Design of SCO2 System Test Rig

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Supercritical CO_2 Power Cycles Symposium

上海电气 SHANGHAI ELECTRIC

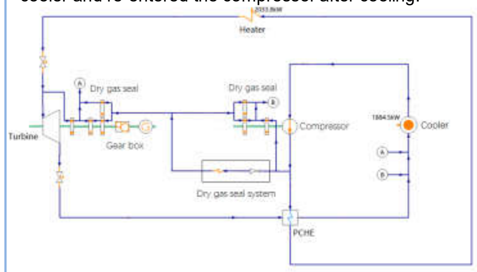
OBJECTIVES

1) Operation design verification of SCO2 cycle.
SCO2 closed Brayton Cycle power generation is a new thermal cycle, including a series of thermal equipment and auxiliary equipment, the establishment and change of the cycle is the result of the coordinated operation of the equipment in the system. Operation design is the design and analysis of the coordinated operation process of the equipment in the system. Many problems that can be analyzed directionally but are difficult to be analyzed quantitatively need to be verified in the test run.
2) Thermal equipment operating characteristics verification
The operating characteristics of thermal equipment (including the characteristics under design parameters and non-design parameters) not only determine the efficiency of the cycle, but more importantly, may affect the success or failure of the cycle operation design. The SCO2 Brayton Cycle has two special reasons that require a comprehensive understanding of the operating characteristics of thermal equipment: First, for small closed cycle systems, there is a strong interaction between the input and output of thermal equipment, and the deviation disturbance is large; Second, the characteristics of the working medium near the critical point change greatly, and it is difficult to measure and control. The operating characteristics given by the supplier of the thermal equipment may be inaccurate and incomplete and need to be measured in the test.
3) Study the control model of the cycle
The control system is software developed by a set of technologies. In the experiment, the control model optimization iteration is carried out, including improving the quality of thermal model and improving the quality of algorithm, and the mature operation control technology suitable for commercial use is found.
4) Verification of complete power generation technology design
Verify the design performance of the complete set of equipment. Including output, cycle efficiency, thermal equipment design deviation and so on.

The motor and compressor

EXPERIMENTAL CYCLE

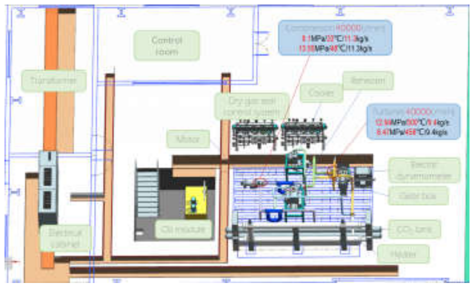
A simple regenerative Brayton cycle was adopted in the test circulation system. As shown in flow Figure, CO2 was pressurized by the compressor and absorbed heat through the regenerator and heater in turn, and then entered the turbine to do work. After work, the CO2 fluid exchanged heat with the pressurized fluid of the compressor in the regenerator, and finally flowed to the cooler and re-entered the compressor after cooling.



Schematic of closed loop

LABORATORY LAYOUT

The laboratory is located in the independent building of the company, and the compressor is arranged with the transmission shaft, as shown in flow Figure. The compressor is installed on the high-speed motor, and the motor provides power to increase the working medium pressure; The turbine is installed at one end of the high-speed shaft of the gearbox, and the opposite end of the low-speed shaft of the gearbox is connected to the electric dynamometer. The turbine converts the heat energy of the high-temperature and high-pressure working medium into the rotating shaft work, and the gearbox transmits the shaft work to the dynamometer. Through the actual power measured by dynamometer, combined with the measured parameters of each component, transmission efficiency and other data, the characteristics of compressor, turbine, regenerator and other components can be tested.

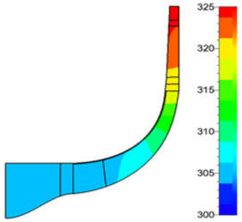


Schematic of closed loop

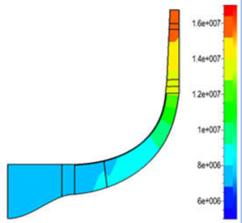
AERODYNAMIC DESIGN

Compressor

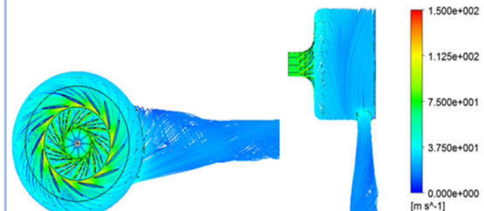
Model



Static Temperature

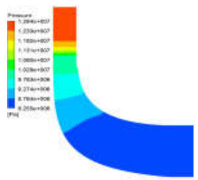


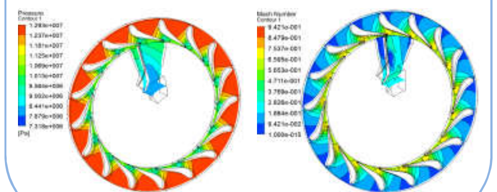
Static Pressure



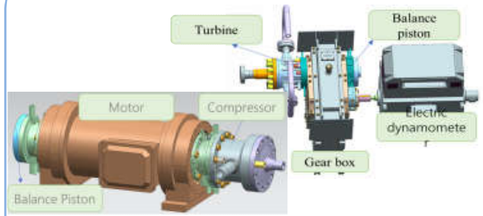
3D Flow

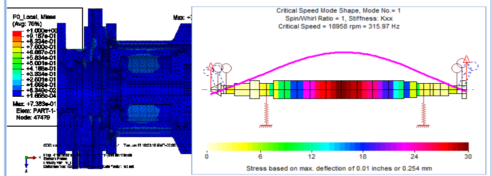
Turbine





STRUCTURE DESIGN



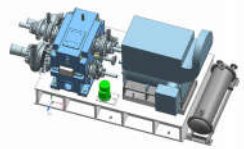


All the FEA and dynamics analysis has been done, and the results fulfill the relevant standards.

CONCLUSION AND FUTURE WORK

- Now, the construction of the test rig has been finished,
- Relevant test is in progress,
- A 300KW TAC unit has been put into operation.
- A 4MW unit is in the course of development.

300KW unit



4MW unit

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