

2015中美煤炭清洁发展论坛

中国煤炭清洁转化利用 现状及趋势简介

Introduction to Current Status and Trends of Coal Clean Conversion and Utilization in China

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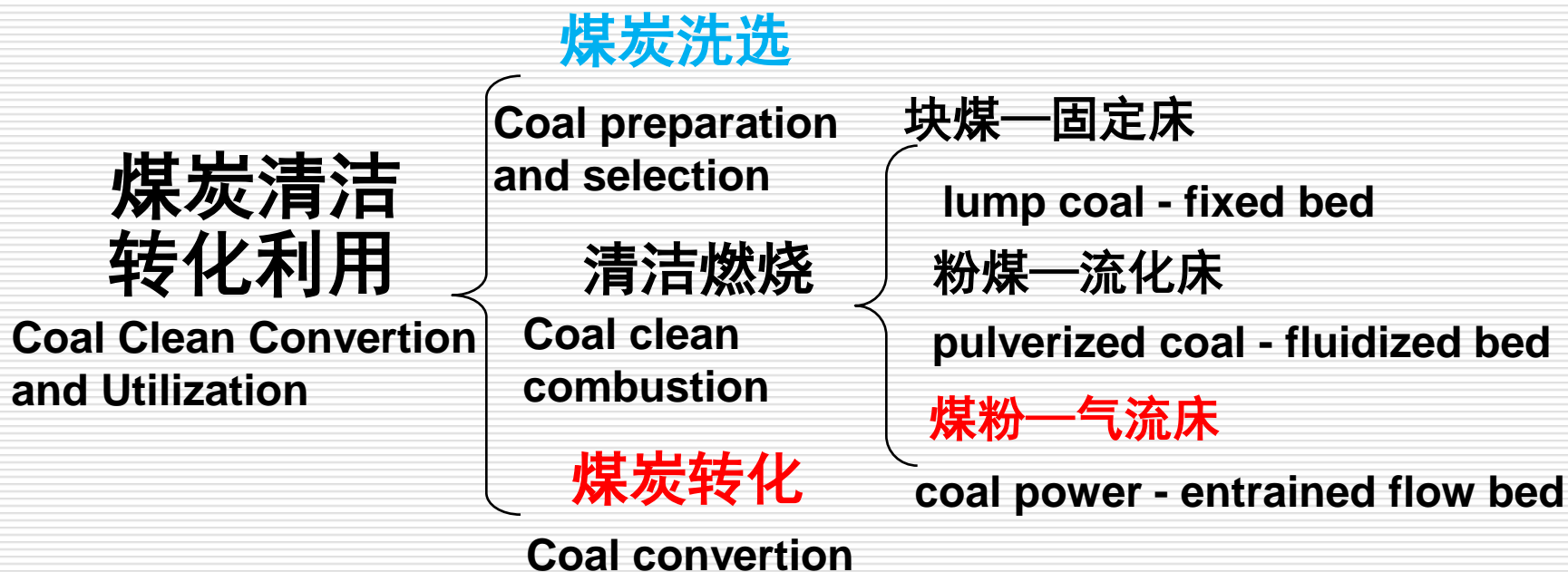
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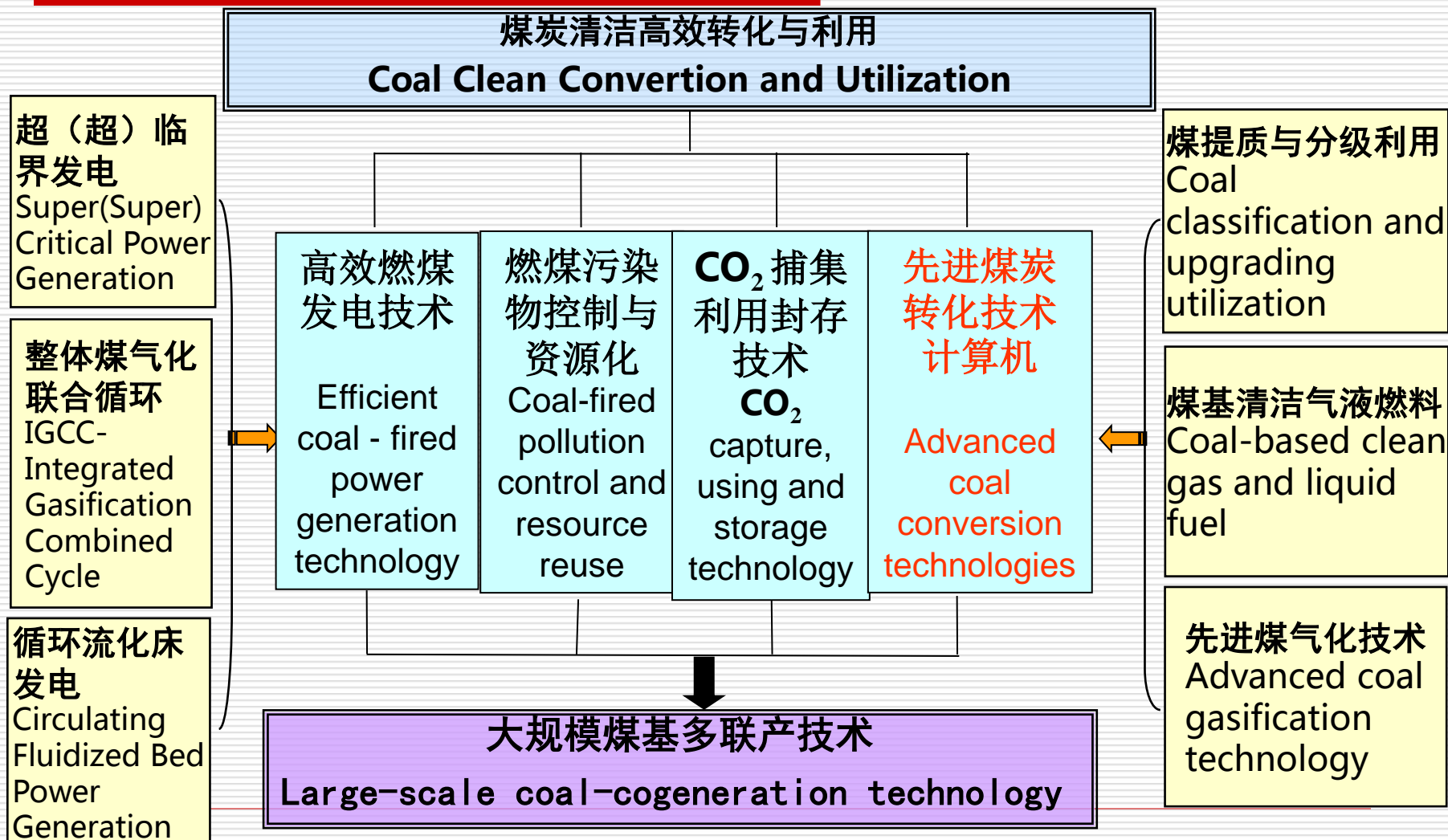
一、中国煤炭清洁转化利用现状

Current Status of Coal Clean Conversion and Utilization in China



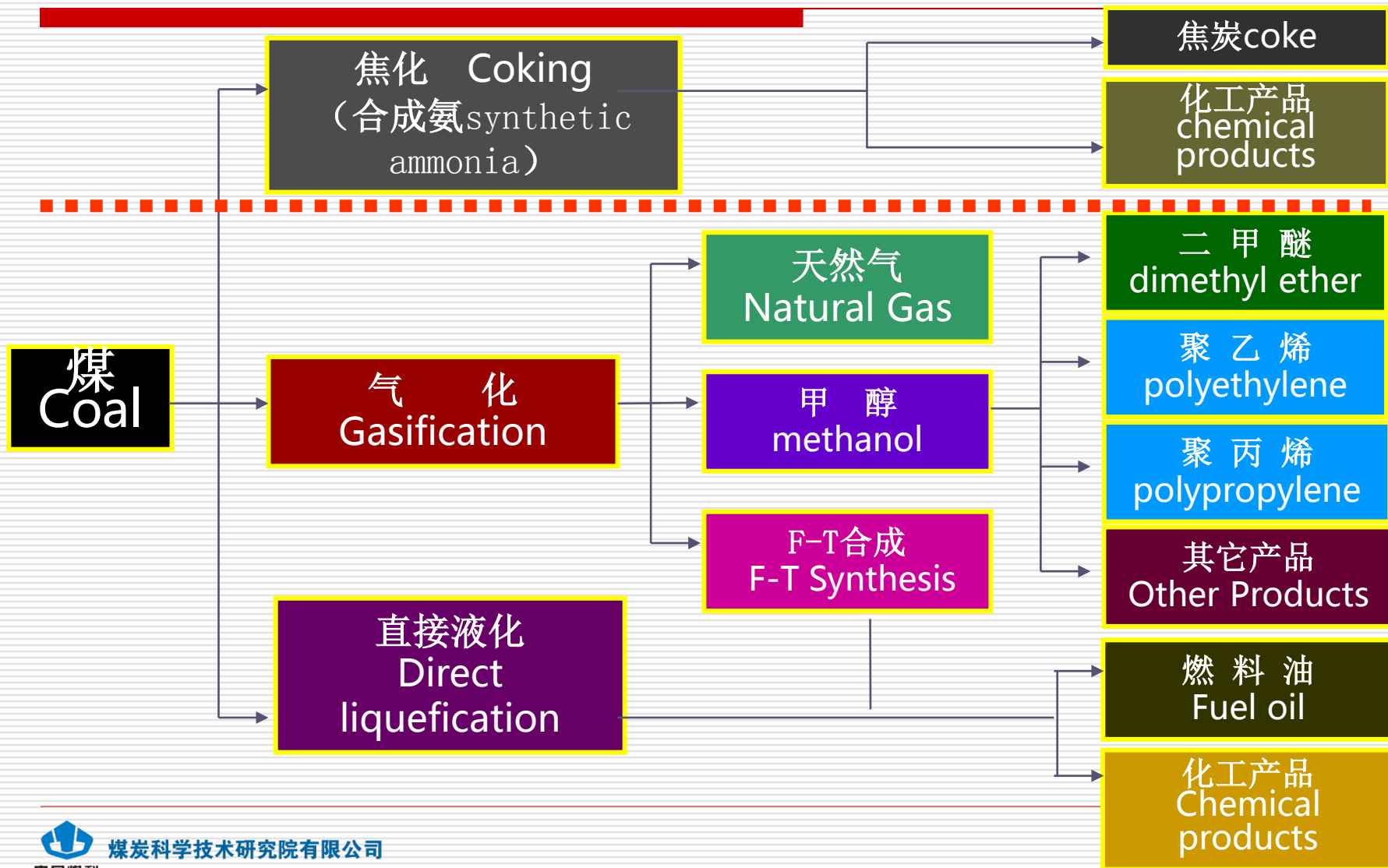
一、中国煤炭清洁转化利用现状

Current Status of Coal Clean Conversion and Utilization in China



一、中国煤炭清洁转化利用现状——煤炭转化

Current Status of Coal Clean Conversion and Utilization in China - Coal Conversion

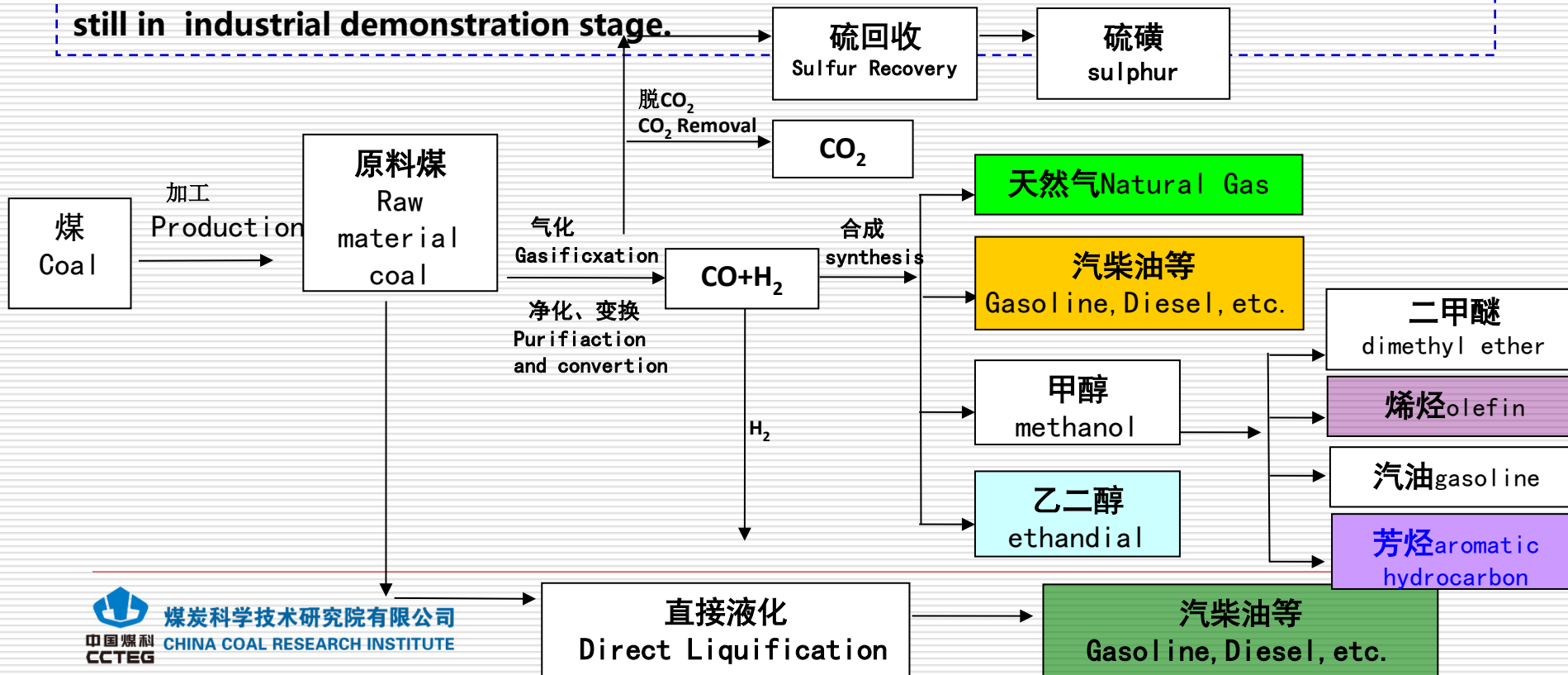


一、中国煤炭清洁转化利用现状

Current Status of Coal Clean Conversion and Utilization in China

中国现代煤化工通过2006~2010年技术攻关、2011~2015年**升级示范**，一大批煤化工关键技术取得突破，但大部分技术仍处**工业示范阶段**。

China's modern coal chemical industry has been through stages - 2006-2010 technology breakthrough, 2011-2015 upgrading and demonstration. A large number of coal chemical key technologies have made breakthroughs and progresses, but most technologies are still in industrial demonstration stage.



一、中国煤炭清洁转化利用现状——气化

Current Status of Coal Clean Conversion and Utilization in China - Gasification

➤ 2006~2010年，中国通过“863”等科技发展计划，系统支持了2000t/d两段式干煤粉加压气化技术、2000t级多喷嘴水煤浆气化技术、500t/d非熔渣-熔渣分级气化技术、千吨级粉煤运输床气化技术、灰熔聚流化床气化技术等研发和示范。

From 2006-2010, China's "863" and other science and technology development programmes had systematically supported the R&D and demonstrations of technologies such as 2000t/d two-stage dry pulverized coal pressurized gasification technology, 2000t multinozzle coal-water slurry gasification technology, 500t/d non-slagging - slagging coal classification gasification technology, thousand-of-ton pulverized coal transport bed gasification technology, and ash melting fluidized bed gasification technology, etc.

➤ 3000t/d级的大型水煤浆气化技术与装备于2014年开始试生产。
Large-scale of 3000t/d coal-water slurry gasification technologies and equipments began trial production in 2014.

一、中国煤炭清洁转化利用现状——气化

Current Status of Coal Clean Conversion and Utilization in China - Gasification

➤ 地下气化技术完成了试验运行，工业化技术仍处于开发阶段。

Pilot operation of underground coal gasification technology has been completed, while industrialized technology is still in the development stage.

➤ 正在开发适应中国特殊煤种（高灰、熔点、较高粘结性煤及高水分褐煤）的煤气化技术。

Coal gasification technologies which are suitable and flexible to the specific coal types in China (high ash content, high ash melting point, high caking property and lignite with high moisture content) are being developed.

一、中国煤炭清洁转化利用现状——气化

Current Status of Coal Clean Conversion and Utilization in China - Gasification

中国首套2000 t/d级干煤粉加压气化炉（天津IGCC）

First 200t/d Dry Pulverized Coal Pressurized Gasifier (Tianjin IGCC)



2010年10月气
化炉安装
Gasifier was
installed in
October, 2010.



2011年1月空分
装置开始调试
Debugging of
air separation
devices
started in
January, 2011.



2012年4月17日气
化装置首次投料
First feeding of
gasification
devices in 17th,
April, 2012



2012年9月MDEA脱硫
投产
MDEA
Desulphurization
was put into
production in
September, 2012



2012年11月6日，
中国首个IGCC工程
进入商业运行
First IGCC project
in China was put
into industrial
operation in 6th,
November, 2012

一、中国煤炭清洁转化利用现状——气化

Current Status of Coal Clean Conversion and Utilization in China - Gasification

2000 t/d新型水煤
浆气化技术
2000t/d New water
slurry gasification
technology



一、中国煤炭清洁转化利用现状——气化

Current Status of Coal Clean Conversion and Utilization in China - Gasification



乌兰察布**无井式**UCG试验和示范系统（15万Nm³/d）

Wulanchabu UCG Non-well testing and demonstration system (150,000 Nm³/d)

新汶**有井式**UCG试验基地

Xinwen UCG with Well Pilot Base



一、中国煤炭清洁转化利用现状——直接液化

Current Status of Coal Clean Conversion and Utilization in China - DCL

- 技术处于工业化示范阶段，**世界首套百万吨级神华示范工程投运**。2013年产品87万t；二期216万t/d已进行建设可行性研究论证。

Direct Coal Liquefaction technology is at the industrial demonstration stage, the first megaton Shenhua demonstration project has been put into operation. In 2013, of productivity was 870kt/a. The second phrase of 2160kt/a project is being constructed with feasibility study.

- 生产1t油品煤耗为3~4t，能量效率约50~58%。

The coal consumption for 1t oil generation is 3~4t, the energy efficiency is approximately 50~58%.

- 直接液化排放的CO₂浓度高，有利于后续处理和资源化利用。

The CO₂ emission of direct liquefaction is high, which is good for the subsequent processing and resourceful utilization.

一、中国煤炭清洁转化利用现状——直接液化

Current Status of Coal Clean Conversion and Utilization in China - DCL



神华集团煤液化厂鸟瞰图

Aerial View of ShenHua Grup's DCL Plant



一、中国煤炭清洁转化利用现状——间接液化

Current Status of Coal Clean Conversion and Utilization in China - ICL

- 已自主研发**低温浆态床**费托合成技术，建成3套16~18万t/a示范装置。

Low temperature slurry bed FT synthesis technology has been developed independently, and 3 sets of 160~180kt/a demonstration units have been built up.

- 生产1t油品煤耗为4~6t，能量效率约为38~43%。

The coal consumption for 1t oil generation is around 4~6t, and the energy efficiency is approximately 38~43%.

- 间接液化排放的CO₂浓度高，有利于后续处理和资源化利用。

The CO₂ emission of indirect liquefaction is high, which is good for the subsequent processing and resourceful utilization.

- 示范规模小，其技术、经济性仍有待工业化验证。

The scale of demonstration projects is relative small, and its economy still needs to be validated in industrial field.

一、中国煤炭清洁转化利用现状——间接液化

Current Status of Coal Clean Conversion and Utilization in China - ICL

16 ~ 18万t/a煤炭间接液化示范装置

160~180kt/a indirect coal liquifacation demonstration units



一、中国煤炭清洁转化利用现状——煤制天然气

Current Status of Coal Clean Conversion and Utilization in China - Coal to Natural Gas

- 首批4个项目获核准建设，至少两个项目已建成。

4 projects were firstly approved, and at least two of them has been constructed.

- 中国煤制天然气技术目前**总体处于工业示范阶段。**

The Chinese coal to methane technology is now on the industrial demonstration stage.

- 煤耗约3~4t/km³，能量效率60%以上，建设投资0.5~0.6万元/t。

The coal consumption is 3~4t/km³, the construction investment is around 5000~6000 RMB/t.

- 目前正开展**煤加氢气化制天然气技术、煤低温催化气化甲烷化技术**等研发。

The R&D work on hydrogasification, low temperature catalytic gasification and methanation technologies are being carried out.



一、中国煤炭清洁转化利用现状——煤制烯烃

Current Status of Coal Clean Conversion and Utilization in China - Coal to Olefin

- 三个煤制烯烃工业化大项目示范或投运，技术可靠性获较好验证。

Three coal to olefin industrialized demonstration projects have been constructed; the reliability of the technology has been proved well.

- 生产1t烯烃的煤耗7.5t，能量效率约40%；投资为3~3.5万元/t。

1t Olefins Product requires 7.5t Coal, Energy Efficiency is about 40%, investment is 30k~35k RMB.

- 煤制烯烃的生产过程长，单位产品的附加值高，单位产品能耗、水耗、三废排放量也较大（按当量计算与煤制甲醇相差不大）。

Coal to olefins has a long production process and high product additional value; energy consumption, water consumption and waste emissions are also large for unit product (similar to the emissions of coal to methanol according to the equivalent calculation).

- **示范存在问题：**煤耗和催化剂结焦率比设计值高。

Demonstration problems: coal consumption and catalyst coking rate is higher than the design

value



大唐国际46万t/a
煤制聚丙烯项目
Coal to Polypropylene
Project
of 460kt/a DaTang
International Group

神华60万
t/a DMTO项目
600Kt/a DMTO
Project of
ShenHua Group



一、中国煤炭清洁转化利用现状——CO₂利用技术

Current Status of Coal Clean Conversion and Utilization in China - CO₂Utilization

- 处于起步阶段，整体上仍处于实验研究阶段。

The technology is in the initial stage, generally the industry is in the experimental stage.

- 神华封存10万t/aCO₂的CCS示范项目已经运行（2011年5月开始，将超临界状态的CO₂注入到目标储层，目前累计注入量已超过20万吨）。

The 100,000 t/aCCS demonstration project of ShenHua Group has been in running (in May 2011, the CO₂ of supercritical status is injected into the target reservoir, and the current is over 200000 tons).

- 目前CCS技术成本较高，单纯封存在经济上不可行，且有一定的安全风险，封存和利用（驱油、驱气）相结合是可行的技术途径。

At present, the cost of CCS technology is relatively high, it is not economy feasible for only Capture and storage, and with the safety risk of storage, thus a combination of capture and utilization(flooding, gas) is feasible .



一、中国煤炭清洁转化利用现状——煤基多联产

Current Status of Coal Clean Conversion and Utilization in China

- Coal-based polygeneration

□中国首座IGCC发电与甲醇联产系统

The First IGCC Generation & methanol Co-Production System in China

□ 60MWe级，24万吨甲醇/年

60MWe level, 240,000t/a Methanol

兖矿煤气化发电与甲醇联产系统

Coal Gasification Generation & methanol Co-Production System in Yankuang coal mining area



一、中国煤炭清洁转化利用现状——煤基多联产

Current Status of Coal Clean Conversion and Utilization in China

- Coal-based polygeneration

- 中国**第一座**250MW IGCC示范电站
- The **1st** 250MW IGCC Demonstrate Power Station



二、2016~2020中国煤炭转化利用主要方向

The main direction of coal conversion and utilization in China from 2016-2020

1、主流煤气化关键技术开发

Key development of mainstream coal gasification technology

- **气流床气化：规模大型化、能量利用高效化、原料适应多样化；**
Entrained flow bed gasification: large-scale, High energy efficiency and utilization, Adaptive diversity of feedstock
- **碎煤固定床液态排渣：熔渣区冷却壁长寿化、连续式溢流排渣；**
Crushed coal fixed bed liquid slagging: extension of cooling wall life in slagging area; continuous overflow slagging
- **基于流态化的煤气化：着重循环流化床煤气化、催化气化、化学链气化等技术的规模化**
fluidization based coal gasification: focus on the scale development of technologies of circulating fluidized bed coal gasification, catalytic gasification, and chemical chain gasification, etc.

二、2016~2020中国煤炭转化利用主要方向

The main direction of coal conversion and utilization in China from 2016-2020

2、新型煤气化技术开发

New coal gasification technology development

- **煤直接加氢制清洁燃气新技术（千吨级）**

New technology of Direct coal hydrogenation to clean gas (thousand tons level)

- **超临界水煤气化制氢耦合发电（“水煮煤”）技术**

Power Generation technology of supercritical water gasification for hydrogen production(water boiling coal)

- **内在碳捕集气化技术**

Inner coal carbon capture technology

- **地下煤气化工程技术**：合理的地下气化炉构建及施工；地下气化过程稳定控制，污染物产生、迁移规律及防控。

Underground coal gasification Engineering Technology: a reasonable construction and construction of underground gasification furnace; the stability control of underground gasification process, prevention and control of pollutants generation, and migration pattern.

二、2016~2020中国煤炭转化利用主要方向

The main direction of coal conversion and utilization in China from 2016-2020

3、新型合成气甲烷化技术开发

The development of new synthetic gas methanation technology

适用于甲烷化反应的大型**流化床反应器**，与之匹配的高活性耐磨催化剂，实现CO转化率高于99%，甲烷选择性达到100%。

For methanation reaction of large scale fluidized bed reactor, and matched high activity of attrition resistant catalyst, CO conversion rate is higher than 99%, the methane selectivity can reach 100%.

4、新型煤液化技术开发 Development of new coal liquefaction technology

➤ **直接液化**：温和液化、煤油共炼工艺——**缓和反应条件苛刻度**、定向转化生产喷气燃料、提高油收率、降低水耗；

DCL: Moderate liquefaction, coal-oil co-refining process - Moderate reaction condition severity, directional conversion and production of jet fuel, improve oil production yield, reduce water consumption;

➤ **间接液化**：基于高效**钴基催化剂**，开展以大型固定床反应器和过程强化工艺为核心的技术攻关，完成百万吨工艺包开发。

Indirect coal liquefaction: Based on the high efficiency cobalt based catalyst, to focus on the technology breakthrough of large fixed bed reactor and process intensification technology, and finish the technology and process package development millions of tons.



二、2016~2020中国煤炭转化利用主要方向

The main direction of coal conversion and utilization in China from 2016-2020

5、煤制醇醚及工业清洁燃气技术开发 Coal alcohol ether and industrial clean gas technology development

- 煤制醇醚燃料：降低煤制甲醇装置操作成本，合成气制乙醇和**低碳混合醇**等关键技术和工程技术的研发；
- Coal alcohol ether fuel: reduce coal to methanol plant operating costs and technology R & D of syngas to ethanol and low carbon mixed alcohol and other key engineering technologies ;
- 煤制工业燃气：用于加热各种工业窑炉或直接加热产品煤制工业燃气技术及装备示范（**200-500t/d规模**）。
Coal to industrial fuel gas: The demonstration of industrial gas technology and equipment for heating various industrial furnaces or direct heating products of coal(200t-500t/d)

6、煤制大宗化学品工程技术开发 Technical development of coal bulk chemical engineering technology

- 以煤为源头生产**芳烃**、**烯烃**（乙烯、丙烯、聚烯烃）、乙二醇等工业化应用，重点开发高效催化剂、反应器，以及工艺优化、系统集成等工程化开发和验证。

The production and industrial applications of aromatics, olefins (ethylene, propylene, polyolefin), ethylene glycol, etc. the coal is the source of the source, and the development and verification of high efficiency catalyst, reactor, process optimization, system integration and so on.



二、2016~2020中国煤炭转化利用主要方向

The main direction of coal conversion and utilization in China from 2016-2020

7、煤热解—气化分级转化及废水/烟气大规模净化技术开发

coal pyrolysis- gasification and classified conversion and effluent/ large-scale purification technology development

热解反应过程调控、油气产品定向、汽尘高效分离、**大型热解反应器研制**，构建与热解配套的半焦大规模燃烧与气化**耦合技术系统**。

Process control of coal pyrolysis, oil gas product orientation, high efficiency separation of gas and dust, **R&D of large scale pyrolysis reactor**, the coupling technology system of semi-coke combustion and gasification.

➤ 研发与不同煤转化工艺相适应的废水有机物提取、提高可生化性、高含盐水提浓结晶等关键技术，废水规模化、分级、分质净化及全部回用。

R&D of different coal conversion process to adapt to the extraction of organic wastewater, improve the biodegradability, high water content and other key technologies, such as water, scale, classification, purification and all of the sub quality.

➤ 高温热解（焦化）与气化的耦合、气化气替代焦炉气、**新一代煤焦油加工（加氢）成套技术、焦炉气化工技术等**。

High temperature pyrolysis coupled with gasification, gasification gas taking place of coke oven gas, **a new generation of coal tar processing (hydrogenation) sets of technology, coke oven gas chemical technology, etc..**

➤ **传统焦化的节能环保：系统能量优化、余能余热回收利用、焦化烟气的高效脱硫脱硝技术。**

Energy-saving and environmental protection of traditional coking technology: energy system optimization,

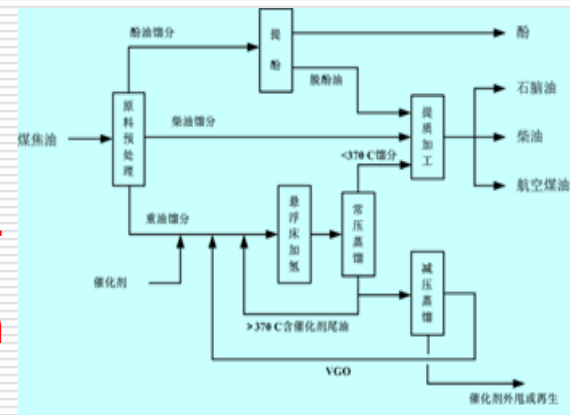
residual heat recovery and utilization, and high efficiency desulfurization and denitrification of coking gas.

三、中国煤炭科工集团煤炭清洁转化利用技术——1

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group - 1

将煤直接液化技术与渣油加氢技术、油品加氢技术集成创新，形成**煤焦油全馏分分质分级加氢制清洁燃料技术**

Coal direct liquefaction technology and residue oil hydrogenation technology can be integrated with innovation, forming a **technology of coal tar full-range of sulfur quality-divided and classification and hydrogenation to clean fuels**



三、中国煤炭科工集团煤炭清洁转化利用技术——1

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group -1

技术特点 Characteristics :

- ✓ 原料适应范围广 (Raw materials is widely adaptable)

高温煤焦油、中低温煤焦油、其它劣质油

High temperature coal tar, medium low temperature coal tar, other inferior oil

- ✓ 工艺技术应用灵活 (Application technology adapt to wide area)

全馏分、各种温度切割后馏分、重质馏分等

The whole fraction, fractions after cutting at whole temperature, heavy fractions

- ✓ 轻质油收率高，产品质量好 (High light oil yield, good product quality)

中温煤焦油：油收率在90%左右，柴油十六烷值 41-49

Medium temperature coal tar: oil yield about 90%, diesel cetane number is 41-49

高温煤焦油：油收率在80%以上，柴油十六烷值 35-39

High temperature coal tar: oil yield is above 80% , diesel cetane number is 35-39

三、中国煤炭科工集团煤炭清洁转化利用技术——2

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group - 2

活性焦干法烟气一体化净化技术

Activated-coke Dry Flue Gas Cleaning Technology

技术特点 Characteristics:

✓ 可同时脱除烟气中 SO_2 、 NO_x 和Hg

Simultaneously remove SO_2 , NO_x , Hg in flue gas

✓ 联合脱除，装置占地小

Combined removal, occupies small ground ground

✓ 脱除效率高 (SO_2 , $\geq 95\%$, $\text{NO}_x \geq 70\%$)

High Removal efficiency (SO_2 , $\geq 95\%$, $\text{NO}_x \geq 70\%$)

✓ 脱除过程不消耗水

Removal process does not consume water

✓ 无二次污染

no secondary pollution

✓ 可实现硫资源化利用 ($\geq 90\%$)

Sulfur resource utilization ($\geq 90\%$)



烟气处理能力 $500\text{km}^3/\text{h}$ 燃煤烟气联合净化装置

$500\text{km}^3/\text{h}$ Coal fired gas co-purification device

三、中国煤炭科工集团煤炭清洁转化利用技术——3

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group -3

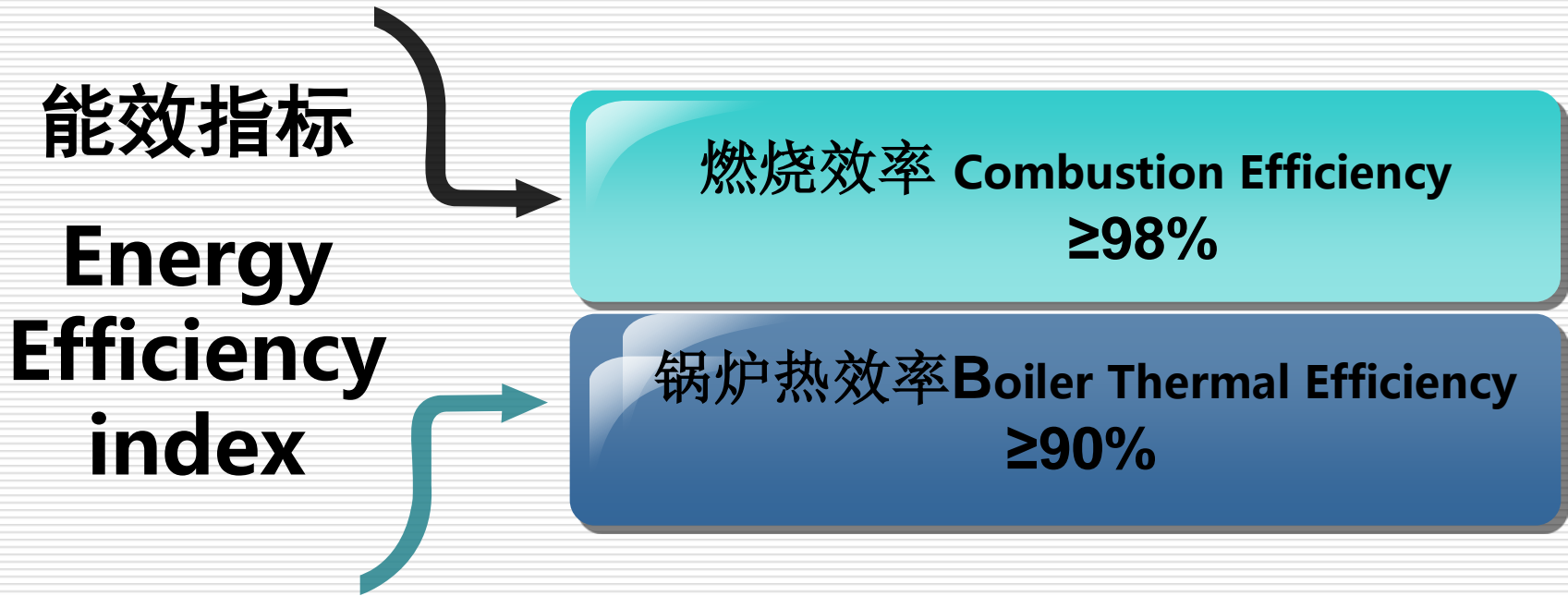
高效煤粉工业锅炉系统

Efficient coal powder industrial boiler system



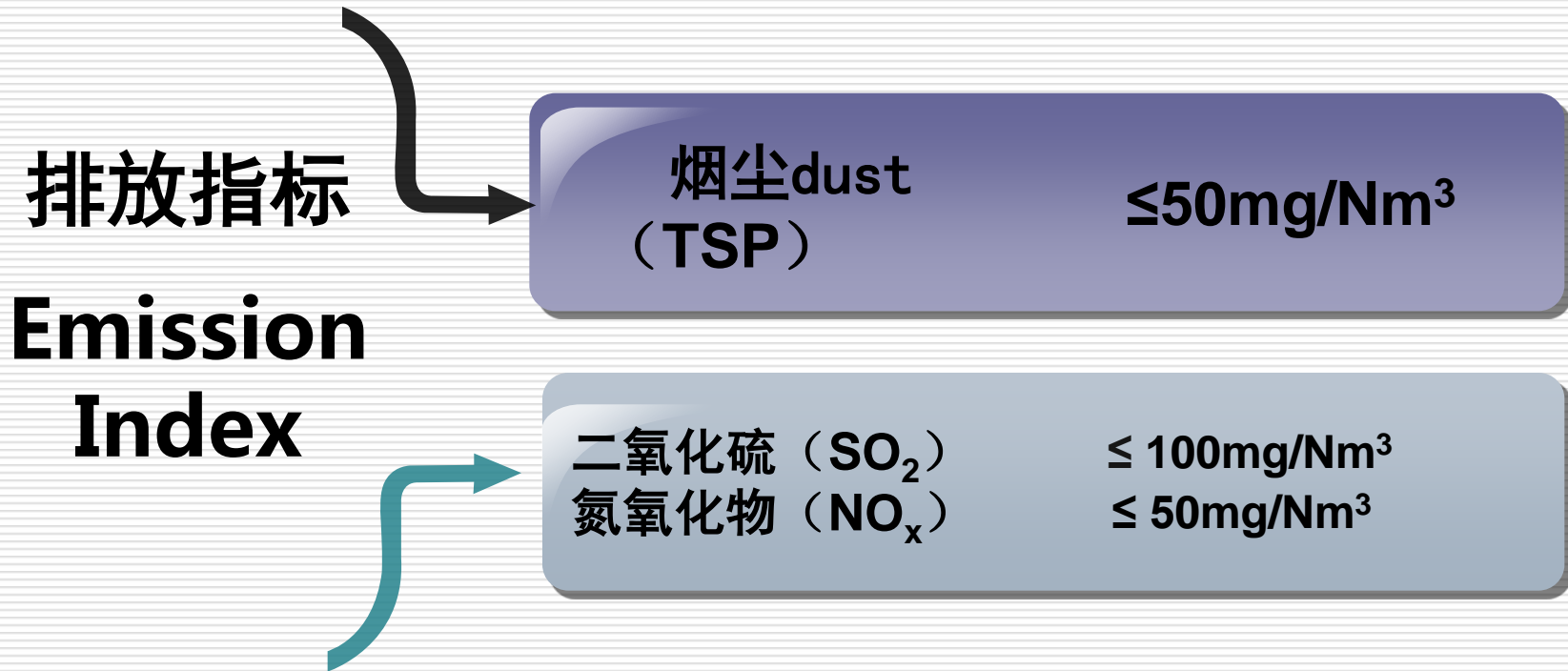
三、中国煤炭科工集团煤炭清洁转化利用技术——3

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group -3



三、中国煤炭科工集团煤炭清洁转化利用技术——3

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group -3

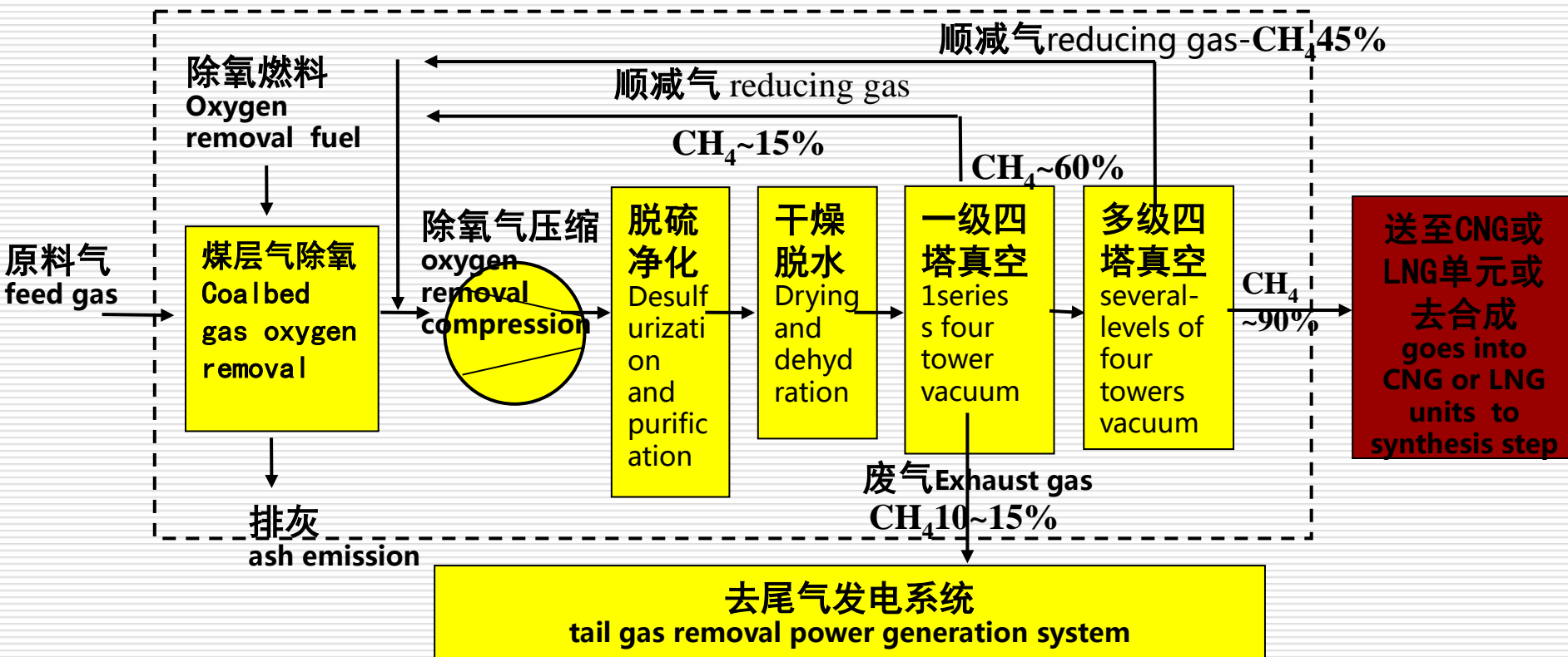


三、中国煤炭科工集团煤炭清洁转化利用技术——4

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group -4

低浓度煤层气除氧浓缩成套技术

Low concentration coalbed gas oxygen removal and concentration sets of technology



三、中国煤炭科工集团煤炭清洁转化利用技术——4

Coal Clean Conversion and Utilization Technology of China Coal Technology and Engineering Group -4



100m³/h煤层气浓缩提纯中试装置2010年7月
100m³/h coalbed methane Enrichment
and purification plant, Jul.2010.

5万Nm³/d制液化天然气（LNG）装置
即将于2016年5月运行
50,000 Nm³/d LNG devices will be on
operation in May, 2016

1万Nm³/d煤制液化天然气（LNG）装置，
原料气浓度20%，产品气浓度
95%，2015年5月

10,000Nm³/d LNG plant, with a
concentration of feed gas is 20%
concentration of product gas is
95%, May.2015



谢谢！
Thank you!