EXPERIENCE IN THE MANAGEMENT OF THE BEIJING GEOTHERMAL RESOURCES, CHINA

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SUMMARY - The management of the Beijing geothermal resources such as filing geothermal data, planning of water supplies, examining well drilling, developing relevant research, has been put into effect by the Administration of Geothermal Resources, Beijing, which was established in the Bureau of Geology and Mineral Resources, Beijing, as a department of the Beijing Municipal Government. The resources are protected under the new scientific management.

1. Introduction

There are three separate geothermal fields (Figure 1) that have been explored since the 1970s in Beijing. The largest one is the Beijing Urban Geothermal Field which covers about 120 km^2. It has two reservoirs, both being in Sinian silicious dolomites. The cap rock is mainly Tertiary and Quaternary and partially Jurassic, with a total thickness between 500 and 2500 m. There are now 67 wells in the field, and the temperatures are 39-70°C at the wellhead. The well depth is between 650 and 2600 m. Recent assessment (Zheng, 1991) of the geothermal resources indicates that the resource can be exploited at a rate of 8.9 M m^3/yr.

The second field is the Xiaotangshan Geothermal Field covering about 20 km^2, which has been explored since 1974. This field has surface manifestations (warm springs) which occur in an area of 0.6 km^2. Three geothermal reservoirs were found in carbonate-type rocks of Cambrium to Sinian age. The cap rock is Quaternary, mainly and partially Jurassic in the south with a total thickness between 60 and 1500 m. There are 36 wells in this field. Wellhead temperature is between 35 and 65°C, and well depth between 76 and 1186 m. The resource can be exploited at a rate of 5.2 Mm^3/yr as assessed in 1985.

The third field, the Lisui Geothermal Field, was not explored until the 1980s. Geothermal fluids are stored in a Sinian reservoir. The Quaternary cap rock is 300-400 m thick, and three wells have been drilled so far with depths of 450 to 510 m and temperatures of 42 to 54°C. Preliminary resources assessment shows that geothermal fluids can be produced at a rate of about 5 M m^3/yr over an area of 12 km^2.

As well as these three fields, further geothermal wells have been drilled in other areas, i.e. near warm springs or as the result of other exploration aims (see Figure 1). There are now 126 geothermal production wells in the greater Beijing area. More than 80% of the wells are now utilized, and total annual production of geothermal fluids is about 8.5 M m^3, reaching a maximum rate of 9.2 M m^3/yr in the past. This corresponds to savings of about 20,000 tons of standard coal per year.

Figure 1: Distribution map showing the geothermal resources of Beijing.

Geothermal wells have been used for space heating, bathing, medical treatment, aquaculture, greenhouse cultivation, mineral water bottling, industrial processes, and for monitoring and predicting earthquakes.

It was necessary to establish unified management of the Beijing geothermal resources encompassing so many geothermal wells and springs, and for such a high production rate.

2. Management of the Beijing Geothermal Resources

In the past, many low temperature production wells were decentralized, and wells were drilled by users themselves. Geothermal utilization was not unified, even for the same geothermal field. Some wells were drilled close to each other, causing significant interference. Hence, resources were not well developed for utilization resulting in a decrease in water level. In order to control and solve these problems, management of the Beijing geothermal resources was introduced in 1984.

2.1 Administration of Beijing's geothermal resources: Issue of Management Regulations

A resolution was passed at a Mayor's Working Meeting of the Beijing Municipal Government in September 1984. This called for: "Strengthening of exploration and development, research and management of the Beijing geothermal resources". According to this resolution, the Administration of Beijing's geothermal resources was established in the Bureau of Geology and Mineral Resources as a department of the Beijing Municipal Government. Provisional regulations for management were laid down in legislation, to be put into effect by the Municipal Government.

Later, detailed rules and regulations for enforcement were issued, which included rewards and penalties for saving and wasting geothermal fluids, respectively. Since that time, the Beijing geothermal resources have been brought under a unified management.

2.2 Geothermal exploration and filing: of basic; geothermal data

Geothermal exploration has been undertaken by the Beijing Corporation of Hydrogeology and Engineering Geology, which belongs to the Bureau of Geology and Mineral Resources in Beijing. The Administration of Geothermal Resources in Beijing is in fact one of the departments of the Bureau. Therefore, all geothermal and geological information, including exploration records, logging, testing and monitoring data of geothermal wells, exploration and production reports; and research reports and papers were collected and filed as basic files of the geothermal resource.

In addition, the status of well head equipment and pipelines, and the exact utilization objective for each well, were surveyed and filed at the same time. Specialized investigations and measurements were undertaken to assess utilization for geothermal space heating and bathing.

The collection of this information has laid the foundation for the management of all geothermal resources in the Beijing area.

2.3 Decisions on exploitation and planning of water supply

Since 1985, every user has been required to install a flowmeter for their production well. Users must manage their geothermal water quota as given by the Administration. The Administration assesses the total exploitable rate for a certain geothermal field, allowing for about 70% of the quantity as determined in a recent geothermal resources assessment report.

A compensation fee for geothermal water has been collected from users since 1986 and is assessed by flowmeter data and heat content (temperature range). Some indices of specific consumption for bathing and space heating were examined on the basis of specialized investigations. For example, 0.10 to 0.13 m^3 is allocated per person for bathing. On the basis of these indices, an annual quota is allocated to each geothermal user. The reward and penalty regulations were put into effect in July, 1991.

2.4 Licensing of production wells

In the past, geothermal wells could be drilled after a contract was signed between the user and a drilling team. Today, plans for well drilling have to be examined to get approval by the Administration of Geothermal Resources. The following points are considered:

* If new wells are approved, the exploitable rate for the field is not usually increased. A promised quota for the new well will have to be balanced by savings from other wells.
* New wells must be 500 to 1000 m away from other wells both in the Urban and the Xiao-tangshan geothermal fields.
* Scattered well sites outside the area with concentrated wells are recommended.
* A new well which is used in comprehensive utilization and involving reinjection or testing is given priority.
* Priority is also given for new wells if an existing well is being scrapped.

* The adjacent environment, especially scenic spots and historical sites, must be preserved.

2.5 Geothermal Users' Conference

A geothermal users' conference is held once or twice annually. Several things can be accomplished at these conferences:

* The general trend of changes of the geothermal reservoirs of the geothermal fields is presented to all users.
* Effects and experience in comprehensive utilization of geothermal fluids, saving of water and electricity costs, monitoring of the reservoirs and related aspects are discussed during the conference.
* The quotas of annual production rate for each well are distributed to each user.
* Sponsorship of certain tests and research pjects are discussed.

2.6 Financial support of applied science and technology projects

Although the users' fees are submitted to the municipal financial organisation, some portion of them is used to sponsor applied geothermal science and technology development projects. These projects include, for example, the speed modulation of motor controls when pumping. Better control can result in savings of 33% of the pumped water (including savings in electricity costs). Other projects include: scrubbing of hydrogen sulphide from geothermal water, better cultivation techniques in geothermal greenhouses, removal of iron content, and water purification.

3. Effects of Resource Management

The effects of the management of the Beijing geothermal resources have been noticeable during the past nine years.

3.1 Resolving previous confusion about drilling

Well drilling is now licensed. The examination of applications observes relevant principles. In recent years, 12 wells have been approved for drilling out of 32 applications. Since 3 licences covered re-drilling, and 2 were exploration wells for a new geothermal field, only 7 new production wells were added to the existing number of wells.

3.2 Comprehensive utilization and associated savings

If one compares the utilization for 1989 with that as it was practised in 1984, we find that the number of wells has increased by 24, space heating area increased by 8.4 x 10^4 m^2, 15 public bath houses and 4 sanatoriums were added, and the area of geothermal greenhouses increased by 1.7 x 10^4 m^2. However, the total annual production of geothermal water in 1989 was almost the same as that in 1984.

3.3 Protection of geothermal resources

The decrease in piezometric level (and hence reservoir pressure) has levelled off in recent years. For example, for the two reservoirs in the Wumishan and the Tieling Formation in the Beijing Urban Geothermal Field, the water level dropped in the past 5 years by 6.04 m and 6.08 m respectively, but 5 to 10 years ago the levels dropped by 15.69 m and 11.69 m respectively.

At present, although the annual production rate has increased by about 5% compared with that in the late 1980s, the change in piezometric level is far less, amounting to about –1 m/yr.

3.4 Scientific Research and Management

A simulation model to predict the relationship between production rate and water level was established for the Beijing Urban Geothermal Field in 1989 and has been used for management. The model has been used to predict the monthly water levels in the reservoirs for future exploitation. A modified model can predict water level changes with an error of 0.2 to 0.4 m. This model is also used for the Xiaotangshan geothermal field. Predicted water levels can be used to modify the plan of water abstraction.

4. Experience in the Management of the Beijing Geothermal Resources

Some cities, e.g. Tianjin (Xiong and Liu, 1992) Kunming (Ren, 1991), and Fuzhou have also established administrations for their geothermal resources. Our experience from the past 9 years can be summarized as follows:

4.1 Legislation and Management

Although the importance of the management of geothermal resources was recognized early by geothermal scientists and engineers, enforcement began with legislation. The Administration now manages production of geothermal waters according to the law. Users also consume geothermal water according to the law. The law provides a unified rule to solve previous problems.

4.2 Strict enforcement of leeislation

Geothermal management involves looking after the interests of the Administration and of the user. It is necessary to deal impartially with all

complicated situations. A municipal geothermal group has been established, headed by a vice mayor, who stands above the Administration of geothermal resources of Beijing. This group attends meetings involving major decisions and has solved some complex problems.

4.3 Initiative of the Users

By involving the users when organizing the Users' Conference, the Administration directs users to utilise the resources fully and to protect the available resources. The user's initiative is therefore brought into full play.

4.4 Promotion of production by science and technology

Mr Deng Xiaoping said: "Science and technology are the first productive forces." Science and technology must face economic realities. The development and protection of geothermal resources depend on science and technology. Users' fees have been returned in part to fund other geothermal research projects; this funding, in turn, led to improvements in utilisation. The level of geothermal utilisation and scientific development is constantly increasing.

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