Deployment of IGCC Technology with Carbon Capture

Sixth Annual Conference on Carbon Capture & Sequestration

May, 2007

Takashi Fujii

MITSUBISHI HEAVY INDUSTRIES, LTD.

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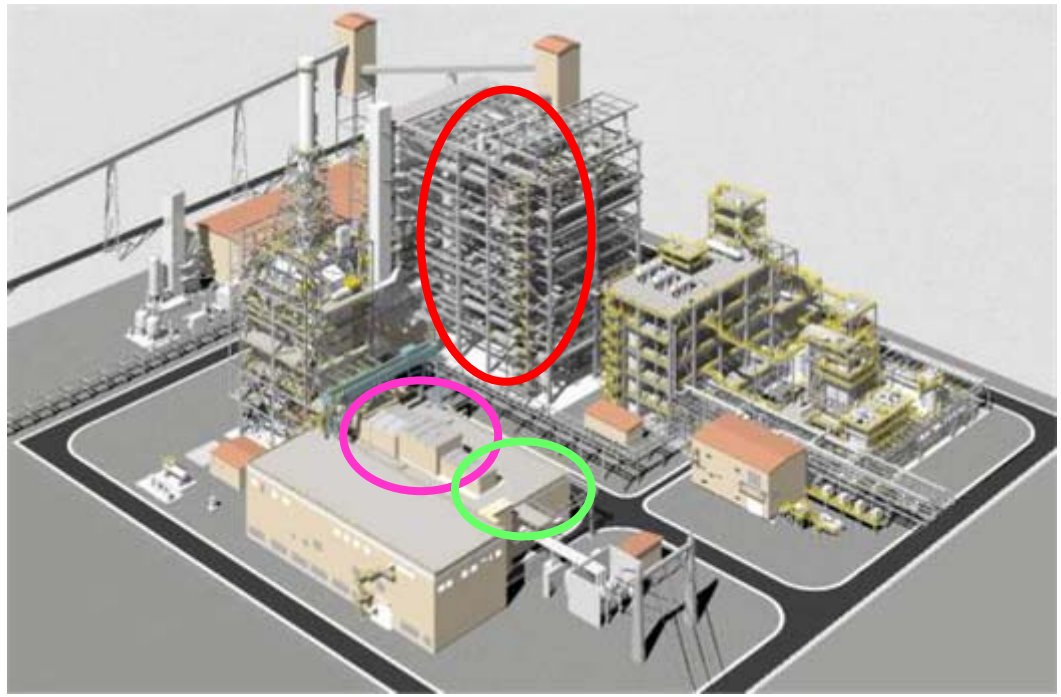
MHI Offers IGCC Solution for Power Generation as;

- **Gasification Technology Provider**
- **OEM of Main Equipment (Gasifier/GT/ST)**
- **EPC Contractor**



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MHI Offers IGCC Solution Technology-Wise;

Air-Blown Coal Gasifier

- ✓ **Membrane WW Structure (Based on 2,800 Boiler Units)**
  ⇒ ***Higher Reliability***
- ✓ **Two Stage Gasifier**
  ⇒ ***Sufficient Syngas Calorie***
- ✓ **Higher Efficiency**
  ⇒ ***Lower Aux. Power***

Low Btu Gas Firing GT

(110Btu/scf / 1,000 kcal/Nm3)

- ✓ **More than 1 Mil. Op-hrs w/ BFG/COG Firing**
- ✓ **High Reliability 2,460ºF IGCC Unit Running in Japan**

High Temperature GT

- ✓ **G type (2,730˚ F) 43 units**
- ✓ **F type (>2,460ºF) 135 units**

R&D and Manufacturing Capabilities

+

System Integration Engineering

Higher Efficiency IGCC Plant with Higher Reliability

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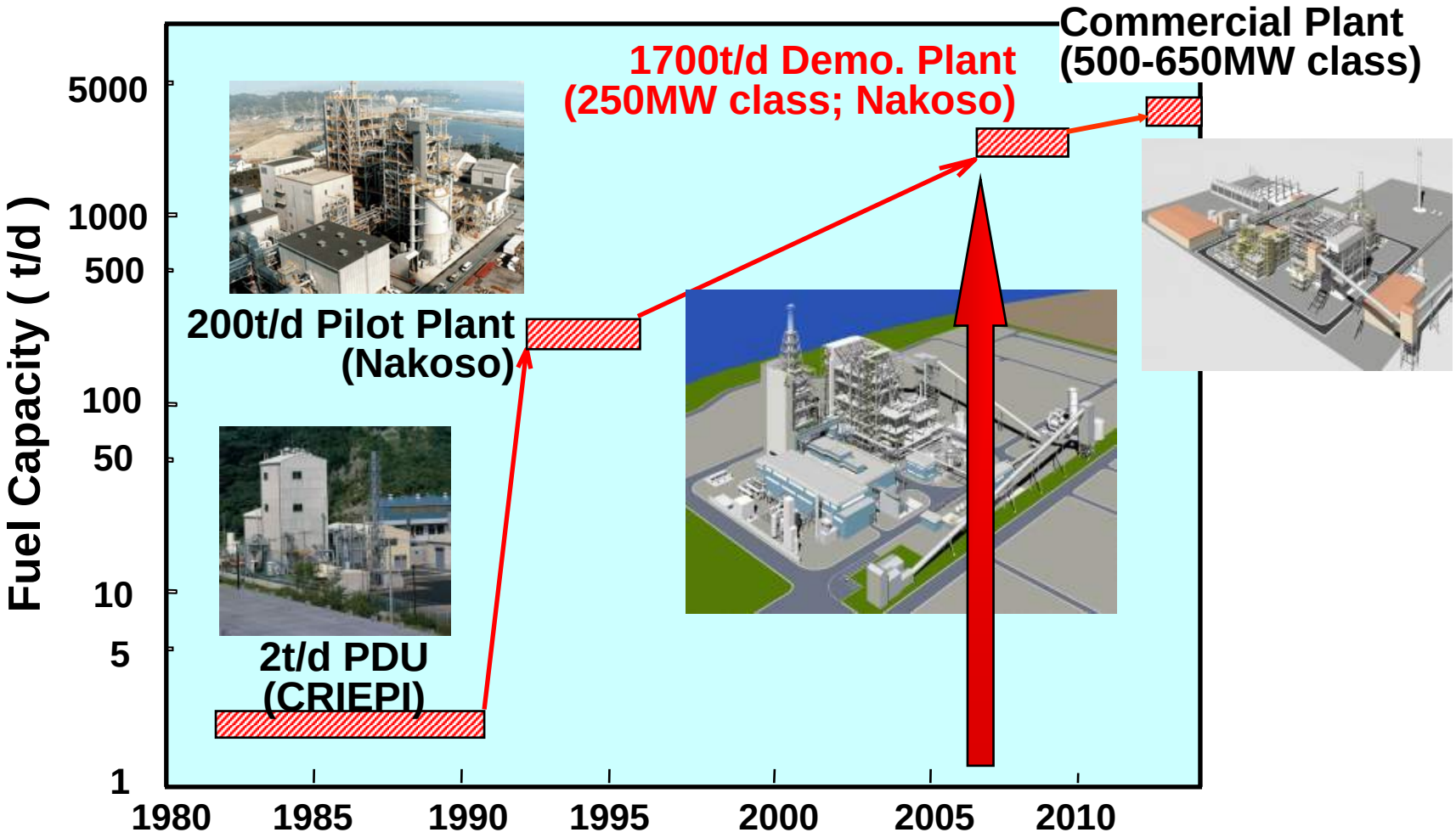
Contents

1. Features of Mitsubishi IGCC

Development of IGCC in Japan



PDU : Process Development Unit
CRIEPI : Central Research Institute of Electric Power Industry

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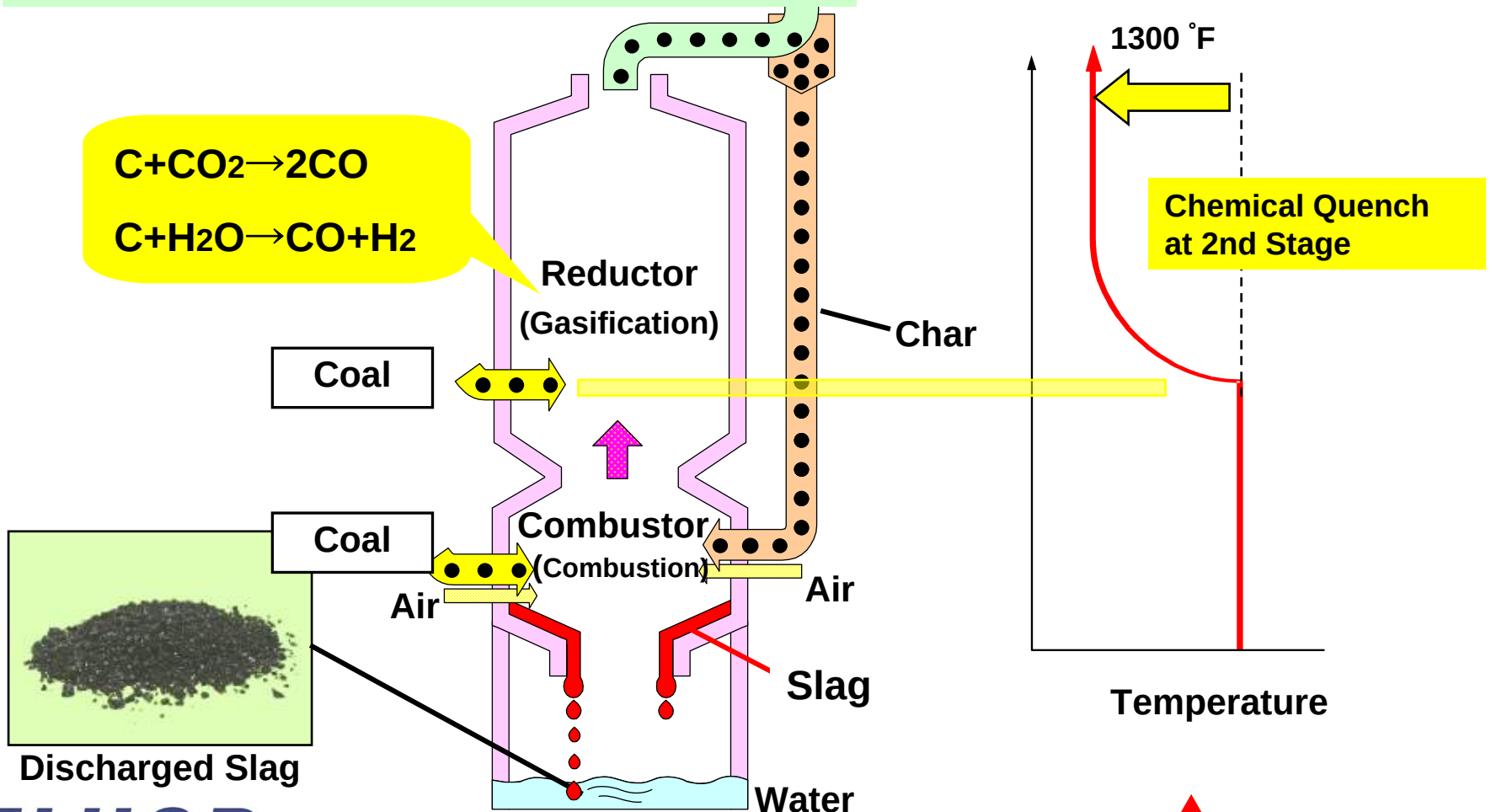
Principle of MHI Air-Blown Gasifier

Syngas CO:30vol%, H2:10vol%
HHV: 130Btu/scf (1,150kcal/m³N)

→ Sufficient Syngas Calorie



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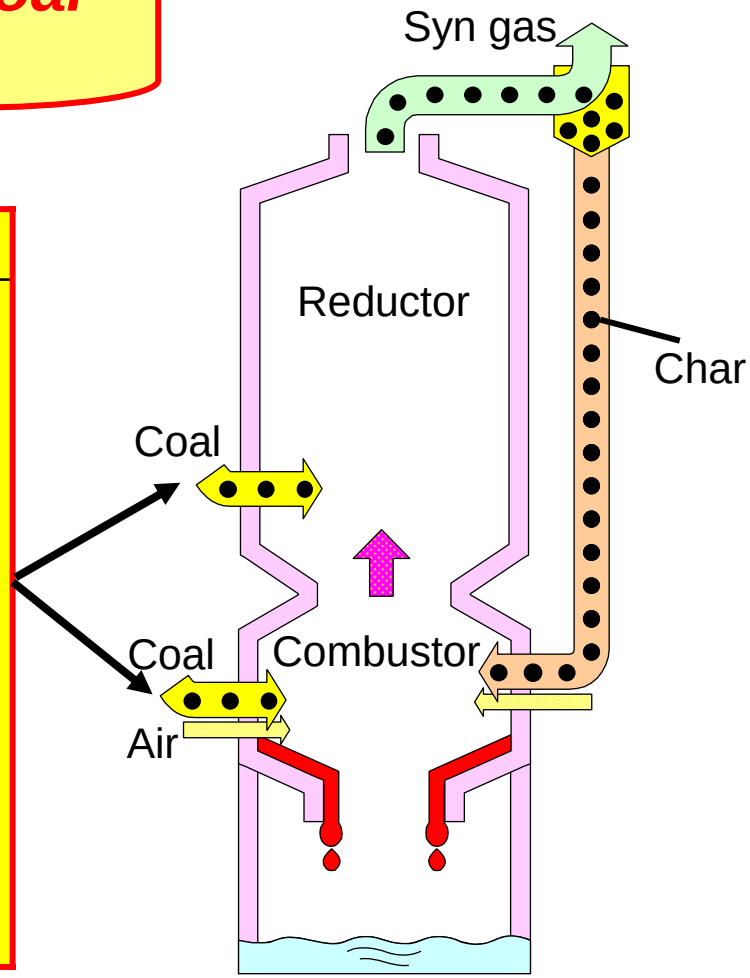
Dry Coal Feed
- Fitting to High/Low Moist. Coal

Dry Feed System Fits to PRB Coal and the Others Flexibly.

Wet Feed	Dry Feed
	
Slurry Transportation Affected by Moist. Content	**Pneumatic Coal Powder Transportation**



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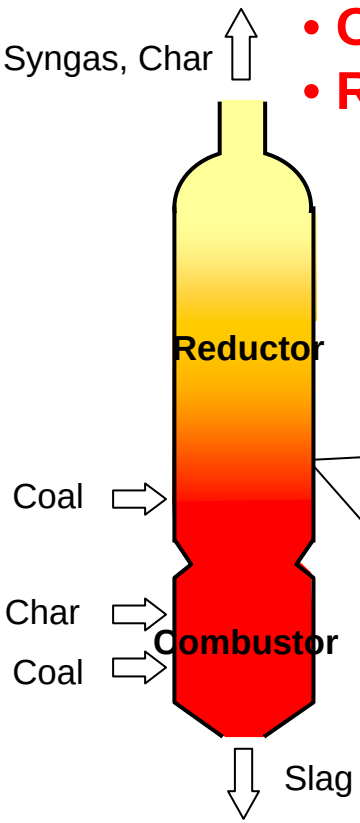
Highly Reliable Water Cooled Gasifier Wall

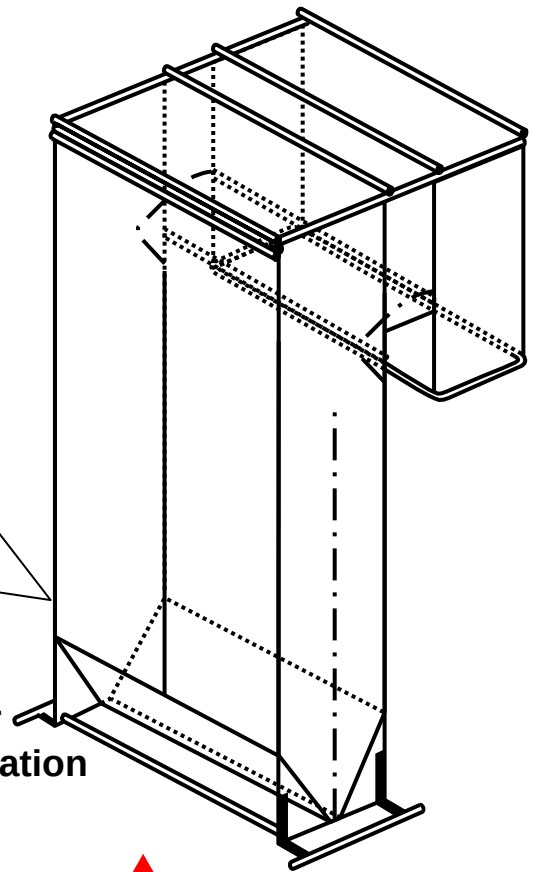
Applying Membrane WW Structure
Based on MHI's Abundant Boiler Experience (2,800 Units) :

- **Ensures Higher Reliability.**
- **Offers Remarkably Better Durability.**
- **Reduces Maintenance Work.**



Membrane WW

WW of Coal Firing Boiler
More than 10 years Operation



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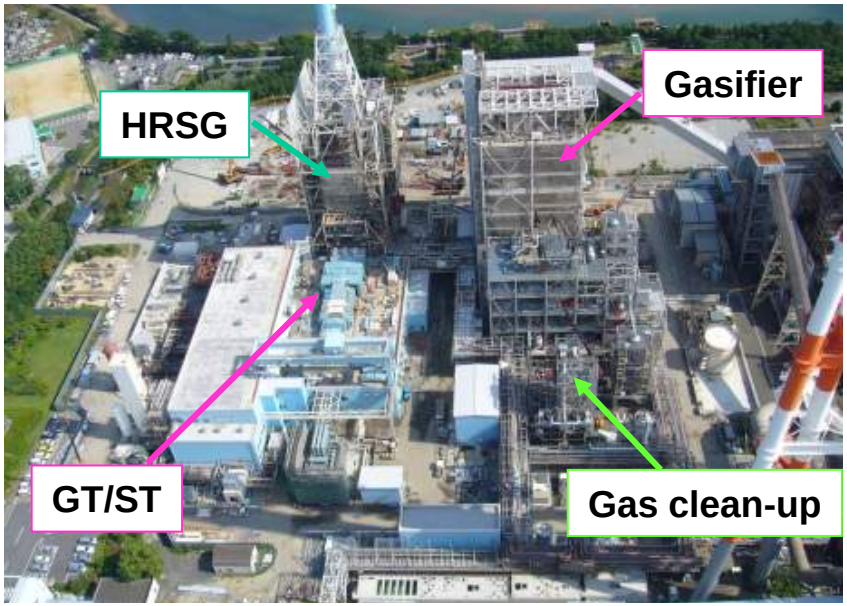
250MW IGCC Demonstration Plant

Clean Coal Power R&D CO., LTD (CCP)



- Specification

Gasifier	Dry Feed, Air Blown, Two-Staged Entrained Flow
Gas Clean-up	Wet MDEA + Gypsum Recovery
Gas Turbine	2,200F-deg Class

- Coal Feed: 1,700t/day
- Net Efficiency: 40.5%(HHV)
- Emission: SOx : <0.06 lb/MMBtu
  NOx : <0.03 lb/MMBtu with SCR
  PM : <0.006 lb/MMBtu
- Construction Started: Aug. 2004
- Operation to Start: Sept. 2007

- National Project
  - 10 Japanese Utilities & 30% Government Subsidy
- MHI Single TK Contract
  - All Key Components Supplied under Single Point Responsibility

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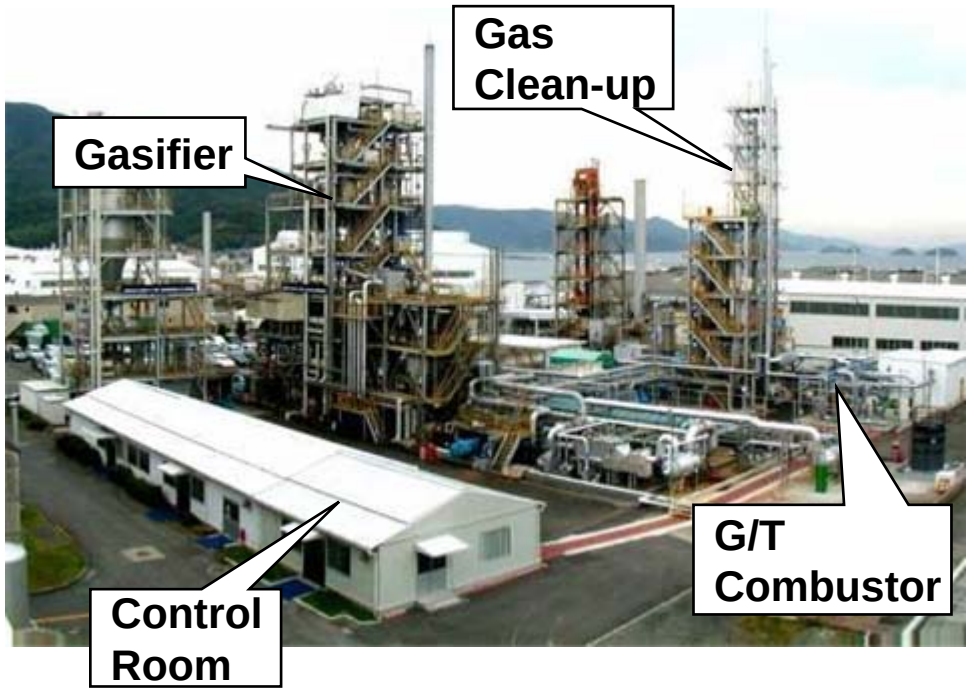
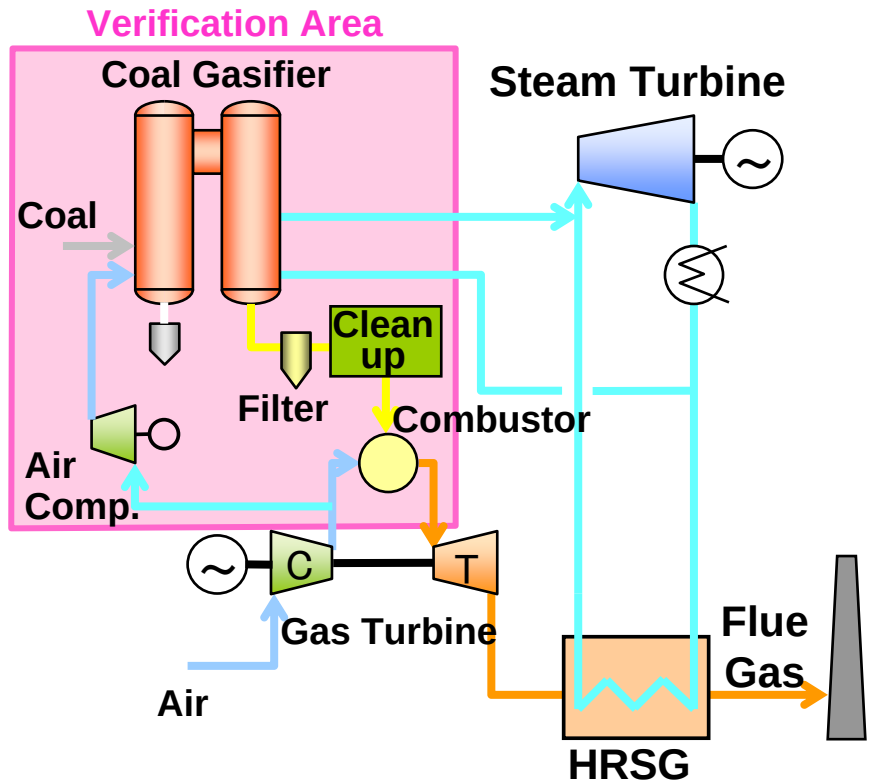
2. PRB Coal Gasification Test Results

24t/d IGCC Test Plant in MHI Nagasaki R&D Center

Verifying Key Components and Plant Performance for Various Kinds of Coal





Gasifier : Air-Blown
Capacity : 24t/d (8MWth)

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PRB Coal Gasification - Expected Syngas Produced

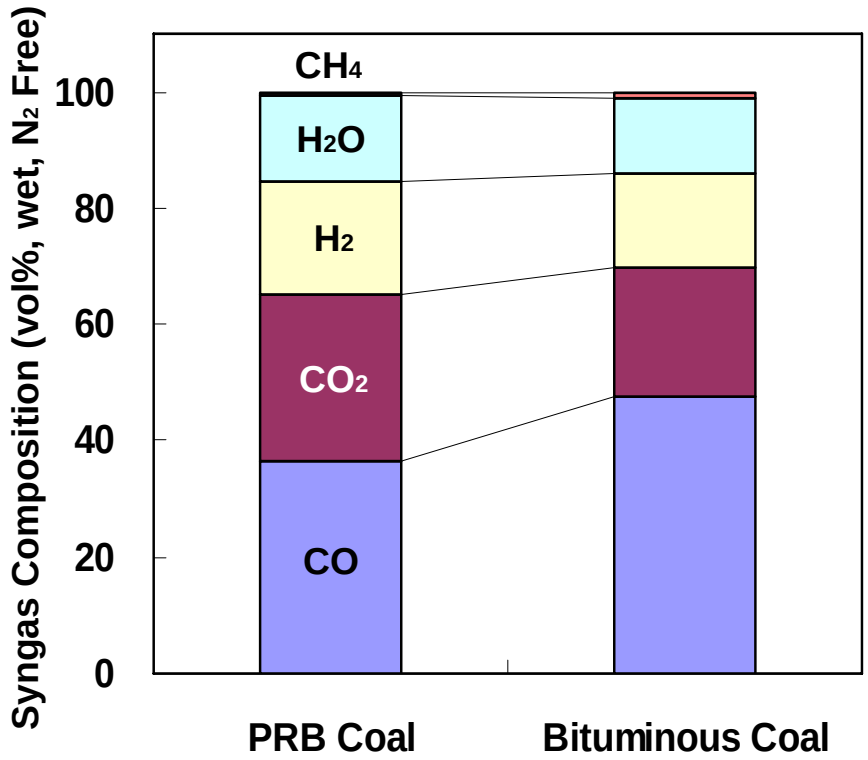
1.PRB Coal Property

PROXIMATE, wt.%, a.r.	
Moisture	26.7
Ash	3.9
Volatile	32.3
Fixed Carbon	37.1
HHV, Btu/lb	9,100
ASH FUSION TEMPERATURE (Reducing)	
Fluid, F-deg	2,165

Appearance of PRB Coal

2.Syngas Compositions

- Meeting Expectations for Each Coal.
- Verified for High TIT GT Application.



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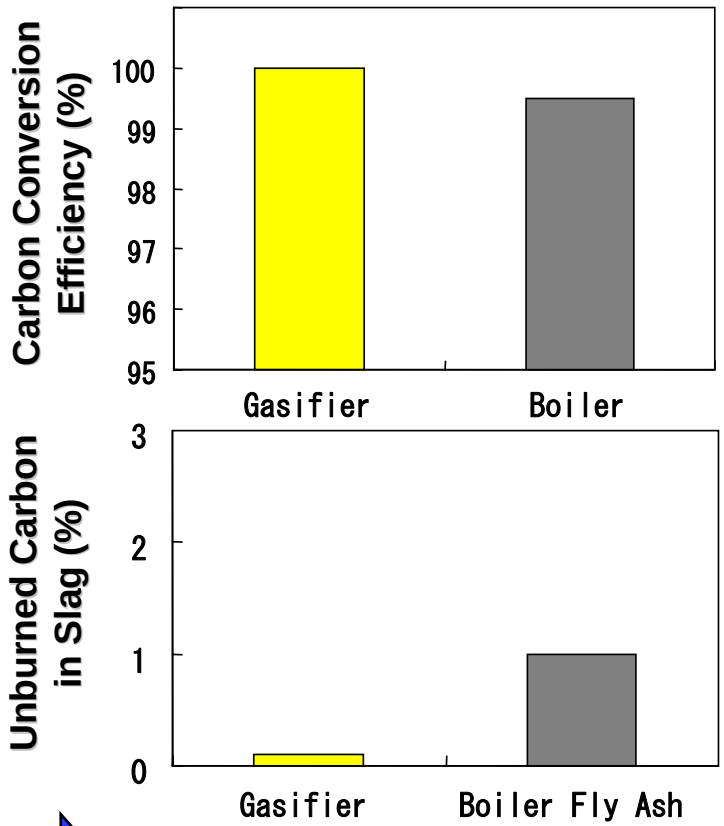
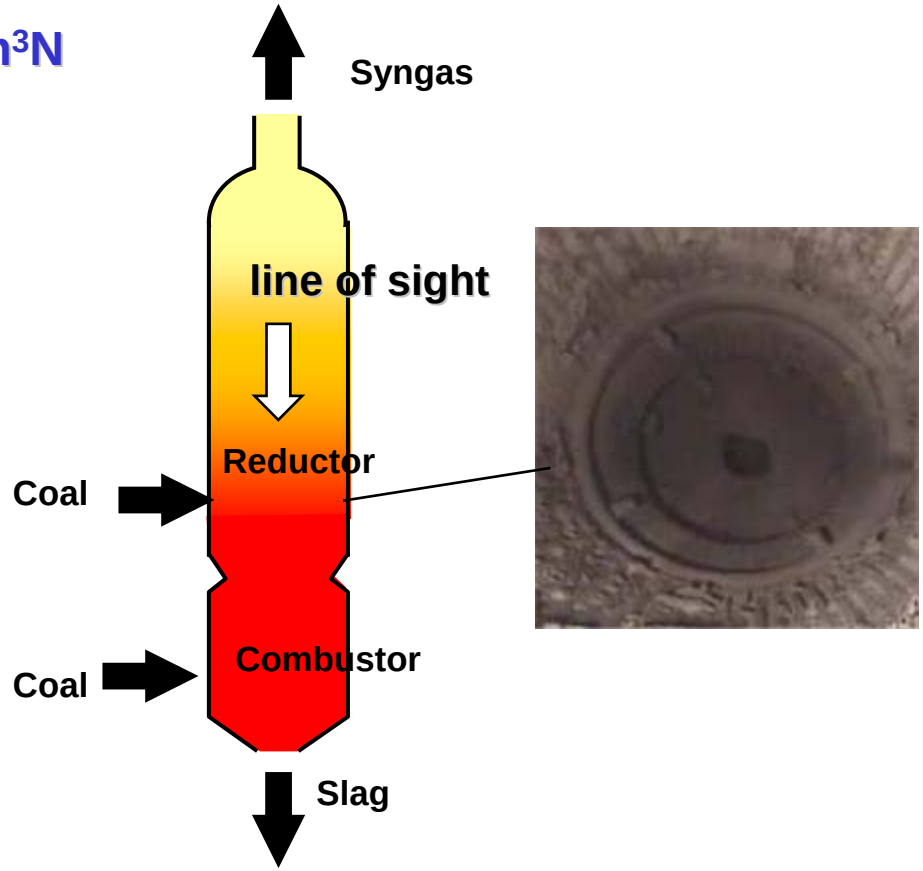
PRB Coal Gasification - Low UBC / No Slagging Verified

Carbon Conversion Efficiency: >99.99%
Unburned Carbon in Slag : < 0.1%
Dust in Syngas at filter outlet : < 1mg/m^{3}N

No "Slagging" Tendency in Gasifier





Knowledge Accumulated & Feasibility Verified of 'Using PRB'

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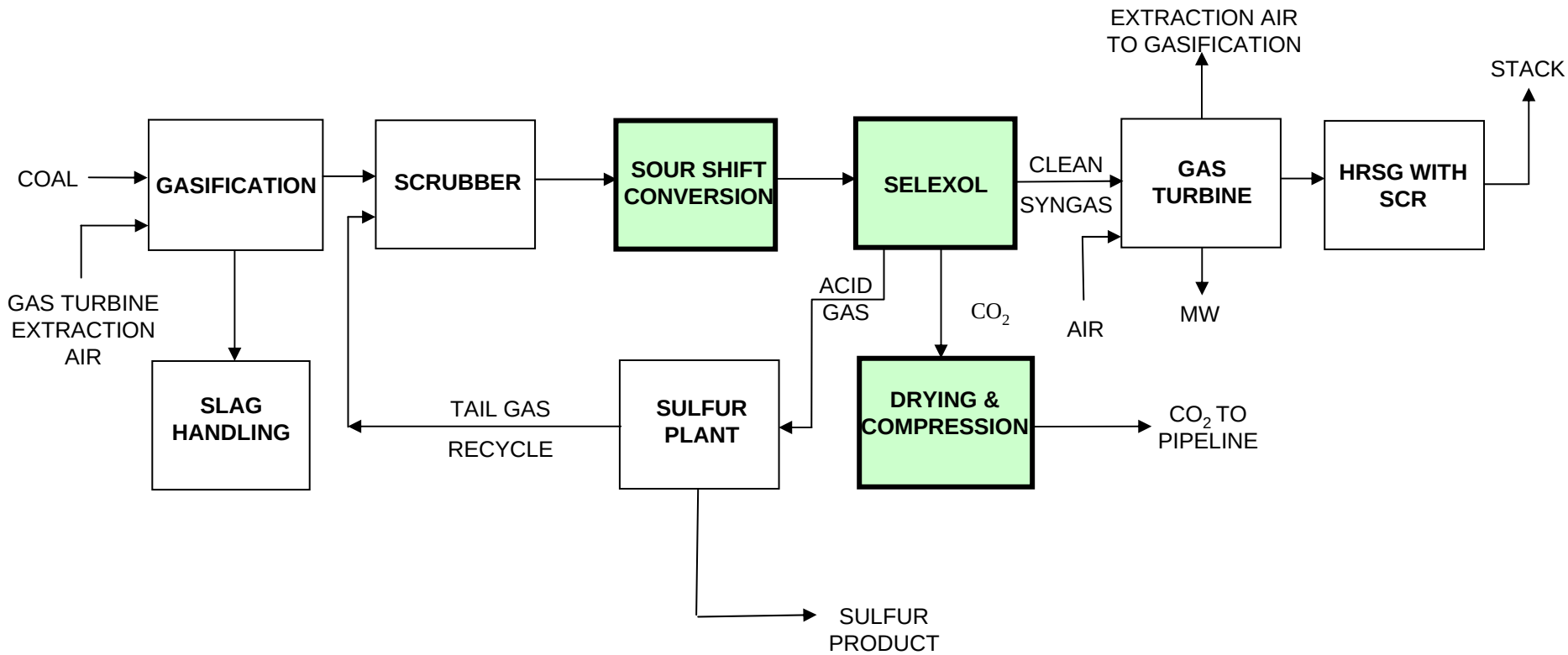
3. Approach to CO_2 Capture

CO_2 Capture System
-Newly Built IGCC Plant-

Sour Shift for concurrent CO_2 capture with Air-blown gasification



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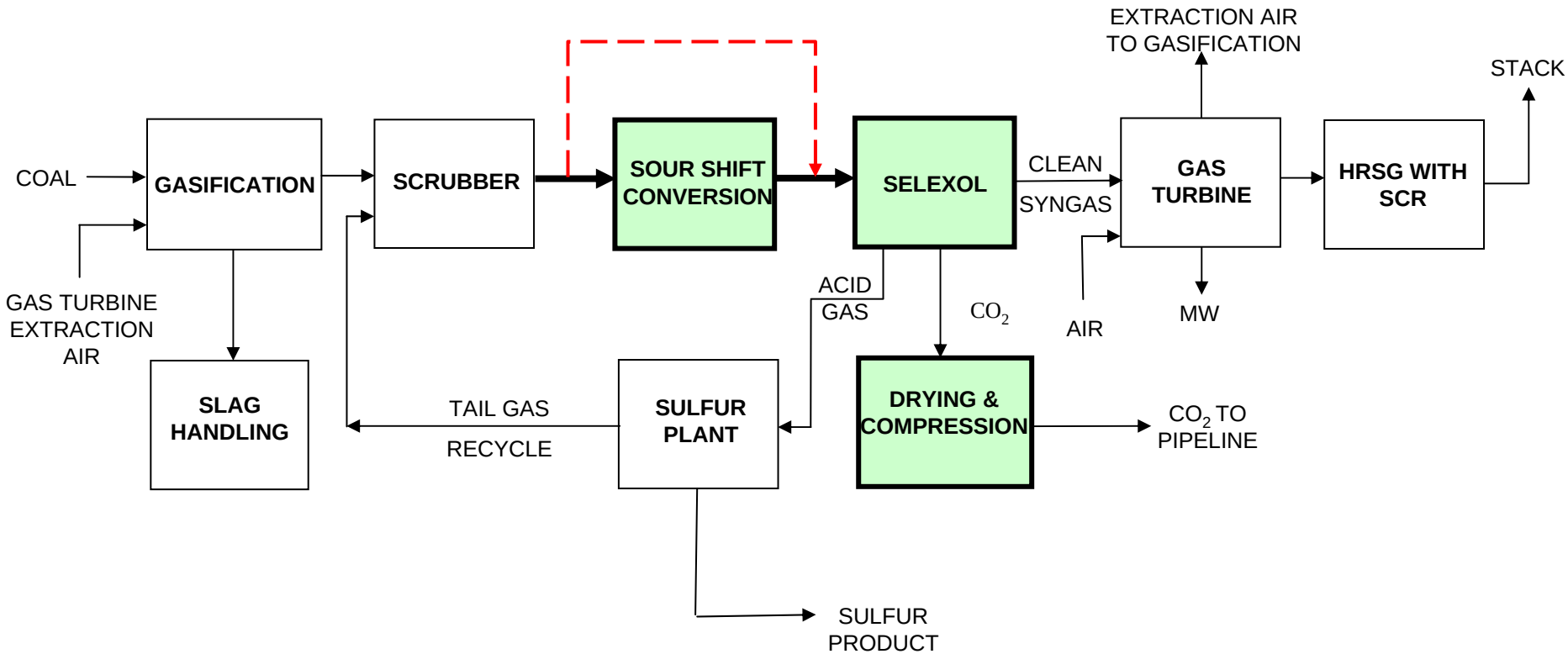
Key Feature of Sour Shift CO_2 Capture with Air-blown Gasification (1/3)

- 50 mol% N_2 content in air-blown syngas is a good heat sink for shift conversion
- Simple process flow with no syngas bypass line



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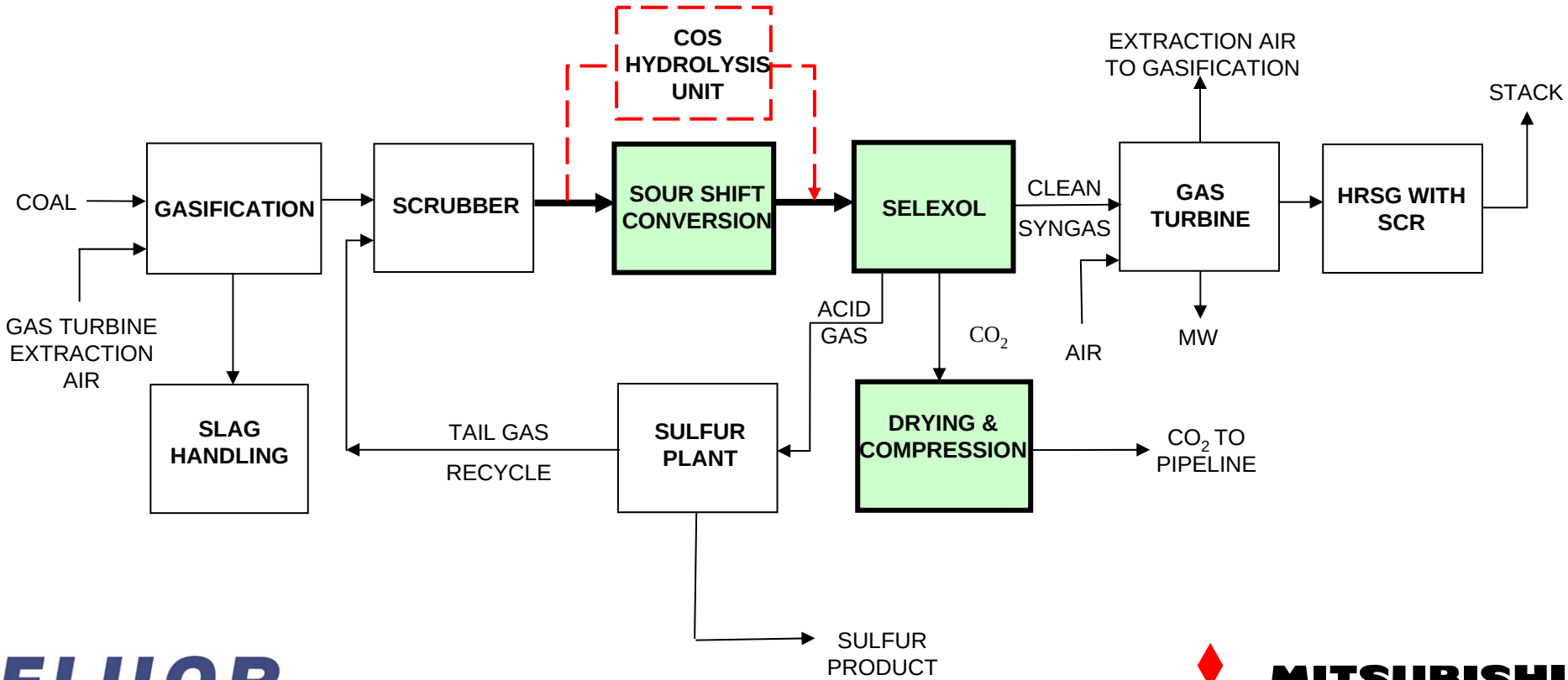
Key Feature of Sour Shift CO_2 Capture with Air-blown Gasification (2/3)

- **Full syngas flow through shift converter needs NO COS hydrolysis unit**
- **Clean syngas from SELEXOL contains less than 10 ppmV sulfur to facilitate SCR**



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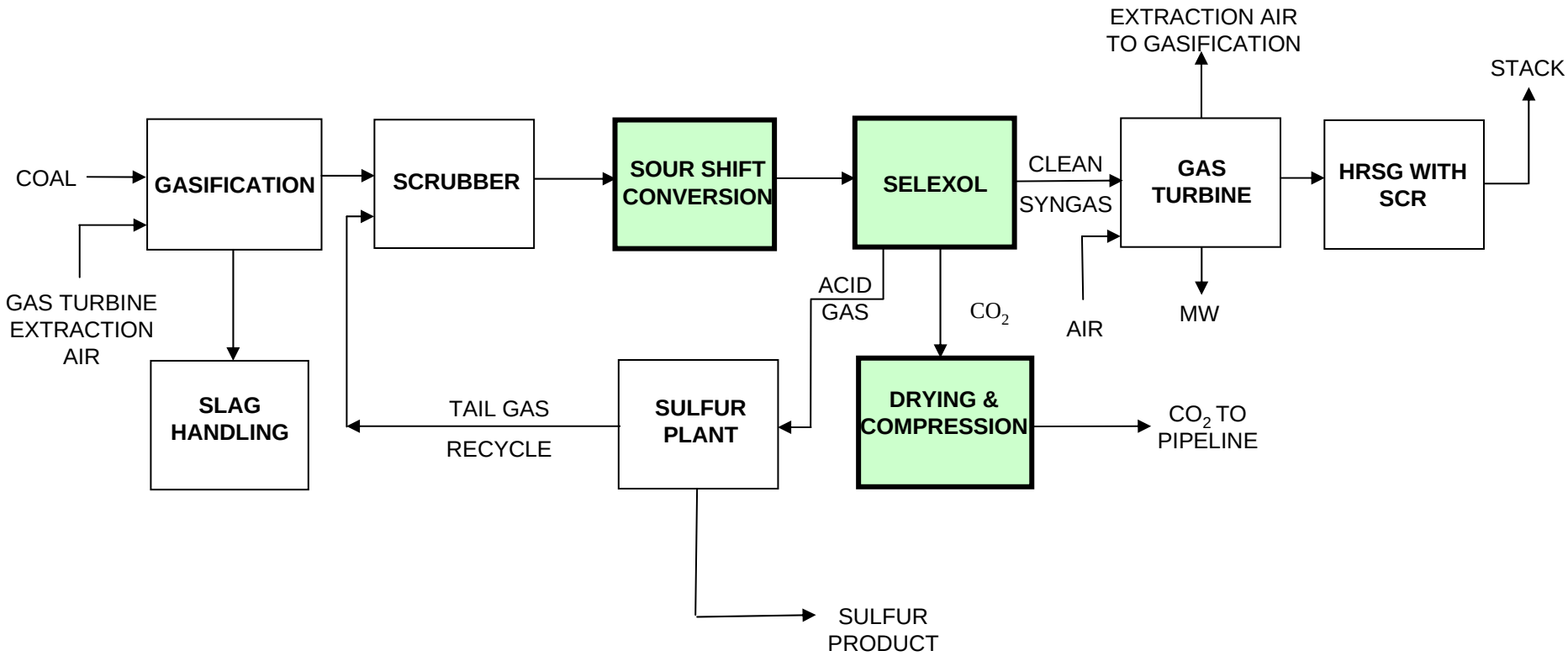
Key Feature of Sour Shift CO_2 Capture with Air-blown Gasification (3/3)

- **Varying syngas temperature to shift unit offers control of CO_2 capture required**



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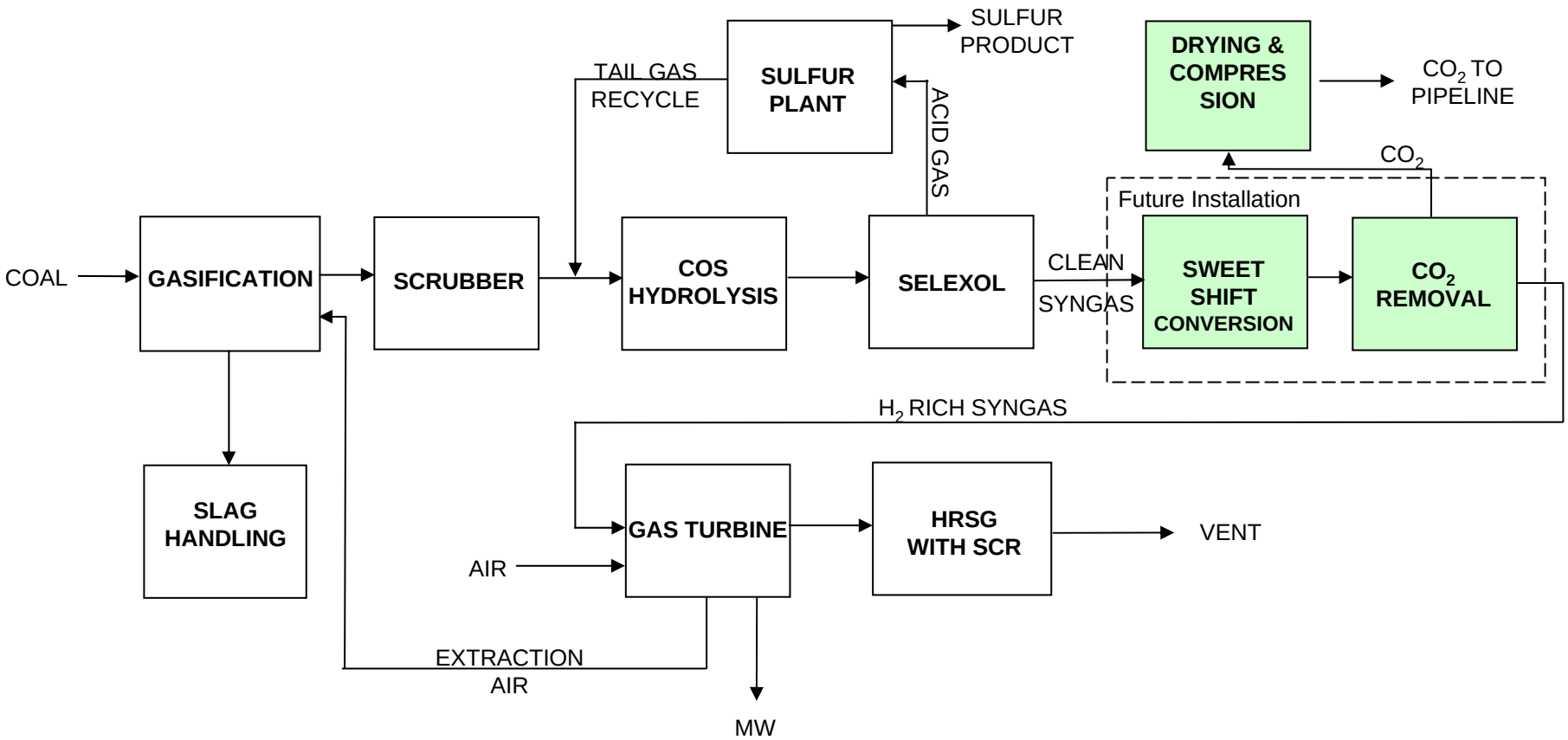
CO_2 Capture System -"Capture Ready" Design -



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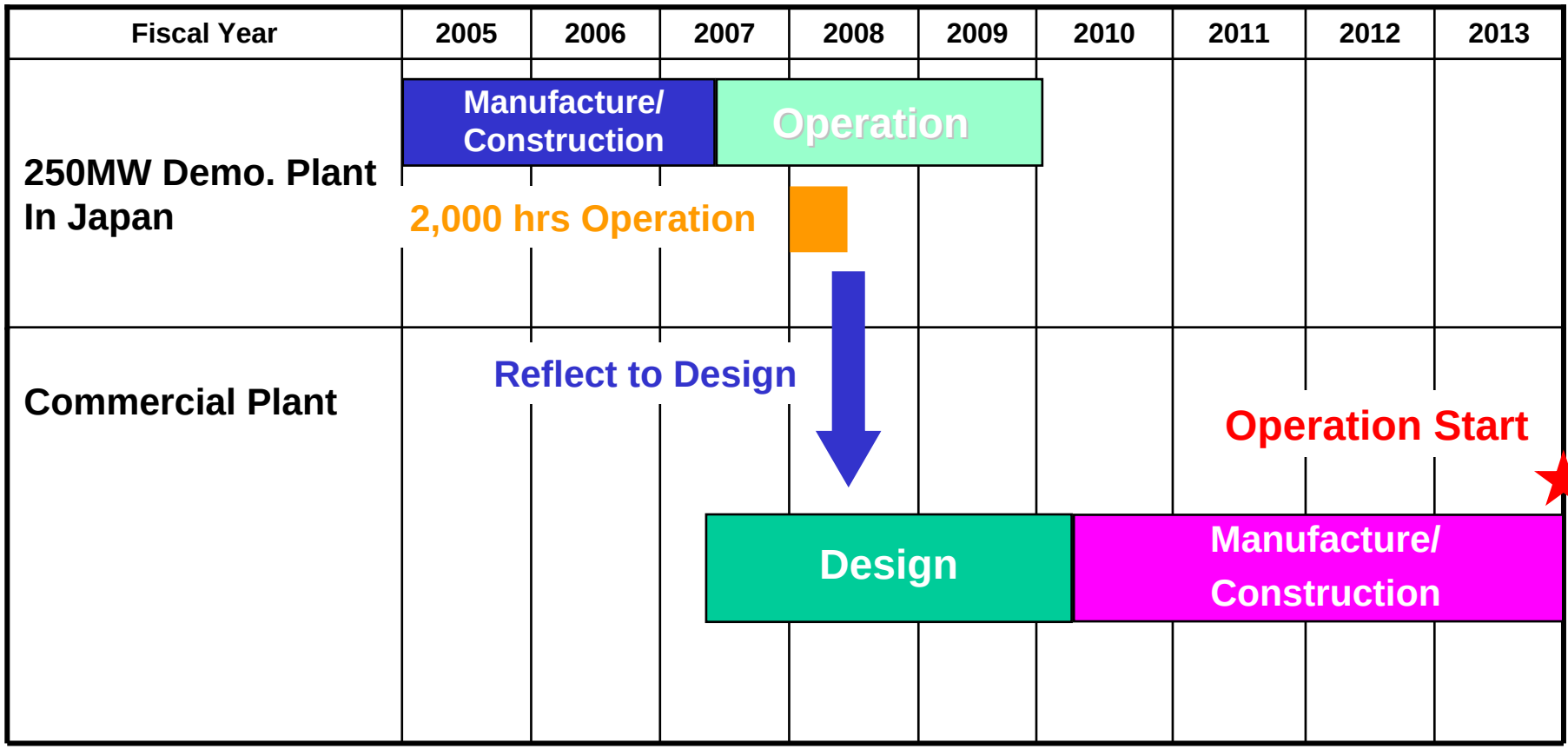
CO_2 Capture System "Capture Ready" Design Features

- Sweet shift appears more suitable for future CO_2 capture with minimum impact on the existing facility
- CO_2 removal after H_2S/COS removal can be performed using MDEA or FLUOR solvent with flash regeneration
- SELEXOL for sulfur only removal is less expensive than SELEXOL for H_2S & CO_2 REMOVAL
- SELEXOL for sulfur removal achieves low sulfur concentration in clean syngas suitable for SCR

IGCC Commercial Plant - Realization Schedule

Ready for Commercial Plant Operation in 2013



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4. Summary

1. Air-Blown/Dry-Feed Gasifier & Low Btu/High Temp. G/T
   ⇒ Higher Plant Efficiency
   ⇒ Higher Reliability w/ Long-Term Operation Experience
2. 250MW Demonstration Plant - Operation in 2007
   ⇒ Ensuring Quality/Performance of Commercial Plant
3. PRB Coal Verification
   ⇒ The design data for commercial scale gasifier acquired in 24t/D confirmation test plant
4. CO2 Removal Concurrent with Air blown IGCC
   ⇒ Simple process flow with reduced capital cost
5. After Demonstration Plant Project
   ⇒ Ready for Commercial Plant Operation in 2013


Thank you for
your attention!