ISSN 0040-6015, Thermal Engineering, 2013, Vol. 60, No. 2, pp. 118–129. © Pleiades Publishing, Inc., 2013.
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STEAM-, GAS-TURBINE, AND COMBINED-CYCLE POWER INSTALLATIONS, AND THEIR AUXILIARY EQUIPMENT

Development of New-Generation Pumps for the Feed System of Large Power Units

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Abstract—Main results from design developments of a sequential totality of condensate, booster, and feed pumps for thermal power units of the gigawatt class are described. The presented design solutions are innovative in nature and are aimed at achieving better energy efficiency, higher reliability, and longer service life of the main-cycle pumps.

Keywords: power, feed system, the unit of condensate pumps, booster feed pumps , energy efficiency, reliability, service life

DOI: 10.1134/S0040601512080101

In the author's opinion, this paper describes innovative and prospective design solutions for a sequential totality of main-cycle pumps, including condensate, booster, and feed pumps (CPs, BPs, and FPs) for large gigawatt-class power units operating under supercritical steam conditions.

This paper can be regarded as a continuation of publication [1], which is supposed to be known, as well as the intricate design and technological problems relating to its topic, which arise in a natural manner in improving the existing or developing new-generation feed systems as applied to power units with an installed capacity of higher than 1 GW.

To keep the size of this paper within reasonable limits, discussion of the well-known approaches used to achieve high-efficient performance of feed systems for power units belonging to the above-mentioned class of unit capacity is omitted here. Sufficiently full information on this issue can be found, in particular, in [2–4].

The developments presented below are related to the conceptual stage of work aimed at synthesizing superlarge power components of feed systems with the estimate of purpose and quality indicators predicted at a level corresponding to this stage. These indicators are mainly based on generalization and extrapolation of experimental data, on semiempirical approaches, and partially on recommendations of experts.

We will now present, in the sequence indicated above, makeup versions of the feed system's pump equipment for the operating parameters adopted in [1], i.e., the condensate pump set (CPS) consisting of three CPs, one BP, and one FP with the total installed capacity of around 50 MW. Enhanced properties relating to their power and cavitation characteristics, reliability, and service life are predicted for each of these components. In particular, we turn our attention to the fact that the inlet and outlet devices of the pump designs discussed below do not contain spiral elements, which behave as sources of unbalanced radial loads having especially significant levels in nonoptimal operating modes of large hydraulic machines.

THE SET OF CONDENSATE PUMPS

The CPS concept and the preliminary design reflecting this concept are shown in Fig. 1. Such version of the CPS is intended for solving the following two most important tasks:

—creating the head H_{k1} in the specified temperature operating conditions T_0, range of supply flowrates $[Q_i, Q_s]$, pressure at the phase interface boundary in the condenser H_k, and immersion head $H_{s.k}$ at the inlet to the first-stage condensate pump (CP1) at which efficient operation of the deaerator and cavitation-free operation of the BP is secured; and

—fulfilling the requirement for the maximally high own suction capabilities of the CPS similar to that imposed on the BP while keeping sufficiently acceptable level of efficiency.

Figure 1 containing sectional views *A–A* and *B–B* and items *1–11*, *13*, *16–18*, and *20* shows only the right-hand assemblies, components, flow channels, or parts of these units. Their left-hand analogs are the mirror images of the right-hand halves with respect to the 0*XY* plane in the Cartesian system of coordinates 0*XYZ* marked in the figure. It follows from Fig. 1 that the CPS includes two vertical axial first-stage pumps CP1 with single-sided inlet of working fluid and one horizontal second-stage pump CP2 with two-sided