

Study on Configuration Optimization of Natural Gas Cooling, Heating and Power Systems Coupled with New Energy Sources

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Abstract: The study on the configuration optimization of natural gas combined cooling, heating and power system coupled with new energy can provide reference for the planning, design and operation of this type of project. The optimal configuration problem is a multi-system coupling and multi-objective optimization problem. The optimal system configuration is obtained by establishing model, using algorithm and numerical simulation based on optimization software.

Keywords: New Energy; Natural Gas Cold; Heat and Power; Configuration Optimization.

1. Introduction

The situation of global coping with climate change is very serious, and the pressure of reducing greenhouse gas emission is increasing day by day. The shortage crisis of traditional energy and the environmental problems caused by it have become a major problem that restricts the development of human economy and society. The 14th five-year plan of modern energy system aims to improve the capacity of gas storage and natural gas supply, which will make natural gas-based clean energy popular in China. The utility model has the advantages of being close to the user side, realizing the energy cascade utilization, and having broad application prospects. It is helpful to improve the flexibility, economy and cleanliness of the power system to construct a combined natural gas cooling-heating-power system coupled with new energy and realize multi-technology coupling and multi-energy synergy, it has important research value.

Gas-fired Combined Cooling, Heating and Power (CCHP) refers to the electricity demand of users, which is generated by the operation of Power generating equipment such as steam turbines and generators driven by natural gas as the main fuel, an energy supply system in which the waste heat discharged by the system after power generation is supplied to the users for heating and cooling by waste heat recovery equipment in order to meet the cold-heat-electricity demand, it usually consists of a gas electric generator, a waste heat recovery refrigeration unit, and a heat exchange unit. The triple supply makes the heat energy of natural gas be fully utilized, and greatly improves the efficiency of energy comprehensive utilization.

2. The Principle of Configuration Optimization

Because of the variability of building load, the equipment in CCHP system is in variable operating mode in most cases, that is, partial (hourly) load operating mode. Therefore, it is very important to study the thermodynamic characteristics of the equipment under variable operating conditions. In general,

the performance of equipment in CCHP system under partial (hourly) operation will decrease, and the degree of decrease is related to the degree of partial load. The partial load power generation efficiency η_{LPGHWP} and the partial load thermal efficiency η_{LPGHWA} of gas-fired internal combustion engine are composed of heat dissipation efficiency $\eta_{LPGHWA1}$ of high temperature flue gas and heat production efficiency $\eta_{LPGHWA2}$ of cylinder liner hot water.

Considering that the multi-objective optimization research of multi-energy cooperative triple supply system belongs to a nonlinear, multi-variable and multi-constraint optimization problem, in this paper, the hybrid algorithm of hawksearch-particle swarm optimization (HPSO) is used to solve the global problem with high accuracy, fast convergence and strong optimization. Based on the coupling platform of TRNSYS energy consumption software and GENOPT optimization software, the numerical simulation is carried out.

3. Instance of System Configuration Optimization

Taking a centralized energy supply system as an example, the building is a two-story underground and three-story above-ground building with a total floor area of 20607.5 m². The energy supply network adopts four-control system. Year-round cooling, heating in winter. It covers an area of 2.83 km² and needs to provide heating, cooling and domestic hot water for 2.17 million m² of offices, businesses and hotels in the region. Natural gas distributed energy cogeneration, to heat fixed power, residual power grid (10kV high-voltage grid). Electric drive refrigerator in summer, heat pump in winter and energy storage system to balance production and marketing.

According to the data of energy supply area and the calculation method of load demand, the cooling load of air conditioning is designed to be 135109 KW, the index of cooling load per unit area is 62 W/m², the design heat load is 58408 KW, the index of heat load per unit area is 27 W/m². According to the annual load forecast, the regional planning annual cooling needs 136.22 million kWh, annual heating

A Guide To Natural Gas Cooling

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