



**PÖYRY**

**ROLL PELLETIZING AND ACCELERATED CARBONATION**

International Ash Seminar in Stockholm

January 26, 2012

Linnéa Lövgren, senior consultant, Pöyry, +46 (0)70 377 79 20

## Roll pelletizing

- Patented ash pelletizing technique
- First machine was built in 1999. Mobile. Capacity of 10'000 ton ash /year. Was ran at two paper board mills in Sweden
- Second stationary machine located at a CHP plant in Sweden



---

## Ash properties

Roll pelletizing requires an ash with the following properties:

- Fresh (not yet wetted)
- High content of reactive oxides
- Well combusted with a low content of unburnt organic matter
- No or very little slag/cinders (hard particles will wear the machinery)



## Roll pelletizing and hardening

- Dry ash is mixed with an optimized amount of water during controlled energy input with a forced batch mixer.
- Under good physical and chemical conditions the ash will agglomerate well.
- Agglomerating ash is fed into the roll pelletizer
- Compaction will provide good contact between the ash particles and water



Good mixing!



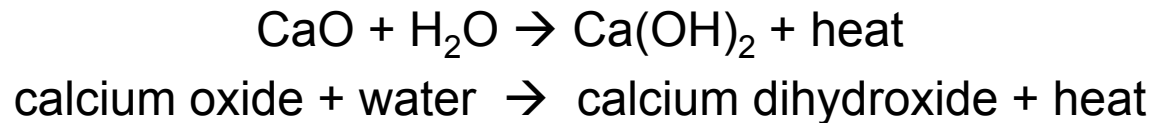
---

## Hardening time

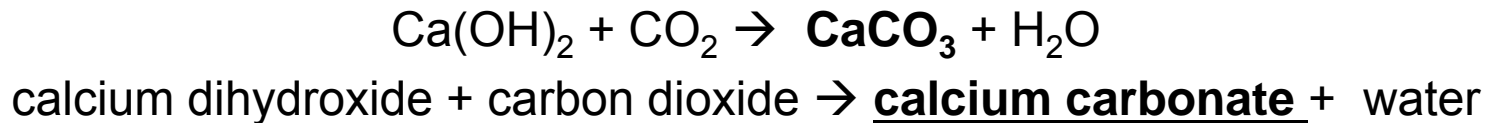
- One year: a normal self-hardening ash
- One month: roll pelletized CFB ash without accelerated carbonation
- 20 minutes: moistened ash with accelerated carbonation [ref. 9]



When fresh dry ash is wetted the following chemical reaction will occur:



Under the influence of carbon dioxide (air or flue gas) the carbonation will occur:



Carbonates are less chemical reactive to soil, soil water, flora and micro fauna than oxides or traces of hydroxides.

---

## The objectives of our study in 2011

1. Can bottom ash from biomass-fired boiler with inclined grate be roll pelletized?
2. Evaluate the impact of CO<sub>2</sub> treatment on carbonation/leaching properties using freshly rolled pelletized ash in laboratory scale
3. Method development for analysis of leaching behavior comparable with forest conditions (a subordinate objective)

---

## Materials and methods

- 10 ash recipes were tried-out in laboratory scale with a hand driven roll pelletizer
- Raw materials were:
  - Bottom ash from inclined grate boiler, wet ash removal
  - ESP fly ash from inclined grate boiler, dry
  - ESP fly ash from CFB boiler
  - ESP fly ash from rebuilt steam power plant with Axon cyclone boiler and plane grate
  - CaO
- CO<sub>2</sub> treatments:
  - A. No CO<sub>2</sub> treatment
  - B. 10 minutes CO<sub>2</sub> treatment at 50 °C humid atmosphere
  - C. 24 hours CO<sub>2</sub> treatment at 50 °C humid atmosphere
  - D. 30 days outdoor-under-roof-treatment

---

## Results

### The grate boiler ashes

It was not possible to agglomerate the ashes from the grate boiler, neither the bottom ash alone, nor in an ash mixture with the grate boiler fly ash, and not with grate boiler fly ash only.

A well burnt CFB ash had to be mixed in with the grate boiler ashes to obtain a hard and good ash pellet.

This one ash recipe was selected for the carbonation tests.



---

## Evaluation of the ash pellet quality

pH and electric conductivity was measured according to recommendations from the Swedish Forest Agency

Ash dose [ton DS/ hectare]	EC limit [mS/m]	Results
Clearcut forest area	2'400	C
2-3	2'800	B
1-2	3'200	
< 1	3'600	A, D

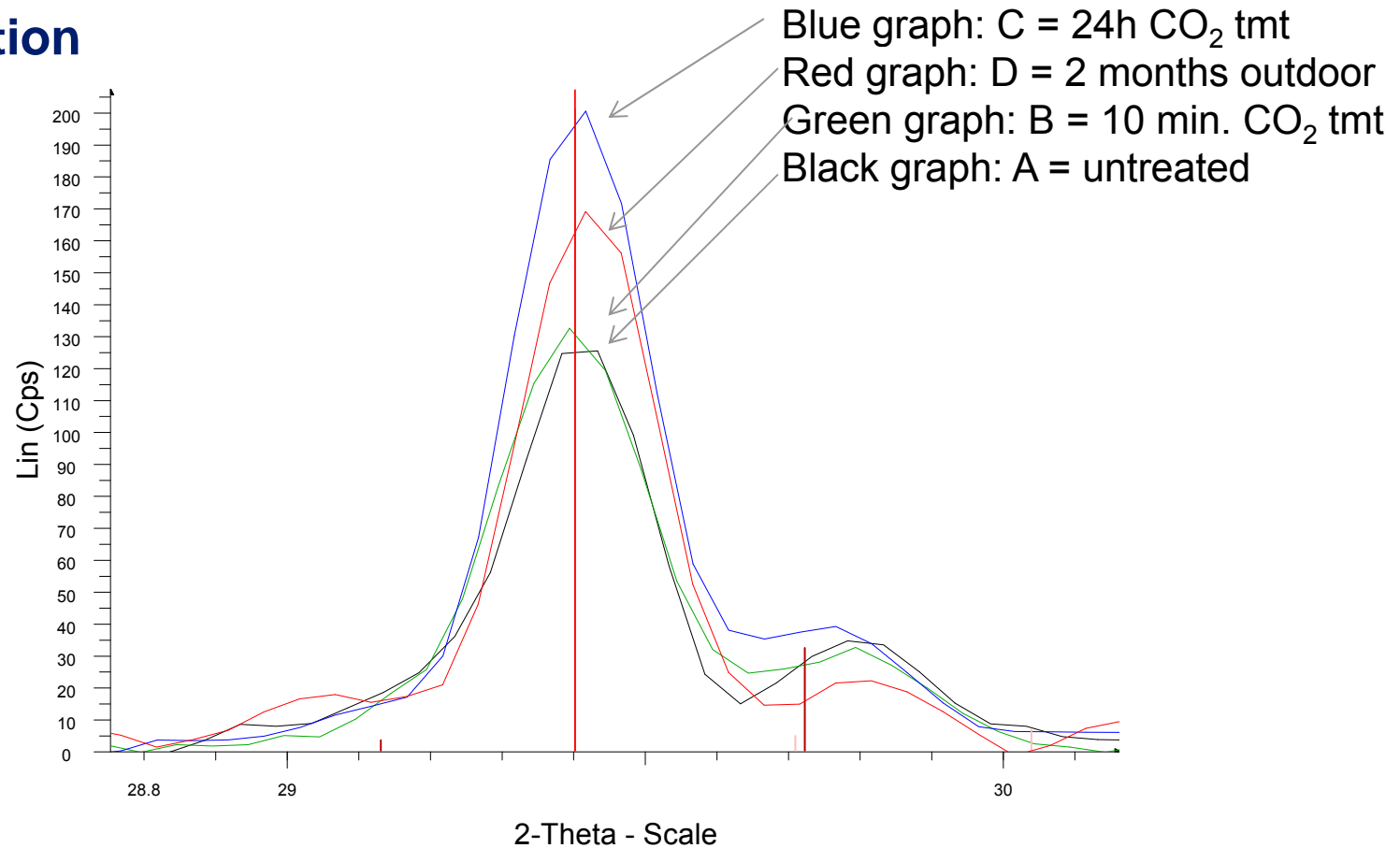
All ash pellets gave a pH of above 12.0 when added to water.

## Evaluation of the ash pellet quality

Content of macro and micro plant nutrients and heavy metals was measured according to recommendations from the Swedish Forest Agency

Element	Unit	Limits	Ash pellet
Calcium Ca	g/kg DS	$\geq 125$	188
Magnesium Mg	g/kg DS	$\geq 15$	20
Potassium K	g/kg DS	$\geq 30$	62
Phosphorous P	g/kg DS	$\geq 7$	15
Boron B	mg/kg DS	$\leq 800$	140
Copper Cu	mg/kg DS	$\leq 400$	180
Zink Zn	mg/kg DS	500-7'000	3'000
Arsenic As	mg/kg DS	$\leq 30$	8
Lead Pb	mg/kg DS	$\leq 300$	120
Cadmium Cd	mg/kg DS	$\leq 30$	25
Chromium Cr	mg/kg DS	$\leq 100$	120
Mercury Hg	mg/kg DS	$\leq 3$	0.4
Nickel Ni	mg/kg DS	$\leq 70$	61
Vanadium V	mg/kg DS	$\leq 70$	32

## Results Carbonation



X-ray powder diffraction (XRD) analysis.

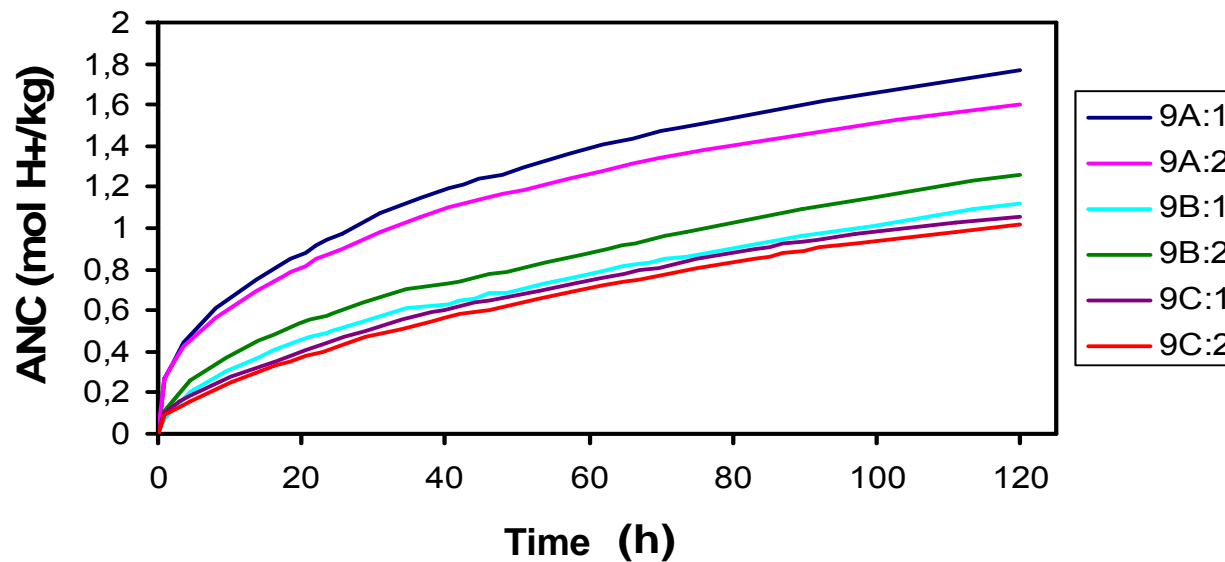
The areas under the graphs show the content of CaCO<sub>3</sub> in the form of the mineral calcite.

## Results

### Acid neutralization capacity, ANC

pH-stat leaching test during 5 days, L/S 100, pH 4

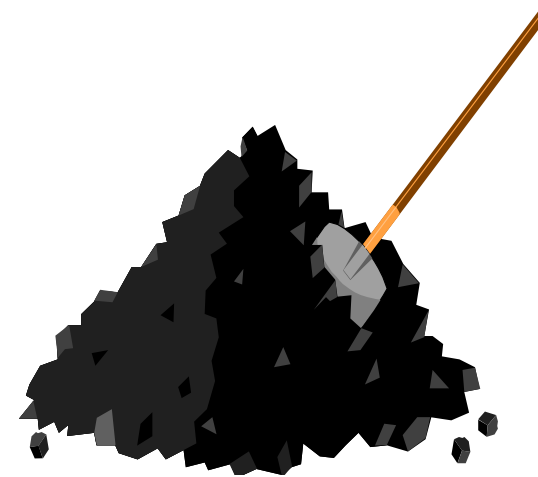
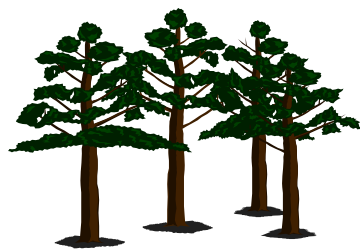
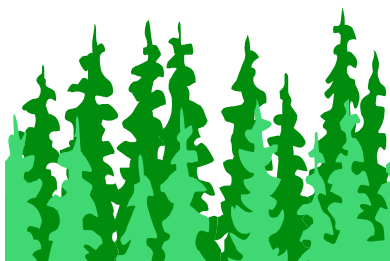
#### ANC vs time (BL000174-182)



Treatment C gave pellets with the slowest leaching – most favorable in the forest.

## Conclusions and next steps

- Carbon dioxide treatment did
  - shorten the hardening time, and
  - give the ash product slower leaching properties.
- Roll pelletizing followed by accelerated carbonation in an immediate production step will
  - make the ash pellet production more effective, with fewer handling steps and fewer manhours
  - reduce need of areas for ash hardening



Thank you for your attention.

