The S-CO2 Brayton cycle code development and the thermal dynamic analysis of a small scaled facility

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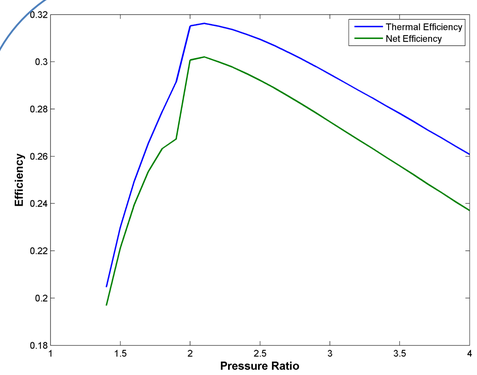
The S-CO2 Brayton cycle is a transforming power conversion technology with high thermal efficiency, compactness and low cost. It could be applied into various areas, such as ship power, waste heat reuse, solar energy, etc. The cycle was first proposed in last middle century and saw profound progress in these few years as the development of small turbo machinery technology and high compact heat exchangers.

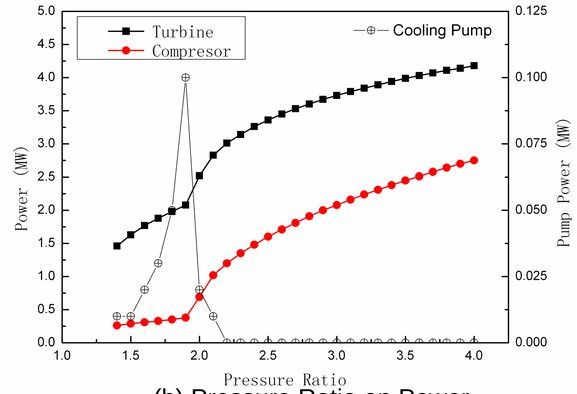
The thermal balance code is used for steady analysis and thermal design of the whole cycle. For example, the code could be used to get the cycle efficiency for specified parameters, to analyze the parameter effects and cycle optimization that meets a set of design requirements (Figure 1). Up to now, the thermal dynamic code for supercritical carbon dioxide cycles are usually self-developed.

The code was used to analyze a conceptual design of Mega Watts loop. There exists an optimal point for the pressure ratio, recuperator volume fraction (VF), recuperator length and cooler length (Figrue 2) . Increasing the total heat exchanger volume will increase the thermal efficiency. When the volume is bigger than 0.5m^3, the increasing rate is small.

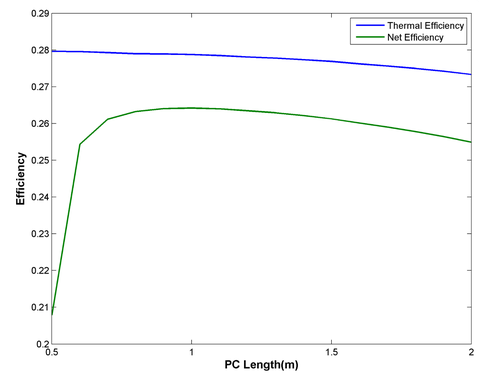
Finally, a thermal balance diagram was proposed(Figure 3). This analysis could provide theoretical guidance for the future facility design and operation.



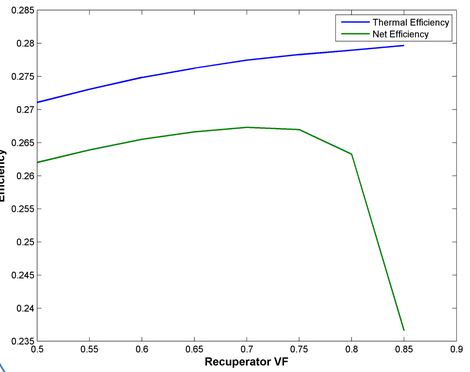
(a) Pressure Ratio on Cycle efficiency



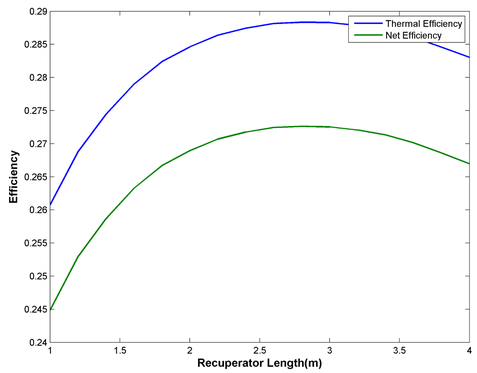
(b) Pressure Ratio on Power



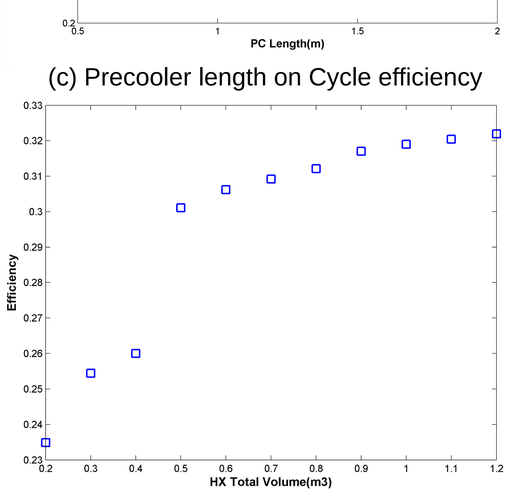
(c) Precooler length on Cycle efficiency



(d) Recuperator VF on Cycle efficiency

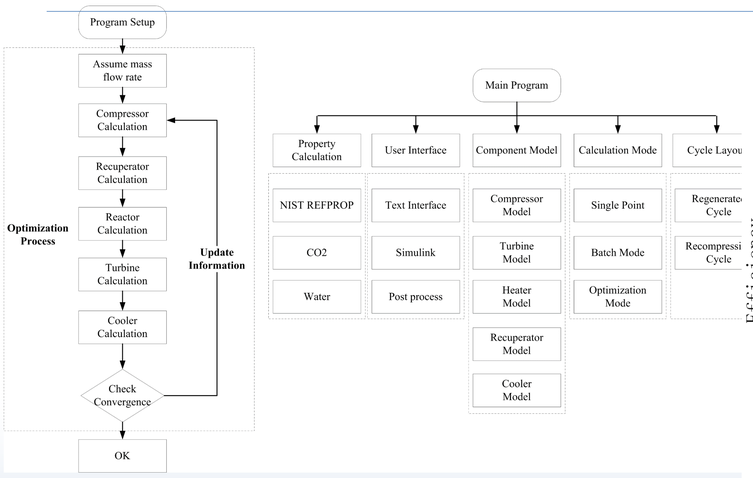


(e) Recuperator length on Cycle efficiency



(f) Heat exchanger volume on Cycle efficiency

Figure 2 Various parameters effects on cycle efficiency



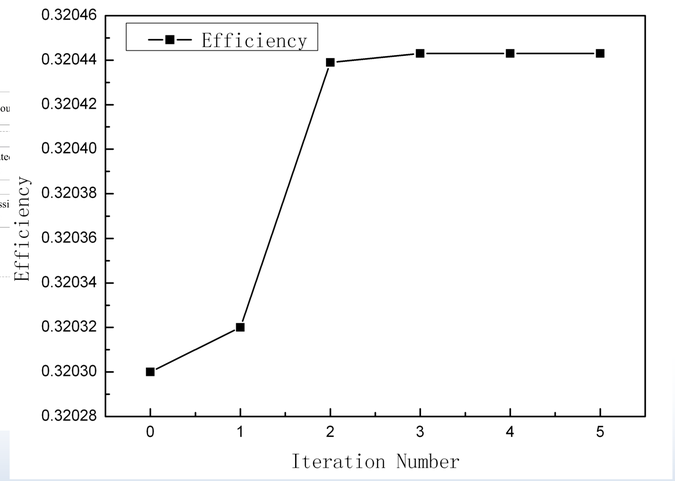


Figure 1 Program procedure and structure & Optimization iteration process

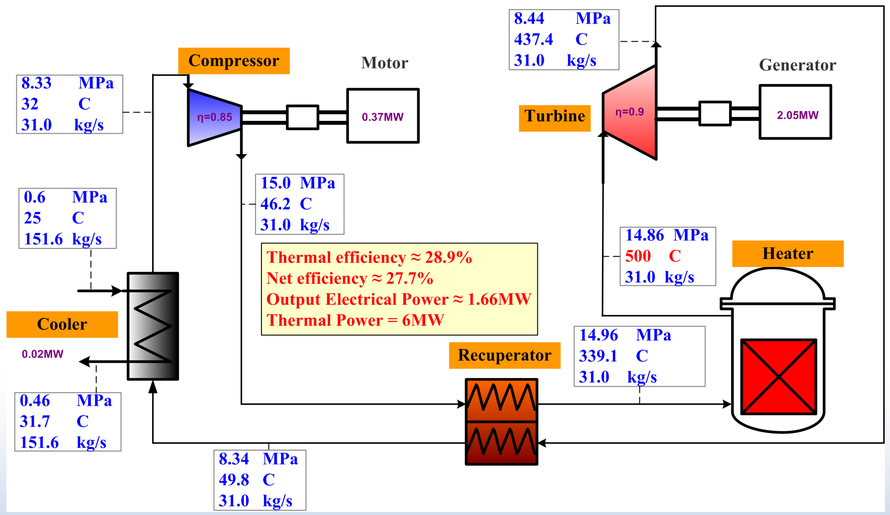


Figure 3 The thermal diagram for MW class loop (conceptual)