

Geothermal Development in Tianjin of CHINA

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ABSTRACT

In the early 1970's, Tianjin begin to exploration, research and develop for geothermal resource. Low- medium temperature geothermal resources were directly and comprehensively used as new energy in Tianjin of China since that time. It was utilized in space heating, agricultural greenhouse, aquiculture in winter, bathing and medical care etc.

During 1980's, lots of achievements were obtained because the state continued to offer great of funds for geothermal development. Since 1990's, the geothermal markets have been broadened and made great progresses with the rapid developing processes and growing need for geothermal resource in Tianjin of China. The total area of geothermal space heating has reached 12 million m² in 2008.

The geothermal development had been playing an important role in Tianjin's economical development. Tianjin city and Binhai new district have been the biggest areas that use geothermal for heating. Three thermal spring resort areas have been set up where are locate in the main geothermal fields.

1. INTRODUCTION

Hot springs have been used for bathing and washing for thousands years in China. And it is at the top of countries in direct using of geothermal energy. The growth rate of geothermal utilization in China is more than 10% per year during the last few decades. Particularly in North of China, low-medium temperature geothermal resources are rich and widely used for space heating, bathing, agriculture and aquaculture. We have a great increasing in recent years to fit with the need of modern market economy in Tianjin. By the Year 2007, there are total 314 geothermal wells in Tianjin. Hot water production is $25,838 \times 10^3$ m³. About $12,000 \times 10^3$ m² areas are used geothermal for space heating. There are 100×10^3 families use geothermal hot water in daily life. The geothermal utilization have been served in economical development in Tianjin.

2. GEOTHERMAL EXPLORATION

The exploration of geothermal resources in Tianjin started in early 1970'. Under the guidance of Prof. Li Siguang, a geothermal investigation campaign was launched, and 10 geothermal anomalies were delineated in an area of 8700 km² to the south of Tianjin (figure 1). Aided by the former Ministry of Geology and Minerals Resources invested 80 million yuan RMB for geothermal exploration in 1980's, including large-scale investigation and exploration on Wanglanzhuang, Shanlingzhi, geothermal fields.

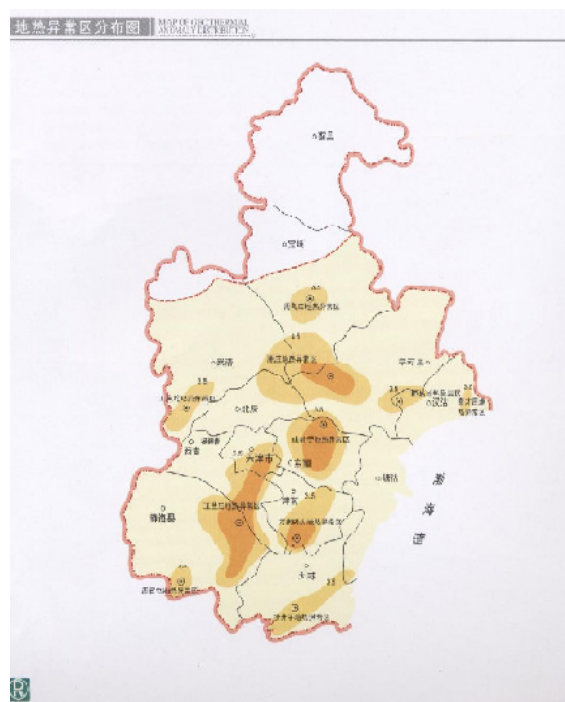


Figure 1: Geothermal Anomalies

In 1990's, geothermal exploration and evaluation were carried out in Wuqing and Binhai where is the coastal area. After the year 2000 Zhouliangzhuang, Panzhuang, Wanjiamatou, , and Jinghai geothermal field have been explored (Table 1).

Table 1: Geothermal fields

Geothermal field	Area (km ²)	Geothermal gradient (°/100m)
Wanglanzhuang	534	8.0
Shanlingzi	315	8.3
Wanjiamatou	235	8.8
Panzhuang	610	6.9
Zhouliangzhuang	180	5.5
Binhai	2000	3.0
Jinghai	190	4.5

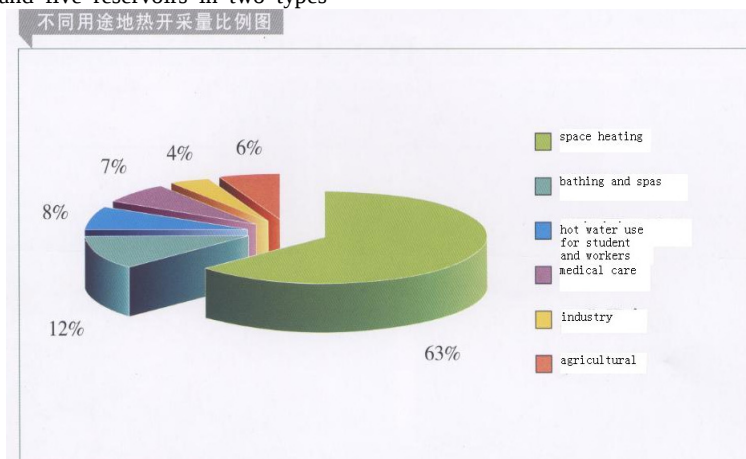
At present, there are seven geothermal fields whose reserves have been proven up by national reserve administration department (Table 2).

Table 2: Geothermal resources reserves ($10^3\text{m}^3/\text{a}$)

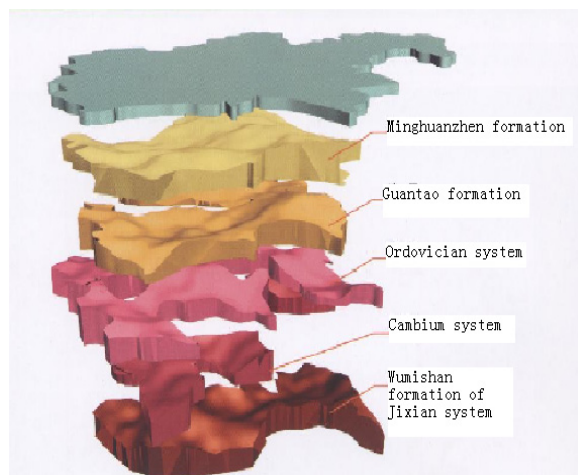
Geothermal field resource reserves		WIZ	SIZ	BH
Tertiary	Total reserves	15210	6010	10440
	Reserves class	B	C	B+C
	Minghuazhen	9887	3907	6786
	Guantao	5323	2103	3654
Bedrock	Total reserves	6260	11780	-
	Reserves class	B	C+D	-
	Ordovician system	1815	3416	-
	Hanwu system	63	118	-
	Jixian system	4382	8246	-
Geothermal field resource reserves		WQ	WJMT	PZ
Tertiary	Total reserves	1180	730	3100
	Reserves class	C+D	C+D	C+D
	Minghuazhen	767	730	3100
	Guantao	413	-	-
Bedrock	Total reserves	-	2100	-
	Reserves class	-	-	-
	Ordovician system	-	-	-
	Hanwu system	-	-	-
	Jixian system	-	2100	-

3.GEOTHERMAL RESERVOIRS

The geothermal fields in Tianjin belong to the low-medium temperature geothermal resource. The unique characteristics is regional distribution as resource. The main geothermal field is in the urban and the surrounding areas. The other geothermal fields are distributed out side of the city. They are buried at the depth of 1000m-4000m with good economic features and five reservoirs in two types

**Figure 3: Geothermal Utilization in Tianjin**

vertically (figure 2). One is sandstone porous geothermal reservoir in Tertiary system including Minghuazhen and Guantao formation. The other is lamarstone fracture reservoir in the bedrock including Ordovician system, Cambium system and Wumishan formation of Jixian system. It is can be developed and used on the space heating in winter, agricultural greenhouse, aquiculture, bathing and medical care etc. The hot water is of good quality and medium temperature, maximum temperature of hot water is 103°C. The single well discharge ranges from 102-150 m^3/h , maximum is 340 m^3/h . The geothermal resource is about 60 million m^3/a .

**Figure 2: Geothermal reservoirs in Tianjin**

4.GEOTHERMAL UTILAZATION AND ECONOMIC DEVELOPMENT

Geothermal resources utilization is according to the geothermal characteristics and the demand for geothermal energy. The geothermal resources are mainly used for space heating, living water greenhouse, aquiculture and bathing etc. the geothermal utilization made good economical, social and environmental benefit.

The geothermal resources of exploration and development had been playing an important role in many cases for Tianjin's economical development, such as in attracting investment, improving environment quality and the living level of people, expanding tourism resources and developing industrial and agricultural productions (Figure 3).

Tianjin is the first city that use geothermal for space heating. Wanglanzhuang geothermal field is located there, which is the first exploration geothermal field in Tianjin in 1980's. There are 4 geothermal reservoirs in Wanglanzhuang geothermal field: Minghuanzhen sandstone porous geothermal reservoir in Tertiary system and lamerstone fracture reservoirs in the bedrock including Ordovician system, Cambium system and Wumishan formation of Jixian system. The reserves that can be developed are 21.47 million m^3/a . Geothermal energy is widely used for space heating, and the heating area has reached 12 million m^2 . It is taking the first place in geothermal heating in China. According to "report of the present state of geothermal resources development and utilization in China" by China Geological Investigation Bureau, that geothermal space heating area in Tianjin are more than half of that in China. For domestic use, hot water has been provided to households. More than 10 million peoples of worker and students use hot water for bathing. Total area of hot spring swimming pool has reached 20000 m^2 . A multiple purpose utilization pattern has been formed in Tianjin.

Tuanbo New Town is at south of Tianjin. It is at south part of Wanglanzhuang geothermal field. It is 16 km from Tianjin. The total programming area is 210 km^2 . The population will be 600 thousands. It will be built up a comprehensive the ecosystem live district, recreation holiday spend, business meeting exhibition center, education training center etc. high quality of internationalization ecosystem New Town.

Tangu is the center of Binhai district where is the national economic development area. Binhai geothermal field were exploration in 1990's. The amount of hot water that can be developed is 10 million m^3/a . The geothermal reservoirs are in Tertiary system including Minghuanzhen and Guantao formation. Water temperature is 46-78 $^{\circ}\text{C}$, the quality of the water is good for use. The production of single well is 50-160 cubic meters per hour. There are 35 geothermal wells have been drilled for production in there since 1980's. The production of geothermal water is more than 5 million m^3/a . Most of the geothermal energy is used for space heating, which the area has reached 1 million m^2 . About 180 office buildings, schools, and kindergartens have been using geothermal water in daily life. 18000 families, 120,000 residents are using geothermal water for bathing. In 1993, we got 3 millium USD loan from NIB&NDF for developing geothermal energy in Tangu. TGREC setup in 1996, the aim is to study of geothermal energy and utilization.



Figure 4: Tangu geothermal experiment center

The Wanke Crystal Town is located between urban area and Binhai district in Tianjin. It covers an area of 85.51 km^2 , which is one of the top eight traveling areas and seven natural protection districts in Tianjin. It is in Sanlingzi geothermal field which it have been exploration in 1990's. There are five geothermal reservoirs in vertically (Figure 2): sandstone porous geothermal reservoir in Tertiary system including Minghuanzhen and Guantao formation and lamerstone fracture reservoir in the bedrock including Ordovician system, Cambium system and Wumishan formation of Jixian system. Total storage reserves is 57.3 billion m^3 . The total geothermal energy is 3.58×10^{15} J. The amount of geothermal resource that can be developed is 17.79 million m^3/a . Geothermal water is used for space heating, swimming, bathing and spas. The space heating area will reach 4 million m^2 . The largest hot spring resort in Asia-- Dongli Lake Hot Spring Resort and Wanke Crystal Town have been set up.

Jingjin City is located in Zhouliangzhuang geothermal field where is 100 km southeast of Beijing and 70 km north of Tianjin. Four geothermal wells have been drilled for the exploration of geothermal from 2003 to 2007. It is a low-midmedium temperature geothermal field. There are also five geothermal reservoirs. The storage of geothermal water is 8.6 billion cubic meters. The capacity is 154.59 MW. The amount of geothermal resources that can be developed is 7.38 million cubic meters per year. The temperature of the Wumishan formation of Jixian system reservoir is more than 100 $^{\circ}\text{C}$. The pressure of the reservoir is 0.4 Mpa. The maximum discharge is 340 m^3/h . The quality of hot water is better than that in other geothermal field. The chemical type of hot water are $\text{HCO}_3\text{-Na}$, $\text{HCO}_3\text{ SO}_4\text{ Cl-Na}$, total solid are 1~ 1.2 g/L.

The fluid quality is better, which is rich contain mineral for the human body beneficial. The total investment for the City is reach to 20 billion RMB. Total building area more than 6 million square meters, gather with small houses buildings, hotel and business city.



Figure 5: Jinjing Geothermal Resort

CONCLUSION

- Low -medium temperature geothermal resources are directly and comprehensively used as new energy in Tianjin
- The geothermal utilization have played an important role in economical development in Tianjin.
- Binhai New District is a national economic development area.

Three thermal spring resort areas have been set up :

- Wanke Crystal Town and The Dongle Lake Hot Spring Resort area are located Shanlingzi geothermal field.
- Jingjin City have been set up because Zhouliangzhuang geothermal field development.
- Tuanbo New Town will be a high quality of internationalization ecosystem New Town.

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