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GEOTHERMAL POWER STATIONS IN CHINA

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ABSTRACT

This paper describes the status and development of geothermal energy power generation in China. The basic characteristics of seven experimental geothermal power stations in China are listed and a sketch of the thermal system principles of the 3 MWe geothermal machine in the Yangbajing (Tibet) geothermal field are given. At the end, the recent development and future use of geothermal resources in China are pointed out.

INTRODUCTION

Geothermal energy, a new energy source, has opened up a broad prospect for man, and it will be one of the important energy sources indispensable for him. It is estimated that the geothermal reserve in all geothermal abnormal zones within 5000 m from the earth's surface is 1.45×10^{26}J, which is equivalent to 5×10^{15} tons of standard coal. Geothermal energy is a natural resource with a large potential (Lü and Wei, 1983).

GEOTHERMAL RESOURCES IN CHINA

Our land is situated amidst the well known Circum-Pacific geothermal zone and Mediterranean-Himalayas geothermal zone, and is relatively rich in geothermal resources. Six geothermal zones have been defined in China in terms of characteristics of the geothermal distribution. They are Xizang-Yunnan, Taiwan, the southeast coast, Tancheng-Lujiang, Sichuan-Yunnan north-south and the Qilian-Luliang arc-shaped zone (Xin and Zhang, 1982). Our country began exploiting and utilizing geothermal resources early. On the whole, however, exploration and exploitation are still in the investigation stage. Up till now we have only exploited liquid-dominant geothermal reservoirs; those of dry vapour have not yet been discovered. The highest temperature geothermal waters in China are those of Datong Mountain of Taibei, Taiwan province (293°C, 1510 m) and Yangbajing of Xizang (Tibet) (141 to 161°C, 82 to 457 m). Two thousand or more geothermal resources in some other areas are all of medium and low temperature. Nonelectric utilization or direct use of such resources has been carried out to different extents.

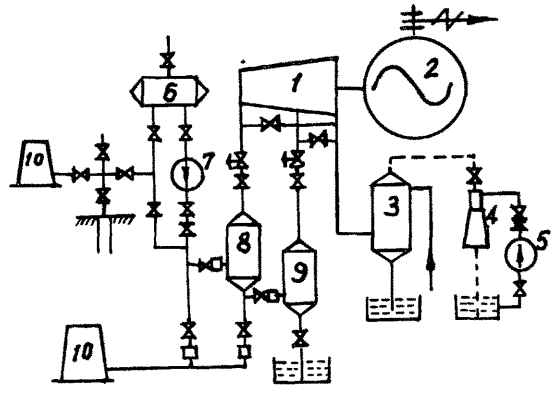

Figure 1. The thermodynamic system of the 3000 kW unit of Yangbajing pilot geothermal power station. 1-turbine, 2-generator, 3-condenser, 4-air ejector, 5-injection pump, 6-water tank, 7-hot water pump, 8-first stage flashing, 9-second stage flashing, 10-silencer.

GEOTHERMAL POWER STATIONS

Since the winter of 1970 when geothermal water of 91°C was used to produce electricity in Dengwu of Fengshun, Guangdong province, some of the pilot power stations with different temperatures and with different cycle systems have been set up. The installed capacity totalled 8586 kW (up to the end of 1983, excluding Taiwan). A survey of geothermal power stations of our country is shown in Table 1.

It is indicated in Table 1 that extensive research and practice have been conducted in the field of power generation using geothermal fluids of medium and low temperatures (systems, working substances, turbines, heat exchangers) in our country. A lot of achievements of science and technology have been made and a wealth of experience has been accumulated. The installed capacity of the pilot geothermal power station at Yangbajing, Xizang has reached 7000 kW. Since years ago, electricity has been transmitted to the region of Lasa, which is seriously lacking in conventional energy resources. Good results have been achieved. The power station is being extended presently, as another unit of 3000 kW has reached the worksite.

Table 1. A survey of pilot geothermal power stations in China*

Properties	Station & Location						
	Dengwu	Huailai	Wentang	Huitang	Xiongyue	Zhaoyuan	Yangbajing
	Fengshun Guangdong	Hebei	Yichun Jiangxi	Ningxiang Hunan	Yingkou Liaoning	Shandong	Xizang (Tibet)
Capacity, kW	86,200,300	200	50 50	300	100 100	200	1000 2x3000
Geo. temp., °C	91	85	66	92	75-84	90-92	140-160
Type of Cycle	Flash Flash Binary	Binary	Binary	Flash	Binary	Flash	Flashing System (Single)(Double)
Working Substance	i-Butane	C_2H_5Cl n-butane	C_2H_5Cl		F-11 n-butane		
Type of turbine	Axial-flow impluse	Multi-stage A-F.refitted	Single-stage Ax.Ra.	A-F impluse	Ax. Ra. impulse refitted	Ax.-flow	Multi-staged Axial-flow
Time of operation	Dec. 1970 Dec. 1982 Sept. 1977	Sept. 1971	Sept. 1971 1974	Oct. 1975	Sept. 1977 July 1982	1981	Sept. Nov.1981 1977 Nov.1982
Purpose and Assignment	Experiment & Research Power (electr.)	E & R Power (e)	E & R Power (e) Multi-staged using	E & R Power (e)	E & R Power (e) Multi-staged using	Experiment	E & R Power (e) Multi-stated utilization

*It is reported that a 2x1500 kW power station has been set up at the Qingshui geothermal field, Yilan, Taiwan province of China (Lee, 1982).

The thermodynamic system of this unit is shown in Figure 1. It is noticeable that it employs a two-stage expansion (flashing) and it produces 15 to 20 percent more electricity than that of a single-stage expansion. The Qingdao Steam Turbine Plant manufactured the D3-1.7/0.5 turbine. The entrance pressures of the first and second stage are respectively 1.7+0.5 ata and 0.5+0.05 ata, and the discharge pressure is 0.09 ata. Five production wells connected in parallel supply hot fluid for the turbine. Depths of these wells are between 82 and 457 m; temperatures in the geothermal reservoir at the bottom of these wells range from 141 to 161° C. Pressures at the wellheads are 3 to 4.6 ata. The dryness of the mixture of vapor and water issuing from the wells is somewhere around 6 percent. In winter, the output of Yangbajing power station is one third that of Lasa, playing an important role in easing the lack of electricity of this city (Wu and Liu, 1983).

The temperature of geothermal water at Wentang power station of Yichun, Jiangxi province, which adopts a binary cycle system with ethyl-chloride as the working substance, is the lowest one, only 66° C.

The temperature of water discharged by geothermal power stations is still comparatively high. In order to make full use of the geothermal energy, some power stations practice multistaged utilization. Taking the Xiongyue geothermal power station in Yingkou, Liaoning province as an example, the discharged water from the binary cycle is applied to district heating, greenhouse, aquatic cultivation and so on. The economic benefit of such multistaged utilization has been satisfactory (Lü and others, 1984).

Exchange of technologies and experiences in geothermal power generation is very active and comprehensive in China. The first symposium on generation was convened cooperately by the National Committee of Science and Ministry of Water Conservancy and Hydropower in Yichun, Jiangxi province in the summer of 1979. In March of 1982 the CSEE held the second national symposium in Liuzhou, and last July, the third one in Jiujiang.

SUMMARY

Exploitation and utilization of new resources of energy in our country are still at the stage of experiment, development and demonstration. To ensure the exploitation and utilization of geothermal energy, a high temperature geothermal zone (Xizang-Yunnan zone) and medium and low temperature zones (Beijing-Tianjin region and Fuzhou-Zhangzhou region) have been given priority and listed in the national plan. The former geothermal fluid is mainly used to produce electricity and the latter is mainly used for district heating and multistaged utilization. It is estimated that the utilization of geothermal energy will be equivalent to 5 million tons of standard coal up to the year 2000 (Gu, 1984). Geothermal power generating units will reach the level of 10 MW. Fundamental research work on hot dry rock and geopressured geothermal resources will soon be listed in the nation's seventh "five-year plan" of science and technology.

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