Proceedings World Geothermal Congress 2000
Kyushu - Tohoku, Japan, May 28 - June 10, 2000

ENGINEERING AND TECHNOLOGY FOR DIRECT UTILIZATION OF LOW ENTHALPY GEOTHERMAL ENERGY

Ren Guo Qing [1] and Wang heng zhou [2]
[1]Tianjin Environmental Protection Geothermal Center of China
[2]Tianjin Environmental Protection Geothermal Center of China

Keyword direct heating system

Abstract

Directly utilization of low temperature geothermal enthalpy energy has been carried out in 24 space heating projects with other comprehensive utilization. Main technology includes : new type welll head installation, automatic control system both for surface space heating system and downhole measurements, corrosion control technology, air-conditioning system etc. Compare with the indirect utilization system , directly system can safe producing geothermal water 23%, economize on electricity 26% ,improve utilizable heat energy 20%, cut down manager 33%, increase temperature of supply hot water of 4-5 ℃ , increase temperature inside of the room of 2℃, reduce drain off temperature of 10℃.Directly utilization of low enthalpy geothermal energy has received good environmental and economical benefit.

1.Developing Geothermic Direct-supply Technique to Promote Geothermal Utilization Cause

Supported by related departments of Tianjin government, we had a project of tackling the key problem of geothermic heating supply system. Experiments were began in 1994, and the first automatic geothermec direct-supply heating station was built in the same year. During the 30th international geologic conference in August 1996, experts from all of the countries came to visit the station. Up to now, this technique is applied in Hebei , Tianjin, Liaonin and Shanxi provinces.

1.1 The plan of our work approach:

1.1.1 To utilize geothermal energy in terraced way. To adopt new techniques, reducing energy wastage.

1.1.2 To take geothermie water amount with reason, automatic monitoring the amount of water taken.

1.1.3 Geothermic utilization goes with the environment protection. Getting thermic pollution controlled, lowering down the temperature of geothermal water letting.

1.2 In 5 years' practice, we had the following attempts:

1.1.3 Geothermic water above 60 ℃ ,were considered in priority to supply heating. Backwater was controlled lower. 40-50 ℃ geothermal water were mainly used in physical therapy and bathing. Geothermic water with 25 ℃ were used in body fit programs.

1.1.4 Geothermal water about 60 ℃, with great flux and poor water quality, were used in direct heating supply. Reducing heat energy loses, lowering the speed of erosion.

1.1.5 Geothermic heating combined with boiler, taking full advantage of geothermal water with second heating, to expend the heating supplies area. Investment was cut down, and efficiency promoted.

Currently there are two modes in geothermic heating supply:

One is direct heating supply. To pump geothemic water from the well and supply to each user and then the backwater were let. This mode of heating supply is easy to operate, needs less investment; and heat energy utility rate is high; but the geothermal water may cause severe erosion to the pipes and equipment. The HD anti-erosion reagent we developed and put in usage is the key technique to solve this problem.

The other is indirect heating supply. After pumping geothermic water from the well, send them to the heat changer, and by circulate pump sending the heated water to users' radiators, and let out the geothermal water after heat changer. With this mode of heating supply, the erosion of the pipes and equipment by the geothermic water can be avoided, but the investment is comparably great; heating efficiency is lower, and a lot of resources wastage occurred.

We use geothermal water to supply heat from 1990. The well depth 3323.09 m, the wel head temperature is 84 ℃, the water flux 120 m^3/H. The water from this well supplies our heating system, as well as the systems of other units, such as city library, archives bureau, law office, etc and other living water supply. From 1990 to 1993 , with the indirect heating supply method, supplies 70,000 m^2 , nearly saturated. In 1994 , the direct heating supply technique is used, heating area reached 100,000 m^2 ,

2.The geothermic auto monitoring direct heating technique

The geothermal auto monitoring direct heating technique was developed on the basis of heating supply experience of Tianjin area. This research was listed the key project of the earth sedimentation control plan of Tianjin government, and was named the model project by Tianjin Construction Committee.

Geothermic auto monitoring direct heating technique was consisted 5 parts:

2.1 Getting water

The frequency conversion velometer (Made in Japan) and heat-resistant under water pump (Made in China) were used as water getting equipment. The characteristics are

2.1.1 Electricity saving. By using frequency conversion velometer, lower down the electricity consuming.

2.1.2 Hz change zone , to fit the needs of heating supply in the area with temperature variation from -21℃ to +21℃,

getting geothermal water, according to weather variation.

2.2 Well head instolation

The characteristics of the multi-function well-mouth apparatus are:

2.2.1 Airproof. Preventing the spillage of geothermic water, and preventing the air coming. Improved in the outlook and the quality.

2.2.2 Adding new function of auto monitoring water level apparatus. Easy to know the dynamic level of geothermal water.

2.3 Water treatment

In 5 years, after indoor and field tests, we developed DH—I type, DH—II type water quality anti-erosion reagent to applied in the geothermic heating supply units, with satisfaction of users. The feature is:
2.3.1 Simple equipment. Only two remedy storage vats and measuring plunger pumps are needed. Easy to operate.
2.3.2 Remarkable anti-erosion results. The erosion rate of the geothermal water from the well to cementite is 0.745 mm /year; with the anti-erosion reagent added, the erosion rate is only 0.044—0.02 mm/year, much lower than the required national standard.

2.4 Heating supply

The circulation equipment will be needed whether the boiler heating supply or geothermic heating supply is used. The difference is:

2.4.1 A loop was added between supply vat and backwater vat. The water in backwater vat could fill the supply vat.

2.4.2 One of the main backwater pipes was directly connected to the supply vat.
We substitute the indirect heating supply to direct heating supply, and made a few variations to the circulation. The strongpoint is:
Fully utilize geothermal energy. The let water temperature of indirect heating supply was 50--55°C, that of direct heating supply is 38--40°C. Rational utilizes geothermic resources. The repetition rate of geothermal water reaches to 33.4%.

2.4.3 Promoted the heating supply quality.

2.5 Automatic monitoring

Automatic monitoring in the geothermic heating supply management was the first case in our country. Traditional PID control can hardly get the expected results. We use fuzzy control plan to control the entire system, 24-hour monitoring the key elements of pressure, flux, indoor and outdoor temperature, electricity current and voltage, etc.
The feature of automatic monitoring:

2.5.1 Hardware was easy to repair, with strong anti-interference capacity.

2.5.2 Developed the geothermal heating supply software to display, operate and control the system state, which can be used in the geothermic heating supply area.

2.5.3 Geothermal management department may connect the automatic monitoring system with the users of geothermic well, to manage the system scientifically.

3.Cost and Economic benefit of the direct utilization compare with the indirect utilization

Cost and Economic benefit of the direct utilization compare with the indirect utilization see **table 1, table 2, table 3.**

4.Conglution

To sum up, by using automatic monitoring direct heating supply technique, one-off investment is cut down, heating area is expended. Daily cost is low, with water saving, electricity saving and energy saving.
The geothermal utilization center of Tianjin Environment Protection Bureau has formed a social service mechanism to tackle all the issues relating to the geothermic utilization, such as design institute, anti-erosion reagent study institute, erosive geothermal water treatment institute and synthesize utilization of geothermic water counseling institute.
We would like to cooperate and communicate with people who are interested in the development of geothermal utilization technique both domestic and abroad to promote the development of geothermic utilization cause.

Table 1 Comparison of the Runing cost for two heating systemt(RMB)

Heating form Item	Auto-direct heating	Indirect heating	Notation
Water expenses	120000	156000	The total installed capacity for Indirect heating system is 79.5KW.
Expenses for Chemical agent	50000	20000	
Expenses for Water soften	/	40000	
Expenses for Electricity	52300	68800	
Expenses for Maintenance	20000	100000	
Expenses gor Drainage	44100	54500	
Salary and managmente	5700	9200	
	17500	76500	The total installed capacity for Auto direct heating system is 117.0.5KW.
Total	309600	471300	

Table 2 Initial Investment for different heating system(RMB)

Heating Form Item	Auto-direct heating system		Indirect system	
Pumping Room	$160m^2$	120000	$300m^2$	225000
Circulation Pumping Mashing	4	48000	4	48000
Down Hole Pumping	1	54000	1	54000
Mixing Tank	2	20000	1	30000
Frequency Convector	2	100000	/	
Heat Exchanger	/		4	829000
Water Tank	/		4	8800
Replenishing Water Tank	/		1	1000
Expanding Water Tank	/		1	1000
Electric Cupboard	7	60000	7	60000
Microcomputer Auto Controlling System	1	350000	1	350000
Total		822000		1273000

Table 3 Energy benefit compare between Auto-control Direct-heating systemthe and indirect heating system

Heating Form Item	Auto-control Direct-heating system		Indirect-heating system	
	amount	unit	amount	unit
Expanding of Geothermal water	200,000	T	260,000	T
Expanding of Tap water	0.00	T	4200	T
Expanding Electricity	16.97	Kw	22.94	Kw
Supply water temperature	50-60	℃	50-54	℃
Indoor temperature	18-20	℃	16-18	℃
Drain water temperature	38-41	℃	50-60	℃
Heating area	95000	M	75000	M
Heating effect	70.0	%	56.00	%
Supply water pressure	0.29~0.32	Mpa	0.56/0.58	Mpa
Working stuff	2	Person/shift	3	Person/shift