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INTEGRATE APPLICATION OF GEOTHERMAL WATER IN XIAOTANGSHAN SANATORIUM OF BEIJING TELECOM ADMINISTRATION BUREAU

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ABSTRACT

Xiaotangshan Sanatorium of Beijing Telecom Administration Bureau (in short: Telecom Sanatorium) has utilized geothermal water for space heating about 14 years. Now the space heating for buildings is graded and zoned. The computer control system could distribute and regulate the heating load, decrease the peak load, and save water consumption and electric energy.
The enthalpy of geothermal water and efficacy are utilized integrated, not only for space heating, but also for washing, swimming pool, recreation center and so on. It has got actual effect of technical development.
The space heating effect is very obviously. The environment and service quality of sanatorium are improved a lot.

1. INTRODUCTION

Telecom Sanatorium is situated in east of Mafang village, Xiaotangshan town, Changping County of Beijing. It occupies 6.6 hectares and has 5 sets of guest buildings with 8250m^2 build squares, restaurant and recreation center of 4710m^2, balneotherapy room and two pump stations of 860m^2, dormitory and workshop of mineral water of 4833m^2. All buildings only occupy area of 0.92 hectares. Other area is for fishing pond, water view garden, grasses, fruits, trees and so on. The environment here is clear, green, quiet and elegant. There are staffs of 150 persons and 270 beds in sanatorium.

Xiaotangshan is famous in history and called as town of thermal springs in north of Beijing. Now an advanced hot water supply system for heating and washing has been set up in sanatorium. It is working in success now and could meet the demands of future development. The geothermal water is used integrated for heating, bathing, swimming, fishing, botanical garden and sports.

In the last 10 years, 60,000 persons have visited here. Fishes of 40 tons, vegetables of 60 tons and flowers of 60 pots were cultured.

2. INITIATION AND PERFORMANCE OF PROJECT

In sanatorium the first geothermal well WR11 was drilled in 1984. The depth is 824m with water temperature of 64.5^{0}C. Except Fe and F elements, other chemical contents are in range of State Standard of Drinking Water. A deep well pump 150 TD 56x8 was equipped with nominal output of 56M^3/h. By water tower the geothermal water was supplied for space heating. But the supplied water was not clear and had rusts to subside on bathing and washing basins. In 1993 when the balneotherapy rooms were building up, a pump station 1 was designed and constructed to filter and remove Fe, and to add pressure of water in pipe.

2.1 Diagram and effect of direct water supply with one grade and one zone.

When the water tower was removed, an aeration filter tank TCQ-30 was put up. The thermal water with 62^{0}C(one grade) direct flowed to zone XI with building square of 7440M^2. The computer IPC 610/286 controlled the deep well pump, electric-magnetic valves and intermittent discharged [redacted] used water with temperature of 37-40^{0}C. The room temperature could be kept in above 20^{0}C.

This kind (one grade and one zone) of water supply system has worked two years. The effect could be seen. In 1994 the water consumption (78,400M^3), the specific water consumption (10.54M^3/m^2) and the electricity consumption (32,300Kwh) were decreased as 50%, 60% and 40% of those in 1993 respectively. The saving water and electricity costs 193,500 Yuan, even more than the automation investment of 132,400 Yuan.

2.2 Diagram and effect of direct water supply with two grades and two zones

At the end of 1994 a new building of 4500m^2 was build up. The primary diagram could not meet the needs. A new design and diagram with two grades and three zones were proposed. A pump station 2 for treatment and distribution and a pipe net were reconstructed. The reconstruction was not only for present, but also for future development. In the project all guest buildings and service buildings were zoned as area X1, X2, X3 (Fig1).

The thermal water of 62^{0}C through the distributor flowed to areas X1, X2 for space heating. The effluent water from areas X1 and X2 with temperature lower than 45^{0}C gathered in pump station 2 and again was distributed to area X3 and service buildings for space heating. So it is called diagram of two grades and three zones. The figure 2 shows the control system. Here the industrial controls computer in station 1 works as lower-level computer and other computer in station 2 services as upper level. They could control 5 electrical regulating valves S01, S02, and S05 for buildings, S04 for bathing and S03 for discharge as well regulate the enthalpy and peak loading.

In fact from 1996 to April 1998 the water supply was only for areas X1 and X2, because the X3 was in construction. In 821 days the water and electricity saving costs half million Yuan.

which covers 50% of automation investment (900,700 Yuan) in this stage. In 1997 the specific water consumption was decreased to 7.76 M^3/m^2, as 77% of 1994 (Tab.1). The discharge water of 44^0C (about 200,000M^3), and of 35^{0C}(about 24.000M^3) were provided to swimming pool, water view garden and green house. Since the thermal water was utilized integrated and economically, the second geothermal well was approved to be drilled in S-E part of sanatorium.

2.3 Diagram and effect of direct water supply with two grades and three zones.

The second geothermal well WR38 has depth of 1601m, with temperature of 66.5^0C, yield of 74 M^3/h. In March 1998 the area X3 was built up and well WR38 began to work and played the main role in the water supply net. The water supply diagram almost is the same, but the control soft-wares have been modified quite lots. Two sets of industrial control computer have been changed by IPC 610/586.

In the period (Apr. 1998---Mar. 1999), including 162 days of space heating, for heating space of 19099m2 (Tab.1) the specific water consumption is 5.61 M^3/m^2, as 50% of 1994 (10.52 M^3/m^2), and as 65% of 1997 (7.7 M^3/m^2). Figure 3 illustrates the daily flow fluctuation of 9 Jan. 1999. In that day the mean outdoor temperature was -6.4^0C, as the minimum mean temperature in that year. When given temperature difference of 25.72^0C, the mean flow rate should be 51M^3/h, according the calculation formula. Actually, based on the record (Fig3), the mean flow rate was 39M^3/h, as 76% of the calculated. In this way the peak load could be cut about 24%.

The cost of saving water and electricity is 184,000 Yuan, as the 46% of automation investment (400,000 Yuan) in this stage.

3. TECHNICAL RESULTS

3.1 Graded and zoned space heating

The computer control system made the space heating and hot water supply graded and zoned. It distributes and regulates the loading of heating system, especially the peak loading as well automatically fits the weather condition for keeping room temperature.

3.2 Stable operation

The working system is operated stable without hard turning. For all equipments, installations and water pipes have not be seen any corrosion influence.

3.3 Distributed control system

The distributed control system ST-95 set up in 1993 by many times modification. Now it has high ability of disturbance resistance, possibility of computer-user interface based on Chinese characters. Because the system is easy to handle, it would be applied in other institutions.

3.4 Electrical control panel with computer

For automation it was equipped 11 sets of electrical control panels with microcomputers. Using modern electrical-electronic technique, the control lines were designed. It has excellent condition and reliability. From 1995 until now it works normally without any damage of elements. Now this technique is used in other projects, such as in China Central TV station.

4. ECONOMIC BENEFITS AND SOCIAL INFLUENCE

4.1 Save water resource and electricity energy

Making a comparison between the compared parameters of 1994, 1997, 1998(Tab.1), the heating space and heating load were increased year by year. But the specific geothermal water consumption was decreased and the specific electricity consumption was decreased too in 1998. The valuable water resource and electricity energy is saved.

From 1994 to March 1993, it has been saved geothermal water of 492,819M^3 and electricity of 438,932 Kwh in total. According the cost 1 Yuan/M^3 of water and 0.6 Yuan/Kwh of electricity, the saved water and electricity cost 756,178 Yuan, about half of automation investment of all stages.

4.2 Low operating expense

Because the heat source is geothermal water with low price (1 Yuan/M^3), the operating expense become much more lower than that of coal boiler and gas boiler. In recent year, the operating expense of geothermal heating is 10.43 Yuan/m^2. It is about 1/3 of that of coal boiler and 1/5 of gas boiler. Comparing with the coal boiler, every year 0.456 million Yuan could be saved. The investment on automation would be recovered by about 3.33 years.

4.3 Environment protection

The utilization of geothermal water for space heating could keep the environment smokeless and clean. The sanatorium is immersed in fresh air and confomtable sphere, even in winter. It has got prestige of excellent environment and high quality service. The social influence has been recognized by clients and authorities.

4.4 Potential to development

Now in heating period average thermal water consumption is 23.69M^3/h, about 32% of yield of geothermal well. It could supply the heating space by 19099m^2. If water consumption would be developed to 28.12M^3/h, about 38% of well yield, the heating space could be 22680m^2. It just would be the planning scale. If water consumption would be enlarged to 55.84M^3/h, about 75% of well yield, the heating space could

be increased to 45.039 m^2 of the final scale. Sanatorium really has potential in space heating for future development.

4.5 Successful model

The Telecom Sanatorium is a successful model in application of high and modern technique and integrate utilization of geothermal resource. It could promote the development and reasonable utilization of geothermal water in other places.

5. CONCLUSION

Since 1993 Telecom Sanatorium began build and reconstruct the heating system and facilities. Now it is reformed as system with two grades and three zones. The computer control system distributes and regulates the load, especially the peak load, decreased water and electricity consumption, and automatically fits to the weather condition for keeping the room temperature.

The enthalpy and efficacy of geothermal water have been used integrated. With low operating expense, safety and environment protection. In the case utilization of geothermal source has sustainable meaning.

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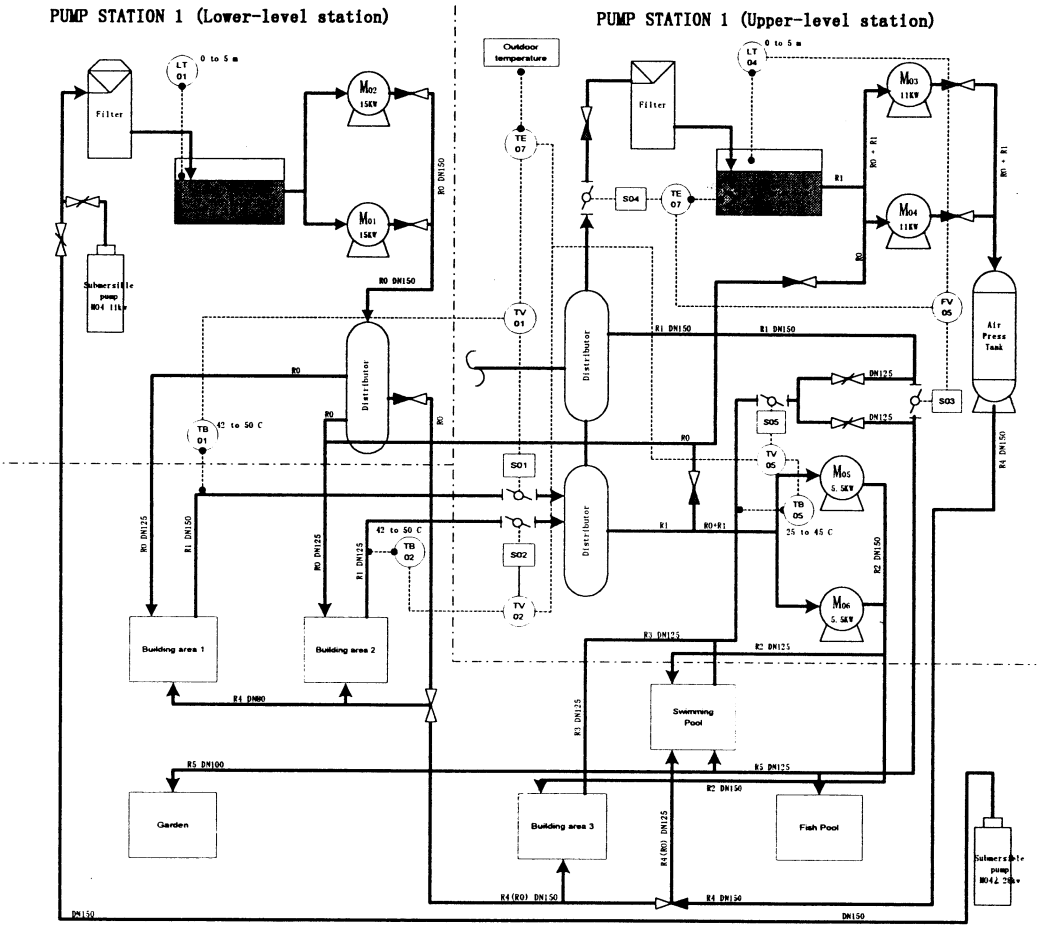


R0-Primary thermal water for heating (63C)
R1-Effluent heating water (45C)
R2-Secondary water for heating (<45C)
R3-Effluent heating water (<35C)
R4-Secondary water for bathing (45C)
R5-Final effluent water (30~45C)

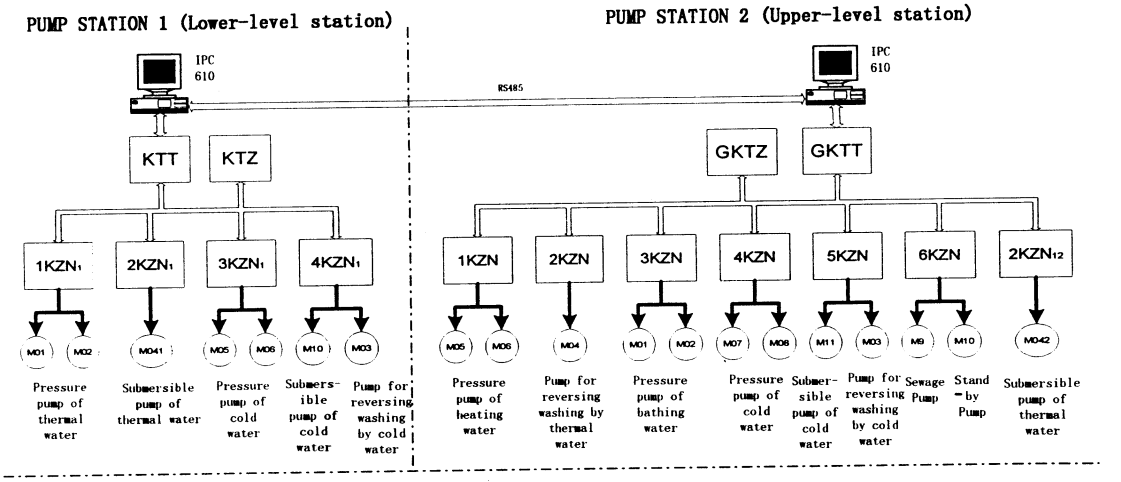
Figure 1. Heat supply diagram with instruments of effluent water

Table 1. Geothermal water space heating from 1994 to 1999

	Characteristics	Unit	1994	1997	Apr.1998-Mar.1999
Heating period	Heating space	m^2	7440	13916	19099
	Heating loading	kw	513	761	667.49
	Specific heating loading	w/m^2	69	54.69	34.45
	Geothermal water consumption				
	Annual	M^3	71831	103578	92088
	Specific	M^3/m^2	9.65	7.44	4.82
	Average	M^3/h	19.19	27.14	23.69
	Maximum	M^3/h	39.58	41.43	43.99
	Electricity consumption				
	Annual	kwh	32324	105729	110426
	Specific	Kwh/m^2	4.34	7.6	5.81
Whole year	Geothermal water consumption				
	Annual	M^3	78405	107945	107097
	Specify	M^3/m^2	10.54	7.76	5.61
	Electricity consumption				
	Annual	kwh	35282	133508	160492
	Specific	Kwh/m^2	4.74	9.59	8.4

Table 2. Economic-technical parameters of geothermal space heating

Parameters	Unit	Geothermal Heating			Boiler	
		Present	Planning	Final	Coal	Gas
Heating space	m^2	19099	22680	45039	22680	22680
Heating load	kw	667.49	792.42	1573.44	2077	2077
A. Investment	Yuan					
1 Equipment	Mil.	0.956	0.956	0.956	1.760	3.200
(including automation	Mil.	(0.132)	(0.132)	(0.132)		
2 Heating distribution system	Mil.	2.431	2.553	2.616		
(including automation	Mil.	(0.991)	(1.040)	(1.066)		
3 Wells or gas source	Mil.			2.200		3.361
4 Total	Mil.	3.387	3.509	5.772	1.760	6.561
(including automation	Mil.	(1.123)	(1.172)	(1.189)		
5 Specific investment	$Yuan/m^2$	117.35	154.71	127.06	0.776	2.893
(including automation	$Yuan/m^2$	(58.79)	(51.70)	(26.61)		
B. Operation expense	Yuan					
1 Thermal water	M^3/h	56	56	74	2x2t/h	2 t/h
Heating content	kwh/M^3	28.18	28.18	28.18	4.89	9.88
Water cost	$Yuan/M^3$	1.00	1.00	1.00	2.5Y/t	1.8
Specific water consumption	M^3/m^2	4.82	4.82	4.82	$72kg/m^2$	27
Specific water fee	$Yuan/m^2$	4.82	4.82	4.82	18	48.6
2 Electricity						
Consumption	kwh/m^2	5.81	5.81	5.81	2.81	0.83
Cost	Yuan/kwh	0.60	0.60	0.60	0.60	0.60
specific fee	$Yuan/m^2$	3.49	3.49	3.49	1.69	0.50
3 Labour						
Workers	Persons	4	4	4	12	6
Cost	Yuan/p.year	10,000	10,000	10,000	10,000	10,000
specific fee	$Yuan/m^2$	2.09	1.76	0.91	5.29	2.65
4 Total operating expense	$Yuan/m^2$	10.4	10.07	9.22	25.00	51.75
5 Total heating expense	$Yuan/m^2$	14.25	13.80	12.64	35.09	72.45



$1KZN_1$~$2KZN_{12}$-Electrical control panel with control system
KTZ,GKTZ- Control operation board
KTT,GKTT- Computer terminal desk

Figure 2. Framework of the computer electrical control system

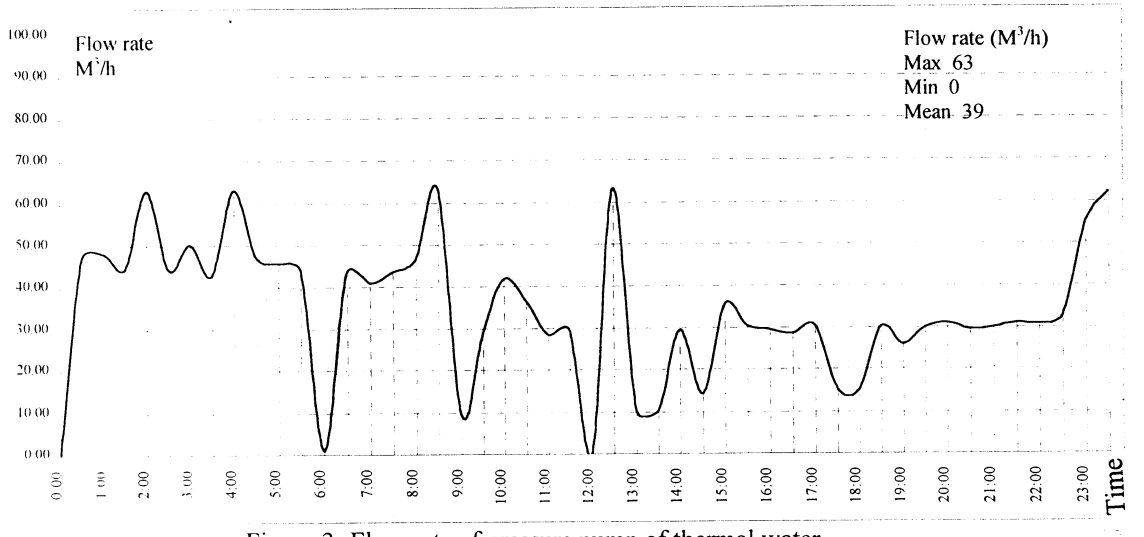


Figure 3. Flow rate of pressure pump of thermal water