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Analysis on the effect of networked central heating of middle-deep geothermal wells in Weishi

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ABSTRACT

The middle-deep geothermal system is receiving extensive attention due to its high efficiency and stable system operation. Select the networked geothermal heating project in Weishi as the research object. This project has been integrated and networked existing geothermal wells in the district since 2018. After the standardized network transformation, the networked geothermal heating system has complete heating for approximately 2,000,000 m2 and meet the heating needs of 60,000 people. In this paper, 10 networked retrofit projects have been selected for energy consumption analysis for three stable heating seasons, in which the system COP of each project can reach 4.8~5.8. By comparing the economics of Weishi's networked heating project with other conventional clean energy heating projects, it is confirmed that the networked mid-deep geothermal system has good sustainable development potential and promotion value in the future.

1. INTRODUCTION

Geothermal energy is a kind of green, low-carbon and recyclable clean energy, featuring large reserves, wide distribution, clean environmental protection, stability and reliability[1-4]. China is very rich in geothermal resources[5-9], and the heating market has huge potential. The 13th Five-Year Plan for the Development and Utilization of Geothermal Energy[2] specifies that during the 13th Five-Year Plan period, China will increase the geothermal heating area by 11×108m2. By 2015, the geothermal energy heating area in China is only 3.92×108m2, among which shallow geothermal energy heating is mainly developed by ground source heat pump [10-11], and the geothermal energy heating in middle and deep water has not yet formed a scale.

Weishi County is 40.77 kilometers long from north to south and 43.76 kilometers wide from east to west, with a total area of about 1307.7 square kilometers. It has a warm temperate semi-humid monsoon climate with distinct four seasons. The average annual temperature is 14.1℃. The annual average frost-free period is 215 days, and the annual average precipitation is 692.3 mm. The average annual sunshine is 2481.9 hours.

Taikang bulge is a broad and gentle complex anticline spreading NW, superimposed with NW trending short-axis fold, and cut by NW trending, NE trending and NE trending faults (see Figure 1). This area received Marine, Marine and continental transitional facies and continental basin sediments from Paleozoic to Triassic, and the strata were widely denuded at the end of Triassic bulge.

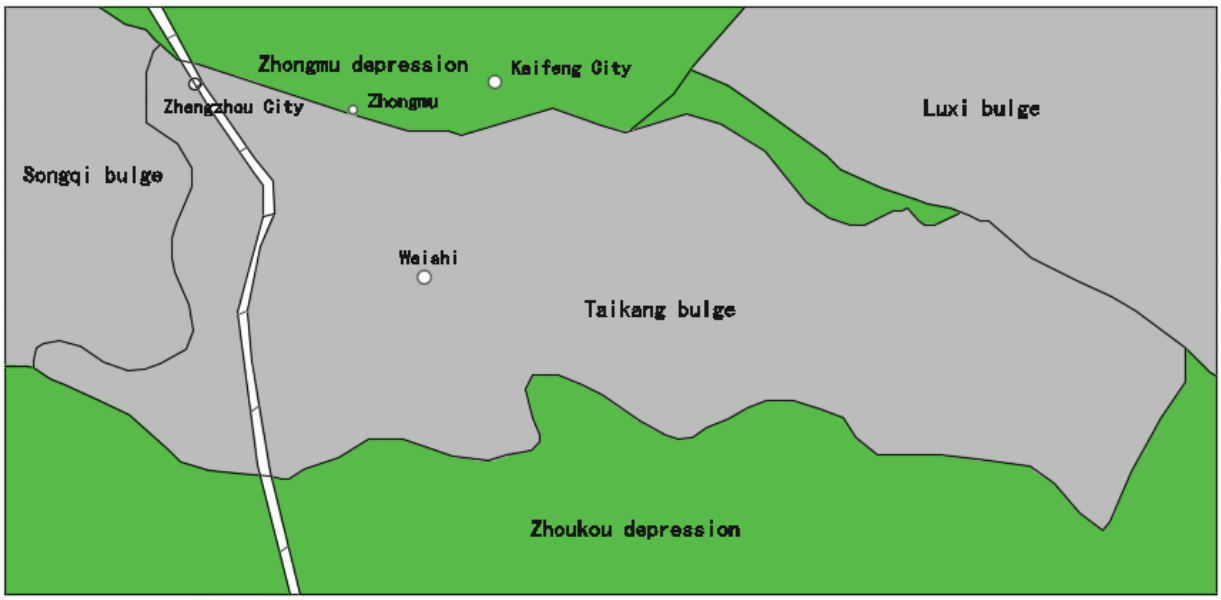


Figure1 Regional topographic map

Neogene strata in this area are the main water storage layer that is exploited at present. Covered by Quaternary system, Neogene strata are distributed in the whole area and developed well. They are found in gullies in the western mountainous area and on both sides of Zhengzhou Xinmi Road. Neogene strata can be divided into two groups from old to new.

2 ANALYSIS OF REGIONAL GEOTHERMAL WATER RESOURCES

According to the main geological conditions that control the formation and distribution of geothermal resources, there are three types of geothermal systems: volcanic-magmatic type, deep fault circulation type (convection type) and sedimentary basin type (conduction type). The deep geothermal is a sedimentary basin type, and the Ordovician - Cambrian soluble fissure thermal reservoir is widely concealed in the lower part of the eastern plain. The thermal reservoir is mainly in the middle of Ordovician and the middle and Upper of Cambrian. The lithology is mainly limestone, dolomitic limestone, dolomite and so on. The thickness of the reservoir is 70 ~ 860m. The buried depth of the roof in the bulge area is generally less than 2000m, which is suitable for mining. The buried depth of roof in concave (fault) depression area is generally greater than 3500 ~ 4000m, which makes mining difficult. The development degree of heat storage gap weakens with the increase of depth, and the water temperature, water quality and water quantity in different structural locations have great differences. Due to the absence of Paleogene and Mesozoic, the pore type thermal reservoirs of Neogene Guantao Formation are widely distributed in the basement Ordovician and Cambrian strata. The deep hot water rising along the fault and fracture concentrates at the bottom of Neogene with short runoff, and the heat source condition is better. Therefore, the Guantao formation in this area is a set of good thermal reservoirs.

In order to better understand geothermal resources and solve the heating problem in Weishi County, before the transformation of connected geothermal Wells in Weishi County, field survey was conducted on geothermal Wells in Weishi County, and parameters of a hot spring well in the transformation area of Weishi County were selected as reference. At the same time, in the initial stage of reconstruction, the recharge well in the selected area was selected for the recharge test. Natural recharge was adopted, and the initial recharge volume was about 40m3/h.

A hot spring well in Weishi County, used for bathing water, was completed in January 2014, with a first-level diameter reduction of 273mm and a second-level diameter reduction of 159mm. The measured moving water level is 108m and the well depth is 1100m. After consulting, it can be known that the peak temperature of the well after continuous pumping is about 51℃, the water inflow is 50t/h, the head is 145m, and the pump power is 38kW. Measured stable water temperature 44.6℃, geothermal well specific parameters

According to the survey data, pumping test and recharge test, the parameters of the networked transformation geothermal well are determined. The depth of geothermal well is 1300m, the outlet temperature is 50℃, and the outlet water quantity is 80m3/h. The recharge volume of a single well is 40m3/h, and the ratio of pumping and filling well is 1:2.

3 GENERAL SITUATION OF DISTRICT HEATING BEFORE NETWORK RENOVATION

The actual survey data and data query of the research team before the network renovation of the project clearly concluded that there was a large heating demand in the central urban area of Weishi County, Kaifeng, but there was no central heating. Some public buildings and residents used gas wall mounted furnaces and self-built small gas boilers to meet the heating demand in winter. Some buildings use geothermal, air source heat pump, split air conditioning for winter heating, while some buildings have no heating measures. Recently, the total area of heating buildings in Weishi County is 2.254 million m2, and many residential districts use distributed heating mode, which has low heating efficiency. Some districts have no heating, poor comfort in winter. Weishi County has an urgent need for central heating in winter.

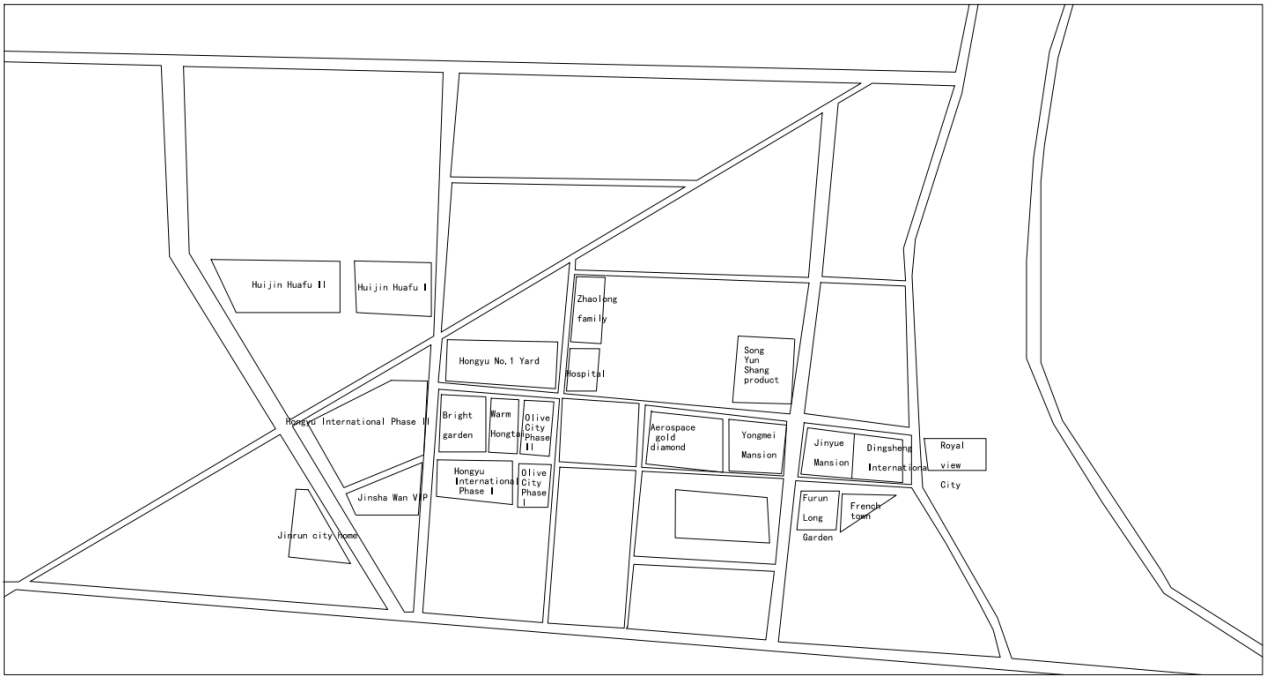


Figure 2 Project distribution map of the reconstruction area

Table 1. Statistical table of heating methods in Weishi County before renovation

sequence number	Community name	Total construction area (10,000 square meters)	Heating mode
1	Hongyu No.1 Yard	11	NO
2	Huijin Huafu I	13	geothermal
3	Huijin Huafu II	16.9	NO
4	Hongyu International Phase I	11	geothermal
5	Hongyu International Phase II	20	boiler
6	Bright garden	7	geothermal
7	Warm Hongtai	7.5	geothermal
8	Olive City Phase I	7	geothermal
9	Olive City Phase II	7	geothermal
10	Rehabilitation center	2	geothermal
11	Zhaolong family	5	NO
12	Jinrun city home	13	geothermal
13	Jinsha Wan VIP	9	geothermal
14	Build Xinghong County	23	geothermal
15	Jinyue Mansion	8	geothermal
16	Song Yun Shang product	8	NO
17	Dingsheng International	10	boiler
18	Yongmei Mansion	15	NO
19	Furun Long Garden	7	NO
20	Royal view City	6	NO
21	Aerospace gold diamond	12	NO
22	French town	7	NO

Based on the comprehensive analysis of the heat supply demand in the central urban area and the survey results of heat supply methods, as a whole, the current heating problems in Weishi County are as follows:

(1) There is a serious shortage of central heating and heat sources

From the perspective of heat load development, with the urban construction and development of the central urban area of Weishi County, it is basically impossible to build high-pollution facilities such as large coal-fired boilers within the region, and only the distributed small system cannot meet all regional heating needs. Weishi County has a serious shortage of heating and heat sources, which can not meet the needs of urban buildings.

(2) The heating system has low energy efficiency, serious pollution and is not sustainable

In the scope of transformation, distributed small system heating is adopted, mainly for small boilers and distributed gas wall-mounted furnaces, as well as the traditional distributed heating system with low energy efficiency, large pollutant emission and high operation cost. The proportion of clean energy in heating is low.

(3) Poor heating safety

The distributed heat source operates independently, and the heat supply security is poor. With the large increase of gas heating, gas boiler or wall mounted furnace independent heating, not only cause high heating cost, but also the surge of gas supply and peak valley difference, at the same time, the security of gas supply seriously affects the safety of heating.

4 REGIONAL NETWORKING SYSTEM AND COP ANALYSIS

4.1 Regional networking system

According to the preliminary investigation and field investigation, the central district heating in Weishi County is reformed to meet the building heating demand of 2.2540 million m2, and the exploitation of geothermal resources by mining and irrigation equalization technology is a way to "take heat without water". In the same layer mining and irrigation equalization technology, heat value extraction of underground hot water is carried out and then re-injected into the same heat storage system as mining heat storage. In this process, groundwater is used repeatedly in the continuous cycle as the carrier of geothermal energy. The use of the same level mining and irrigation equalization technology can ensure the balance and stability of the groundwater system, maintain the pressure and water quantity in the mining well, and is conducive to the long-term sustainable and stable development of geothermal resources. Moreover, 33 geothermal Wells are set in the medium-deep geothermal system, including 11 heat extraction Wells and 22 recharge Wells.

The system provides networked central heating for 33 deep geothermal Wells through large pipe network, realizing the flexible allocation of regional heat source Wells and recharge Wells, which has reached the maximum utilization of geothermal resources. The network distribution is shown in the figure3.

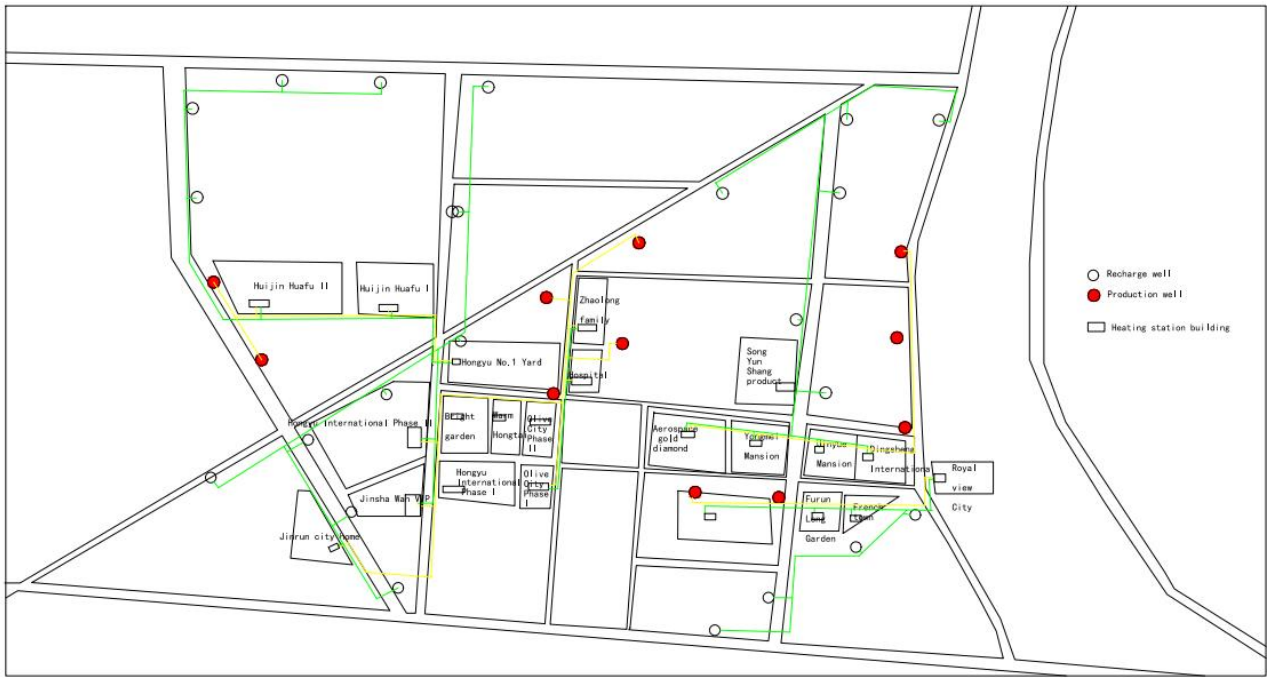


Figure 3 Regional well location pipe network distribution

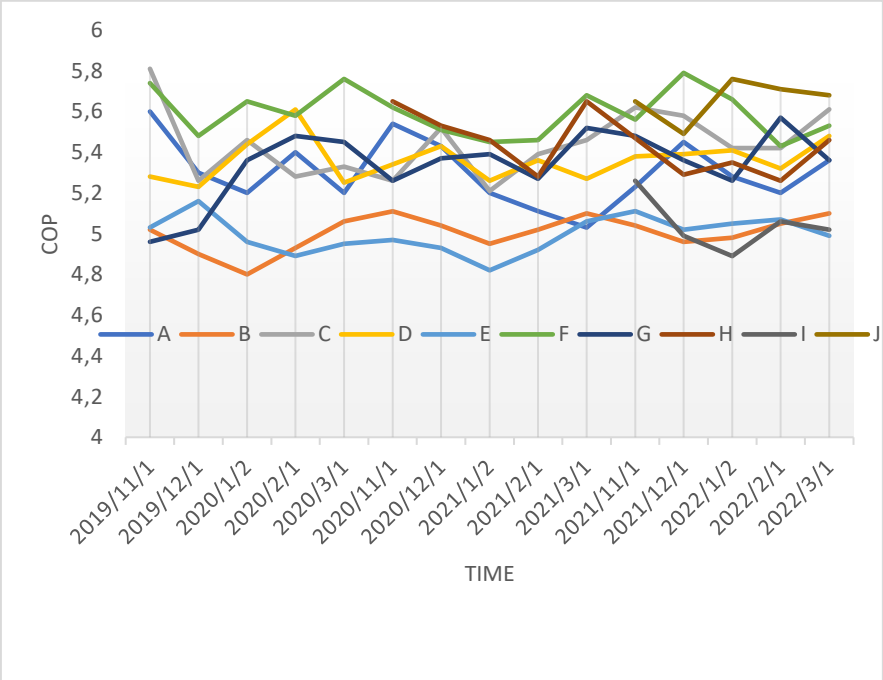
4.2 Cop analysis of networked heating system

Combined with the actual progress of the project renovation, this paper selected 10 residential districts with heating for data analysis, among which 3 residential districts with stable heating season were 7. Stable heating 2 heating season district 2; Stable heating 1 heating season district 1. Through the information acquisition system of the intelligent heating system platform, the data of the monthly average comprehensive cop of the heating system in 10 heating districts are collected, and the data content is shown in the following table2.

Tab2 Monthly cop of each heating community

	2019 /11	2019 /12	2020 /1	2020 /2	2020 /3	2020 /11	2020 /12	2021 /1	2021 /2	2021 /3	2021 /11	2021 /12	2022 /1	2022 /2	2022 /3
A	5.6	5.3	5.2	5.4	5.2	5.54	5.43	5.2	5.11	5.03	5.23	5.45	5.28	5.20	5.36
B	5.02	4.9	4.8	4.93	5.06	5.11	5.04	4.95	5.02	5.10	5.04	4.96	4.98	5.05	5.10
C	5.81	5.26	5.46	5.28	5.33	5.26	5.52	5.21	5.39	5.46	5.62	5.58	5.42	5.42	5.61
D	5.28	5.23	5.44	5.61	5.25	5.34	5.43	5.26	5.36	5.27	5.38	5.39	5.41	5.32	5.48
E	5.03	5.16	4.96	4.89	4.95	4.97	4.93	4.82	4.92	5.06	5.11	5.02	5.05	5.07	4.99
F	5.74	5.48	5.65	5.58	5.76	5.62	5.51	5.45	5.46	5.68	5.56	5.79	5.66	5.43	5.53
G	4.96	5.02	5.36	5.48	5.45	5.26	5.37	5.39	5.27	5.52	5.48	5.36	5.26	5.57	5.36
H						5.65	5.53	5.46	5.28	5.65	5.47	5.29	5.35	5.26	5.46
I											5.26	4.99	4.89	5.06	5.02
J											5.65	5.49	5.76	5.71	5.68

Area for the modification of the networking of 10 district heating cop of the system data is analyzed, and the line chart drawing, you can see from the data, connected to the Internet community transformation of the system in the range of 4.8 ~ 5.8, the cop and the comprehensive system cop fluctuation values were less than 0.5, the system cop to stabilize. It can be seen from this that the central heating system of medium and deep geothermal well network has obvious advantages of high efficiency and stability in operation.



5 COMPLIMENTARY CLOSE

In this paper, through the overview of the connected central heating project in Weishi County, the networking mode of the connected central heating well is described. The COP of each project system can reach 4.8~5.8, indicating high efficiency of the heating system equipment. The advantages of centralized installation, convenient maintenance and management, etc., confirm that the networked medium and deep geothermal system has good sustainable development potential, and has the value of popularization.

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