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NUMERICAL Model Design Inspection and Simulation of Merge LNG Cold Energy Power for Recovering Electricity Building

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ABSTRACT

A Brayton and Rankine cycle is used to model LNG cold energy recovery in Aspen Plus. For the combined power cycle, researchers used sensitivity analysis to examine the effects of various parameters including turbine input and outlet pressures, ammonia-water flowrates, condensation temperatures, and compressor outlet pressures. Thermodynamic efficiency increases with higher turbine and compressor inlet and outlet pressures. The ammonia-water flow and the temperature of the condenser may also be reduced.

Keywords: Thermal efficiency;Aspen plus; sensitivity analysis; LNG cold energy recovery

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1 INSTRUCTION

Natural gas will become the world's primary fuel as the economy expands. A long distance away is where China gets its natural gas. The transportation of LNG is straightforward. Terminals pump LNG, which is then evaporated in heaters, before being supplied to customers. A lot of cold energy may be recovered during the vaporization process of LNG. That's how much energy it produces per kilogram. Cryogenic grinding, LNG cold energy recovery, and light hydrocarbon separation are all possible uses for LNG cold energy recovery [2–5]. Save both time and money by using LNG cold energy.

There has been a lot of research on the combined power cycle. It was postulated by T. Miyazaki, Y.T. Kang, and others that waste heat may be combined with LNG cold energy to create a power cycle. Specifically, they looked at the effects of ammonia water content, turbine inlet/outlet pressure, and condenser heat transfer coefficient on the combined power cycle. Recovering LNG cold energy using a moderate heat source was investigated by Wang and Li [7,8] et al. [7,9]. Exergy efficiency rises when the heat source, turbine intake pressure and condensing temperature are increased. It was shown by Manuel Romero Gómez et al. [8] that a closed Brayton cycle may be combined with a stream Rankine cycle. Some crucial characteristics, such as compressor intake temperature and compression ratio were examined to see how they affected the performance of the cycle.

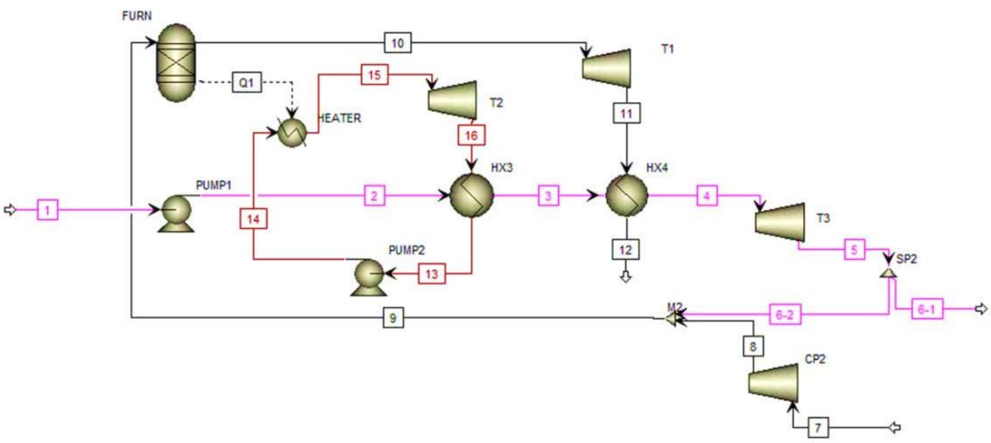
The LNG CER CPC is modeled in Aspen Plus in this article. Analyzing turbine input and output pressures, as well as compressor outlet pressure, ammonia water flow rate, and condensing temperature, improves the cycle efficiency.

2 COMBINED POWER CYCLE MODEL

The Aspen Plus process model is shown in Fig. 1, as shown. 1 kmol/s is the rate at which the LNG is flowing in the simulation. Liquefied natural gas (LNG) is made up of 0.82 CH_4, 0.112 C_2H_6, and 0.009 nC_4H_{10}, as well as 0.007 N_2. Table 1 shows the parameters. To accurately simulate and calculate medium characteristics, the appropriate property technique must be utilized. The NRTL model was utilized to determine the mutually soluble system, and the ammonia water property method was used. The SRK state equation is used for LNG, whereas the Peng-Rob equation is used for combustion gas.

Table1: Simulation parameters

Parameter name	Value
Combustion efficiency in the furnace η	0.99
The atmosphere temperature/ ℃	25
The atmosphere pressure /MPa	0.1
LHV / （kJ/kg）	50056
LNG flow rate/(kmol/s)	1
Ammonia water flow rate /(kmol/s)	0.365
Ammonia water mole ratio	7:3



FURN—furnace,HX—heat exchanger ,CP—compressor, PUMP—pump, T—turbine, HEATER—heater Q1—heat flow

Fig.1.Aspen Plus's CPC model

3 COMPUTER SIMULATED ANALYSIS

Thermal efficiency measures cycle performance. Thermal efficiency is the ratio of the combined power cycle's outwork to the heat source's input work. The cycle's thermal efficiency is.

$$\eta_1 = \frac{W_{net}}{\eta_{furn} q_{m,6-2} LHV}$$

Here, $W_{net} = W_{out} - W_{in}$;

$$W_{out} = W_{T1} + W_{T2} + W_{T3};$$

$$W_{in} = W_{P1} + W_{P2} + W_{CP}.$$

Where, η_1 is the thermal efficiency. The total network is represented by W_{net}. W_{out} and W_{in} are the output and input work of the system. W_{T1}、W_{T2} and W_{T3} represent the output work of the turbine T1、T2 and T3 respectively. W_{P1}、W_{P2} and W_{CP} represent the work of the PUMP1、PUMP2 and CP respectively. In addition, η_{furn} is the combustion efficiency in the furnace, and $q_{m,6-2}$ represents the NG mass flow rate at the point 6-2. *LHV* is short for low heat value of LNG.

4 RESULT ANDANALYSIS

4.1 T3 turbine inlet pressure

FIGURE 2 depicts how the temperature and ammonia water flow rate affect efficiency. Efficiency improves with p4 because turbine T3 work increases and PUMP1 work lowers at the same ammonia water flow rate. Fig. 3 illustrates how, when the turbine rises above the pump, so does the whole cycle network, resulting in an increase in thermal efficiency. Ammonia water flow may lower thermal efficiency at the same pressure. When ammonia water flow rises, PUMP2 must work harder. Turbine T2's work would be reduced if the furnace heat was the same as the ammonia water temperature at turbine T2's inlet. Thermal efficiency is reduced by the network.

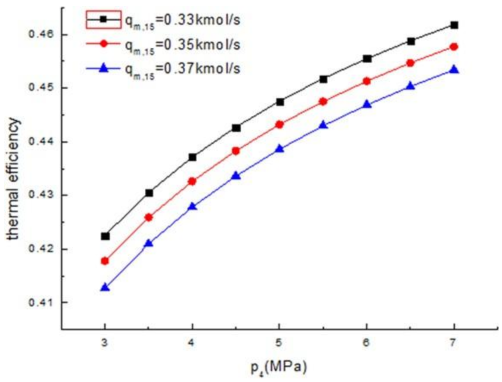


Fig.2 Thermodynamic efficiency fluctuate.

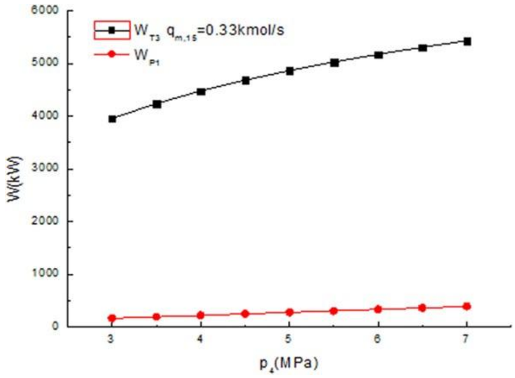


Fig.3 There is a lot of work done by T2 and PUMP1.

4.2 Condensing temperature

Back pressure and work are affected by the ammonia water condensing temperature of turbine T2. The vacuum, turbine T2 back pressure decreases as the condensing temperature rises, reducing the turbine's workload and affecting the network. Figure 6 depicts the decline in thermal efficiency. As far as I can tell, no one has taken into account the direct relationship between condensing temperature and pressure [9] or how it impacts turbine vacuum. According to earlier studies [1–6], this paper's results are in line.

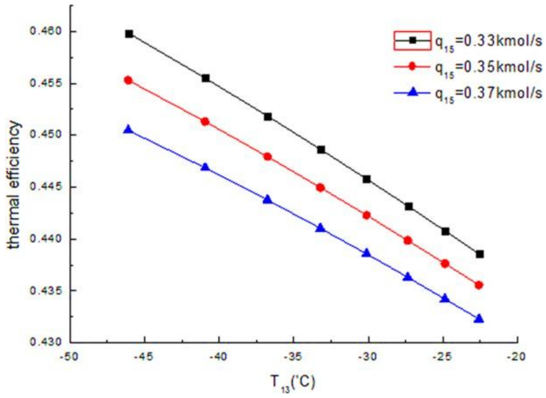


Fig. 6 Thermal efficiency fluctuations

4.3 CP compressor outlet pressure

Exhaust pressure CP and outlet pressure T1 are intimately linked. Exhaust pressure from the compressor drives up gas turbine work, which in turn drives up compressor work. Despite the gas turbine's slower development than the compressor's, T2 work continues to expand. ' (in Fig.8). As the compressor output pressure rises, the network expands and the thermal efficiency improves (in Fig.7).

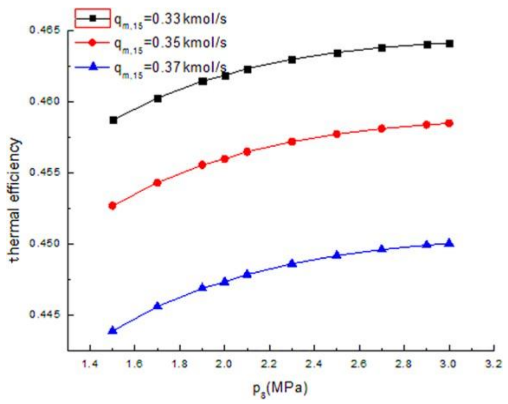


Fig.7 Thermal efficiency fluctuations

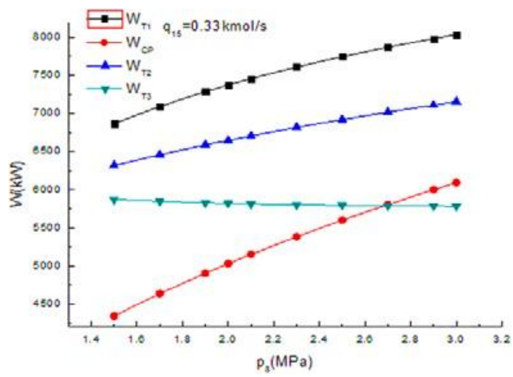


Fig. 8 T1, T2, T3 turbines with CP compressor

5 CONCLUSION

This article studies the impacts of important factors on thermal efficiency under varied ammonia water flow rates, including compressor exhaust pressure in the Brayton cycle, ammonia turbine input pressure, condensing temperature, and LNG turbine inlet and outlet pressures. As compressor exhaust and turbine input/output pressures increase, thermal efficiency improves while ammonia water flow and condensing temperature decline.

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