Importance of Ozonation and Oxidation-Reduction Methods in Wastewater Treatment

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ABSTRACT

In the process of oxidation, the toxic impurities in the water turn into non-toxic substances as a result of a chemical reaction, so they can be separated from the water. When wastewater is treated with oxidizers, a large amount of reagent is consumed. Therefore, this method is used when it is not possible to treat wastewater pollutants by other means. Oxidation with ozone makes it possible to simultaneously discolor water, remove various tastes and odors, and neutralizes water. Ozonation of wastewater can remove phenol, petroleum products, hydrogen sulfide, arsenic compounds, surfactants, cyanides, dyes, carcinogenic aromatic hydrocarbons, and pesticides.

Keywords: Effluent, waste, ozonation, cyanides, phenol, petroleum products, hydrogen sulfide, arsenic compounds, surfactants, dyes, carcinogenic aromatic hydrocarbons, pesticides, ferrous sulfate, sodium bisulfate, hydrogen, sulfur dioxide, pyrite gray

Today, as the number of people on our planet increases, the need for clean water is increasing day by day. Due to the increase in waste and sewage, the level of pollution of water bodies is increasing. As a result, water bodies are becoming unusable. It is one of the most important problems facing the countries of the world in solving this issue positively. If this problem is not solved wisely in time, the consequences will worsen day by day.

Therefore, if scientific and technical achievements are not used in the protection of water bodies, the relevant control bodies do not strengthen their work in this way, as long as the factories and city waste water treatment facilities do not work, the health of the population and the need for clean water will always remain in danger. .

Water plays an important role in the main processes occurring in nature, as well as in human life. In industry, water is used as a raw material and energy source, as a cooling or heating agent, as a solvent, as an extractant, as a medium for transporting raw materials and materials, and for a number of other purposes.

In this regard, paying great attention to the protection of nature and water bodies of the Republic of Uzbekistan, the Supreme Council of the Republic approved the Law on State Sanitary Control on July 3, 1992. This law

attaches great importance to the protection of the environment, water bodies, and the provision of clean water to the population.

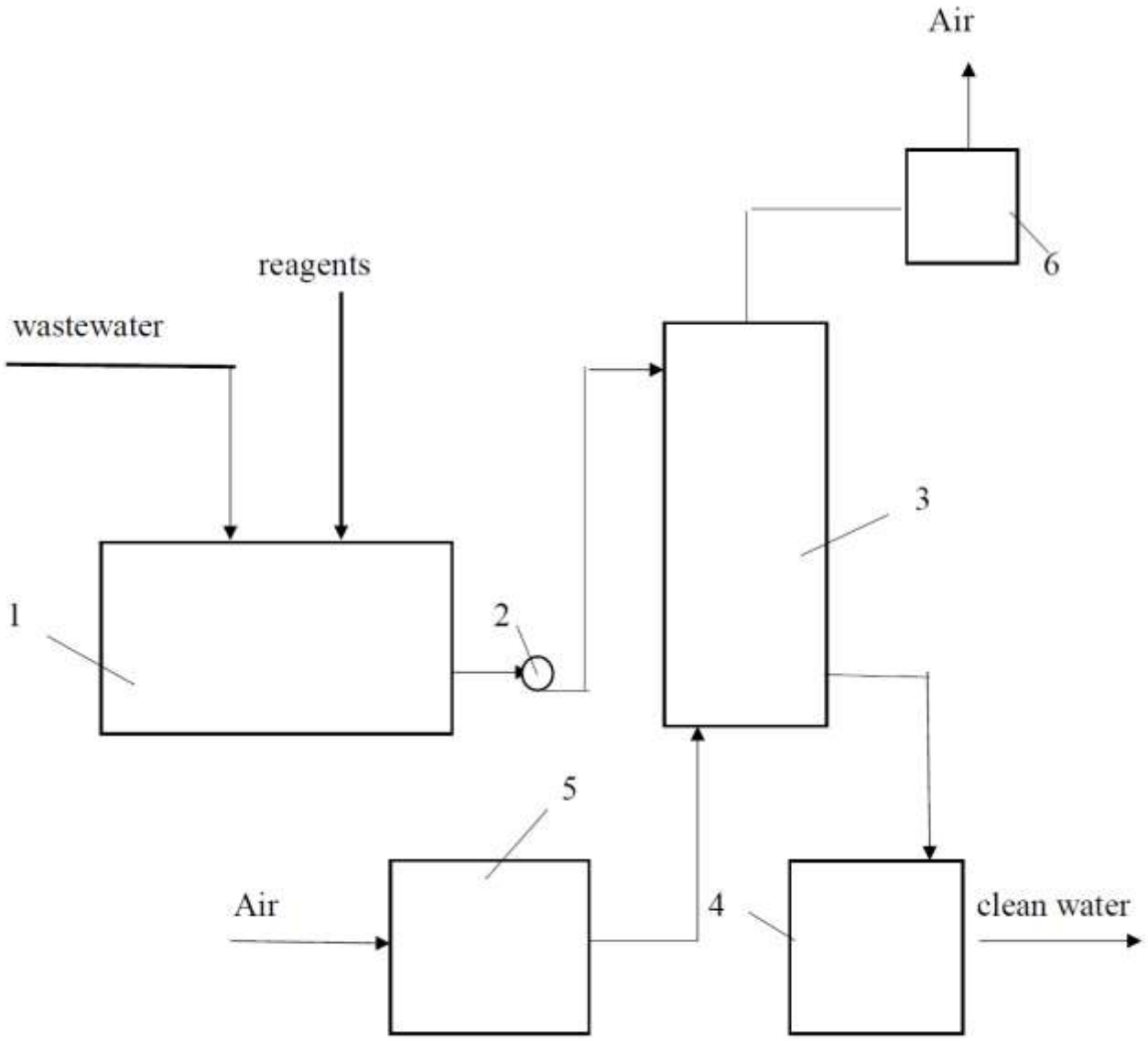
Therefore, filters, coagulants, various reagents, disinfectants (chlorine, calcium chloride, ozone) and physical methods are used to improve water quality. Maintaining the taste of water depends on the choice of water sources. The smell and unpleasant taste of suvnung is done by processing it.

The degree of harmfulness of wastewater depends on the nature and composition of pollutants (toxicity) in it. Salts of heavy metals, cyanides, phenols, hydrogen sulfide, carcinogenic substances and other similar substances cause high level of poisoning and odor of wastewater.

So, wastewater ozonation (transfer of O3 gas) is of great importance. By passing ozone gas through the water, it is possible to clarify, improve the taste, remove the smell and neutralize the waste water. Ozonation can remove phenols, oil products, H2S, arsenic compounds, PAV (surfactant), dyes, carcinogenic aromatic hydrocarbons, pesticides from waste water.

Ozone is an allotropic modification of oxygen and is a pale blue-green, highly toxic gas. Its unique smell has a concentration of 1*106. Located in the upper stratospheric layer of the atmosphere, molecular weight - 48, density - 2.154 g/1. Pure ozone has an explosive property (in industry it is obtained from oxygen - 0.2), an extremely toxic compound. The maximum permissible concentration in the air of the working zone is 0.0001 mg/m3. The neutralizing effect of ozone gas is due to its high oxidizing properties, that is, it has the ability to easily give atomic active oxygen (O3 = O2 + O). Ozone oxidizes all other metals except gold, turning them into oxides. It decomposes very slowly in dry air. When wastewater is treated with ozone gas, organic compounds in it are decomposed, bacteria die (1000 times faster than chlorine).

The solubility of ozone in water depends on the pH of the solution and the substances dissolved in it. If acid and neutral salts dissolved in water meet, ozone dissolves well. If there is alkali in the water, it becomes difficult for ozone to dissolve. The effect of ozone can go in three different directions: through the effect of atomic oxygen in ozone, through the complete combination of ozone with an oxidizing substance, and through the catalytic effect of atomic oxygen in ozone. When ozone is transferred through wastewater (dispersion), 2 main processes take place: oxidation and disinfection. In addition, the water itself is saturated with oxygen. Ozone is supplied to wastewater in the form of an ozone-air or ozone-oxygen mixture. The amount of ozone in the mixture is around 3%. Now let's look at the technological scheme (Fig. 1).



1 - picture. A harmless device using the ozonation method of wastewater:
1-mixer; 2nd pump; 3rd reactor; 4th collector; 5-ozonator device; 6-gas cleaning unit.

In this scheme, wastewater is mixed with reagents in mixer 1 and then fed to reactor 3 using pump 2.

Here, under the influence of ozone gas prepared in ozonator 5, the substances contained in wastewater are oxidized and become harmless. Purified water is sent to the next stage through collector 4. The gases produced during the cleaning stage are neutralized in block 6 and released into the atmosphere. The residual amount of ozone used in the cleaning process should also be retained. Because ozone gas is actually a strong poisonous gas. Therefore, this gas coming out of the reactor is passed through activated carbon (Fig. 2). 450 g of activated carbon is used for 1 kg of ozone.

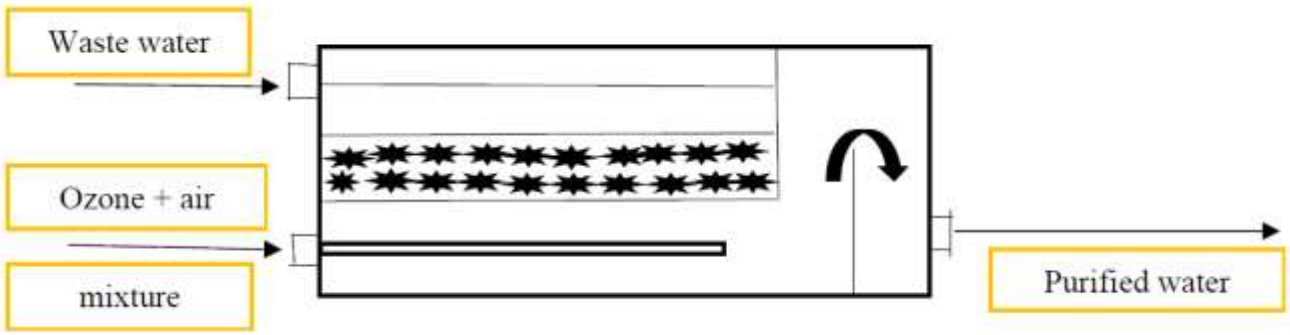


Figure 2. Nozzle ozonation device.

Ozone oxidizes both inorganic and organic compounds in wastewater. For example, the following reactions occur with iron and manganese compounds:

$2FeSO_4+H_2SO_4+ O_3 = Fe_2(SO_4)_3 + 3H_2O + O_2$

$MnSO_4 + O_3 + 2H_2O = H_2MnO_3 + O_2 + H_2SO_4$

$2H_2MnO_3 + 3O_2 = 2HMnO_4 + 3O_2 + H_2O$

The oxidation of hydrogen sulfide proceeds as follows:

$H_2S + O_3 = H_2O + SO_2$ $3H_2S + 4O_3 = 3H_2SO_4$

Ammonia oxidation proceeds as follows:

$NH_3 + 4O_3 = 4NO_3^- + 4O_2 + H_2O + H^+$

This produces nitric acid:

$(NO_3^- + H^+ = HNO_3)$.

Recirculation method: Waste water recirculation treatment is used when there are rapidly recirculating substances in the water. This method is widely used to separate mercury, chromium, and arsenic substances from wastewater, and they are separated from water using settling, filtration, or flotation methods.

When organic compounds of mercury are found in water, first the organic substance is decomposed, and then the mercury cations are reduced to the metallic state. To purify wastewater from hexavalent chromium, it is first converted to trivalent chromium based on the reduction process, and then precipitation of chromium hydroxide is carried out in an alkaline environment. Activated carbon, iron sulfate, sodium bisulfate, hydrogen, sulfur dioxide, pyrite ash, etc. are used as reducing agents. In practice, sodium hydrosulfate (bisulfite) is often used.

$4H_2CrO_4 + 6NaHSO_3 + 3H_2SO_4 = 2Cr_2(SO_4)_3 + 3Na_2SO_4 + 10H_20$

$2Cr^{+6}$	- 6e	$2Cr^{+3}$	6	3
S^{+4}	+2e	S^{+6}	2	1

This reaction is fast, and the environment is around pH=3-4. Alkaline reagents are used to precipitate trivalent chromium.

$$Cr^{+3} + 3OH^- = Cr(OH)_3$$

The cleaning process is carried out in periodic and continuous devices.

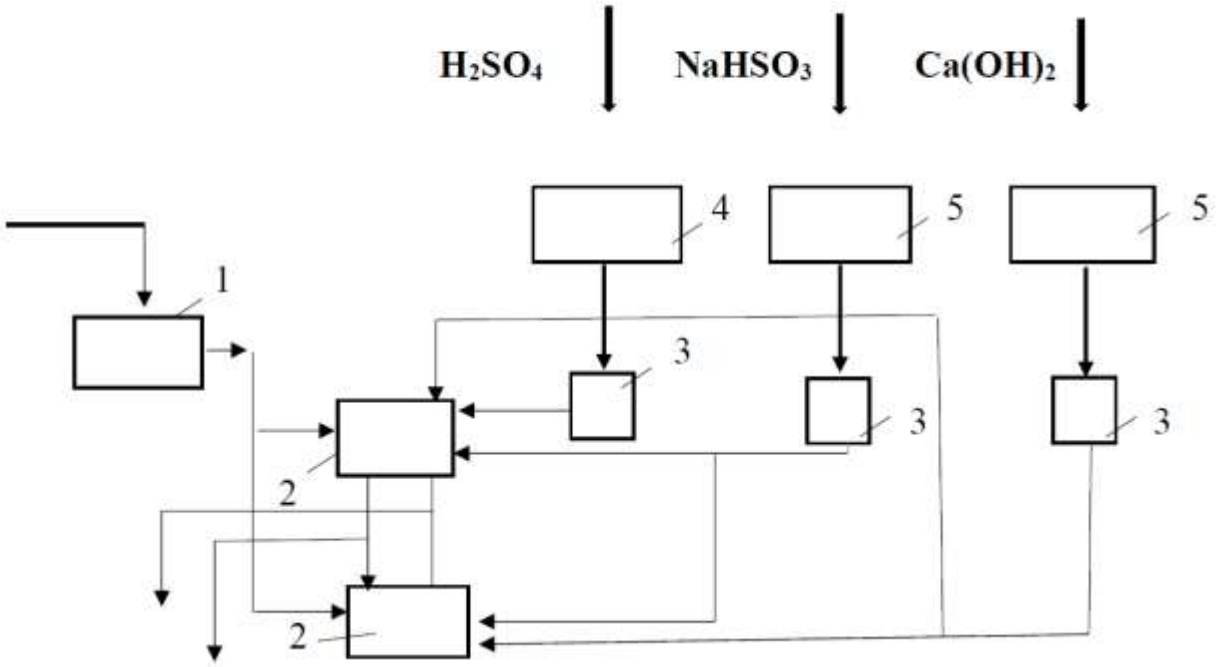


Figure 3. Scheme of the chromium return device:
a) Capacity 1; 2-reactors; 3-gauge; 4-6 capacities; b) Mediator 1; 2nd mixer; 3-capacities for neutralization and deposition.

b)

In the periodic device (a), wastewater is pumped from tank 1 to reactor 2 using a pump. If the wastewater pH is more than 3, sulfuric acid is supplied from the 4th container until the medium pH is 2.5-3. Then sodium bisulfite was added and stirred vigorously for 30 minutes. Then alkali and polyacrylamide are added and precipitation is carried out. In continuous devices, wastewater is first fed to the 1st intermediate, then to the mixer and neutralizer. The bisulfite solution is fed to the mixer after the pH of the medium has decreased to 2.5-3. At the end of the mixer, calcium hydroxide (lime water) is added to increase the pH of the medium. The cleaning process takes 30 minutes. A precipitate is formed in the neutralizer. To accelerate the precipitation, polyacrylamide is added to the solution.

Better results can be obtained when ferrous sulfate is used as a reducing agent. The process can be carried out in both alkaline and acidic environments.

$2CrO_3 + 6FeSO_4 + 6H_2SO_4 = 3Fe_2(SO_4)_3 + Cr_2(SO_4)_3 + 6H_2O$

$2CrO_3 + 6FeSO_4 + 6Ca(OH)_2 + 6H_2O = 2Cr(OH)_3 + 6Fe(OH)_3 + 6CaSO_4$ $FeSO_4$ consumption depends on the pH of the environment and the concentration of chromium. Favorable process conditions are as follows: T=20° C, pH = 7, consumption of FeSO4 is 1.3 times more than the target.

Summary. 1. Oxidation involving one atom of oxygen. 2. The combination of ozone molecule with the oxidizing substance forming ozonides. 3. Catalytic acceleration of the oxidizing effect of oxygen contained in ozonated air. 4. The reaction mechanism of ozone destruction is very complex, because many factors affect the rate of destruction. These factors include the conditions of the transition of ozone from the gas phase to the liquid phase, the ratio between the partial pressure of the gas and its solubility in an aqueous solution, and the kinetics of ozone oxidation of pollutants in water.

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