东方电气
DONGFANG ELECTRIC
东方电气集团东方汽轮机有限公司

THE TECHNOLOGY DEVELOPMENT OF HIGH EFFICIENCY 700℃ GRADE STEAM TURBINE

Dong Fang Steam Turbine Co. Ltd.

2017.12

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2、630℃ POWER STATION of DONGFANG

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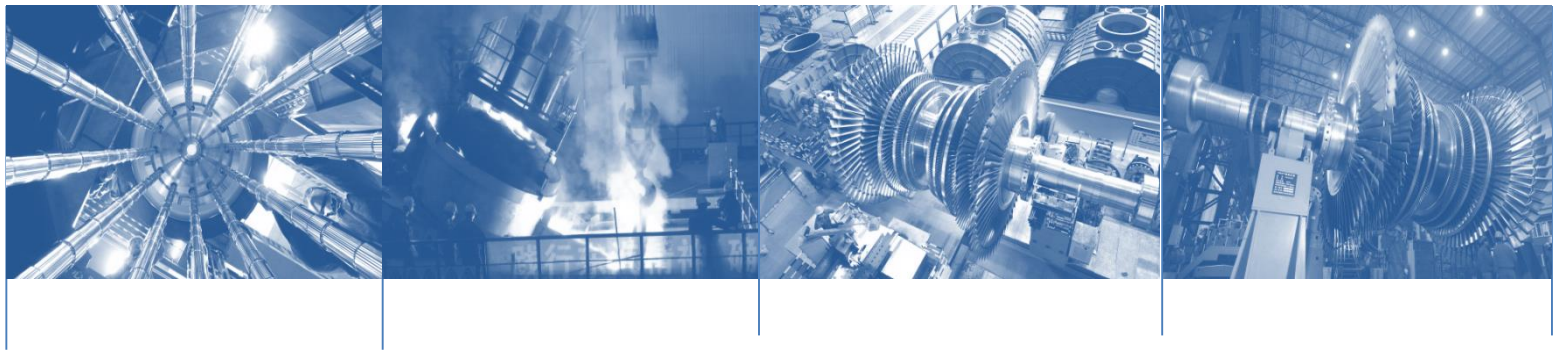
1

BACKGROUND



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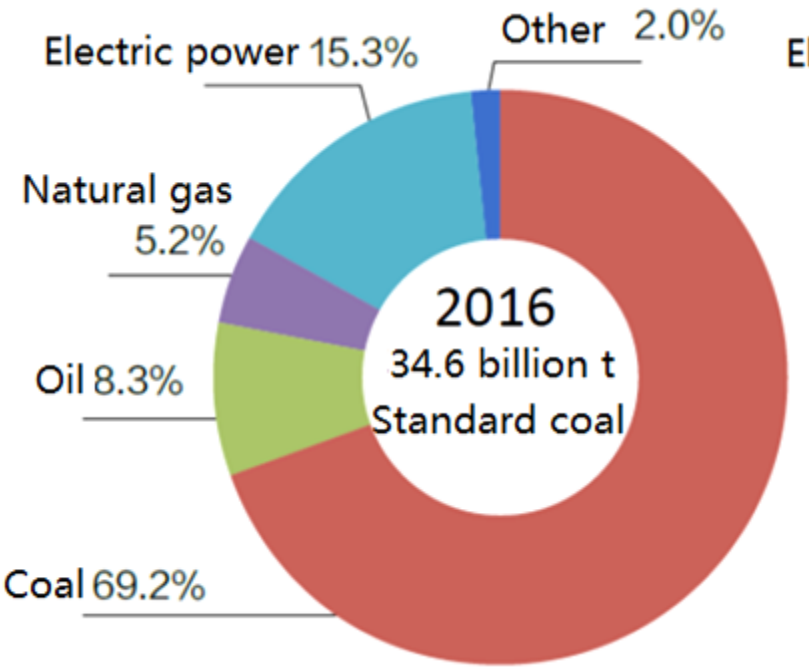
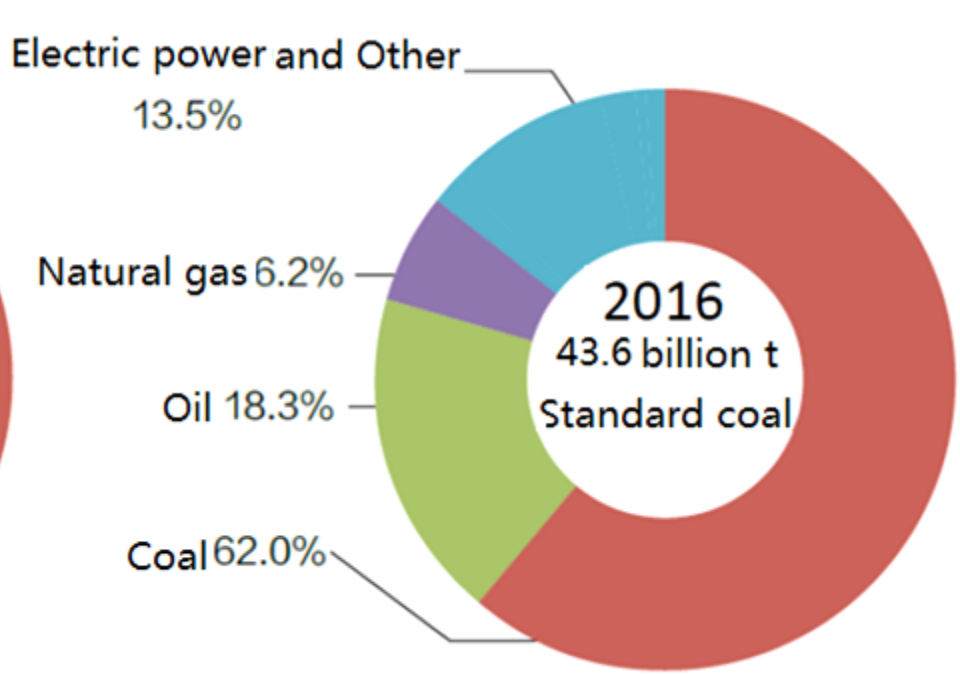
➢PRODUCTION, CONSUMPTION STRUSTURE OF NON-RENEWBLE ENERGY



production



consumption structure

In 2016, about 20% consumption of China's energy are from foreign countries, of which 65% of crude oil, 34.4% of natural gas and 6.3% of coal.

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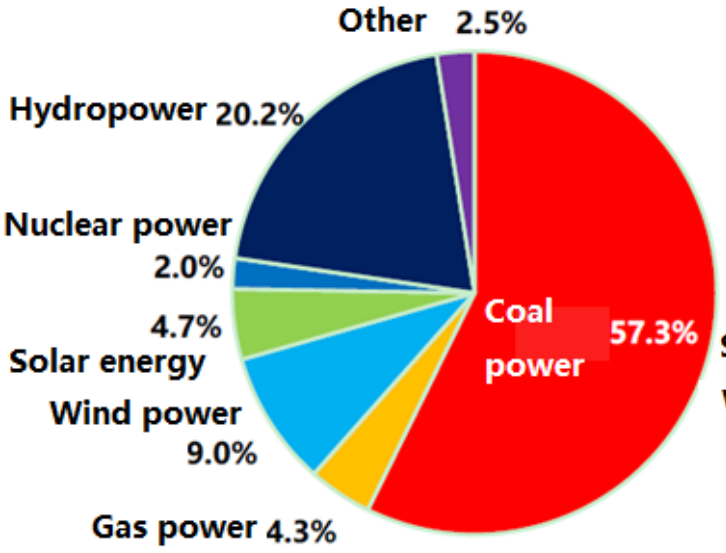
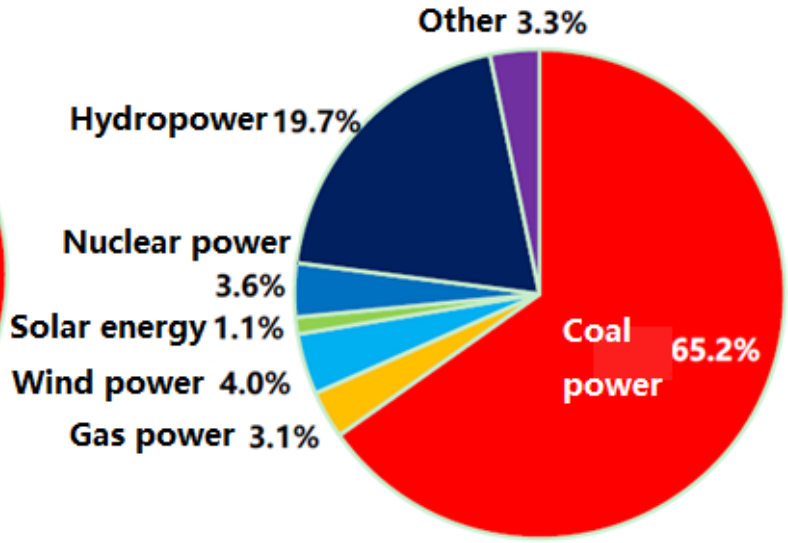
➢POWER INSTALLED STRUCTURE AND POWER GENERATION STRUCURE

Coal power in China's installed capacity and power generation structure both occupy a major position in China's power supply is the basic power



Installed Structure



Generation Structure

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➢ENERGY AND POWER

- It is estimated that by around 2030, China‘s carbon dioxide emissions will peak and will strive to reach its peak as soon as possible；
- China plans to increase the proportion of non-fossil fuels to primary energy consumption to 20% by 2030；
- China has promised to reduce its carbon dioxide emissions 60-65% per unit by 2030 ；

By 2020, large-scale power generation unit of carbon dioxide emissions control of 550g CO2 / kWh.

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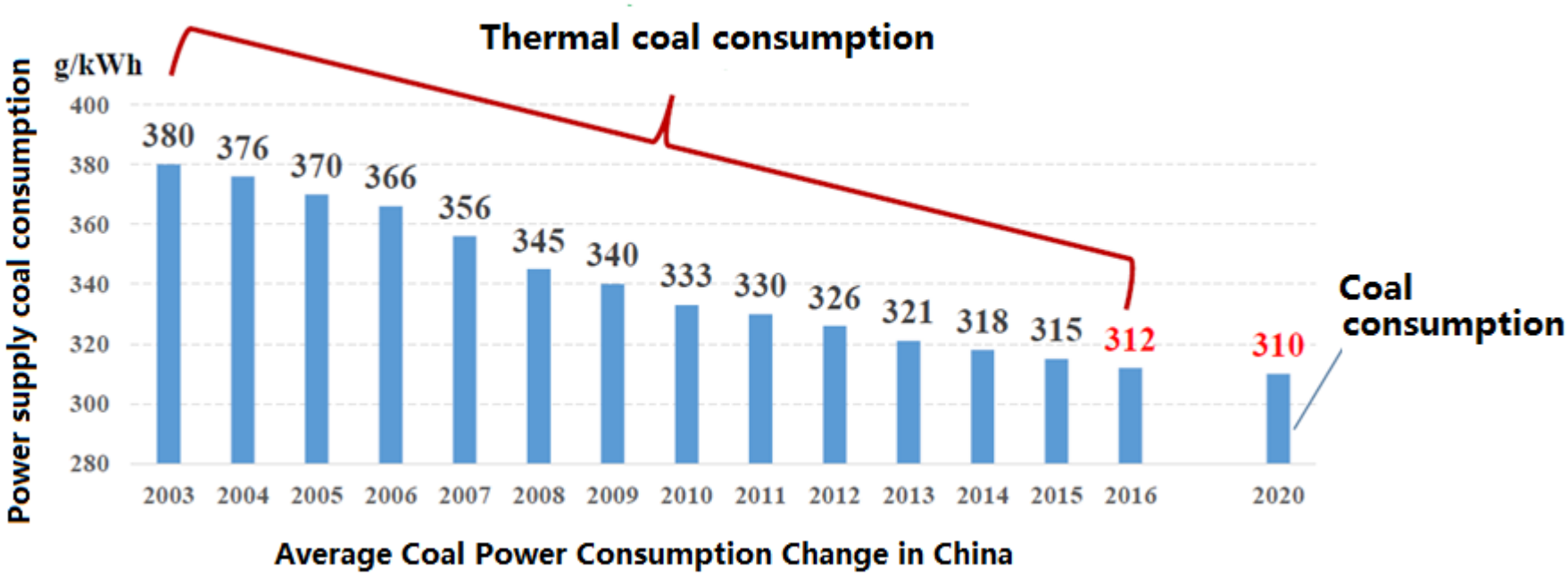
➢EFFICIENCY CONTINUES TO IMPROVE

In 2016, the thermal coal consumption dropped to 312g standard coal / kwh,

(of which coal consumption was about 317g standard coal / kWh)



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➢PARAMETER DEVELOPMENT PROCESS

- 1966 Dongfang established
- 2007 The first USC plant (25MPa/600℃/600℃)
- 2014 28MPa/600℃/620℃
- 2015 The first double-reheat plant (31MPa/600℃/620℃/620℃)
- 2020 35MPa/615℃/630℃/630℃
- 2025 37MPa/650℃/650℃
- 2030 40MPa/700℃/720℃

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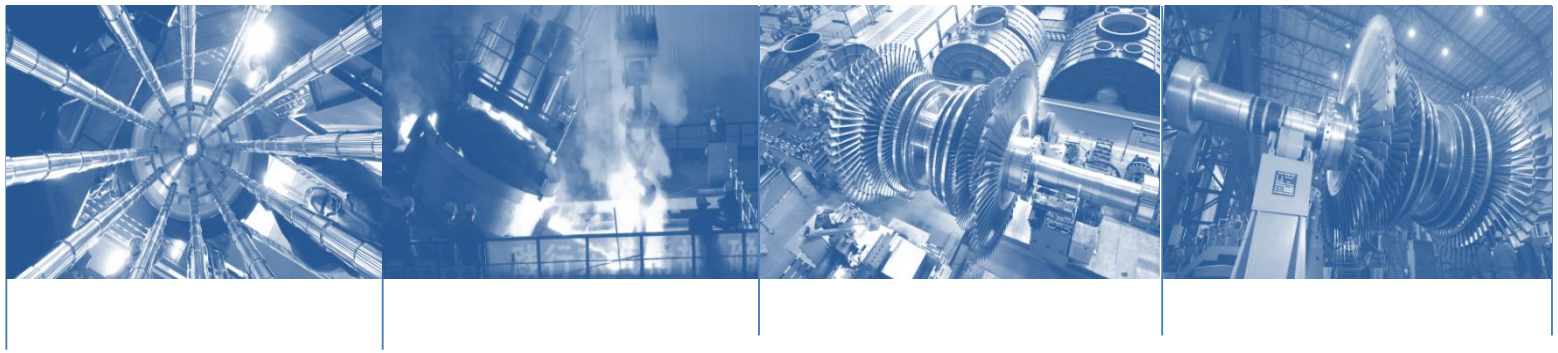
2

630℃ POWER STATION of DongFang



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➢630 ℃ ADVANCED TECHNICAL PERFORMANCE

- Main steam pressure 35MPa
- Reheat steam temperature 630℃

- Turbine heat consumption＜6900kJ/kWh
- Power generation efficiency ＞50%

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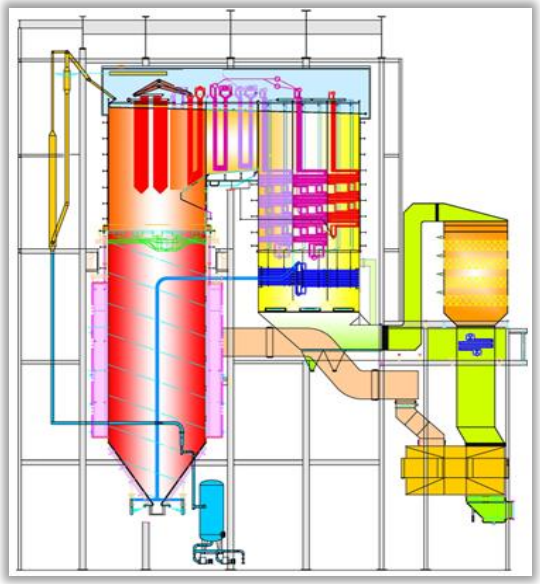
➢BOILER

- Boiler outlet steam parameters：

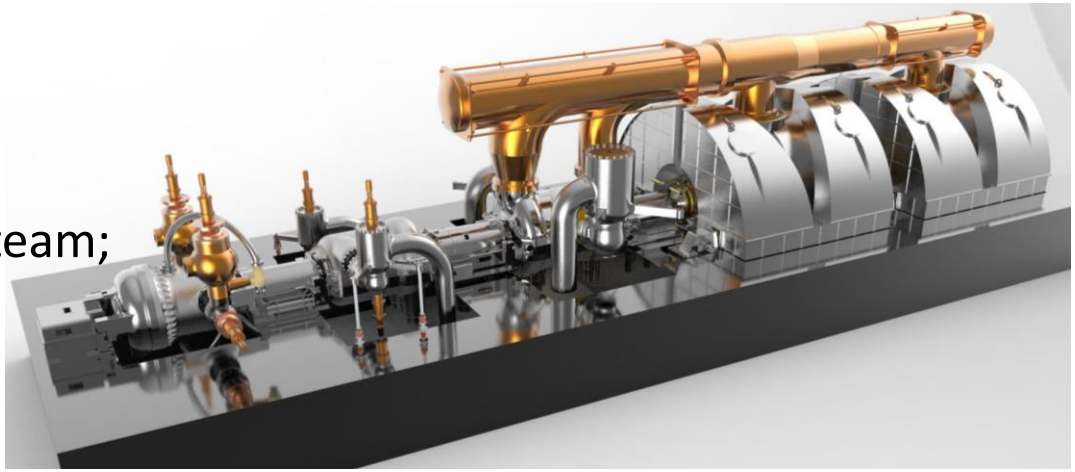
  36.75MPa/620℃/633℃/633℃;

- Π-type hearth;



➢STEAM TURBINE

- Parameters 35MPa / 615 ℃ / 630 ℃ / 630 ℃;
- back pressure 4.1kPa;
- double reheat;
- five cylinder four exhaust steam;
- single shaft;



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➢MATERIAL

● Boiler

project	material
High-temperature heated face	Sanicro25
High-temperature Large pipe	G115

G115 material by the China Iron and Steel Research Institute independent research and development, fully domestic.

● Steam turbine

project	material
High-temperature casting	CB2
High-temperature forgings	N-FB2

The N-FB2 material is optimized from the FB2 material, which is developed by Dongfang and JSW to share intellectual property.

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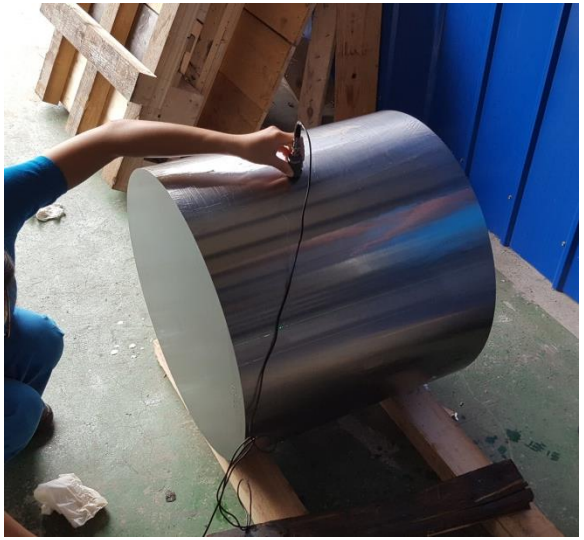
➢MATERIAL

3t N-FB2 test rotor is carrying out experimental research.

Φ592X500mm



UT flaw detection

Analog wire cutting sampling

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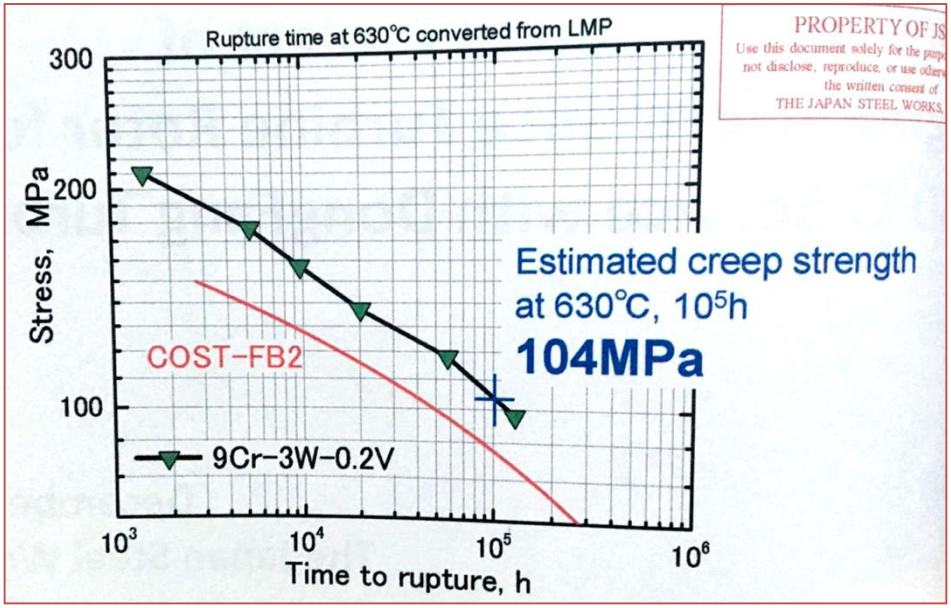
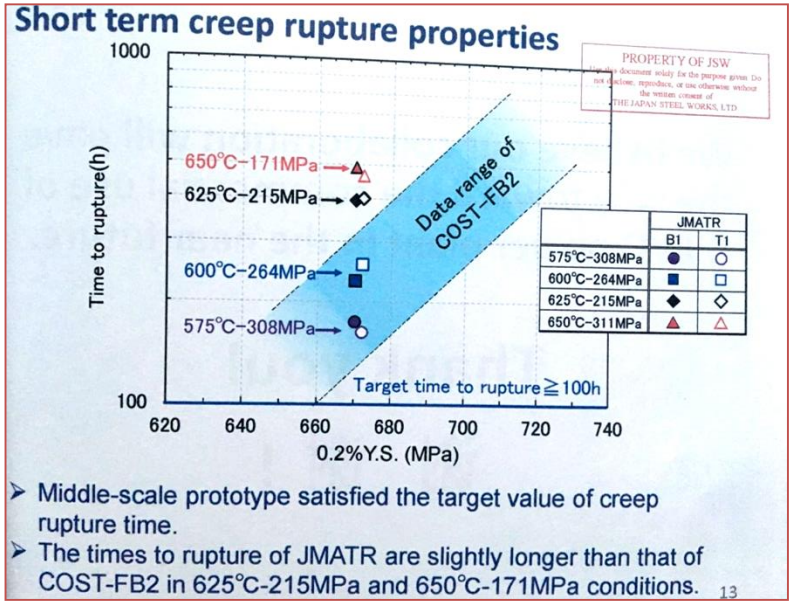
➢MATERIAL

The current research results of N-FB2 show that excellent performance reach the desired level.





Data from JSW

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➢MATERIAL

Casting MATERIAL CB2 Spray anti-oxidation coating.

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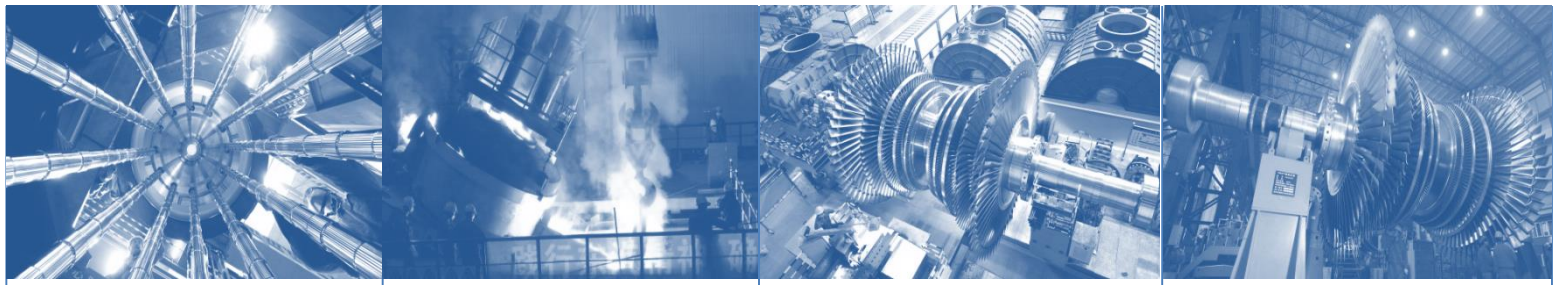
3

KEY TECHNOLOGY of 700℃



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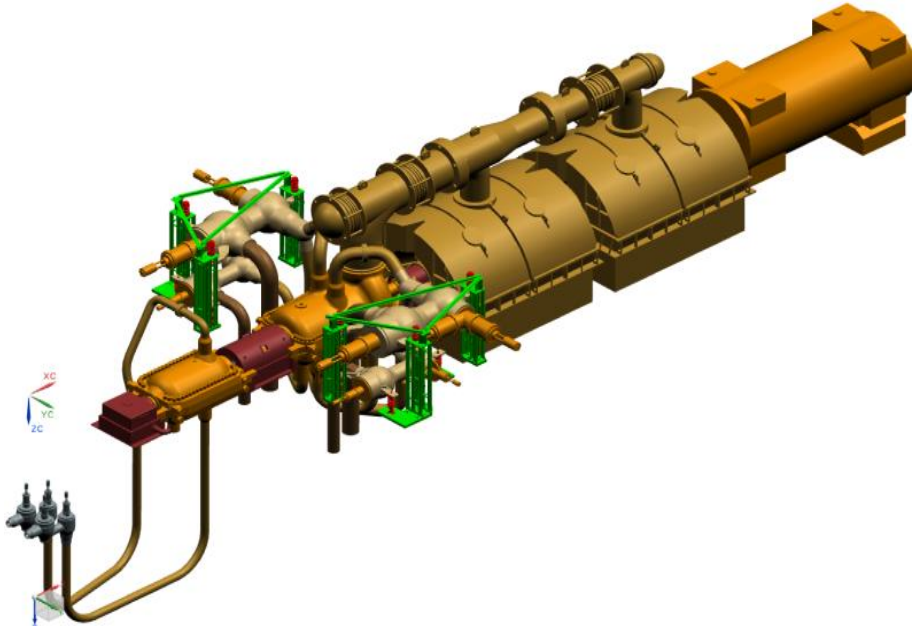
➢DOUBLE REHEAT TECHNOLOGY

The double-reheat technology has been matured in China and is a concern measure in the 700℃power plant.

The first double-reheat unit which was manufactured by DTC put into operation in Jiangxi province, of which the parameter reach 31 MPa/600℃/620℃/620℃.



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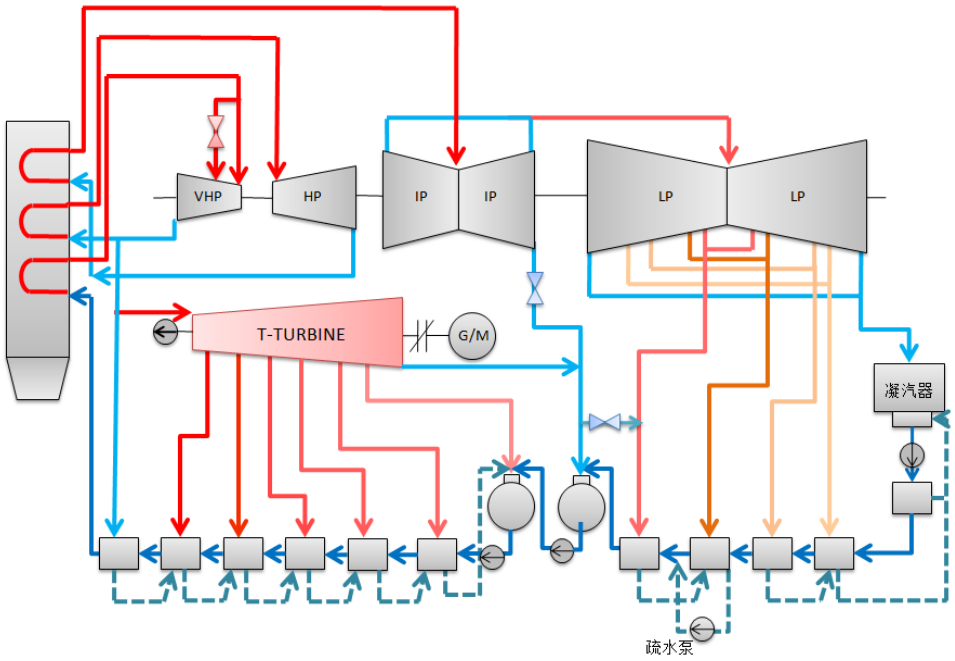
➢THERMAL SYSTEM

For 700℃A-USC turbine adopts the Double-machine heat recovery system.

- ✓ The volume flow of reheating steam was reduced by 35%;
- ✓ The high pressure module of steam turbine has no steam extraction;
- ✓ The system can reduce the initial investment without setting the steam cooler;
- ✓ The inlet temperature of the heater can be reduced significantly;



- ✓ After the reduction of the flow rate, the geometric size of the high pressure module of the steam turbine is decreased.

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➢MATERIAL

For the Materials research, the main choice are TOS1X, IN740, Haynes282, Waspaloy, Nimonic105 and other high-temperature alloys as a candidate material for a comprehensive performance research. The main material table is as follows：

Component	Operating temperature	material
Rotor	700/720℃	TOS1X和Haynes282
Inner casing	700/720℃	IN 740、IN617
vane／blade	700/720℃	Waspaloy、 Udimet 520 、Nimonic105
valve	700/720℃	IN625
bolts	700/720℃	Waspaloy、Nimonic105

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➢WELDED DISK ROTER

700 ℃ steam turbine rotor is welded disk rotor, using Haynes 282 and 12Cr welding.

DTC carried out a large number of experimental studies in this regard.

Performance test group

Haynes 282 + 12Cr

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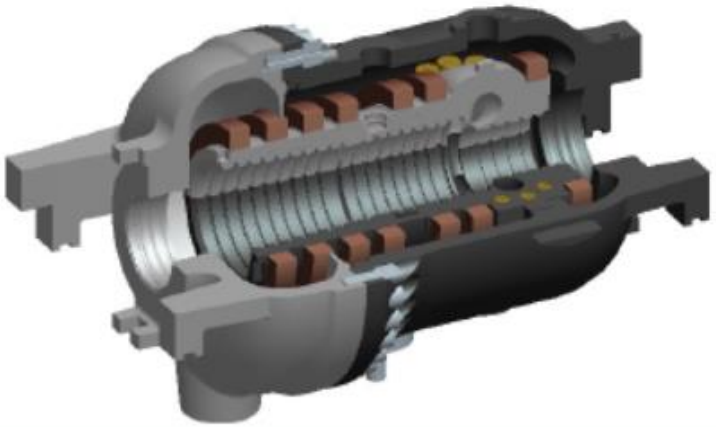
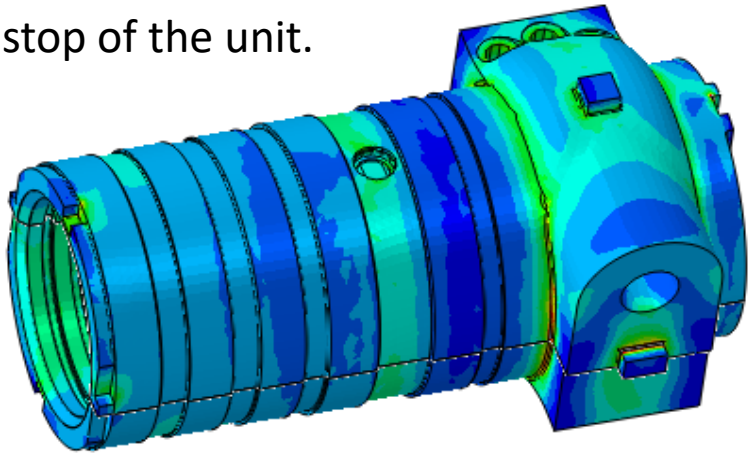
➢DOUBLE BARREL CYLINDER

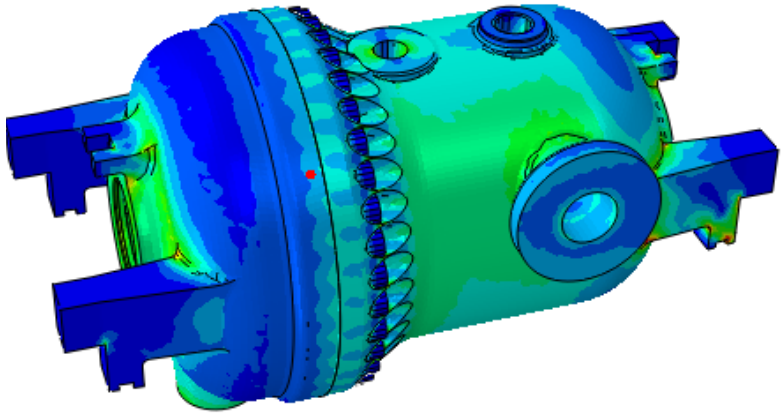
Because of the high pressure, DTC developed new type cylinder which was named double barrel cylinder.



The upper and lower half of the inner casings are set together by seven rings. The outer casings also barrel cylinder.

The cylinder with simple and compact it has strong capacity under high pressure. And the cylinder is isotropic, the thermal stress of it is small, so it can adapt the quick start and stop of the unit.





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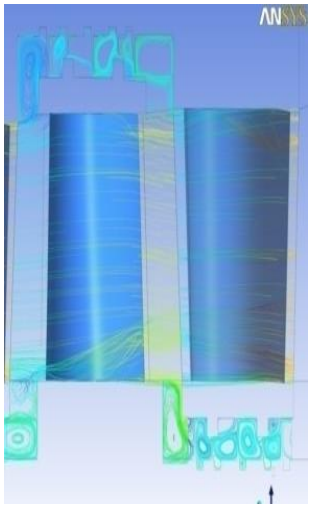
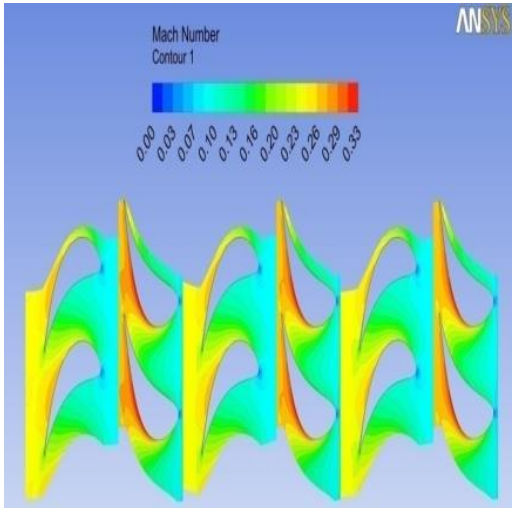
➢FLOW PATH TECHNOLOGY

DTC has developed a new highly after loaded stator profile. For stages with large blade aspect ratio, DTC has developed and applied highly frontal loaded stator profile. The secondary loss does not dominates anymore, and the flow pattern is more like a 2D flow.





DESIGN OF THE NEW BLADES

Turbine test rig

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➢LAST STAGE BLADE

The LP module uses the mature one where the last stage blade height is 1200mm. The blade has applied in many 1000MW units, such as Zhou Shan, Wan zhou, Liu heng project.

1200mm

1400mm

DTC designed a new steel last blade whose height is 1400mm. The LP model design has been completed. It will be used in some 1000MW units with low back pressure.

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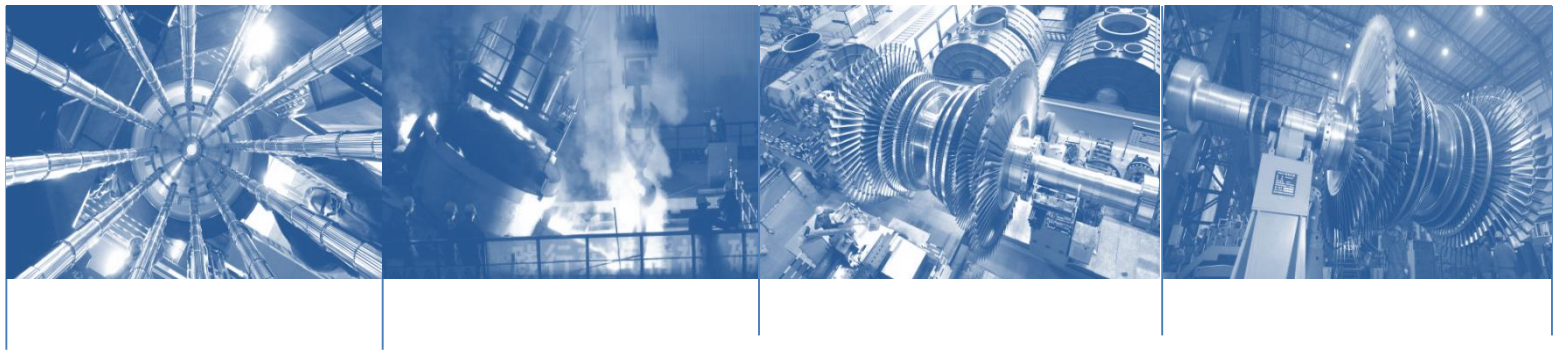
4

CONCLUSION



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➢CONCLUSION

Due to the high cost of 700℃A-USC turbine construction cost, 700℃ A-USC in the short time is difficult to achieve commercial operation, but the improvement of higher parameter is the inevitable direction.

DTC continues to improve in terms of turbine parameter improvement, including steam turbine thermal system optimization, steam turbine layout program innovation, optimization of high temperature components, improvement of the efficiency of steam flow path, last stage blade development to better cope with the commercial operation of 700℃A-USC turbine.

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