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The Cogeneration Steam Turbine of the T-63/76-8.8 Type for a Series of PGU-300 Combined Cycle Power Plants

A. Ye. Valamin[a], A. Yu. Kultyshev[a, b], V. N. Bilan[a], A. A. Goldberg[a], Yu. A. Sakhnin[a], M. V. Shekhter[a], H. C. Paneque Aguilera[a], M. Yu. Stepanov[a], T. L. Shibaev[a], and Ye. N. Polyaeva[a]

[a] *Ural Turbine Works, ul. Frontovykh Brigad 18, Yekaterinburg, 620017 Russia*

[b] *Ural Federal University, ul. Mira 19, Yekaterinburg, 620002 Russia*

Abstract—This paper describes in detail the design of the T-63/76-8.8 steam turbine manufactured by Ural Turbine Works (refurbished significantly), its electrohydraulic control and protection system made according to the current requirements on control and protection, the heat flow diagram, and arrangement of the turbine. The T-63/76-8.8 steam turbine is intended to be used in double-shaft double-circuit combined-cycle monoblocks at a number of thermal power plants currently under construction. The turbine has a great future, since it may be employed in various combinations with gas turbine units having the output of 150–170 MW that are manufactured by virtually all firms.

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The T-63/76-8.8 cogeneration steam turbine with two heating steam extraction points is intended for operating as part of a PGU-230 combined-cycle plant together with the GTE-160-4(7) gas turbine manufactured by the OAO Leningrad Metal Works (LMW) or the V94.2A gas turbine manufactured by Siemens, and the heat-recovery boiler manufactured by the OAO EMAlliance (Russia). The project of the combined-cycle plant has been developed for the Izhevsk CHP-1 plant, Vladimir CHP-2 plant, Novobogoslovsk CHP plant, and Kirovsk CHP-3 plant.

The T-63/76-8.8 turbine (Fig. 1) is a unit with one cylinder having the double-casing design and the loop scheme of steam motion. The inner casing of the turbine cylinder is cast, the outer one is welded.

The flow section of the turbine consists of 21 stages. In the inner casing of the cylinder 12 pressure stages are arranged.

The disks of stages 1–17 are forged integral with the rotor, while the disks of stages 18–21 are capped. The shroud seals of stages 1–12, the end seals, and the diaphragm seals of stages 1–16 have the honeycomb structure. The shroud seals of stages 13–16 have been made multi-edged because of considerable relative displacements of the rotor. For the same reason the diaphragm seals of stages 17–21 have been made direct-flow.

In order to eliminate oil leakages, advanced oil seals are installed.

The length of rotor blades of the final stage is 660 mm. The design and material of the disks and the blade system operating in the phase transition zone provide their reliability, preventing corrosion-fatigue, and corrosion-erosion cracking in the course of long-term usage, while maintaining steam quality upstream of the turbine.

The turbine has throttle steam distribution, and it will be operated under variable steam conditions. High-pressure steam is fed from the heat-recovery boiler to the stand-alone high-pressure valve unit (HPVU), in which one stop valve with an automatic gate and two control valves with their servomotors are arranged. The HPVU is partially unified with the valve unit of the T-113/145-12.4 turbine, intended for the combined-cycle facility of the Krasnodar CHP plant. The shell of the HPVU is welded–forged and consists of steam and distribution chests of the stop valve (SV); steam inlet branches, intermediate connections, steam chests of the control valves (CV), and steam outlet branches, are welded together. The SV is actuated by means of levers of the automatic gate. After passing through the SV, steam is split into two flows and enters through intermediate connections into the steam chests of the CVs and, further, into the valve channel of the CVs. The latter are actuated by servomotors. From the HPVU steam goes through four pipes (through two into the upper and through two into the lower half of the cylinder, which provides even distribution of steam over the circumference of the first pressure stage) into the inner casing of the cylinder. After passing the left-hand flow path, steam turns 180° and is directed through the intercasing space to the stages of the right-hand flow path.

The use of throttle steam distribution in the turbine made it necessary to study variants of the design of the steam admission unit in order to provide the uniform velocity field in both circumferential and axial directions at the first stage inlet. As a result of design optimization, geometry of the steam admission unit has