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To cite this article: A Kozodaev *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **492** 012020

IOP Conf. Series: Materials Science and Engineering **492** (2019) 012020 doi:10.1088/1757-899X/492/1/012020

Waste water depuration of the manufacture of mirrored surfaces for energy saving

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Abstract. The article points out that to protect against overheating of various energy facilities including hydraulic cylinders involve the use of a large number of mirror surfaces. The article deals with the problem of insufficiently effective water treatment of the production line of mirrors of a large enterprise. The authors analysed of the composition of pollution at each stage of production and water treatment technologies, which showed that the modernization of the water purification line from silver and ammonium nitrogen is required. The authors proposed a flow chart that allows a significant improvement in water quality and provides evidence of its effectiveness. The authors believe that it is possible to indirectly reduce the negative impact on the environment of enterprises producing components for the power engineering industry.

1. Introduction

The manufacturing process of the mirror surface includes several stages, the main of which are the following: surface preparation, application of the mirror layer, and application of a protective coating.

In the first stage, the surface is subjected to washing. After this, the blank is fed to the polishing site, carried out by mechanical brushes using a suspension of cerium dioxide. Then the process of sensitization is carried out by applying a solution of tin chloride. After sensitization, the glass is rinsed and it enters the stage of surface activation. The activation process is carried out by spraying a solution of palladium chloride on the glass. Rinse follows again. The prepared glass is sent to the silvering chamber, where the silver solution and the reducing agent are applied. This is followed by surface preparation for painting, rinsing and drying. The dried mirror is covered with a layer of protective paint and sent to high-temperature drying.

The main contribution to environmental pollution by mirror production is made by heavy metals. The main methods of wastewater treatment from heavy metals and their salts: reagent, ion-exchange, sodium cation-exchanger, sorption, etc. [1-10]. Silvering lines are the most of things to environmental pollution [11].

Sewage from the silvering line is contaminated with silver and nitrogen compounds. In many enterprises, the main aspect of the purification process is the removal of dissolved silver from wastewater, while the removal of nitrogen compounds is not provided.

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2. Methods

Cleaning technology is as follows. Sewage waters contaminated with silver and nitrogen compounds enter the receiving tank (pos. 1 in figure 1), where they are treated with hydrochloric acid to a pH value of 2.0 ... 2.2. As a result, the reaction proceeds to form silver chloride, which is insoluble in water and precipitates. To intensify the reaction, the receiving tank is equipped with a mechanical stirrer. Then the water enters the precipitation chamber (see figure 1, pos. 2).

After settling, the flow flows into the chamber (pos. 3), where the precipitation of silver chloride continues. Then the wastewater enters the settling tank with a sloping bottom (pos. 4). After settling, the water from the sump with a pump is fed to the fine filters (pos. 5 and 6). Filtration fineness is 1 micron. As filters, cartridge filters with a non-woven filter element are used. Then the flow of water enters the chamber (pos. 7), where the final neutralization is performed with hydrochloric acid (pos. 8) and sodium hydroxide (pos. 9). In addition, a flow from the silanization line is supplied to the neutralization tank. The wastewater from the silver recovery line, mixed with the flow from the silanization line, is neutralized in the chamber (pos. 7) and discharged into the domestic sewage plant. Then they go to the biological treatment unit of the plant-wide sewage treatment plants or city sewer.

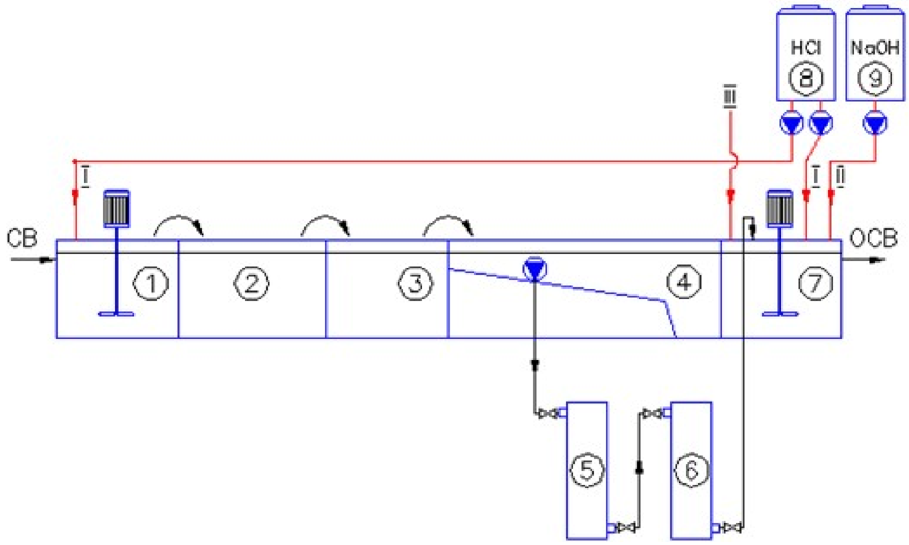

Figure 1. The scheme of wastewater treatment from the silver line:1 – tank for receiving and treating wastewater with hydrochloric acid; 2 – settling zone; 3 – the capacity of the reagent treatment of wastewater with hydrochloric acid; 4 – sump; 5, 6 – cartridge filters; 7 – neutralization capacity; 8 – hydrochloric acid supply unit; 9 – sodium hydroxide supply unit. I – supply HCl; II – NaOH feed.

During the purification process, sewage sludge is formed, the main part of which is silver chloride. Periodically, it is manually removed from the structures. In addition, in the process of purification formed waste bag filters contaminated with fine silver chloride particles. Waste generated on the silver recovery line is surrendered to refineries. Wastewater analysis results are showed in table 1.

Table 1. Qualitative composition of wastewater before and after treatment at existing facilities.

No	Name	Enter	Exi end	Notice
1	Ammoniumion	97…261	58…201	
2	Silver	0.2…3.38	0.03…0.49	

As can be seen from the results presented in the table, the purified water has a mediocre quality, especially if it is to be discharged to local biological treatment facilities. In this case, silver ions, as well as nitrogen compounds in such high concentrations will have a toxic effect on activated sludge aerotanks.

In this regard, it is necessary to modernize the presented technological scheme.

3. Analysis result

Analysis of the literature data showed that the use of reagent methods based on pH adjustment and subsequent coagulation can significantly improve the cleaning efficiency. Based on the analysis [12–15], an improved purification scheme was developed, based on the existing technology, enhanced by the post-treatment stage and the use of a flotation tank with a new aeration system [16]. The design of a flotation tank should be carried out taking into account the initial concentration of pollutants [17, 19]. An improved scheme is showed in figure 2.

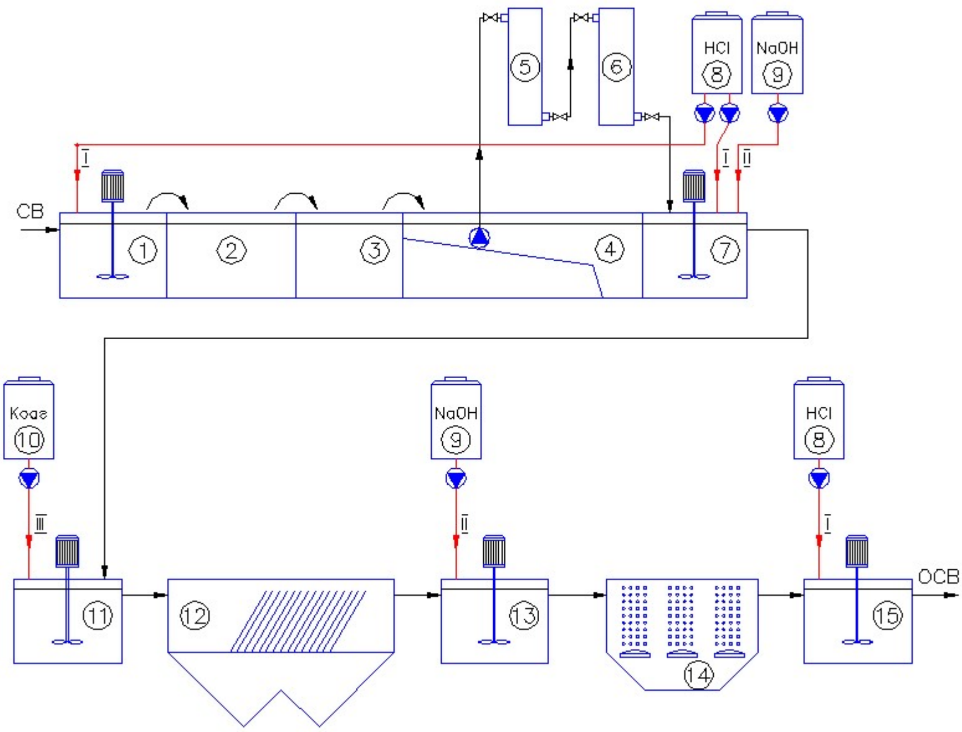

Figure 2. Improved wastewater treatment scheme:1 – tank for receiving and treating wastewater with hydrochloric acid; 2 – settling zone; 3 – capacity of the reagent treatment of wastewater with hydrochloric acid; 4 – sump; 5, 6 – cartridge filters; 7 – pH adjustment chamber; 8 – hydrochloric acid supply unit; 9 – sodium hydroxide supply unit; 11 – camera for coagulation of water; 12 – flotation sump; 13 – pH increase chamber; 14 – aeration chamber; 15 – neutralization capacity. I – supply HCl; II – supply of NaOH; III – coagulant feed.

Wastewater contaminated with silver and nitrogen compounds enters the receiving tank (figure 2, pos. 1), where they are treated with hydrochloric acid to form and precipitate silver chloride, which is insoluble in water and precipitates. Then the water enters the precipitation chamber (pos. 2). After settling, the flow flows into the chamber (pos. 3), and then into the settling basin with a sloping bottom (pos. 4), where the precipitation of silver chloride continues. After settling, the water from the sump with a pump is fed to the fine filters (pos. 5 and 6). Filtration fineness is 1 micron. As filters, cartridge filters with a non-woven filter element are used. Then the flow of water enters the pH adjustment chamber (pos. 7), where the pH is raised. Then the purified water enters the coagulation chamber (pos. 11) and is treated with an aluminum-containing coagulant. There is a process of formation of flakes on which dissolved contaminants are sorbed. The treated water is directed by

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gravity into a flotation tank (pos. 12) for clarification. The clarified water enters the pH increase chamber (pos. 13), where the pH rises to 11 units. At this value, ammonium goes into molecular nitrogen. Then the water passes into the aeration chamber (pos. 14), where it is blown off to the atmosphere, and the purified water is neutralized in the tank (figure 2, item 15).The proposed technological scheme was tested on the field drains of a glass factory. The results are showed in table 2.

Table 2. Qualitative composition of waste water after removal efficiency.

No	Name	Existed process scheme	Suggested scheme	Efficiency final purification, %
1	Nitrogen ammonium	175	32.6	81
2	Ammonium ion	226	42	81
3	Argentum	0.13	0.0065	95

The results presented in the table showed that the use of a method for the removal of ammonium nitrogen, based on an increase in pH and its subsequent stripping, can reduce the concentration by 80%. Silver after-treatment reaches an efficiency of 95%.

4. Conclusion

The silver recovery lines of industrial enterprises allow a large part of the metal to be returned back into production, but the residual concentration of silver in wastewater exceeds the allowable values for discharge into the sewage system [19]. Technological solutions proposed in this work have shown high efficiency at the stage of wastewater purification, ensuring a reduction in the concentration of silver ions below the allowable values [20] for fisheries.

The currently known method for the removal of ammonium nitrogen, based on pH adjustment and subsequent stripping, has shown high efficiency for the treatment of wastewater from mirror production

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