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NextGenBioWaste

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Mechanical activation – for what purpose?

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential , only for members of the consortium (including the Commission Services)	

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Abstract

Mechanical activation is a technology that has been used to enhance the properties of CCP's and primary fly ash not fulfilling the requirements set for utilisation in the cement- and concrete industry. The development in ash management will in a few years time be further pushed by the changeover from fossil to renewable fuels in order to secure a high level of utilisation. Mechanical activation could be one of many up-grading technologies that possibly could path the way to new areas of utilisation.

With support from the EU financed project NextGenBioWaste and a company setting up mechanical activation facilities, the research and development department of Vattenfall is about to evaluate the mechanical activation technology for three purposes:

1. Replacement of cement with activated fly ash from biomass and co-combustion
2. Reactivation of fly ash from biomass combustion that has been stored under moist conditions
3. Activation of ash as a soil stabilization agent

The primary results show that storage under moist conditions result in a decrease of ash hardening properties with 30-60%. By reactivation, the hardening properties can be restored to the same level as before the moistening and storage. These results will be validated since only a few ashes and samples have been studied.

Storage can imply high costs, especially storage under dry conditions in a silo. Additionally, new markets have to be developed for the up-coming co-combustion ashes. Soil stabilisation is considered as a new potential market. Increasing costs for conventional stabilizing agents as cement and limestone stress the need for substitution to alternative materials. Mechanical activation of bio and co-combustion ashes could either decrease the need for limestone and cement or at best both of them. This would also imply a reduction in the emissions of CO_2 since both the production of cement and limestone is very energy intensive industries. The demand for material with a low carbon footprint is only in its infancy.

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1 INTRODUCTION TO PRESENTATION

An oral presentation was held at the EuroCoalAsh Conference in Warsaw (October 2008). The presentation included the background and scope of the project and some preliminary results. For the presentation as a whole see enclosure.

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2 ENCLOSURES – POWER POINT PRESENTATION

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Mechanical activation of ash

EuroCoalAsh Conference, Warsaw, October 2008

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Vattenfall Research & Development AB

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Mechanical activation of ash

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Agenda

1. Introduction – what is mechanical activation?
2. How to make use of the technology?
3. Evaluation of activated ash
    - Activation of ash for cement utilisation
    - Reactivation of ash stored under moist conditions
    - Soil stabilization with activated ash
4. Future outlook

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What is mechanical activation?

- Vibrating ball mill
- Increases the specific surface → increased reactivity
- Ash mixture with cement or alone
- Influence on environment??

1. Support from, NextGenBioWaste
2. Co-operation with mechanical activation companies

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How to make use of the technology?

Construction

- Cement replacement
- Soil stabilisation

Reactivation of ash

- Storage

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Evaluation of activated ash

Laboratory studies

1. Activation of ash for cement utilisation
2. Reactivation of ash stored under moist conditions
3. Soil stabilization with activated ash
    - Technical properties
    - Environmental properties

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Activation of ash for cement utilisation

The evaluated materials were tested as cement replacement.

Materials for evaluation

- Peat and wood fly ash (Swedish)
- Wood fly ash (Swedish)
- Fluidized bed hard coal fly ash (German)

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Activation of ash for cement utilisation

Three different binder mixtures were tested (Standard EN-196):

- 100% Cement
- 50% Cement and 50% unprocessed ash
- 50% Cement and 50% activated ash

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Activation of ash for cement utilisation

Water demand

Type of the ash	Water demand [%]
Hard coal ash	22.5
Activated hard coal ash	18.1
Wood ash	23.0
Activated wood ash	17.3
Peat ash	22.8
Activated peat ash	17.8

Reduced water demand gives same workability at a lower water to binder ratio

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Activation of ash for cement utilisation

Setting time

Type of the ash	Initial setting time [h:min]	Final setting time [h:min]
Hard coal ash	03:12	04:35
Activated hard coal ash	02:35	03:40
Wood ash	03:25	04:45
Activated wood ash	02:38	03:45
Peat ash	03:20	04:12
Activated peat ash	02:20	03:33

The material sets faster → curing time can be reduced

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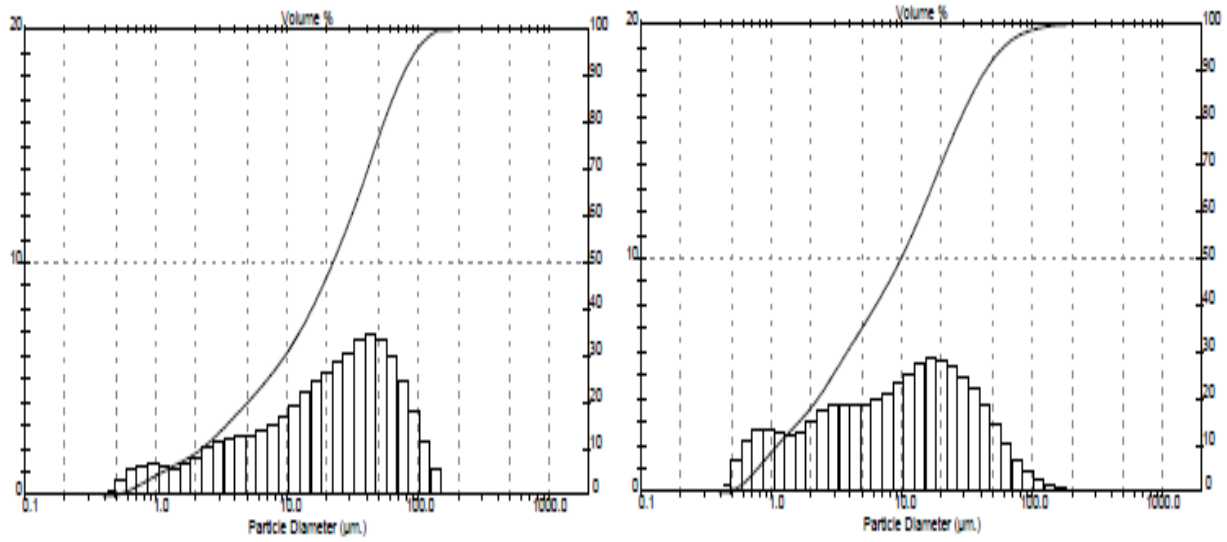
Activation of ash for cement utilisation

Particle size distribution (hard coal CFB ash)



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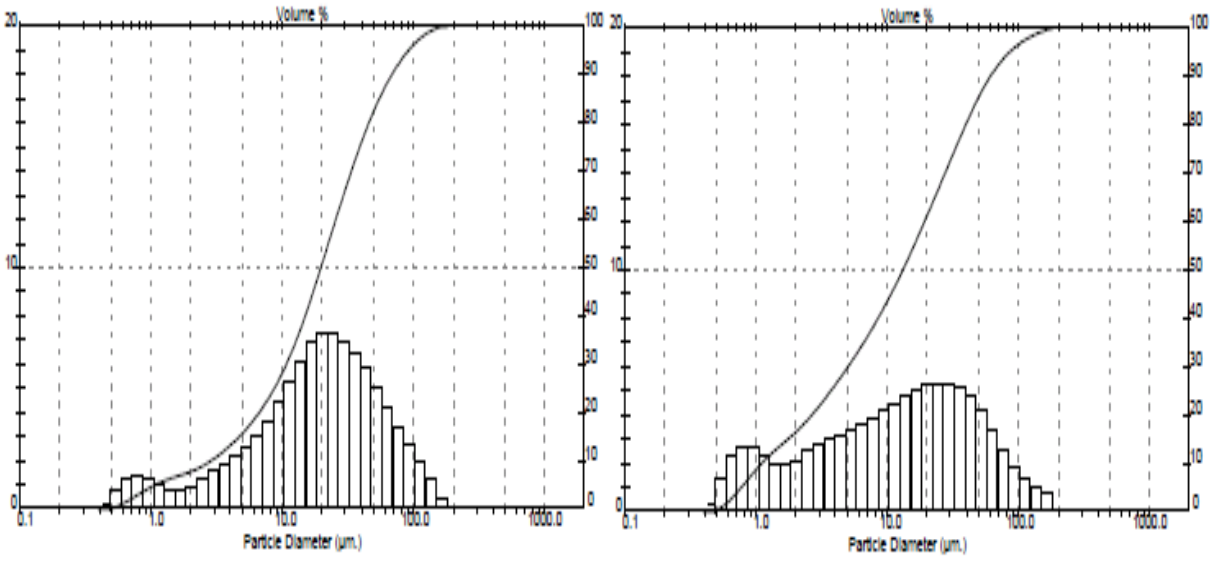
Activation of ash for cement utilisation

Particle size distribution (wood ash)



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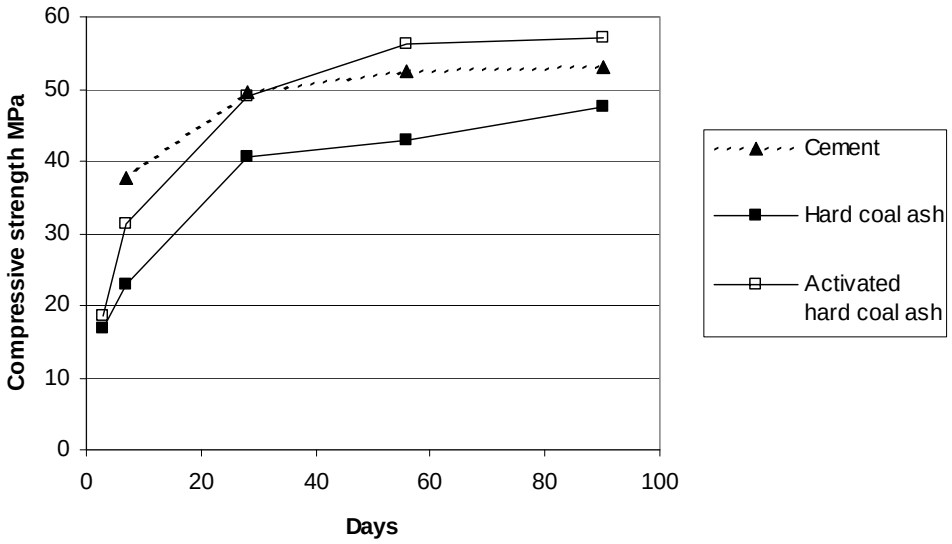
Activation of ash for cement utilisation

Compressive strength (hard coal CFB ash)



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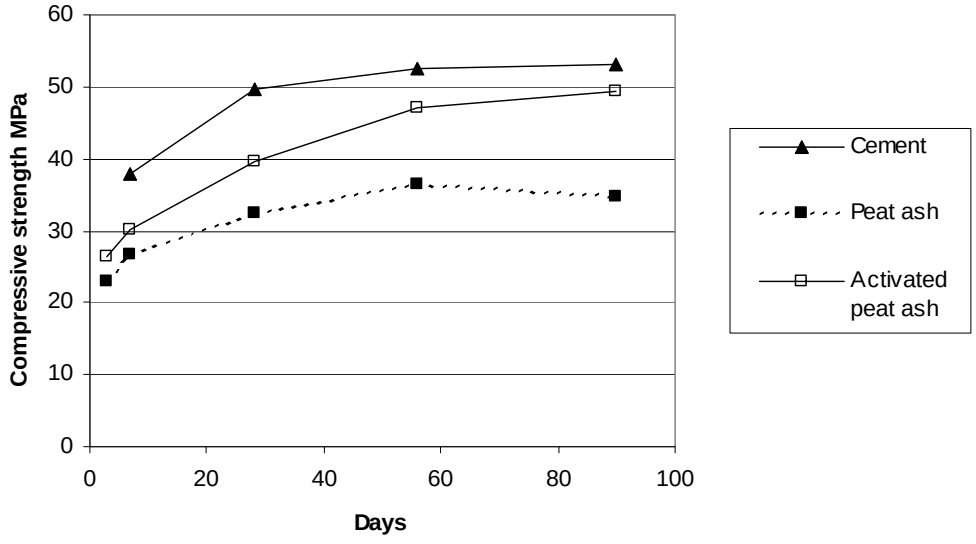
Activation of ash for cement utilisation

Compressive strength (peat ash)



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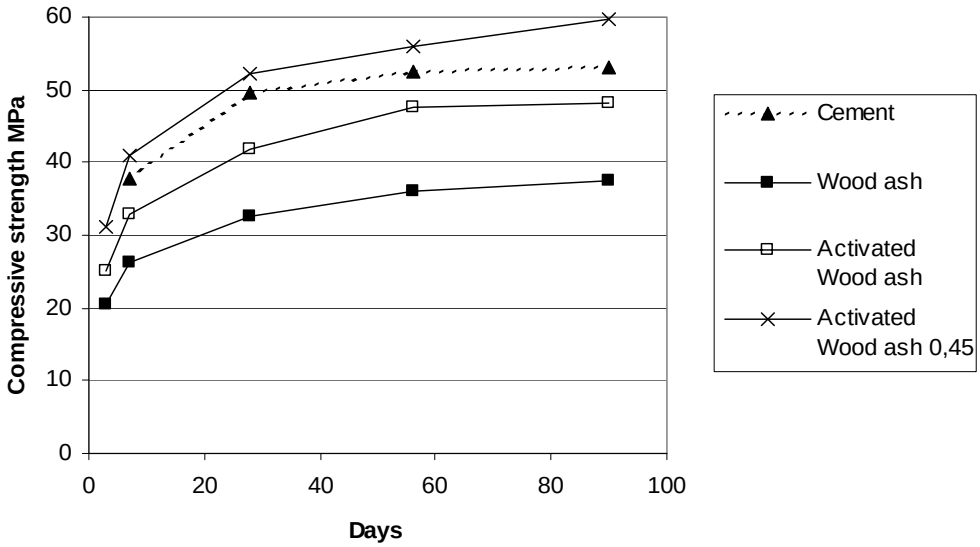
Activation of ash for cement utilisation

Compressive strength (wood ash)



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Activation of ash for cement utilisation

Conclusions

- Cement with 50% replacement of ash get in average 25% increase of strength if the ash is activated
- Coal ash gives strongest cement
- Bio ashes also give good results
- Lower water demand allows a reduced water to binder ratio which gives a stronger and denser cement
- Faster setting time gives shorter curing time before use

→ The efficiency of mechanical activation of bio ash is equivalent to CFB coal ash.

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Reactivation of ash stored under moist conditions

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Reactivation of ash stored under moist conditions

- Ash stored in silo maintains its properties well
- Silo storage is expensive, therefore storage in piles under moist conditions are sometimes necessary
- Moistening of ash during storage is necessary to prevent dusting which is a work environment problem
- Ash stored under moist conditions loose 30-60% of their strength building capacity
- Mechanical activation can be used to reactivate the strength building properties of ash

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Reactivation of ash stored under moist conditions

Dusting from dry ash

Dusting from moist ash

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Reactivation of ash stored under moist conditions

Laboratory experiments

- Ash moistened with water was stored during 28 and 91 days
- Stored ash was mixed with water and packed into test specimens and evaluated using unconfined compression tests
- As reference dry ash was tested identically
- Ash stored under moist conditions for 91 days was mechanically activated and tested identically

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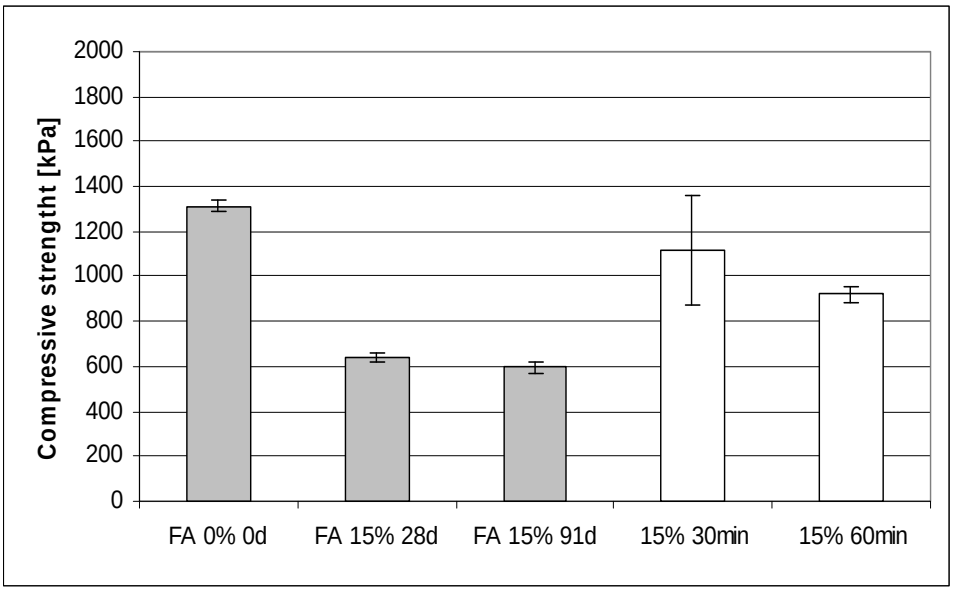
Reactivation of ash stored under moist conditions

Compressive strength (peat ash)



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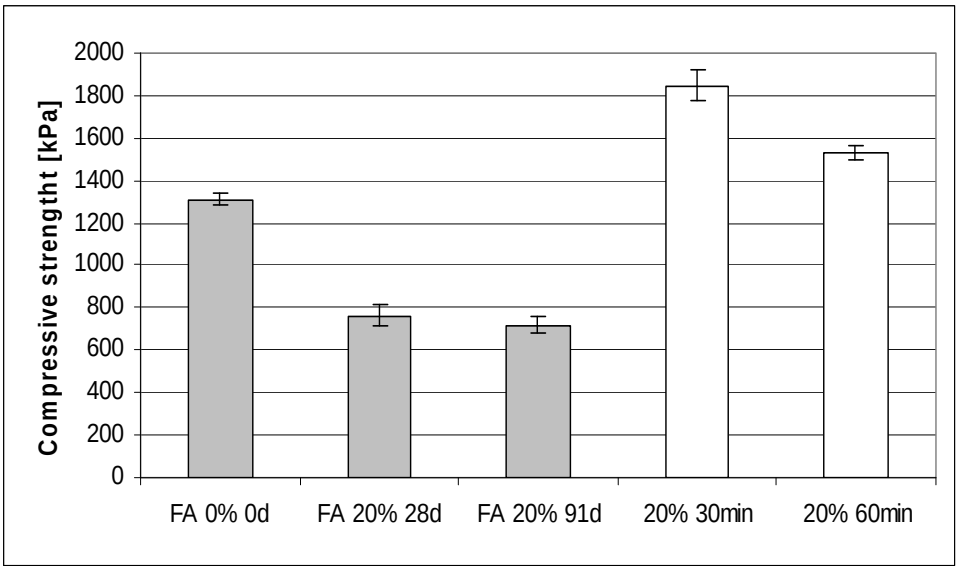
Reactivation of ash stored under moist conditions

Compressive strength (peat ash)



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Reactivation of ash stored under moist conditions

Conclusions

- Ash stored under moist conditions loose 30-60% of their strength building capacity
- Strength building capacity of ash can be fully restored
- In some cases the strength building capacity of reactivated ash are superior to dry untreated ash
- These results are based on few samples, but the results show that reactivation of ash is usable

→ Strenght building properties of stored ash could be restored by mechanical activation

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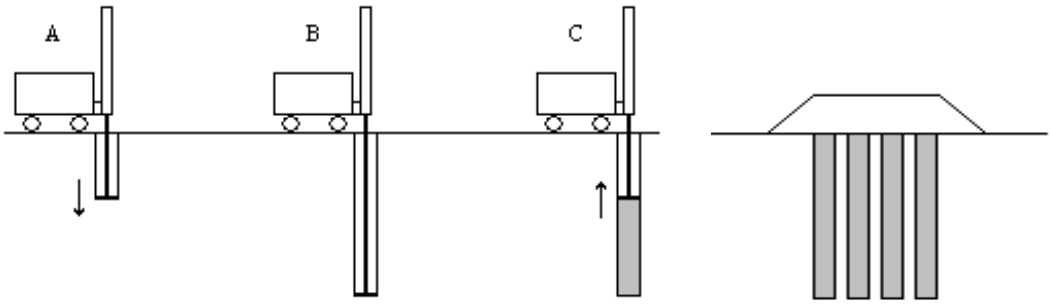
Soil stabilization with activated ash - planned



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Soil stabilization with activated ash - planned

Materials for testing are clay soil stabilized using the following binder mixtures:

- Lime + Cement
- Lime + Cement + Ash
- Lime + Cement + Activated ash

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Soil stabilization with activated ash - planned

Technical properties will be evaluated using

- Unconfined compression tests

Test results will show strength development over time

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Soil stabilization with activated ash - planned

Environmental properties will be evaluated

using the following leaching tests:

- Diffusion tests
- Batch tests
- Percolation tests

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Future outlook

- Increase of biomass and co-combustion ash
- New power plants in operation will add ash to an already stretched market
- Need for development of new utilisation areas

- Greater demand for low carbon footprint materials
- Need for alternative materials as replacement to “extinct” conventional ones

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Thank you for listening!

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