International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-3, Issue-5,May 2017
ISSN: 2395-3470
www.ijseas.com

Research on Operation Mode of PVT Cogeneration System

Yang Zhao

Department of Mechanical and Electrical Engineering, Guangdong University of Science&Technolog, Dongguan 523083,Guangdong,China

Abstract

At present, when the cogeneration system configuration and operation plan of civil buildings are analyzed, the output performance of the unit is not comprehensive enough, and most of the typical daytime load is based on the system whose operation results are not ideal. This paper studies the matching of hot water production and power generation capacity of the unit with the hot water demand and power demand of the users, and discusses the flow and operation plan of the civil construction cogeneration system, and provides valuable value for the configuration and operation of the civil construction cogeneration system theoretical reference.

Keywords:*PVT,Running Mode,Hot Water Load,Electrical Load.*

1. Introduction

Distributed energy supply is relative to the traditional centralized energy supply approach, is the power generation system, heating and cooling systems combined to small-scale, decentralized way arranged in the vicinity of the user can independently output electricity, heat Or cold system. Distributed power supply with the city power grid with power supply, when the distributed power supply power does not meet the needs of users of electricity, the user from the power grid to buy electricity, distributed power supply power is higher than the user needs, the user can Electricity. The waste heat from the recovery system at the same time is used for heating or cooling. Distributed energy supply to achieve a different grade energy cascade use, effectively improve the comprehensive utilization of energy.

Cogeneration and cogeneration are an important form of distributed energy supply. The system consists of gas generator and waste heat recovery unit. The United States began to promote the development of small-scale combined heat and power (CHP) since 1978, with more than 6,000 distributed energy stations. According to the US Department of Energy's energy plan, by 2020, 50% of new commercial buildings and schools, and 15% of existing commercial buildings and schools using hot and cold power supply system. In Europe, Denmark, the Netherlands and other countries to support and encourage the application of hot and cold power supply projects, including the Danish government to allow the supply of electricity from the hot and cold power supply, the power supply system installed capacity in the power system has more than 60% The The Netherlands cogeneration power generation priority to the Internet, Germany on the existing cogeneration plant, not limited to give encouragement. Britain currently has more than 1,000 distributed energy stations, mainly used in commercial centers, schools, hospitals and other buildings, the United Kingdom has a dedicated energy services company, and to give the necessary subsidies for the project. Japan is very important to energy conservation, earlier began to support the development of natural gas cogeneration system. Japan's hot and cold power supply for the rapid development of a wide range of applications. Hot and cold power projects are mainly concentrated in the office buildings, restaurants, shopping malls and hospitals and other more stable load of the building.

Compared with the traditional mode of supply, the advantages of the Cogeneration system are obvious, the development of cogeneration is of great significance. Cogeneration systems create the conditions for energy conservation. Cogeneration system by energy level of the level of recovery unit waste heat, to achieve the energy cascade use. The joint supply system is generally built near the user, reducing the loss of traditional transmission and transmission and heating losses, effectively improving the energy efficiency. The cogeneration system reduces emissions from air pollutants and reduces environmental stress. Cogeneration system fuel is mainly natural gas, the unit work when the excess air coefficient is high, natural gas can be completely burned, the system emissions of nitrogen oxides and carbon monoxide emissions is very small, carbon dioxide emissions than carbon dioxide emissions by 50% or more. The cogeneration system can balance the peak-to-valley difference between electricity and gas. In the summer, air-conditioning cooling makes the summer power load surge, the power grid in short supply needs large area power cuts, and natural gas consumption in the summer is low, cogeneration system is widely used, not only help to ease the power shortage, but also balance the natural gas Of seasonal fluctuations. Cogeneration system load adjustment flexibility, improve the reliability of energy supply. Different users of the cold and heat load, the unit for a variety of options, and can be modular configuration to meet the needs of different users of the load. In addition, natural disasters and other external factors will generally lead to large-scale power outages, combined heat and electricity and urban power grid can greatly improve the reliability of power supply. The need for uninterruptible power supply equipment, cogeneration system advantage is even more prominent.

2. Evaluation of Cogeneration System

At present, the evaluation of cogeneration system is mainly focused on three aspects: thermodynamics evaluation, economic evaluation and environmental evaluation. Based on the first law of thermodynamics, the commonly used thermodynamic evaluation index is mainly primary energy efficiency, primary energy saving rate and coal saving. Based on the second law of thermodynamics, the commonly used thermodynamic evaluation index is efficiency, combined with the economic efficiency of economic factors, combined with the economic efficiency of economic factors and economic costs. Economic evaluation indicators are mainly investment recovery period, net present value, internal rate of return and annual operating costs and so on. The environmental assessment mainly considers the emission reductions of nitrogen oxides and carbon dioxide in the system of relative supply.

Most of the economic evaluation can not reflect the difference of the economic nature of the different operation schemes of different systems, and the human factors interfere seriously. In the literature [2], the incremental evaluation method is proposed, which mainly includes incremental investment recovery Period and equivalent power plant efficiency of the two indicators. The so-called incremental investment payback period is based on the initial investment of the sub-supply system as the base, the system for the system to increase the initial investment by the system part of the income needed to recover the time. The so-called equivalent power plant power generation efficiency, is the combined heat and power supply system and sub-supply system to increase the initial investment, saving the amount of natural gas consumption and power generation equivalent equivalent as a gas power plant initial investment, Fuel consumption and power generation, the ratio of electricity generation to fuel consumption of the equivalent power plant. The efficiency of the equivalent power plant and the current efficiency of the general gas power plant can be compared to determine the efficiency of energy supply system. These two economic evaluation indicators are only related to natural gas prices and electricity prices, to avoid the interference of hot and other human factors, so that the economic evaluation of the joint supply system is more objective, the actual economic analysis and calculation is simple and feasible.

Energy conservation, economy and environmental protection are the three major advantages of the joint supply system, but also the evaluation of the joint project in the technical and economic feasibility of the indicators. Through the energy efficiency and economic evaluation of the joint supply system, the proportion of the thermoelectric output of the system, the energy price and the operating time of the unit have obvious influence on the energy saving rate and the investment payback period.

3. Simulation of Hot Water Load

For the simulation of hot water load, simulation calculation is mainly residential hot water combined with the monthly peak load, hot water load accounted for load ratio and hour load for daily load ratio, calculated the life of hot water hourly load.

International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-3, Issue-5,May 2017
ISSN: 2395-3470
www.ijseas.com

3.1 Related formulas

Maximum hourly hot water consumption is calculated according to formula (1).

$$V_h = K_h \frac{mq_h}{T} \quad (1)$$

In this formula V_h is the maximum hourly hot water dosage (L/h); K_h is the hourly variation factor, calculated according to formula (2); m is a unit of measurement, such as the number of people; q_h is the hot water quota (L/d); T is hot water supply time and the hot water is available, and when the hot water is available all day, take T=24h.

The value of hourly variation factor Kh can be calculated by empirical formula (2)

$$K_h = 1.2355 + 23.0257 / \sqrt{m} \quad (2)$$

The amount of hot water from the cold water temperature is 60 DEG C to calculate heating area maximum hours required consumption according to the formula (3) calculation.

$$Q = \frac{c_{pm}\rho_h V_h (t_h - t_1)}{3600} \quad (3)$$

In this formula, Q is hot water consumption required for consumption(kW)for the maximum hours; c_{pm} is the average specific heat of water inlet and outlet of heating equipment(kJ/kg·□); ρ_h is the density of hot water (kg/m^3); t_h is the temperature of the outlet of the hot water(60□); t_1 is the inlet temperature of cold water(□).

3.2 The proportion of monthly hot water load to annual load

Figure 1 shows the proportion of monthly hot water consumed per month to the amount of annual hot water.

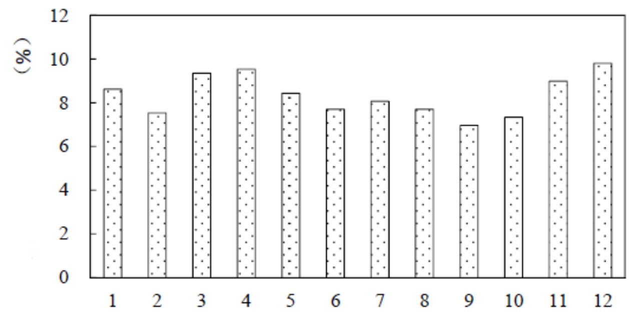

Figure 1 The proportion of monthly hot water consumption in a residential area to annual hot water consumption

As can be seen from Figure 1, the annual hot water load in this district is basically stable. In December, the amount of hot water was the largest, accounting for about 9.8% of the total amount of hot water. In September, the amount of hot water used was the lowest, slightly less than 7%, and the other months were about 8%.

The percentage of monthly hot water load per cell load per year, as shown in Figure 2.

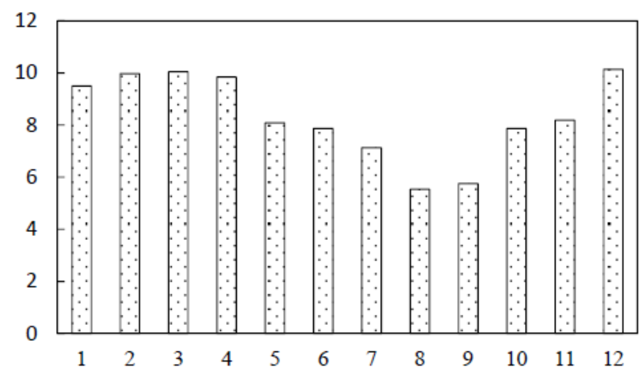

Figure 2 The proportion of monthly hot water load to total annual load

As can be seen from Figure 2, the district has a relatively stable annual hot water load, in which the amount of hot water in winter is nearly 2 times the amount of hot water in summer.

3.3 The ratio of hourly hot water load to daily load

Figure 3 shows the proportion of hot water load to daily load in typical summer, winter and transition seasons in a given area.

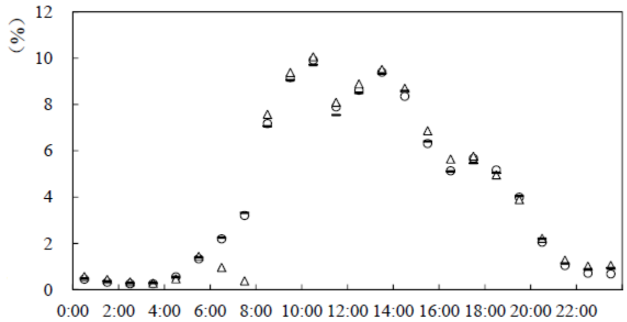

Figure 3 Percentage of daily hot water load on daily load

In the figure, ○is on behalf of the summer, △is a representative of winter, and — represents the transition season.The data shown in Figure 3 show that the data for the summer, winter and transition seasons in the residential area are consistent with the daily load ratio, and that the winter data only slightly deviates from the 7:00~8:00 data. During the day, the water consumption was large, and there were two peaks in 9:00~10:00 and 13:00~14:00. The amount of hot water used at night was smaller and more stable. There is no seasonal difference in the proportion of hourly load to total daily load.

3.4 Annual total hot water load

The annual consumption of gas (oil) and the amount of heat used in the construction area of 4 residential quarters are investigated, and the results are shown in Table 1.The amount of gas consumed in the production of domestic hot water accounted for about 54.80% of the low calorific value gas fuel of low calorific value is 35.6MJ/m^3, 46.04MJ/kg, boiler efficiency is 90%, water temperature calculated by 15 □, total annual water consumption accounted for the proportion of total water use are listed in Table 1.

Table 1.Hot water consumption in 4 residential quarters

Energy consumption per unit area	village 1	village 2	Village 3	Village 4
Annual gas consumption	13.2	8.8	10.22	15.96
Annual fuel consumption	0.0078	0.0018	0.0064	0.0088
Annual hot water consumption	1.28	0.76	0.66	1.41
Annual water consumption	3.52	1.45	3.5	4.7
The ratio of hot water to total water use	35.5	52.4	24.7	36.6

From the data listed in the table, the annual hot water consumption accounts for about 38% of the total annual water consumption, and the average annual total hot water consumption of civil buildings is about 1.08t.

For civil building energy consumption data, and data processing and analysis, the peak load of civil construction electricity and hot water to get, unit area total load and monthly load percentage of total load, and the hourly load percentage of daily load parameters. According to the results, the hourly power and hot water load of the building can be simulated and calculated. By using the characteristics of civil construction electricity and hot water, electricity load of the building at the unit area total load as a benchmark for simulation, the peak load for reference and check data, hot water load to peak load as a benchmark for simulation calculation, unit area total load for reference and check data. The processing and analysis of data in the literature, get the civil construction unit area total load reference range is 40~70kwh, peak load reference range is 40~50W, per unit area total annual water load reference range is 0.8~1.8t.

4.Simulation Study on Electric Load

Simulation of power load by hour load allocation method, is to grasp the user annual electric load and monthly load accounted for the total load and the proportion of hourly load accounted for daily load ratio, the total annual electricity load assessed by the proportion of annual electric load, the electrical load of the same month and day.

4.1Annual total electric load

Survey and statistics on the power consumption of 7 civil buildings and 7 civil buildings in a certain area, as shown in Figure 4. Annual power consumption includes the power consumption of electrical refrigeration (or heating). Survey and statistics of power consumption, as shown in Figure 4. Annual power consumption includes the power consumption of electrical refrigeration (or heating).

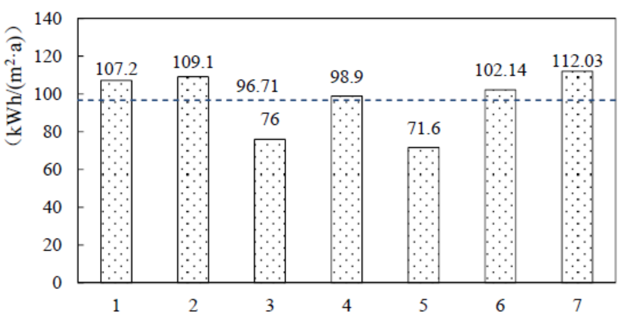

Figure 4 Annual electricity consumption per unit area of 7 units in a region

As can be seen from the diagram, the survey area of 7 hospitals in Shanghai, the annual electricity consumption per unit area is the highest, 112.03kWh/ (M2 = a), the lowest is 71.6kWh/ (M2 = a), the average is about 96.71kWh/ (M2 = a), little difference.

4.2 Monthly electricity load as a percentage of annual load

The proportion of monthly electricity consumption to total annual electricity consumption. As can be seen from Figure 5, the district has 7 months of electricity consumption in January ~5 months and November ~12 months, accounting for about 5% of the total annual electricity consumption, and only the common electricity load in winter and spring. In June, ~8 was the peak period of power consumption, in which the consumption of electricity was the largest in July, accounting for 16% of the total annual electricity consumption, accounting for 13% and 15% respectively in June and August. The power consumption during the peak period of electricity consumption is the result of the operation of the electric air-conditioning in summer, and the cooling power consumption of the autumn air conditioning system is obviously reduced. The power consumption in September and October respectively accounted for 10% and 9% of the total annual electricity consumption. The monthly load varies greatly, and the monthly maximum load is about 4 times of the minimum load.

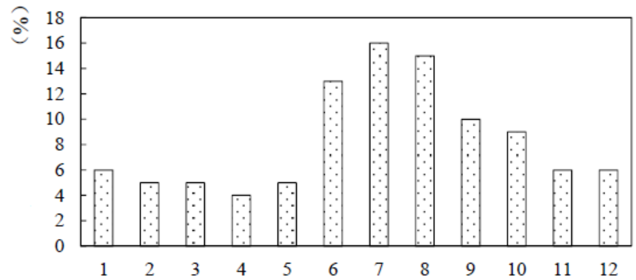

Figure 5 The proportion of monthly electricity consumption in an area to annual electricity consumption

The proportion of monthly electricity consumption in an area to annual electricity consumption

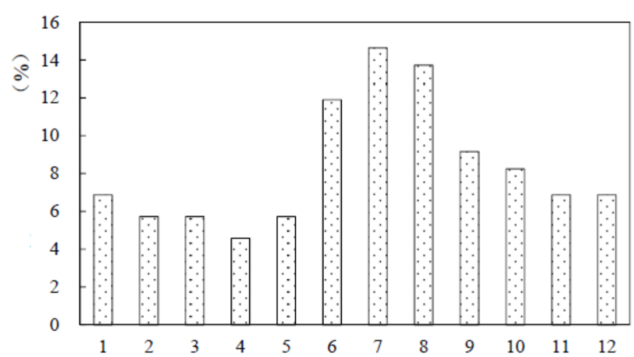

Figure 6 The proportion of monthly actual electric load to annual load

By Figure 6 Analysis of the air conditioning host power consumption, due to other air-conditioning equipment power consumption, June to August is still the peak power period. After analysis, the maximum electrical load is about 3.2 times of the minimum electrical load, and the monthly load difference decreases slightly.

Figure 7 shows the annual load of a hospital during the year.

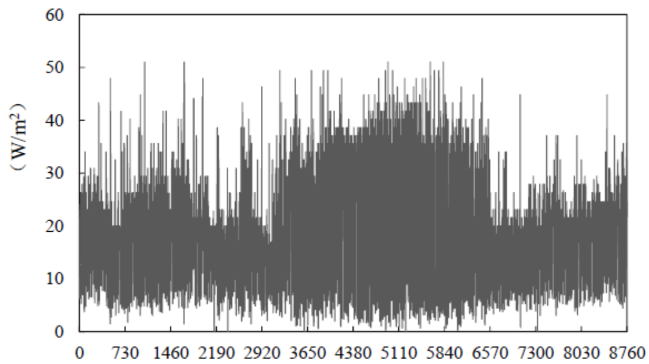

Figure 7 Annual electricity load of a district

The monthly electricity consumption is calculated, and the monthly electricity consumption is calculated as the proportion of annual electricity consumption. The result is shown in Figure 8.

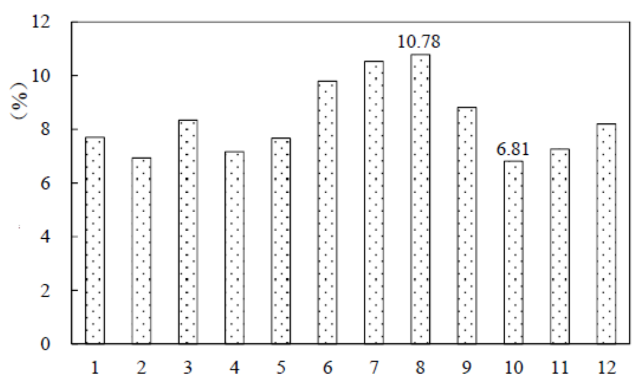

Figure 8 Monthly electrical load represents a percentage of annual total load

As can be seen from figure 8, the proportion of monthly electricity load in this area reached the maximum value of 10.78% in August, the lowest value in October was 6.81%.

4.3 The ratio of hourly electrical load to daily load

The electric load data of the measured area are selected, and the typical daily and hourly electric load of each season is selected. The ratio of hourly load to daily load is calculated, and the result is shown in Figure 9.

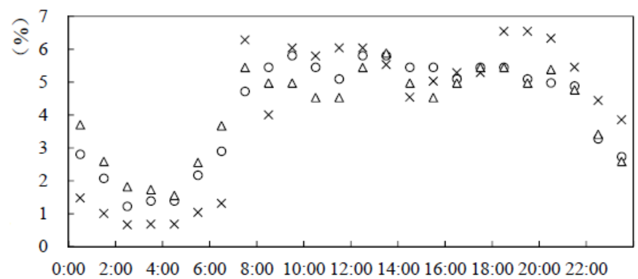

Figure 9 Percentage of daily load per day in typical season

× stands for summer, ○ stands for winter,and △ represents transition season.From the figure, the summer and winter and transition season hour load proportion is basically the same trend. The change of 8:00~22:00 is basically stable at around 5%, 0:00~8:00 hours of electricity load decrease after increase of about 3:00 is reduced to the minimum, reduce or increase the load changes rapidly, 22:00~24:00 also decreased rapidly.

4.4Peak load

At present, in the design of the combined supply system, only if the system configuration is rough estimated, the peak load should be estimated according to the basic electric load allocation of the corresponding unit and the determination of the basic electric load. The domestic civil building electrical load design index of general 40~70W/m^2, the upper limit of 70W/m^2 considered the use of electric refrigeration and air conditioning when the situation, if the non electric refrigeration of direct fired machine to meet the cooling demand, while electricity index decline is about 30W/m^2, which is China's civil power load design index to be 40W/m^2. To sum up, the reference value of civil peak load is 40~50W/m^2.

5.Conclusions

Civil building cogeneration system is being actively promoted, application of thermoelectric cogeneration system of civil construction prospects, combined with the characteristics of civil building load, configuration and operation strategy of CCHP system of civil construction power were studied to provide reference research results for the thermal power cogeneration system for civil buildings.

Acknowledgments

This work is supported by the Scientific Research Project of Guangdong University of Science&Technology,"Basic research on optimization of cogeneration system based on solar photovoltaic thermal technology".

References

[1] Yang Zhao,Yanguang Cai,Defu Cheng, "A Novel Local Exploiation Scheme for Conditionally Breeding Real-coded Genetic Algorithm", Multimedia Tools and Applications, 2016.In Press.
[2] Liya Wang,Yang Zhao,Yaoming Zhou,Jingbin Hao, "Calculation of flexible printed circuit boards (FPC) global and local defect detection based on computer vision", Circuit World, Vol. 42, No. 2, 2016, pp. 49-54.
[3] Yang Zhao, Zheng-hong Guo, Jian-ming Yan, "Vibration signal analysis and fault diagnosis of bogies of the high-speed train based on deep neural networks",Journal of Vibroengineering,Vol.19, No.4, 2017.
[4] Yang Zhao,Yanguang Cai,Guobing Fan, "Dynamical Behavior for Fractional-order Shunting Inhibitory Cellular Neural Networks", Journal of Nonlinear Science and Applications,Vol.9, No.6, 2016, pp.4589-4599.
[5] Yandong Zhang,Yang Zhao, "Design & implementation of an Air Quality Monitoring System for Indoor Environment based on Microcontroller", International Journal of Smart Home, Vol. 9, No.11, 2015, pp. 301-312.
[6] Yang Zhao,Yanguang Cai,Guobing Fan,"Dynamical Behavior for Fractional-order Shunting Inhibitory Cellular Neural Networks",Journal of Nonlinear Science and Applications,Vol.9,No.6,2016, pp. 4589-4599.
[7] Yang Zhao,"Research on Active Control of the Dynamic Vibration for Underwater Robot", Journal of the Balkan Tribological Association,Vol.22,No.1A,2016,pp770-779.
[8] Bing Liu,Yang Zhao,Yuanyuan Dang, "Data flow network security strategies based on data mining",Metallurgical and Mining Industry, Vol.7, No.10, 2015, pp. 46-53.
[9] Yang Zhao,Yanguang Cai,Xiaojun Yang,"A Local Fractional Derivative with Applications to Fractal Relaxation and Diffusion Phenomena",ThermalScience,Vol.20,No.S3,2016, pp723-727.
[10] Hanqing Tao,Yang Zhao, "Intelligent fault prediction of railway switch based on improved least squares support vector machine",Metallurgical and Mining Industry, Vol.7, No.10, 2015, pp.69-75.
[11] Huiling Guo,Wengang Zhou,Yang Zhao, "A license plate recognition algorithm based on image processing technology",Metallurgical and Mining Industry, Vol.7, No.8, 2015, pp.322-328.
[12] Liya Wang,Jiankun Shang,Yang Zhao, "Information Prediction of the trend of network attacks based on mechanism analysis method",Metallurgical and Mining Industry, Vol.7, No.8, 2015, pp.328-334.
[13] Zongyi Xing,Xinrong Liu,Yang Zhao,Yong Qin,Limin Jia, "Optimization of Vibration Damping for the Power Assembly Suspension System Based on Ant Colony Algorithm",International Journal of Simulation,Systems, Science & Technology, Vol.21, No.5, 2016, pp.281-289.
[14] Huiling Guo,Yan Hou,Yang Zhao, "Research on Image Matching Algorithm based on TPS Transformation Model",International Journal of Simulation,Systems, Science & Technology, Vol.17, No.8, 2016, pp.102-110.
[15] Wengang Zhou,Huiling Guo,Yang Zhao, "A Novel Method for Detecting Similar Microblog Pages based on Longest Common Subsequence",International Journal of Simulation,Systems, Science & Technology, Vol.17, No.8, 2016, pp.111-118.