Presentation Data

Location:	IWA Specialist Conference on Wastewater Biosolids. Moncton, New Brunswick, Canada. 24-27 June 2007
Presentation title:	The reuse of bio ash for the production of concrete. A Danish case study
Presenting author:	Dan Kjersgaard

Warning

Prof. John Sweller, New South Wales University, Australia:

”Powerpoint is a catastrophe.
It ought to be abandoned”

Quotation in Danish weekly paper ”Ingeniøren” 20 April 2007

The Vision

The present way of bio ash disposal

The future way of bio ash disposal

Spildevandscenter Avedøre I/S

The BioCrete Project

Purpose:	To increase the reuse of sludge ash for concrete production by improvement of the documentation
Period:	June 2005 - December 2007
Budget:	720,000 €. To be financed by the Partners (58%) and the EU-LIFE programme (42% max.)
Partners:	Two Wastewater Treatment Plants with sludge incineration, and a Producer of concrete
Home page:	www.biocrete.dk

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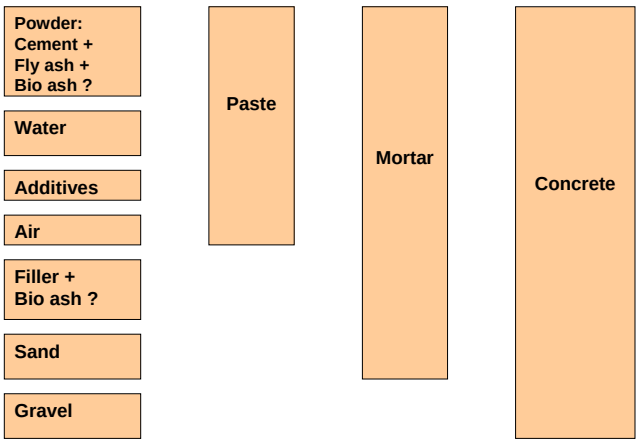
Terminology

Bio ash = Sludge ash

Reuse of bio ash = Use of bio ash

Fly ash: The ash from coal fired power plants

Concrete Ingredients



Results and Conclusions

It is technically acceptable to use bio ash for concrete production

- Present reuse approx. 1000 t/y
- Concrete of lower strength and exposure classes
- Bio ash content in the concrete approx. 2,5 % w/w

There are many differences between bio ash and fly ash
Does bio ash have pozzolanic properties?

Aluminium based bio ash seems advantageous – compared to iron based bio ash

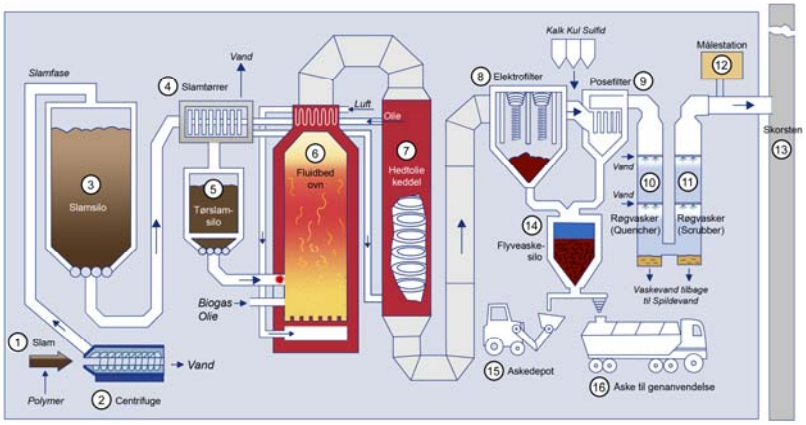
Bio ash from a multiple hearth oven has to be preteated (milled)

The environmental documentation has not yet been completed

The Wastewater Treatment Plants

Aerial View of Avedoere Wastewater Services

Incineration flow



1) Digested sludge
2) Centrifuges
3) Dewatered sludge Silo
4) Sludge Driers
5) Dried sludge Silo
6) Fluidbed Furnace
7) Oil Heat Exchanger
8) 2-field Electrostatic Precipitator
9) Bag Filter
10) Quencher & HCl Scrubber
11) 2-step SO_2 Scrubber
12) Cleaned flue gas Monitor
13) Chimney, height 50 m
14) Ash Silo
15) Local Controlled Landfill
16) External use of dry ash

The Bio ash outlet

The Producer of Concrete

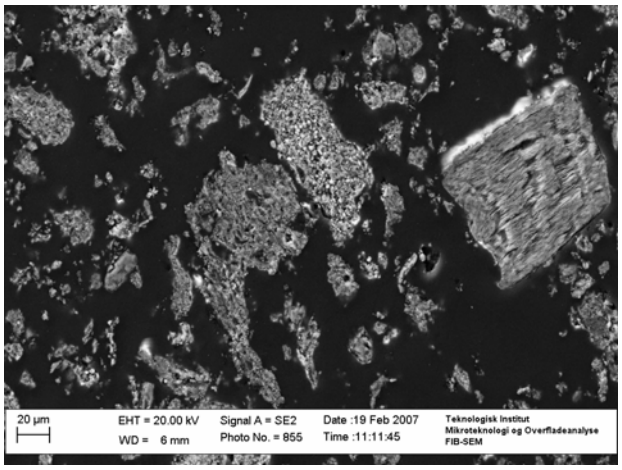
Unicon, Stamholmen

Bio ash and Fly ash characterization. Chemical parameters

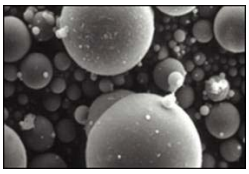
Analytical parameter			Bio ash	Fly ash for concrete	
Name	Unit	Method	Range	Typical value	Requirement
Loss on ignition (950 ^{0}C)	%	EN 196-2	1.5 - 2	2.1	< 5 (Category A)
Soluble phosphate	mg/kg*	Annex C*	70 - 85	27	< 100
Phosphorus as P_2O_5	%	WDXRF	26 - 27	0.3	
Silicon dioxide (SiO_2)	%	EN 196-2	21 - 24	51	
Reactive silicon dioxide (SiO_2)	%	EN 197-1	11 - 13	36	> 25
Free calcium oxide (CaO)	%	EN 451-1	< 0.01	0.4	< 2.5
Calcium oxide (CaO)	%	EN 196-2	19 - 20	7.1	
Iron oxide (Fe_2O_3)	%	EN 196-2	14 - 16	8	
Aluminium oxide (Al_2O_3)	%	EN 196-2	6.2 - 6.8	22	
Sum of SiO_2, Al_2O_3 & Fe_2O_3	%	EN 196-2	42 - 47	81	> 70
Magnesium oxide (MgO)	%	EN 196-2	3.0 - 3.1	2.5	< 4.0
Sulfuric anhydride (SO_3)	%	EN 196-2	1.3 - 1.7	1,1	< 3.0
Chloride (Cl^-)	%	EN 196-21	0.005 - 0.02	0.015	< 0.10
Total content of alkalis (as Na_2O)	%	EN 196-21	1.0 - 1.2	2.3	< 5.0

* Annex C in EN-450-1:2005; the analysis expresses mg "available phosphorus pentoxide" (P_2O_5) per kg ash

Bio ash and Fly ash characterization. Physical parameters



Bio ash



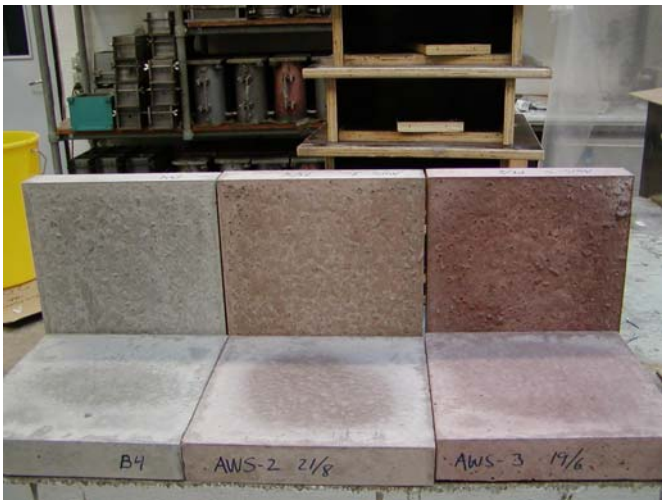
Fly ash

Comparison of Fe and Al bio ash

Analytical parameter			Bio ash	
Name	Unit	Method	Iron (Fe)	Aluminium (Al)
Colour			reddish	light brownish
Soluble phosphate	mg/kg*	Annex C*	75	30
Silicon dioxide (SiO_2)	%	EN 196-2	23	35
Reactive silicon dioxide (SiO_2)	%	EN 197-1	12	15
Calcium oxide (CaO)	%	EN 196-2	20	16
Iron oxide (Fe_2O_3)	%	EN 196-2	15	6,5
Aluminium oxide (Al_2O_3)	%	EN 196-2	6.5	13
Sum of SiO_2, Al_2O_3 & Fe_2O_3	%	EN 196-2	45	54
Phosphorus as P_2O_5	%	WDXRF	27	22
Calcium as CaO	%	WDXRF	21	16
Silicon as SiO_2	%	WDXRF	21	29
Amorphous	%	QXRD	55	63
Calcium phosphate	%	QXRD	19	14
Quartz (crystalline SiO_2)	%	QXRD	10	15
Haematite (crystalline Fe_2O_3)	%	QXRD	6	< 1
Particle density	kg/m^3	EN 196-6	2820	2640

* Annex C in EN-450-1:2005; the analysis expresses mg "available phosphorus pentoxide" (P_2O_5) per kg ash

The colour of bio ash concrete



No bio ash Al bio ash Fe bio ash

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Concrete Production Data

	Unit	Bio ash concrete	Reference concrete
8 MPa concrete			
Cement (C)	kg/m3	114	101
Fly ash	% of C	75	100
Bio ash	% of C	33	0
Water	% of eqC*	97	100
Compressive strength 28 d	MPa	12	10
12 MPa concrete			
Cement (C)	kg/m3	148	138
Fly ash	% of C	50	66
Bio ash	% of C	22	0
Water	% of eqC*	82	86
Compressive strength 28 d	MPa	17	16

* eqC = equivalent cement,
calculated using an activity factor of 0.5 for fly ash as well as bio ash

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