NATURAL AND ACCELERATED CARBONATION TREATMENTS FOR MUNICIPAL SOLID WASTE INCINERATION BOTTOM ASHES INERTIZATION (MSWI): A COMPARATIVE STUDY

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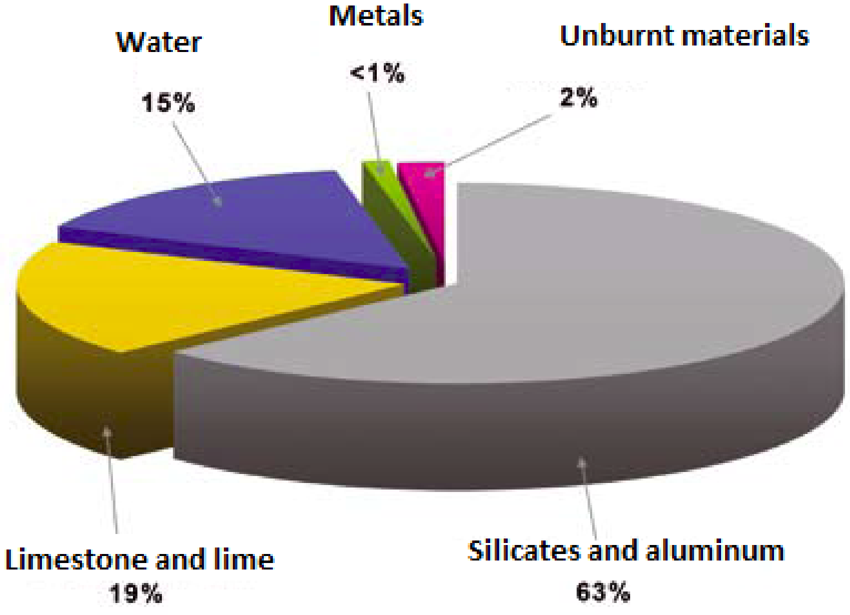
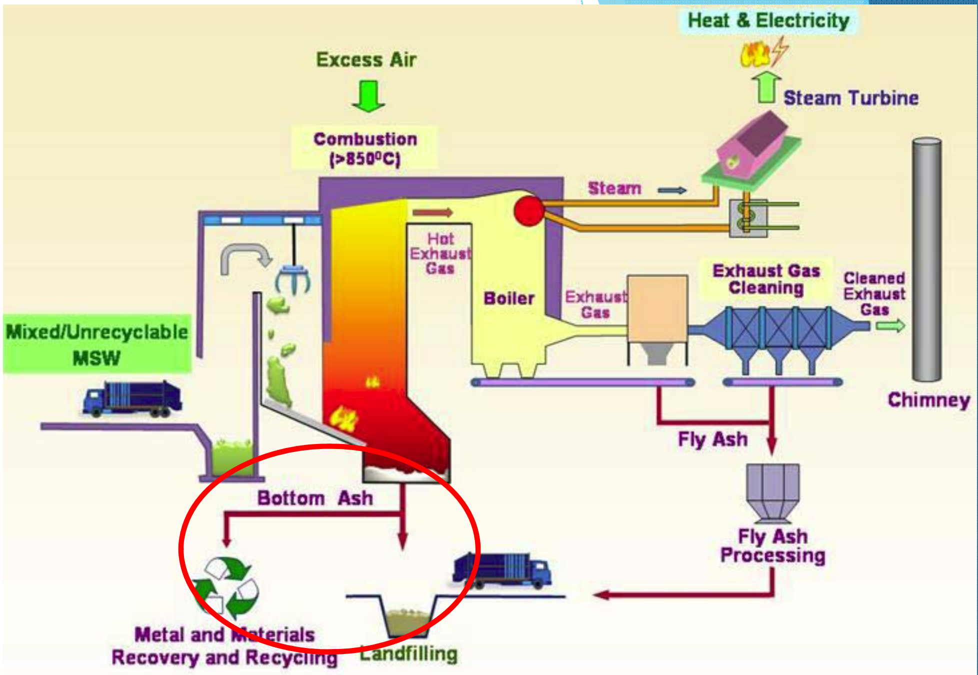
BOTTOM ASHES AVERAGE COMPOSITION IN EUROPE

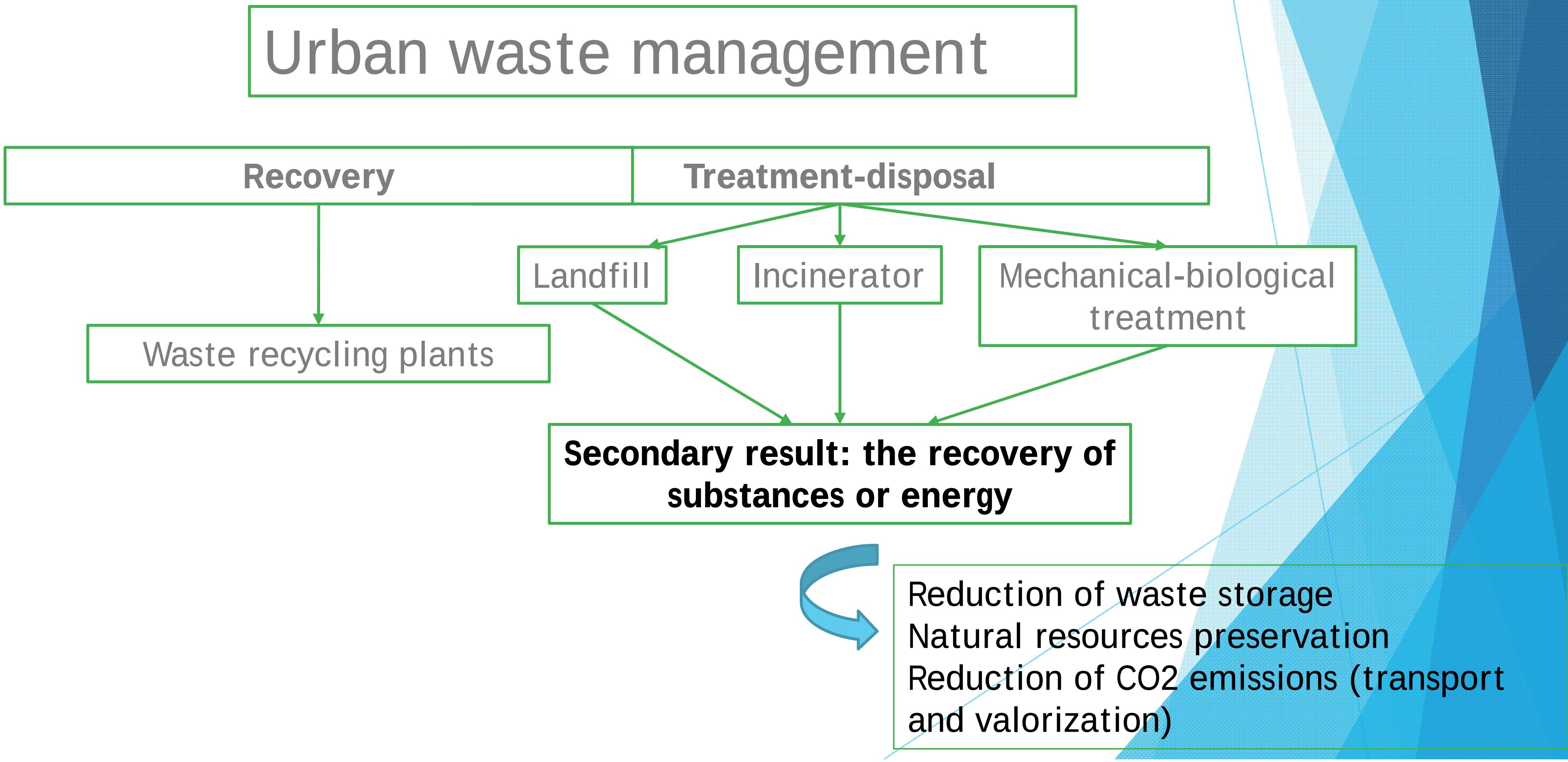
- Mineral fraction: 80-85%
- Metals: 10-12% (steel and non-ferrous metals)
- Non-ferrous metals: 2-5% (of which 2/3 aluminum)





Sétra, 2012

VALORIZATION AND REUSE OF BOTTOM ASHES FROM MUNICIPAL INCINERATORS



BOTTOM ASHES PRODUCTION AND RECYCLING

Europe Yearly production (EU, 2016):
circa 19 million tonnes of bottom ash

Country	Use as a secondary construction material
Austria	No intention to reuse except as landfill structure material
Belgium	Use of granulates in road construction, concrete products
Denmark	Road subbase and embankments, Filler for marine structures (dams, ports), Construction material for parking and small building foundations
France	80% of bottom ash recovered in road construction
Germany	Road subbase construction, recovery on landfills (roads, shaping) or storage in salt mines
Italy	40% Recovery in cement kilns, road construction, landfill construction

From Born & Van Brecht, CEWEP WTE Congress, 2014

BOTTOM ASHES FROM MSWI PLANTS

In this work we have analyzed two situation: plant A and plant B

- Plant A (Italy) sends bottom ashes to specialized factories for treatment

A

- Plant B (France) is older than A but equipped with a system of metal separation and natural carbonation

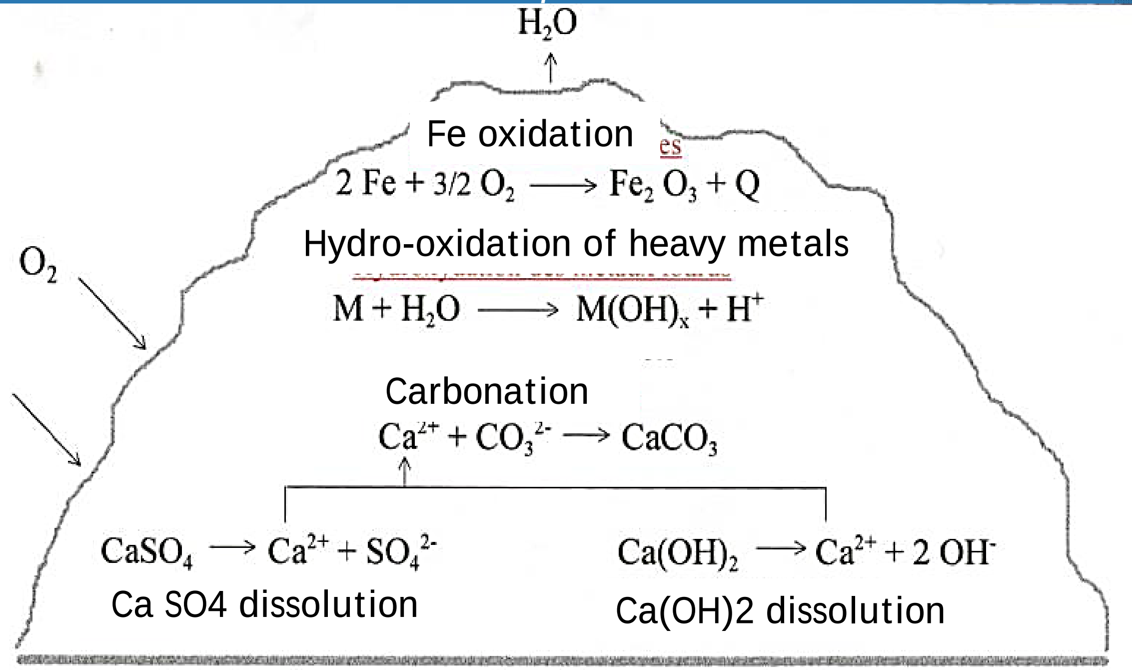
B

NATURAL CARBONATION («MATURATION») 3- 6 MONTHS (PLANT B)

Carbonation with atmospheric CO_2, with stabilization of heavy metals, pH and porosity reduction, humidity loss and oxidation of ferrous metals. Maturation treatment is applicable especially on BA > 1 mm

$$CaO_{(s)} + H_2O \rightarrow Ca(OH)_2$$

$$Ca^{2+} + 2OH^- + CO_{2\ aq} \rightarrow CaCO_3 + H_2O$$



From http://www.afoco.org/journees-techniques.php

PLAN OF THE WORK

BA not treated from plant A and B

Grain size separation in > 1 mm and < 1 mm

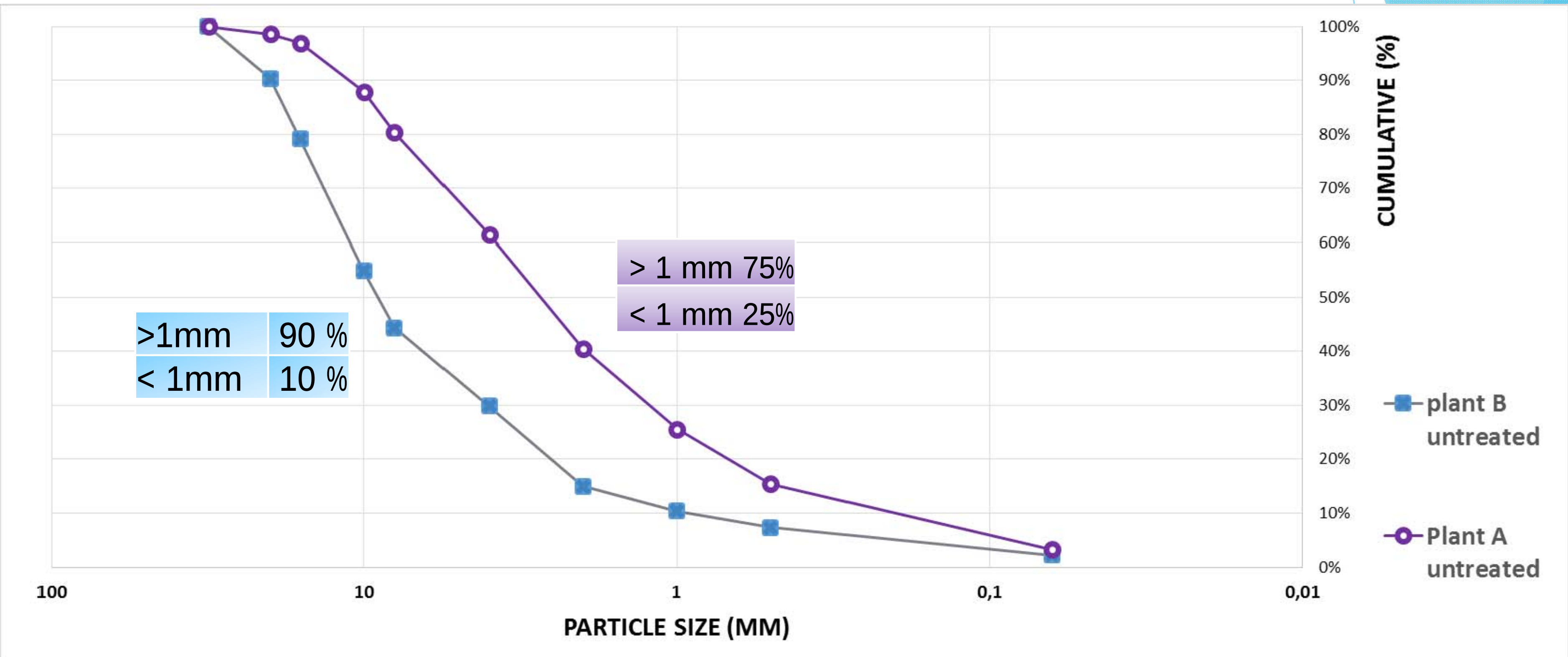
Accelerated carbonation tests

Leaching tests L/S 10:1 for 24 h and water analyses

Comparison between not treated samples vs accelerated carbonation (A-B)

Comparison samples treated by natural carbonation vs. accel. Carbonation (B)

BA GRAIN SIZE DISTRIBUTION



The heavy metals are concentrated mainly in the grain size < 1 mm.

ACCELERATED CARBONATION

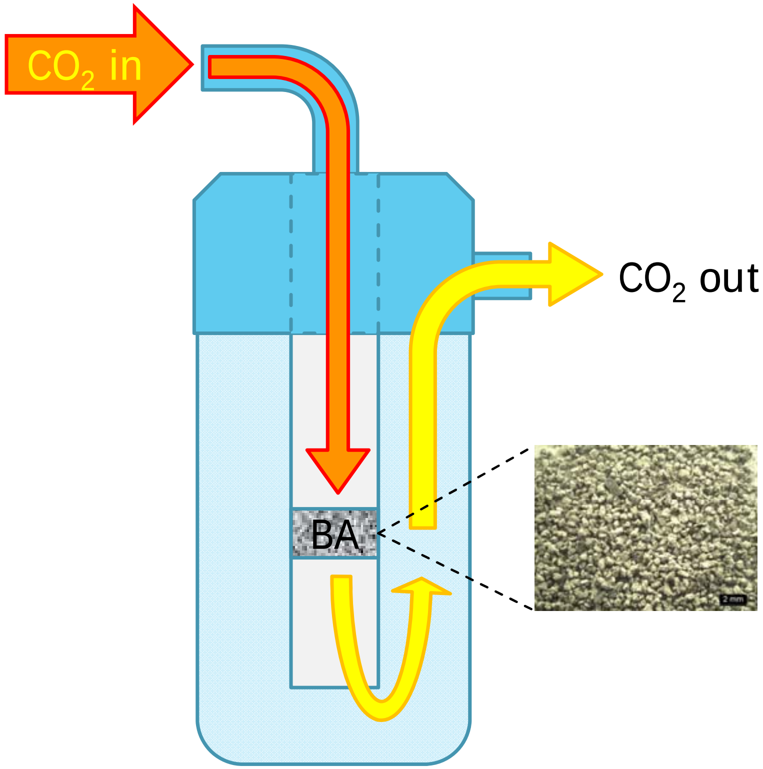
$CaO_{(s)} + H_2O \rightarrow Ca(OH)_2$ $\quad$ $Ca^{2+} + 2OH^{-} + CO_{2\,aq} \rightarrow CaCO_3 + H_2O$

Reduction of porosity and pH, reduces the release of heavy metals

Parameters in

- P CO_2 = 2 bar
- T = 25°C
- χ CO_2 = 100%
- Water content: 0,2 L/S
- Time : 60 minutes

20 g of sample: grain size < 1 mm



CO_2 in - CO_2 out = 3-4 %

Parameters out

- P CO_2 = 1,8 bar
- T = 25°C
- χ CO_2 = 100%
- Water content: 0,2 L/S
- Time : 60 minutes

Wt increase (measured in laboratory) after carbonation: 3-4%

LEACHING TEST LEGISLATIONS FOR BA REUSE: A COMPARISON

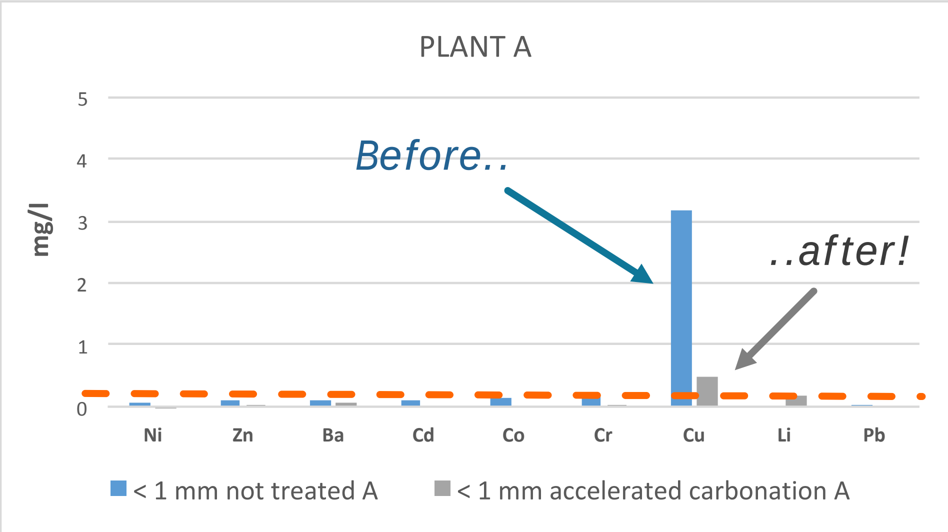
For leaching test L/S 10/1, 24 hours

Elément	Italy (mg/l) L/S 10/1	France (mg/l) U1 L/S 10/1	France U2(mg/l) L/S 10/1	Netherlands (mg/l) L/S 10/1
As	0,05	0,06	0,06	0,09
Cd	0,005	0,005	0,05	0,004
Cr	0,05	0,2	0,1	0,063
Cu	0,05	5	5	0,09
Hg	0,001	0,001	0,001	0,002
Ni	0,01	0,05	0,05	0,04
Pb	0,05	0,16	0,1	0,23
Zn	3	5	5	0,45
F	1,5	6	3	5,5
Ba	1	5,6	2,8	2,2
Mo	N.I.	0,56	0,28	0,1
Sb	N.I.	0,07	0,06	0,032
Se	0,01	0,01	0,01	0,015
Chlorides	100	1000	500	61,6
Sulfates	250	1000	500	173
pH	5,5-12	5,5-13	5,5-13	5,5-13

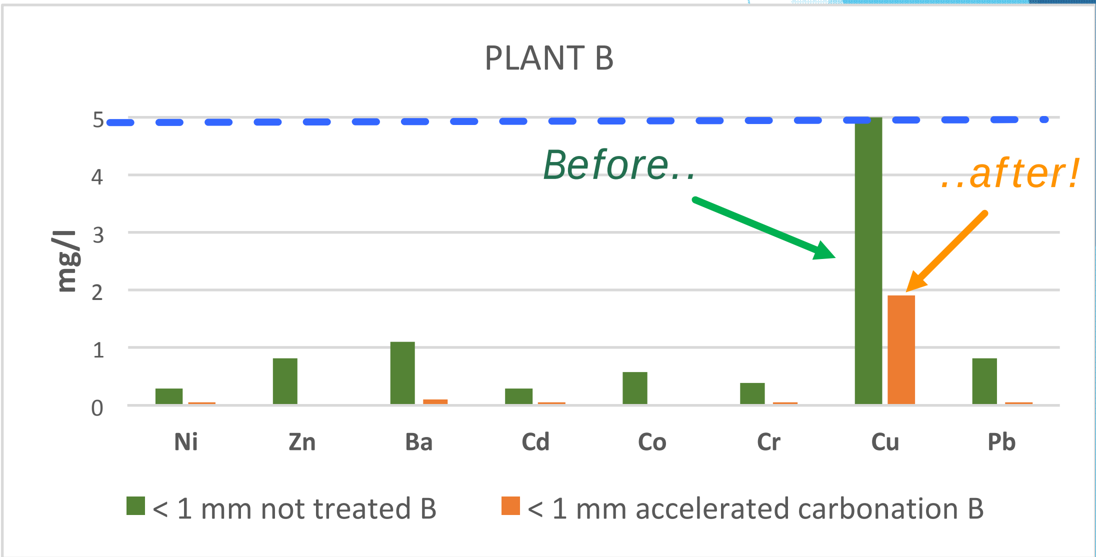
ACCELERATED CARBONATION: COMPARISON BETWEEN PLANT A AND B AFTER RELEASE TEST L/S 10:1

Accelerated carbonation test are carried on samples < 1 mm

Cu threshold value plant A (0,05 mg/l)



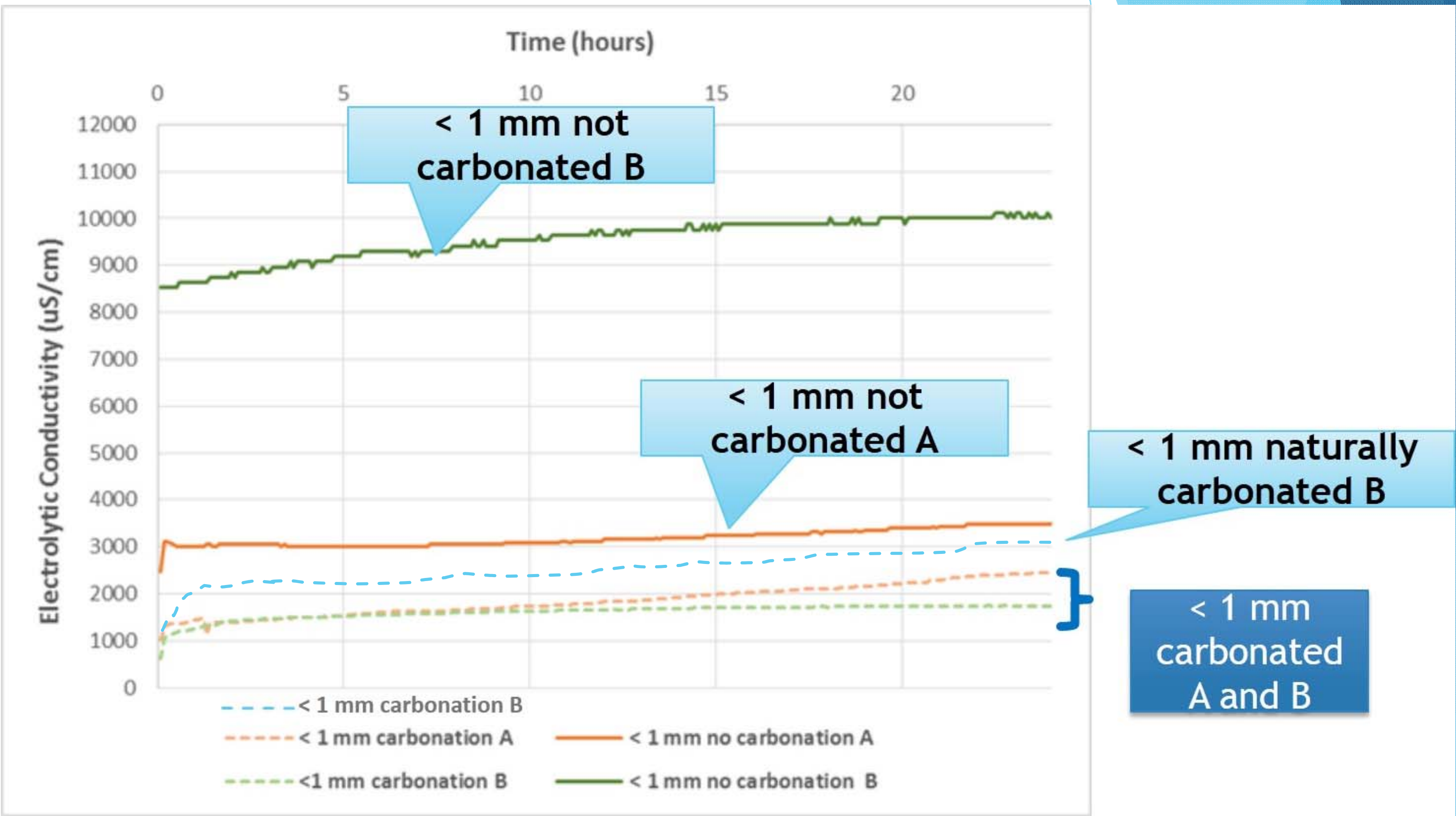
Cu threshold limits plant B (5 mg/l)



All the heavy metals are reduced. Cu is reduced up to <u>70% for plant A</u> and <u>60% for plant B</u>

CONDUCTIVITY MONITORING DURING LEACHING TEST

LEACHING TESTS
(EN 12457)
L/S 10:1, 24 hours

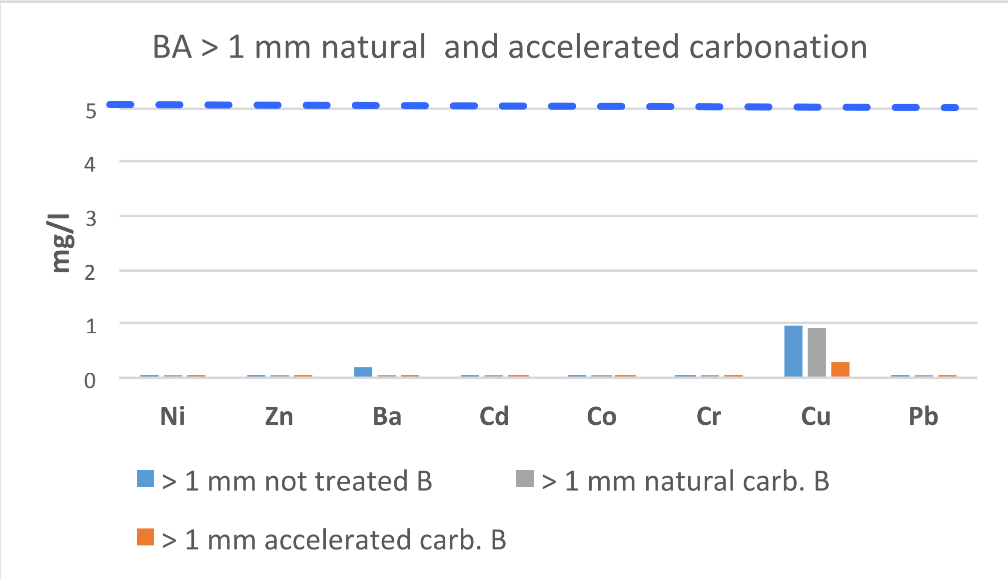


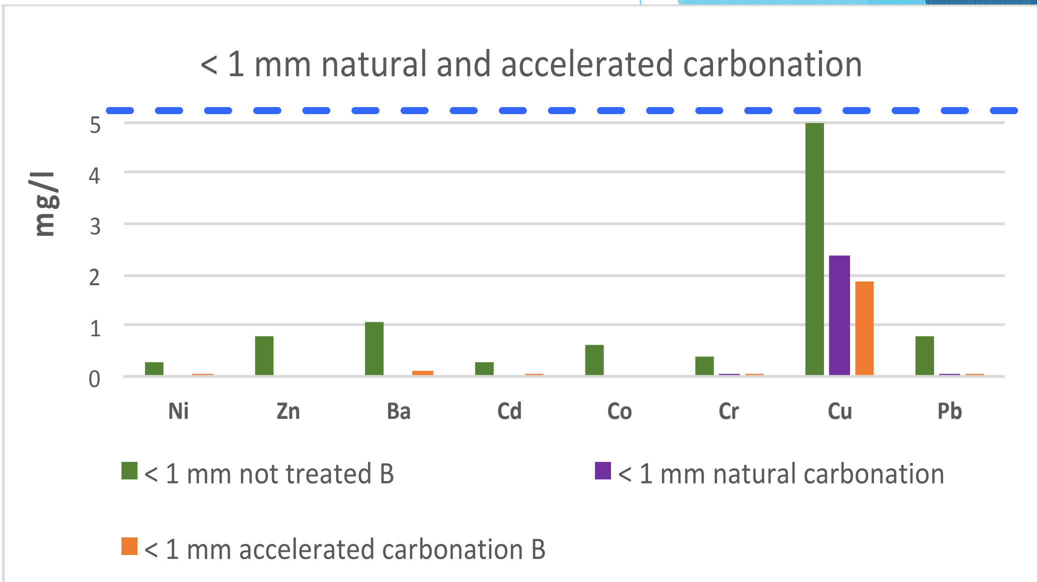
<u>El. Conductivity</u>
linked to chlorides and sulfates

- Chlorides: over 100 mg/l
- Sulfates: 250 mg/l
- <u>pH</u> values decrease from 12 to 8.5

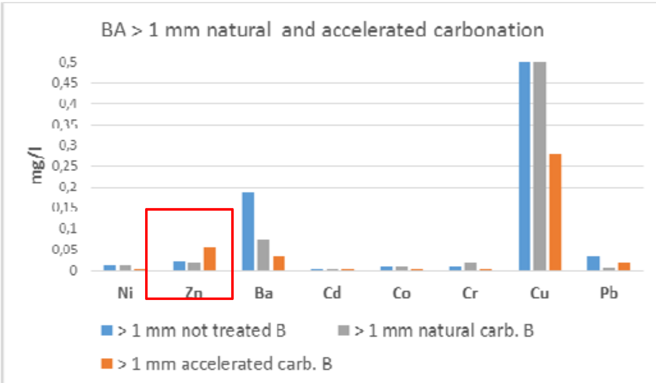
NATURAL CARBONATION VS. ACCELERATED CARBONATION AT PLANT B

- - - - Cu threshold value plant B (5 mg/l)





- Accelerated carbonation is more effective in Cu reduction
- Natural carbonation is more effective carbonation on Zn reduction



- All heavy metals under the legislation limits
- Cu reduced up to 50% by natural carbonation
- Cu reduced 70% by accelerated carbonation
- pH values decrease from 12 to 8-8.5

CONCLUSIONS

Natural and accelerated carbonation are effective for inertization and reuse of BA (End of Waste), especially for the reduction of heavy metals:

- Cu can be reduced up to 70% but often is over the threshold values provided by the legislation for reuse.
- Chlorides and sulfates are also reduced remaining often high.

Natural carbonation requires large spaces for BA storage during the maturation period and long periods. It works better on the >1 mm fractions.

Accelerated carbonation is more effective than natural carbonation on the finer fractions (<1 mm), especially on the reduction of heavy metals. It requires a more complex technology but shorter times than the natural carbonation.

The application of the two techniques can be integrated:

- natural carbonation on grain size > 1 mm (70%)
- accelerated carbonation on grain size < 1 mm (30%).

→ The amount of BA sent to landfill can be reduced.

Thanks for your attention!