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The Longitudinal Layout Alternate Version of Cogeneration Steam Turbines with the Generator Placed on the Side of the High-Pressure Cylinder

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Abstract—The schematic design of a cogeneration steam turbine with the generator placed on the side of the high-pressure cylinder is proposed. It is shown that the use of this solution is most promising for turbines with a longitudinal layout (like a T-175/210-12.8 turbine).

Keywords: cogeneration turbine, low-pressure cylinder (LPC), high-pressure cylinder (HPC), steamless mode, cooling device, generator, split coupling

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It is well known that running a cogeneration turbine with its low-pressure cylinder (LPC) operating in a steamless mode in the heating season results in a noticeable drop of generated power by as much as a few megawatts for large power units and involves the need to take certain measures and install additional equipment for ensuring reliable operation of the turbine LPC's last stages [1].

Cogeneration turbines of the T-175 series have a length larger than that of T-100 turbines. These turbines are therefore arranged in a longitudinal manner in order to accommodate them within the same spans of buildings. The T-175/210-12.8 turbine has three cylinders. The steam crossover pipes from the intermediate-pressure cylinder (IPC) to the LPC are fitted with disconnecting receiver-type gate valves.

The last-stage blades used in the low-pressure part of different design versions of T-175 turbines have a length equal to 660 or 830 mm, i.e., larger than in a T-100 turbine, due to which more stringent requirements are imposed on the steamless operating mode of the LPC.

For the turbine be able to operate with the receiver gate valves held in the closed position, it is furnished with a cooling device, which has a bulky design and is rather complex in operation. Some pipes used in this device have a diameter of around 1 m with insulation (Fig. 1).

When the turbine operates in cogeneration modes with the receiver gate valves held in the closed position, its LPC rotor furnished with long blades and rigidly connected to the IPC shaft rotates with the nominal frequency. The friction between the blades and surrounding steam and intense generation of vortices cause a large amount of heat to release, which must be removed to protect the rotor, blades, shells, and exhaust hood from inadmissible overheating. Flow pulsations accompanying this process give rise to additional vibration loads on the LPC blades, which has a negative effect on the turbine reliability.

To reduce these negative phenomena, a proposal is suggested in [1] to remove the LPC last stage in addition to the cooling device used in this case if the condensing modes last for no more than two months a year. At some cogeneration stations (CSs) (e.g., those operating in the Tatenergo power system), the last stage was removed from cogeneration turbines for the heating season, which, however, turned to be a rather labor-consuming work.

Some other technical solutions were also proposed, which were mainly aimed at organizing better cooling of the LPC during operation with low steam flowrates passing through it as, for example, in the applied cooling device. In the given case, the solution used in the T-175/210-12.8 turbines installed at the Naberezhnye Chelny CS for cooling the LPC flow path is that steam from the extraction to the horizontal delivery-water heater No. 2 (HDWH) is supplied through a special cooling device to the chamber upstream of the control diaphragms. This cooling device makes it possible to obtain a constant steam flowrate with the necessary parameters irrespective of the mode in which the HDWH No. 2 operates. This device includes the following components: inlet nozzles reducing steam pressure to around 0.05 MPa (0.5 abs. atm); a unit of moisturizers with atomizers, in which steam temperature is brought to the saturation temperature at the existing pressure; a separator, in which excess moisture is removed; a steam desuperheater made in the form of a diffuser the throat of which contains atomiz-