Correction of the Water and Chemical Mode of Boilers Utilizers at Sharp Changes of a Boiler Water Quality, Including for Power Complexes on Recycling

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Abstract. The results of a research of the water and chemical mode of boiler utilizers including determination of quality of saturated steam, nutritious and boiler water are given in article. Researches were conducted at the actual loadings and pressure and the average level of boiler water in a drum. The dependence of change of controlled indicators of quality of boiler water and saturated steam of a boiler utilizer on fluctuations of a purge size a copper and the set range of change level is established, and also dynamics of salinity of saturated steam depending on salinity of nutritious and boiler waters. We developed recommendations about control of additional indicators when carrying out chemical control at threat of various violations of the water and chemical mode. We gave an assessment of extent change a quality of boiler water when using on water treatment installations of membrane methods of desalting of initial waters. Also studied water and chemical modes can be used in units for recycling.

1. Introduction

Now the recycling problem of which main share is made by municipal solid waste is particularly acute. Features when processing waste is use of a boiler utilizers. It is possible to transform the energy which is marked out when processing waste to thermal and/or electric energy.\cite{1, 2}. For boiler utilizers, as well as for any power, the question of providing optimal conditions of the water and chemical mode is particularly acute. In the course of a steam generation in boiler water there is an increase in concentration of salts as in couple they are practically not dissolved. At achievement of a certain concentration in boiler water, loss of the dissolved impurity in a deposit with formation of slime and a scum on the surfaces of heating begins. Drop ablation is resulted by transfer of salts in boiler superheaters and steam lines. Besides, the scum and slime which are deposited on walls of a boiler drum and pipes lead to their overheating. As a result of it the probability of emergencies increases and reliability of installation in general decreases.

For reliable work of a copper and ensuring the required quality of steam, it is necessary to provide constantly set intra boiler water and chemical mode. For this purpose it is necessary to maintain standard quality of boiler water. One of the rated maintenance methods of concentration the dissolved impurity in boiler water are periodic and continuous purges. Purges are carried out from the lower part of a drum where the greatest number of salts and slime concentrates.
2. Experimental Part

Object of a research was the boiler-utilizer with one-stage evaporation. Feed of a copper was carried out by the feedwater representing mix of chemically purified water and condensate, passed the deaerator. From the copper drum boiler water is pumped by circulation pumps in the reactor block in regenerator coils. As a result of heating water in a regenerator and its separation, steam-and-water mix is returned to the top part of a drum of a copper, and boiler water comes to the lower part.

In a drum there is a further separation of steam-and-water mix. As a result, separation is formed saturated steam which part goes to heat supply, part of steam is selected for own needs of knot of utilization of heat, and a part comes to the reactor block on receiving superheated steam. Productivity of a copper is 8 t/h of saturated steam with pressure of 1.2-1.3 MPas. Characteristics of a boiler-utilizer are given in tab. 1.

The continuous purge is carried out for decrease in constantly increasing salinity of boiler water and maintenance of permissible values on this indicator. For removal of the slime gathering in the lower points of a boiler the periodic purge is carried out the average duration of which is about 30-60 seconds at constant control behind water level in a boiler-utilizer drum. Sizes of constant and periodic purges need adjustment for the purpose of optimization of their values for providing the reliable indicators of quality of boiler water corresponding to the mode accepted water chemically.

Table 1. Characteristics of a boiler-utilizer.

| Parameter                                    | Value |
|----------------------------------------------|-------|
| Max pressure, kgf/cm²                       | 32    |
| Operating pressure, kgf/cm²                 | 16    |
| Maximum temperature of the environment, °C  | 235   |
| Steam generating capacity, t/h              | 8     |
| Maximum salinity of steam, mkg/kg           | 0,5   |
| Admissible range pH steam                    | 6,0 – 9,0 |

For the purpose of this adjustment a number of experiments was conducted, Results of experiments are given in a type of graphic dependences in fig. 1 - 5. The program of carrying out tests of various categories of environments is provided in tab. 2.

Table 2. The program of carrying out tests of various categories of environments of a boiler-utilizer.

| The analyzed environment | Transparency on a cross | Size of the general rigidity | Alkalinity size on a fenolft aleina | Salinity size general | Concentration size turned sour sorts | free carbonic acid | oil products | pH |
|--------------------------|-------------------------|-----------------------------|-------------------------------------|-----------------------|-------------------------------------|-------------------|--------------|----|
| Feedwater                | +                       | +                           | +                                  | +                     | +                                   | +                 | +            | +  |
| Boiler water             | +                       | -                           | +                                  | +                     | -                                   | -                 | -            |    |
| Saturated steam          | -                       | -                           | -                                  | +*                    | -                                   | +                 | -            | +  |

* - conditional salinity in terms of NaCl, mkg/kg.

When carrying out experiments determination of quality of nutritious and boiler waters and saturated steam in 2 parameters specified in the tab. was carried out by standard techniques [3-8].
Figure 1. Dynamics of a boiler water salinity $C_k$, mg/l, from purge size $p$, %, by preparation of additional water by method of a two-level ionize (1) and two-level reverse osmosis (2).

Figure 2. Dynamics of conditional salinity in terms of NaCl of saturated steam $C_{\text{s.s.}}$, mkg/kg, from purge size, $p$, %.
Experiments showed that by preparation of additional water by method of a reverse osmosis [9, 10] any of the analyzed indicators of boiler water and saturated steam (transparency on a cross, alkalinity sizes (the general and on a fenolftaleina), sizes of salinity and pH) did not go beyond the normalized values (tables. 3,4). By preparation of additional water by method of a two-level ionirovaniye steady respect for the normalized values in controlled parameters is provided only at the increased values of purges. It happens because of fluctuations of concentration of the dissolved impurity in initial water on an entrance on water treatment installation.

Table 3. The normalized values of a boiler-utilizer water quality.

| Indicator                              | Unit of measurement | Value          |
|----------------------------------------|---------------------|----------------|
| Alkalinity on a fenolftaleina          | mg-equ/dm^3         | not less 0,1   |
| Salinity                               | mg/dm^3             | no more 2500   |

Table 4. The normalized values of a steam quality.

| Indicator                                           | Unit of measurement | Value          |
|-----------------------------------------------------|---------------------|----------------|
| Величина условного солесодержания (в пересчете на NaCl) | mg/dm^3             | no more 0,5    |
| Concentration of free carbonic acid                | mg/dm^3             | no more 20     |
| pH at 25°C                                          | ед. pH              | 6.0 – 9.0      |

3. Conclusions
The made experiments allow to draw a conclusion that the saturated steam produced by a copper utilization satisfies to norms on salinity by preparation of additional water with method of a two-level reverse osmosis. However, the quality of saturated steam at increase in salinity of boiler water to 3500 mg/dm^3 leads to an exit of pH from the recommended range from above. The value pH steadily
remains in the recommended range at increase in level of boiler water over 50% if the salinity of boiler water is in limits of 2000 mg/dm$^3$. By preparation of additional water by method of a two-level ionirovaniye the optimum salinity of boiler water will be by results in an interval of 1,500 - 2,500 mg/dm$^3$ if the size of a purge exceeds 5.5%. Also periodically the increased concentration of dissolved oxygen in feedwater and the lowered alkalinity were registered. These factors lead to initiation of the increased speed of various forms of corrosion of metal.

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