Characterization of Oxy-Fuel CFBC Ash

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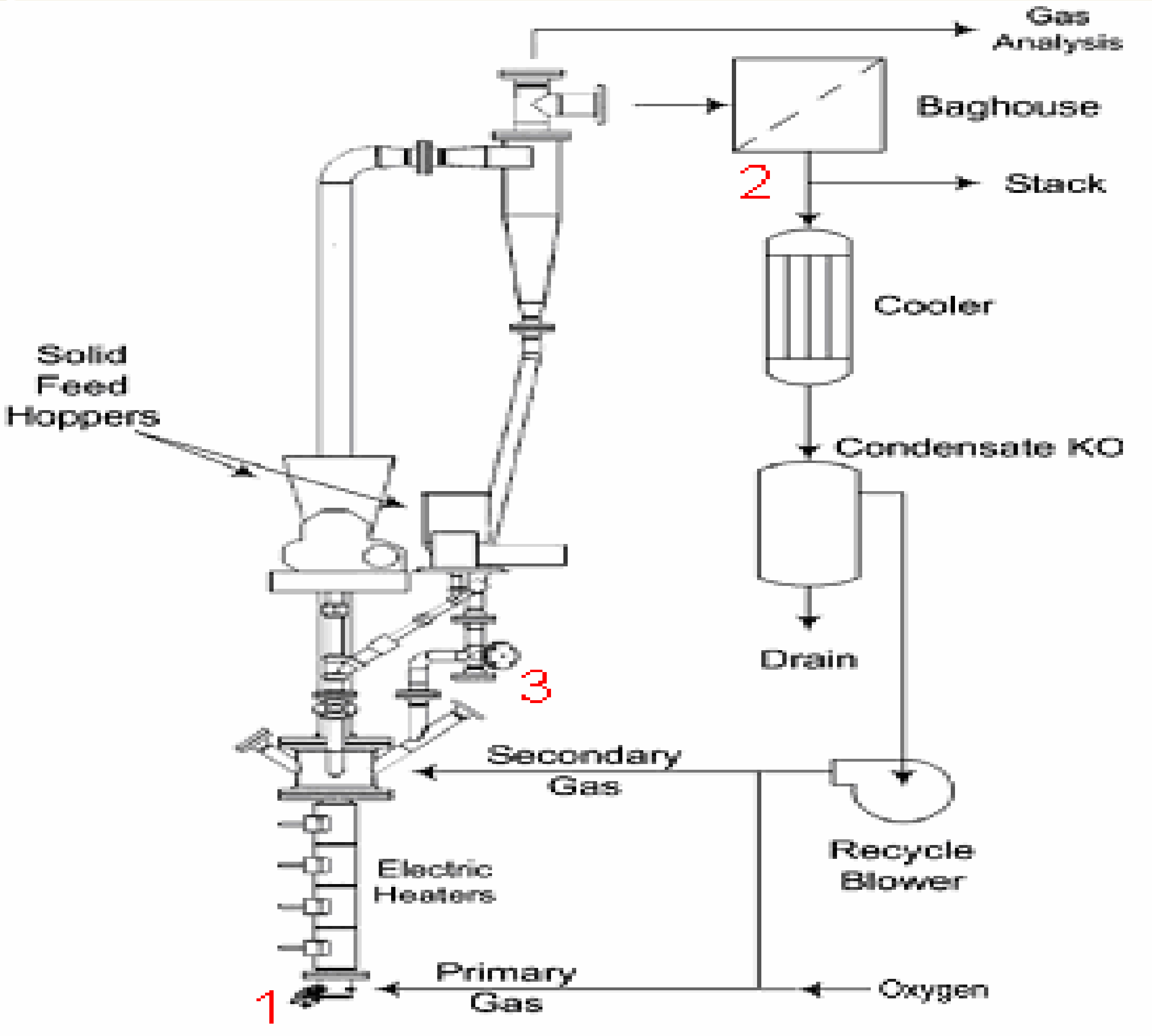
CFB 9th Conference, May 13-16, 2008

Hamburg

Outline

- Oxy-Fuel Combustion at CETC-O
- Ash Characterization Results
- Preliminary Conclusions and Outlook

Oxy-Fuel CFBC at CETC



Fuels

	Eastern bituminous (EB)	Eastern Kentucky (EK)	Petroleum coke
Proximate analysis, wt% (dry)			
Moisture, wt% (as analyzed)	1.08	2.38	0.66
Ash	8.86	12.27	1.0
Volatile Matter	35.78	35.79	11.46
Fixed Carbon	55.56	51.94	87.54
Ultimate analysis, wt% (dry)			
Carbon	77.81	73.17	86.91
Hydrogen	5.05	5.01	3.22
Nitrogen	1.49	1.62	1.83
Sulphur	0.95	1.52	5.88
Ash	8.86	12.27	1.0
Oxygen (by difference)	6.04	6.41	1.16
Heating Value (MJ/kg)	32.51	30.01	34.71

SO_2 Sorbents

	Havelock (H)	Cztkowice (C)
$CaCO_3$, wt%	96	97
$MgCO_3$, wt%	1.2	1.0
SiO_2, wt%	1.23	1.9
Particle size, mm	0-0.5	0-0.8

Oxy-Fuel Combustion Conditions

Fuel	Limestone	Ca/S	Bed Temperature
Eastern bituminous	Havelock	2-3	840-900°C
Eastern Kentucky	Havelock	3	820-920°C
Coke	Havelock	2-3	840-960°C
Coke	Cztkowice (0.1-0.8 mm)	3	840-950°C
Eastern Kentucky	Cztkowice (0.1-0.8 mm)	3	840-900°C
Eastern bituminous	Cztkowice (0-0.8 mm)	3	820-900°C

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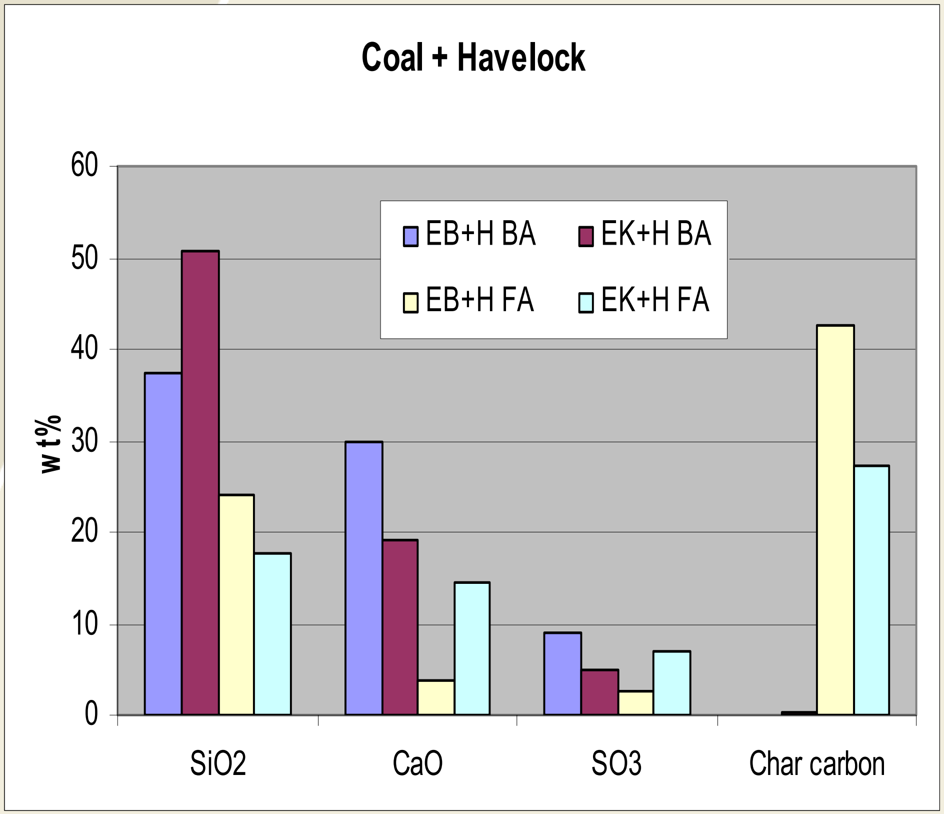
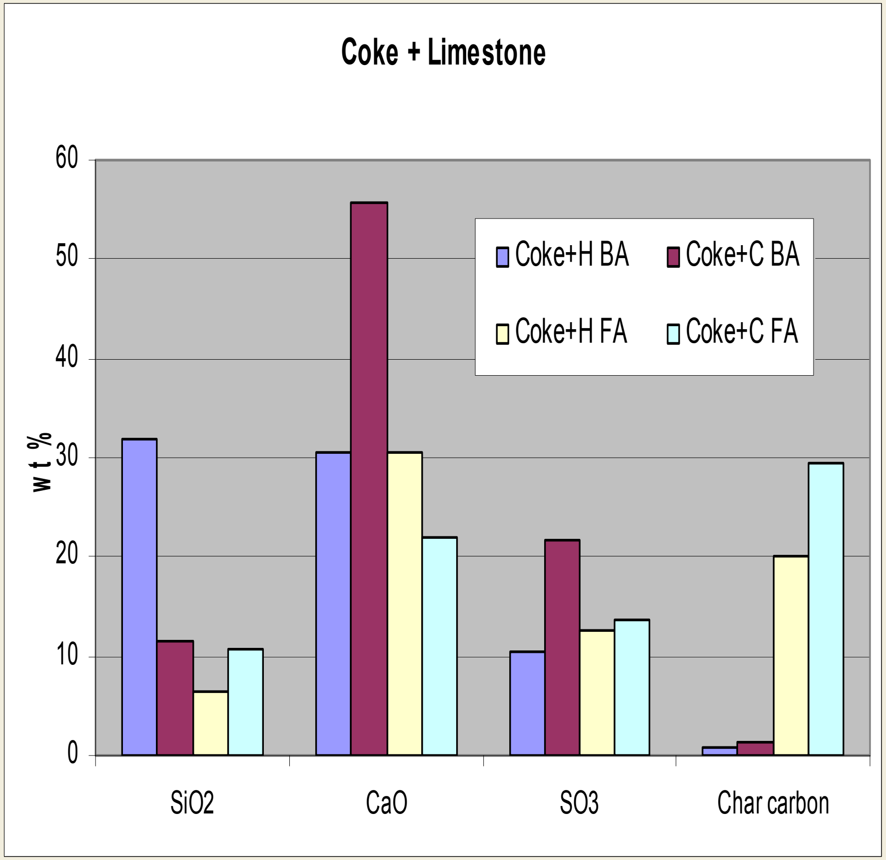
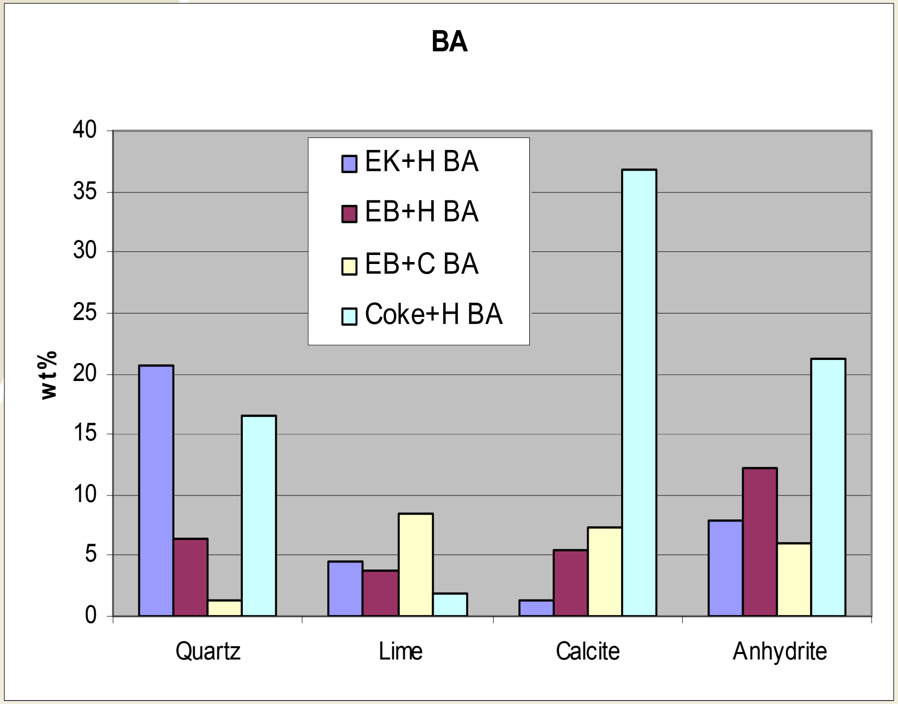
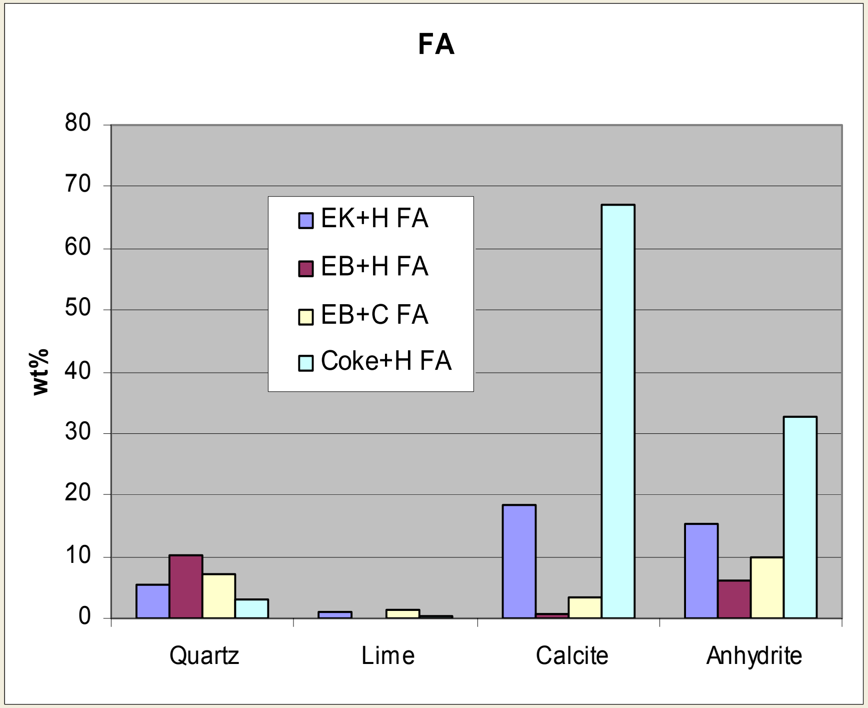
XRF Analysis Results



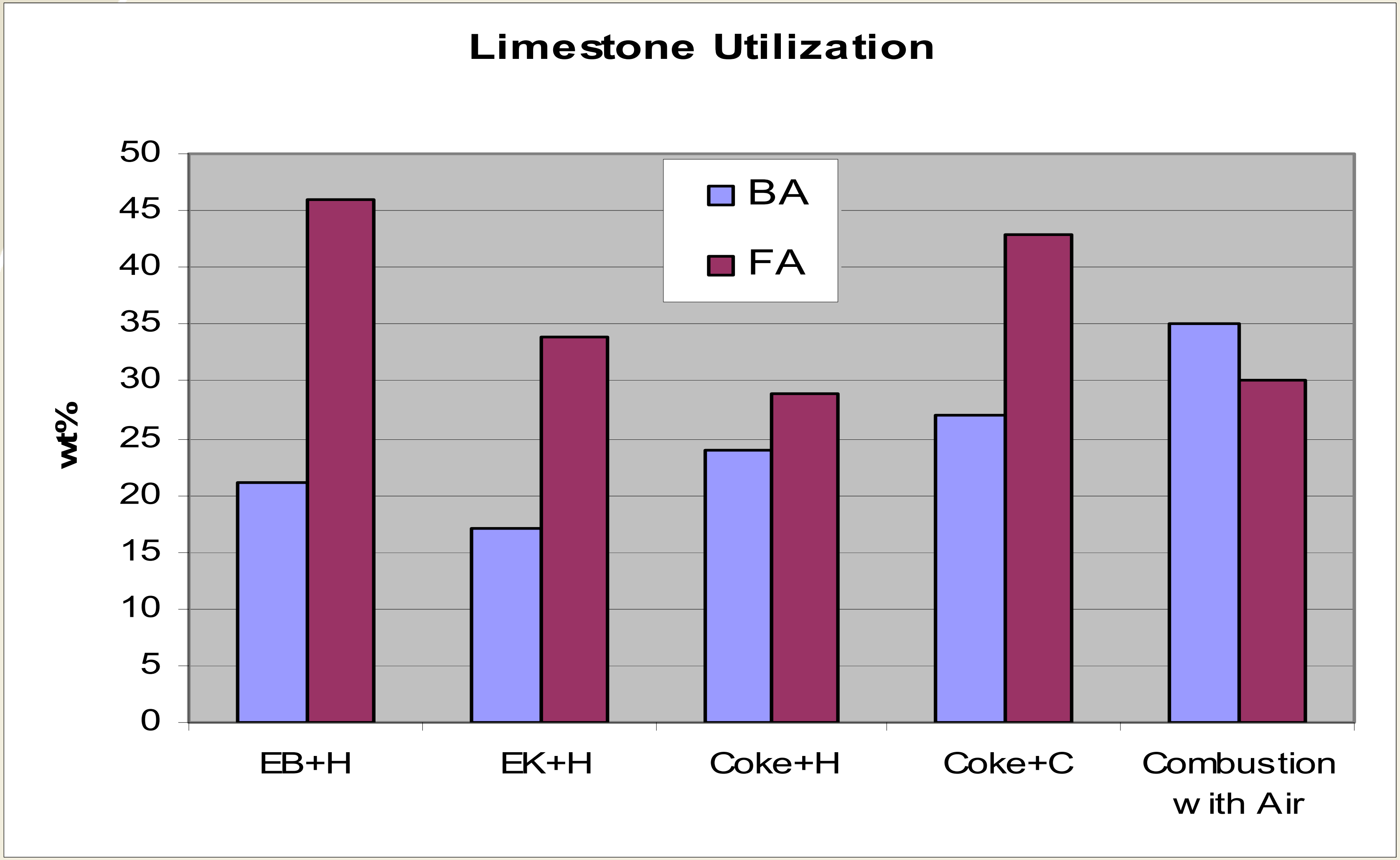


XRD Analysis Results





Limestone Utilization

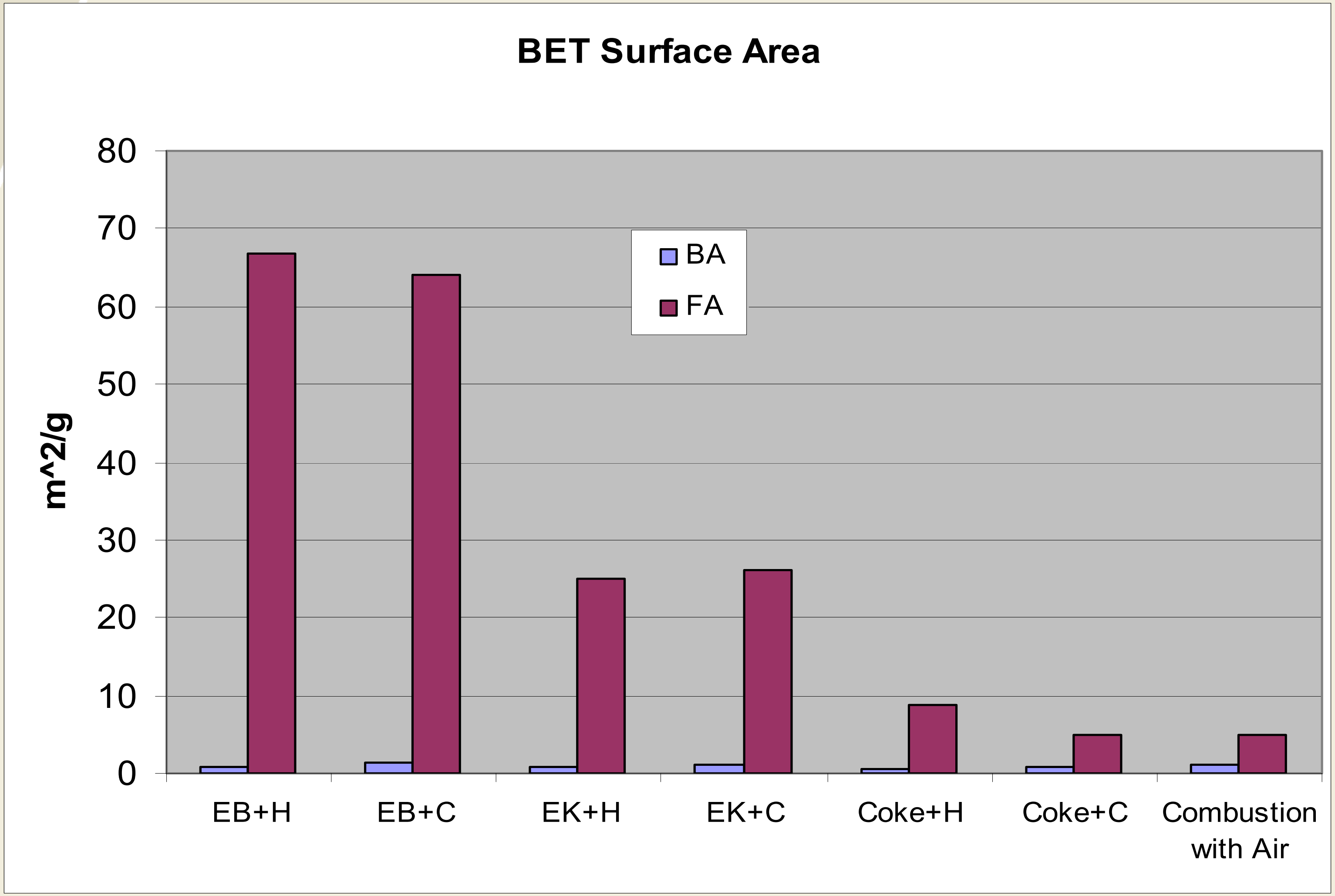


TGA Analysis

- Coke + H

	TGA Environment	$CaCO_3$ Decomposing Temperature, °C	Comments
BA	N_2	480-520	
	Air	580-600	
FA	N_2	500	Observed $CaSO_4$ decomposition at 780°C in N_2
	Air	600-620	

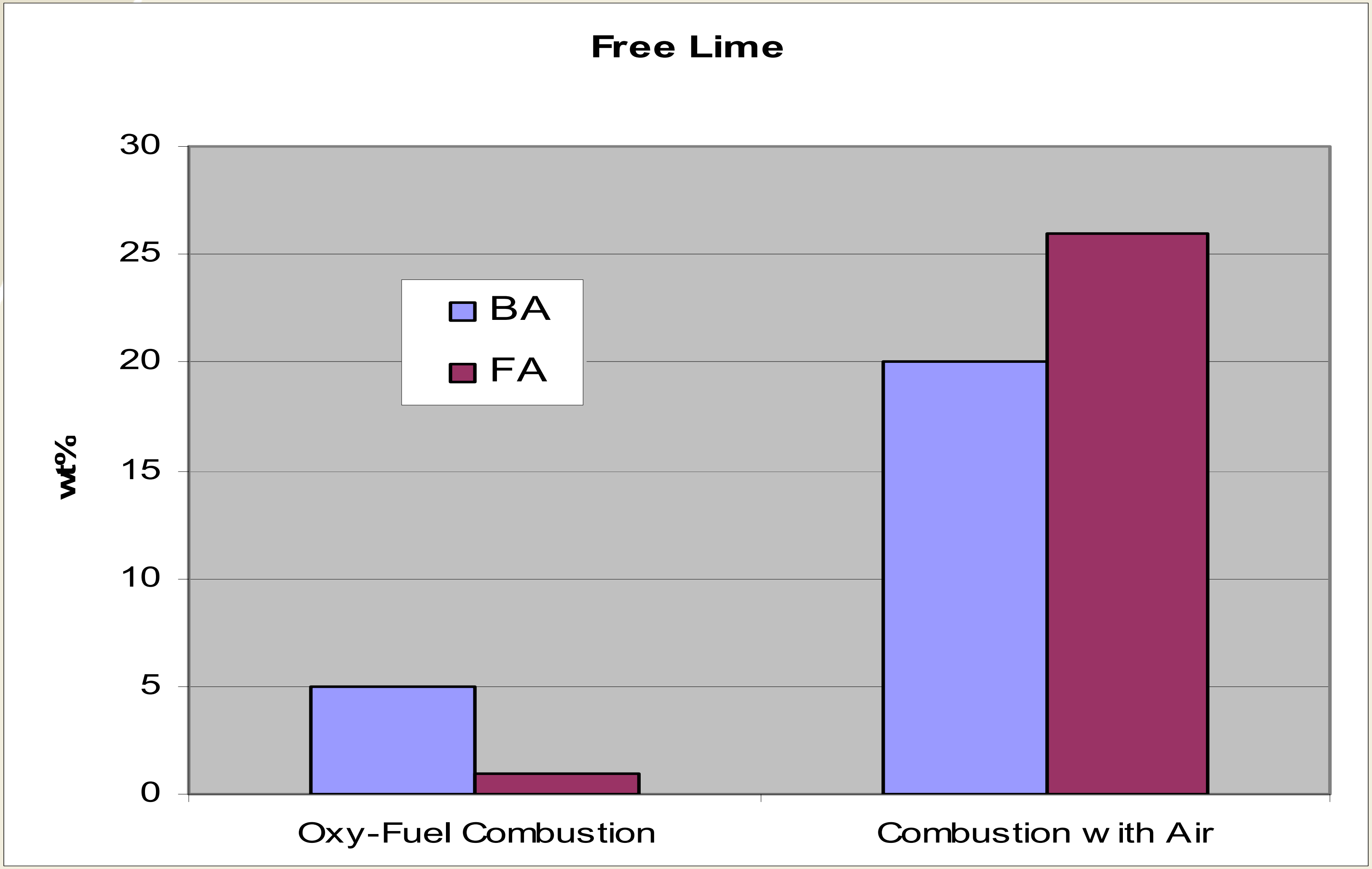
BET Surface Area



Pore Volume and Pore Radius

		Pore volume, cm^3/g	Pore radius, nm
EB+H	BA	0.0026	6.66
	FA	0.040	1.20
EB+C	BA	0.0019	3.03
	FA	0.038	1.18
EK+H	BA	0.0018	3.79
	FA	0.018	1.47
EK+C	BA	0.0022	4.35
	FA	0.020	1.51
Coke + H	BA	0.0011	3.42
	FA	0.0083	1.91
Coke + C	BA	0.0015	3.30
	FA	0.0068	2.78
Combustion with Air	BA	0.0033	15.7
	FA	0.026	22.4

Free CaO Analysis



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Conclusions and Outlook

- Char carbon content in FA is significantly high
- Calcite and anhydrite contents are higher in coke derived ash compared with coal derived ash
- Limestone utilization in FA is higher than BA, which is different from the air combustion ash
- In coal derived ash, the BET surface area of FA is much bigger than BA; In coke derived ash, the difference between FA and BA is smaller, which is similar to the air combustion ash

Conclusions and Outlook

- Since free CaO contents are low and calcite existed in the oxy-fuel CFBC ash, it should have different behaviours in ash disposal sites compared to air firing CFBC ashes. Issues related to high pH leachate and land fill cracking may be expected to reduce. Agglomeration and fouling due to continued sulphation of CaO in CFBC firing high sulphur, low ash fuel may also be reduced.
- More investigations on oxy-fuel CFBC ash are necessary