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THE TECHNOLOGY OF SPACE HEATING BY USING LINKAGE-RUNNING APPROACH WITH SOME ASSOCIATED HEATING RESOURCES APPLIED TO 975 PROJECT IN TIANJIN CITY

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ABSTRACT

The 975 project is one of the most important municipal projects in Tianjin city's infra-construction facilities. However, it is very difficult for the project to get heating resource of pollution free because it locates in a region with dense buildings. The technology of space heating by using linkage-running approach with some associated heating-resources has been put forward to solve the problem, in which the deposed wasted-water of city and lake water are treated as main pollution free energy resources, while the geothermal water of the Tertiary system is treated as ancillary and peak adjusting heating resources. The results of its application indicate that the technology has been satisfactory and has solved the problem of energy shortage in 975 project successfully, thus meeting the basic demands of cooling, heating and hot water for life.

Keywords: space heating, heating resources, geothermal, heating pump

1 INTRODUCTION

The 975 project is one of the most important municipal projects in Tianjin city's infra-construction facilities. It locates in Yingbin artery and Meijiang ecological district. As planned, the whole project's building area amounts to 90500 square meters, during which the initial project's building area is 61000 square meters. The layout of the whole project is shown as Fig.1.

Fig.1 General layout of Tianjin 975 project

At the same time, an amount of 3789kw in heating load and 4965kw in cooling load are also required by the project. Moreover, the municipal government of Tianjin city strongly requires that every building's air-conditioning system reflect the principle of energy-saving, environmental protection and comfort.

However, a new geothermal deep well cannot be drilled in this region because there have been densely existed many geothermal wells. And only the geothermal resource of the Tertiary system, which belongs to shallow geothermal wells, can be exploited. In this case, the geothermal well's flow capacity is 80~100m^3/h, the water temperature ranges from 60℃ to 70℃. In addition, there are a man-made lake and much deposed wasted-water in this zone. The man-made lake is over 100 acres in area and 199,800m^3 in its storage capacity. And the deposed wasted-water is 50,000m^3/h in flow quantity as well as 15~24℃ in temperature.

2 THE TECHNOLOGY OF SPACE HEATING BY USING LINKAGE-RUNNING APPROACH WITH SOME ASSOCIATED HEATING RESOURCES

The air-conditioning system programs in past all use oil, coal or gas as their energy resources, during which, the air pollution is inevitable. Therefore, the mankind suffers much from the pollution and now become aware of the importance of environmental protection increasingly. Now, it is a tendency that the pollution free and clean energy resources replace the traditional and pollution energy resources. As a result, the geothermal water is used widely because of its safe and sustainable.

In some cases, only the geothermal water may not meet the needs of the project. The new technology of space heating by using linkage-running approach with some associated heating-resources has been put forward, which can overcome the shortage of clean energy resources.

2.1 The principle of the technology

In the new technology, the geothermal water and other kinds of water can be used as heating or cooling resource to supply the heating and cooling load. The technology has its own advantages. Firstly, the heating or cooling resources are sustainable and recyclable energy resources. Secondly, the technology of space heating by using linkage-running approach with some associated heating-resources may maintain a heating-supply balance in the project. Thirdly, the use of the technology can make the air-conditioning system work more efficiently, energy-saving and environment-protecting as well.

2.2 The technological flow of the technology

Fig.2 shows the technological flow of the technology of space heating by using linkage-running approach with some associated heating-resources. It consists of three parts: heating-resources, heating-pumps, heating. All these three parts play different roles in the whole system.

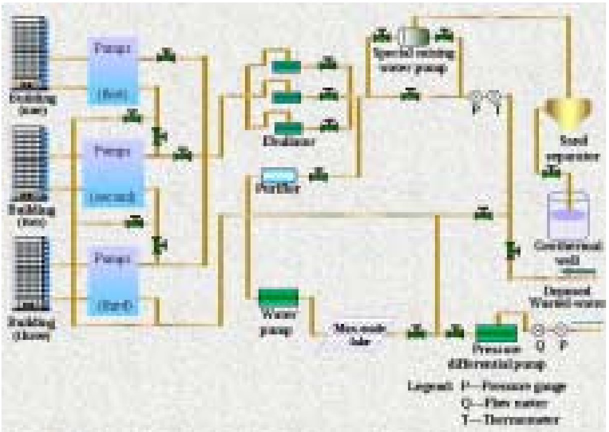

Fig.2 the technological flow of the space heating by using linkage-running approach with some associated heating-resources

The heating resources, including geothermal water, lake water and deposed wasted-water, provide the air-conditioning system with heat energy, and the heating pumps connect the different heating resources and terminal heating. There are two connection types: the parallel connection and the series connection. Furthermore, the different heating resources will have different connection types. When the air-conditioner system uses the lake water or the deposed wasted-water as heating resource, the pumps operate in parallel. But if the heating resource is geothermal water, the pumps operate in series to utilize the geothermal energy step by step, which will make full use of the geothermal energy.

3 APPLICATION OF THE TECHNOLOGY IN TIANJIN 975 PROJECT DESIGNING

3.1 The program decision of the technology

The on-going Tianjin 975 project is facing a difficulty in getting heating resources because it locates in an area of dense buildings. As a result, firstly, it is very difficult and expensive to lay another new pipe to connect the main transport net of heating-resources in the city. Secondly, local common heating-resources, such as coal-burning boiler, cannot be used because of the regularity about environmental protection by the municipal government. Thirdly, new geothermal deep wells cannot be drilled in this region because of the densely existed geothermal wells. In order to solve these problems, an adaptive approach is put forward, in which the deposed wasted-water and lake water are treated as main heating or cooling resources, while geothermal water is treated as ancillary and peak adjusting heating resources. At the same time, a heating pump system is also built. The number of the heating pumps, which are running, is depended on the purpose of the project, heating or cooling. That is to say, there are six heating pumps operating in winter and nine ones in summer.

3.2 Step-utilizing the geothermal water

In winter, six heating pumps are working in the step-utilizing way in order to make full use of the geothermal water. All the six pumps are divided into successive three-step and every step consists of two pumps. Three-step different heat pumps system connects in series and every stage pumps in parallel, so the pumps system can work to its most effective condition. Having been mixed by 7℃ back-water, the 65℃ geothermal water's temperature will be reduced to 25℃, which serves as the heat medium for the first-step pump. After circulating in this first-step pump the heat medium's temperature comes to 18℃, during which, the energy yielded by 7℃ of temperature difference has been available. Correspondingly, the energy generated by 7℃ of temperature difference in the second-step pump and 6℃ in the last-step pump will also be obtained respectively.

3.3 Calculating the maximum quantity of the circulating water

In many cases, the quantity of the circulating water may be the major factor to determine the air-conditioning system's efficiency that the system will yield adequate supplies of heating or cooling. The main factors that can affect the quantity of the circulating water have four aspects: the pump's heating load, the rated power capability of the heat pumps, the inlet water's temperature and the back-water's temperature. The equation of calculating the maximum quantity of the circulating water is described as:

$$G = \frac{(Q_1 - Q_2)\times 0.86}{(t_2 - t_1)\times C \times \rho}\times n \qquad (1)$$

where:

G — the maximum quantity of the circulating water, in t/h

Q_1 — the heating load of the heat pump, in W;

Q_2 — the rated power capability of the heat pump, in W;

t_2 — the inlet water's temperature, in ℃;

t_1 — the back-water's temperature, in □;
n — the number of the heating pumps;
C — the water's specific heat ratio, in kcal/kg□;
ρ —the water's density, in kg/m^3;
0.86 — the coefficient of the unit conversion.

In Tianjin 975 project, the SSRB0.5MW-2.5 type heating pumps are selected. The pump's heating load is 500000w and its rated power capability is 103000w.

1) The maximum quantity of the circulating water in winter season

When the deposed wasted-water is treated as thermal resource, the six pumps runs in series. The deposed wasted-water temperature is 12□. After circulating in the pumps, it reduces to 7□, the deposed wasted-water will release energy from 5□ of the temperature difference. According to the equation 1, the maximum quantity of the circulating water per hour is:

$$G = \frac{(500000 - 103000) \times 0.86}{(12 - 7) \times 1 \times 1000} \times 6 = 410(t/h)$$

When the geothermal water serves as heating resource, the pumps work in parallel. The maximum quantity of the circulating water per hour is:

$$G = \frac{(500000 - 103000) \times 0.86}{(25 - 7) \times 1 \times 1000} \times 6 = 120.5(t/h)$$

Correspondingly, the quantity of geothermal water per hour is:

$$G = \frac{25 - 7}{65 - 7} \times 100\% \times 120.5 = 37.4(t/h)$$

2) The maximum quantity of the circulating water in summer

In summer, the lake water serves as the cooling resource and all 9 heating pumps will work in parallel. Suppose the lake water temperature difference is 5□, namely, the lake water that gets into the air-conditioning system is 25□, and the water that outflows from the air-conditioning system is 30□. So the maximum quantity of the circulating lake water per hour is:

$$G = \frac{500{,}000 \times 0.86}{(30 - 25) \times 1 \times 1000} \times 9 = 774(t/h)$$

3.4 Initial costs and operational costs

The initial costs are mainly composed of three parts, namely, the costs of the equipments, the costs of the drilling well and those of the pipes network facilities. The whole initial costs of the project amount to 1.78 million yuan in the 975 project.

On the other hand, the operational costs are another kind of the total costs. And the costs mainly include several aspects, such as: electric charge, water charge, geothermal water charge, amortized installation costs, maintenance costs and that of supervision and so on. The operational costs can be divided into two parts: the operational costs in winter and that in summer. Respectively, the operational costs are 10.5yuan RMB per square meter in winter and 11.3yuan RMB per square meter in summer. So the operational costs just only are 21.8yuan per square meter per year.

4. CONCLUSIONS

1) The Tianjing 975 project has achieved some new development in the utilization of geothermal because a new kind of technology, space heating by using linkage-running approach with associated heating-resources, is applied in it. And the new technology can make full use of heating resources, such as the lake water and deposed wasted-water as well as the geothermal water, which are clean and pollution-free energies, thus purifying the atmosphere.

2) Compared with other traditional heat system, the project can save raw coal 3146.3t per year, decrease sulfur dioxide outflow discharge 37.76t per year and make a reduction in outflow discharge of nitrogen oxides 27.4t per year.

3) The whole geothermal heat supplying system in the 975 project has an advantage of requiring much less space area because it efficiently use the environment of the surrounding buildings .As a result, it can develop harmoniously with the scenery nearby. The low operating cost and good integrative economic effect is another advantage of the project.

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