KALUGA TURBINE WORKS SC IN GEOTHERMAL POWER ENGINEERING OF RUSSIA

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ABSTRACT

Practically all the turbosets, supplied for the geothermal power plants in Russia (Pauzhetsky, South-Kuril on Kushashir island, Verkhne-Mutnovsky and Mutnovsky GeoPP), were manufactured by the Kaluga Turbine Works. When designing the geothermal turbosets, "KTW" O.J.S.C. has used its wide experience in producing and operating the wet-steam turbines. Scientific-and-technical solutions, introduced in the turboset design, have been presented. Some technical and financial problems with the geothermal projects have been indicated. To the date KTW SC has gained a wide experience in designing the geothermal turbosets (including those designed according to international standards) and is ready to supply 0.5…50 MW turbosets of any standard size for GeoPP.

1. INTRODUCTION

In the recent years there is the world tendency towards using the untraditional sources of electric power, and in the first place, using the geothermal steam energy.
Geothermal power plants (GeoPP) are one of the cheapest and the most reliable sources of electric power due to its independence from supply conditions and fuel prices.
Russia possesses rich geothermal deposits, with which connection it is very important that these deposits are located in the places, problem relative to electric power generation: Kamchatka, Sakhalin, Primorsky Territory, the Kuril islands.
The first in Russia Pauzhetsky GeoPP was put into operation in 1966 and, unfortunately, it had been being the only one before the early 90-th.
The "Geotherm" company became an initiator of the further development of geothermal power engineering in Russia.
KTW SC appeared to be a basic enterprise delivering power generating units for the "Geotherm" orders.

2. TURBOSETS OF KTW SC FOR GEOPP

The Kaluga Turbine Works (KTW) supplied the 2.5 MW turboset (being in operation in the present) for the Pauzhetsk GeoPP.
Appeal to the KTW was not random, since by that time one of the main problems of geothermal turbines – operation with wet steam – had been practically solved.
This problem consists in necessity of protecting the last stage working blades against erosion. The wide spread protection method is installation of special patch pieces, made of erosion resistant materials. To protect the blades against erosion the "KTW" uses the method, based on a fight not against the consequence but against the very cause of erosion, i. e. against highly

dispersed moisture. Applied for this purpose are the following methods of separating the moisture in a wet-steam turbine flow path:

- peripheral separation;
- root-channel separation, representing moisture draw-off through slots in hollow nozzle blades;
- "stage-separator" – the most effective way of moisture draw-off ("know-how" of KTW SC).

All these methods were theoretically substantiated and experimentally tested as a result of a large volume of scientific-and-research and development works, carried out in the 60-th by the "KTW" jointly with the Steam and Gas Turbines Department of the Moscow Power Engineering Institute. By the date, the KTW's wet-steam turbines, having been operated within over 100000 hours at a good condition of the last stage working blades, are still in operation.

2.1. Turbosets for Verkhne-Mutnovsky GeoPP (VMGeoPP)

A break-through in developing the Russian geothermal power engineering began from the moment of starting the "Geotherm" company's works on developing the experimental-industrial VMGeoPP of 3×4 MW capacity.

All the equipment of power generating units for the VMGeoPP was supplied by the KTW in compliance with the contract with the "Geotherm" company.

Designing the power generating units was based on the following principles new for GeoPP:

- Arranging the equipment as stand alone units, suitable both for being transported by all the modes of transport (even by plane) and for minimizing building and assembly works at the site;
- Using the natural overfall of height in highlands, what allows performing "barometric" condensate discharge (under atmospheric pressure) from the condensate vacuum zone into a hot well of an atmospheric type. This allowed departing from special (condensate) pumps and apply the only one type of pumps for the entire turbine generator unit;
- Applying the combined heat flow scheme providing for simultaneous operation of three power generating units with cooling, condensate collection and discharge and ecology protection systems common for the entire plant.

Specially noted should be the fact that the plant is equipped with the ecology-protecting device, representing a bubble column included into the heat flow scheme. The ecology protection system ensures dissolving of practically entire volume of escaping aggressive gases and its return to the pumping well, what excludes the atmosphere pollution.

The VMGeoPP was put in commission in 1999. Three-year term of operation proved correctness of the laid solutions and reliability of the equipment supplied by KTW SC.

Operation of the turboset also revealed some technical problems. One of them is exception of probability of the air condenser unfreezing under the Kamchatka conditions

2.2. Turbosets for Mutnovsky GeoPP

Successful and timely putting into operation of the Verkhne-Mutnovsky GeoPP promoted to get the European Bank of Reconstruction and Development to take part in financing the construction of the first turn of Mutnovsky GeoPP, what was initiated by the "Geotherm" company.

Contract for construction was placed with according to the results of the international tenders announced by the "Geotherm" company in 1999.

KTW SC as a member of the consortium "Technopromexport – Siemens", having offered a turboset with optimum parameters, won the tenders and secured an order for supplying two turbine-generator sets of 25 MW capacity each. A distinctive feature of the tender was condition of supplying the equipment, meeting the requirements of the international standards.

In compliance with the Contractual Obligations within 18 months the Kaluga Turbine Works developed the complete set of drawing for the turboset fundamentally new for it, manufactured the equipment for the Kamchatka project, what ensured erecting and putting the turbosets into operation in the specified period in 2001(see Fig. 1).

Figure 1. Erection of type К 25-0.6 Geo Turbine at the Mutnovsky GeoPP.

Applied in the turboset design were the technical solutions, new for KTW SC:

- Double-flow turbine;
- Heat exchanging equipment (condenser, ejector coolers) of mixing type, practically inapplicable in the Russian power engineering;
- Large dimension ejectors, designed for removal of large amount of non-condensing gases;
- Clad (double-layer) metals for equipment, operating under aggressive medium conditions;
- Washing system for the flow path and end packings with the turbine being in operation.

Participation in the Mutnovsky project revealed a problem, which may occur in cases when financing is improperly organized. Point is that the most of large dimension equipment (condensers, ejector coolers, turbine rotors, pipelines), contacting with aggressive medium, is made of expensive grades of stainless steel. As a result, cost of materials and complete articles makes up to 50…60% the cost of the equipment.

Since the materials and complete articles are purchased at the initial stage of the work, the rate percentage would make up not less than 40% the cost of the contract (but not 20% as it was in the Mutnovsky project).

3. CONCLUSION

Kaluga Turbine Works SC has gained the wide experience in designing, manufacturing, mounting and operating the turbosets for GeoPP, and at the present it is a leading enterprise in geothermal power engineering.

KTW SC possesses the technical potential for creating the geothermal turbines of 30…50 MW unit power and is ready to supply the turbosets of 0.5…50 MW capacity for geothermal power plants.