Journal of Young Scientist, Volume III, 2015
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

ASPECTS OF ADVANCED WASTEWATER PURIFICATION

Adina CIOBANESCU, Georgiana DONE

Scientific Coordinator: Prof. PhD. Eng. Paulina IANCU

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67, Email: adee.adina05@yahoo.com , georgina.done@yahoo.com

Corresponding author email: georgiana.done@yahoo.com

Abstract

The problem of wastewater treatment is an important issue for environmental protection.
Businesses with different specific according to the law are required to carry wastewater treatment products.
In the meat preparation units appear special problems . The case study shows solutions for removing nitrogen and phosphorus from meat preparation units and cold storage- Mogosoaia.

Key words*: advanced treatment, denitrification, wastewater treatment plant*

INTRODUCTION

The human actions modifying substances penetrate water quality features, leading to an imbalance in the environment. The problem must be related to water quality and use. Conditions quality varies from one use to another, and the range considered acceptable varies in a wide range.
Water quality is most affected by the discharge of human waste water. Therefore, the main practical measure to protect surface water quality is to wastewater treatment.
Water purification is a complex process of retention and neutralization harmful substances dissolved or colloidal suspensions, present in municipal and industrial wastewater, which are not supported in the aquatic environment where the wastewater is treated and allows restoring the physicochemical properties of water before use.

MATERIALS AND METHODS

Processes for removing pollutants from wastewater

Waste water purification can be achieved by methods that are based on the physical, chemical and biological properties which differ according to the type of pollutants and their concentrations in the waste water.
Primary stage (mechanical treatment) consists of retention systems bodies and large suspension (barbecues, site), separation of oils and fats by flotation (grease separators, settling solids in suspension, made in sand-clearing basins and decanters).
Secondary stage (biological treatment) is carried out based on biochemical processes that remove colloidal solids and biodegradable organic compounds. It is made in activated sludge basins in biological filters or lagoons.
Advanced treatment of wastewater or tertiary stage, is a new technological solution from wastewater retention especially nitrogen and phosphorus compounds and other contaminants whose chemical and biological structure do not allow be retaining and disposing of in a conventional treatment plant.

Nitrogen and Phosphorus removal from wastewater

The chemical elements nitrogen and phosphorus are known as nutrients, the substances necessary for life. In situations where these quantities exceed the allowable limit in wastewater pose a negative impact on the environment, becoming aggressive pollutants to groundwater, surface water, soil and air. In the case of surface water eutrophication occurs frequently.

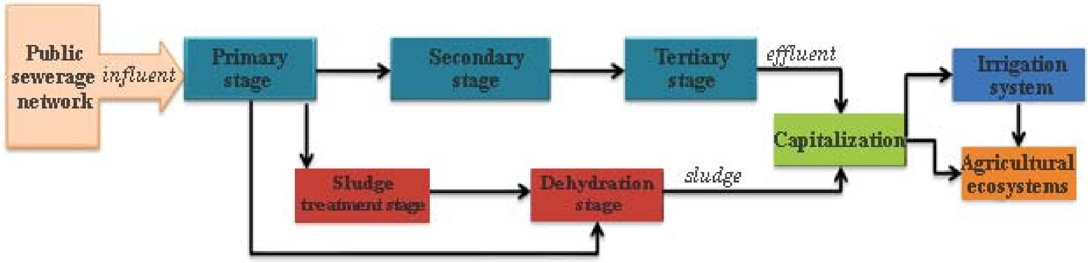


Figure 1. General scheme of water and sludge circuits in treatment plant

Figure 2. General scheme of all wastewater treatment plants

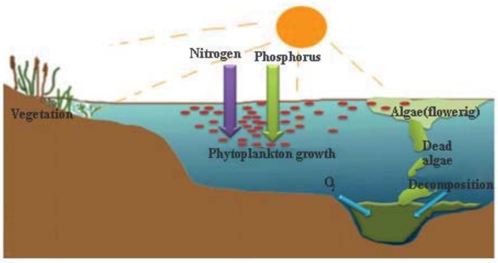


Figure 3. Eutrophication scheme

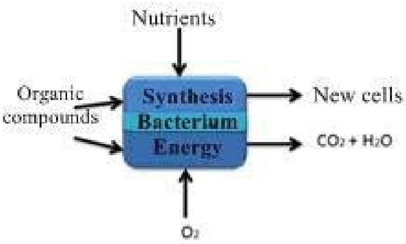
Biological nitrogen removal methods from wastewater:

Domestic wastewater containing organic nitrogen, 60%, and inorganic ammonium about 40%. Biological nitrogen removal from wastewater is done sequentially by nitrification and denitrification.

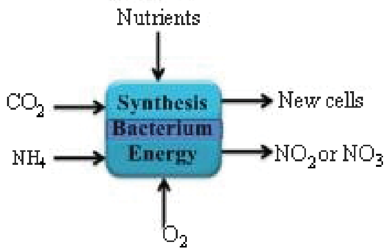
Nitrification stage:

Nitrification is the oxidation of ammonium to nitrite and then of oxidation of nitrite to nitrate, by autotrophic microorganisms. The process can take place in pools suspension or biofilm. The most common method is to achieve nitrification in the same pool that carry and remove carbon compounds (single-sludge system), the process is similar to the activated sludge process, requiring an aeration basin, a decanter and a recirculation system.

Nitrification consists of two important processes: reduction of organic matter, which is carried out by aerobic heterotrophic bacteria (figure 4.a.) and ammonia reduction of nitrogen (nitrification itself) is performed using autotrophic aerobic bacteria populations (figure 4.b.), which oxidize ammonium to nitrate with intermediate formation of nitrite.



a) aerobic heterotrophic



b) aerobic autotrophic

Figure 4. Schematic representation of the metabolism of the bacteria involved in the nitrification

Biochemically speaking, nitrification process involves more than successively oxidation of ammonia to nitrite by bacteria

Nitrosomonas and of nitrite to nitrate by Nitrobacter. It involves many intermediate reactions and enzymes.

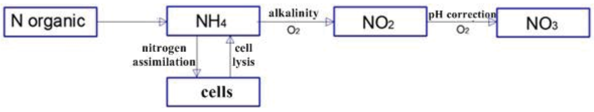


Figure 5. Nitrification scheme

Factors influencing the nitrification are: temperature, dissolved oxygen concentration, pH and alkalinity, organic carbon ratio influent / nitrogen system.

Denitrification stage:

Nitrification process is continued with biological denitrification and consists in the progressive reduction of nitrate to nitrite and nitrite to molecular nitrogen finally, using an oxygen-free environment under the action of denitrifying bacteria. The prerequisite of this reaction is the lack of molecular oxygen instead, to ensure bacterial respiration, nitrate is taken.

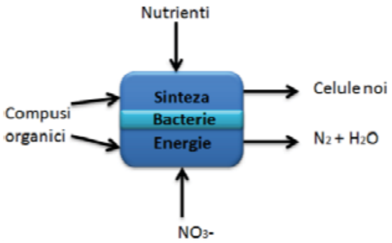


Figure.6. Schematic representation of anoxic heterotrophic bacterial metabolism

The transformation of nitrate in a more easily removed form is achieved by bacteria like Achromobacter, Aerobacter, Alcaligenes, Bacillus, Brevibacterium, flavobacteriu, Lactobacillus, Micrococcus, Proteus, Pseudomonas and spirillum.

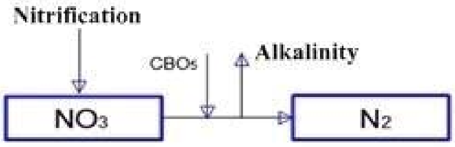


Figure 7. Denitrification process scheme

In the process of denitrification, nitrate and nitrite acts as the electron acceptor in the electron transport chain in the same way as the oxygen.

The process involves the transfer of electrons from a donor electron (eg. The organic substrate) to an acceptor electron oxidized (eg. Oxygen, nitrate, nitrite). Theoretical stoichiometric equations reveal donor electron mass (eg carbon substrate) and acceptor (eg oxygen, nitrate and nitrite) consume, mass of cells produced during any biological process.

Factors influencing the denitrification are: temperature, dissolved oxygen concentration, pH and the presence of the organic layer.

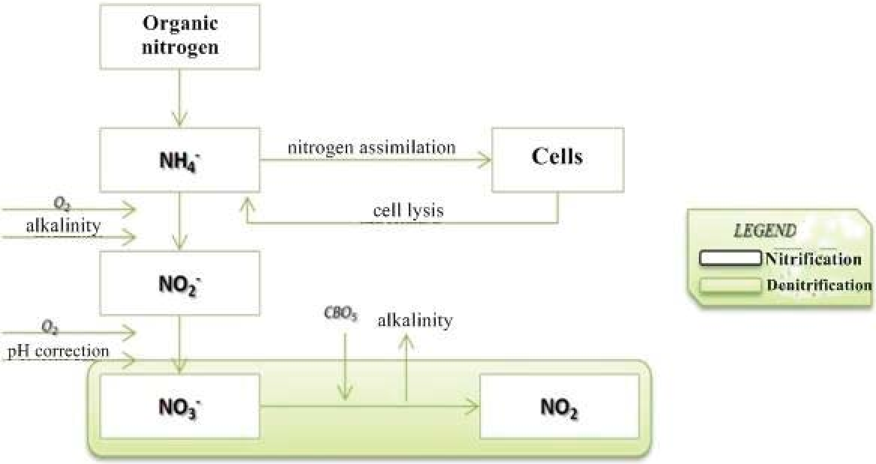


Figure 8. Nitrification – denitrification chart

Methods of removing phosphorus from wastewater:

Removing phosphorus as advanced treatment process can be achieved either by physico-chemical, or on biological pathway.

Chemically removing phosphorus from wastewater, especially loaded with manure, are made based on precipitation and adsorption processes under the influence of coagulants, which connect the form of sparingly soluble salts of iron, aluminum and cadmium, which then decanted. Transformation of phosphorus compounds using these reagents precipitation in achieving a suitable pH conditions leads to the formation of phosphate (PO4-) sparingly soluble and easily sediment flocculants. These compounds have good adsorption capacity of organic phosphates and polyphosphates.

To ensure the formation of agglomerates is recommended that the reagents introduced into the pool to be constantly moving.

Biological method is based on the exposure of microorganisms to alternative aerobic or anaerobic conditions. For removal of phosphorus, it is done in two steps, the effect of aerobic and anaerobic bacteria. To remove phosphorus by biological, it is necessary in the waste water subjected to the treatment process to be a satisfactory quantity of organic substances easily degradable in order to form organic acids and enrichment reserve substances for bacteria.

Phosphorus is retained by incorporating orthophosphates, polyphosphates and organically bound phosphorus in the cellular tissue, total phosphorus is removed from the system depending on the amount of biological floaters actually produced.

• Anaerobic Process / Onix (A / O):

This procedure involves removing phosphorus in biological stage while the oxidation of organic substances based on carbon. The concentration of phosphorus in the effluent depends largely on the ratio of BOD5: P wastewater influent.

• The PHOSTRIP process:

This process involves removing phosphorus sludge line. Thus, part of the return activated sludge is directed into the anaerobic tank for stripping phosphorus

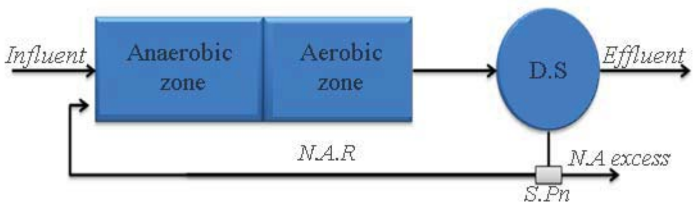


Figure 9. The flowchart of removing phosphorus, A / O

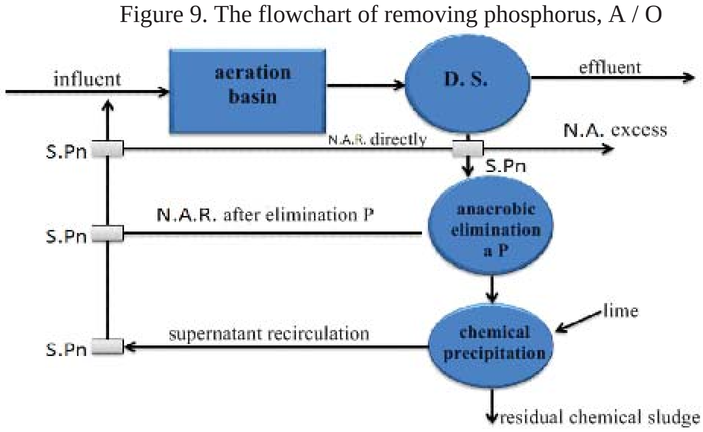


Figure 10. The flowchart of phosphorus removal, PHOSTRIP

• Basins with running sequential process:
It involves removal of phosphorus in 4 phases: filling, mixing or aeration, sedimentation and draining.

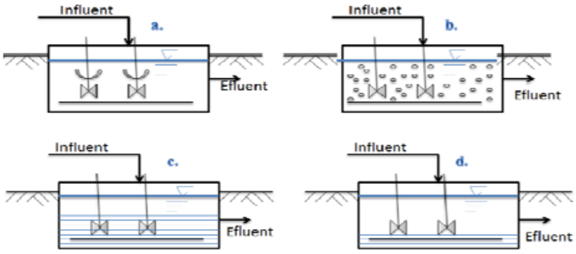


Figure 11. Flowsheet of phosphorus removal in the basin with running sequence (a. fill the basin; b. ongoing biological process - mixing or aeration; c. sedimentation process; d. drain the tank)

RESULTS AND DISCUSSIONS

Case studies – Wastewater treatment plants for meat preparation unit and warehouse frigorific Mogosoaia

Characterization of industrial unit

The warehouse is certified for cold storage, meat processing and trade under intra-Community rules, including sanitary veterinary authorization for intra-Community trade in food of animal origin. Meat processing plant has a processing capacity of 10 tons of meat per shift (8 hours) and can process meat and meat products of pork, beef, mutton, chicken, turkey, except fish.

Processed products:

The unit will provide processing and processing of meat and delicatessen products, including products ready for selective distribution, ex. grilled minced meat rolls and sausage, automatic packaging from 500 grams to 25 kg per casserole. Minced meat production will have a capacity of 2 tons per hour, free pregnancy 3.5 tons per hour, reaching up to 40 tons of minced meat daily.

• Average daily flow Qzi med: 12.28 m3 / day
• Maximum daily flow Qzi max: 16 m3 / day
• The average hourly rate Qo avg: 1.53 m3 / day
• The maximum hourly rate Qo max: 4 m3 / day
• Working time: 8 hours / day

Treatment plant

The treatment plant consists of mechano-chemical and biological treatment stage. Mechano-chemical treatment step consists of: grilled rare, grill often, mixing tank, flotation unit adios chemicals. From homogenization tank, wastewater is pumped into the grill (filtration plant) and then the dissolved air flotation unit (DAF) with automatic system of recruitment, timer and addition of chemicals. The operating principle of this dissolved air flotation units is based on the formation of fine air bubbles with sizes ranging from 30-50 micrometres in suwspensie adhering particles, grease, oil, grease, etc.

It utilizes dosing of chemicals (coagulant and flocculant) before placing in water concentration unit. They coagulation-flocculation processes take place after which it can hold about 80-90% of the total suspended solids in wastewater and existing fat and 50-60% of BOD5 and COD loads.

Before arriving in flotation unit, the water goes through a chemical mixing system where chemical injection occurs from precipitation and flocculation system. The precipitation and flocculation system is the precipitating agent dosing unit and the flocculant preparation and dosing unit. Particles float to the surface are removed mechanically and are downloaded to the upper phase separation compartment using a scraper, while the treated water will be discharged by gravity and go biotreater. The particles settled out of the concentration unit are removed by pneumatic valve for sediment extraction and collected sludge storage tank.

The whole process is fully controlled through a control panel. Biological treatment step consists of: tank selection, denitrification tank, nitrification tank and sedimentation tank.

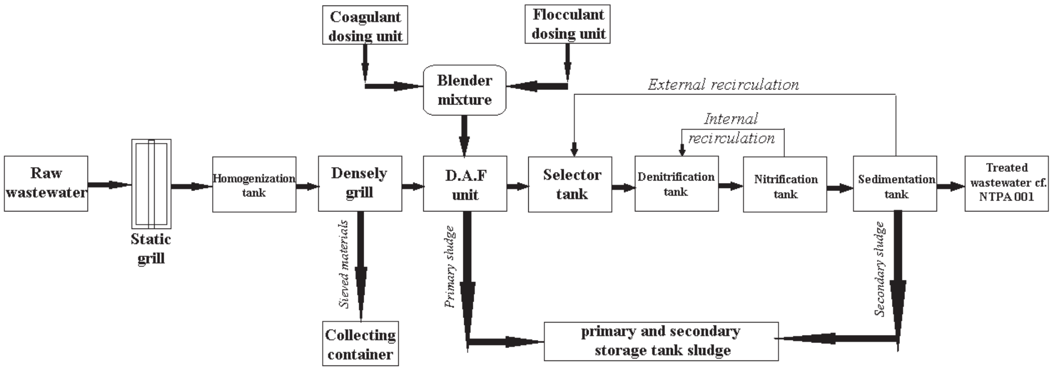


Figure 12. Operating Chart station

Pool of denitrification

From selector mixture wastewater-biological sludge reaches the denitrification tank. Denitrification is the biological process of transformation of nitrates into nitrogen gas under the influence of biochemical catalysts

Part of nitrate is formed in the next stage of nitrification. This part of nitrates will be reintroduced in the denitrification tank as external recirculation flow rate of sedimentation in the selector. In this way, the necessary quantities of nitrates are placed in the denitrification tank for nitrogen removal.

Specific binding of bacteria anoxic activated optional in this basin, metabolize organic substrate in the presence of adequate amounts of nitrates as "oxidants" in place of molecular oxygen. Part of organic pollution is eliminated while simultaneously reducing nitrates. This process is accompanied by release of nitrogen in the atmosphere. Furthermore, by removing a portion of the nitrogen in this stage will be significantly reduced tendency flotation (by removing gaseous nitrogen) which would lead to flotation sludge is downloaded, thus adversely affecting the operation of sedimentation.

Pool of nitrification

From the denitrification tank, wastewater and biomass mixture passes in nitrification tank, where aerobic treatment and cultivation of activated sludge is. Here are kept optimal aeration conditions necessary for the growth of microorganisms groups, aerobic conditions under which biomass is able to use and break down of wastewater organic substrate (organic pollutants).

To maintain a high concentration of dissolved oxygen in wastewater-sludge mixture and maintain turbulent conditions in the aeration tank (to prevent unwanted sedimentation sludge) tank is aerated and homogenized content.

Pressurized air from a blower is injected through porous membranes with high efficiency specially designed for fine bubble diffusers are installed in the bottom of the basin, to obtain a better homogeneity and a maximum amount of oxygen dissolved in wastewater

Water quality

Wastewater influent parameters

• COD concentration:1200-1400 mg / l
• BOD5 concentration: 500-600 mg / l
• SS concentration: 500-600 mg / l
• total nitrogen concentration:50-100 mg / l
• total phosphorus concentration: 50-70 mg/ l
• The concentration of fat: 66-180 mg/l pH: 6.5 to 8.5

Total daily loads

• Charging COD: 19,2- 22.4 kg / day
• BOD5 load: 8 to 9.6 kg / day
• Charging SS: 8 to 9.6 kg / day
• Charging total N: 0.8 to 1.6 kg / day
• total P load:0.8 to 1.12 kg / day
• Charging fat:1.06 to 2.88 kg / day
• pH: 6.5 to 8.5

Treated water quality and yields

Daily flow of wastewater		Q = 16 m^3/day
The quality of treated water and wastewater treatment plant efficiency		
-CBO_5	< 25 mg/l	> 91%
-CCO_{Cr}	< 125 mg/l	> 95,83%
-MTS	< 60 mg/l	> 90%
-Fats	< 20 mg/l	> 85%
-total N	< 15 mg/l	> 97,14%
-total P	<2 mg/l	> 88,89%
-pH	6,5-8,5	

CONCLUSIONS

By analyzing the characteristics of the influent wastewater treatment station and influent characteristics, result in a reduction of 97% nitrogen and 89% phosphorus.

REFERENCES

Iancu P., 1999. Canalizari si epurarea apelor uzate. GLOBUS Publisher. Bucharest

Ianculescu O., 2001. Epurarea apelor uzate. MATRIXROM Publisher. Bucharest

Stancu M., 2013. Statie de epurare ape uzate pentru < Unitatea de Preparare a Carnii si Depozit Frigorific, Comuna Mogosoaia, Sat Mogosoaia, Judetul Ilfov >" – Dissertation Thesis

http://www.creeaza.com/legislatie/administratie/ecologie-mediu/Epurarea-avansata-tertiara-a-a987.php

https://www.wikipedia.org/