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THE TERTIARY TREATMENT STAGE OF WASTEWATER

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Abstract: *At present many of the substances discharged into the wastewater sewerage are not eliminated by classical methods (mechanical and biological) of sewage treatment plants. The presence of these substance (especially compounds of nitrogen and phosphorus) in the treated sewage water has a significant impact on the environment and on human health. The treatment of drinking water taken from the respective emissaries water require additional costs. The removal process of resistant substances can physical, physicochemical or biological methods. Each of the processes are the tertiary treatment stage, that could complement current wastewater treatment plants technology.*

Key words: *wastewater treatment plant.*

1. Introduction

The extension of sewer systems following the increase degree of comfort in all populated areas determined diversification of substances discharged, some of these without being neutralized by conventional treatment stages: mechanical and biological.

In mechanical treatment stage normally eliminate the solids in suspensions (sedimentation) and the oils. In biological stage to ensure a high elimination of organic solids, dissolved or in suspension.

However there are often resistant substances that can not be eliminated and are discharged into natural water courses with the treated water. Theses resistant substances can have a negative impact on human health, even if present in a small percentage in drinking water.

In additional the effect of spill of resistant substance appears in the emissary where it is found the floating materials, foam, large areas with algae, bad smell or coloration of natural water.

The effects of resistant substances on the environment and human heath have determined the development of technologies that complement the classical methods used in sewage treatment plants.

Often downstream of areas where natural water courses (emissary) take over treated wastewater are points which are the source of drinking water for other localities. For these reasons are imposed severe conditions for the retention of organic substances, suspensions and specific toxic compounds in wastewater treatment plants.

Thereby in the seventh decade of the past century was outlined the notion of "tertiary treatment" or "advanced treatment" of wastewater.

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Usually the tertiary treatment stage include supplementary procedures to classical biological treatment (biological oxidation of organic substances).

2. The necessity of Introducing Tertiary Treatment Stage

The main resistant substances over which have focused in recent decades the research in this domain are the compounds of nitrogen and phosphorus, that cause expansion of planktonic algae in emissary water, with important impact of the environment.

In the classical treatment plant the nitrogen and the phosphorus are reduced as follows:

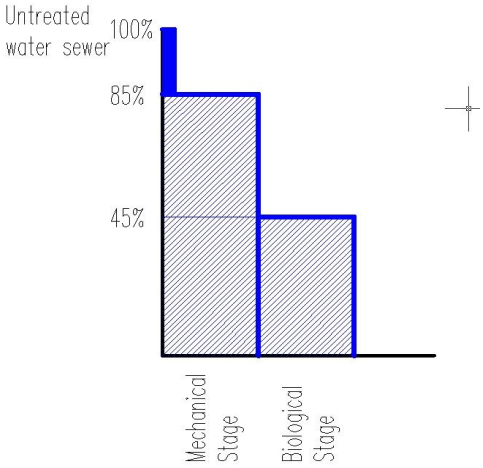

Fig. 1. *Reducing the concentration of nitrogen*

Thereby in sewerage treatment plants with mechanical and biological stage the efficiency is 55% nitrogen reduction and 40% phosphorus reduction.

The growth of algae due to increased concentration of nitrogen and phosphorus in the emissary water has long terms effects of environmental pollution and the later treatment of drinking water. The development of tertiary treatment processes is a permanent concern of specialists in this domain.

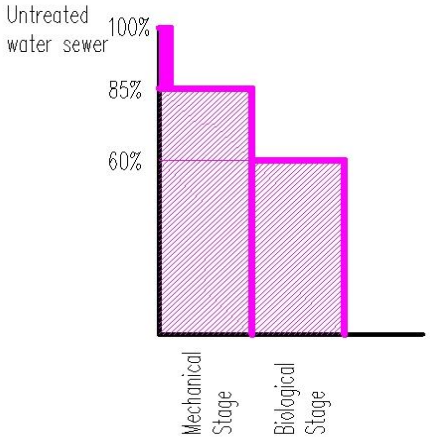

Fig. 2. *Reducing the concentration of phosphorus*

The methods used are physical, physicochemical or biological.

2.1. Physical processes of tertiary treatment

The physical methods used for tertiary treatment water are the passing trough microscreeners or sand filters.

The water passing through the microscreener is aimed capture fine particles in suspension, which remained in wastewater after secondary settlement. The sieve of microscreener has maximum size 23μ and its surface is fixed fine particles that determine retention of other particles smaller than the mesh of microsreener.

In figure 3 shows a current user microscreener.

The water enters through the frontal sieve and exits radially, through the sieve of the side surface of the drum. The particles in suspension retained on sieve are removed whith pressurized water, which is recirculated and treated.

To prevent bacterial growth in excessive amount is used the ultraviolet radiation.

Also with good performance in stage tertiary wastewater treatment are used the sand filters similar to those of water supply systems.

Fig. 3. *Microscreener*

The conclusions drawn from practice by using the two methods (microscreeners and sanf filters) are the following:

- both of physical methods are adequate for treatment of higher flow;
- sand filtration is more efficient and economical than use of the microscreeners, but produces a decrease of dissolved oxygen in water treated and it is necessary aeration;
- use of the microscreeners is not recommended for the treatment of wastewater with discharge large quantities of colloid or variable composition;
- advantages of microscreeners using consist in putting into operation easy and oxigenation of flow treated.

The process of oxygenation can be based on oxygen in the air, on ozonated air or on pure oxygen directly. The taking over oxygen from the air is accomplished by aeration installations including:

- diffusers for air dispersion in water (porous materials, porous rigid plastics, elastomeric membrane);
- compressed air system (pneumatic generators type blowers or turbo blowers);
- distribution pipes that connect the compressed air system and diffusers devices.

Another type of aeration equipment is the mechanical installations type agitators which extracts atmospheric air in the form of bubbles and it continuously recirculate in mass of water.

2.2. Physicochemical processes of tertiary treatment

In the tertiary treatment stage can be applied more physicochemical methods: adsorption, chemical coagulation, foaming, electrodialysis, revers osmosis, distillation, freezing, solvent extraction, ionic exchange, chemical and electrochemical oxidation.

The methods most often used are adsorption and chemical coagulation.

Adsorption is the phenomenon of retention on the surface of an element (solid or liquid) of molecules of other substances (in this case the fine particles in suspension which remained in wastewater after secondary settlement). The material used as adsorbent could be active carbon, coke, fine cinders from the gas generator, cinders from thermal power plants, slag from coal gasification, metallurgy slag etc.

The substances retained by the adsorbent can be removed by physical processes (heating or extraction), adsorbent regaining entirely initial properties.

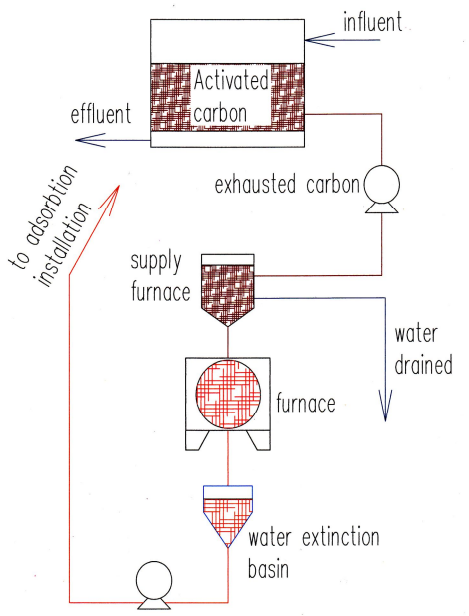

Fig. 4. *Schematic of adsorption installation*

Most often in the installations for treatment by adsorption using active carbon layer with grain size 0,5-2,5 mm and filtering layer height of 1,0-3,0 m. Traverse speed of the water shall be of 5,0-30,0 m/h. But it requires an advanced rinse water before adsorption, more specifically a chemical treatment and water filtration after the exist from secondary settlement.

This adsorption could reduce organic substances remaining after secondary settlement with about 80%.

Chemical coagulation has high efficiency in removal of phosphorus from wastewater, using the following substances:

- ferric chloride in aqueous solution;
- aluminium sulphate in aqueous solution also
- lime powder or water solution.

The firs two substances (ferric chloride and aluminium sulphate) are indicated for removal of phosphates, provided they are properly agitated (by aeration or agitation equipment). Is very advantageous simultaneous use of these substances, which can be lead to total removal of phosphorus from wastewater.

The coagulants can be introduced directly into activated sludge aeration basin (construction of the secondary treatment stage) or in separate installations belonging to the tertiary treatment stage, with all the necessary compartments – preparation, mixture, reaction – installed after secondary settlement. The residual iron can get into the natural water courses, but do not cause the growth of algae.

Extraction is used to recover certain precious substances from wastewater, for example certain metals.

The wastewater in contact with a solvent – that does not mix with water – determine the pollutant removal that is more soluble than water. After mixing, to perform a larger contact surface between two fluids, result separation between the two layers, followed by recovery of the solvent.

The solvent used for the extraction wastewater treatment must meet the following conditions:

- to posses a high affinity towards impurities as compared to that of water;
- to have a low solubility in water;
- do not form emulsions with water;
- do not turn chemically during the use;
- to have a boiling point as distant from the water.

These quality are found in aliphatic hydrocarbons (hexane, isobutylene, isobutene) used for the removal of organic pollutants resistant to biological treatment of wastewater.

2.3. Biological processes of tertiary treatment

Biological processes of tertiary treatment with acceptable efficiency (65-80%) are culture fields irrigation with treated water and stabilization ponds.

The culture fields irrigation with wastewater is a simple method, natural, applied fairly low cost. During passage of wastewater through soil is produced mineralization of organic phenomenon, obtaining the following percentages of reduction:

- 60-65% organic nitrogen;
- 65-85% total nitrogen, by the process of natural denitrifying process.

The irrigation of grassland or hayfields with treated water resulting from the secondary treatment stage is quite spread in Europe. The parcels for irrigation should be cleaned periodically by removing suspended matter deposited on the surface.

The stabilization ponds are also often used in tertiary treatment stage. This method uses algae property to assimilate the nutrients – especially nitrogen and phosphorus – thereby removing them from

the water. In these ponds sometimes grow plants that need fertilizer: rush (*Tipha angustifolia*), hors tail (*Equisetum arvense*) etc.

There is a disadvantage of stabilization ponds: intensive growth of algae in certain periods, which cause the amount of suspended solids. The algae in the natural course water (emissary) removes oxygen in theses periods, causing degradation of the invertebrate fauna, which depend number and variety of fishes.

The culture fields irrigation with wastewater and the stabilization ponds are conditioned by the climate and by the existence adequate surfaces of these constructions.

The best efficiency is obtained in activated sludge basins and in biological filters in which the phosphorus is removed at the rate of 95%. In the activated sludge basin most of the phosphorus is removed by the action of aerobic and anaerobic microorganisms. The same treatment is achieve by adding coagulants (ferric salts) before biological filters.

For removal of nitrogen from sludge is used the denitrifying basins. The sludge microorganisms degrades the organic matter, finally the nitrogen eliminating in the form of gas. The denitrifying is influenced by many factors: temperature, pH, quality of substrate made available to bacterial respiration etc. Using denitrifying as tertiary treatment process the nitrogen is reduced by 90%.

Removing the nitrogen by nitrifying/denitrifying in two stages, as it follows:

- the first stage, the nitrifying one, where the ammonia is changed into nitrate, in an aerobic environment;
- the second stage, the denitrifying one, where the nitrate is changed into gas nitrogen.

In the removing process of nitrogen from the wastewater, there are involved two types of enzymatic systems: assimilating ones and non-assimilating ones. In the assimilating process of reducing the nitrates, the nitrogen as a nitrate is changed into ammoniacal nitrogen in order to be used by the cells in biosynthesis and it occurs when the nitrogen as a nitrate is the only available form of nitrogen. In the non-assimilating process of removing the nitrate, the gas nitrogen is formed of nitrate; the denitrifying of the waste water consists of this process.

Also as tertiary treatment process is considered disinfection that aims the removing pathogens from wastewater, after treatment by classical methods. The desinfection is accomplished by water chlorination, thermal, UV-rays etc.

3. Conclusions

The advanced wastewater treatment also known as tertiary treatment stage is introduced in treatment technology when is necessary to obtain a water superior quality, impossible to achieve by secondary treatment processes. The advanced wastewater should be performed to protect the environment, prevent excess algae in natural water courses – downstream of the discharge point, in order to reusing treated water for drinking water downstream localities.

For choosing the advanced treatment processes must consider the following:

- self-purification capacity of the water flow is made the effluents discharging;
- discharged water treatment costs in order to obtain drinking water in the case of water catchment located downstream of discharge point;
- construction and installation costs for the proposed technology;
- energy requirement for the operation of installations and equipment related to the proposed technology.

At the moment in Romania there are

very few stations municipal wastewater treatment with tertiary stage.

The treated water discharges, bat with important content of nitrogen and phosphorus, result in a low quality of drinking water taken from natural sources, where nitrites should not exceed 0,5 mg/l and nitrates have a maximum concentration of 50 mg/l.

The implementation of tertiary treatment processes is not only current, but urgent also. Should be considered the present legislation and the commitment assumed by the Government of Romania through the document "European Union common position" – Bruxelles, 25 November 2004, Chapter No. 22 – "Environmental protection. Water quality", requiring tertiary treatment in town with over 10,000 population equivalents till the year 2015.

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