Formation of by-products during water chlorination as a result of corrosion of elements of the mechanical system.

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Annotation The work considers corrosion of the metal elements of the filtration system as an electrochemical process, and also presents the results of the analysis of the swimming pool water using the modern gas chromatographic equipment with a flame ionization detector and highly efficient quartz capillary columns. It was found that the swimming pool water is contaminated with the low-boiling organochlorine compounds and by-products, what is associated with the formation of the hydroxyl radical FeOOH, which occurs as a result of corrosion of elements of the mechanical system.

The primary stage of water purification is its mechanical purification from suspended impurities. Mechanical contaminants (suspensions) from large streams of water, as a rule, are removed in bulk filters with a combined (zeolite + filtrate) loading (periodic mechanical filters) of batch action.

Figure 1. Conceptual design of the bulk filter (©Shivam Water Treaters Pvt)
The mechanical bed pressure filter «Shivam Water Treaters Pvt» (Fig.1) is a vertical metal or plastic casing with drainage distribution systems filled with, as a rule, it is quartz sand, hydroanthracite, etc. To improve the distribution of the solution over the cross section and reduce the clogging of the holes of the lower drainage device, it is placed into a layer of gravel [1-3].

Filtration of the contaminated water is performed from top to bottom. In this case, large particles are retained in the pores between the granules of loading, and small contaminants, due to some various effects, primarily the electrostatic one, adhere to the particles of loading. The more contaminants are retained by the layer of loading, the narrower the passageways for the liquid are and the higher the depth of the water treatment is. Most of the contaminants are collected at the top of the layer of loading. At a certain point, the layer becomes so dirty that the filtration resistance rises sharply, and productivity falls. An increase in water pressure can lead to a “breakdown”, that is, to carrying-out of dirt into the clean water. The filter is stopped and the layer of loading is regenerated.

Regeneration of the granulated loading (loosening) consists in washing it with water from bottom to top at a rate, at which pseudofluidization of loading and its expansion by 30-50% occurs. In this mode, the particles seem to “boil” and the delayed suspended solids are removed from the interpore space, and when the particles collide the adhering contaminants are removed from their surface [7-9].

Before being fed to the central networks, the water undergoes mandatory preparation, including cleaning and disinfection, since at the outlet it must comply with the safe drinking water standards. But going through many kilometers of labyrinths of the water supply, the water quality deteriorates – it absorbs corrosion products of the pipes and other mechanical impurities. On the surface of stainless steel equipment, a “point” attack of high concentration chlorides is constantly conducted. Corrosion products may include oxides, chlorides, sulfides:

\[
\begin{align*}
4Fe + 3O_2 & \rightarrow 2Fe_2O_3; \\
2Al + 3Cl_2 & \rightarrow 2AlCl_3; \\
4Ag + O_2 + H_2S & \rightarrow 2Ag_2S + 2H_2O.
\end{align*}
\]

Over some time, they “eat out” small holes in the surface. This leads to a premature failure of the heat exchangers, pipelines, equipment.

Table 1 shows the physical and chemical properties of low-boiling organohalogen compounds, being present and formed in the swimming pool water as a result of treatment with a chlorinating reagent.

As we can see from the table, these compounds are characterized by a wide variety of boiling points and solubility. It has also been revealed that the presence of by-products is associated with the formation of free radicals of the hydroxyl group (OH *), which appear during the corrosion of metal elements of the pumping system [4-6].

| No. | Compound                     | T_{boil}, °C | Solubility in the water, mg/l | Saturated steam pressure at 25°C, mm Hg |
|-----|------------------------------|--------------|-------------------------------|-----------------------------------------|
| 1   | Methyl iodide                | 42.5         | 14000                         | 437                                     |
| 2   | Chloroform                   | 61.2         | 10000                         | 200                                     |
| 3   | Ethyl iodide                 | 72.2         | 4000                          | 128                                     |
| 4   | Carbon tetrachloride         | 76.8         | 800                           | 113                                     |
| 5   | Bromodichloromethane         | 87.0         | 4500                          | 65                                      |
| 6   | Trichlorethylene             | 87.2         | 1000                          | 72                                      |
| 7   | Tetrachlorethylene           | 121.2        | 400                           | 19                                      |
Figure 2 shows a chromatogram of the separation of the swimming pool water, obtained by concentrating a sample with a statistical vapor-phase sampling unit.

![Chromatogram](image)

**Figure 2** Results of a chromatographic analysis of the swimming pool water.

Chromatograph PerkinElmer Clarus 680.

Corrosion was considered in the work as an electrochemical process occurring due to interaction of the water and oxygen. To protect the metal elements of the filter equipment from corrosion we use the various inhibitors, which, when introduced into the water, significantly reduce the rate of the corrosion process and do not reduce the quality of the water in accordance with the sanitary standards.

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