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Steam Turbines of the T-50/60-8.8, K-63-8.8, and Tp-100/110-8.8 Types Destined for Modernization of Thermal Power Plants with K-50-90 and K-100-90 Turbines

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Abstract—This paper describes the design, schemes of regulation, and control and protection of steam turbines of the T-50/60-8.8, K-63-8.8, and Tp-100/110-8.8 types destined for modernization of thermal power plants with replacement of K-50-90 and K-100-90 turbines that have very low efficiency and exhausted not only their designed, but also fleet life. The replacement proposed is based on state-of-the-art engineering solutions and will be carried out at concrete thermal power plants and CHP plants.

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As of today, more than half of the steam turbines installed at thermal power plants have reached their useful fleet life. An increase in operating time is accompanied by accumulation of structural damages caused by the processes of creep, thermal fatigue, as well as by degradation of the structure and properties of metal. Exhaustion of not only fleet, but also physical life with respect to high-temperature strength is a criterion used for replacement of an obsolete and worn-out turbine. In most cases the turbine operation beyond useful fleet life ranges from 40000 to 80000 hours, whereupon the turbine becomes fatal not only because of poor high-temperature strength and the physical state of the high-temperature section, but also because of the poor physical state of the low-temperature section of the turbine.

Specialists from the Ural Turbine Works (UTW) replaced old, obsolete, and worn-out turbines with new, modern ones having high technical-and-economic indices. For example, at the Vasileostrovskaya CHP plant, the R-50-90 turbine manufactured by the Leningrad Metal Works (LMW), which had already exhausted its useful life, was replaced by the cogeneration steam turbine of the T-50/60-8.8 type (Fig. 1), and, in doing so, structural components of the existing foundation were used. The turbine is a single-cylinder unit with single-stage network water heating. The flow section of the turbine consists of the two-row control stage and 17 pressure stages. The first 10 disks are forged integral with the rotor shaft, while the remaining ones are capped. The high-pressure section (HPS) has 16 stages, while the low-pressure section (LPS)—two stages. The length of the rotor blades of the final stage is 550 mm.

The turbine has nozzle steam distribution. Live steam is fed to the stop valve, and from there it goes through crossover pipes to the control valves of the HPS of the turbine. Four control valves are situated in steam chests welded onto the cylinder. The controlled heating steam extraction intended for network water heating is arranged downstream of stage 16, after which the diaphragm with the revolving ring is installed that governs steam passage into the LPS. At the Vasileostrovskaya CHP plant steam goes from the heating extraction line of the turbine into the main header. From the LPS steam enters into the surface condenser of the K-3100 type, the area of heat-exchange surface of which is 3100 m^2, and the flow rate of cooling water is up to 8000 m^3/h. The condenser is directly welded onto the exhaust branch of the turbine at its installation, and no steam receiver has been provided in its design.

The turbine is conjugated with the air-cooled generator of the TFP-60-2U3 type manufactured by the NPO ELSIB OAO.

The turbine unit arrangement involves longitudinal positioning of the turbine in the turbine hall, in the bay 33 × 24 m in size. The height of the foundation of the turbine unit (from the level of the floor of the condenser basement to the level of the turbine hall) is 8 m. For placement of the equipment, in combination with which the turbine should operate, pits are required.

In 2012 the UTW shipped the T-50/60-8.8 turbine to the Petropavlovsk CHP-2 plant (Kazakhstan). Specially for this plant, there was developed and manufactured the new horizontal network water heater of the PSG-1250-3-18 type, designed for the heightened pressure of network water (surplus pressure 1.8 MPa), with the area of the heat-exchange surface 1250 m^2 and network water flow rate of up to 3000 m^3/h.

Specialists from the UTW developed and shipped the K-63-8.8 turbine (Fig. 3) for the CHP plant in the town of Rudny, which is the condensing analog of the T-50/60-8.8 turbine.

In the flow section the control diaphragm of stage 17 is replaced by the common one due to the absence of heating steam extraction and turbine operation in the condensing modes only.