Physicochemical treatment of waste water from complex organic substances

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Abstract. This paper considers with the issues of extracting polycyclic hydrocarbons from wastewaters by using physicochemical technology, including the use of flotation, settling, filtration, adsorption, ozonation. The usage of this technology could significantly reduce the concentration of such hazardous substances as benzopyrene in the treated wastewaters. Under certain regimes of wastewaters treatment using physicochemical technology, the concentration of benzopyrene does not exceed the standard values. The prospects for the usage of bioflotation harvesters for the treatment of wastewaters, which contains complex organic substances are indicated.

Polycyclic aromatic hydrocarbons (PAHs) are the most common substances in nature, inter alia, in the atmosphere, water, soil, plants, food, powerplant emissions, ferrous and non-ferrous metallurgy, chemistry and petrochemistry, etc. PAHs are supertoxic organic substances, some of which are carcinogenic. Wastewaters, which contains such substances, must be rendered harmless from such contaminants.

Many developers have shown that adapted bacteriocoenosis is in position to utilizing oil and petroleum products to safe substances, PAHs - benzopyrene, naphthalene, phenanthrene, biphenyl, phenol and its derivatives, cyanides [1-17]. The efficiency of using traditional biological treatment facilities for the removal of organic pollutants for these purposes is directly related to the possibility of adaptation of the activated sludge bacteriocoenosis. At biological treatment plants, autoselection of bacteriocoenosis occurs under the influence of incoming effluents. There are many examples of microbial biocoenosis adaptation to organic pollutants. This process could take a long time. So, the time of adaptation to different concentrations of phenol of bacteriocoenosis of activated sludge on treatment facilities, which received phenol-containing industrial wastewaters, was about 60 - 75 days or even more. In this regard, the task of changing the composition of the bacterial community during the oxidation of xenobiotics becomes an important scientific and practical task, since it allows predicting the possibilities of their biooxidation.

The development of biochemical research methods has led to the emergence of new directions in the study of the processes of decomposition of xenobiotics in biological treatment systems. In particular, works have appeared on laboratory modelling of the decomposition of xenobiotics using activated sludge [17].

The analysis carried out according to the sources of scientific, technical and patent literature [1-18] showed that PAHs, incl. benzopyrene, trichloromethane, carbon tetrachloride, naphthalene, etc., are resistant to oxidation substances in the process of biological wastewaters treatment. The data noted in...
the literature [13] show that the oxidation rate, for example, of benzopyrene, is about 60%, using special selective strains of microorganisms. It should be noted that the usage of bio-flotation harvesters is very promising for the biological oxidation of PAHs [19, 20].

Thus, the results of studies have shown that the microflora of wastewaters, which are contaminated with PAHs, is capable of destroying PAHs, including benzopyrene. Consequently, in nature, processes of destruction of aromatic compounds are constantly going on in wastewaters. The destruction of PAHs by the microflora of wastewater can be enhanced by adding a culture of microorganisms that actively oxidize PAHs. However, the results of biological treatment do not always give a guaranteed result. In this regard, the problem of finding alternative ways of extracting complex organic pollutants from water arises. One could use other methods, for example, ozonation, exposure to ultraviolet light. In this case, the oxidation efficiency reaches about 90% [12]. In the course of our experimental studies, it was found that physicochemical methods are the effective methods for extracting of complex organic pollutants from water.

On the basis of the researches carried out, we proposed an original technological scheme for the treatment of wastewaters, which contain complex organic substances.

Figure 1 shows us an apparatus and technological scheme for the treatment of wastewaters, which contain PAHs.

![Figure 1. Apparatus and technological scheme of the plant for treatment of wastewaters, which contain PAHs.](image)

The principle of operation of the plant (Figure 1) is as per below given. The original wastewater enters the receiving tank 1, from which it is pumped out into the flotation harvester 4 with the help of the pump 3. Then the water enters the intermediate collector 7, from which, by means of the pump 8, it is sequentially supplied to the mechanical filter 9 and then to the adsorption filter 11 and is accumulated in the collector of clean water 13. This also uses the stage of water treatment with ozone using the device 10 and ultraviolet using the device 12.

Removal of sediment from the receiving tank 1 is carried out using the pump 2, and removal from the flotation harvester - using the filter 5 with a perforated surface. In this case, the filtered water is accumulated in the collector 6.

The results of control tests analyses are shown in Table 1. (in the column “actual concentrations”, the values of the source (contaminated) water / purified water are sequentially indicated).

Analysis, being represented in data Table 1, shows that for all the considered indicators, the standard values are achieved. This testifies to the effectiveness of the proposed wastewater treatment technology.
Table 1. Results of experimental tests of physical and chemical wastewater treatment.

| Substance                                      | Concentration above which discharge is prohibited | Actual concentrations, mg/l |
|------------------------------------------------|--------------------------------------------------|-----------------------------|
| HYDROGEN ION CONCENTRATION (pH), units        | less 4.5 or over 12                               | 7.94/8.55                   |
| NITROBENZENE, mg/dm³                          | 0.04                                             | 0.06/-0.0002                |
| ANILINE (AMINOBENZENE, PHENYLAMINE), mg/dm³  | 0.0004                                           | 0.0009/-0.0002              |
| BENZOPYRENE, mg/dm³                           | 0.00002                                          | 0.011/-0.00002              |
| NAPHTHALENE, mg/dm³                           | 0.016                                            | 0.19/-0.01                  |
| TETRACHLOROETHYLENE (PERCHLOROETHYLENE), mg/dm³ | 0.02                                             | 0.07/-0.001                 |
| 1,2-DICHLOROPROPANE, mg/dm³                   | 0.08                                             | 0.12/-0.01                  |
| 1,2-DICHLOROETHANE, mg/dm³                    | 0.012                                            | 0.11/-0.01                  |
| BROMODICHLOOROMETHANE, mg/dm³                 | 0.12                                             | 0.18/-0.001                 |
| TETRACHLOROMETHANE (TETRACHLORIDE CARBON), mg/dm³ | 0.004                                           | 0.021/-0.0002               |
| TRICHLOROETHYLENE, mg/dm³                     | 0.02                                             | 0.16/-0.001                 |
| CIS- 1,3-DICHLOROPROPENE, TRANS-1,3- DICHLOROPROPENE, mg/dm³ | 0.02 | 0.17/-0.0001 |
| TRICHLOROBENZENE (SUM OF ISOMERS), mg/dm³    | 0.004                                            | 0.22/-0.0002                |

Purification of such wastewaters from especially toxic substances leads to rather high technological results. Above data indicate the high efficiency of the use of physicochemical methods placed into the technological scheme developed by ourselves (Figure 1).

The represented data allow us to recommend the developed technological scheme for wastewaters treatment for the widespread use in the industrial practice.

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