ORGANIC COMPOUNDS DESTRUCTION BY A RELATIVISTIC ELECTRON BEAM IN WASTE-WATERS

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The electron beam influence on the decomposition of organic compounds in effluents has been investigated. In the tests, waste-water has been processed with a relativistic electron beam of the energy 3...4 MeV, formed with a linear resonance accelerator. The model samples of the following solutions have been put on trial: nitrite-, nitrate-, ammonium- and phosphate ions, glucose and purified kerosene. The results of the investigations have indicated that the application of relativistic electron beams is prospective for the water purification from these organic compounds.

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1. INTRODUCTION

Organic compounds, oil products included, belong to the mostly wide spread and dangerous substances, which contaminate the environment.

Petroleum and oil products are poorly oxidizable in sewerage purifying installations as well as under the natural conditions (in water reservoirs). Domestic and industrial effluents bring nitrogen into the urban waste waters (especially those from the enterprises of food industry). Ammonia nitrogen is coming from chemical, metallurgical, petrochemical, varnish-and-paint, photographic and other enterprises. Effluents from the fertilizer manufactures contain ammonia nitrogen in especially large quantities.

Therefore, diminution of concentrations of nitrogen, phosphor and oil products in the purified waste water makes one of the serious and actual problems. In this connection, it is urgent to elaborate new effective methods of the water purification from mineral oils. One of these methods consists in the application of a relativistic electron beam.

Choosing the chemical compounds to be decomposed under the relativistic beam influence, the authors above all have proceeded from the extent to which these substances has been disseminated in waste- and surface waters as well as from the influence of the compounds on the environment. On the basis of these considerations, oil products, glucose and mineral compounds of nitrogen and phosphor have been chosen. Model samples of water solutions of these substances have been prepared for the investigations.

2. TECHNICAL APPROACH

Because of a very poor solvability of oil products in water, the starting model solutions had been prepared with the help of the ultrasonic disperser. Further the corresponding quantity of the dispersion obtained was injected into the tap water. The quantity of oil products has been determined by the method of infrared spectrophotometry. First, oil products had been extracted with the help carbon tetrachloride. Further, polar compounds were separated from non-polar ones (oil products) by the method of column chromatography. Model solutions of nitrite-, nitrate-, ammonium- and phosphate ions have been prepared by diluting the basic standard solutions, with the distilled water.

The method of determination of the content of nitrates is based on the interaction between nitrate- and sallicylate ions in a sulphate medium. As a result, there comes into existence a mixture of 3- and 5- nitro-salicylic acids.

Studying decomposition of organic compounds, we used the model solution of glucose. Glucose was put into dechlorinated tap water. The results of determination of the chemical consumption of oxygen served for determination of the content of organic compounds.

For the water sample irradiation with doses of relativistic electrons, we have used the linear resonance accelerator of electrons. Parameters of the beam, formed with this device are the following: the electron energy is 3...4 MeV; the electron current is 0.5 A; the current pulse duration is 2 μs. The irradiation dose absorbed by the sample is measured with the help of dacryl sensors. In Fig.1, one can see the electron energy spectrum.

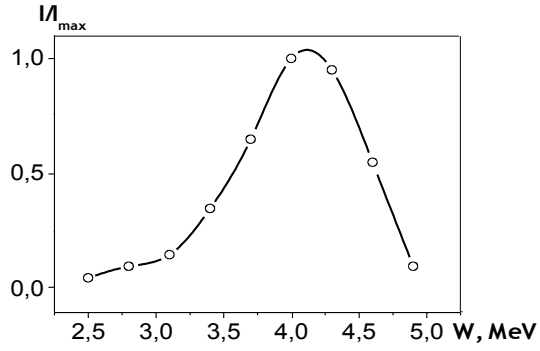

Fig.1. The beam energy spectrum

In the experiments, the mode of operation of the accelerator has been chosen so as to get a wide-range distribution of the electrons in energy at the accelerator output.

Water samples have been irradiated in the pans of stainless steel, especially elaborated for this purpose. Their height is 50 cm, the width is 5 cm and the depth is 2 cm. The pans are pressurized with a mylar film of thickness 50 mcm, which minimizes the beam energy losses.

Uniformity of the beam energy distribution over the water sample volume, in general, does not exceed 10% in the experiment. Under the condition of water agitation, this parameter is much low.

3. EXPERIMENTAL RESULTS

Irradiation of model solutions of glucose with the beam doses (2.4...32) kGy results in an inessential decrease of the organic compound concentration (by (9.4...20.0)%). An increase in the energy expenditure on the mentioned parameters has stimulated the diminution in the glucose amount by (1.5...5.6)% in comparison with the initial value (see Fig.2).

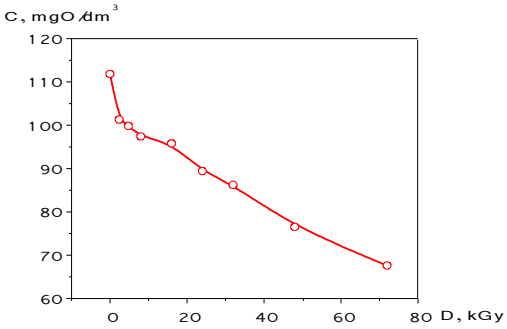

Fig.2. The glucose decomposition as a function of the irradiation dose

To start with the dose 48 kGy, the augmentation in the decomposed compound quantity makes about 10%.

The beam effect on oil products is characterized by the analogous specificity. The irradiation with the dose 48 kGy has caused decomposition of 50% of kerosene in the model solutions, which is by 17.1% larger than the amount decomposed with the beam dose 2.4 kGy.

Among inorganic compounds, nitrites become decomposed most readily under the beam influence. We have tested the model solutions, where the nitrite concentration is 6 times higher than the indices, tolerable for the drinking water. As Fig.3 illustrates, more than 50% of the given compound is neutralized already with the irradiation dose 4.8 kGy. Heightening the dose up to 12 kGy has permitted reducing the nitrite content down to the concentrations, safe for the people health.

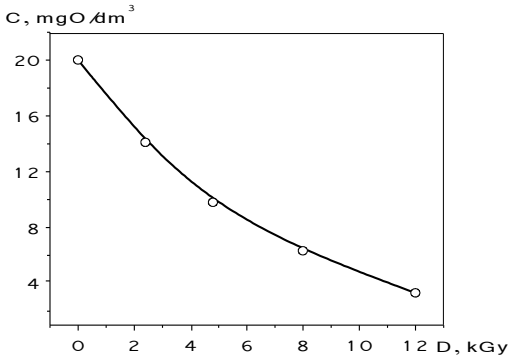

Fig.3. Decomposition of nitrites in model solutions (in the initial concentration 20 mg O/l) by their irradiation with various doses

Processing of model solutions of nitrates, phosphates and ammonium ions with the irradiation dose 2.4 kGy does not affect the initial concentrations of the given compounds.

4. CONCLUSIONS

The beam influence on chemical compounds was investigated with the help of the model samples of solutions of oil products and nitrite, nitrate and ammonium ions (the irradiation dose was up to 20 kGy).

Irradiation of the water model samples containing oil products in the initial concentration about 5mg/dm^3 has resulted in diminution of their total content by 60% (the irradiation dose was 16 kGy).

As regards the beam influence on the solutions of glucose in the initial concentration 100mg/dm^3, the irradiation has diminished the glucose content by 30% (the irradiation dose was 20 kGy).

Thus, this work has demonstrated that relativistic electron beams are really prospective for decomposition of organic compounds, prevalent in sewage.

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РАЗРУШЕНИЕ ОРГАНИЧЕСКИХ СОЕДИНЕНИЙ СТОЧНЫХ ВОД РЕЛЯТИВИСТСКИМ ЭЛЕКТРОННЫМ ПУЧКОМ

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Выполнен цикл исследований по влиянию релятивистского электронного пучка на разрушение модельных образцов растворов нитрит-ионов, нитрат-ионов, амонийного иона, фосфат-ионов, глюкозы, керосина.

Показано, что использование релятивистских электронных пучков является перспективным для очистки сточных вод от этих соединений.

РУЙНУВАННЯ ОРГАНІЧНИХ СПОЛУК СТІЧНИХ ВОД РЕЛЯТИВІСТСЬКИМ ЕЛЕКТРОННИМ ПУЧКОМ

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Виконано цикл досліджень по впливу релятивістського електронного пучка на руйнування модельних зразків розчинів нітрит-іонів, нітрат-іонів, амонійного іону, фосфат-іонів, глюкози, гасу. Показано, що використовування релятивістських електронних пучків є перспективним для очистки стічних вод від цих сполук.