

Hg Control- The Effects on Byproducts

What Do We Know and Where Do We Go?

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Objective

- To determine the effect of Hg control on byproducts
- What do we know?
 - Traditionally - Hg b.d. in byproducts
 - $<$ Hg in air emissions = $>$ Hg in byproduct
- Post- Hg control byproducts.....
 - More Hg... More leaching?
 - ... More volatilization?
- DOE large-scale Hg testing
- Where do we go... **Testing program**



New Terminology

- **CUB- Coal Utilization Byproducts**
 - Includes gasification residues
 - Gasification - DOE's Vision 21
- **Gasification = environmentally-friendly**
 - low particulate
 - low SO₂ - product
 - low (CO₂ capture)
 - But...**Hg air emissions**
 - **as high or higher than P.C.**

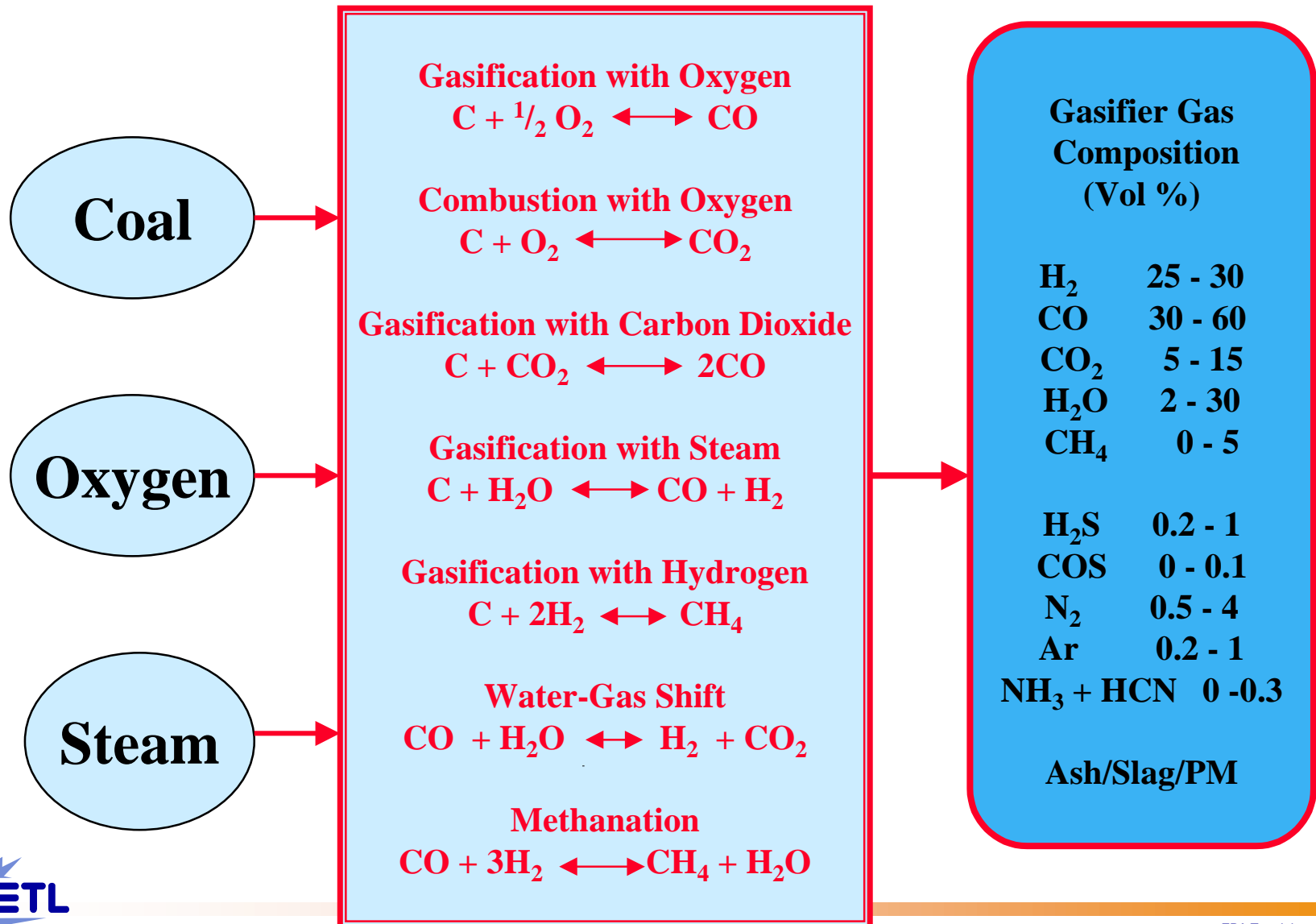


Byproduct Program

- **Purpose-**
 - Environmental
 - Utilization
- **CBRC**
- **Targeted Solicitations**



WHAT IS GASIFICATION?



By-Product Generation at Existing Gasifiers



- **Polk Power Station**

Net 250 MWe

- maximum 77,000 tpy slag generation (moisture free basis)
- 77,000 tpy liquid sulfuric acid generation

- **Wabash River**

(1999 annual generation, 40% capacity)

Net 262 MWe

- 45,216 tons slag generated (moisture free basis)
- 8,557 tons elemental sulfur generated



Solids Generation Comparison for Conceptual Plants, PC-Fired vs. IGCC

Plant Data	Conventional PC-Fired Plant with Advanced Wet FGD	IGCC Plant
Plant Operating Data		
Plant Size, MWe	300	300
Annual Capacity Factor, %	65	65
Heat Rate, Btu/kWh	9,750	9,000
Carbon Conversion, %	99	99
Feed Fuel, tpd	3,480	3,216
Feed Limestone, tpd	466	-
Fuel Properties		
HHV, Btu/lb	10,100	10,100
Sulfur, wt%	4	4
Ash, wt%	16	16
Carbon, wt%	57.6	57.6
Solids Generated, tons/day		
Ash (dry)	557	0
Slag (dry)	0	515
Carbon in Ash (dry)	20	19
Elemental Sulfur	0	126
CaSO ₄ (Anhydrite)	562	0
Water in CaSO ₄ •2H ₂ O	149	0
CaO (Dry)	10	0
Water in Ca(OH) ₂	3	0
Inerts from Limestone	23	0
TOTAL SOLIDS GENERATED, tons/day	1,324	660
TOTAL SOLIDS GENERATED, lb/MWh	367	183



Comparison of Solid By-product Composition, PC vs. IGCC

Major Constituents, Coal-Fired Utility Gasification Carbon Free Basis Boiler Slag Slag			
	Units	Range	1997-1998 Avg.
SiO ₂	wt%	45.9 - 70.0	42.5
Al ₂ O ₃	wt%	15.9 - 28.3	29
Fe ₂ O ₃	wt%	2.0 - 14.3	21.2
CaO	wt%	0.4 - 15.3	4.6
MgO	wt%	1.9 - 5.2	1.1
Na ₂ O	wt%	0.6 - 1.0	0.5
K ₂ O	wt%	0.1 - 0.3	1.8



Source: EPA, Praxis Engineering, Inc.

Comparison of Slag Trace Elements PC vs. IGCC

Constituent	Range	Coal Fired Utility Boiler Slag - Range	Wabash River Gasifier Slag
Antimony	wt ppm	0.25-1.0	4.8 - <10.0
Arsenic	wt ppm	0.01-254.0	6.39 - <10.0
Barium	wt ppm	6.19-1720	37.9 – 80
Beryllium	wt ppm	7.0	2.03 – 10.9
Boron	wt ppm	0.1-55.0	128 – 283
Cadmium	wt ppm	0.01-40.5	<0.50 – 0.76
Chromium VI	wt ppm	1.43-5981	29.6 – 120
Copper	wt ppm	1.37-156	12 – 54.1
Lead	wt ppm	0.40-120.0	8.19 – 97
Mercury	wt ppm	0.016-9.5	<0.08
Nickel	wt ppm	3.3-177	22.9 – 146.7
Selenium	wt ppm	0.010-14.0	3.02 - <10.0
Silver	wt ppm	0.01-74.0	<1.0 – 3
Thallium	wt ppm	33.5-40.0	<0.4 – 16
Vanadium	wt ppm	75.0-320.0	25.1 – 156
Zinc	wt ppm	4.43-530	32.97 - 213
TCLP-Total	mg/l	1.28 ¹	<0.682 ²

¹ Sum of calculated average of all reported TCLP data.

² Values represent total leachate present in the analyzed sample. Barium was the only constituent that demonstrated leachable characteristics.



Source: EPA, Wabash River Energy, Ltd.

Existing and Planned Gasifiers for the Power Generation Industry

Plant Name	Gasifier Technology	Start-up Year	Generating Capacity (MW)	Fuel
Kentucky Pioneer Energy AFT-IGCC Plant	BGL	2003	549	Coal
Lima Energy IGCC Plant	BGL	2003	549	Coal
Fife Electric	BGL	2002	400	Coal
Fife Power	BGL	2001	127	Coal
Port Arthur GCC Project	E-GAS (Destec/Dow)	2005	1109	Petcoke
Wabash River Energy Ltd.	E-GAS (Destec/Dow)	1995	322	Petcoke
Polk County IGCC Project	Texaco	1996	246	Coal
Unspecified Plant	Texaco	2006	1508	Coal
Delaware Clean Energy Cogeneration Project	Texaco	2001	284	Petcoke
Deer Park GCC Plant	Texaco	2006	700	Petcoke
Lake Charles IGCC Project	Texaco	2005	768	Petcoke
Polk County Gasification Plant	Texaco	2005	747	Petcoke
El Dorado IGCC Plant	Texaco	1996	6	Petcoke
Total			7,315	MW



Conclusions

- **Gasification will...** supply a significant amount of new electric power in the future.
- **Gasification does...** generate byproducts.
- **Gasification does...** emit Hg to the air.
- **CUB - Testing Program**



Webpages

- **By-products:**
 - WWW.Netl.DOE.gov/coalpower/environment
- **Gasification:**
 - WWW.Netl.DOE.gov/coalpower/gasification

