Current development situation of Coal to SNG in China

Chunqi Li

Datang International Chemical Technology Research Institute Co., LTD.

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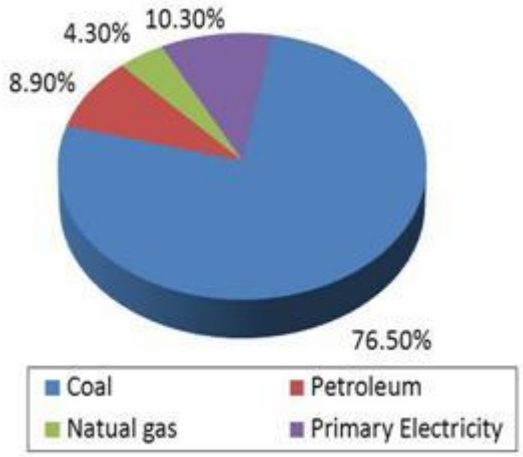
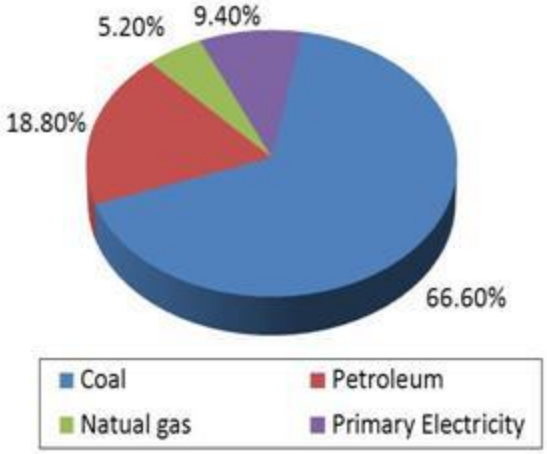
Outline

1. Background
2. Coal to SNG Technology Route
3. Key Technology Development in China
4. Coal to SNG Projects in China
5. Technology Developing Trends and Challenges

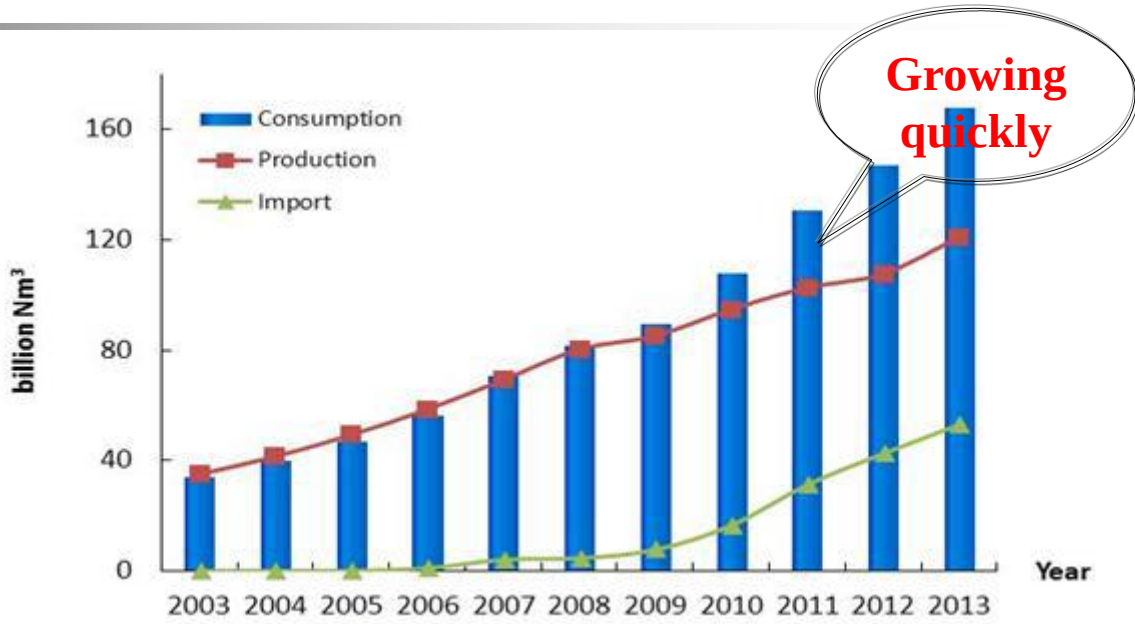
China's Energy Status and Natural Gas Supply



China's Energy Production Structure in 2013



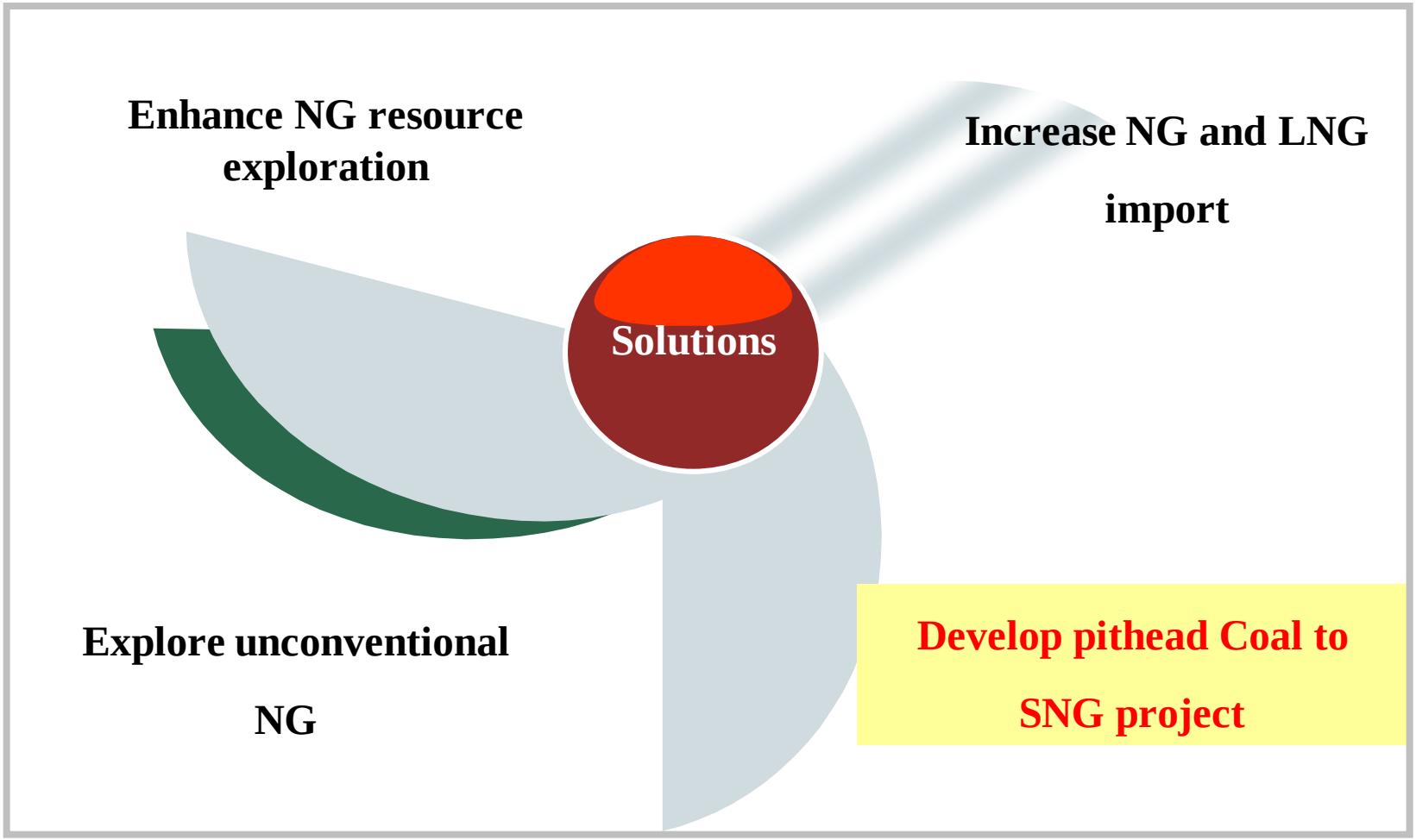
China's Energy Consumption Structure in 2013



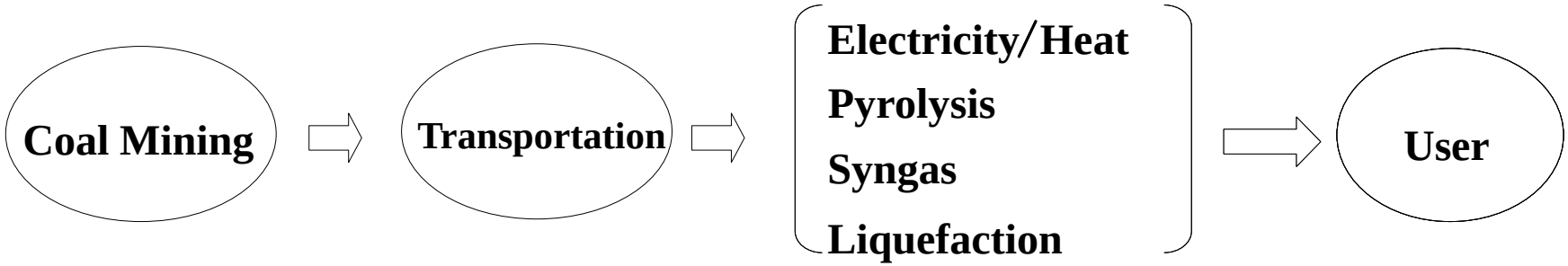
Year	2015	2020
Consumption	1700～2100	2200～2600
Production	1400	1500
Import	300～700	700～1100

The dominant role of coal in energy supply will keep unchanged in a long period. The dependence of NG supply on import grows quickly.

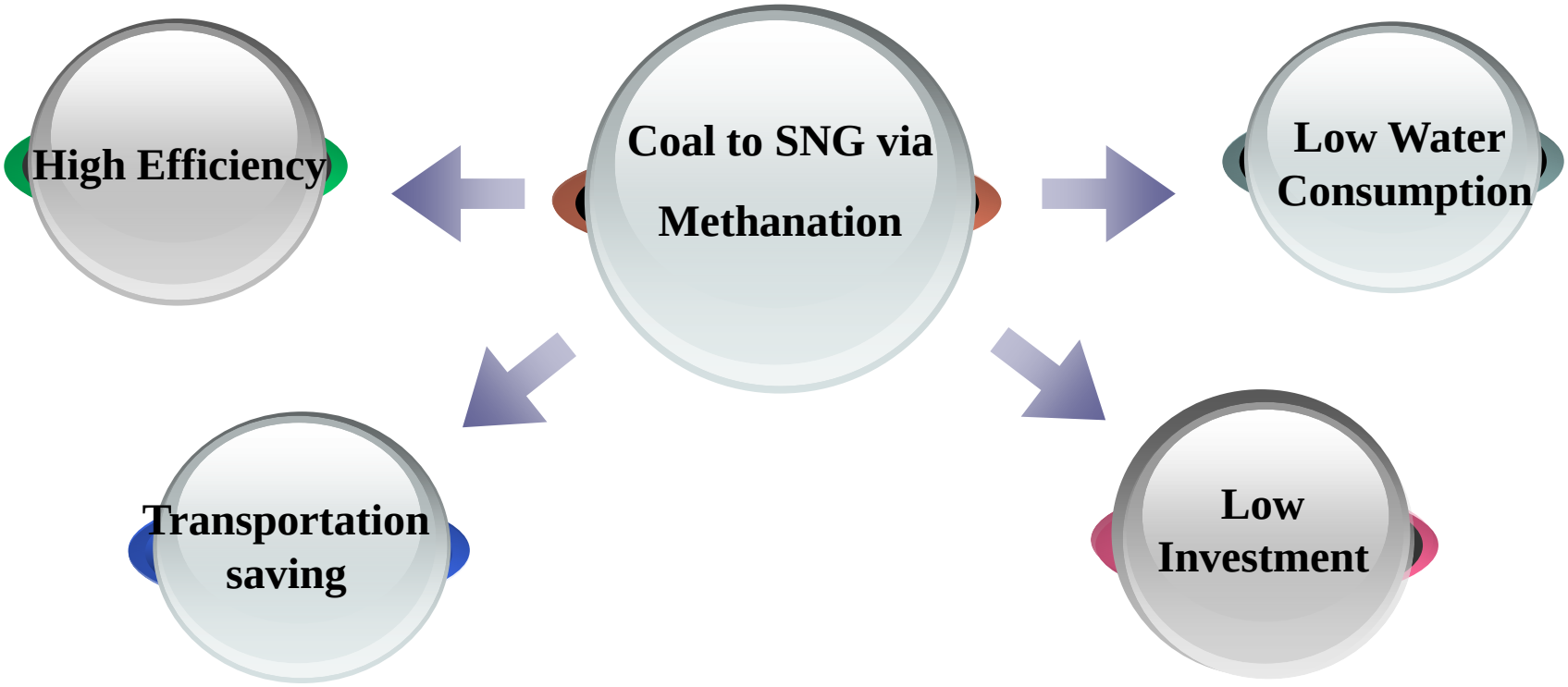
A New Industry Chain of Coal Utilization



A New Industry Chain of Coal Utilization

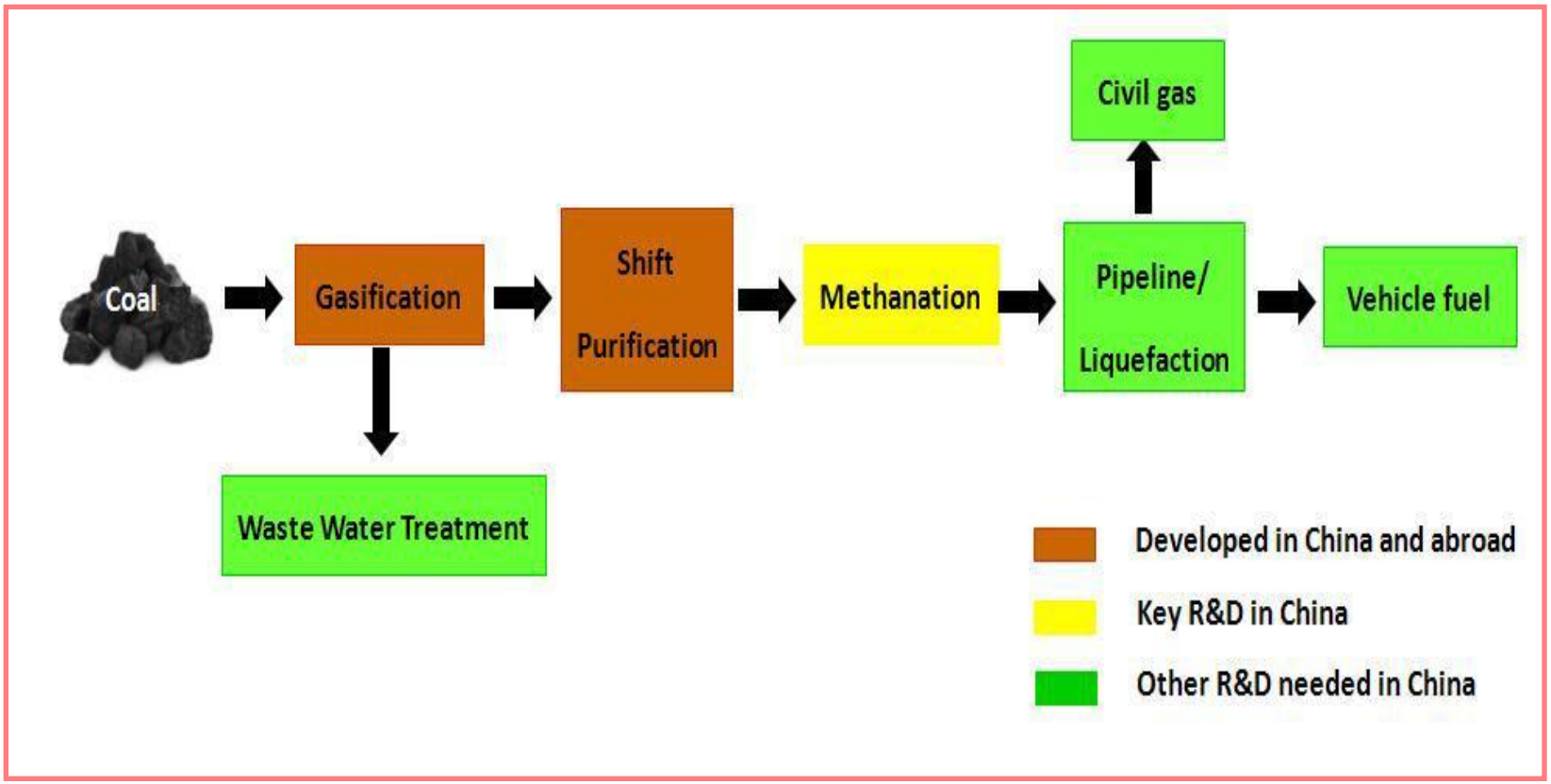


Advantages of Coal to SNG



Coal to SNG via methanation is an effective and clean way to utilize coal and reduce the gap between the supply and consumption of natural gas .

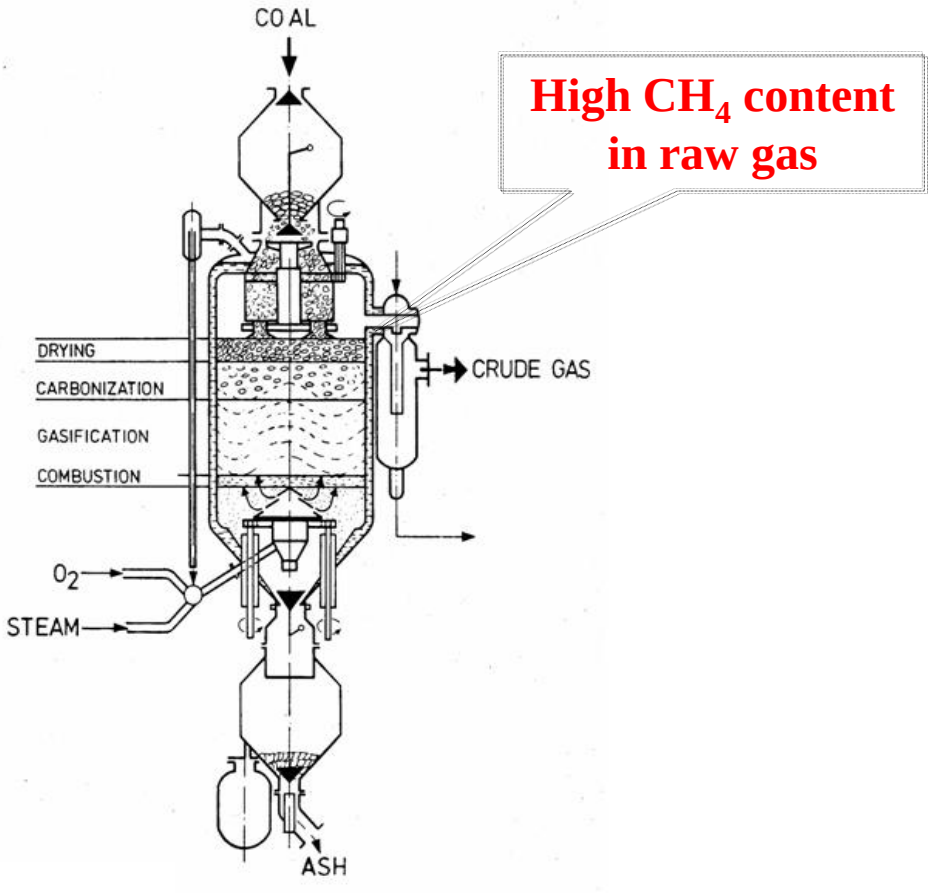
Technology Route of Coal to SNG



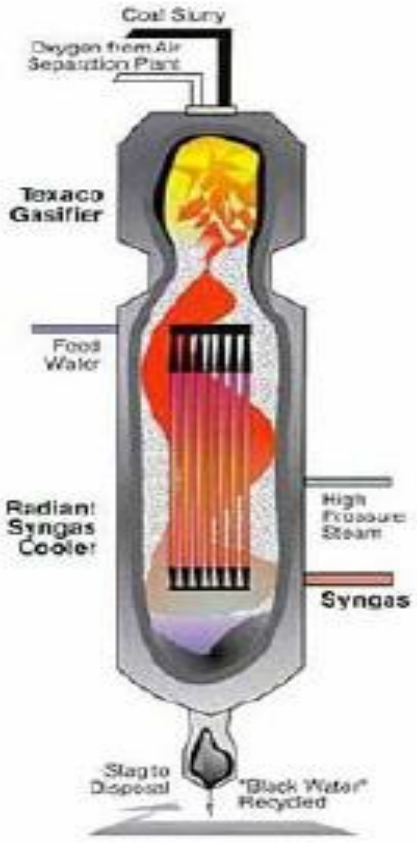
SNG Production Units and Technologies

Unit		Technology
Gasification	Fixed bed	Lurgi, BGL
	Fluidized bed	U-Gas, TRIG, HTW, Winkler
	Entrained flow bed	Shell, GSP, HT-L, Choren, TPRI
		GE, E-GAS,OME, Tsinghua, East China University of Science and Technology
WGS	Sulphur tolerant shift	
Purification	Lurgi, Linde, Dalian University of Technology	
Methanation	Lurgi, Topsoe, Davy	
Waste Water Treatment	Anaerobic biochemical process, UASB, AO process, Adsorption, Ultrafiltration, Nanofiltration, RO, BAF	

Gasification



Fixed Bed Gasifier



Slurry Gasifier

Methanation Processes of Coal to SNG

- **One-step Process**
  - **Hydrogasification Process**
  - **Catalytic Gasification Process**
  - **Bluegas™ Process**
- **Two-step Process**
  - **Fixed Bed Process(Lurgi, TOPSØE and DAVY)**
  - **Fixed Bed Process (Linder, RMP, ICI)**
  - **Fluidized Bed Process (Bureau of Mines, Bi-Gas,Comflux)**

High efficiency, but engineering problems existed, no industrial application reported.

Successful applications in USA and China

Characteristics and Applications of Lurgi, Davy and Topsøe Processes

Process	Characteristics	Applications
LURGI	✓ Catalyst: G1-86HT ✓ T: 280-650℃ ✓ High-pressure super heated Stream ✓ Low recycle flow ✓ Low pressure drop ✓ High conversion ✓ High energy efficiency	the Great Plains Synfuels Plant , USA
DAVY	✓ Catalyst: CRG-S2S, CRG-S2C ✓ T: 250-700℃ ✓ Middle-pressure super heated Stream ✓ Low recycle flow ✓ Low pressure drop ✓ High conversion ✓ High energy efficiency	1. Fuxin project, Liaoning, China 2. Keqi project, Inner Mongolia, China 3. Xinwen Project, Xinjiang, China
Topsøe	✓ Catalyst: MCR-2X, PK-7 ✓ T: 250-700℃ ✓ High-pressure super heated Stream ✓ Low recycle flow ✓ Low pressure drop ✓ High conversion ✓ High energy efficiency	1. Huineng Project, Inner Mongolia, China 2. Qinghua Project, Xinjiang, China

Key Methanation R&D Progresses in China

Catalysts

- 3000~5000 Nm^3/d SNG side stream test at high temperature (> 620℃)
- 120,000Nm^3/h SNG production from coke-oven gas (COG)

Processes

Adiabatic fixed bed reactor process

- 3000-5000 Nm^3/d SNG side stream test at high temperature(> 620℃)
- 30000 Nm^3/h SNG production from COG

Isothermal reactor process

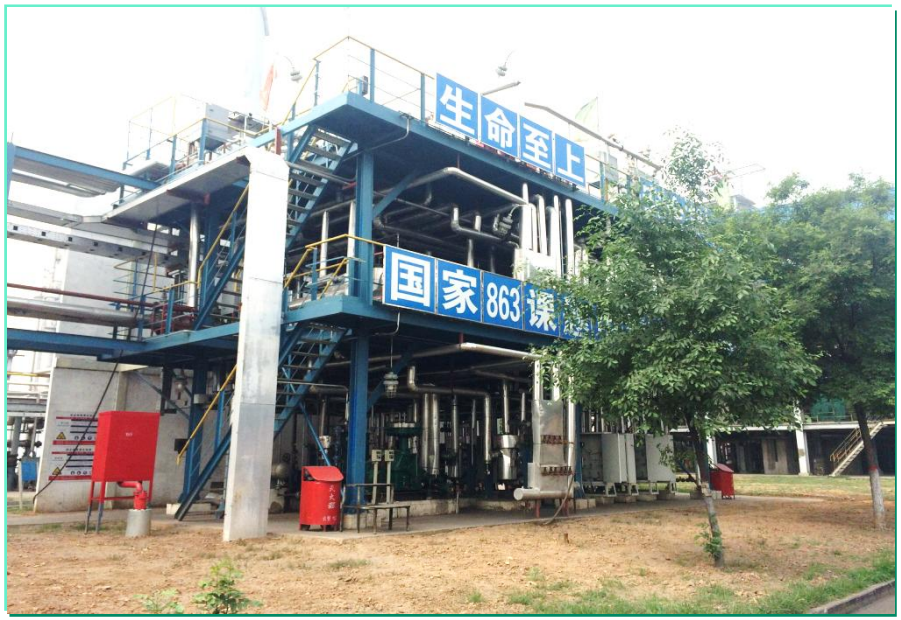
- 18000 Nm^3/h SNG production from COG

Since 2006, the methanation catalysts and process technologies have been developed quickly.

Key Methanation R&D Progresses in China

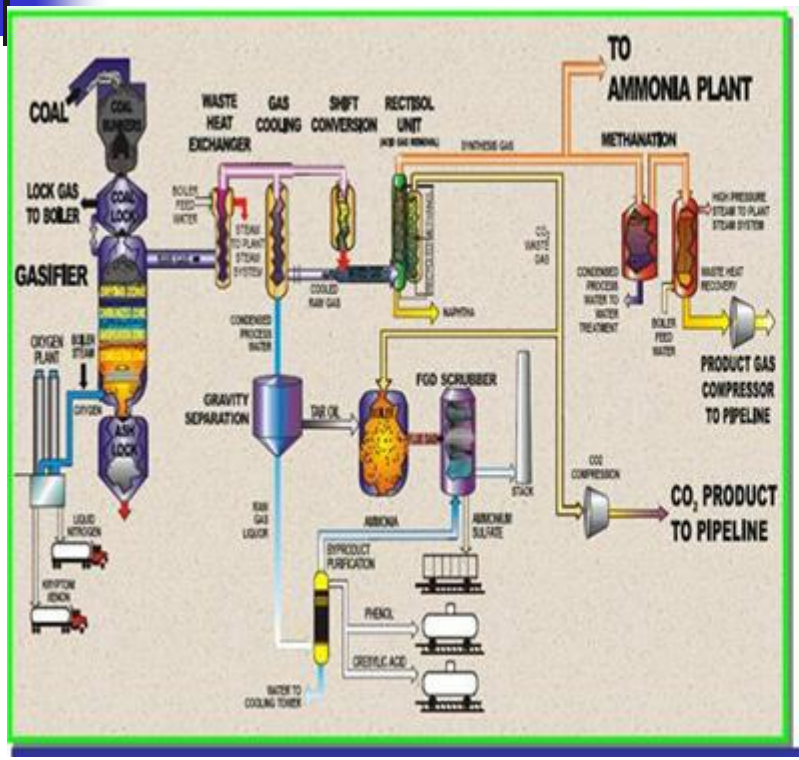
Datang International Chemical Technology Research Institute	3000-5000 Nm^3/d SNG side stream test
Dalian Institute of Physical Chemistry	3000-5000 Nm^3/d SNG side stream test
Dalian Catalytic Engineering Technology Ltd.	20000 Nm^3/h SNG production from COG
The Northwest Research Institute of Chemical Industry	10000 Nm^3/h SNG production from COG
Wuhan Kelin Chemical CO., Ltd.	120000Nm^3/h SNG production from COG
ENN Group Co., Ltd.	25000Nm^3/h SNG production from COG
Southwest Research & Design Institute of Chemical Industry	-
Shenhua Group Co., Ltd.	-
Shanghai Chemical Building Materials Co., Ltd.	-
Taiyuan University of Technology	-
Nanjing GoodChina Chemical Technologies CO., Ltd.	1000h stability test

Datang 3000-5000Nm^3/d SNG Side Stream Test



- **The side stream test has been stably operated more than 2000 hours since March, 2014.**
- **Based on the results of side stream test , the 100,000 Nm^3/d SNG pilot plant is being constructed.**

the First Coal to SNG Plant



Based on the results from Lurgi and SASOL, the Great Plains Synfuels Plant was commissioned in North Dakota, USA

- 14 Lurgi Mark IV fixed bed gasifiers
- Followed by WGS, rectisol and methanation units.
- Designed to produce 3.54 million Nm^3/day SNG, after to 4.81 million Nm^3/day.
- 3MPa,250-550℃, multi -adiabatic fixed bed reactor, BASF and Johnson Matthey catalysts

Coal to SNG Projects in China

- **According to the 12th five-year plan，the annual SNG production capability will reach to 15～18billion Nm^3 by 2015.**
- **More than 10 coal to SNG projects have been built or planned.**

Basic Information of the Approved SNG Projects

Item	Datang Keqi Project	Datang Fuxin Project	Huineng Inner Mongolia Porject	Qinghua Xinjiang Project
Scale (billion Nm^3/a)	4.0	4.0	1.6	5.5
Coal Type	Lignite	Lignite	Low sulfur and ash coal	Long flame coal
Gasification Type	Fixed Bed	Fixed Bed	Fluidized Bed	Fixed Bed
Gasification Process	Crushed Coal Pressurized Gasification	Crushed Coal Pressurized Gasification	Coal-Slurry Gasification	Crushed Coal Pressurized Gasification
Status	**Plant phase-I operating normally**	Under construction	Plant phase-I under test run	**Plant phase-I operating normally**

SNG Projects Preliminarily Approved by Government

NO.	Project	Scale (billion Nm^3/a)
1	CPI Yili SNG project ,Xinjiang	
2	Guodian Xinganmeng SNG project, Inner Mongolia	
3	Xinmeng Energy comprehensive utilization of coal	8.0
4	Xinao underground gasification	0.20
5	CNOOC Datong SNG project, Shangxi	4.0
6	CNOOC Utilization of Coal, Inner Mongolia	12.0
7	Zhundong Wucaiwan SNG project, Xinjiang	12.0
8	Zhundong Dajin SNG project, Xinjiang	4.0
9	Zhundong Xiheishan SNG project, Xinjiang	6.0
10	Zhundong Kamusite SNG project, Xinjiang	4.0
11	Zhundong Hefeng SNG project, Xinjiang	4.0

Total Capacity >60 billion Nm^3/a

Datang Keqi SNG Project

Item	Characteristics
Capacity(billion Nm^3/a)	4.0
Coal Type	Lignite
Gasification Type	Lurgi crushed coal pressurized gasification
Air Separation	Domestic
Sulphur Tolerant Shift	Domestic
Rectisol	Domestic
Methanation	DAVY process
Product Gas Price	￥2.75 /Nm^3

Progresses of Datang Keqi SNG Project

- **Put into production on Dec 18, 2013, and began to supply SNG to Beijing .**
- **Successfully solved the gasifier corrosion .**
- **Optimized waste-water treatment process to reach near-zero waste water discharge.**
- **Currently plant is running stably.**
- **Plant phase-II is under construction and scheduled to put into production in 2015.**

Progresses of Datang Keqi SNG Project

Item	National Standard (First）	National Standard (Second）	SNG
CH_4，vol.%			98.38
CO_2，vol.%	≤2.0	≤3.0	0.21
H_2，vol.%			1.13
N_2+Ar，vol.%			0.28
H_2S ($mg \cdot m^{-3}$)	≤6	≤20	Undetectable
Total sulphur ($mg \cdot m^{-3}$)	≤60	≤200	Undetectable
HHV ($MJ \cdot m^3$)	＞36	＞31.4	＞37

Progresses of Datang Keqi SNG Project

Progresses of Datang Keqi SNG Project

Currently the plant is operating at 60% load stably, and have supplied about 0.3 billion Nm^3 SNG to Beijing.

Demonstration Significances of Keqi SNG Project

- Technical feasibility of SNG production from low-rank coal in China .
- Economical benefits of the coal to SNG plant.
- Safety, reliability and stability of crushed coal pressurized gasifier operating with lignite.
- Safety, reliability and stability of crushed coal pressurized gasifier operating at 4.0MPa.
- The effects of acid and alkali corrosion on the equipment.
- The effects of organic sulfur on the methanation catalysts.
- Whether the waste water treatment system can reach zero discharge?
- Whether the lignite to SNG plant can satisfy the national environmental policies?

SNG Technology Developing Trends

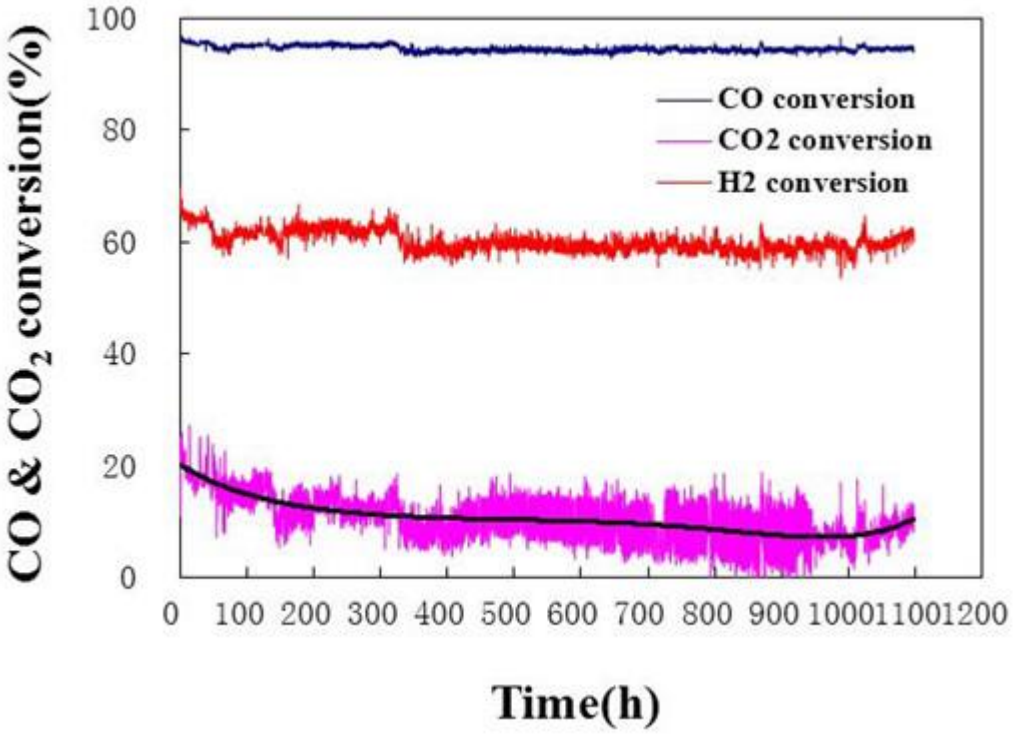
- **Gasifier**
  - ✓ China's own gasification technologies will play an important role along with the development of coal to SNG industry.
- **Methanation Catalyst**
  - ✓ More China's own methanation catalysts will be used in coal to SNG industry.
  - ✓ To make SNG plant operation more stable, sulfur tolerant methanation catalyst is a promising technology.
- **Methanation Process**
  - ✓ China's own methanation process will be used in coal to SNG industry.
  - ✓ Fluidized bed reactor process is an attractive technology.
  - ✓ One-step methanation process is a promising technology.

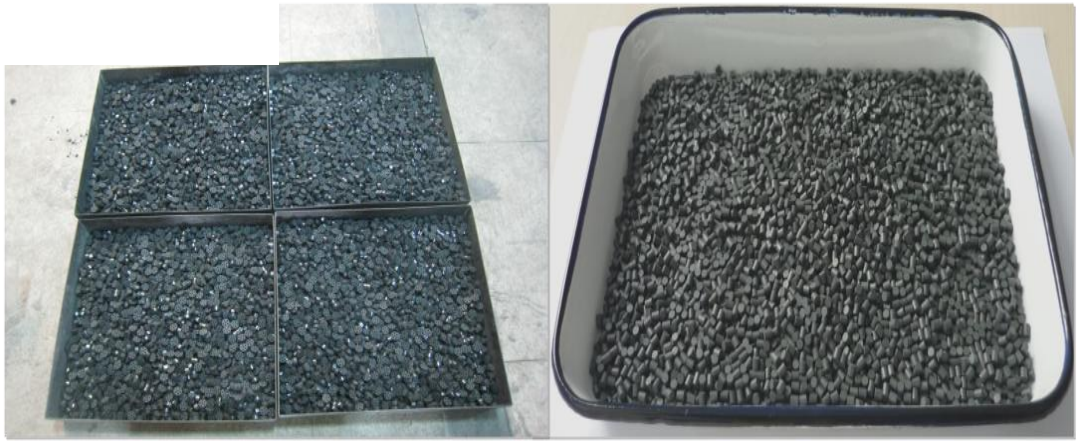
Challenges of China's SNG Industry

- **Technology**
  - ✓ Methanation processes are still heavily depended on imported technologies.
  - ✓ Research on CO_2 capture and utilization is urgent.
- **Production**
  - ✓ Safe, stable, long term and full load operation is crucial for the enterprise and market.
  - ✓ The fluctuation of market demand affects SNG production.
  - ✓ To obtain higher economical benefits, it is essential to strengthen the deep processing and utilization of by-products.
- **Policy**
  - ✓ SNG pipeline transportation and price mainly depends on government's policy.

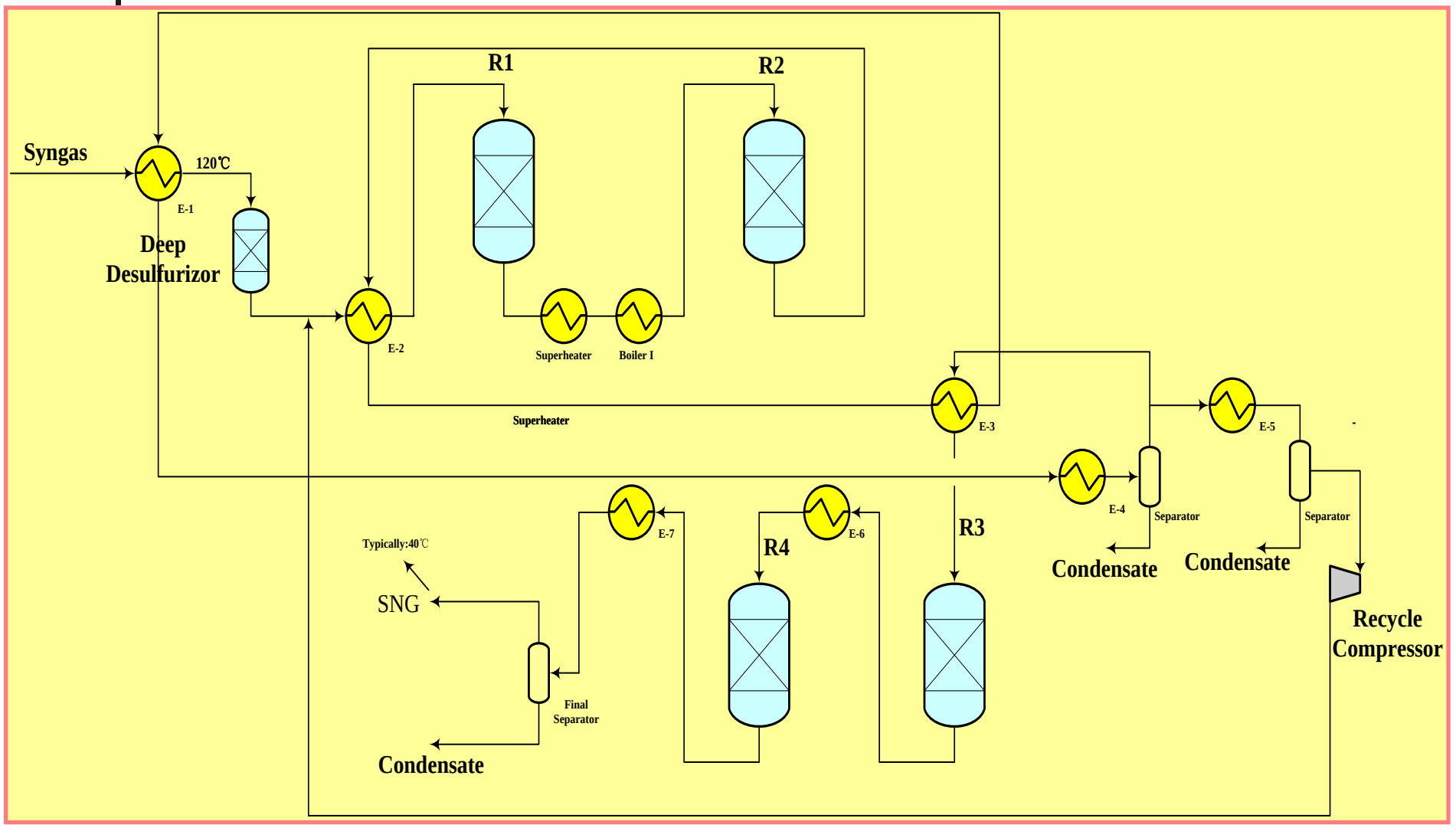
Thank you!

Program Progress-Catalyst



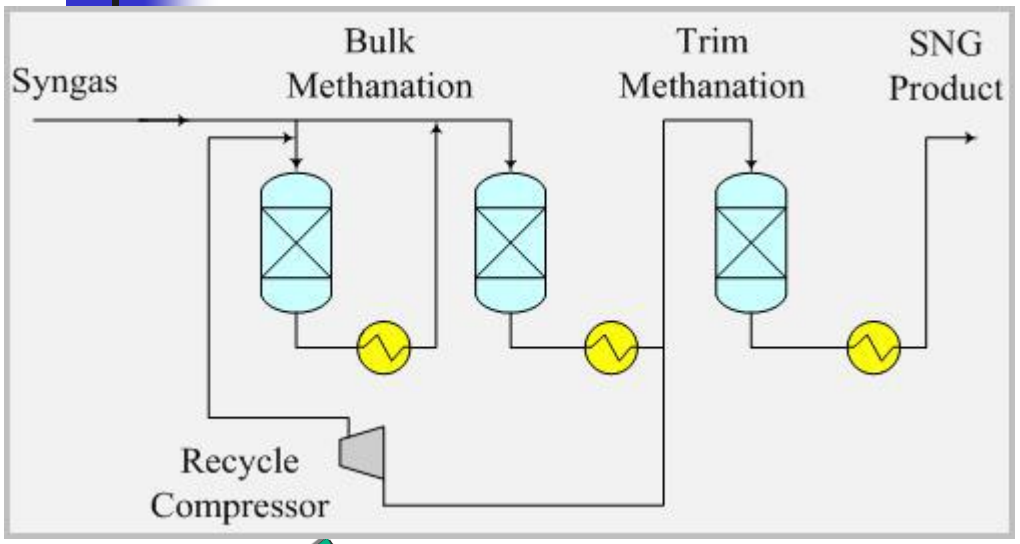


Program Progress-Process



External Total Methanation Processes-

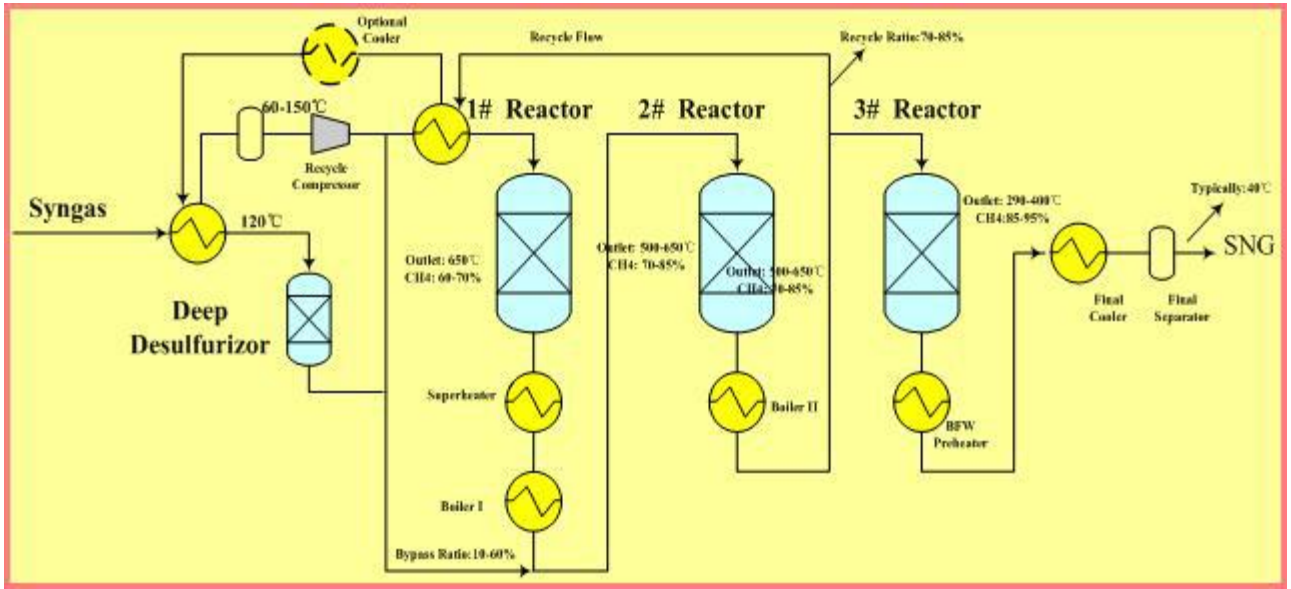
Lurgi Process



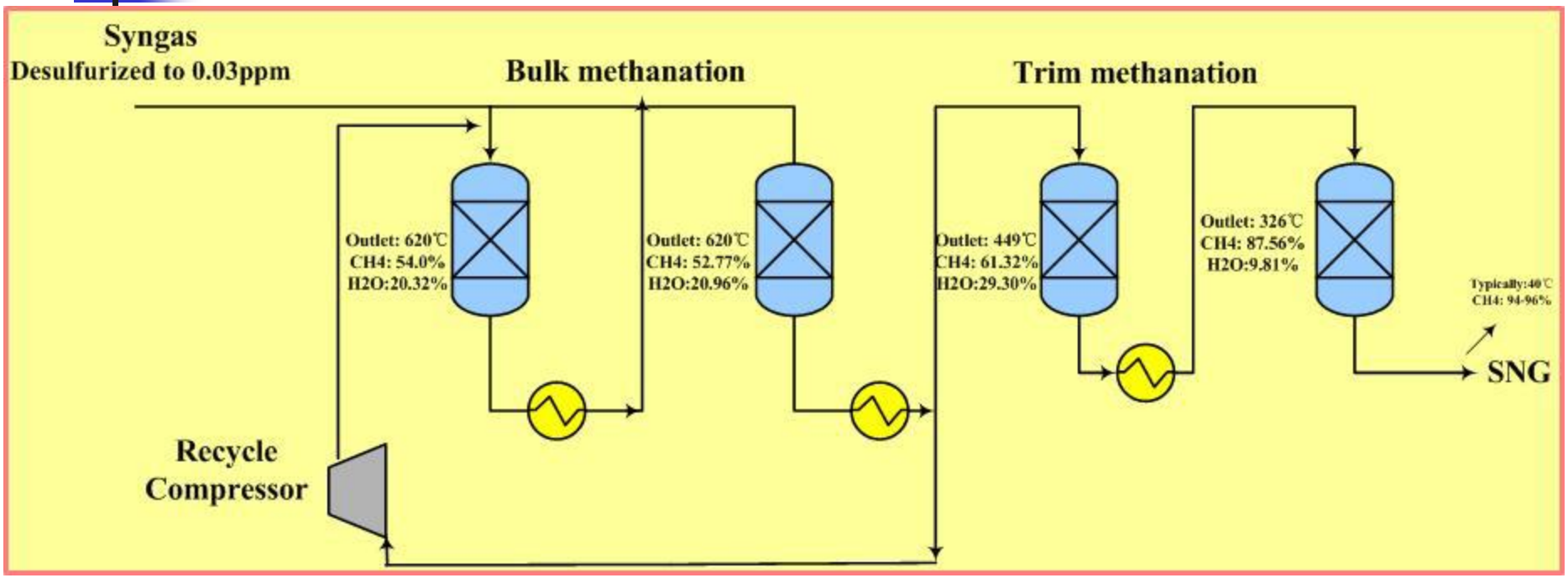
- ✓ Low investment
- ✓ High capacity
- ✓ High conversion
- ◆ Adiabatic cycle dilution
- ◆ Low energy efficiency

Optimized Process

- ✓ High temperature catalyst(G1-86HT)
- ✓ High conversion
- ✓ Low recycle flow
- ✓ High energy efficiency



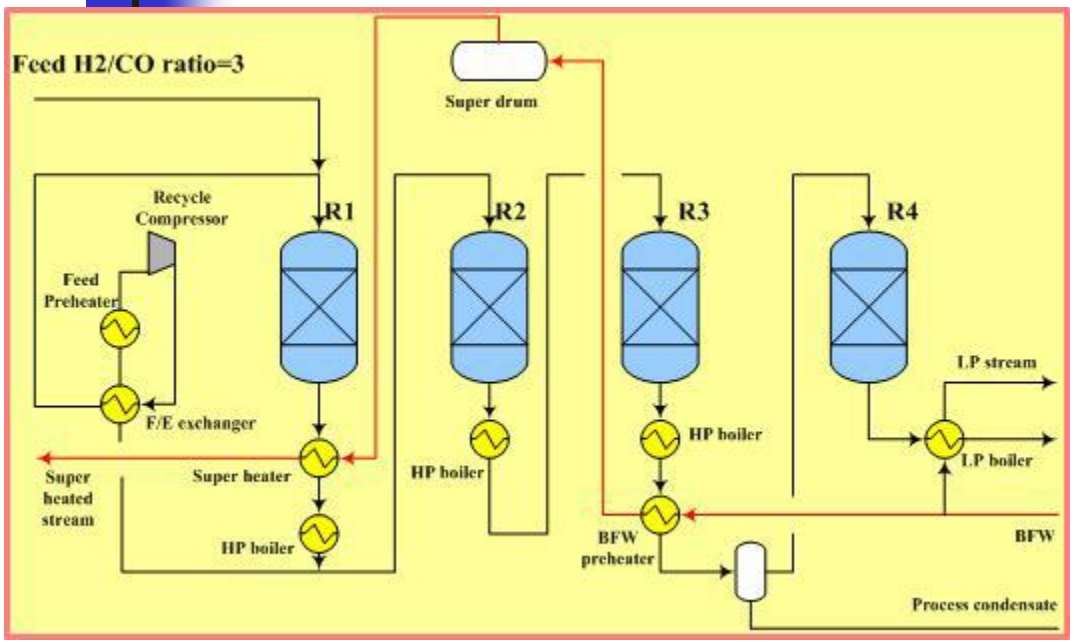
Davy Process-HICOM



- ✓ High temperature catalyst(CRG)
- ✓ High conversion
- ✓ Low recycle flow
- ✓ High energy efficiency

From 1980s, CRG catalysts have been applied to produce SNG in the Great Plains Synfules plant.

Topsøe Process-TREMP™



- ✓ 10000Nm^3/h.
- ✓ 3MPa,250-700℃,
- ✓ MCR-2X, MCR4 catalysts
- ✓ Operation time >45000hours

TREMP™ stands for Topsøe's Recycle Energy efficient methanation Process and is a heat recovery concept, which produces high pressure superheated steam.