



MANAGEMENT OF GEOTHERMAL RESOURCES IN TIANJIN

Wang Kun

Tianjin Bureau of Land, Resources and Real Estate Management

84 Qufu Road

Tianjin 300042

CHINA

kun1302@sina.com

ABSTRACT

The geothermal resources in Tianjin are classified as typical low-medium geothermal resources in a sedimentary basin. As a clean energy, the geothermal resource is widely used for space heating, potable water and agriculture etc. This paper gives a brief introduction to the related laws, policies and processes concerning geothermal resources, exploration and development in Tianjin. The main contents of the Plan for Geothermal Development and Utilization in Tianjin are reviewed from the point of view of sustainable development, integrated use, reinjection etc. The related encouraging policies of the application of reinjection and integrated technologies, and some examples are amply discussed here.

1. INTRODUCTION

1.1 The Laws and Technical Standards in China Related to Mineral and Geothermal Resources

The main laws and statutes related to the exploration, development and reinjection of mineral resources or geothermal resources are listed here.

1. Mineral Resources Law of The People's Republic Of China (Order No. 74 of the President of People's Republic of China)
2. Rules of Implementation of the Mineral Resources Law (Decree No.152 of State Council of People's Republic of China)
3. Regulation For Registering To Explore For Mineral Resources Using The Block System (Decree No.240 of State Council of People's Republic of China);
4. Regulations For Registering To Mine Mineral Resources (Decree No.241 of State Council of People's Republic of China)
5. Regulations For Transferring Exploration Rights and Mining Rights (Decree No.242 of State Council of People's Republic of China)
6. Regulations For Geological Data Management (Decree No.349 of State Council of People's Republic of China)
7. Provision For Collection and Management of Mineral Resources Compensation (Decree No.150,222 of State Council of People's Republic of China);
8. Others promulgated by related department.

The main technical standards and criterions are:

1. Standard for Drinking and Tap Water Quality (GB5749-2001);
2. Standard for Irrigation Farming Water Quality (GB5084-92);
3. Standard for Groundwater Quality (GB/T14848-93);
4. Standard for the Classification of Groundwater Resources (GB15218-94);
5. Demands For Modelling of Groundwater Resources Management (GB/T14497-93);
6. Geological Exploration Standard for Geothermal Resources (GB11615-89);
7. Appraisal Measures for Geothermal Resources (DZ40-85)
8. Others

1.2 Main Contents

It is prescribed in Mineral Resources Law of the People's Republic of China that:

1. Mineral resources shall be owned by the State. The State's ownership of mineral resources shall be exercised by the State Council.
2. Anyone who wishes to explore or mine mineral resources shall apply for and obtain upon approval, in accordance with law, the respective exploration and mining rights, and shall carry out the registration procedures
3. The department in charge of geology and mineral resources under the State Council shall be responsible for supervising and administering the exploration and mining of mineral resources throughout the country. The department in charge of geology and mineral resources under the people's governments of the provinces, autonomous regions and municipalities directly under the central government shall be in charge of supervising and administering the exploration and mining of mineral resources within their respective administrative areas.
4. The State shall adopt the system so that exploration and mining rights are to be obtained with compensation.
5. Anyone who mines mineral resources must pay resource tax and mineral resource compensation of relevant provision of the State.

All the above prescriptions can be summarized so: at first, the mineral resources shall be owned by the State; secondly, the State implements the rights of the ownership, utilization and management of mineral resources, through the system of registration for mineral exploration, examining and approving mineral mining, obtaining exploration and mining rights with compensation. Thirdly, the State Council has licensed to the department in charge of geology and mineral resources under the State Council the practice of unified management of mineral resources assigned to the whole country.

2. LAWS AND SYSTEM OF GEOTHERMAL MANAGEMENT IN TIANJIN

2.1 Provision of Geothermal Management in Tianjin

In order to strengthen the geothermal management, Tianjin Municipality set up the special department of geothermal management in 1994. Based on the related state laws and technical standards, the Provision of Geothermal Resources Management in Tianjin was promulgated in 1995; the Regulation of Mineral Resources in Tianjin was enacted in 2001.

With regard to the exploration and development of mineral resources, the department of geothermal resource management shall practise the policy of unified planning, rational distribution, comprehensive exploration, rational mining and comprehensive utilization. Accordingly state and local laws and regulations, a series of effective process have been established, including: permission

for exploring and mining geothermal resources, examination and approval of the development plan and utilization proposal for geothermal resources, supervision of the drilling of geothermal wells, production evaluation of single geothermal wells, annual investigation of issues regarding rational development and utilization of geothermal resources, environmental protection and other obligations in accordance with law, etc.

2.1.1 Registering to Explore Geothermal Resources

Prior to exploring for mineral resources or drilling a geothermal well, each exploration or drilling project shall be examined, approved, registered, and licensed by the department in charge of geology and mineral resources under the people's government of Tianjin Municipality. It includes the following proceedings:

1. Application for exploration rights
2. Exploration-rights applicant shall pay a fee for the use of the exploration rights (hereafter referred to as the exploration fee) and a reimbursement fee for exploration rights.
3. Determination of the mineral resource areas for exploration with Block Registration System;
4. Period of validity for an exploration license is no more than 3 years
5. Obligations that exploration licensees should perform.

2.1.2 Registering to Mine Geothermal Resources

Similar to geothermal resource exploration, mining projects shall be examined, approved, registered, and licensed by the department in charge of geology and mineral resources under the people's government of Tianjin Municipality. It includes the following proceedings:

1. Application for mining rights;
2. Mining-rights applicant shall pay a mining fee and a reimbursement fee for mining rights;
3. Payment for geothermal resource compensation;
4. The length of time for a valid mining license shall be decided in accordance with the magnitude of the mining project, but shall be less than 30 years;
5. Obligations that mining concessioners should perform.

2.2 System of Supervision and Examination of Geothermal Production

The administrative department in charge of geology and mineral resources supervises and examines the geothermal production. The approving authority shall examine its application as to the limits of its mining area, mining design or plan for mining, production technique and safety and environmental protection measures, in accordance with law and relevant state provisions. The geothermal mining concessioners should adopt rational and scientific drilling techniques and production planning, to prevent overproduction and environmental pollution. Meanwhile, the water level, temperature, flow rate and quality of geothermal wells should be monitored.

3. PLAN FOR GEOTHERMAL DEVELOPMENT AND UTILIZATION IN TIANJIN

With the increased geothermal development and utilization, the enhancement of the sustainable potential and economy of geothermal resources is emphasized in geothermal management. A Plan of Geothermal Development and Utilization for 2006—2010 has been compiled and authorized by Tianjin Municipality.

3.1 Regional Division Methods

Each reservoir is divided into three planning sub-areas, depending on its recoverable reserves and monitoring data (water level, pressure etc.) for the last year. The three sub-areas are: restricted to productive zoning, permissible productive zoning, and geological survey zoning.

The restricted productive zoning usually is the geothermal field which has been producing for a long time and the annual production rate has approached or overrun the allowed recoverable reserves of the geothermal field. Its water level drawdown increases very quickly. In the allowable productive zoning, the annual production rate is less than the allowed recoverable reserves of the geothermal field. Its water level drawdown is slow. So the resource potential is still considerable. The geological survey zoning means that little geological exploration work has been carried out in the geothermal field before.

3.2 Objects of Planning

Several objects are involved in the Plan for Geothermal Development and Utilization for 2006-2010.

1. Through the application of heat pumps or other technology for saving energy, the temperature of waste water should be lowered to below 25°C in most of the geothermal utilities.
2. The annual reinjection rate will reach 6,000,000m³, which account for 30% of the total production.
3. Some old geothermal utilities which are of low efficiency and benefits should be rebuilt, especially in zones of relatively poor production
4. Set up automatic metering and monitoring systems by the end of 2010.
5. The government shall encourage scientific and technological research on the exploration and development of mineral resources, promote advanced technology and raise the scientific and technological level of geothermal exploration and development.

4. INCENTIVE POLICIES OF GEOTHERMAL REINJECTION AND COMPREHENSIVE USE

Reinjection studies were started in Tianjin in the 1980s. After a series of tests, reinjection into the basement reservoir is now approved and is a feasible way to maintain the reservoir's pressure and prevent heat and chemical pollution by waste water.

In 1996, the administrative department revised the permit process for mining geothermal resources. Space heating projects should involve reinjection- when mining enterprises develop geothermal energy in a basement reservoir. Furthermore, the government took some measures to promote the drilling of reinjection wells and rebuilding old geothermal utilities

Initially a 70% mineral resource compensation of the reinjection rate is exempt if a doublet system is used. The mining concessioners can also apply for protection projects to get governmental subsidy.

Now, there are about 38 doublet reinjection and production systems in Tianjin. The annual reinjection rate reaches 4,600,000 m³. Reinejction has become an important factor in geothermal management to ensure sustainable geothermal development.

5. ANALYSIS EXAMPLE

5.1 Demonstration Projects on Geothermal Reinjection and Cascade Utilization

The realty project of Haihe New World is located in the centre of the urban area in Tianjin. The building area is 235,000m². The geothermal energy is used for space heating and tap water for more than 1600 families in this residential area. There are three geothermal wells. Two of them (WR93D, WR94D) are reinjection and production doublet systems. Both are drilled into the dolomite carbonatite reservoir in Proterozoic strata. The third one (WR92) is in an Ordovician reservoir. The hydrological characteristics of three geothermal wells are listed in Table 1

TABLE1: The Characteristics of geothermal wells inthe Geothermal Utility Haihe New World.

Geothermal Well	Depth (m)	Wellhead Temp. (°C)	Flowrate (m ³ /h)	TDS (mg/L)	
WR92	1388.6	48.5	43.92	>4000	Production
WR93D	3248.89	81.5	84.02	1830	Production
WR94D	3168	82	106.48	1830	Reinjection

All buildings in the residential area are heated by floor heating during winter. After the heat exchange, the waste geothermal water is reinjected. Geothermal water takes a 4650 kW basic heat load, the residual peak load of 5600 kW is supplied by heat pumps during the coldest period.. The quantity of heat supplied by the Ordovician geothermal well is used for tap water. Figures 1 and 2 show the geothermal utility and its technical flow-chart.



FIGURE 1: The geothermal utility of the Haihe New World Residential Area

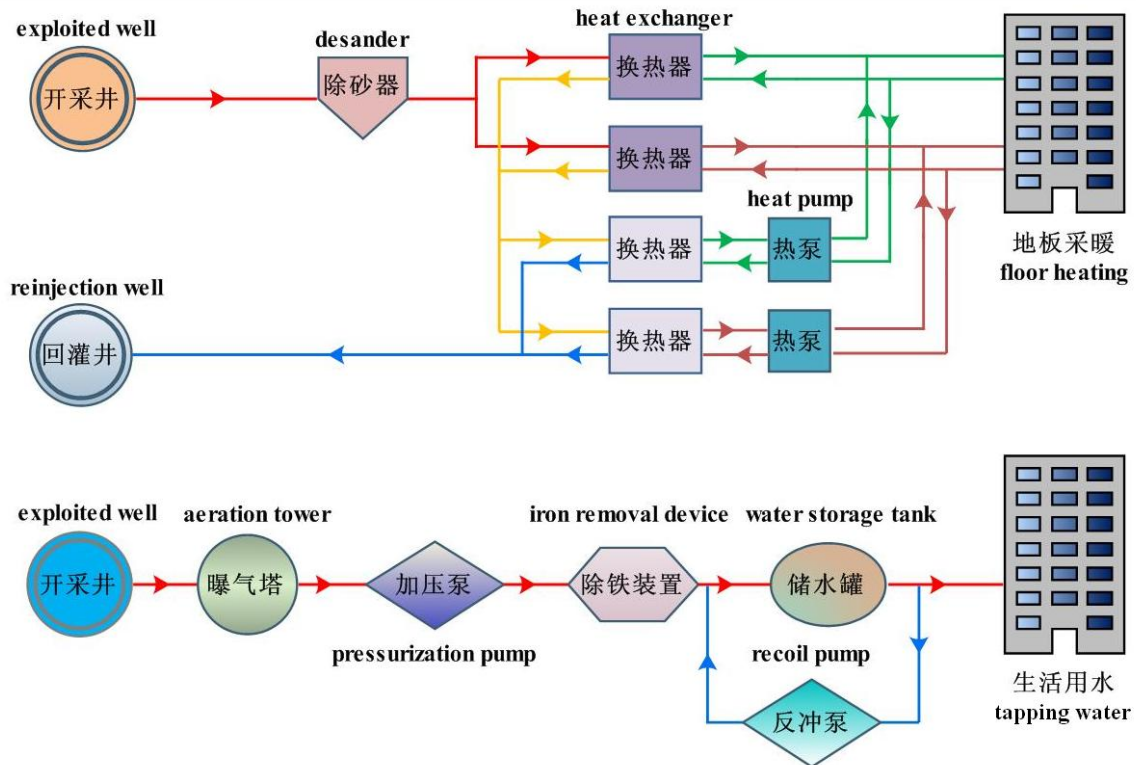


FIGURE 2: Flow-chart for the space heating system Haihe New World Residential Area

The initial investment in this geothermal station is about \$1350,000. The annual overall operational cost for space heating is about \$540,000, which is equal to \$2.3 per unit area of space heating. Compared with space heating by coal-fire boilers, the initial investment in a geothermal utility is more than \$280,000, but its running cost save about \$130,000 every year. Meanwhile, the geothermal use can reduce the discharge of sulfur dioxide, nitrogen oxide, carbon dioxide and coal dust.

As one of the projects of mineral resource protection, the Haihe New World geothermal projects got the financial support of \$340,000 from the Ministry of Finance in 2007.

5.2. Discussion

Since 1996 all the geothermal production from the basement reservoir is balanced by reinjection employing a doublet well system. Many singlet production wells drilled before 1996 are however still used for production. The geothermal waste water is discharged into the sewage system directly after heat exchange and is pumped from these wells. The large scale production has already resulted in a rapid drawdown of water level. It is necessary and urgent to construct additional reinjection wells for the early singlet production wells in order to prolong the useful-lifetime of these geothermal reservoirs.

But the drilling of additional reinjection wells has been hampered by lack of funds and space. The facilities and technology employed in the early geothermal utility are simple and crude. The construction cost of additional reinjection wells is high. Meanwhile, most production wells drilled before 1996 are located in the urban area and in many cases there is not enough space to drill a reinjection wells. Therefore, the administrative departments in charge of geothermal resources and space heating have put forward a plan for recombining early production wells into doublet systems of reinjection and production wells in 2006. This proved successful in the urban area. Through adjusting

the heating system, 3 adjacent production wells located in three different residential areas were combined. One of it is selected as a reinjection well; the others are production wells and supply the space heating for three residential areas.

6 CONCLUSIONS

The policies and regulations are effective measures to promote exploration, development, utilization and protection of geothermal resources and to ensure the present and long-term requirements of city construction in Tianjin. Some related policies of geothermal management will be implemented in the future.

Since 2006, a unified system in which the geothermal mining-rights shall be paid for by the mining concessioner with a geothermal mining fee has been in operation. The mining fee shall be collected according to the standard of \$1000RMB per geothermal well per year. Anyone who applies for geothermal mining-rights to mineral deposits already discovered by the State, at the State's expense, shall pay, in addition to the mining fee, a reimbursement fee for mining rights which have been appraised and confirmed. The detailed specifications for managing the use of the funds mentioned above will be formulated in the near future by the department in charge of geothermal resources jointly with the department in charge of finance under the City Municipality.

Monitoring is the basic work for exploration, potential evaluation, development and management of geothermal fields. The automatic metering and monitoring will be in full force by the end of 2010. The monitoring and research on reinjection should be strengthened in the future.

Reinjection should be an essential part of sustainable geothermal utilization. But reinjection into the sandstone reservoir of the Tertiary system is still a great technical problem in Tianjin. Jointly with the department in charge of finance and space heating, some policies will be established for encouraging the combination and optimization of early geothermal utilization systems. Therefore, the development of geothermal resources will be continued.

REFERENCE

Axelsson, G., 2003: *Essence of geothermal resource management*. Edited by Fridleifsson I.B. and Gunnarsson M. Lectures on the sustainable use and operating policy for geothermal resources--Short course prior to the International Conference IGC2003. United Nations University Geothermal Training Programme, p.249.

Rybach, L., 2003: *Sustainable use of geothermal resources: renewability aspects*. Edited by Fridleifsson I.B. and Gunnarsson M. Lectures on the sustainable use and operating policy for geothermal resources--Short course prior to the International Conference IGC2003. United Nations University Geothermal Training Programme. p. 249.

Song D., Wang K., Xu P. et al., 2007: *The annual of the Mineral Resources in Tianjin*, Tianjin Bureau of Land Resources and Housing Administrative. 43p.

Tao Q., Hu J., 2007: *Geothermal resources exploration, development and management in China*. Transaction of the workshop of Development and Protection of Geothermal Resources in China. p. 121-127.

Wang K., 2005: *The Sustainable Development and Utilization of Geothermal Resources in Tianjin, CHINA*, Proceedings World Geothermal Congress 2005.

Wang K., Han J., 2007: *Demonstration projects on geothermal reinjection and cascade utilization Tianjin*, Transaction of the Workshop of Development and Protection of Geothermal Resources in China. p.121-127.

Wang Kun, 2001: *Application of isotopic technique on establishing hydrothermal concept model*, Journal of Science in China, Dec. 2001, 4.