



# 煤炭清洁利用展望

## Prospect of Clean Utilization of Coal

阳泉煤业（集团）有限责任公司

Yangquan Coal Industry Group






# 1. 阳泉煤业集团

## 1. Yangquan Coal Industry Group

阳泉煤业集团经过六十余年的发展，现已成为一个以煤为基多元化发展的现代企业集团，产业涉及煤炭、化工、装备制造、物流贸易、地产、铝电、现代服务业等方向。



By more than 60-years growth-up, Yangquan coal industry group has become a multiple enterprise group depend upon coal industry now, industries involved in coal, chemicals, equipment manufacturing, logistics, trade, real estate, Aluminum electrolysis industry , Modern service, and so on.





# 1. 阳泉煤业集团

## 1. Yangquan Coal Industry Group

阳煤2016年煤炭产量7086万吨，总资产合计2150亿元，营业收入1794亿元，拥有中国最大的化工设备制造公司和中国第三大煤化工公司。



Yangquan coal industry group produces 70.86 million coal tons, has 2150 billion Yuan total assets, 179.4 billion Yuan revenue in 2016. Yangquan has **the largest chemical industry machinery manufacturing equipment company** and **third largest coal chemical company in China.**





# 1. 阳泉煤业集团

## 1. Yangquan Coal Industry Group

集团拥有567个分子公司，其中包括4个上市公司

The Group is made up with 567 sub-companies including 4 listed companies

总职工17.6万人

Total employees:176,000.

2016年世界500强企业第374位

The 374th in the Fortune 500 Enterprises list for 2014.

中国企业500强第90位

The 90th of Chinese 500 Top Enterprises.

中国煤炭企业100强第7位

The 7th of Chinese 100 Top Coal Enterprises

中国最大的无烟煤生产基地

The largest anthracite coal production company in China



# 1. 阳泉煤业集团

## 1. Yangquan Coal Industry Group

化工产业已发展成为阳煤集团近年来增长最快、增量最多、增幅最大的产业板块。  
Chemical industry has developed into the fastest-growing, most incremental, the largest increase industrial sector of Yangquan in recent years .

煤炭Coal  
26.8 billion Yuan

化工chemical industry  
44.7 billion Yuan

贸易物流  
Trading logistics  
75.4 billion Yuan

铝电  
Aluminum electrolysis  
25.9 billion Yuan

中小企业  
Modern service industry  
96 billion Yuan

地产real estate  
11.7 billion Yuan

装备制造  
Assembling manufacture  
6.3 billion Yuan





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# 化工产业

# Chemical Industry





## 2. 化工产业

## 2. Chemical Industry




2005年重组山西三维华邦集团有限公司，建立化工产业  
Establish the chemical industry in 2005

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2008年成立阳煤集团化工产业管理局负责经营管理化工产业  
Founded Yangquan Coal Chemical Industry Authority responsible  
for the management of chemical industry in 2008

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2016年阳煤集团化工产业管理局下属26个企业，化工产品产量  
880万吨，营业收入463亿元。  
Yangquan Coal Chemical Industry Authority owned 26 companies,  
chemical products 8.8 million tons, operating income of 46.3 billion  
Yuan in 2016.

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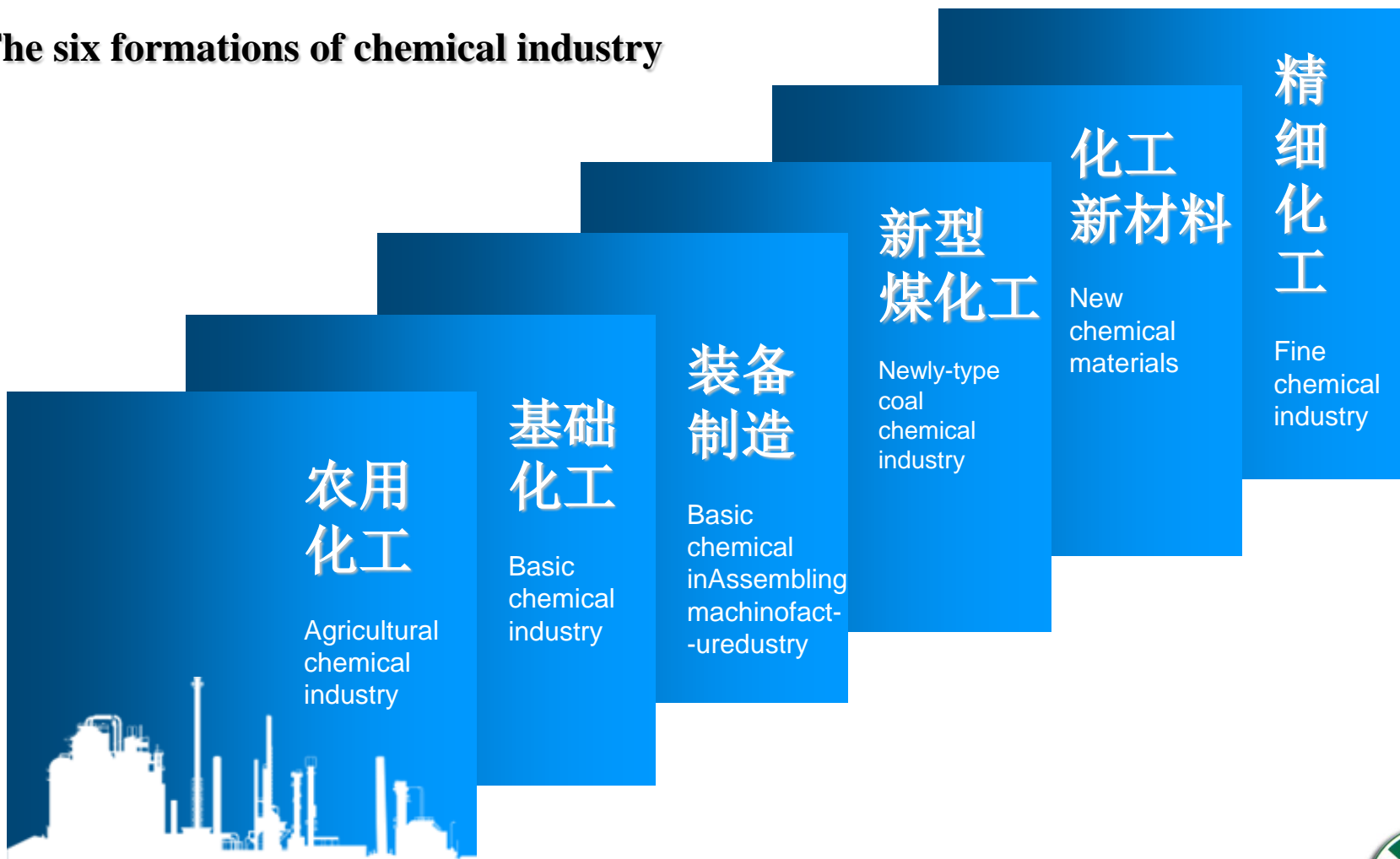


## 2. 化工产业

### 2.Chemical Industry

化工产业六大板块

The six formations of chemical industry





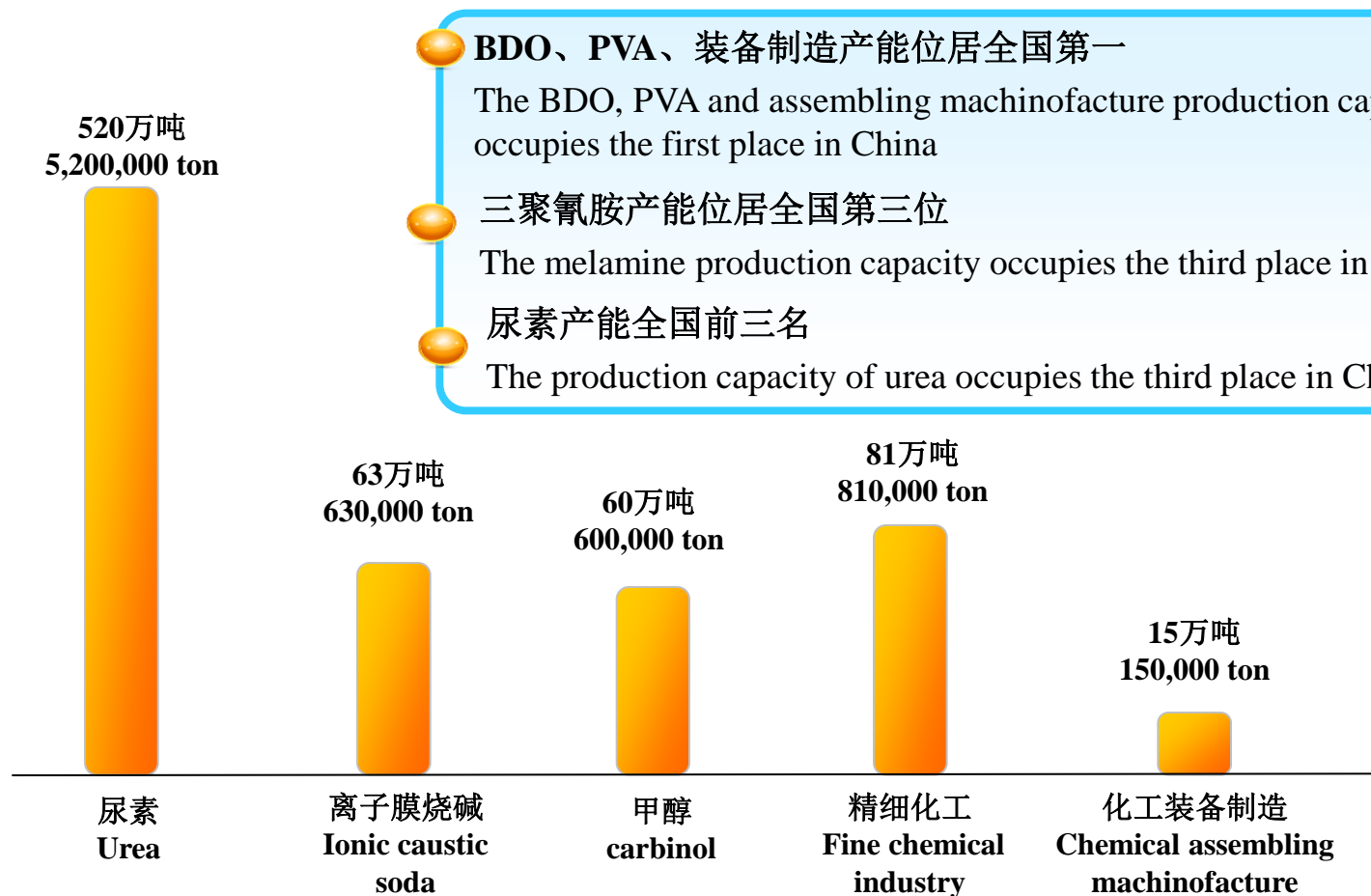
## 2. 化工产业

### 2. Chemical Industry

#### 化工产业规模 Scale of chemical industry

现有化工产品80余种，实物产能880万吨。主要产品生产规模为：

There are more than 80 kinds of chemical products and actual output of 880 million ton every year now. The main products and production scales are being shown as following:



● BDO、PVA、装备制造产能位居全国第一

The BDO, PVA and assembling manufacture production capacity occupies the first place in China

● 三聚氰胺产能位居全国第三位

The melamine production capacity occupies the third place in China

● 尿素产能全国前三名

The production capacity of urea occupies the third place in China

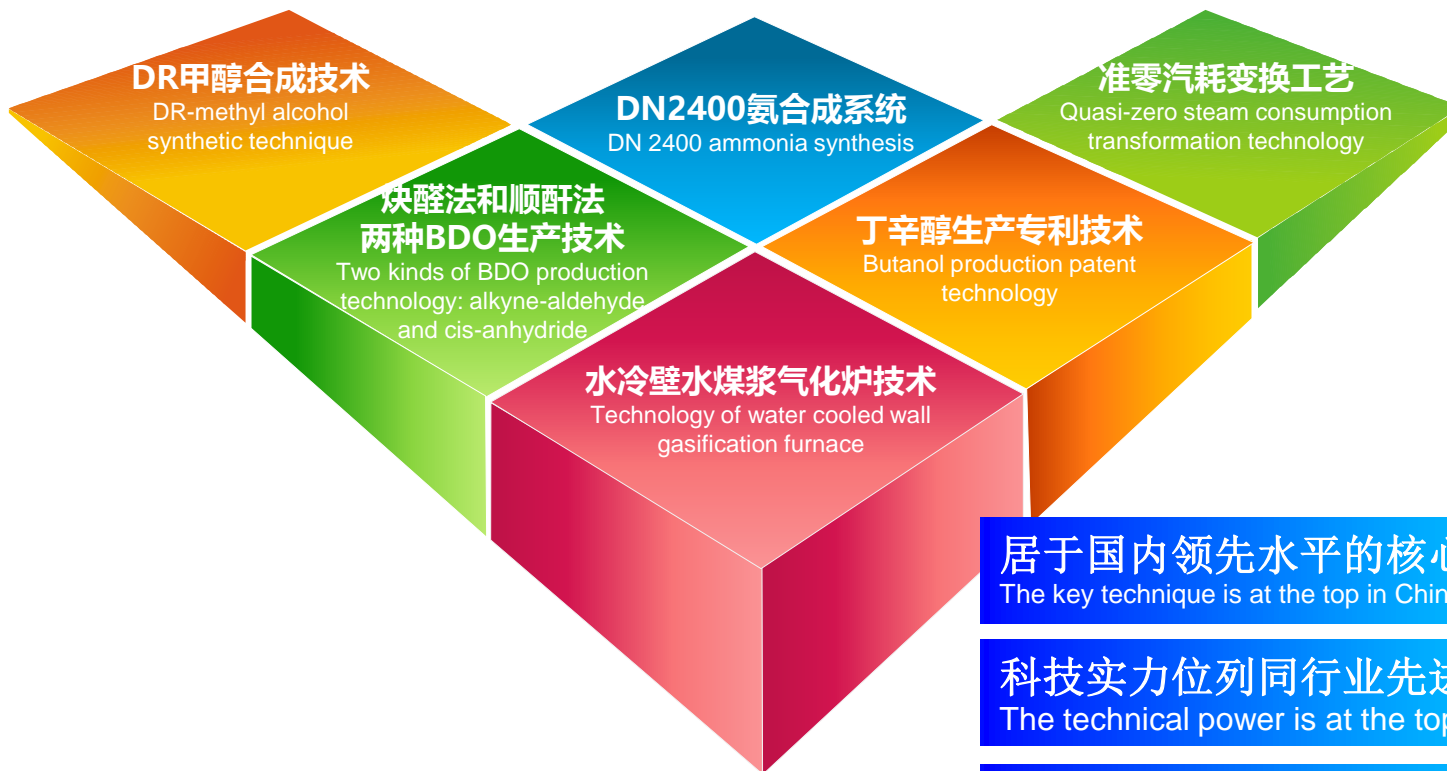


# 2. 化工产业

## 2. Chemical Industry

化工产业科技研发

The technical power of chemical industry



居于国内领先水平的核心技术优势  
The key technique is at the top in China

科技实力位列同行业先进水平  
The technical power is at the top of the industry

总共拥有144项专利技术  
Having 144 kinds of patent technologies





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**阳煤集团化工机械有限公司**  
**Yangquan Coal Group Chemical**  
**Machinery Co., Ltd.**



陽煤集團

YANG QUAN COAL INDUSTRY (GROUP)



### 3.阳煤集团化工机械有限公司

## Yangquan Coal Group Chemical Machinery Co., Ltd.

阳煤集团化工机械有限公司是中国最大的化工设备加工制造企业，总投资17.5亿元，占地55万平方米，设太原、永济、新疆三个化机制造基地，加工制造能力15万吨，年产值30亿元。

Yangquan coal industry group chemical machinery Co., Ltd is the largest chemical industry equipment manufacturing enterprises in China, with a total investment of 1.75 billion Yuan, covers an area of 550,000 square meters, and processing capacity of 150,000 tons, the output value of 3 billion Yuan.



# 3.阳煤集团化工机械有限公司 Yangquan Coal Group Chemical Machinery Co., Ltd.



CK5280数控双柱立式车床



FB260/200X60数控落地铣镗床



DD40E/2卧式双主轴数控深孔钻床



PL4040数控4轴钻床



### 3.阳煤集团化工机械有限公司

## Yangquan Coal Group Chemical Machinery Co., Ltd.

2013年8月，与清华大学教授、中国工程院院士岳光溪团队签署了协议，建立山西省煤气化装备技术院士工作站。

The company signed an agreement with Yue Guangxi in August 2013. He is the Professor of Tsinghua University, the Chinese Academy of engineering. We establish academicians workstation of coal gasification technology.



**academicians workstation**



**Professor Yue**



# 3.阳煤集团化工机械有限公司

## Yangquan Coal Group Chemical Machinery Co., Ltd.

- 世界上第一套水煤浆水冷壁气化炉；

The world's first water-wall in coal-water slurry Gasifier

- 阳煤化机与清华大学共同研发；

This Gasifier was researched and developed by Yangquan Coal Group and Tsinghua University together





阳煤集团太原化工新材料有限公司

Yangquan Coal Group

Taiyuan New chemical Material Co., Ltd.



陽煤集團

YANG QUAN COAL INDUSTRY (GROUP)





## 4.阳煤集团太原化工新材料有限公司-Yangquan Coal Group Taiyuan New chemical Material Co., Ltd.

阳煤集团太原化工新材料有限公司总投资143亿元，占地3000亩，是山西省建设国家新型能源和工业基地示范性工程，是首批省级转型综改标杆项目，是山西省最大的煤化工产品深加工项目。

Yangquan coal industry group Taiyuan new chemical material Co., Ltd. with total investment of 14.3 billion Yuan, covers an area of 3000 hectares, is the key engineering of provincial enterprise for transformation and overall reformation. And it is the biggest coal chemical products deep processing projects in Shanxi province .



## 4.阳煤集团太原化工新材料有限公司-Yangquan Coal Group Taiyuan New chemical Material Co., Ltd.

园区规划20万吨/年己内酰胺、14万吨/年己二酸、12万吨/年聚甲醛，配套24万吨/氨醇、20万吨/年硝酸、24万吨/年硫酸等产品，搬迁太化20万吨/年粗苯精制装置。

The company plan 200,000 ton/year caprolactam, 140,000 ton/year of adipic acid, 120,000 ton/year of POM, supporting 240,000 ton/year of ammonia alcohol, 200,000 ton/year of nitric acid, 240,000 ton/year of sulfuric acid, 200,000 ton/year of crude benzene and other refined products.



## 4.阳煤集团太原化工新材料有限公司-Yangquan Coal Group Taiyuan New chemical Material Co., Ltd.

园区的煤气化部分已建成三套750吨/天航天炉，其空分、水处理等公用工程符合ARGT气化炉工业示范装置的技术要求，目前已在现场为800吨/天商业示范项目预留框架建设用地。

It has been built three 750 ton/day HT-L Gasifiers. Its air separation, water treatment and others meet the technical requirements of ARGT demonstration plant. The demonstration plant can use that. And it already has reserved the place for 800 tons/day of commercial demonstration plant.





# 晋华炉煤气化技术

## Gasification Technology of Jinhua Gasifier



陽煤集團

YANG QUAN COAL INDUSTRY (GROUP)



## 5. 晋华炉煤气化技术

### Gasification Technology of Jinhua Gasifier

2001年，清华大学和阳煤丰喜、阳煤化机合作开发第一代晋华炉（水煤浆+耐火砖+激冷流程）。2006年在阳煤丰喜公司一次开车成功，该技术当时达到国际先进水平。

In 2001, Tsinghua University and Yangquan Coal Industry Group developed the first generation Jinhua Gasifier (Slurry feed+ Refractory Brick + Quench process). In 2006, The first startup was successful in the Yang Coal Fengxi , this technology had reached the international leading level.



## 5. 晋华炉煤气化技术

### Gasification Technology of Jinhua Gasifier

2008年，清华大学和阳煤集团合作开发了具有划时代意义的第二代晋华炉（水煤浆+膜式水冷壁+激冷流程），2011年8月一次开车成功，并连续、安全、稳定运行了140天。

In 2008, Tsinghua University and Yangquan Coal Industry Group developed the second generation Jinhua Gasifier (Slurry feed+ Membrane wall +Quench process) which is landmark. The first startup was successful in August 2011 and it ran for 140 days in a continuous, safe and stable manner.



# 5. 晋华炉煤气化技术

## Gasification Technology of Jinhua Gasifier

### 第二代晋华炉特点 Advantages

- ◆ 成功使用 $1580^{\circ}\text{C}$ 灰熔点的原料煤，褐煤到无烟煤皆可使用；
- ◆ 水冷壁寿命长、投资低和维护成本低；
- ◆ 壳体温度更低，安全性更高。
- ◆ Successful gasification of ash fusion point of coal with  $1580^{\circ}\text{C}$ , coal covers from lignite to anthracite;
- ◆ Long life membrane, low capital cost and maintenance cost;
- ◆ Lower shell temperature, higher security.

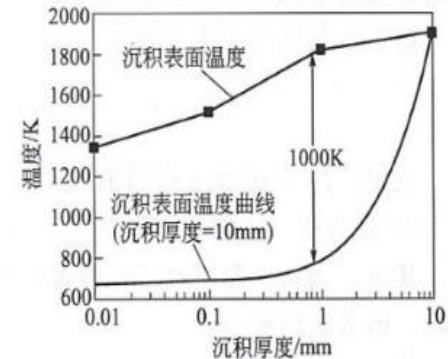


图 7-9 渣层内温度与到炉壁距离的关系



## 5.晋华炉煤气化技术

### Gasification Technology of Jinhua Gasifier

2015年，清华大学和阳煤合作开发了第三代晋华炉。2016年4月1日一次开车成功，成功解决了高灰熔点煤气化能耗高的难题，更好的回收了气化装置高温合成气的热量，副产高压蒸汽，提高了能源转化效率，开煤气化技术领域先河，领跑当今国际煤气化技术。

In 2015, Tsinghua University and Yangquan Coal Industry Group developed the third generation Jinhua Gasifier. It had operated successfully for the first startup on April 1, 2016 and successfully solved the problem of high energy consumption of coal gasification with high ash fusion point. It recovers the heat of high temperature syngas in gasification device more efficient, produces high-pressure steam and increases the energy conversion efficiency. It has reached the international advanced level.



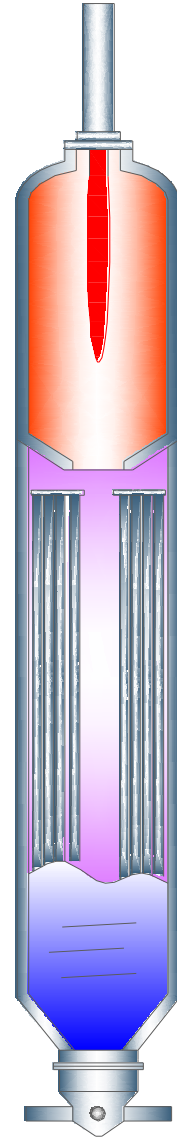


## 5. 晋华炉煤气化技术

### Gasification Technology of Jinhua Gasifier

第三代晋华炉采用废锅组合，和激冷型气化炉相比，晋华炉可以回收高压蒸汽，更适合高灰熔点煤和低浓度水煤浆气化。

Compared with quenching gasifier, the third generation Jinhua Gasifier utilizing RSC can recovery high pressure steam and is more suitable for high ash fusion point coal and low concentration of coal slurry gasification.



## 5. 晋华炉煤气化技术

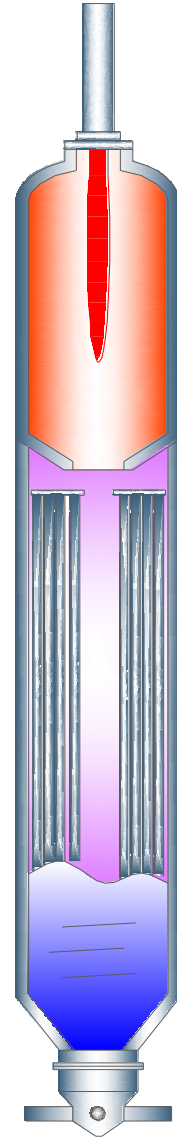
# Gasification Technology of Jinhua Gasifier

晋华炉的煤种适应性

Adaptability of Coal in Jinhua Gasifier

目前晋华炉使用过的煤种有褐煤、烟煤、半焦、无烟煤；煤种的灰熔点最低到 $1120^{\circ}\text{C}$ ，最高到 $1580^{\circ}\text{C}$ ；煤种的灰分最低为5%，最高为28%。

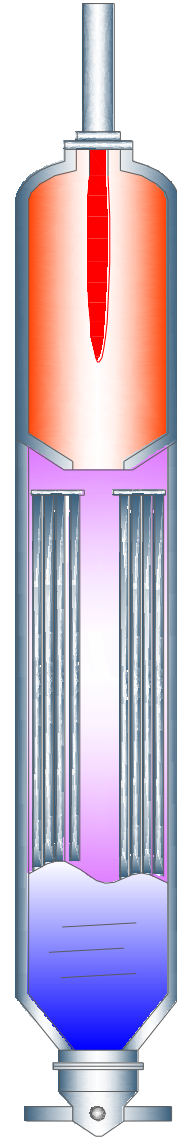
So far, The running coal of Jinhua Gasifier are lignite、bituminous coal、 semi-coke、 anthracite; The ash fusion point of coal is between  $1120^{\circ}\text{C}$  and  $1580^{\circ}\text{C}$ ; The coal ash is between 5% and 28% .



## 5. 晋华炉煤气化技术

### Gasification Technology of Jinhua Gasifier

- 晋华炉采用的点火方式不同，可以使用挥发分低的煤作为原料；
  - 晋华炉采用水冷壁结构，可以使用高灰熔点的煤作为原料；
  - 晋华炉采用废锅结构，可以使用成浆浓度低的煤作为原料
- 
- Jinhua Gasifier applies special ignition methods, and low-volatile of coal can be used as raw materials;
  - Jinhua Gasifier applies membrane wall, and high ash melting point of coal can be used as raw materials;
  - Jinhua Gasifier applies RSC, and low concentration of coal slurry can be used as raw materials.



# 5. 晋华炉煤气化技术

## Gasification Technology of Jinhua Gasifier

### ► 应用案例 Applications

#### 高灰熔点气化数据 Gasification data of high ash fusion point

项目/Item	单位/Unit	无烟煤/anthracite
水煤浆浓度/Concentration of coal slurry	%	63
气化炉出口温度/Outlet temperature of gasifier	°C	1630
干合成气组成/Composition of dry synthesis gas		
CO	%	54.72
H <sub>2</sub>	%	22.04
CO <sub>2</sub>	%	22.67
CH <sub>4</sub>	%	0.04
比氧耗/Oxygen consumption	Nm <sup>3</sup> /[km <sup>3</sup> (CO+H <sub>2</sub> )]	451
比煤耗/Coal consumption	kg/[km <sup>3</sup> (CO+H <sub>2</sub> )]	715
副产蒸汽(10.0MPa)饱和/By-product saturated steam(10.0MPa)	kg/[km <sup>3</sup> (CO+H <sub>2</sub> )]	1150



# 5. 晋华炉煤气化技术

## Gasification Technology of Jinhua Gasifier

### ► 应用案例 Applications

#### 褐煤气化数据 Gasification data of lignite

项目/Item	单位/Unit	褐煤/Lignite
水煤浆浓度/Concentration of coal slurry	%	48
气化炉出口温度/Outlet temperature of gasifier	°C	1250
干合成气组成/Composition of dry synthesis gas		
CO	%	27.34
H <sub>2</sub>	%	35.83
CO <sub>2</sub>	%	35.00
CH <sub>4</sub>	%	0.83
比氧耗/Oxygen consumption	Nm <sup>3</sup> /[km <sup>3</sup> (CO+H <sub>2</sub> )]	574
比煤耗/Coal consumption	kg/[km <sup>3</sup> (CO+H <sub>2</sub> )]	972
副产蒸汽(10.0MPa)饱和/By-product saturated steam(10.0MPa)	kg/[km <sup>3</sup> (CO+H <sub>2</sub> )]	1010



## 5. 晋华炉煤气化技术

# Gasification Technology of Jinhua Gasifier

### ► 应用案例 Applications

从上述案例数据可以发现，虽然用褐煤或者高灰熔点煤气化，煤耗、氧耗均较高，但能副产1.0~1.1吨/ $\text{KNm}^3(\text{CO}+\text{H}_2)$ 10.0MPa蒸汽，装置的效率并没有因为煤质的变差而降低。

From the cases, with lignite or high ash fusion point coal, coal consumption and oxygen consumption are high, but can by-product 1.0 ~ 1.1t 10.0MPa steam / $\text{KNm}^3 (\text{CO} + \text{H}_2)$ , the gasification efficiency is not decrease when using poor coal quality.

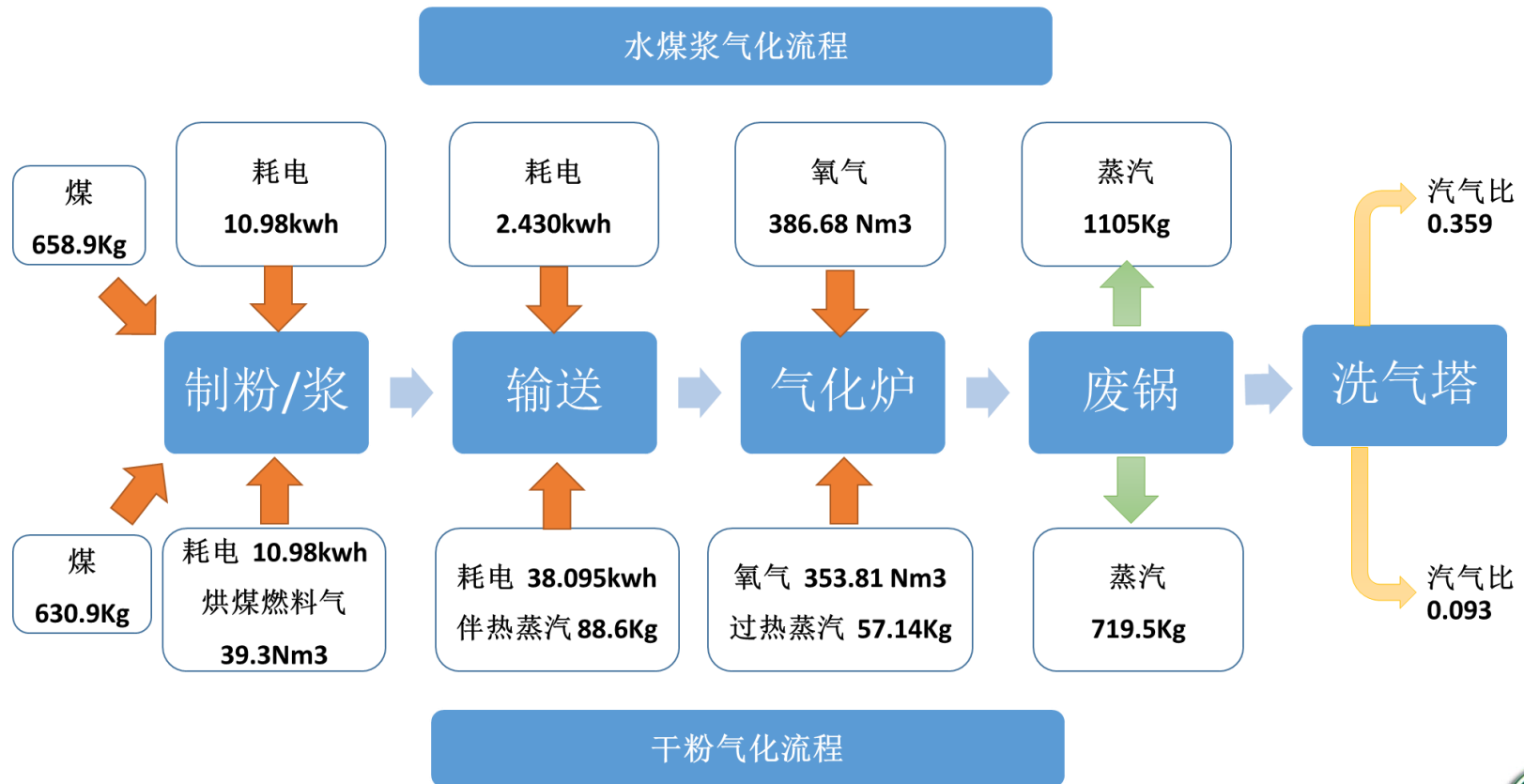


# 5. 晋华炉煤气化技术

## Gasification Technology of Jinhua Gasifier

➤ 针对IGCC全热回收对比

Comparison with IGCC total heat recovery



## 5. 晋华炉煤气化技术

# Gasification Technology of Jinhua Gasifier

### ➤ 针对IGCC全热回收对比

#### Comparison with IGCC total heat recovery

虽然干粉气化的煤耗和氧耗低于水煤浆气化，但是干粉气化过程中的煤粉制备、输送环节的能耗高，而且这部分能量无法回收；如果采用废锅流程回收热量，相同产气量的工况下，晋华炉产蒸汽多于干粉气化流程。

Although coal consumption and oxygen consumption of dry powder gasification are lower than the coal slurry gasification, but power consumption of dry pulverized coal preparation, transport links in the process of dry powder gasification is higher, and this energy can not be recovered. If the waste heat boiler process is used to recover heat, the production steam of Jinhua Gasifier is more than the dry powder gasification process under the same conditions.



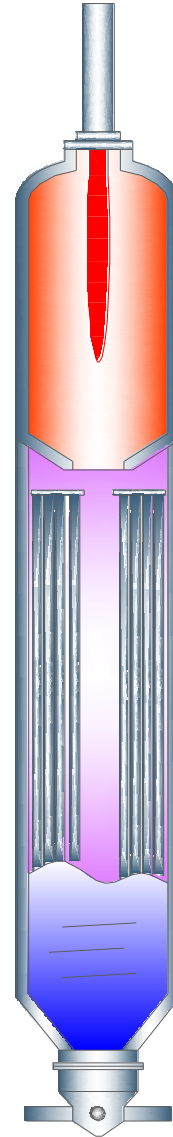


# 5. 晋华炉煤气化技术

## Gasification Technology of Jinhua Gasifier

晋华炉煤气化技术是一种煤种适应性强、效率高、运行成本低的新型气化技术。

Jinhua Gasifier is a new type of coal gasification technology with higher efficiency and low operating cost.



TAHANK YOU

