

Environmental Permitting for IGCC Power Plants

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Gasification Technologies Council Workshop

Tampa, FL

March 2, 2006

URS

Permitting an IGCC Power Plant

- Most electric utility and agency staff have experience with permitting natural gas-fired combined cycle (NGCC) plants over the last 6-8 years
- Some have worked on pulverized coal (PC) units
- But what about IGCC plants?



Permitting an IGCC Plant

- With only two commercial-size IGCC plants in the U.S.....
 - ◆ The technology and its permitting requirements are likely to be new to electric utility environmental staff
 - ◆ State environmental agency staff may not be familiar with the technology and the new regulations that cover it

Comparison of IGCC and PC Plants

PC

- Fuel is coal, coal/pet coke



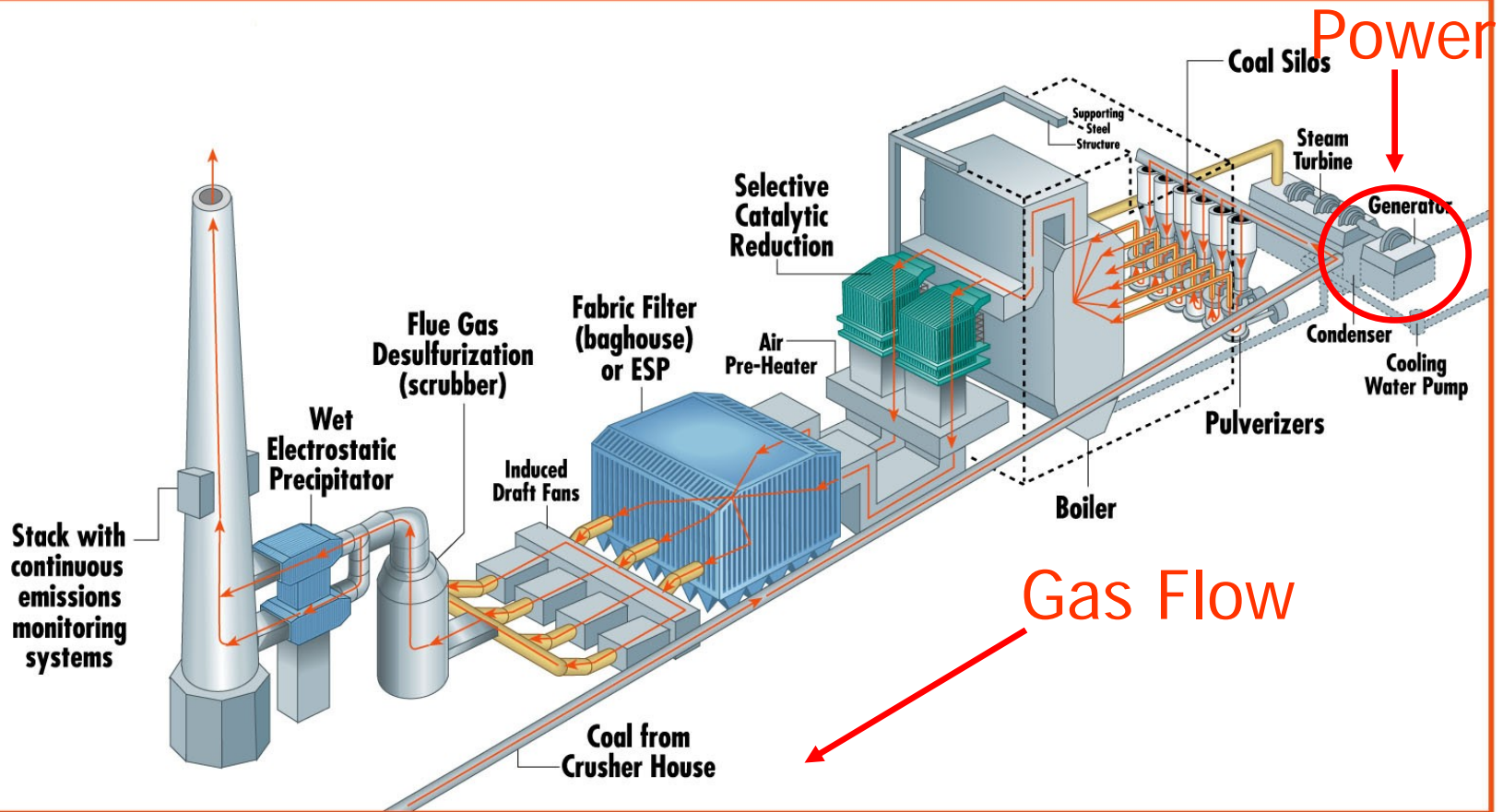
- Combustion (oxidizing environment) in a boiler
- Cleanup of high volume of exhaust gas after combustion

IGCC

- Feedstock is coal, pet coke, coal/pet coke blend
- Fuel is syngas
- Gasification (reducing environment) – thermal conversion
- Cleanup of low volume of syngas prior to combustion

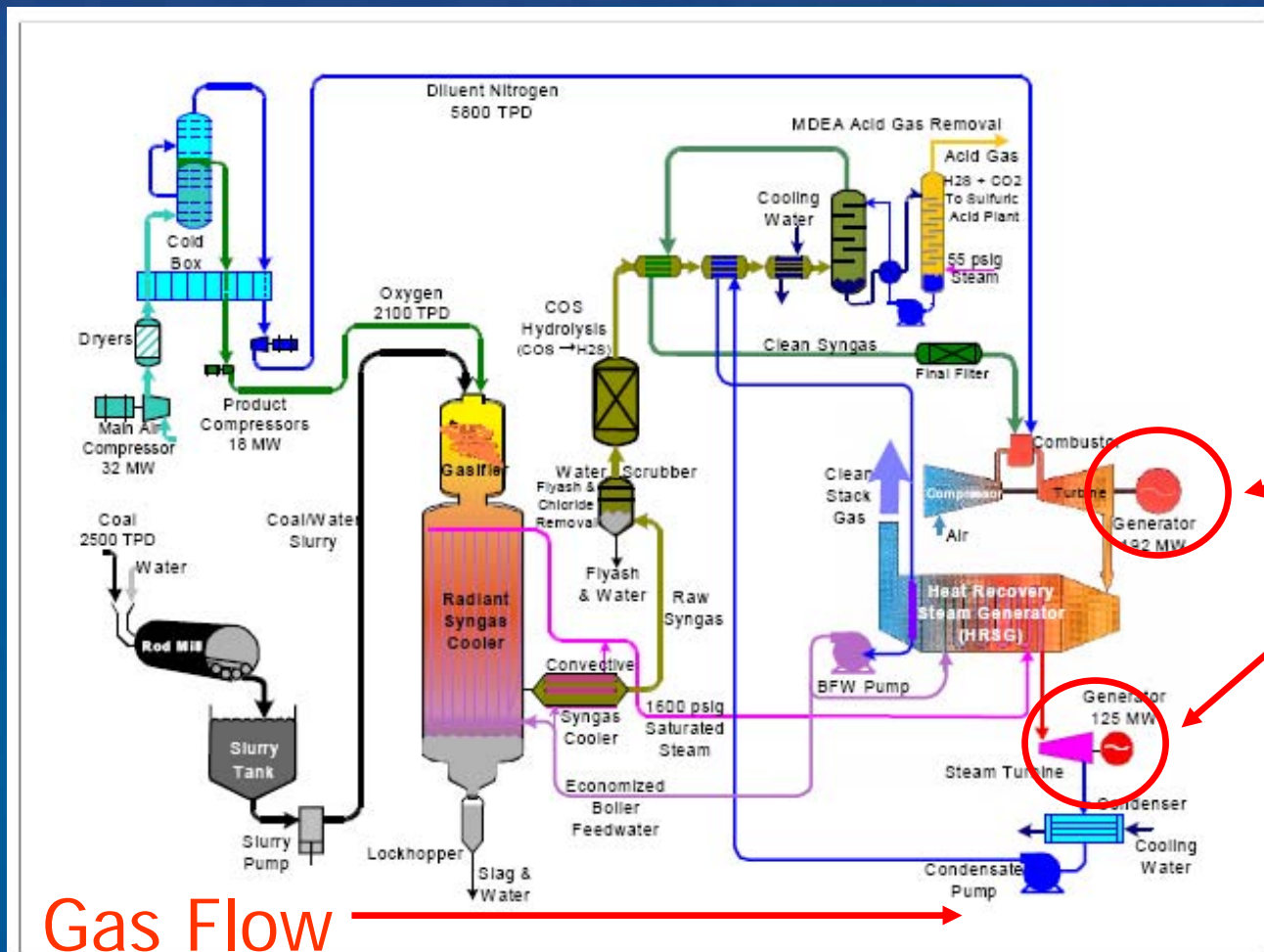
PC Plant

(Power Generation Followed by Clean-up of Exhaust Gases)



IGCC

(Clean-up of Syngas Followed By Power Generation)



Power

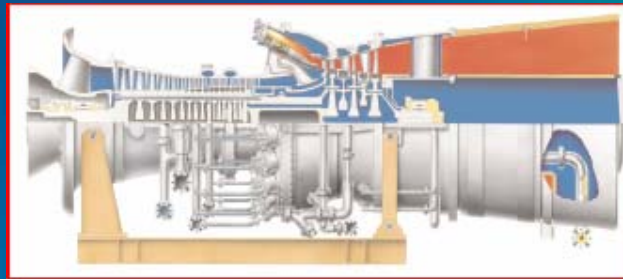
Gas Flow

What Regulations Apply to IGCC?

- 40 CFR 60, Subpart Da, NSPS for Utility Steam Generating Units was amended on February 9, 2006:
 - ◆ “Subpart Da of 40 CFR 60 will apply to combined cycle and combined heat and power combustion turbines and the associated heat recovery units that burn 75 percent or more (by heat input) synthetic-coal gas (e.g., **integrated coal gasification combined cycle power plants**) and that meet the applicability criteria of the final rule amendments, respectively.”

What Regulations Don't Apply to IGCC?

- NSPS for gas turbines (Subpart KKKK) states:
 - ◆ "... Therefore, we consider it appropriate to cover combustion turbines fueled by gasified coal under the Utility NSPS."



- ◆ For air permitting, IGCC is considered as a utility steam generating unit, not a gas turbine

New NSPS

Emission	Old NSPS	New NSPS	New NSPS on Input Basis (estimated)
NO _x	1.6 lb/MWh	1.0 lb/MWh*	0.14 lb/MMBtu
SO ₂	0.6 lb/MMBtu	1.4 lb/MWh*	0.2 lb/MMBtu
PM	0.03 lb/MMBtu	0.015 lb/MMBtu	0.015 lb/MMBtu

*output-based standards are on a gross generation basis, so gross heat rate is used to calculate input-based limit

Implications?

- Heat Input - when specifying heat input in MMBtu/hr, use feedstock to the gasifier, not syngas to the combustion turbines (as if it's a PC unit, not a NGCC unit)
- Emission limits – divide lbs/hr by feedstock input in MMBtu/hr to get lb/MMBtu
 - ◆ On same basis as a PC unit

Emission Rate Example

- Feedstock input to gasifier is 2,500 MMBtu/hr
- Gasification converts ~80% of energy in feedstock to syngas
- Syngas production to CT is 2,000 MMBtu/hr
- NOx emissions are 161 lbs/hr per CT
- Emission rate:
 - ◆ On feedstock input basis = 0.064 lbs/MMBtu (use this one)
 - ◆ On CT input basis = 0.08 lbs/MMBtu
- Permit limits need to be on a feedstock input basis, not CT input basis

Air Emission Controls

Parameter	Typical Emission Control Method
NO _x	Saturation of syngas with water and injection of nitrogen into syngas
SO ₂	COS hydrolysis followed by amine-based <u>sulfur</u> removal (99% +) – removal of H ₂ S, not SO ₂
Particulate matter	Wet scrubber or dry filters
CO, VOCs	Good combustion practices
HCl, HF, NH ₃	Wet scrubber & brine concentrator
Mercury	Sulfur-impregnated activated carbon bed

NO_x BACT Issues

- Is SCR applicable to IGCC?
- Technical issues
 - ◆ The fuel is syngas, not natural gas as in NGCC
 - ◆ Contaminants in syngas can poison SCR catalyst
 - ◆ Ammonium sulfate/bisulfate deposit in the HRSG, causing corrosion and lower availability due to numerous washdowns
 - ◆ No coal-based IGCC system in the world uses SCR
- Economic Issues
 - ◆ No commercial offerings/guarantees with syngas fuel
 - ◆ SCR would require lower ammonia slip or deeper sulfur removal – significant cost adder for IGCC technology



Other Air Emissions

- Feedstock handling
- Fugitive emissions
- Startup/shutdown
- Intermittent and upset conditions
- Flare (raw and clean syngas)
- Sulfur Recovery Unit tail gas incinerator
- Tank vents
- Auxiliary boiler
- Emergency generators
- Cooling tower mist

Mercury Emissions

- Most of the mercury is in the CT emissions
- Mercury can be removed from the syngas prior to sulfur removal
- Activated carbon filter
 - ◆ Eastman reports ~95% removal
 - ◆ Disposal of several drums of material per year
 - ◆ DOE project to evaluate removal of other metals



Liquid Discharges

- IGCC designed for internal re-use of process discharges, i.e. brine concentration system purge stream recycled for use in making coal slurry
- Use of zero liquid discharge treatment system for concentrating unusable process discharges, forming brine or cake for disposal

Solid Wastes

- Slag is the largest volume solid byproduct
- Volume depends on feedstock
 - ◆ Higher with coal (5-15% ash)
 - ◆ Much lower with pet coke (<1% ash)
- Similar characteristics to slag from wet bottom PC and cyclone units – black, glassy & non-leachable
- Marketable for roofing tiles, sandblasting grit, asphalt filler



IGCC Slag

- Slag from coal-fired plants has exclusion from RCRA Subtitle C as a “fossil fuel combustion waste” (Bevill waste)
- Slag from coal gasification is covered as a “mineral processing waste”, if feedstock is >50% coal
- If <50% coal, must show that the slag passes appropriate tests to show it is not hazardous

IGCC Slag

- What about when feedstock is >50% pet coke?
 - ◆ Wabash River used 100% pet coke
 - Slag passed TCLP tests
 - ◆ Polk Power Station used ~50% pet coke
 - Slag passed TCLP tests



CoalFleet
for Tomorrow

EPRI CoalFleet for Tomorrow Program

- Developed detailed design basis document for use in specifying a complete IGCC plant
- Includes detailed section on IGCC environmental issues and emission sources
 - ◆ Air
 - ◆ Water and liquid discharges
 - ◆ Solid wastes
- Design targets specified for SO₂, NO_x, CO, VOC, UHC, PM, Hg emissions

Design Targets vs. Emission Limits

- Three levels of performance
 - ◆ Permit limit
 - ◆ Guaranteed level
 - ◆ Manufacturer's design level
- Owner needs a cushion between each of the three levels to assure efficient performance and compliance

IGCC Permitting Guidelines

- Prepares environmental staff for permitting an IGCC power plant
 - ◆ How IGCC permitting is unique
 - ◆ How IGCC and PC plant permitting are similar
 - ◆ How IGCC and NGCC plant permitting are similar
 - ◆ Process Safety Management and OSHA issues
 - ◆ Monitoring and compliance
 - ◆ Tables with permit conditions from existing units, and data from current permit applications

IGCC Plant Permitting - Summary

- Unique permitting issues:
 - ◆ The technology is different from NGCC and PC
 - ◆ IGCC has a feedstock (coal) and a fuel (syngas)
 - ◆ Regulations that cover IGCC are different from those for NGCC and PC units
 - ◆ Different emission sources
 - ◆ Specific method for calculating heat input and emission limits
 - ◆ Minimized liquid discharges
 - ◆ Solid wastes are minimized and marketable

Questions?

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