

**METHODS OF BIOLOGICAL SEWAGE TREATMENT**

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**Abstract**

Biological sewage treatment is the process basing on the microbes activities, which use the dissolved organic pollutants, or those being brought to that form, partially as the energy source and partially as the structural material for the new cellular substance. This way the contaminations are removed from wastes. Products of pollutants decomposition can have solid, liquid and gas form. Processes of the biochemical oxidation (oxy-processes) take place if there is the sufficient quantity of the oxygen dissolved in the microbes' activity environment. In the presence of oxygen, the organic matters decomposition is quicker in comparison with the oxygen-free conditions. On that reason, to the biological sewage treatment plants it is supplied oxygen as the rule.

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There are substances being biologically degradable in short time, and other in long time. Some organic compounds are practically biologically non-degradable (e.g. humus substances). In light of the most up-to-date researches, the answer to a question whether the particular compound is easily or hardly soluble can be obtained only after taking into account sometime just phenomenal adaptation ability of the biological purification system [3].

As the biocenosis adaptation is understood the micro flora and micro fauna adaptation to the changing environment properties, in which those organisms exist. That phenomenon is possible because of the fact that one or few substances of the wastes act as the stimulus provoking production of enzyme, or a group of enzymes, necessary to decompose and use of the nutrients being in that environment.

The microbes adaptation time is differentiated, sometime it amounts to few days and sometime that process lasts for many weeks e.g. the active sludge needs about 20 days to convert into using aniline as the sole source of coal and energy for living processes.

Biological sewage treatment can be conducted in natural, semi-natural and artificial conditions.

Biological sewage treatment in natural conditions consists in disposing them into lakes, rivers, water reservoirs or sea. It is used here the possibility of self-purification of the superficial waters. It is the way used as a rule in relation to wastes being already biologically treated in artificial conditions and it can be used as the process giving the properties similar to natural waters for the wastes.

Biological treatment in semi-natural conditions consists in the purposeful adaptation, using technological means, of the natural water or soil environment to the wastes receipt, what enables in its turn some natural process of the biological decomposition of the organic substances contained in the wastes. For such kind of sewage treatment are used waste ponds, soil and field systems (irrigated fields, soil filters and filtrating trenches).

Sewage treatment in artificial conditions consists in the multiple intensification of biochemical processes of the organic matters decomposition taking place in natural or semi-natural conditions through using the relevant technological equipment and creating the optimal growing conditions for the complex of living organisms constituting some part of the natural environment therein. To the biological sewage treatment in artificial conditions are used: bio-filters, active sludge plants, fermentation chambers.

## BIO-FILTERS

Bio-filters are the equipment for the oxygen bio-chemical decomposition of organic pollutants contained in the wastes. The basic filter element is a material, on whose surface develops the mucilaginous film, called biological film, composed of plant and animal microorganisms, mainly bacteria. Those microorganisms use the pollutants as the food, decomposing the organic matters contained in the wastes being in contact with the biological film.

Sewage treatment using the bio-filters is arranged in two stages. During the first one takes place the sorption of organic pollutants contained in the wastes on the biological film surface, and thereafter the pollutants are utilised as the food by microbes living on the film. It is accompanied by the film mass increase as well as by the waste pollutants removal. Wastes flow on the biological film surface causes also mechanical separation of its excess from the filter material surface and the outflow of the mixture of purified sewages with fragments of the biological film from the filter. The second sewage treatment stage using the bio-filters is the separation of the biological film fragments from the wastes purified, generally as a result of the sedimentation in secondary settling tanks, though that separation can take place on micro-screens too.

Decomposition processes of organic matters contained in the wastes supplied to the filter take place in oxygen conditions and they are connected with emission of gas products of bio-chemical transformations. It requires securing the inflow to the biological film of the adequate quantity of oxygen from the atmospheric air as well as the removal of the gas products of bio-chemical transformations. Therefore, the biochemical process of pollutants decomposition by the filter's biological film requires securing the contact of wastes with the film with practically simultaneous inflow of oxygen from the air.

Contact of wastes with the biological film is secured by:

- periodical flooding the filter with sewages,
- flowing the sewages through the filter's layer,
- periodical immersing the filter into the sewages.

In this connection the following kinds of bio-filters are classified:

- filters flooded – now out of use,
- filters sprinkled, which can operate as the equipment for organic matters removal (removal of organic coal compounds expressed by BOD<sub>5</sub> and COD indices) or for the amine nitrogen removal,
- filters immersed, also called as disk or rotational one, using which it can be conducted the same processes as in the case of the application of filters sprinkled.

Air inflow to the biological film is connected in the high degree with the way of securing the contact of sewages with the biological film and it can be secured by:

- sewages removal from the filter during the periodical filters flooding (filters flooded),
- air flow through the filter's layer caused by so called natural draught (filters sprinkled),
- periodical emersion of the filter from sewages alternating the periodical immersion of the filter into sewages (filters immersed).

Removal from the biological film and its vicinity the organic matters decomposition products takes place automatically as a result of the diffusion of those products to the air and wastes being in contact with the film and as a result of rinsing out the fragments of the atrophied film from the filter by the sewages purified as well.

Sewages being treated in the bio-filters are as a rule preliminarily mechanically purified. In the case of home sewage treatment plants, the role of an equipment for the preliminary purification plays the two or three chambers' putrid settling tank.

It results from the above-described description of the pollutants biochemical decomposition process in bio-filters that the technological implementation of the process requires the application of the bio-filter and the secondary settling tank, connected with each other hydraulically and co-operating technologically.

As a rule, besides those two plants are used also the equipment for the re-circulation of a part of the sewages treated. The re-circulation purpose is to reduce the contaminants concentration in sewages supplied to the filter or to obtain such a hydraulic load of the filter surface with sewages, to be possible to separate fragments of the biological film. Such equipment complex i.e. bio-filter, secondary settling tank and re-circulation system, is independent on the size of the sewage treatment plant and therefore it is also valid for the home sewages treatment plants.

About the operation effectiveness of the bio-filters sprinkled decides the below-mentioned technological parameters:

#### a) filter load with organic pollutants

$A$  in kg BOD<sub>5</sub>/m<sup>3</sup>d.

Value of that parameter decides about the volume of bio-filter's filling since:

$$V_w = \frac{L_{BOD_5}}{A}$$

where:  $V_w$  – volume of filter's filling [ $m^3$ ]

$L_{BOD_5}$  – organic pollutants load (expressed in  $BOD_5$ ) in sewages supplied to the filter, comprising the load in sewages flowing out from the preliminary settling tank and the load in the re-circulating sewages ( $kg\ BOD_5/d$ )

b) **hydraulic load of the filter's surface**,  $q$  in  $m^3/m^2\ h$ . Value of that parameter allows to determine the required filter's surface area, and so:

$$F_z = \frac{Q_{calc}}{q}$$

where:  $F_z$  – required surface area of the biological filter [ $m^2$ ]

$Q_{calc}$  – calculative sewage flow comprising sewages flowing out from the preliminary settling tank and the re-circulating sewages [ $m^3/h$ ];

c) **kind of filling**, and especially its **specific surface** i.e. its extended surface falling per  $1\ m^3$  of the filling volume,  $F_w$  [ $m^2/m^3$ ]

d) **load of the filling specific surface with the organic pollutants' load**,  $A$ . That value can be determined from the formula:

$$A = \frac{L_{BOD_5} \cdot 10^3}{V_w \cdot F_w}, g \cdot BOD_5 / m^2 \cdot d$$

e) **filling height**,  $H_w$  [ $m$ ] depends first of all on the kind of filling and  $BOD_5$  value in sewages supplied to the filter i.e. in the mixture of sewages after the preliminary settling tank and the sewages re-circulated;

f) **re-circulation degree**,  $R$ , of sewages expressing the relation of the re-circulated sewages quantity  $Q_R$  to the quantity of sewages supplied from the preliminary settling tank  $Q$ ,

$$R = \frac{Q_R}{Q}$$

g) **temperature in the filter**, depending on the sewages temperature and the ambient air temperature;

h) **sewages treatment effectiveness**,  $\eta$ , which can be referred to various pollutants indices, but first of all to  $BOD_5$  value. Sewages treatment effect referred to  $BOD_5$  can be expressed by the following formula:

