Gasification Myths and Realities

Ken Ditzel

Gasification Workshop
June 12, 2007
Indianapolis, IN

Introduction – Gasification Myths and Realities

- **Background:**
  - Gasification detractors have long held onto certain beliefs to explain their reluctance to embracing gasification projects
  - These beliefs often can be based on misinformation or a narrow view of the technology
  - The arguments against the projects become part of “urban myths”, passing unchallenged into the popular press.
  - To help bring “reality” back into focus, the GTC decided to assemble a list of the most prevalent myths and the rebuttals to those myths
  - Tasked with surveying GTC members on the “myths & realities” of gasification
  - The following slides are based on that survey and subsequent discussions with GTC members

Where Myths Proliferate

- Commercial Readiness
- Operational Performance
- Criteria Emissions
- Carbon Capture, Transport, and Storage

Myth: The reliability and availability issues of first-of-a-kind IGCC plants built in the 1990's are indicative of an immature technology

Reality: These were first-of-a-kind plants. Recently built plants have shown high reliability.

- The first round of IGCC plants were government funded and involved a lot of equipment and process testing.
- More recently built plants (Negishi in Japan, e.g.) have attained 70% availability within their first year and over 90% by the third year.
- Initial and long-term availability rates will continue to improve as more IGCC units are built and operated.
- Owners of 1990's plants have plans for new IGCC plants:
  - TECO: 630 MW IGCC
  - NUON: 1200 MW IGCC
- Other existing owners, such as Eastman Chemical and ISAB, have announced expansion plans

Operating IGCC Plants

Plant	On-line Year	Size (MW)	Feedstock	Technology
Nuon	1994	253	Coal/ Biomass	Shell
PSI Wabash	1995	260	Coal	ConocoPhillips
TECO	1996	260	Coal/ Coke	GE
Shwarze Pumpe	1996	40	Lignite/ Waste	Siemens
Shell Refinery – Pernis	1997	120	Visbreaker Tar	Shell
Elcogas Puertollano	1998	320	Coal/ Coke	Prenflo (Shell)
ISAB Energy	1999	510	Asphalt	GE
Valero – Delaware City	2000	240	Coke	GE
Sarlux	2000	550	Visbreaker Tar	GE
API Energia	2001	250	Oil Residue	GE
Exxon Chemical – Singapore	2002	180	Ethylene Tar	GE
Nippon Petroleum	2004	350	Asphalt	GE
Eni Sannazzaro	2006	250	Oil residue	Shell

Source: Gas Turbine World: January – February 2007

Myth: Successes in liquid fuel/ petcoke gasification units will not translate into improved reliability for coal-based gasification.

Reality: Experiences gained from operating on non-coal feedstocks will continue to improve the technologies' overall reliability.

- All gasification-based plants including, petcoke and liquid-fuel gasification units have overlapping systems (air separation units, gas cleanup, integration) with coal-based gasification units where operating learning/ improvements can be applied
- For systems where coal can present different challenges (ash, water content, reactivity, etc.) than petcoke and liquid fuels, operators have shown high reliability (e.g. Eastman Chemical, TECO)

Myth: Non-U.S. gasification experience will not translate into improved reliability for U.S. gasification.

Reality: Gasification original equipment manufacturers (OEM), engineering, procurement and construction (EPC) companies, and plant owner are global entities whose experience and technological improvements will not be restricted by national borders.

Global OEMs, EPCs, and Plant Owners:

Air Liquide
Air Products and Chemicals, Inc.
ALSTOM Power Energy Recovery GmbH
Bechtel Corporation
Black & Veatch
BP plc
Burns & McDonnell
ConocoPhillips
The Dow Chemical Company
Eastman Chemical Company
Fluor Corporation
Foster Wheeler Energy International Inc.
GE Energy
Headwaters, Inc.
Jacobs Engineering
Kellogg Brown & Root
Linde Process Plants
Lurgi AG
Mitsubishi Power Systems, Inc.
Porvair PLC
Pratt & Whitney Rocketdyne
Praxair, Inc.
Reliance Industries Ltd.
Rentech, Inc.
Sasol Technology
Shell Global Solutions B.V.
Siemens Power Generation, Inc.
Uhde Corporation of America
UOP
URS Corporation
Valvtechnologies, Inc.
WorleyParsons Group, Inc.

Myth: The inability to secure a guarantee (wrap) indicates that IGCC is not commercially ready.

Reality: All capital intensive technologies, not just IGCC, are facing issues with securing a financial guarantee from engineering, procurement and construction firms (EPCs)

- Rapid increases in field labor and raw materials have made fixed-price contracting difficult for most technologies.
- Major gasification technology vendors are now working to develop standard reference plant designs that can be supported by a wrap.
- Customers are evaluating alternative contracting approaches that do not include a whole plant wrap.
- Alternative financing mechanisms, such as third party insurance, do exist to offset concerns over cost and operational performance.

Myth: Because gasification technologies were derived originally for the chemical industry, they will present a new set of challenges to traditional power plant designers, builders, and operators.

Reality:

- While the skills to build a PC plant are different than an IGCC plant, large EPC companies typically have the petro-chemical skills necessary to design/build an IGCC.
- PC plants are also becoming more like “chemical plants” as emission limits on NOx, SO2, particulate matter, and mercury are tightened, requiring specialized chemical and mechanical systems:
  - SO2 Scrubbers
  - Selective Catalytic Reduction
  - Activated Carbon Injection for Hg removal
  - Potentially amine-based CO2 removal
- PC plants will become even more chemical-like if carbon capture is employed.
- Gasification investors typically are not traditional power plant owner/ operators
- Companies like Eastman Chemical offer plant start-up and operational support for plant owners

Myth: Gasification technologies are not fuel flexible

Reality:

- A variety of technologies can handle a wide range of coals and other feedstocks.
- Collectively, these technologies have long-term operating experience on a wide variety of bituminous and sub-bituminous coals, biomass blends, and petroleum coke (100% and blends), as well as oils and tar oils.

Solid Fuel Gasification Experience

Biomass	High Ash (>20%) Coals	Lignite	Sub-Bituminous	Bituminous Illinois Basin	Bituminous Appalachian	Anthracite & Other Bitum	Petcoke
				Sasol – Lurgi			
				ConocoPhillips E-Gas			
				General Electric			
				Shell + Uhde PRENFLO			
				Synthesis Energy U-Gas			
				Allied Syngas BGL			
				Siemens SFG			
				KBR Transport			
				Mitsubishi			
				Pratt & Whitney			

Tested			Blended/co-feed
Demonstrated (500 TPD or more)			
Millions of Tons Operation			

Source: GTC Survey

Myth: SCPC technology is as "clean" as IGCC in terms of criteria pollutants.

Reality: DOE and EPA studies have repeatedly shown that IGCC can achieve lower emissions of regulated pollutants, uses less water and generate less solid waste than subcritical or supercritical pulverized coal-based power plants.

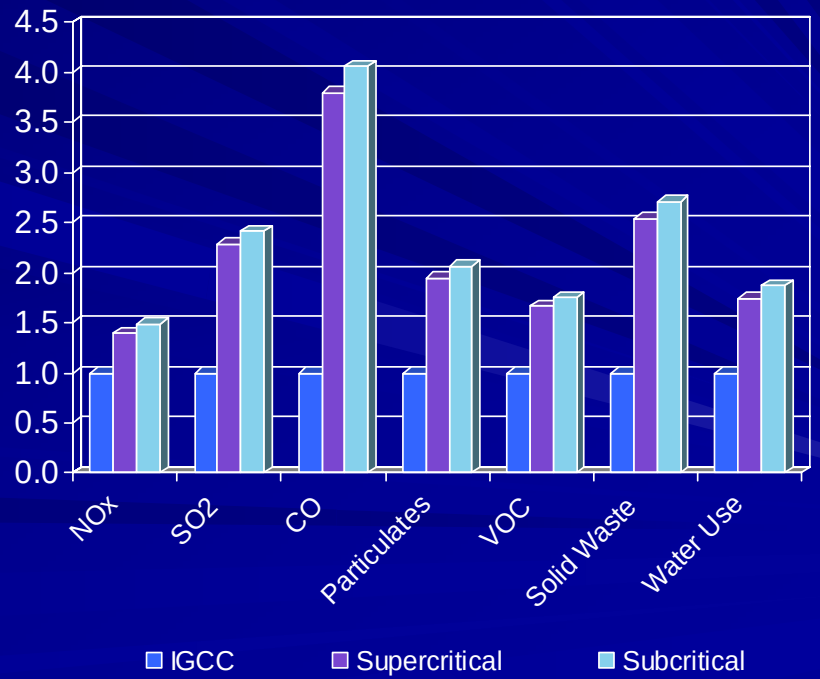
IGCC and PC Comparison (lb/MWh)

	IGCC	Subcritical	Supercritical
NOx	0.355	0.528	0.494
SO_2	0.311	0.75	0.709
CO	0.217	0.88	0.824
Particulates	0.051	0.105	0.099
VOC	0.012	0.021	0.02
Solid Waste	65	165	176
Water Use	4,960	8,640	9,260

Source: *Environmental Footprints and Costs of Coal-Based Integrated Gasification Combined Cycle and Pulverized Coal Technologies*, EPA, July 2206

Normalized IGCC and PC Comparison

IGCC = 1



Myth: New SCPC plants are as efficient as IGCC and therefore are on par with carbon emissions

Reality: Assuming the same efficiency, SCPC with a limestone FGD emits more CO2 per MWh

- A SCPC plant with a limestone FGD will emit 3-8% more carbon dioxide than an IGCC plant, assuming the same overall thermal efficiency.

Flue Gas Desulphurization (FGD) Chemical Reaction:

$$CaCO_3\ (solid) + SO_2\ (gas) \rightarrow CaSO_3\ (solid) + CO_2\ (gas)$$

Myth: Hydrogen turbines, a requirement for carbon capture in an IGCC, are not commercially available.

Reality: Hydrogen turbines are in commercial use today

- Turbines are operating with high hydrogen content fuels (50%-95%+ by volume), in a wide range of process applications.
- Combustion designs are also available that can switch from syngas to higher hydrogen content fuel.
- Offerings are available from GE, Siemens and Mitsubishi Heavy Industries.

Myth: Currently available carbon capture technology for PC and IGCC are similar in cost.

Reality: Numerous studies have shown that the cost of carbon capture using current technology is less expensive for an IGCC plant than a PC plant.

- CO_2 can be captured more efficiently from a concentrated gasifier's synthesis gas stream compared to a PC's flue gas stream, which is 100-150 times larger in volume. As a result, carbon capture from an IGCC will have lower efficiency losses, operating costs, and capital costs relative to a PC unit.
- In terms of technology development, gasification-based carbon capture is being done at commercial scale today in fertilizer and chemical plants, at the Dakota Gasification coal-to-pipeline gas plant in North Dakota and the Sasol coal to diesel plant in South Africa.
- The technical feasibility of post-combustion CO_2 removal (or "CO_2 scrubbing") is not yet proven at the large scale required for typical SCPC plants.

Myth: With R&D advances, combustion based technologies will offer lower cost carbon capture than IGCC.

Reality: Improvements in combustion-based carbon capture could benefit IGCC as well

- If an advanced lower-cost alternative for carbon capture from SCPC facilities is developed commercially, it is likely that the same (or a similar) technology can be applied to IGCC facilities at a proportionately lower cost thus maintaining IGCC's inherent cost advantage for carbon capture.

Myth: Carbon capture and sequestration are not proven at a large scale in the U.S.

Reality: Gasification-based capture and sequestration is being done now in North America

- The Dakota Gasification Company in Beulah, ND, has demonstrated successful gasification-based CO2 capture, compression, and storage since 2000. Capture amount is approximate to a 400 MW IGCC with 90% capture.
- Storage of CO2 is being practiced at commercial scale elsewhere.
  - There are two other large commercial sites in operation in Algeria and Norway.
- FutureGen and the BP Carson project will provide additional examples of large-scale CO2 sequestration from an IGCC plant.
- The oil and gas industry has extensive experience in drilling through various types of underground layers for the injection of water, natural gas, and CO2 into geologic formations either for storage or enhanced recovery.