2014

ISSN : 0974 - 7435 Volume 10 Issue 24

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(24), 2014 [15346-15351]

Research on the application of district cooling system in cloud computing center in cold climate: taking Inner mongolia as an example

Zhuolun Chen[1,2], Xiaowei Wu[1*]

[1]Architectural Design and Research Institute, South China University of Technology, Guangzhou, 510640, (CHINA)

[2]State Key Lab of Subtropical Building Science, South China University of Technology, Guangzhou, 510640, (CHINA)

ABSTRACT

In recent years, the cloud computing center has developed rapidly all over the world, the contradiction between its high energy consumption and the present situation of tension energy supply increasingly stand out. One of the most effective cards to reduce the electricity consumption of cloud computing center and decrease operating cost is reducing the power consumption of air-conditioner. In this project, on the basis of heat supply capacity in thermal power plants and the cold demand of users in terminal cloud computing center, LiBr absorption chiller utilizing gas and electric centrifugal refrigerator were adopted, and the energy was electricity power from thermal power plant and waste heat steam power generation. In addition, in consideration of high reliability about cold source of data center, the standby energy was natural gas, and LiBr absorption chiller utilizing gas was adopted. The guaranteeing design of equipment, energy, water supply and drainage, and cooling network satisfied the request of cooling safety for users. Construction of this district functional item brought out economic benefits such as the reduce of operating cost, plant room, placing cooling tower and maintenance attendance cost, social benefits such as the increase of overall energy utilization degree, the decrease of heat island effect and carbon dioxide.

KEYWORDS

District cooling; Cloud computing; Cold climate; Security.

© Trade Science Inc.

INTRODUCTION

In recent years, the cloud computing center has developed rapidly, there were new projects worldwide. The latest data reveal that up to March 2012, our country have about 30 large data center (above 100,000 servers) construction projects in 13 provinces, the total investment is up to 270 billion RMB. The official website of NDRC declares that in field of cloud computing, together with MIIT, they started cloud computing service innovation and development of pilot demonstration in advance in 5 cities such as Shanghai, Shenzhen, Hangzhou and Wuxi[1].

With the rise of cloud computing center all over the world, the power consumption accounts for the proportion of the total power consumption in national product increases sharply. According to the statistics, in 2007, the power consumption of European data center raised 13 percent than 2006, the total power consumption of civil IT products exceeded 20 billion kilowatt-hours, which is about half of energy output of Three Gorges Project. Some statistics showed that in 2011, the civil total power consumption of data centers was 70 billion kilowatt-hours, which was 1.5 percent of total social power consumption, about total power consumption in Tianjin of the year; 921 commercial data central apparatus rooms, and the area is about 8.8 thousand square meters[2]. Meanwhile, with the rapid rise of cloud computing, the need for flow processing capacity of civil data centers will increase 7-10 times in next 5 years, the room area should double to meet the development of cloud computing.

With the rapid expansion of cloud computing centers, numerous problems revealed gradually, the most prominent one was high energy consumption, which promoted electric charge, made the cloud computing hard to afford after construction[3]. Therefore, the construction of energy efficiency and environmental protection cloud computing center has become the consensus of builders and users.

In cloud computing center, the installed computer equipment (such as server, router, storage device, switchboard, optical transmitter and receiver) and power protection equipment emit heat to data center in ways of heat transfer, convection and radiant, which belong to sensible heat, making the inner temperature of machine room go up. The heat dissipating capacity of equipment in cloud computing center is above 400W／m2, and above 1000 W/m2 for high power density data center[4]. According to statistics, the power consumption of air-condition is above 40 percent for total power consumption in cloud center computing[5]. To reduce the power consumption of air-condition is become one of effective ways to lower the total power consumption in cloud center computing and reduce operating cost.

PROJECT OVERVIEW

The cloud computing industrial base in this project locates in Inner Mongolia Hohhot city, the first phase is to construct 2 district cooling station, each installed gross capacity is 30,000 ton of refrigeration, and increase 30,000 ton of refrigeration forward[6]. Traditional electric refrigerator is replaced by steam absorption chiller, the waste heat from owned thermal power plant is used to construct district cooling system, provide air conditioning chilled water for data center[7]. The owned thermal power plant is cogeneration project, which can provide high grade and reliability waste heat and power resource, take full advantage of waste heat, and decrease repeated construction.

This project takes full advantage of waste heat from cogeneration project; combine the district cooling intensification of computing industry base in Mongolia, decrease operating cost, machine room area, placing cooling tower and maintenance attendance cost, social benefits such as the increase of overall energy utilization degree, the decrease of heat island effect and carbon dioxide.

PLAN OF DISTRICT COOLING SUPPLY AND THE SAFETY DESIGN OF COOLING SUPPLY

Cloud computing center is very important for telecommunications system, and close with daily life of large population, so to assure the normal operation is necessary. A basic condition for the normal operation of cloud computing center is to maintain a constant room temperature, and the safety of cold source also present safety guarantee demand, the design should meet technical standards at home and abroad.

Cooling technical proposal

The project face up to users of cloud computing center in the industry base, Cold water of air conditioning refrigeration is transported by district cooling station and cold water pipe network to replace air-condition cold source in individual building. According to the features of equipment in cloud computing center, equipment operate continuously all the year round, the main reason for cold load is calorific value of the equipment. So yearly cold load of this building is relatively stable, the influence about the change of climate is rare.

In this project, on the basis of heat supply capacity in thermal power plants and the cold demand of users in terminal cloud computing center, LiBr absorption chiller utilizing gas and electric centrifugal refrigerator were adopted, and the energy was electricity power from thermal power plant and waste heat steam power generation. In addition, in consideration of high reliability about cold source of data center, the standby energy was natural gas, and LiBr absorption chiller utilizing gas was adopted. The principle diagram of the refrigeration system of LiBr absorption chiller utilizing gas is shown in Figure 1. When external heating source is broken off by accident, the unit can use the burning of natural gas to produce steam, meeting the need of absorption cooling.

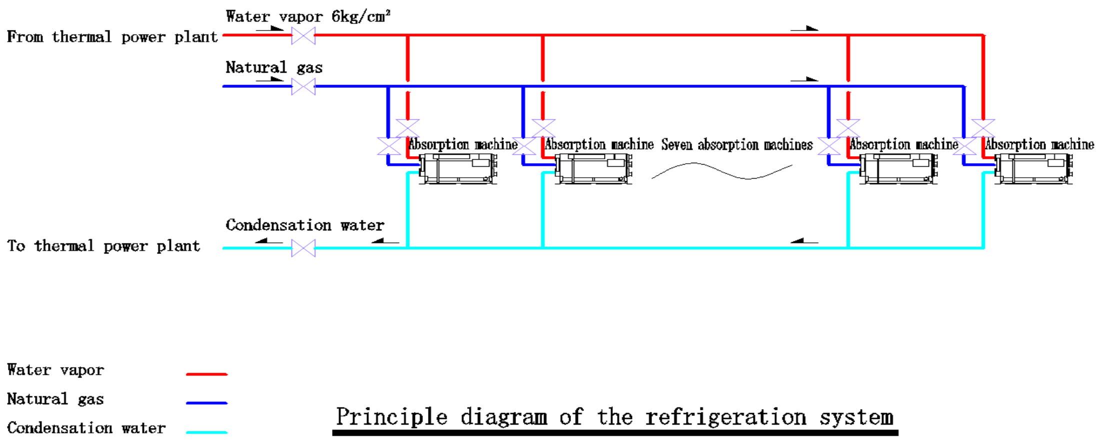

Figure 1 : The principle diagram of the refrigeration system of LiBr absorption chiller utilizing gas

Cooling safety design

On the basis of the need of terminal users in this project, the safeguard rate of cooling source should achieve civil standard A. moreover, may consult TIA design standard abroad, the safeguard rate should above 99.999 percent. The guaranteeing design of equipment, energy, water supply and drainage, and cooling network satisfied the request of cooling safety for users.

1)Guaranteeing design of the cooling equipment in cold station

• To ensure the normal operation of the system, set reserve cooling为units, take into account of 20 percent.

2)Guaranteeing design of energy in cold station

• The cooling source of absorption machine is waste steam of thermal power plant and natural gas, sparing to each other.

• The power source is three power supplies, sparing to one another.

• The energy form is steam, natural gas and electric power. When steam and electric power is stopped by accident, 80 percent of the peak load can depend on natural gas and reserve electrical machine.

• The reliability is doubled by setting two forms of energy.

3)Guaranteeing design of water supply and drainage in cold station

• Set specified water tank in cold station, the volume is designed to meet the need of 8h water discharge. So when the pine networks of municipal administration have an accident, the system can still operate normally.

4)Guaranteeing design of cooling pipe network

• Besides normal freeze water for back-water pipe, set a reserve pipe.

• Make cyclic network of pipes of two pipe lines in two cold statins to fully guarantee the safety of cooling.

• If special condition occurs like power failure, under partial load, it can use emergency cooling by pipe line of two cold station.

OPERATIONAL ANALYSIS OF DISTRICT COLD STATION

According to the meteorological data of TMY in Hohhot, analyze different air conditioning conditions in summer, transition season and winter, by means of outdoor wet-bulb temperature distribution throughout the year, work condition and the cooling need of users.

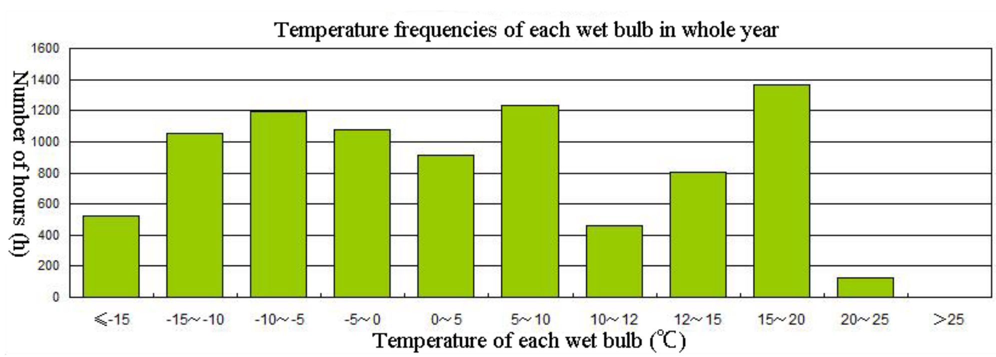

Figure 2 : The number of hours for wet bulb temperature

The number of hours for wet bulb temperature of Hohhot is shown in Figure 2. According to statistics, we can get number of hours in different season, shown in TABLE 1.

TABLE 1 : Number of hours in different season of hohhot

Season	Wet bulb temperature T	Hours
Summer	T>12℃	2296
Transition season	-5℃<T<12℃	3686
Winter	T<-5℃	2778

1) Summer(T>12℃), the operation of cooling system is shown in Figure 3.

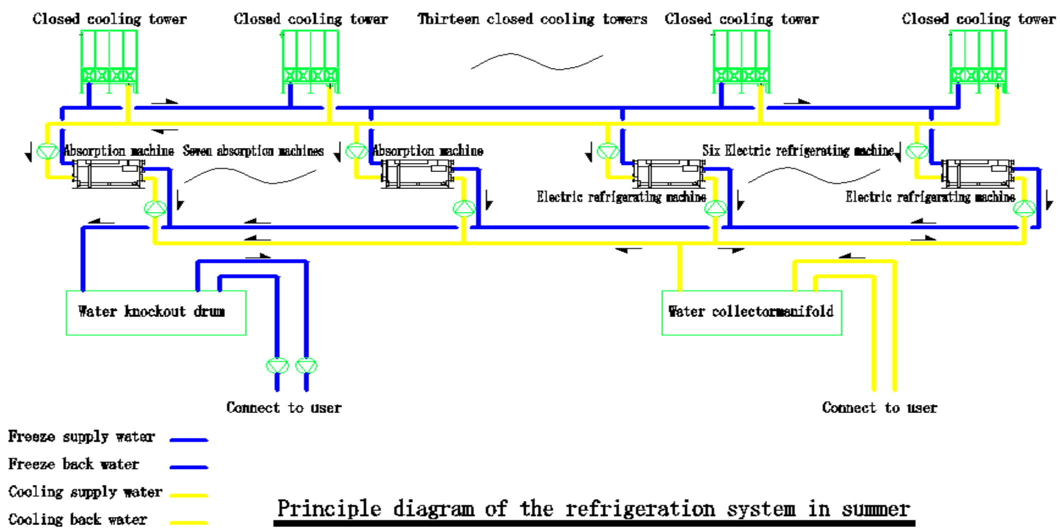

Figure 3 : Operation schematic diagram of cooling system in summer

In summer operation condition, Steam absorption refrigeration unit and centrifugal electric machine work together. Cold water is sent to users by the primary and primary-secondary pump of cold water, the supply and return water temperature of cold water is 6℃/13℃. The cooling tower is closed type, the supply and return water temperature of cold water is 32℃/37℃. It can change water volume and reduce transmission energy consumption according to the change of terminal load, by constant flow of the primary pump and variable flow of the primary-secondary pump.

2)Transition season(-5℃<T<12℃), the operation of cooling system is shown in Figure 4.

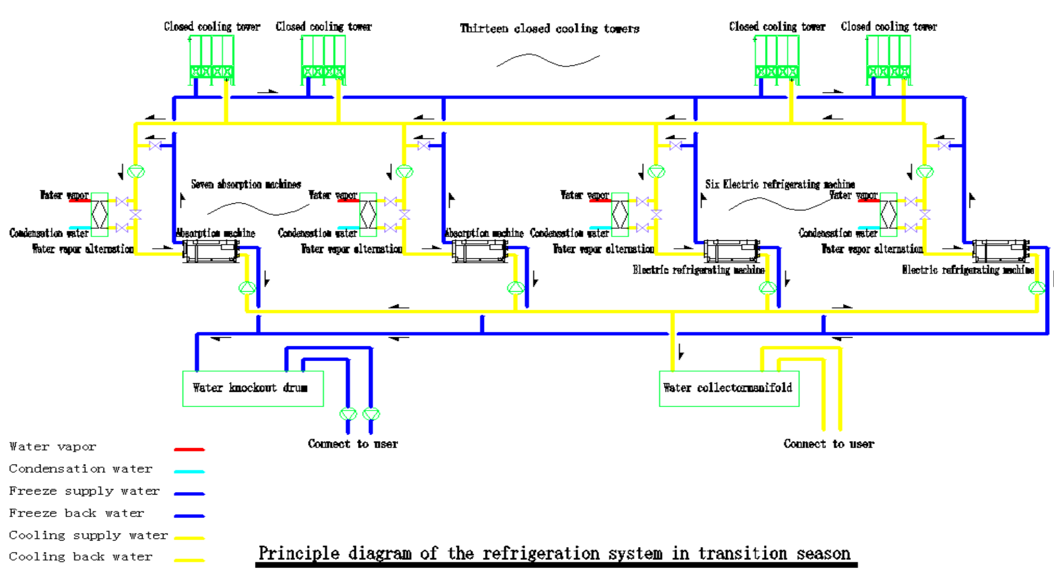

Figure 4 : Operation schematic diagram of cooling system in transition season

In transition season, T＜12℃, the return water temperature of cold water is <16℃, which cannot satisfy the water temperature for the normal operation of steam absorption refrigeration unit and centrifugal electric machine. To increase the return water temperature of cold water, assuring the normal operation of the unit, it can mix the supply and return water, by controlling the mixture of cold water and the open count of cold tower by setting mix water valve group. In addition, consider the mentioned method cannot work in part time because the outdoor temperature is low, it can use auxiliary heating, making the temperature higher than 16℃, so the unit can work normally. But take into account of highly effective using of energy, the scheme is not used commonly.

Winter(T＜-5℃),the operation of cooling system is shown in Figure 6.

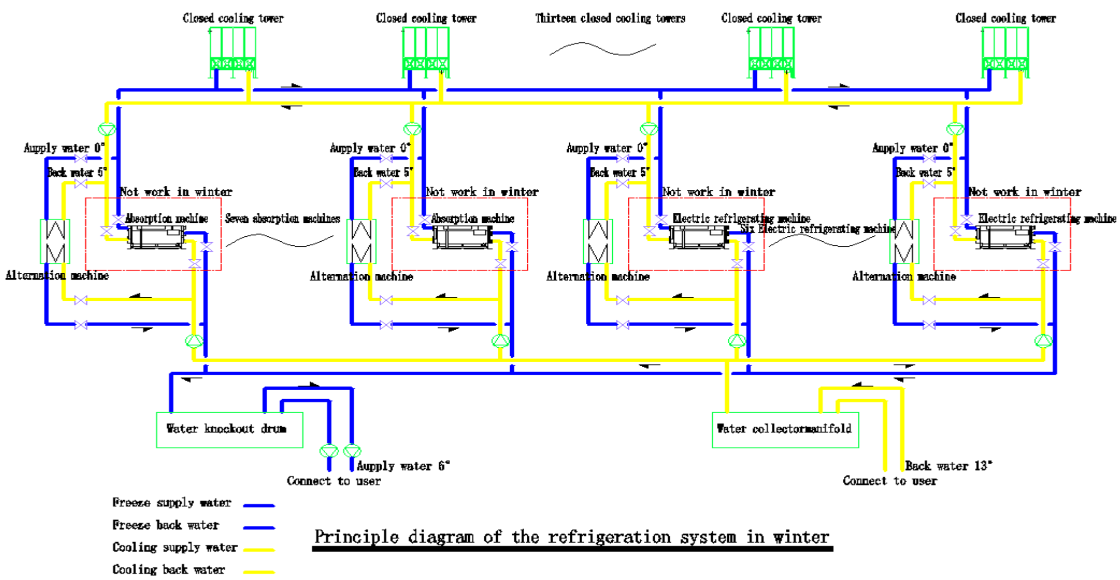

Figure 5 : Operation schematic diagram of cooling system in winter

In winter, outdoor temperature is low, natural cooling can be the natural cold resource. At this moment, the cooling water is sent to users by cold water pump after cooling by closed cooling tower and heat transferring by heat exchanger, the supply water temperature is 5.5℃.

According to the above yearly operational states, the consumption of water, power and steam for the stations each year can be calculated, as shown in TABLE 2.

TABLE 2 : The consumption of water, power and steam for the first and second cold station

	Steam(T)	Power(kWh)	Water(m^3)
The first cold station	348199.8	85664704.7	394021
The second cold station	348199.8	85664704.7	394021

CONCLUSION

This project takes full advantage of waste heat from cogeneration project, which is a efficient path to meet the need of cooling in cloud computing center. The electric power is high-grade energy and can be transported for long distance; while steam is low-grade energy and cannot be transported for long distance. The construction of energy station around power plant and cloud computing base, using the waste steam for the cooling of cloud computing center, can not only solve the problem of the transportation for long distance of steam and realize highly effective using of energy, but also reduce the electricity consumption of cloud computing center and the power supply pressure of urban power grid.

This project use waste heat of thermal plant for cooling, reduce the consumption of primary energy such as electricity. After the preliminary estimates, two cooling stations (According to the total installed capacity of 60000 ton of refrigeration) can make contribution for energy conservation and emission reduction:

1) Reduce about 130 million degrees power consumption for cooling of cold source a year
2) Reduce consumption of about 60000 tons of standard coal
3) reduce emissions of about 150000 tons of carbon dioxide
4) reduce emissions of about 488 tons of sulfur dioxide

ACKNOWLEDGEMENT

This study is sponsored by the Youth Science Fund of National Natural Science Foundation of China (No.51108185) and the funding of State Key Laboratory of Subtropical Building Science (No.2013KB24).

REFERENCES

[1] Lars Davidson, Erik Olsson; Calculation of age and local purging flow rate in rooms, Building and Environment, **22**, 111-127 **(1987)**.
[2] Juan Abanto, Daniel Barrero, Marcelo Reggio, Benoit Ozell; Airflow modelling in a computer room, Building and Environment, **39**, 1393-1402 **(2004)**.
[3] J.D.Posner, C.R.Buchanan, D.Dunn-Rankin; Measurement and prediction of indoor air flow in a model room, Energy and Buildings, **35**, 515-526 **(2003)**.
[4] M.Armbrust, A.Fox, R.Griffith, A.D.Joseph et al.; A review of cloud computing, Communications of the Acm., **53**, 50-58 **(2010)**.
[5] George Pallis; Cloud computing- the new frontier of internet computing, IEEE Computer Society, 70-73.
[6] M.G.Jaatun, G.Zhao et al.; Cloud computing, First international conference, Cloudcom, China, **(2009)**.
[7] S.Ostermann, A.Iosup, N.Yigitbasi et al.; A performance analysis of EC2 cloud computing service for scientific computing, Cloud Computing, First International Conference, CloudComp., Germany, 19-21, **(2009)**.