Patent application no. 2020100737 dated 14.01.2020 (I. Tiknonov)

The Method for controlling and adjusting the water-chemical mode of a steam boiler

Abstract

The invention is related to the field of power engineering and is connected with the control and the adjustment of water chemistry mode (WCM) of steam boilers of low and medium pressure by analyzing the correlation between pH value and electrical conductivity (EC) of boiler water considering hydrolysis of carbonates in the boiler water.

The method includes measuring EC in the boiler water, the pH value and temperature, while the values of the optimal EC of the boiler water, which provides the required quality of steam, are determined at the stage of commissioning. Then, in the steady state of the operation of the steam boiler, we carry out the measurement of pH and EC boiler water, then calculate the pH of the boiler water which is based on the values of alkalinity of the boiler water at methylorange and phenolphthalein when EC is set. The calculation of the boiler water pH value is performed in accordance with the developed algorithm for calculating the pH value of the sodium carbonate solution at different alkalinity values for phenolphthalein and methylorange. The measured pH value will be the same as calculated at a certain temperature of the boiler water sample, then all the measured pH values lead to this temperature. Then we set the value of the phenolphthalein at the level of 3.0 mmol/l less than it was originally installed. Then in increments of 1 mmol/l the value of phenolphthalein is adjusted from min to the value which is 3 mmol/l more than originally set. The value of methylorange is set corresponding to each value of phenolphthalein with 0.1 mmol/L. Then, based on the developed algorithm, the pH values are calculated for each pair of phenolphthalein-methylorange values. Then we make an approximation of the obtained data and build a graph EC=f (pH) of the dependence of EC of water on the pH value. In order to do this, we calculate EC value for each pH value by solving a system of equations that characterize EC of boiler water as the sum of individual salts and bases that make it up, taking into account the evaporation of boiler water and the removal of carbon dioxide from it with steam. Then we provide a constant level of EC value or the pH value of boiler water by regulating the continuous and periodic purging of the steam boiler. Then we provide continuous monitoring of the boiler water pH and EC values with constant comparison of the obtained current values

of the boiler water pH and EC with the values determined by the function EC=f (pH). If the current pH value of the boiler water, with the corresponding current value of EC, is less than 0.05 units of pH than the pH value determined by the function EC=f (pH) at the same value of the current EC, then it is diagnosed that the boiler receives hardness salts and it requires checking the operation of the water treatment system and the quality of the return condensate. The technical result is an increase in the degree of automation of the steam boiler, the absence of constant laboratory control and associated costs.

The proposed method of controlling the WCM is carried out in the following way.

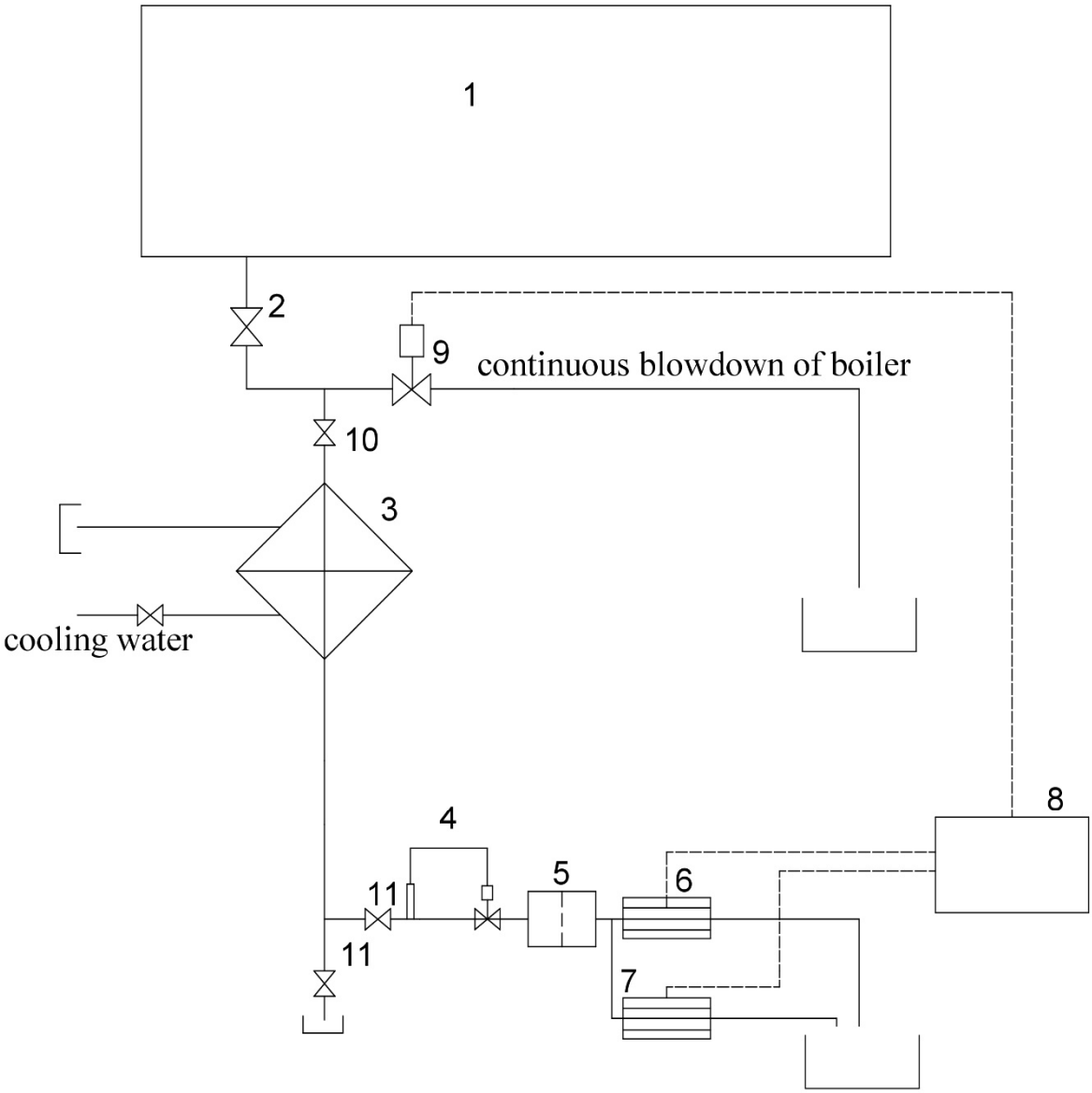
The method contains the following steps. Boiler water from the continuous purge line of the steam boiler 1, passing the shut-off valve 2, enters the water-water refrigerator of the sample 3, in which the boiler water is cooled to 10-30°C by supplying cooling water. Then the cooled boiler water sample passes the temperature sensor 4 with a cut-off valve. If the water sample exceeds 50°C, the valve closes automatically to prevent damage to the pH and EC flow sensors. Then the sample of boiler water passes through the fine filter 5 and simultaneously goes to the flow sensor pH 6 with the temperature sensor and the flow sensor EC 7. The measured values of the pH, EC and boiler water temperature are recorded by the automatic boiler purge controller 8 and compared with the values of the pH and EC of the boiler water, which are pre-set in the controller as a function of the dependence of EC of water on the pH, i.e. EC=f (pH), which is typical for boiler water, which does not get hardness salts with make-up water or condensate. The controller also maintains a constant value of the EC or pH of the boiler water by purging part of the boiler water using the automatic control valve 9 for continuous boiler purging. The supply of a sample of boiler water to the control and adjustment system of the WCM is carried out by means of a control valve 10. The sampling line is purged using the shut-off valves 11.

The error in measuring the pH value should not exceed 0.01 pH units. The error in measuring EC value should not exceed 1% of the measured value. To get more reliable information, all measurements and calculations must be made with an accuracy of up to 2 decimal places.

The main parameter of boiler water quality in this method of controlling and adjusting the WCM of a steam boiler is a function of the form EC=f (pH), i.e. the dependence of the water's EC on the pH, which must be entered into the controller at the commissioning stage. In fact, this is a function of the dependence of the boiler water EC values on the boiler water pH values, which are obtained when the boiler is running on fully softened water. The pH and EC

values of this function depend on the ionic composition of the feed water, the evaporation coefficient of the boiler water, and the pressure in the boiler.

The accuracy of the WCM control for this method depends on the ratio of the alkalinity of the source water to chlorides and sulfates. The more stable this ratio is in the source water, the lower the values of the hardness salts entering the boiler can be detected.


1
2
9
continuous blowdown of boiler
10
3
cooling water
8
4
5
6
11
11
7