

Global Services

全球服务业务

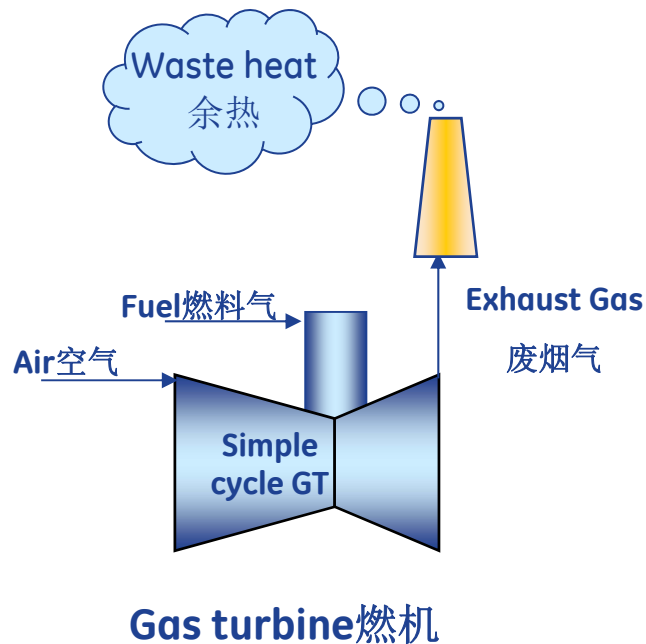
ORegen technology Introduction

ORegen 余热回收技术介绍



May, 2013
2013年5月

Why Waste Heat Recovery? 为什么要回收余热?



Option 1 选项1

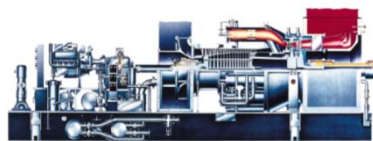
Released into the atmosphere ... No benefits
排放大气无任何收益

Option 2 选项2

Recovery for: 回收余热, 可带来:

- Power Gen ... Additional revenues from energy sell
发电...销售能源可获得额外的收益
- Process more gas thru full utilization of installed gas turbines
现有燃机的完全利用, 从而提高可压气量
- Help comply with CO2-related regulations
响应CO2减排规定
- Increase plant efficiency 提高机组综合效率

ORegen™



Up to 17 MW of power recovery
单套能回收17兆瓦

77% of Oil and Gas installed Gas Turbines are in simple cycle

目前石油天然气已安装燃机机组中的77%为简单循环



GE imagination at work

* ORegen is a trademark of Nuovo Pignone Spa and is available in selected markets

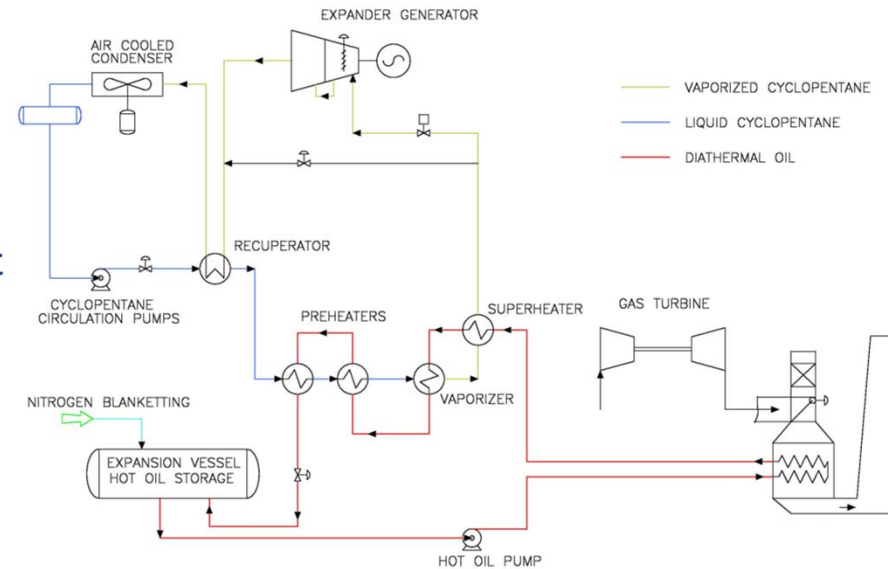
GE Proprietary Information
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ORegen possible application

ORegen应用领域

- Waste Heat Recovery
余热回收
- Geothermal plants
地热发电
- Biomass power plant
生化发电
- Solar Thermal Power
太阳能发电
- Refinery
炼油厂余热回收
- Steel mill
钢厂余热回收

Sources of heat
热源



GE waste heat recovery include GE余热回收包括:

- Gas Engines from 0.3MW up to 5MW developed by GE Jenbacher/GE research center
GE 颜巴赫与GE研发中心共同开发的从0.3兆瓦到5兆瓦内燃机余热回收方案
- GT from 5 MW to 80 MW developed by GE O&G /GE research center
GE油气与研发中心共同开发的从5兆瓦到80兆瓦的燃气轮机余热回收方案
- GT for other manufacturer
其它制造商燃气轮机的解决方案

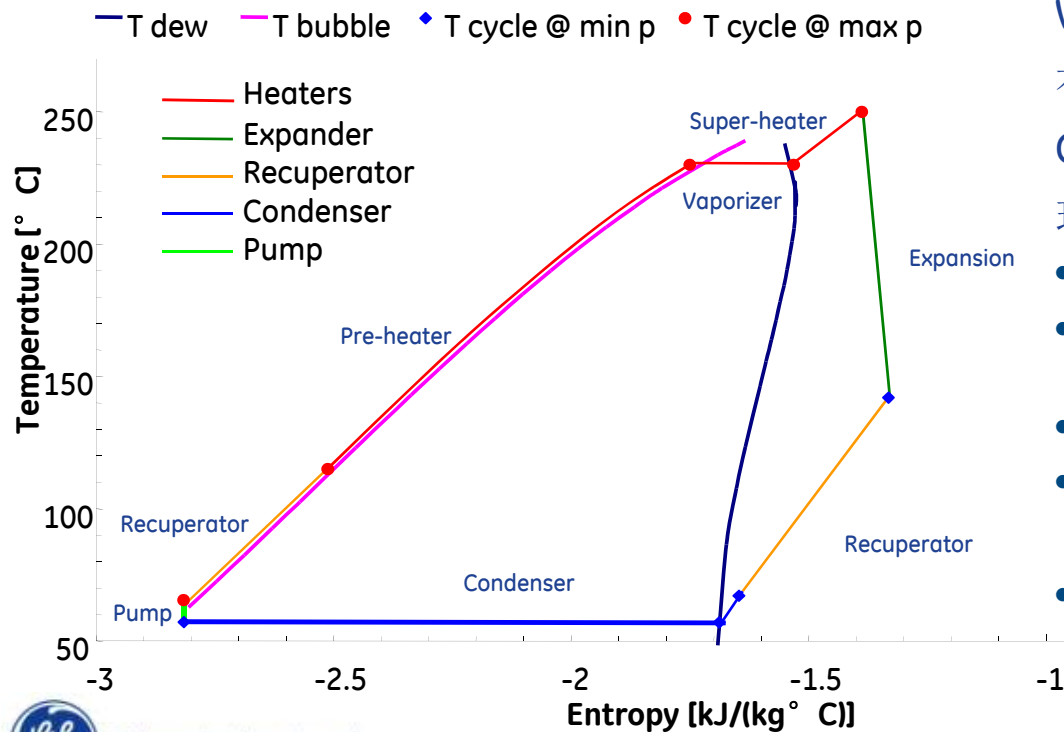


The ORC Concept 有机朗肯循环原理

The Organic Rankine Cycle (ORC) is a thermodynamic cycle based on the Rankine classic cycle using an organic working fluid

有机朗肯循环(简称ORC)是采用有机流体作为介质，基于朗肯经典循环的热力学循环

ORC cycle T-S diagram 温熵图



Working fluid selection by GRC Munich

有机介质由GE研发中心（慕尼黑）选定

Cyclo-pentane main characteristic

环戊烷的主要特性

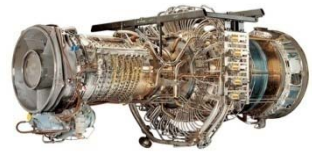
- Boiling point 沸点低: 121° F (49.3° C)
- Freezing point 凝点低: -137° F (-94° C)
- Molecular Weight 摩尔质量高: 70.1
- Appearance: clear, colorless liquid
外观: 透明、无色液体
- No corrosion issue on plant equipment
对装置设备无腐蚀

Plant schematic & scope of supply

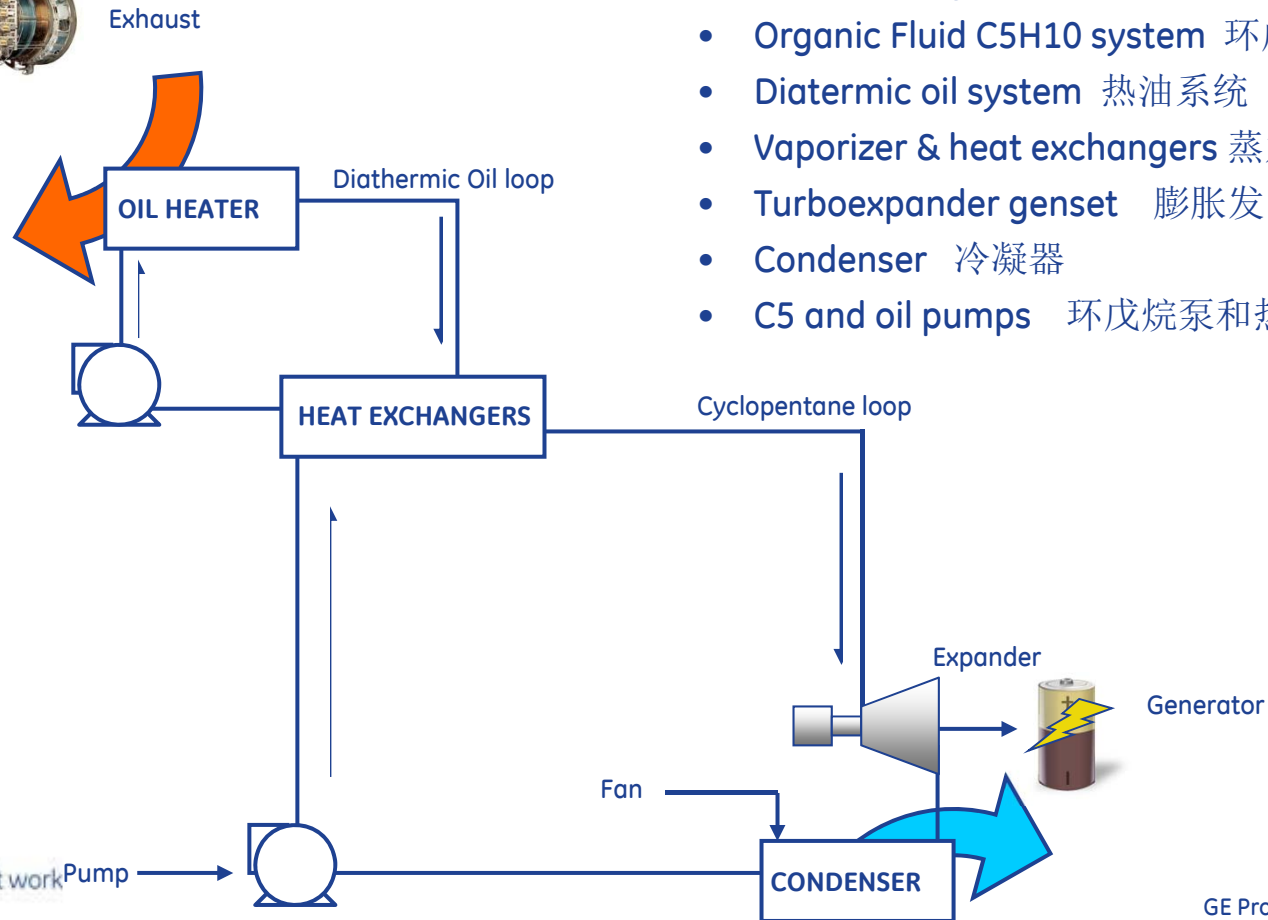
装置示意图和供货范围

PGT25+ case study ... overall plant efficiency up to 51%

PGT25+ 案例分析... 装置综合效率提高至51%



Gas Turbine



The basic scope of supply for a typical conversion includes the following 典型装置包括以下基本设备:

- Organic Fluid C5H10 system 环戊烷系统
- Diathermic oil system 热油系统
- Vaporizer & heat exchangers 蒸发器和换热器
- Turboexpander genset 膨胀发电机
- Condenser 冷凝器
- C5 and oil pumps 环戊烷泵和热油泵



GE imagination at work

Pump

Turbo-expander 透平膨胀机

2 separate basements: 2个独立基础 (撬装)

2个独立基础 (撬装)

- Ease of transportation

方便运输

- Installation cost reduction

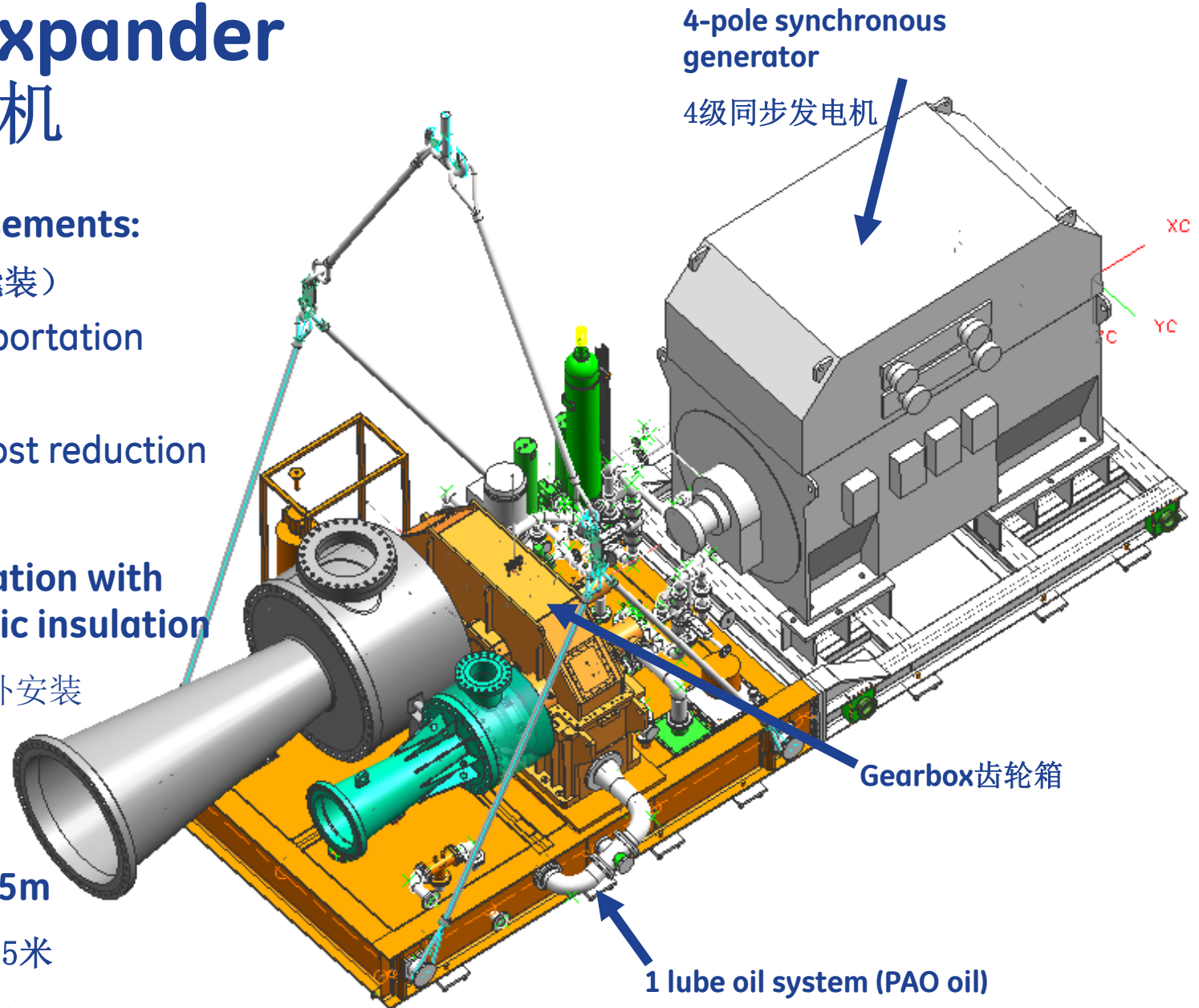
减少安装费用

Outdoor installation with thermo-acoustic insulation

带保温, 可在户外安装

LxWxH: 13x4x5.5m

长*宽*高: 13x4x5.5米



4-pole synchronous generator

4级同步发电机

Gearbox 齿轮箱

1 lube oil system (PAO oil)

1套润滑油系统

Turboexpander (5-17 MW family)

透平膨胀机(5-17MW系列)

2 stage variable IGVs

2级可变的进口导叶系统

Double DGS + standstill ring

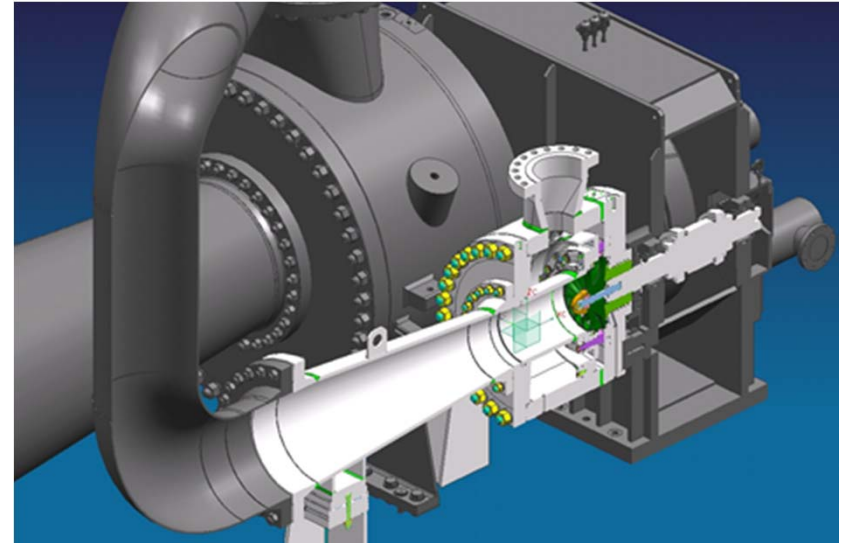
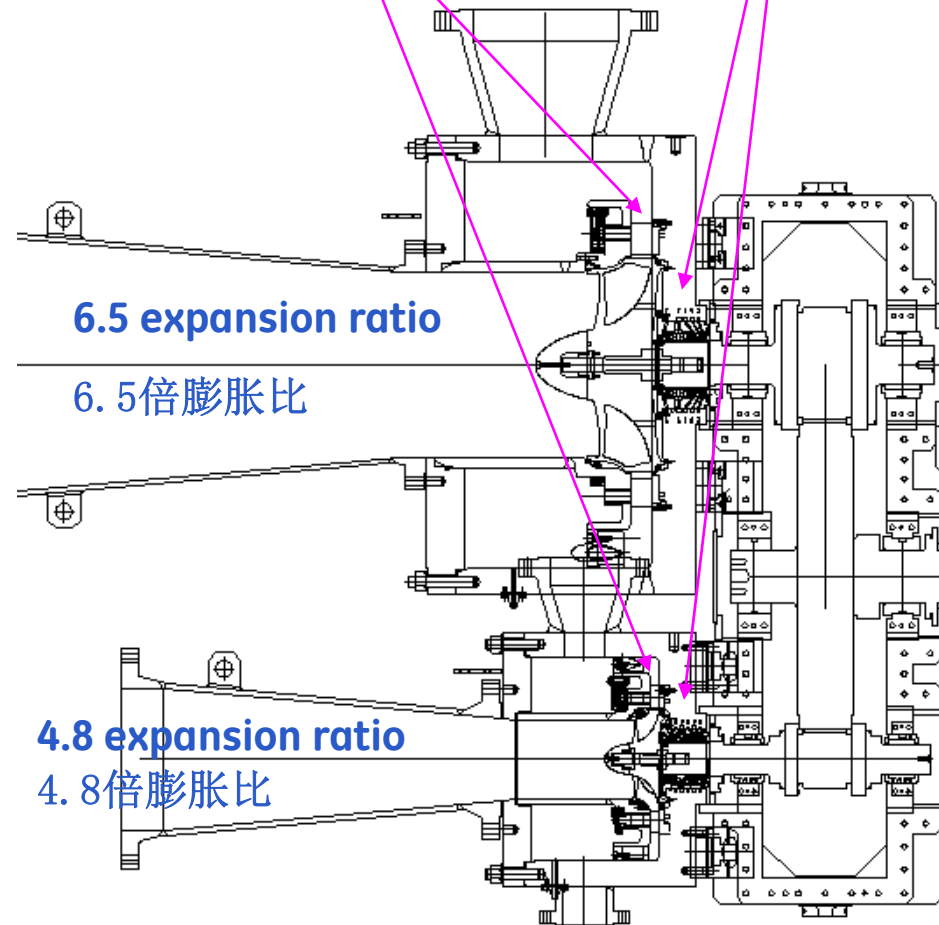
背靠背干气密封

6.5 expansion ratio

6.5倍膨胀比

4.8 expansion ratio

4.8倍膨胀比



16-blade wheels (17-4PH)

16个叶片叶轮(材质17-4PH不锈钢)

5000 rpm shaft

5000转/分 轴

1500/1800 rpm shaft

1500/1800转/分 轴

10000 rpm shaft

10000转/分 轴



ORegen™ Typical Layout

ORegen典型布置图

Diverter only interface with GT 挡板阀是与燃机的唯一界面

GT exhaust stack with ORegen installed 安装ORegen后的燃机烟道

Waste Heat Oil Heater 余热锅炉

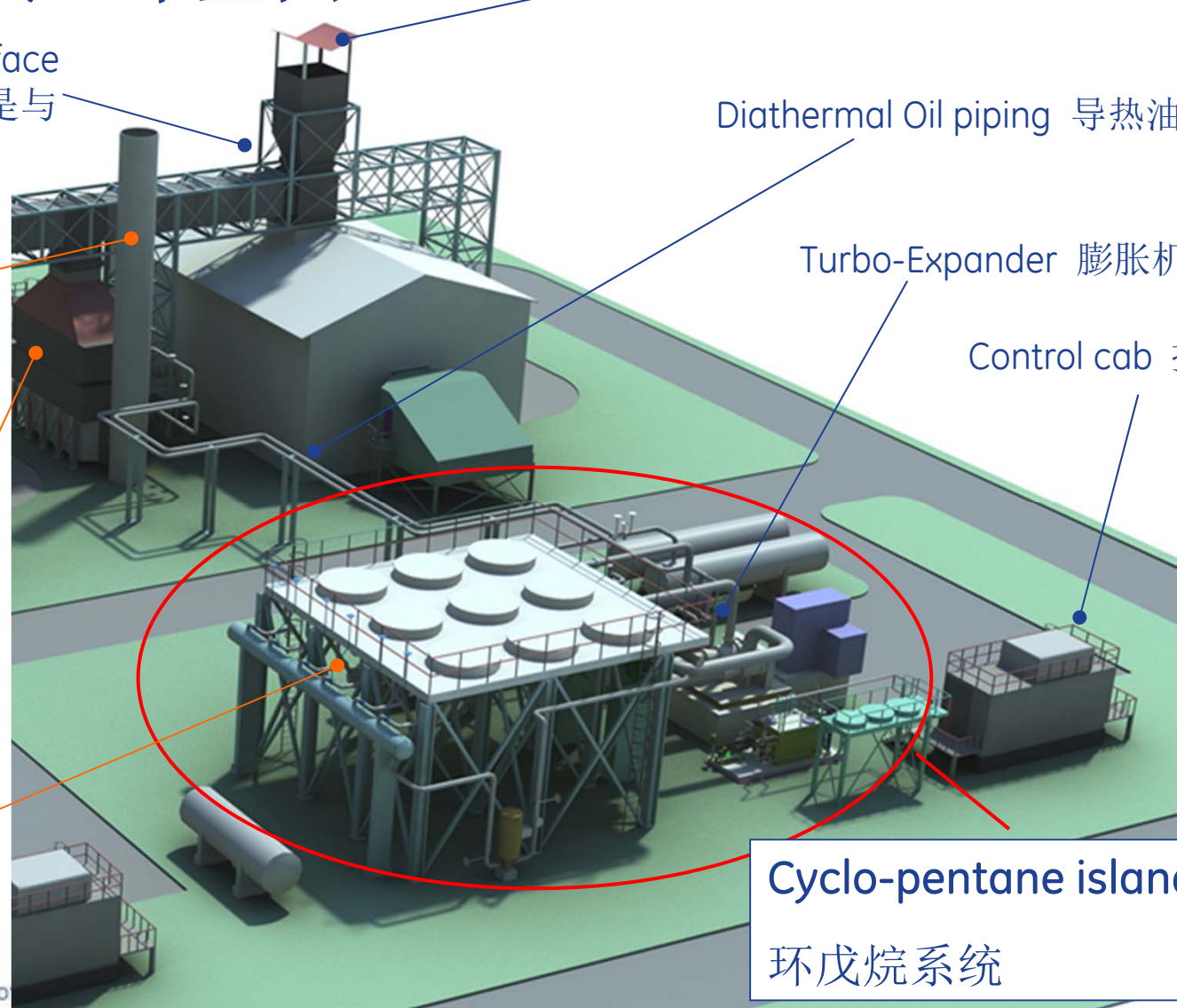
C5 condenser 环戊烷冷凝器

GT exhaust stack 燃机烟道

Diathermal Oil piping 导热油管路

Turbo-Expander 膨胀机

Control cab 控制盘



Cyclo-pentane island
环戊烷系统

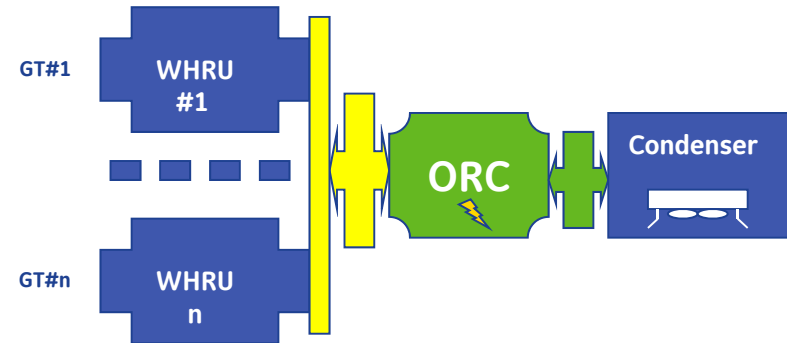
ORegen™ Configurations

ORegen的多种配置

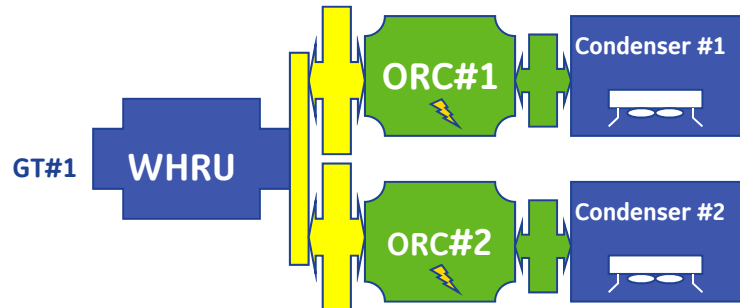
Direct 直接传热



Parallel Oil 热油并联



Multi cycles 多循环



Parallel Gas 烟气并联



 To be defined as typical arrangement 黄色定义为典型布置

 To be scaled up / down from a standard design. 绿色代表标准设计，但大小可变

 To be selected case by case. depending from the site conditions and project requirements

蓝色代表可选项，取决于现场条件和项目需要



ORegen* Output ORegen产品标准输出表

GT Model 燃机型号	GT Power 燃机功率 (KW)	Exhaust Flow 烟气流量 (Kg/sec)	Exhaust Temp 烟气温度 (° C)	GT Efficiency 燃机效率 (%)	ORC Output ORC输出功率 (MWe)	System Efficiency 系统效率 (%)
PGT25 (*)	23 261	68,9	525	37,7%	6,9	48,9%
PGT25+ (*)	31 364	84,3	500	41,1%	7,9	51,5%
PGT25+ G4 (*)	33 973	89,0	510	41,1%	8,6	51,5%
MS5001 (*)	26 830	125,2	483	28,4%	11,3	40,4%
MS5002B (*)	26 100	121,6	491	28,8%	10,8	40,7%
MS5002C (*)	28 340	124,3	517	28,8%	12,4	41,4%
MS5002D (*)	32 580	141,4	509	29,4%	13,8	41,9%
MS6001B (*)	43 530	145,0	544	33,3%	15,6	45,2%
LM6000 (**)	43 397	125,6	454	41,7%	9,7	51,1%

Reference data @ISO Conditions, 100% GT Turbine load, one to one configuration

数据基于ISO标准, 100%的燃机负荷, 一对一的结构形式

(*) Values at gas turbine shaft 燃机轴功率

(**) Values at generator terminals for LM6000PC coupled to 60 Hz generator

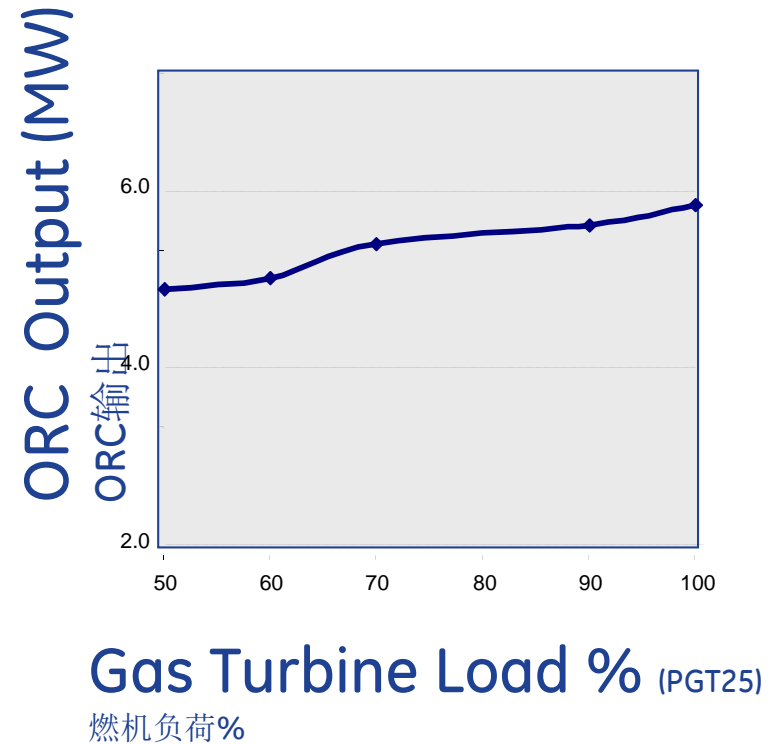
LM6000PC与发电机连接, 在发电机端子的输出功率



Robustness to load variation

适应负荷变化

- 50% load -> 80% ORC power
50% 负荷 对应 超过80% 的ORC输出



Power output from ORC relatively constant compared to gas turbine

Oregon系统电力输出相对燃机更稳定

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