USE OF PHOTOCHEMICAL METHODS IN TECHNOLOGIES OF WATER TREATMENT

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It is known, that the simultaneous processing of water by oxidizers (ozone, hydrogen peroxide) and ultra violet light increases the rate of oxidation of dissolved organic molecules in 100-10000 times, thus mutual amplification of action of ozone and UV-light is observed. Various organic pollutions: halogen hydrocarbons (chlorvinyl, dichloroethane, tricloroethylene, perchloroethylene, chlorbenzene, chlorphenols), aromatic (benzene, toluene, xylol, ethylbenzene) and polycyclic (naphtaline, anthracene, pyrene, benzpyrene) hydrocarbons, herbicides (atrazine, propazine, bromazile), other harmful compounds (phenol, spirits, aldehydes, oils, fats, carbocxilic acids et al.) are effectively decomposed. Usually the reactions go up to complete mineralization of organic compounds, the detoxication of number of inorganic compounds (nitrites, cyanides, hydrazine et al.) is also observed.

At last time the joint action of an oxidizer and UV-light is considered as perspective technology for application for water treatment. The number of firms creates installations by productivity 1-10 m^3/h, using hydrogen peroxide.

The work over practical use of photochemical methods is begun by us a few years ago. It is shown, that using ozone as an oxidizer when excitation by UV-light in a maximum of its absorption band (photolitic ozonization) enables to create installations with specific power consumption in 5-7 times smaller, than with peroxide. Optimum ratio between amount of ozone submitted in unit of time and power of a source of light are determined. It is established, that for maximum efficiency of purification process it is necessary to carry out the reaction in heterogeneous system water - ozone-air mix. The flowing photochemical reactor with thin water layer, for which the opportunities of method of photolitic ozonization on a few model pollutants are experimentally checked, has been designed. It is demonstrated that the efficiency of use of ozone at photolitic ozonization much raises (even for the simplest reactor the efficiency of ozone using increases from 20 to 70 %), oxidation of organic molecules goes up to complete mineralization, the necessary time of contact for oxidation and sterilization decreases in comparison with ozonization (till several seconds).

The degradation of water solutions of pentachlorphenole was investigated in detail. The data received show that degradation of pentachlorphenole occurs much more effective at simultaneous action of UV-light and ozone in comparison with simple ozonization and goes up to complete mineralization. The measuring for concentration of cloride ion have shown evolving stoichiometric amount of ions Cl^-, adequate to complete dechlorination of pentachlorphenole molecules. Spectral data show, that during the time of processing complete destruction of benzene ring occurs, and pH-metric measurements find out increase of acidity, appropriate to stoichiometric amount of hydrogen ions, formed at complete oxidation of pentachlorphenole. In a range of concentration of pollution 0,8 - 12 mg/l the decreasing of concentration of pentachlorphenole not less than in 100 times was observed at passage of water through reactor during 4 sec.

The tested technical decisions are applied by us at the development of a design of the domestic device for water purification with productivity up to 30 l/h at consumed power 40 W. The device is especially effective for removal of those impurities, which poorly leave at centralized clearing of water (phenol, halogenorganic compounds, heavy metals) and provides reliable sterilization of water even at its strong initial bacterial contamination. The device has been sertificated by Gosstandart RF. Its serial issue by the joint-stock company "Pirometr" is begun.

Installations for photochemical water purification with productivity 1-6 m^3/h are designed and issued by small series. The modular principle of construction allows to mount installations with various productivity and to use them for preparing of drinking water of high quality, in systems of clearing and sterilization water of swimming pools with volume up to 100 m^3, and also in technological chains cleaing and disinfection of waste waters, containing plenties of organic pollutions. In comparison with existing analogues (adsorbtion-filtering and ozonizating devices) created installations have the following basic advantages:

- high, unattainable by other ways, degree of removal of impurity (up to one part per trillion) and disinfection (decrease of concentraton of microbiological pollutions not less than in million times);
- low capital and operational expenses, caused by compactness, small metal consumption and small power consumption (at concentration of pollutants up to 5 mg/l the power consumption do not exceed 250 Wh/m^3).

The calculations show perspectivity of application of the given method for purification of large volume of water on stations of centralized water supply for providing of clearing and sterilization without water chlorination. Such systems can be grouped from the let out industrial equipment for UV- sterilization and for ozonization of water.

The laboratory experiments have also confirmed the efficiency of method for treatment of waste waters (including the purification of strongly polluted waters of waste storage area ""Poligon Krasnyi Bor ""). On the waste storage area " Krasnyi Bor " the accumulation of industrial liquid organic waste products is made into the trenches, disintered in the thickness of Cambrian clay. In the trenches there is the lamination of waste on three layers: top - combustible, middle - water and bottom - ground sediments. In present more than 600 000 m^3 of water have been accomulated, containing up to 0.3% of emulgated petroleum, up to 3% of mechanical suspended matter, SAS, dissolved organic and inorganic compounds, with characteristic for it COD up to 4500 mg O_2/l. The general aim is reduction of volume of a water layer by pouring off the purificated water in natural reservoirs.

The direct application to strongly polluted waters of a method of photolitic ozonization cannot be effective. Therefore we offered the multistage technology of clearing, including stages of flotation and coagulation (electrocoagulation). However, after passage of these steps the water still contains a plenty of dissolved petroleum and various dissolved organic compounds.

Application of method of photolitic ozoning by introduction 0,1 g of ozone per litre of processable water with simultaneous influence of UV-radiation with electrical power 8 W for 1 g of ozone per hour allows to obtain water with quality, admitting further biological purification. It is not possible to obtain water of similar quality at comparable time of processing and ozone dozes with ozonization only.

It was established with methods of biological testing with test - object Daphnia magna that the purificated water finds out biological attributes, characterising the waste water,

wich already passed the processing in airtanks. The bringing of water to quality, admitting the pouring off into natural reservoirs can be carried out with the help of typical sedimintation tank with water-plants.

The installation for water processing in water storage area with productivity 20 m^3/h should have electrical power no more than 50 - 60 kW, i.e. specific power expenses will make 2.5 - 3.0 kWh/m^3 with the charge of coagulant ~ 200 g/m^3.

The appearance of free metal ions as result of complete mineralization of metallorganic compounds has allowed to use the photolitic ozonization for preparation of samples of water for the analysis of the contents of heavy metals with a voltamperometric (potentiometric) method.

In natural waters the significant amount of heavy metal ions is in a connected condition (they enter into the structure of metalorganic complexes and also are kept by microbes and bacteria) and is inaccessible to registration by voltamperometric methods. At using of photolitic ozonization it is possible to exclude a stage of long-duration boiling of water probe with addition of hydrogen peroxide for evolving of metal ions from complexes and to make uninterrupted process of measuring of concentration of heavy metal ions.