THE APPLICATION OF HEAT PUMP IN TSINGHUA UNIVERSITY DESIGN CENTER

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ABSTRACT:

This paper introduces the HVAC system of Tsinghua design center. It emphasizes the cooling & heating source and the operating mode in different seasons.

1. INTRODUCTION

Tsinghua design center of approximately 7000 m^2 with 4 floors is located in front of Tsinghua main academic building. Multifunctional hall, refrigerating station, transformer & switch room and offices are in the 1st floor. The 2nd, 3rd and 4th floors are offices and design rooms.

The shape of design center is like 回. It is 54.6m long from west to east, 41.3m wide from north to south. Figure 1 is the 2nd plan.

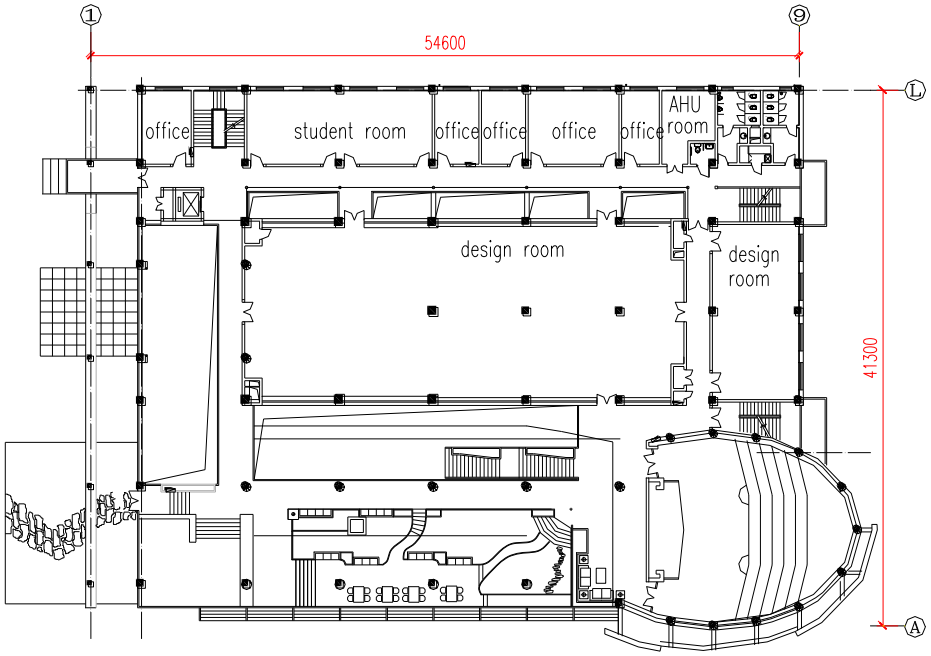

Figure 1　the 2nd plan.

2. AIR CONDITIONING SYSTEM

2.1 Air system

In addition to hall and meeting room adopting all-air system, the others adopt primary air fan-coil system. Each floor has an air handling unit room. There are two air handling units (AHU) on 4th floor, one for the interior area in 4th floor and the other for exterior area in 2nd, 3rd, 4th floor. Three AHUs serve for the interior area on the 2nd, 3rd and 4th floor respectively. The AHU at the 1st floor works for all rooms of 1st floor.

2.2 Water system

The project adopts two-pipe water system. Balance valve at the each branch pipe prevents hydraulic disorder. Chilled water system is primary pumps system.

3. COOLING AND HEATING SOURCE

In accordance with the load pattern, the design rooms belong to interior area and the ambient offices belong to exterior area. In view of the interior rooms' cooling demand in winter, a chiller and a heat pump are used.

3.1 Cooling source

The total cooling load is 928kW. There are a chiller (30HR161) with 464kW refrigerating capacity and a heat pump (30HQ161) with 464kW/531kW refrigerating/heating capacity in the refrigerating room. The chiller and the heat pump can supply chilled water with 7 ^{o}C /12 ^{o}C, which serves for interior fan-coils, exterior fan-coils and fresh air handling units.

The character of water pump is as followed:

Chilled water pump (G315-100): water flow: 85t/h; water head: 28mH_20; power: 11kW

Cooling water pump (G315-100): water flow: 110t/h; water head: 26mH_20; power: 11kW

Make-up water pump (G32-50): water flow: 3.7t/h, water head: 28m H_20; power: 1.5kW

The water flow of cooling tower (CEF-125) is 125t/h.

Chilled water pumps, cooling water pumps and cooling towers are set according to the chiller and heat pump respectively.

3.2 Heating source

The total heating load is 680kW. The heating source is the region heat supply network of university. The temperature of primary water is 75^{o}C /60^{o}C, the secondary water which acquire heat from primary water through plate heat exchangers is 60^{o}C /50^{o}C. Chilled water pumps work as heat water pumps, one for use and one for standby.

4. OPERATING MODE

Air conditioning system can convert operating mode according to the outdoor air conditions and the indoor load conditions.

4.1 Operating mode in summer (Figure 2)

In summer, the interior area have the heat gained from occupants, computers and lighting. The exterior rooms get the heat from building envelope and solar radiant moreover. So interior area and exterior area requires cooling supply. The chilled water from chiller and heat pump enter into the distributing header for all fan-coils and fresh air handling units.

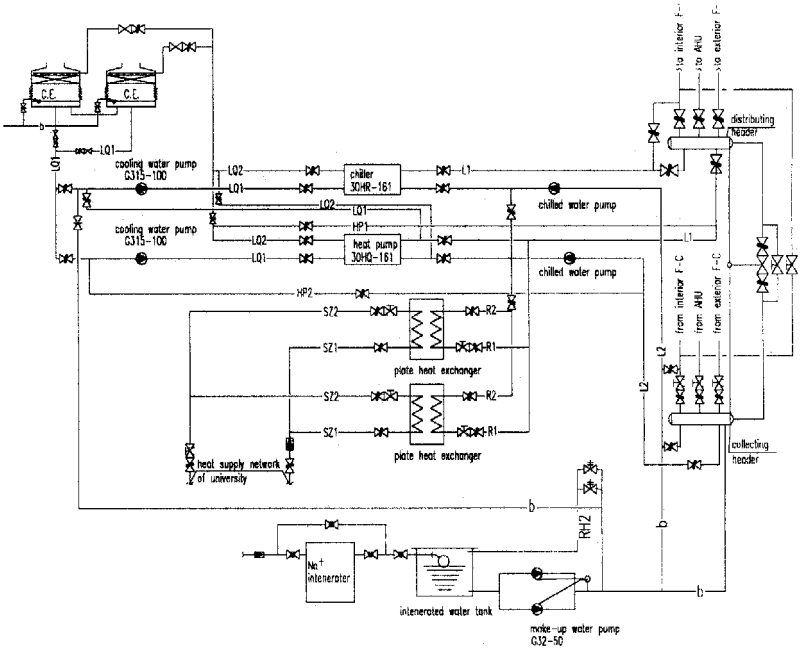

Figure 2 Operating mode in summer

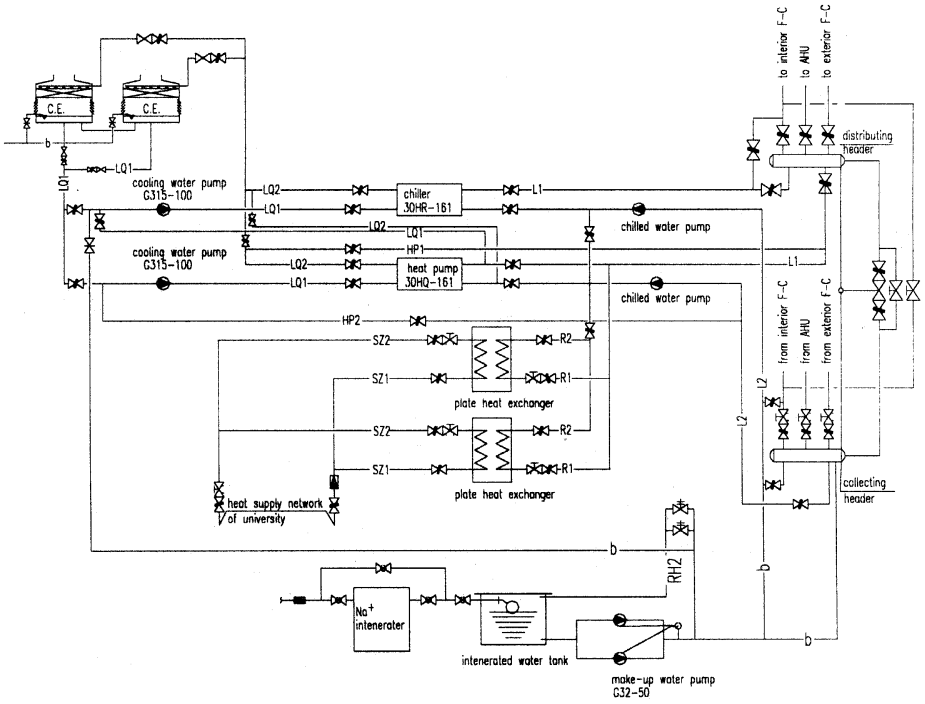

Figure 3 Operating mode in transition season

4.2 Operating mode in transition season (the middle ten days of Mar ~ the middle ten days of Apr, the middle ten days of Oct ~ the middle ten days of Nov) (Figure 3)

In transition season, the interior offices have the heat gained from occupants, computers and lighting. The exterior rooms lose the heat through building envelope. So the fresh

air handing units serve for interior area heat the outdoor air to the indoor air condition and then send it into indoors. The chilled water is delivered to the exterior fan-coil in order to satisfy the cooling demand. The heat water is transported to the interior fan-coils and the fresh air handling units to satisfy the heating demand. At this season, the chiller works at the refrigerating mode and the heat pump at the heating mode. The chiller and the heat pump run at same time. The cooling water of the chiller serves as low temperature heat source of the heat pump in order that the excessive heat of interior can compensate for loss of exterior. The cooling tower doesn't need to work.

4.3 Operating mode in winter (Figure 4)

Because we can take advantage of the heat supply network of university, the secondary water which acquires heat from primary water through plate type heat exchangers is supplied for the building. Excessive heat from interior area could be transfered to exterior region through the opened doors and corridor.

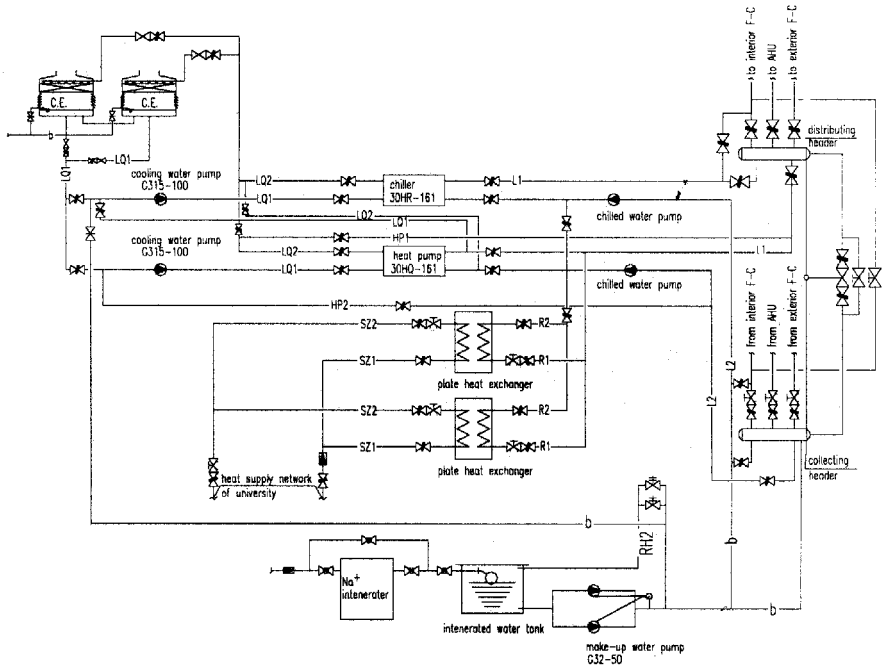

Figure 4 Operating mode in winter

5. EXPERIENCE

5.1 the select of the equipment

The chiller and the heat pump can be selected according to the load and the operating mode respectively. Commonly, the equipment is selected in conformity to the largest load in order to work steadily. The number of the working compressors could be reduced with the decrease of the load automatically. The heat pump is controlled by the heating load and the chiller is controlled by the temperature of the chilled water in actual operating. The select of the chiller must consider whether the cooling load of the interior area in transition seasons makes the chiller work continually.

In this project, the chiller (30HR161) has four compressors. Two of the compressors can adjust the refrigerating capacity by changing the number of cylinders. The regulating range of the chiller is 16/25/41/50/67/75/91/100%.

The least cooling load which chiller could meet is: 464x16%=74.24kW
The cooling load of interior area is: (the area of interior region is 1250 m2 with 125 people)
In which
heat gaining from lighting: 1250x40=50kW
heat gaining from occupants: 125x130=16.25kW
heat gaining from computers: 125x100=12.5kW
the total heat : 78.75kW
the cooling load of interior area makes the chiller work normally, and that is the excessive heat of interior area can serves for the exterior area.

5.2 Make-up water, pressure-steady and bypass in transition season

In transition season, the heat pump and the chiller operate combinedly. The heat water from the heat pump is delivered to the fresh air handling units and the exterior fan-coils by collecting headers. There is a bypass pipe between the two heads. It makes that the flow of exterior terminal units is variable and the flow of heat pump is constant. The chilled water from the chiller is supplied to interior fan-coils, not by collecting head. So make-up water and pressure-steady of chilled water system must be considered. Bypass pipe is set between the supply and return chilled water. The flow of interior terminal units is variable, but the flow of the chiller is constant. It is apt to be ignored.

6. REFERENCE

1. Series-wound heat pump system HVAC 1983,5:32-33
2. Tsinghua university, air conditioning (edition 2) architecture publish company, beijing china