

# **EFFICIENT REACTIVATION OF FLUIDIZED BED COMBUSTOR ASHES: TEST RESULTS FROM A 35 MWt UTILITY BOILER**

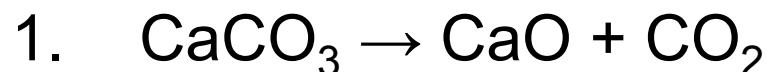
O. Trass, C.Delibas and E.J.Anthony

# Outline

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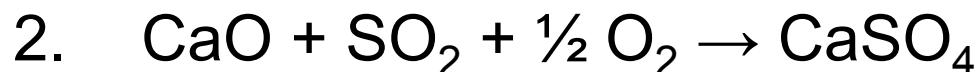
# Introduction

Thermal stability and sulfur capture in fluidized bed combustion (FBC):



$$\eta_1 = 100 \%$$

$$\Delta H_1 = 182.1 \text{ kJ/mol}$$

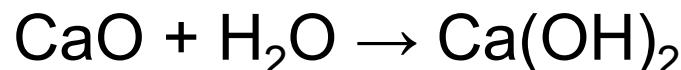


$$\eta_2 = 30 - 40\%$$

$$\Delta H_2 = -481.4 \text{ kJ/mol}$$

$V_m(\text{CaSO}_4) > V_m(\text{CaCO}_3) \rightarrow$  pore plugging  $\rightarrow \eta_2 < \eta_1$

Sorbent utilization is a linear function of the degree of hydration:



$$\Delta H = -65.3 \text{ kJ/mol}$$

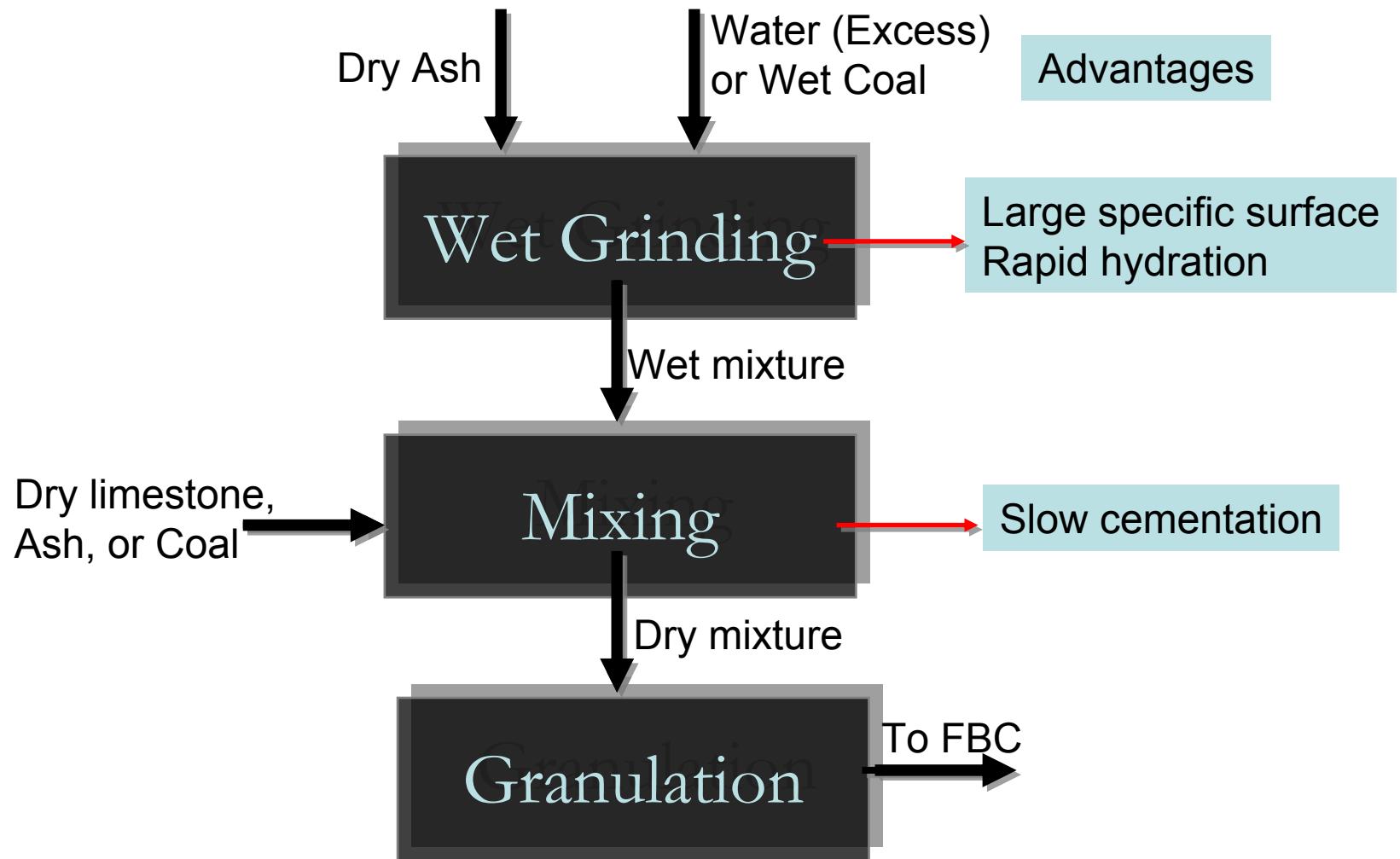
# Motivation

If remaining CaO can be reused then:

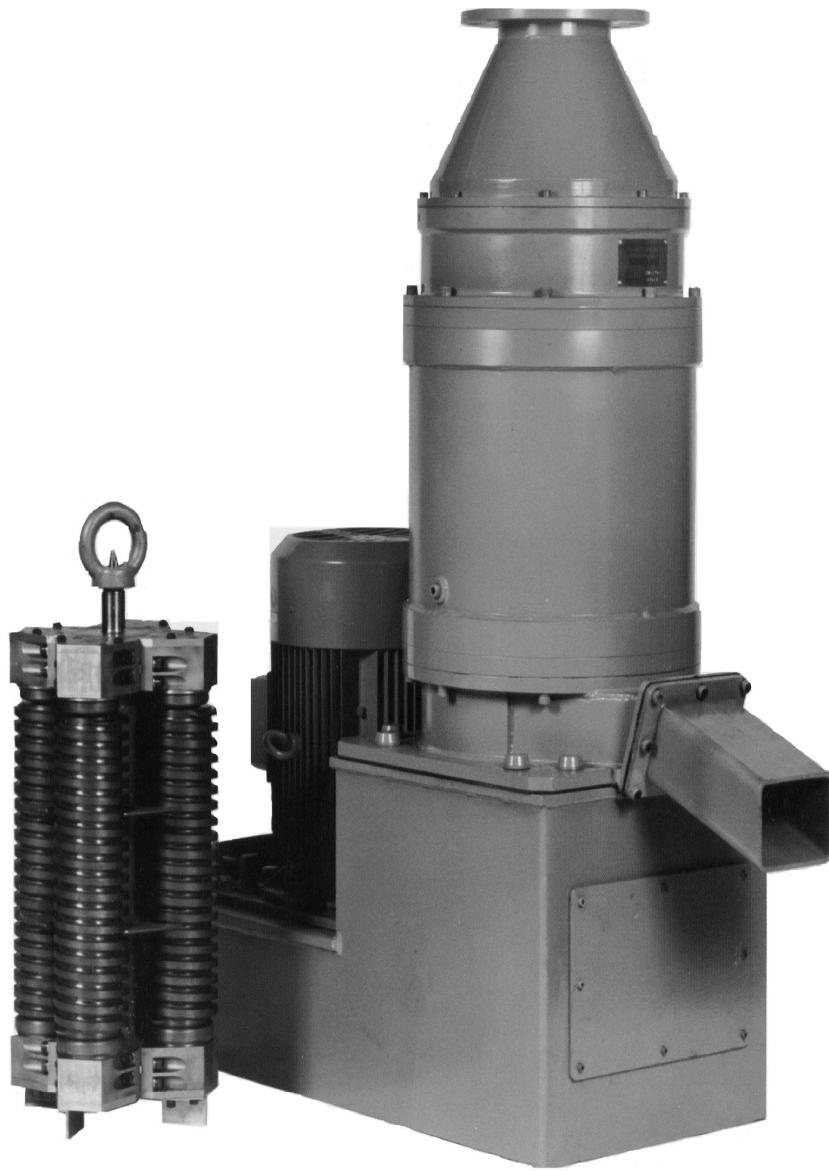
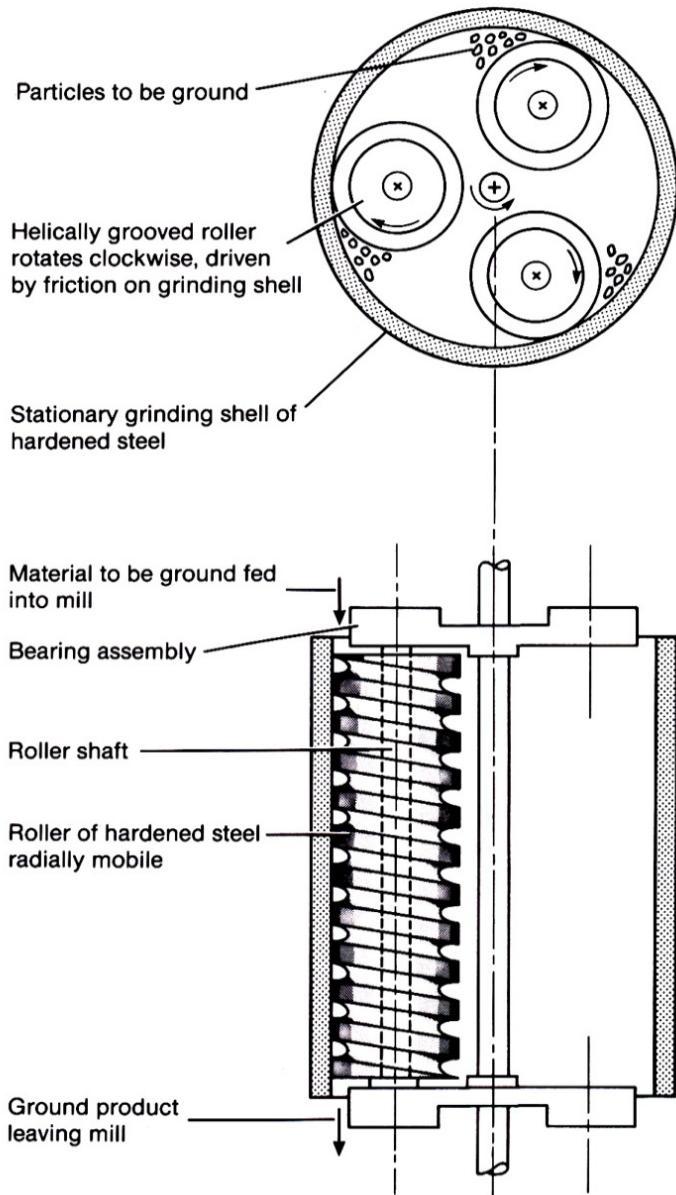
- Less  $\text{CaCO}_3$  consumed
- Less  $\text{CO}_2$  produced
- Less ash of better quality (higher  $\text{CaSO}_4$  content, less CaO) to be disposed.
- Energy savings

Proposed technologies are effective but  
expensive (high temperature, high pressure  
operation)

# Proposed Process



# Szego Mill



# Mill Characteristics

- High Specific Capacity
- Low Specific Energy Consumption
- Dry and Wet Grinding
- Slurry and Paste Grinding
- Ultrafine Grinding
- Flexibility in Operation/Versatile Applications
- Low Capital Cost

# Testing to Date

- Canadian Energy Technology Centre, CANMET, Ottawa, Ontario  
100 mm dia, 5.5 m high pilot combustor
- Wade Utility Plant, Purdue University, Lafayette, Indiana  
35 MWt boiler  
One 54 h. Test
- Southern Illinois University (SIU), Carbondale, Illinois  
35 MWt boiler  
Several shorter tests, different conditions

# Wade Utility Plant Tests

Szego Mill, SM -320 used for bottom ash activation  
with:

Dry ash feed rate: 3000 kg/h

Flow rate of water: 850 kg/h

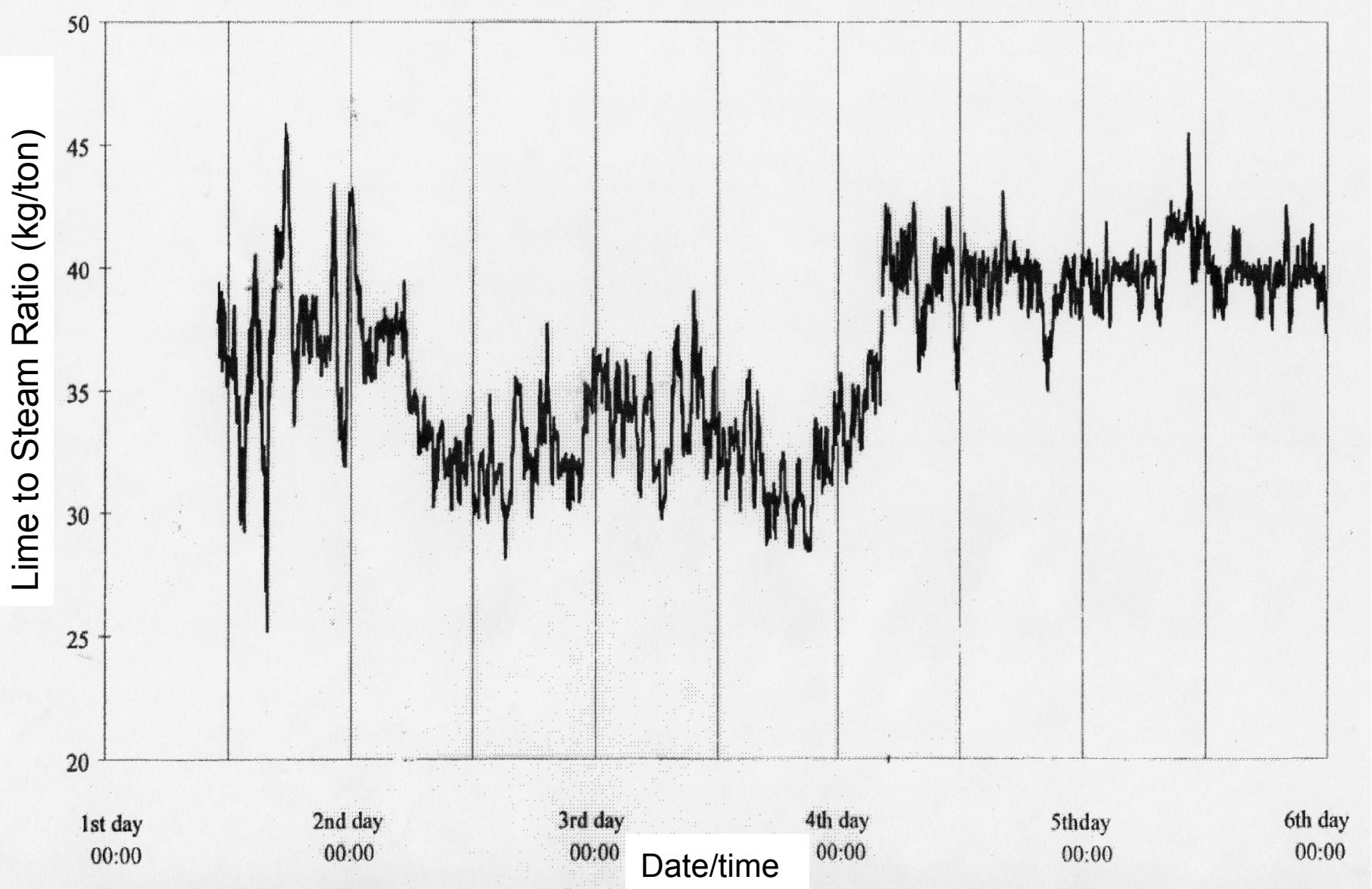
Drying materials in tumbler: coal and ash

Amount of recycled ash: 36 t → 58 t of mixture

Limestone savings: 30 t in the 54 h-run

∴ Double Ca utilization

# Wade Utility Plant Results



# Use of Wet Fine Coal and Ash

- Coal is source for both water and some fuel
- No need for coal filtration + centrifugation
- No operational problems at  $\geq 25\%$  water
- Slower hydration than for wet grinding of ash
- Waste fine coal becomes a useful, easy to handle granular fuel with its own S sorbent

# Most recent tests

Collaboration between:

- General Comminution Inc. (Szego Mill™, I.P.)
- Babcock & Wilcox (Boilermaker, international contacts)
- Canadian Energy Technology Center (R&D)
- Southern Illinois University, Carbondale  
Babcock & Wilcox designed FBC boiler

Figure 1. The experimental set-up for recycling reactivated ash

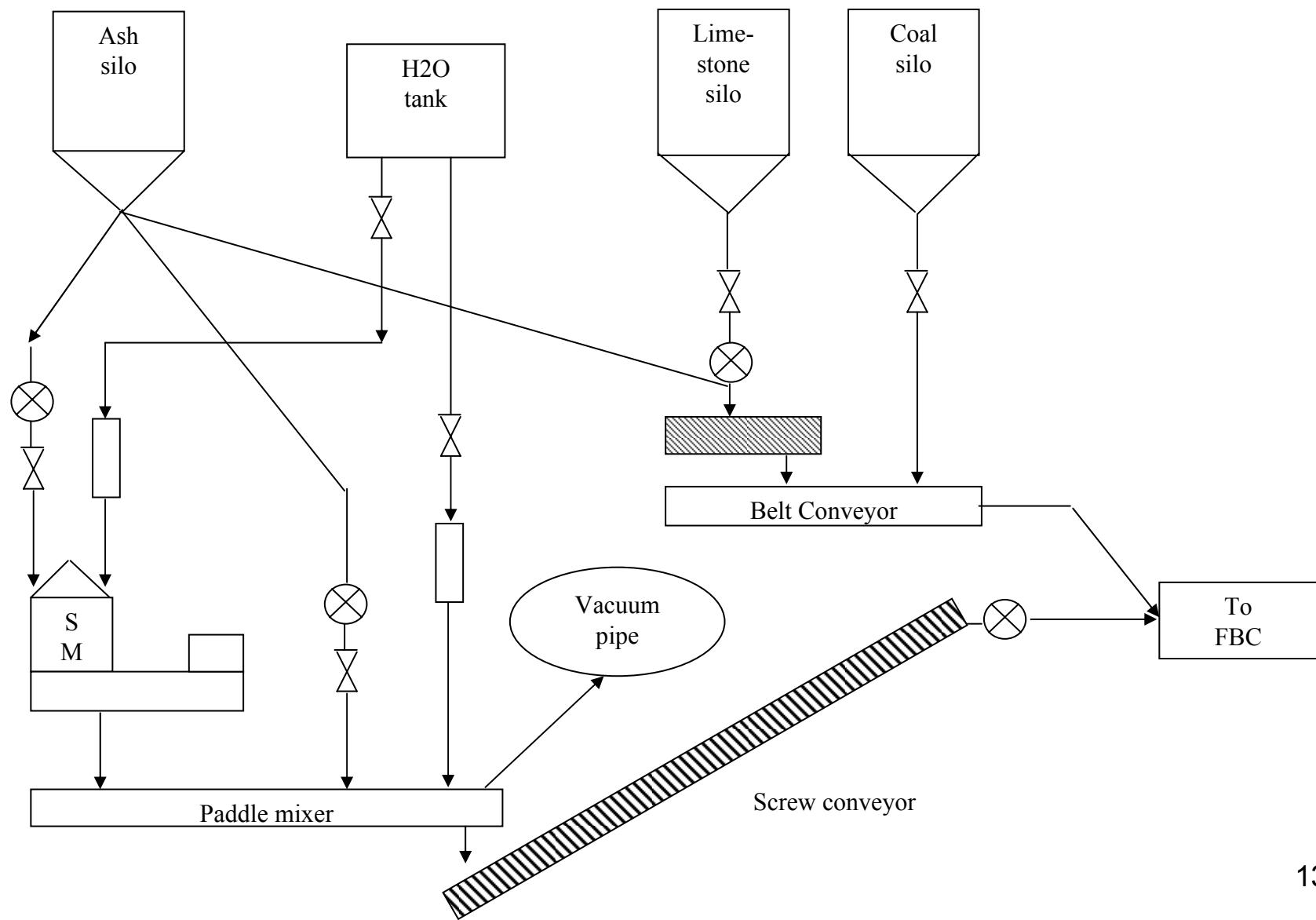
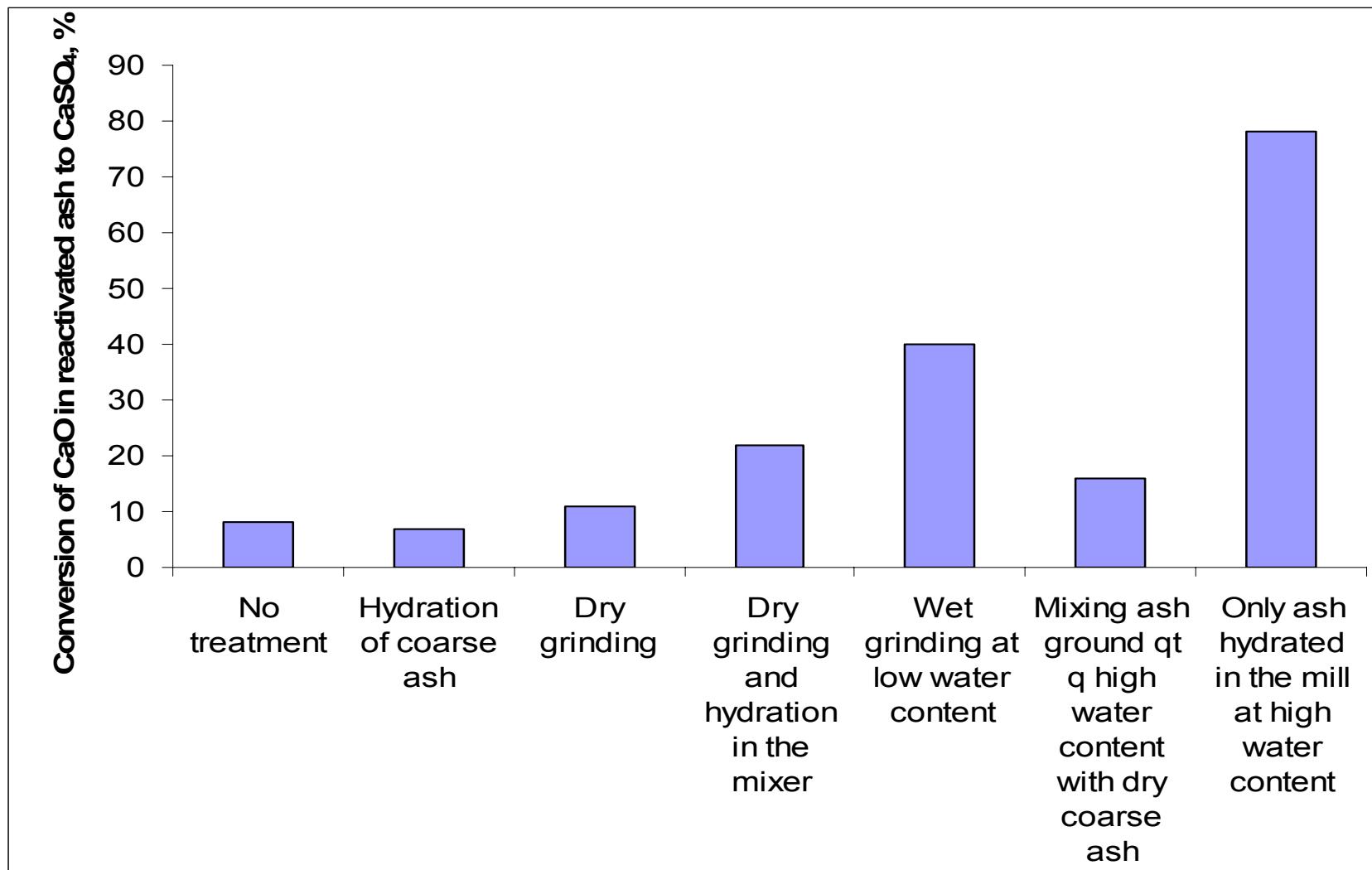


Figure 2. Additional CaO utilization from spent bottom ash treated in various ways



# Practical Conclusion

- When CaO content of ash is high, e.g. First of dual boilers, no recycling, then use large excess (>25%) of water/dry/pelletized/feed...
- When recycle processed ashes, CaO content drops to relatively low value. Use low excess (<8%) of water, so can grind on “dry” side. Grind and feed...
- Expect 60-70% utilization of the reactive  $\text{Ca}(\text{OH})_2$  in the reprocessed ash.

# Advantages

- Better Ca utilization
  - ∴ Reduced limestone requirements
  - ∴ Reduced CO<sub>2</sub> emissions
- Reduced amount of ash with a higher CaSO<sub>4</sub> content and lower CaO or unburned C content
- Potential energy savings
- Cheaper fuel can be used as wet, fine coal is acceptable, in pelletized form

