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Experience of Applying the Results of Investigations into Controlling Lines of the Salt Ratio between the Salt and Pure Sections of High-Pressure Drum Boilers

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Abstract—Layouts of the connection of the salt ratio lines (SRLs) existing in domestic boiler building are analyzed and the main causes of their low operational efficiency are shown. The results of investigation of hydraulics and the salt mode of an internal boiler layout with the SRL of the TPE-208 boiler are presented. Recommendations on designing the SRL in internal boiler layouts of high-pressure drum boilers, which make it possible to increase the reliability of boilers and to decrease the annual consumption of phosphates, are developed.

Keywords: high-pressure drum boilers, internal boiler layouts, salt remote chambers, controlling lines of the salt ratio, tests, recommendations

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Controlling salt ratio lines (SRLs) are foreseen by boiler plants for almost all domestic high-pressure boilers with stepped evaporation. The application of this line is substantiated by the suitability of internal boiler circuits of the boilers with the selected steam capacity of salt sections to varying water conditions, which appear in the course of the prolonged service of the boilers [1]. The SRL connects water volumes of the salt and pure sections (SS and PS).

According to [2], the excess of phosphates in the boiler water for boilers with a pressure of 13.8 MPa should be, mg/dm^3:

For the pure section	0.5–2.0
For the salt section	No larger than 12.0

According to the data [3, 4], the excess of phosphates in boiler water, which is regulated by the regulations for pipeline technical maintenance, provides no less than fivefold excess of phosphates compared with the calculated concentration of bound phosphates (for the hardness of supply water $Zh_{\text{s.w.}} = 0.5$–1.0 μEq/dm^3, relative steam capacity of the SS, % of steam capacity of the boiler, $n_{\text{II}} = 10\%$, continuous blowing, and $P = 1.0\%$ of the steam capacity of the boiler).

With the stepped evaporation, the concentration ratio in regards to phosphates between the PS and SS is determined by the formula (we neglect carryover of phosphates with steam in view of its insignificance):

$$\frac{S_{\text{bwII}}}{S_{\text{bwI}}} = \frac{n_{\text{P}} + P}{P}.$$

Consequently, with continuous blowing of the boiler with $P = 0.5$–1.0%, the concentration ratio:

$$\frac{S_{\text{bwII}}}{S_{\text{bwI}}} = 6\text{–}11 \quad \text{at } n_{\text{II}} = 5\%;$$

$$\frac{S_{\text{bwII}}}{S_{\text{bwI}}} = 11\text{–}21 \quad \text{at } n_{\text{II}} = 10\%.$$

Allowing for the fact that when holding the excess of phosphates in the PS, an approximately fivefold excess is provided compared with the calculated concentration of bound phosphates according to the regulations for pipeline technical maintenance, as well as from the above presented calculated concentrations of phosphates in the SS, it follows, that the amount of introduced phosphates for most of the boilers with the stepped evaporation is considerably larger than it is necessary to provide the deposit-free (by calcium) water mode.

One of the methods to optimize the distribution of phosphates over the evaporation steps is recirculation of the boiler water of the SS and PS over the SRL (a decrease in the stepped appearance).

Authors of [5] represent the procedure for calculating the circuits of the stepped evaporation with the two-sided SSs and show that the presence of the one-sided SRL leads to the appearance of the salt disbalance between the SSs. They also represent computational formulas for salt balances of the boiler in the presence of boilover or recirculation over the SRL (we neglect carryover of the salts with steam). The concen-