IGCC and Co-Production in China

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The National Joint Expert Group for IGCC and Co-Production Demonstration Engineering

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IGCC/Co-production

- Solution to the issues with coal, power, and oil
  - Clean and efficient power generation from coal
  - Ultra-clean fuels and chemicals from coal
  - Fuel and product flexible
- Consistent with hydrogen economy, CCS
- To build a stable, economic, clean and secure Energy supply system
IGCC/Co-production

- IGCC
- Gasifier
- ASU
- Heat Recovery
- Purification
- H₂/CO₂
- GTL
- GT
- HRSG
- ST
- S Recovery
- Zero Emission System

Outputs:
- Chemicals
- Liquid Fuels
- Electricity
IGCC/Co-production

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China Vision

Natural gas
- GTL
- Advanced reactor (F-T)

Coal
- IGCC
- Co-production of power, liquid fuels, chemicals
- Syngas conversion to fuels and chemicals
- High T heat exchange

Progress

70's
- 31.2% 1st Generation

80's
- 39-45% 2nd Generation

90's
- 45-50% 3rd Generation

00's
- 75% Adding Co-product Near Zero Emission

2015
- 60% Adding FC/GT Near Zero Emission

Advanced Technologies
- Chemical Energy Release
- Purification
- Power Conversion
- Air/Gas Separation
- High T Heat Exchange
- Syngas Conversion to Fuels and Chemicals
The Course and Evolution of IGCC and Co-production in China

- **1970’s, Suzhou IGCC pilot plant — Abortion**
  - Platform

- **1990’s, Yantai 300~400MW IGCC demonstration plant — not start construction yet**
  - Dependent on imported technologies
  - High capital cost
  - High COE
The Course and Evolution of IGCC and Co-production in China
The Course and Evolution of IGCC and Co-production in China

- 863 Project——High-Tech Research and Development Program of China (2001~2005)
  - Yankuang 240,000 t/a methanol and 60MWe Co-production demonstration
  - 1000 TPD coal slurry feed gasification
IGCC & Co-Production Development in China

— Yankuang 240,000 t/a methanol and 60MWe Co-Production Demo Plant
IGCC & Co-Production Development in China

Yankuang 240,000t/a methanol and 76MWe Co-Production Demo Plant

- New type slurry feed gasifier: 1150 TPD × 2
- Investment 1.58 billion RMB
- Financial investment recovery in 8.1 years (construction period included)
- Operating, totally >6000 hours achieved by now

Commercial Operation since Apr. 2006
Gasification

- new-style coal-water slurry gasification
  - scale: 1150 tons/day
  - operation times up to 5130 hours
- dry pulverized coal pressurized gasification (1)
  - scale: 24 tons/day
  - operation times up to 2100 hours
- dry pulverized coal pressurized gasification (2)
  - scale: 45 tons/day
Synthesis

- **750 tons per year pilot plant of CTL**
  - 7 operation experiments
  - In 2004, operation with full load 1500 hours
  - sufficient operation experience and engineering data through 5000 hours run of the plant

- **5000 tons per year pilot plant of CTL**
  - operation for 6068 hours
  - full load operation times up to 4706 hours
IGCC & Co-Production Development in China
——Advantages, Barriers and Strategies Research

- **Barriers Recognized**
  - **Policy barriers**
    - No special policies
    - Lack of market measures or incentives
    - Environmental policies and standards need further improvement
  - **Institutional/organizational barriers**
    - Unfavorable sectoral structure and division
    - Low investment
    - Lack of market mechanism and effective government supervision
  - **Technical barriers**
    - Key Technologies
    - System integration & design
  - **Financial barriers**

- **Breakthrough Needed**
  - **High-Tech**
    - Gasification & Syngas Preparation
    - Syngas Gas Turbine
    - Fuels and Chemical Synthesis
    - Hydrogen Production and CCS
  - **Industrial Reform**
    - Power Utility
    - Coal Chemical Industry
    - Technology providers, engineering design, equipment manufacturing
  - **Cooperation Mechanism**
    - Government
    - Industry
    - Institute
    - University
IGCC & Co-Production Development in China
——Coal Co-production Technology Roadmap

- Goals: provides a blueprint for the coordinated, long-term, efforts required
  - Develop unified roadmap
  - Maintain high-level approach

- Supported by
  - Ministry of Science and Technology, China
  - China Academy of Sciences
  - NRDC

- Implementation by
  - IET, CAS
  - 863 Clean Coal Technology Experts Group
IGCC & Co-Production Development in China
———Coal Co-production Technology Roadmap

- Energy System Innovation Integration
- Step-by-step Strategy
  - Mature Individual Technologies Integration
  - Key Technologies Breakthrough
  - Near Zero Emission Technologies
- Combined Strategy
  - State Guide and Enterprises Voluntary Participate
  - Industrial Development and Technological innovation
  - International Cooperation and Self Creation
Technology Development Strategies
——Roadmap Goals

- **Overall Goal**
  - Form the clusters of the Clean Coal Technologies, support the development of China’s energy manufacturing industry, achieve the efficient, clean, and affordable of coal

- **Stage Goal**
  - 2010
    - commercial demonstration power plant
    - coal gasification based co-production of oils and power system
  - 2020
    - Installed capacity of IGCC to reach 20,000MWe
    - Synthetic oil and chemical products to substitute 50 million tons of crude oil on annual basis
    - Conversion of coal into hydrogen and electricity, and near-zero emission of CO₂
IGCC & Co-Production Roadmap in China

- **2005**
  - Power/Methanol Coprod.
  - Slurry Fed 1,000 t/d
  - Dry Fed
  - Fuel Flex. Gas.
  - Syn Oil 5,000 t/a
  - Synthetic alcohol ether
  - 60MW Power 240,000 t/a Methanol Coprod.

- **2010**
  - Slurry Fed 2,000-3,000 t/d
  - Dry Fed 2,000 t/d
  - Fuel Flex. Gas. 600 t/d
  - Syn Oil 1,000,000 t/a
  - Synthetic alcohol ether 10,000 t/a
  - Power-oil-Chemical Coprod., Oil 1 Mt/a, IGCC 200MWe

- **2015**
  - Slurry Fed
  - Dry Fed 2,000-3,000 t/d
  - Fuel Flex. Gas. 1,000 t/d
  - Syn Oil
  - Synthetic alcohol ether
  - 3 Power-oil-Chemical Coprod., Oil > 1 Mt/a, IGCC 400MWe

- **2020**
  - Adv. System Integration Technology
  - Dry Fed
  - Fuel Flex. Gas.
  - Power-oil-Chemical Coprod. Totally 15,000 MWe/55 Mton

- **B Class GT Retrofit**
- **E Class GT Retrofit**
- **F Class GT Retrofit**
- **G&H Class GT Retrofit**
- **HAT Cycle Key Tech. R&D**
- **Near Zero Eml. Power & H₂ Coprod. 1,000 t/d Coal**
- **Integration**
  - Laboratory
  - Pilot
  - Demo
  - Commercial
  - Syst. Demo
The 11th Five-Year Plan Co-Production Projects

- High Technology Research and Development Program of China (863 program)
- RMB 350 million from government
- RMB 25000 million from industries
The 11th Five-Year Plan Co-Production Projects
—-863 Major Project, 2006-2010

Key Technologies R&D and Demonstration

- New style Slurry Feed Gasifier
  - 1150 TPD
- Dry Feed Gasifier
  - Pilot Scale
  - 2000 TPD
- Fuel Flexible Gasifier
  - Laboratory Scale
  - 1000 TPD
- low emissions GT Retrofit
  - B Class Single Burner
  - 750 t/a
  - 5000 t/a
- CTL
  - 0.1-1 Mton/a
- Operation Control
  - Power and CTL Co-Product
  - IGCC&0.1-1Mton/a

3 IGCC Demo Plants
2 Power and CTL Co-Product Plants

Operation and Control Technologies
System Integration Technologies

Key Tech.
2001-2005
2006-2010
## The 11th Five-Year Plan Co-Production Projects

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The 11th Five-Year Plan Co-Production Projects
—— Administrative Framework of the Project

Ministry of Science and Technology
Office of Energy Field

Office of Project

Expert Group

Mandatory Supervision Comp.
## Expert Group

<table>
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<tr>
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The Alliance for IGCC and Co-production

- Government
- CAS
- Universities
- Institutes
- Industries

Cooperation:
- FutureGen
- Tech & Eng. Advisory
- Policy …
- RDD?……
The Alliance for IGCC and Co-production

—— Organization of the Alliance

- Integration of Industries, Universities and Institutes
  - Industries: Manufacturer, Designing Institutes, Coal Companies, Power Companies
  - Institutes
  - Universities

- Start with current participants in the IGCC and co-production demonstration engineering
The Alliance for IGCC and Co-production

——Functions of the Alliance

- Coordinate R&D$^2$ activities on IGCC and co-production technologies
- Jointly develop and construct platform for key technologies R&D$^2$
- Accumulation of information and experience, assessment of technical direction, promote application and development
- Form industrial norms and standards
- Provide consultation and suggestions for formulating national policies
The Alliance for IGCC and Co-production

—— Functions of the Alliance (cont.)

- Provide a platform for international cooperation
  - Speed up the learning process of IGCC and Co-production technologies
  - Joint R&D to IGCC and Co-production technologies
  - International cooperation on CCS
70’s  90’s  2001-2005  2006-2010

Project  Suzhou Pilot IGCC  Yantai IGCC  Yankuang Co-production  IGCC & Co-production Projects

Concept Study  Preliminary Research  National 863  National 863

R&D

IGCC Design Integration & Dynamic Performance
Basic Research of the Coal Pyrolysis and Gasification and High Temp. Purification
Large-Scale Efficient Entrained Flow Coal Gasification Tech.
High Temp. Purification Tech.

1150 t/d New Slurry-Feed Gasifier Tech.
36 t/d Dry-Feed Gasifier Tech.
Syngas GT Combustor Retrofit Tech.

2000 t/d New Slurry-Feed Gasifier Tech.
2000 t/d Dry-Feed Gasifier Tech.
1000 t/d Fuel Flexi. Gasifier Tech.
Low Emission Syngas GT Combustor Retrofit Tech.

Key Technologies
Remarks

- IGCC/Co-production is very important to China. It is the direction of the development of clean coal technology and an option to resolve energy problems of coal, power, oil and transportation.
- Efforts and progresses were made and will continue.
- Governmental support and right decision, combination of industry, university and institute, effective international collaboration are needed.
Thanks for Your Attention!