weeks. This study investigates an accelerated carbonation process for MSWI-BA maturation, which aims to enhance both its engineering properties and its environmental sustainability. The results demonstrate significant improvements in shortening treatment duration without compromising physical properties such as density and water absorption while concurrently reducing greenhouse gas emissions through CO_2 sequestration.

The accelerated carbonation was carried out in CO_2 incubator maintaining a volume concentration of 12% CO_2 at atmospheric pressure for 0/20 and 0/2 sieving samples. The temperature and relative humidity inside the incubator were kept at 30±1 °C and 60±3%, respectively.

The experiment was carried using two approaches:

- Approach A: the MSWI-BA was conditioned in a climate chamber at a temperature of 30±1 °C and relative humidity of 60±3% until its weight stabilized (4 days). The moisture content of the samples decreased from 20% to 2% for both BA0-20_A and BA0-2_A before starting the accelerated carbonation.
- Approach B: the carbonation was carried out directly without any type of pre-conditioning (BA0-20_B and BA0-2_B).

Samples were collected after being carbonated for 1, 2, 4, 8, 24, 48 and 168 h where CaCO3 content, CO2 uptake, pH value and moisture content were measured. The Figure shows that the CO_2 uptake of BA0-20 rises proportionally with time, reaching its maximum value at 4 hours for approach A and 8 hours for approach B. Beyond these points, CO_2 uptake stabilizes. Notably, approach B exhibits a more pronounced increase in equivalent CO_2 uptake where it reached almost 14g/kg of MSWI-BA compared to approach A (only 10 g/kg). A similar behavior is observed for BA0-2, where the CO_2 uptake increases with time up to 8 hours for approach B, after which the results remain constant. However, with approach A, the gain in CO_2 uptake was negligible compared to approach B even after 7 days of carbonation.

The results are similar to those obtained by Lin et al (2015a), Lin et al (2015b) and Yoa et al (2022).

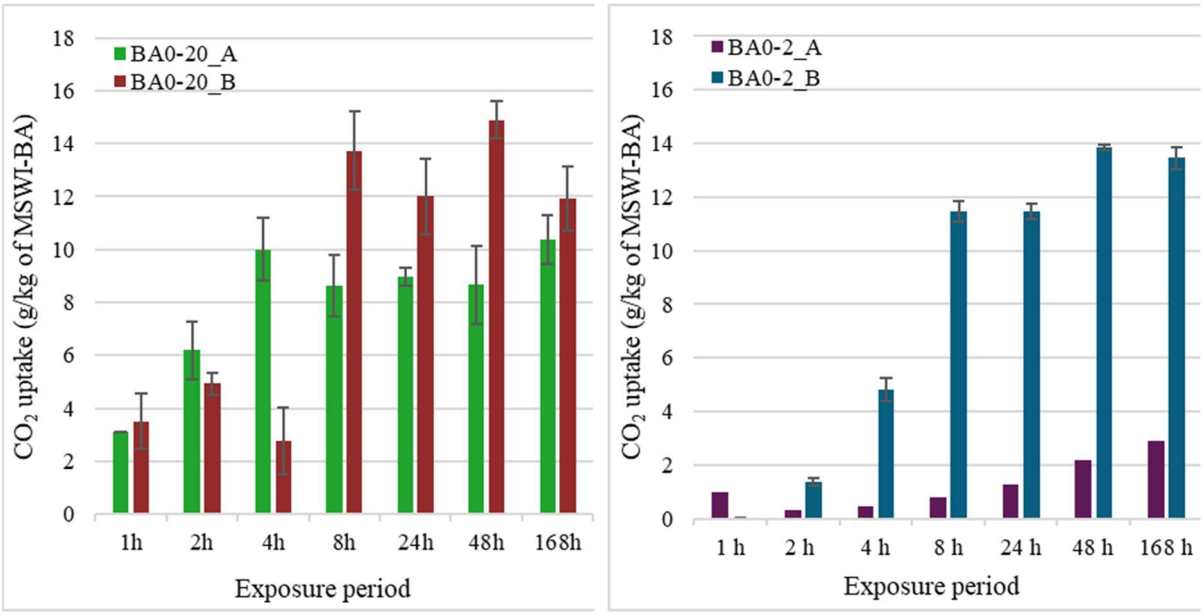

Figure 1 : CO_2 uptake of BA0-20 (left) and BA0-2 (right) after different exposure periods to accelerated carbonation

For both fractions studied, moist carbonation (approach B) was showed to be more effective regarding carbon capture and pH stabilization and more practical since no pre-conditioning was required. Regarding the type of treatment used (accelerated carbonation or traditional maturation) there was no significant improvement in the physical properties of MSWI-BA.
These findings have established that accelerated carbonation could be an effective maturation technique for MSWI-BA, thus offering new insights for its practical implementation in waste management and resource recovery strategies.

Keywords
Carbonation, incinerated municipal solid waste, moisture, duration, CO^2 uptake.

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