Reduction of COD values of wastewater from the production of energy-saturated materials

Aidar Zainullin[1*]

[1]Kazan National Research Technological University, 68, K. Marx str., Kazan, 420015, Russia

Abstract. The initial physico-chemical characteristics of wastewater of chemical production of special-purpose substances have been studied. Several neutralizing agents have been investigated and the final parameters of the wastewater under study have been determined. Experiments on adsorption wastewater treatment have been carried out. The cleaning efficiency was at least 91%.

1 Introduction

Wastewater is one of the largest in scale and degree of impact of anthropogenic factors, which makes significant changes in the composition and quality of natural waters, which necessitates their purification. And in a market economy, not only qualitative indicators should be invested in efficiency, according to the requirements put forward, but also the economic component.

In recent years, nitro-, azo-compounds and aromatic hydrocarbons, which are, in particular, part of some initiating explosives, pose an extremely serious danger of environmental pollution. Initiating explosives have found wide application in many industries. In connection with the greening of production technologies, the development and application of closed water supply cycles and effective local wastewater treatment becomes important [1-2].

One of the super toxicants entering the sources of water supply and water consumption are mercury ions. Due to the increasing spread of mercury and its significant global impact on all components of the biosphere, the problem of mercury pollution has acquired global importance. An example is the environmental problem of the twentieth century, Minamata disease – caused by environmental pollution with mercury. This problem is quite relevant, since mercury has become one of those toxic elements, the share of which from natural sources in the biosphere cycle has decreased with the share coming as a result of anthropogenic pollution. This is primarily due to the fact that outdated industrial wastewater treatment systems of enterprises do not allow for high-quality wastewater treatment from mercury compounds. The result of such actions is pollution of water and terrestrial space and poisoning of living organisms.

[*] Corresponding author: zainullin@list.ru

2 Methods

The purpose of this research work is to study the possibility of physico-chemical wastewater treatment of mercury fulminate production, which does not require large financial investments and does not have a negative impact on the natural environment.

The specificity of mercury requires an individual approach to the isolation of one or another of its forms. With this in mind, all cleaning methods can be divided into three groups:

- Reduction methods.
- Sulfide methods based on the conversion of mercury into water-soluble compounds.
- Ion exchange methods.

3 Results

Mercury fulminate is an initiating explosive, very sensitive to shock, incandescence and friction, heating and capable of exploding in small quantities. White or gray crystalline substance; flash point 170 ^{o}C, explosion heat 1.8 MJ/kg, detonation velocity 5400 m/s at a density of 4 g/cm^3.

Wastewater from the production of mercury fulminate is a liquid with the indicators that are presented in Table 1.

Table 1. Physico-chemical parameters of the source wastewater.

Parameter	Dimension	Value
COD	mgO/dm^3	8880
pH		3.55
Optical density (D)		0.142
Density	g/sm^3	1.007

From the above table it can be seen that CB have a low pH value and a high COD. In this regard, the neutralization method was chosen as the initial stage of wastewater treatment [3,4].

The following reagents were selected as neutralizing agents: sodium hydroxide, sodium carbonate and sodium bicarbonate. As a result of the neutralization process, wastewater has changed its physico-chemical characteristics:

- In the case when the neutralizing agent is sodium hydroxide: COD = 7400mgO/dm^3.
- In the case when the neutralizing agent is sodium carbonate: COD = 6660 mgO/dm^3.
- In the case when the neutralizing agent is sodium bicarbonate: COD = 2960 mgO/dm^3.

From the above data it can be seen that after the neutralization process, the COD of the studied solutions decreased. The lowest value was observed in CB treated with sodium bicarbonate (COD = 2960 mgO/dm^3), the highest in sodium hydroxide (COD=7400 mgO/dm^3) and sodium carbonate (COD = 6660 mgO/dm^3).

Table 2 shows some physico-chemical characteristics of wastewater after the neutralization process.

Table 2. Physico-chemical characteristics of wastewater after the neutralization process.

Parameter	Source wastewater	Neutralizing agent		
		NaOH	**Na_2CO_3**	**$NaHCO_3$**
COD, mgO/dm^3	8880	7400	6660	2960
Optical density (D)	0.142	0.299	0.365	0.024
pH	3.55	6.75	7.3	7.1

Thus, from the data presented in Table 2, it can be seen that after the neutralization process, the optical density of wastewater in the case of neutralization with hydroxide and sodium carbonate increased, which may indicate the formation of compounds in solutions that affect its transparency, in the case of bicarbonate, the optical density decreases, the solution becomes more transparent accordingly.

The choice of the purification method in each specific case is determined by the source and nature of the pollution, the amount of the contaminant in the industrial runoff and the subsequent targeted use of the purified water. Of particular interest are inexpensive, effective methods of water purification from pollution, which include sorption. Their advantages are: the ability to remove contaminants of a very wide nature to almost any residual concentration, regardless of their chemical resistance; the absence of secondary contaminants and controllability of the process.

A large number of materials of natural and artificial origin are used for wastewater treatment by the sorption method, however, activated carbons (AC) are used more often than others. Despite the active search for substitutes, finding a material that would be as effective as a sorbent as activated carbon is an urgent task [5].

It is known that a decrease in COD and the color of colored solutions is observed during sorption wastewater treatment.

As the latter, activated carbons of the BAU-A and SKD-515 brands were studied, the technical characteristics of which are presented in Table 3.

Table 3. Technical characteristics of activated carbon grades BAU-A, SKD-515.

Grade AC	Bulk density, g/ dm^3	Total pore volume, sm^3/g	Adsorption capacity for iodine, %
BAU-A	420	1.6	60
SKD-515	600	0.7-1.0	-

The experiment was carried out as follows: an adsorbent in the amount of 1, 5, 10 g/dm^3 was introduced into a flask with 100 ml of wastewater. The contents of the flask were continuously mixed, and after certain periods of time, the studied wastewater was subjected to the determination of a number of physico-chemical parameters. The same experiment was carried out with neutralized wastewater, the COD of which, as shown by previous experiments, decreased to a value of 2960 mgO/dm^3. The physico-chemical parameters of the effluents measured at the end of the experiment are shown in Table 4.

Table 4. The main physico-chemical parameters of effluents measured at the end of the experiment.

Sorbent	Dosage, g/dm^3	COD, mgO/dm^3			Optical density (D)	light transmission (L), %
		3 min	15 min	30 min		
BAU-A (source wastewater)	1	8450	7960	7540	0.318	48
	5	8270	7460	6980	0.360	46
	10	8070	7290	6490	0.350	45
BAU-A (neutralized wastewater)	1	1643	1280	987	0.083	82
	5	1460	980	670	0.076	84
	10	1240	760	490	0.056	88
SKD-515 (source wastewater)	1	8450	7960	7860	0.504	31
	5	8270	7460	7380	0.404	39
	10	8070	7290	7190	0.388	41
SKD-515 (neutralized wastewater)	1	2210	1630	1260	0.135	73
	5	1830	1467	987	0.126	75
	10	1650	1290	843	0.097	80

Based on the data presented in Table 4, it can be concluded that the nature of the change in the values of COD in these activated carbons has a systematic dynamics of decline, especially during the first time of interaction. An increase in the dosage of the sorbent leads to the achievement of lower values of physico-chemical parameters.

4 Discussion

Wastewater neutralization of mercury fulminate allows not only to stabilize the pH value, but also has a positive effect on the depth of purification. The efficiency of wastewater treatment to reduce the COD value was 91% when using activated carbon of the BAU-A brand. The efficiency of reducing the COD value when using activated carbon of the SKD-515 brand according to the best indicators was 85%.

The data presented above showed the high efficiency of activated carbons of the BAU-A, SKD-515 brands in relation to impurities of waste water produced by mercury.

5 Conclusions

Thus, the conducted studies allow us to propose a two-stage wastewater treatment system for the production of mercury fulminate, including neutralization and adsorption.

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