GEOTHERMAL POWER IN TIBET TODAY AND YESTERDAY

Wu Fangzhi

Electric Power Scientific Research Institute,
Beijing, 100085, P. R. China

ABSTRACT

Most of the geothermal fields, especially the high temperature geothermal fields in China, are mainly Located at the western part of the country. Since 1970s, the exploitation and exploration work has been well carried out such as the Yangbajian geothermal power plant. With the development of local economy and people's life, more and more geothermal power is to be developed to overcome the energy lack in the area.

Key words: geothermal, Tibet, power plant

1. The development of Yangbajian field

It can be traced back to 1975 that geothermal fluid was first utilized for producing electric power in Tibetan Autonomous Region. With the invitation of Tibetan Government Water Conservancy,' the Electric Power Department sent a group of water power and geothermal experts to Tibet for comprehensive investigation on various kinds of power resource. Working jointly with the experimental group of Tibetan Industrial Bureau and the physical survey team of Geological .Bureau, the experts investigated Yangbajian geothermal field and its nearby area in terms of geological, physical and chemical survey, as well as shallow hole gauging. The most important work was that they have measured .the quantity of natural thermal flux and also estimated the generating capacity. The Water Conservancy and Electric Power Department formally proposed in their report to the government to exploit the Yangbajian geothermal field included in the national development plans. The most pressing task at that moment was to overcome scientific difficulties for Yangbajian is the first high temperature liquid-dominated field to be exploited with 30 MW-50 MW prospect capacity.

At the end of 1975, the State Planning Committee called the concerning departments together to discuss the arrangement and set up an adjustable group for Yangbajian geothermal resource. The Water Conservancy and the Electric Power Administration were appointed to be the group leaders. They put into action all the works related to exploration of geothermal wells or experimental machines. In June 1976, the Administration and China Academic Institute held the second-stage meeting of the First National Geothermal Electricity Generation in Tibet. With full discussion, they made some decisions of setting up the Yangbajian geothermal power plant. They implemented construction and study task of production well and also decided to reform the 2.5 MW steam turbogenerator used in Sichuan Neijing Power Plant for Yangbajian No.1 geothermal turbogenerator of 1 MW electric power.

From 1976 to 1977, the Tibetan Geothermal Geological Organization started the drilling of well ZK315, while the power plant sections were reformed for installation and debugging. On September 13, 1977, the geothermal turbogenerator succeeded in operating and generated electric power on October 1 in the same year. During the experimental operation, the biggest technical difficulty was CaCO, scaling. After two-day operation, the power decreased, so the staff had to stop to clean CaCO, in the well. At that time, only one well provided the turbogenerator with steam, therefore, the turbogenerator operated discontinuously.

Tibetan Autonomous Industrial Bureau required the adjustable group to send people for solving the problem of turbogenerator discontinuous operating in 1978. Five experts arrived at the site in October, 1978 and the empty well-cleaning mechanic equipment succeeded in experiment. Without closing the production well, the equipment could constantly clean up the CaCO, scaling and test the old turbogenerator at the same time, which would eliminate the drawback of vibration with dynamic balance. Since then, the generating unit has been working continuously and ensures the electricity supply for production and people's life, as well as provides many experimental data.

On the basis of the operating success of turbogenerator, the State Planning Committee approved to build a 2x3 MW geothermal power plant in Yangbajian in 1978. The generating units were self-designed and manufactured. Qingdao Steam Turbogenerator Factory provided steam turbogenerator using double flash system of higher thermal efficiency and Jinan Shengtian Electric Generator Factory provided

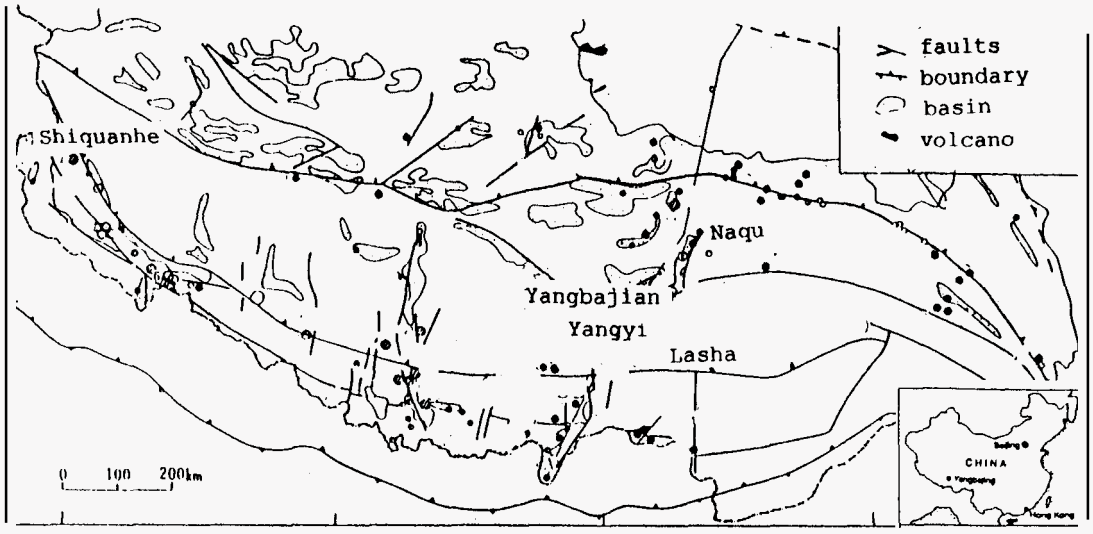

Figure 1. The geothermal fields distribution in Tibet

electric generator. The measurement was taken to keep the electric generator and other electric apparatus from corona discharge. Because under the high voltage, the low air pressure in the location will cause corona discharge. The first 3 MW geothermal generating unit started operating in November 1981, ,meanwhile, 110 KV cable was set up in November 1982. By the end of 1984, the electricity output of the two 3 MW generating units had been 40 million KWh, which did great contribution to enhance the development of national economy and improvement of people life in Tibet. Since then geothermal generating went on the stage of electric power course in Tibet.

The third 3 MW geothermal generating unit started to operate in 1985. In 1986, the packaged 3.18 MW geothermal generating unit imported from Japan and American ran successfully. The installed capacity increased 2x3 MW at the end of 1989 and another 2x3 MW in 1991. The total installed capacity of making use of shallow geothermal resource reached 25 MW, which is proved to be a piece of splendid pearl on the world ridge. The electricity output history of Yangbajian geothermal power plant is shown in the table 1.

By the end of 1993, Yangbajian geothermal power plants had generated 63395.99x10⁴ KWh electricity. Except the 12% house service electricity 7607.52x10⁴ KWh, the net generation was 55788.47x10⁴ KWh. If every KWh brings about one yuan (RMB) economic effect, the total one would be 557.88 million yuan (RMB). According to the present oil price, the saved oil will worth about 500 million RMB.

2. Other geothermal fields in Tibet

In Tibet, besides Yangbajian, Naqu and Ailishiquanhe geothermal fields are also used to generate electricity. With the help of United Nations, Naqu 1 MW double cycling geothermal demonstration power plant whose apparatus are from ORMAT Cooperation, started to operate on November 11, 1993. The main machine is working well. Since then there is a formal geothermal demonstration power plant in Naqu whose altitude is over 4500 M. Shiquanhe geothermal field was once equipped with geothermal generating unit in 1980s. But it did not operate properly because of the unsteadiness of the production well. On the base of experts' improvements, it will have a bright future if the wells are rearranged and well adjusted.

It was necessary to point out Yangyi geothermal field which locates in the south-west of Yangbajian, where the shallow resource exploration was finished and a formal report has been referred to the state. The big differences among Yangyi and other exploiting geothermal fields in Tibet are that: (1) shallow reservoir, in well ZK208, the temperature reaches 207.16°C at 325 m depth. It saves the cost of production well. (2) good water quality. The thermal water contains many kinds of non-condensable gas. Comparatively low content of CO_2 causes a little scaling. From September 18, 1990 to October 26, the group wells' test blowout lasted 896 hours. The temperature, pressure and flow measured at the well head had few changes, which is second to none of the exploited thermal fields in Tibet. (3) high level thermal exploration field. According to the information provided by Tibetan Geothermal Geological Organization, big gradient of water level may gather 1045 t/h(200°C) steam and water. A 30 MW power plant has been qualified to be built in this high temperature solid rock-fissure geothermal field. The author considered that Yangyi geothermal field should be brought into line with the developing plan as soon as possible.

Among the exploited geothermal fields, the geothermal fluid is utilized for producing electric power while the thermal water is also widely used in heating, greenhouse,

Table 1 The electricity output history of Yangbajian field

Period (year)	MW	Electricity output KWhx10⁴	Period (year)	MW	Electricity output KWhx10⁴
1971	1	4.94	1986	13.18	4954.98
1988		83.15	1987		4373.52
1979		247.84	1988		4268.90
1980		314.52	1989	19.18	4766.55
1981	4	163.59	1990		6059.58
1982	7	1123.97	1991	25.18	8659.56
1983		2936.6	1992		8607.32
1984		3398.43	1993		9800.00
1985	10	3633.44			
			Total		63395.99

bathing, etc.. For instance, Yangbajian geothermal field provides the stuff and Tibetan markets with greenhouse vegetables. In term of this, it has sizable economic and social effects.

3. Further geothermal exploitation

On the basis of experts' advice, the Yangbajian field was suitable to add more generating units after the installed capacity of shallow geothermal resource reached 25 MW in 1991. The state in charge departments and Tibetan Autonomous Government took up deep reservoir exploration. They overcame the difficulty of lack of cash and allocated much fund to deep-drilled well. At last, the ZK4002 well was fulfilled in November 1993. The well depth is 2006 M and the temperature at its bottom is 329.8°C. According to the original blowout parameters, generating capacity of single well is estimated to be over 10 MW. The accuracy depends on the measurement when putting in pipes and flushing. The great achievement which provides our 10 MW geothermal generating unit with dependable resource make the Tibetan geothermal developing course go on a new stage. Basically the estimated generating capacity will reach 50 MW-80 MW in the year of 2000. In the 2010 year, it will be 100 MW-150 MW.

4. Conclusions and discussions

Summing up the experience of exploiting Tibetan geothermal resource in the past twenty years, the author would like to point out some views to arouse geothermal researchers' attention in these fields:

(1) The working quantity and time are 1imited since the exploited geothermal resource are non-renewable. The weakening of surface heat manifestation and the decreasing of water level are observed in any exploited geothermal fields in the world. In this case, if the working quantity of geothermal fluid is not be controlled, the subsidence and the decline of generating capacity will turn out. It is because of the quality loss of geothermal fluid. For example, at the beginning of 1992, water level in the north part of Yangbajian field decreased and steam sent out from the weak link of overburden between the turbogenerator room and sensual cabinet leading to partial subsidence. At last it was overcome by controlling the working quantity, pouring into cold water and reinforcing stratum. Tt shows that the scale of shallow geothermal resource exploration should be firmly controlled, especially when the recharge conditions are still not clear.

(2) With condition permission, big diameter pipes in geothermal production well are much better than small ones. Gasification accompanies come up and cause two-phase flow. The smaller diameter of pipes often encounter big resistance and have effect on the single-well output. Tn Yangbajian, under the same situation, compared well 13.375" to well 9.625", the output of 13.375" geothermal well is as twice high as that of the 9.625" one, so is in Naqu. If 13.315" pipes are put into 300 m depth, the single-well output will easily reach 300 t/h. The big diameter pipe brings convenience for putting in the pipe.

(3) To strengthen the inspecti·on. It is important to keep on detecting the relevant parameters because the inspection in geothermal field is concerning with the evaluation of its past and future.

(4) To make a comprehensive utilization. In order to enlarge further effect, while people are in good charge of electricity generating and providing, they also should put forward a step exploration of comprehensive utilization. Breeding, tourism, medical treatment and industry utilization should be widely developed in Tibet in future.

(5) To enhance further international cooperation and academic interchange. In the past decade, we have accepted free aid from United Nations and Italian Government, also imported new technology from United States, Japan, New Zealand and Iceland. We should pay more attention to the experience of Philippines, Indonesia and other developing countries in Asia-Pacific area for how to

quickly exploit geothermal resource.

(6) To keep on overcoming the critical scientific difficulties. (a) Anti-scaling, scale eliminating and anti-corrosion. In the exploited geothermal fields, $CaCO_3$ scaling in production well is very serious, among which Naqu is the most serious one. To make good use of time to do the experiments of putting high temperature pump down and anti-crustator into wells so as to assure the generating unit's safe operation. The Naqu field succeed down hole pump in geothermal well in 1993. (b) To make steady reinjection. It is necessary to reinject the discharge thermal water on account of preventing from environmental pollution, earth subsidence and lengthen the longevity of geothermal field. This work is now carrying out in the Yangbajian field. If the experience is obtained, it will be used in other geothermal fields. (c) To use the technology of drilling inclined well step by step. The fault angles in Yangbajian and Yangyi fields are quite steep (about 90°). It is difficult to reach the passage if just to construct a vertical well. In addition, high temperature geothermal resource often lies beneath mountain, which makes it a trouble to carry drilling machine and other concerning facilities. Therefore, the problem of high temperature directional drilling should be put on the agenda to promote the project together.

(7) The in charge departments should draw up the favorable policies as soon as possible to speed up exploration of geothermal resource.

As known to us all, it is not easy to develop new energy resource for it will cost a lot of money and also a risk to drill geothermal well. Therefore, preferential policy should be carried out in terms of investigation and favorable policies to promote the development of new energy resource. In a word, with twenty year difficulties overcoming, Tibetan geothermal utilization has already got a great achievement. We are confident that it will be more developed in the future.

Reference

1. Wu Fangzhi, The Urgency and Immediate Significance of Constructing A 1 MW Geothermal Demonstration Power Plant in Naqu, Xizang(Tibet), Proceedings of the 12th New Zealand Geothermal Workshop 1990.
2. Wu Fangzhi, Tong Wei,etc., Research on The Yangbajian Geothermal Power Station, Publishing House chongqing Branch for Scientific and Technical Document 1985.