Repairsing a High-Pressure Cylinder at the Manufacturer’s (Taking the T-110/120-130-5 Turbine at the Sakmar Cogeneration Station as an Example)

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Abstract—The main methods of repairing a high-pressure cylinder after the occurrence of deep cracks in its casing are considered. The technology of repairing the high-pressure cylinder at the Sakmar cogeneration station is described.

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The service life of turbine high-temperature elements, such as the high-pressure cylinder’s (HPC) casing, stop valve, and fasteners of the HPC horizontal joint and steam boxes, is assigned proceeding from the characteristics of heat-resistant steels used in them, as well as from the design features of the flanged connection.

The single-wall casing of the HPC used in turbines of the T-100-130 series (Fig. 1) is the most metal-intensive article subjected to the effect of high temperature and thermal stresses. The pressure downstream of the cylinder (approximately 3 MPa) and the use of a two-bucket control stage are the main factors that have determined the cylinder’s design. The HPC has been made with a relatively small number of cageless stages, without extraction fittings, and in the final analysis it has relatively compact overall dimensions.

The HPC casing flanges are sufficiently high, due to which it became possible to place the attaching studs close to the inner surface and make the horizontal joint’s flanges with a smaller width (Fig. 2).

Four nozzle boxes are welded into the cylinder’s sockets in the steam admission section (by two in the upper and lower halves). The nozzle box throats protrude beyond the cylinder socket boundaries. Live steam after the stop valve is supplied to the HPC via the crossover pipes through four control valves. The control valves are placed in the steam boxes welded to the nozzle box throats. Prior to be welded into the cylinder socket’s throat, each nozzle box is installed and fixed with respect to the steam admission axis by one vertical and two transverse keys (see Fig. 2) [1].

Cracks in the HPC casing are one of the most frequent flaws occurring in it. Casting and welding flaws, occurrence of off-design forces applied to structural elements during thermal expansion of parts, and structural changes occurring in the metal under the effect of high temperatures in the course of long-term operation are the main factors due to which cracks appeared in the older designs of HPCs used in turbines of the T-100 series.

It was determined from the results of calculations and strain-gage measurements that the control wheel chamber’s area in the cylinder lower part and the area behind the nozzle boxes, in which there is a high probability of cracks propagating to the horizontal joint and stud holes are the zones in which cracks are most likely to occur. Cracks were indeed found during an inspection. Unfortunately, this zone is situated in a location technologically inaccessible for visual and instrument-assisted examination.

To prevent such flaws from occurring again, a new HPC design was developed, with characteristics optimized with respect to thermally stressed state and HPC casing casting and solidification conditions. This solution was implemented for serial production and has been used since 2009. Some additional nondestructive test methods have also been put in use, due to...