

Worldwide Pollution Control Association

**Dry Scrubbing
O&M Training**

**APC/PCUG Conference
July 12-16, 2009
The Woodlands, TX**



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A**

Babcock Power Environmental Inc.



One Source

Many Solutions

One Purpose

Turbosorp[®] CDS ***End Product Utilization*** ***Coal Fired Applications***



End Products From Dry FGD (DFGD) Scrubber Technologies



Courtesy of North American Aggregate, Inc

**There are
alternatives
to landfill**



End Products From Dry FGD (DFGD) Scrubber Technologies

Fact: Contains CaSO_3

– **Opinions and perceptions:**

- **Chemically unstable**
- **Compromises the structural integrity of concrete**
- **If mixed with coal ash it has to go to landfill**
- **Cannot be used in any concrete applications**

ACAA Coal Combustion Product (CCP) Survey 2007

- Total US CCP production 131,127,693 tons
 - Utilization 42.7 %
- FGD Gypsum 12,300,000 tons
 - Utilization 75.0 %
- DFGD End Product 1,812,511 tons
 - Utilization 8.3 % (Mostly mining)



DFGD End Product Utilization

Comparison: Europe v. USA

Difference in statistics

- **Europe: Commonly Coal ash pre-collection**
- **USA: Commonly no coal ash pre-collection**

Fate of DFGD End Products:

Market	Production [Ton]	Utilization [%]
Europe (1999)	1,208,000	91
USA (2007)	1,812,000	8.3



Europe v. USA

Differences in utilization are market driven based on:

- **Legislative**
- **Economic drivers**
- **Opinions and perceptions**



Properties of End Product From DFGD Technologies:

- **Spray Dryer**
- **Turbosorp®**
- **Other DFGD**

**Produce very similar end products.
Sulfur content and $\text{SO}_3^-/\text{SO}_4^-$ ratio vary.**



Composition of End Products From DFGD :

Main Components [%]	Typical Range	Siekierki Cyclone pre-sep.	Nanchang ESP pre-sep.
Fly ash/lime inerts	3-90	50-60	5.7
CaSO ₃ *1/2H ₂ O	20-70	5-30	54.5
CaSO ₄ *2H ₂ O	2-20	1-20	20.4
Ca(OH) ₂	1-10	1-8	5.0
CaCO ₃	1-15	2-8	11.8
CaCl ₂	0.5-4	0-5	1.1
Moisture (free)	0.5-3	0.3-2	0.8



European Perspective

Bengtsson, S. “Semi-Dry FGD End-Product Utilization – European Experiences”

Presented at the MEGA Symposium, Chicago, IL, August 20-23, 2001; paper 219.



Bengtsson, European Perspective

More than 20 years of experience

Applications:

- filling of mine shafts and workings and other enclosed voids
- reclamation/restoration of land
- structural embankment fill
- synthetic aggregate



Bengtsson, European Perspective

Applications contd. :

- soil amendment and plant nutrition (Ca/S fertilizer)*
- civil works (sealing, capping material, sub-base for parking lots and storage areas, road banks, noise protection walls, fill behind a new harbour quay)
- reagent in wet FGD*
- Thermal oxidation into technical anhydrite*

* Ash pre-collection necessary



The US Perspective

UND EERC and EPRI, 2007:

“A Review of Literature Related to the Use of Spray Dryer Absorber Material: Production, Characterization, Utilization Applications, Barriers and Recommendations”

Contains 90 references



No lack of information



UND EERC and EPRI Review

Fields of use:

- **High potential:** cementitious products (such as masonry, flowable fill and synthetic aggregate) and mining applications
- **Moderate potential:** cement replacement in concrete, engineering applications, agriculture, soil stabilization and wet FGD sorbent
- **Low potential:** binder material, cement manufacture, hazardous waste fixation, marine applications, mineral wool, sulfuric acid production and wallboard



UND EERC and EPRI Review

Obstacles:

- Inconsistent terminology used to define the material
- Lack of understanding of the material
- Limited data on environmental and health effects
- Inconsistent guidelines on beneficial use
- Economics

The properties of DFGD material: Not mentioned



UND EERC and EPRI Review

Beneficial properties:

- Cementitious when mixed with coal ash
- The hardening properties can be used in many applications
- Leachability is low after hardening
- A cheap source of Ca and S
- Contains residual alkalinity that can be used in several applications



Utilization of DFGD End Product

Requirements for high potential applications:

- Large volume
 - Low cost
 - Local manufacture
 - Local marketing
- Forgiving for site specific raw material variations due to
 - Boiler type and operation
 - Fuel
 - Requirements on emissions control



Utilization of DFGD End Product

High potential applications EPRI/EERC:

- Masonry
- Flowable fill
- Synthetic aggregate
- Mining applications

These do satisfy to varying degree the requirements for high potential applications.



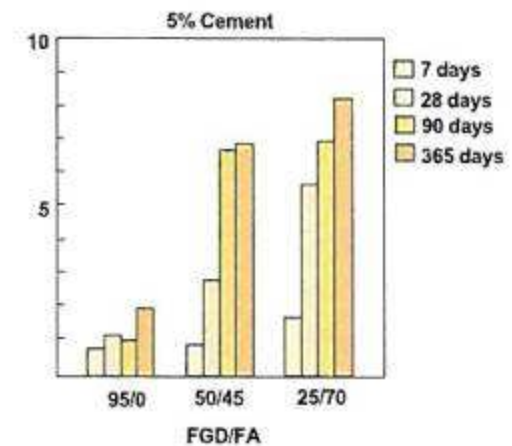
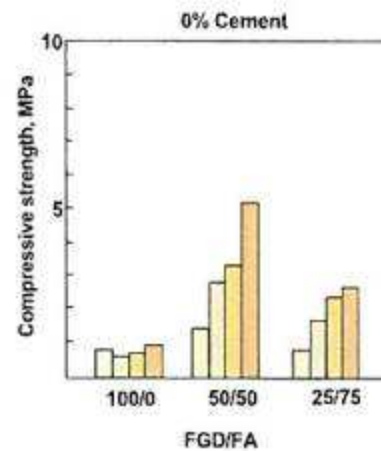
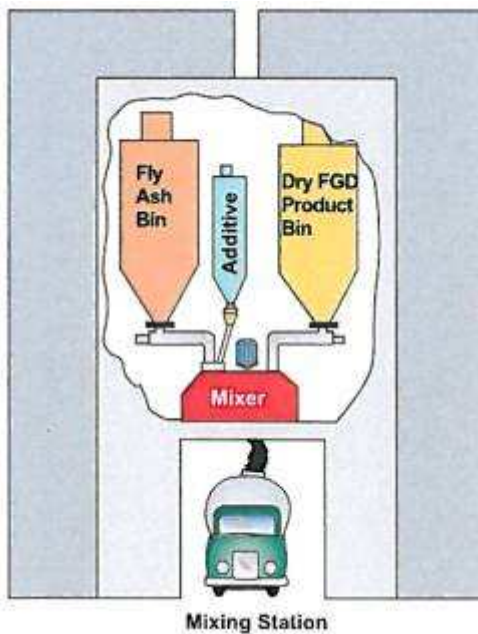
Utilization of DFGD End Product

Examples of Commercial Technologies



Cefill (20 years of experience)

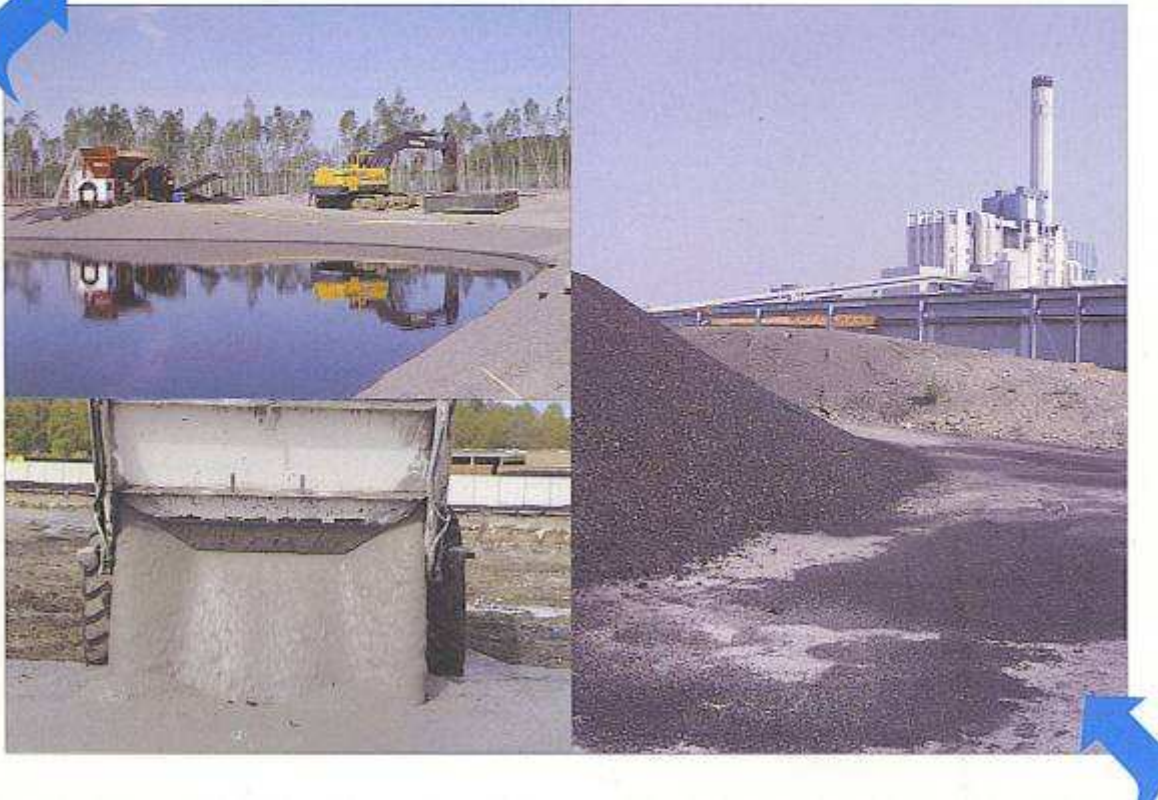
- Consists of Coal ash/DFGD product/Additive
- Different composition and amount of additive (0-8%) → different compressive strength
- Cefill A, B and C



Cefill mixing station



CEFYLL®



Examples:

- Base liner and cover for landfill
- Sub-base for storage area
- Road banks

Cefyll® i vägar och industriytor.

Råvaran i Cefyll® kan till 80-95% bestå av rester från kolförbränning.

Restprodukterna blir både kemiskt och fysikaliskt bundna, genom inblandning av tillsatsmedel och aktiverande cementmaterial.

Hållfasthet och täthet kan anpassas efter skilda behov.



Cefyll hårdnar kemiskt, och är därför ett idealiskt fyllnads-material i gator och vägar.

Cefyll® som återfyllning.

Med Cefyll® som återfyllning blir det:

1. Ingen efterpackning som ger dyrbar och återkommande justering.
2. Bättre lastutbredning och därmed mindre risk för rörbrott.
3. Väsentligt mindre in- och utläckage.



Examples cont'd.:

- Flowable fill
- Backfill for underground utility installations

Examples contd.: Waterproof seal and cover

Cefyll® som tätningmaterial.

De kemiska reaktionsprodukterna i Cefyll® tätar mot vatten och luft. Det gör materialet speciellt lämpligt för tätning och inkapsling av diverse produkter.



Tätning och täckning av kreosotförorenad jord i Katrineholm.



I Borsbo gamla gruvssamhälle har malmresterna tätats med bl.a. Cefyllindränkt varm för att förhindra utlakning av metaller. Projektet har delvis bekostats av Statens Naturvårdsverk.

Creosote contaminated soil

Mining waste (heavy metals)



Examples cont'd.:

Base course for wood chippings and coal



Fill and base course for harbour quay

Synthetic Aggregate

Production plant in Virginia



Courtesy of Universal Aggregates, LLC



Synthetic Aggregate contd.

Extruder



Cured and crushed aggregate



Courtesy of Universal Aggregates, LLC



Synthetic Aggregate contd.

Masonry block



Blocks after curing process



Courtesy of Universal Aggregates, LLC

Synthetic Aggregate

Production plant in Minnesota



Courtesy of North American Aggregate, Inc



Replacement of Cement In Concrete Masonry



Courtesy of North American Aggregate, Inc

**Architectural
masonry blocks**

**Church in
Princeton,
Minnesota**

**Approximately 35
% DFGD end
product**

Ca/S Fertilizer



Conclusions:

- **At present, only 8% of DFGD end products are utilized in USA (volume growing)**
- **End products from DFGD are useful as raw material for several high volume applications**
- **Technologies for utilizing these materials are already in commercial operation**

