ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 1 , January 2021

Modern Approaches and Modernization of Water Treatment Plants with Filter Materials, Maintenance of the Heat Network by Small-Drain Technology MubarekCTPP

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ABSTRACT: The article presents the main calculated results of the use of carboxyl cation exchangers in the boiler house of the "Mubarek Gas Refining Plant" and the Mubarek CTPP. Reconstruction is carried out at a WTP with a maximum capacity of 1000 m^3/h, equipped with filters with a diameter of 3 m, when operating at the reservoir, water with an average hardness of 11 mg-eq / dm^3 and an alkalinity of 8.4 mg-eq/ m^3.

I. INTRODUCTION

The Mubarek CTPP is designed to cover the thermal and electrical loads of the enterprises of the gas chemical complex of the industrial base in Mubarek, the main of which is the Mubarek Gas Processing Plant (MGPP).
In accordance with the heat loads presented in 1982, the CTPP's capacity was determined to be 120 MW with the installation of two turbine units of the R-50-130/13 type and two boiler units of the E-500/140 GMO type. Natural gas from the Shurtan field from two independent sources (1 and 2) was used as the main and reserve fuel for the CTPP. Losses of steam and condensate in the CHP cycle are replenished with the distillate of the evaporation plant 165 t/h. Raw water is purified from the source of water supply - the Kui-Mazar reservoir. Initial raw water analysis:

Total hardness	11 mg eq / l	Hardness carbonate	3.2 mg eq/l
Calcium	142.2 mg/l	Magnesium	47.0 mg/l
Iron	0,04 mg/l	Copper	0,12 mg/l
Chlorides	183 mg/l	Sulphates	541 mg/l
Sodium	200 mg/l	pH	8,4
A	19.7 mg eq/l	K	19.7 mg eq/l
Totalsaltcontent	1310 mg/l		

About the existing problem

The treatment of source water at water treatment plants (WTP) of boiler houses (MGPP) and CTPP plants for replenishment of open heating networks is often carried out by the method of H-cationization with the mode of "hungry" regeneration of filters. A distinctive feature of the method is the use of sulfuric acid with a minimum specific consumption of no more than stoichiometric g-eq/g-eq of absorbed cations, in contrast to other methods of parallel-precision ion-exchange purification with specific consumption of reagents more than 2 g-eq/g-eq. Chemically treated H-cationized water is characterized by a simultaneous decrease in hardness, alkalinity, carbonate index, and salt content.

II. SIGNIFICANCE OF THE SYSTEM

The treatment of source water at water treatment plants (WTP) of boiler houses (MGPP) and CTPP plants for replenishment of open heating networks is often carried out by the method of H-cationization with the mode of "hungry" regeneration of filters. A distinctive feature of the method is the use of sulfuric acid with a minimum specific consumption of no more than stoichiometric g-eq / g-eq of absorbed cations, in contrast to other methods of parallel-precision ion-exchange purification with specific consumption of reagents more than 2 g-eq / g-eq. Chemically treated H-cationized water is characterized by a simultaneous decrease in hardness, alkalinity, carbonate index, and salt content.

Sulfonated coal is traditionally used as a loading material for filters at operating WTPs, the characteristics of which during long-term use do not, as a rule, meet the requirements of TU 113-08-5015182-78-91 in terms of dynamic exchange capacity (actually less than 150-200 g-eq/m^3) and mechanical properties. As a result, there is a significant over expenditure of acid and water for own needs due to the increase in the number of filter regenerations. Insufficient height of the loading of sulphonated coal along with its low quality ultimately lead to a limitation of the productivity of boiler houses for the production of make-up water [1].

At this time, the production of sulfo coal in Russia has practically ceased, and in the West it has not been used for more than 30 years. In this regard, it is extremely important to transfer the WTP filters to work with modern weakly acidic carboxyl cation exchangers. On the domestic market there are many brands of effective carboxyl cation exchangers recommended for use in open hot water supply circuits with a working exchange capacity that is an order of magnitude higher than that for sulfo coal.

III. METHODOLOGY

The conversion of filters to work with a new high-capacity ion-exchange material is not reduced to a simple reload of the material in the filters, as is often assumed, but requires the development and implementation of a number of technical solutions that prevent the direct loss of expensive carboxyl cation exchanger, as well as the formation of calcium sulfate deposits during regeneration and transportation Wastewater.

According to the calculation, the features and experience of introducing the filtering material of carboxyl cation exchangers WTP Mubarek CTPP and MGPP.One of the main conditions for ensuring reliable operation of filters is to determine the optimal rate of supply of regeneration solution and washing. Manufacturers of carboxyl cation exchangers recommend an unreasonably wide range of speeds for feeding a regenerative 0.5-0.8% sulfuric acid solution: from 5 to 20 m^3/h (Lewatit CNP80, Dowex MAC-3), from 8 to 15 m3 / h (TulsionCXO12) and from 15 to 40 m^3/h (Amberlight IRC86). The bench tests performed by us and the experience of many years of operation of filters with carboxyl cation exchangers make it possible to recommend a regeneration and washing rate equal to 15-20 m^3/h (depending on the conditions of use), i.e. much more than for sulfocarbon. This decision necessitates the reconstruction of the regeneration unit of the WTP with the manufacture of a non-standard ejector of increased productivity or the installation of appropriate metering pumps.

The loading height is another important condition for the reliable and economical operation of filters with carboxyl cation exchanger. Manufacturing firms regulate only the minimum loading height within 0.7-0.8 m.With regard to the conditions of the object under consideration, a filter loading height of 1.5 m was adopted. It should be noted that in filters with a loading height of less than 1 m during operation on hard water of the specified quality, there is a significant decrease in the working exchange capacity of the cation exchanger by almost 1.5 times [2,3].

A number of technical solutions will be implemented in the WTP modernization project to increase the reliability of operation:
• replacement of the bottom drainage and distribution systems of filters with filter elements with 0.2 mm slots and installation at the outlet of filters-traps of granular materials;
• replacement of the upper distribution systems of the filters with slot beams, which prevent the loss of cation exchanger during backwash washing;
• reassembly for large diameters of part of pipelines and fittings;

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International Journal of Advanced Research in Science, Engineering and Technology
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• stabilization of the pressure of the source water of the WTP with the help of frequency converters of electric motors and automatic redundancy of the source of the ejection water, which allows to continue the regeneration process in case of interruptions in the supply of source water;
• equipping the WTP with modern physicochemical devices for monitoring and recording water quality.

IV. EXPERIMENTAL RESULTS

The calculated results of the operation of the reconstructed filters with a carboxyl cation exchanger are the following calculated results.

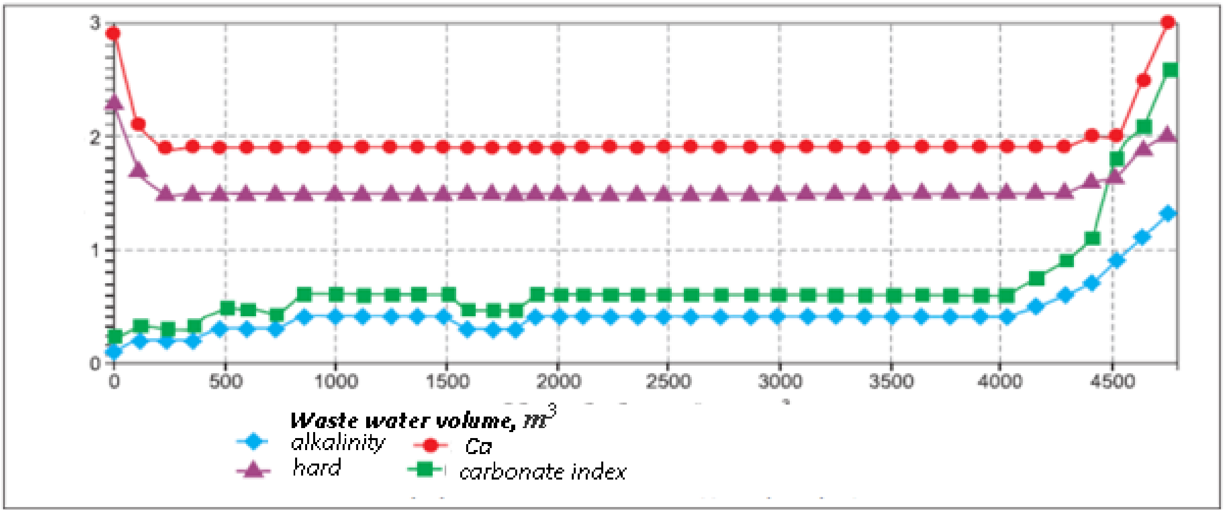

Fig. 1 Graph of changes in water quality per filter cycle.

According to the calculation, the average quality of treated water on the filters shows the changes in water quality in Fig. 1: alkalinity A = 0.4-0.5 mg-e/dm^3, carbonate index C_i = 0.5-0.7 (mg-eq/dm^3) 2, which is less than the regulated PTE [1] at pH_{25}<9 and heating water to 150 ° C. The unit capacity of the filters is increased from 70 to 120-140 m^3/h [1, 2, 3,4,5].

1. The number of active filters is reduced by 2 times.
2. The working exchange capacity of the Lewatit CNP80 carboxyl cation exchanger under these operating conditions averages 2200 g-eq/m^3.
3. The amount of waste water from the WTP filters is reduced on average from 17 to 7% according to the measurements of water meters and is in good agreement with the calculated values:

Auxiliary needs of the WTP with sulphonated coal before reconstruction is:

$$Qcy=100q_{as}(A_s-A_{tw})/E_{cs}=100*5,7(6,5-0,5)/200=17,1\%$$

Aaccording to the calculation of the own needs of the reconstructed filters loaded with a carboxyl cation exchanger:

$$Q=100q_{cc}(A_s-A_{tw})/E_{cc}==100*27(6,5-0,5)/2300=7\%$$

Here A_s, A_{tw} - alkalinity of the source and treated water, mg-eq/dm^3; q_{as}, q_{cc} - actual specific water consumption for regeneration and washing of sulfocoal and carboxyl cation exchanger, m^3/m^3; E_{cs}, E_{cc} - working exchange capacities of sulfocoal and carboxyl cation exchanger, g-eq/m^3.

4. Reduced acid consumption for water treatment by an average of 9%. A decrease in acid consumption when using carboxyl cation exchangers was also noted by other authors [2] and is explained by us as a result of a decrease in

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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unproductive acid losses for neutralizing the alkalinity of the initial water spent on the preparation of the regeneration solution and washing the cation exchanger.
5. The number of filter regenerations at the WTP is reduced by 6 times.
6. The need for WTP in the carboxyl cation exchanger, taking into account the decrease in the loading height and the number of filters, has been reduced by 2.5-3.3 times from the amount of previously used sulfo coal; the addition of the carboxyl cation exchanger was not carried out.
7. Buffer filters after Hr-filters with carboxyl cation exchanger are removed from the operation scheme (regulation of water alkalinity, if necessary, is carried out by adding Na-cationized water from a backup filter).

Economically efficient calculations of replacing sulphonated carbon with a carboxyl cation exchanger are mainly due to a decrease in the total amount of wastewater and a corresponding reduction in the consumption of thermal and electrical energy, a decrease in the consumption of sulfuric acid, as well as the elimination of costs for pre-filling the cation exchanger.

Calculations show that, despite the relatively high cost of the carboxyl cation exchanger, the payback period for the necessary reconstruction of the WTP at current prices does not exceed 2 years. It is expedient to use the obtained profit from the use of high-quality loading material to solve the problems of the WTP ecology. Wastewater from the WTP when working on sulfocoal, and even more so when working with a carboxyl cation exchanger, is characterized by a multiple excess of the maximum permissible concentration (MPC) for sulfates and salt content.

A significant excess of the MPC for sulfate ion in the wastewater treatment plant according to the Hg-cationization scheme, as well as in the rest of the WTP with ion-exchange technology (for sulfate or chloride ion, depending on the reagents used), put the operating organizations under the constant threat of multiple penalties for the discharge contaminated wastewater. In addition, as can be seen from the data shown in Fig.1.most of the wastewater (about 70%) contains calcium sulfate in concentrations.

V. CONCLUSION AND FUTURE WORK

From the above, conclusions can be drawn:

1. Therefore, for an objective assessment of the profit from the modernization of the WTP, it is advisable to organize a unit for direct measurement of the wastewater flow of the WTP. The advantage of this solution lies in the achieved "transparency" of the wastewater amount accounting and universal applicability for all planned changes in the WTP schemes.
2. On the environmental and economic relevance of the modernization of the WTP technology with Ng-filters by replacing sulfocoal with a carboxyl cation exchanger, building a gypsum extraction unit and reusing the bulk of wastewater in a closed loop.

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