# CONSIDERATIONS REGARDING SOME WATER DENITRYING PROCEDURES TO OBTAIN DRINKABLE WATER

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**Keywords**: polluting agents, denitrifying procedures, technologies.

**Abstract:** *The unprecedented economic-social development, the use of chemical substances in agriculture, lead undoubtedly to the evacuation of large amount of waste water, which contain important polluting agents. Their discharge into the receptors results into their pollution when the environment protection measures are not enough. At present, numerous efforts are made in order to maintain and improve the quality of water. New and various technologies of water purification for waste water appear and develop, which at the end, have the purpose to protect the water quality. But, the water protection measures prove to be not enough in some cases, remaining behind in comparison with the water pollution increasing rhythm.*

## 1. INTRODUCTION

Environment protection represents for all countries a major problem determined almost exclusively by atrophic pollution and amplified by the existence of trans borders pollution. Pollution of environment factors generated by industrial and agricultural activities or by great urban centers determined disorder of some ecosystems and aggravation of life conditions of persons in certain areas. Economical – social development without precedent, using chemical substances in agriculture, lead directly to evacuation of some great quantities of used waters containing important pollutions. Their discharge in receptors has as result, when environment protection measures are insufficient, their non purification [1].

Satisfying water requirements of population and economy, the capitalization pf new water resources, rational use of waters and their protection against exhaustion and pollution, as well as complex arrangement of water courses, must be realized in a unitary modality and in conformity with economical and social development.

## 2. PROCEDURES OF WATER DENITRIFYING

Existing denitrifying procedures can be classified depending on the nature of the processes that are at the basis of their realization. A first category is represented by *physical – chemical procedures* which are based on ion exchange, inverse osmoses and electro dialysis. All these are concentration procedures which allow the alienation of nitrate ions, concomitant with other ions [3].

The concentrate which incorporates nitrates is obtained in a continuous manner, either in discontinuous manner.

### 2.1. PROCEDURE OF DRINKABLE WATER DENITRIFYING THROUGH ION EXCHANGE

The most economical solution in case of sources with increased content of nitrates situated next to sources with small content of nitrates is amalgamation. On contrary, the only option might be realization of an installation of nitrates alienation.

*Inverse osmoses* becomes a more applied procedure, due to the economical efficiency for treatment of waters with reduced content of silica but still, exploitation expenses are high enough to discourage most potential users.

*Biological purification* is a treatment method that is very expensive and complicated, uses denitrifying bacteria which reduce nitrates from gaseous azotes. It requires supplementation of an external source of carbon like methanol, ethanol and acetic acid to ensure energy source for the transformation of gaseous azotes N by bacteria. The dose of organic substance must be carefully controlled, as in case of excess become non correspondent for human consumption.

Biologically treated water might, also, contain spores of the anaerobes microorganisms, so that it must be re aerated, sterilized, and presented suspensions must be alienated through flocculation and filtration. On the other side, biological reaction is a lent one, especially at decreased temperatures, so that their efficiency can hardly be foreseen [2].

An adequate and efficient solution, from economical point of view to alienate nitrates from sources of drinkable water is *technology based on ion change.* In the process of denitrifying through ion exchange will be used anionic resins powerfully based in chloride form to alienate water nitrates [5].

**Denitrifying principle through ion exchange**

During application, the resin frees chloride ions and absorbs free ions of nitrate, sulfate and bicarbonate from raw water. Chloride ions remain in treated water. After resin saturation, this is regenerated by treatment with a salt saturated solution (brine). This forces the realization of inverse reaction, determining the effluent release of the nitrate, sulfate and bicarbonate ions and regeneration of resin which overtakes chloride ions.

A disadvantage of the procedure through ion exchange is that which increases chloride concentration in treated water. Each mg/l of nitrate will bring to the increasing of chloride concentrations with 0.57 mg/l, and the one of sulfate with 0.74 mg/l. Treated water becomes more corrosive, and in some cases is not adequate to human consumption. The effect of increasing chloride concentration can be reduced by realizing a series of operation units as part of the installation that is situated in diverse phases of the functioning cycle. The level can be more reduced by mixture of raw water with water released by nitrates.

For regeneration, it cam be used the countercurrent method, in which regeneration solution (brine) flows contrary to the one of nitrates retention. This improves the capacity/ influence of resin, making that the water produced come into contact with resin that has an increased regeneration degree, with a small content of nitrates [4].

At the basis of the layer, water produced meets resins that are well regenerated with finishing action. A system of pushing with air ensures the maintenance of resin in a compact status, to reach a maximum brine contact and a uniforms distribution in the entire resin masse. Air injected in the upper part of the recipient and pushes on an uncertain resin layer which surrounds the collection system of the regenerate.

The procedure is simple, flexible in exploitation and easily automated. The procedure with ion exchange is so predictable that the treated water constituents and from realized mixture can be calculated with an outstanding exactness.

Long time exploitation of installations with ion exchange underlined the problem of depositions of calcium carbonate on recipients and on evacuation system of the effluent. At some installations will be realized arrangements of washing/ recirculation with acid solutions for alienation of problems of deposits of calcium carbonate. A permanent solution of this problem might be the incorporation of a purification installation during regeneration.

**Biological procedures of denitrifying**

- heterotrophy procedures, in which bacteria can not be developed in a strictly mineral environment, being necessary a contribution of organic layer;
- autotrophy procedures, in which bacteria obtain carbon and energy that they need from oxidation of some mineral substances.

## 2.2. DENITRIFYING IN BIOLOGICAL REACTOR WITH CONTINUOUS EVACUATION OF BIOMASS IN EXCESS

Denitrifying process is based on the action of denitrified bacteria and on their use in a reactor which allows the continuous elimination of spare biomass. There have been identified 70 different types of bacteria which contains species capable of reducing nitrates.

**Biomass** which is used for denitrifying must accomplish the following requirements:

- accepted temperature field by the metabolism of denitrified bacteria must be high enough (4° to 35°C);
- bacteria must be able to develop as a unique source of molecules of organic carbon as one, two or three carbon atoms;
- carbon source must not lead to formation of unwanted sub- products.

**Granular material support**

In biological procedures with bacteria fixed, will be aimed the maintenance in reactor of an increased mass concentration. Selection of the support material will be realized depending on the capacity to retain formed biomass and to maintain, after washing, a sufficient biological activity.

Besides this, the material must have granular characteristics which must ensure a filtration effect to obtain a small turbidity. The most efficient material is granular sand adapted to the continuous procedure that will be described as follows:

**Biological reactor**

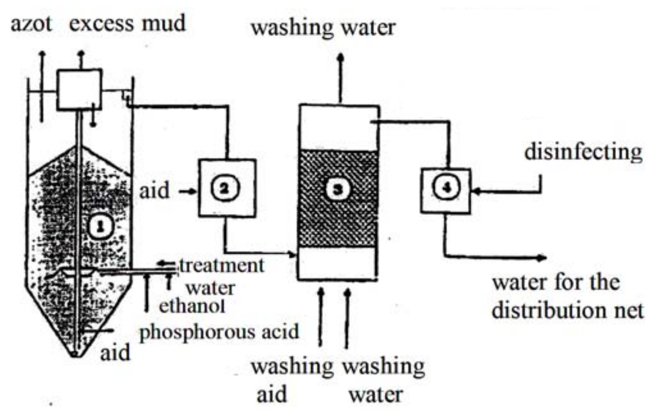
The principle of biological reactors named with “fix bed” is well known: treated water crosses a reactor in which biomass is fixed on a bed (filling) with fix granular material; periodically, in washing phases (water and/ or air injection with high debits) will be evacuated the excess mass and suspensions restrained in bed. Washing periodicity is regulated at 24 hours.

Treatment water, to which will be added a under layer (source) of carbon (ethanol) and phosphoric acid, is introduced in the reactor; it crosses down – up a sand layer which serves as support for denitrified biomass. Sand is pulled out continuously from the basis of the bed with the aid of a pneumatic ejector (air-lift). Sand is exhausted by the biomass in excess in the washing deposit that is situated outside bed, and then is reintroduced in the superior part of the bed. So, sand crosses from up to down in countercurrent with treated water. Sand speed circulation is low (some millimeters a minute), which brings to durations of the sand cycle (duration that is necessary to wash the entire sand mass) of some hours.

As a result of the experiments realized it was developed a complete line of denitrifying – drink ability (Fig. 1).

**Advantages of the procedure**

- the procedure was developed to reduce denitrifying costs of drinkable waters ensuring the efficiency, usefulness and easy exploitation;
- sand continuous regeneration allows the maintenance of some constant physical and biological parameters of the reactor, especially the biomass quantity, unlike reactors with fix layer. In these conditions it will be obtained a stability of the hydraulic resistance and a constant of the denitrifying rated capacity.
- regulation of the regeneration cycle of sand allows the maintenance of the optimal biomass and so obtaining some constant rated capacities which are not reached by reactors with periodical washing but in certain periods of their functioning cycle.




***1- biological reactor; 2- aeration; 3-filtration with active coal; 4- disinfection***

***Fig.1. Complete line of denitrifying – drink ability.***

## 2.3. DENITRIFYING PROCEDURE OF UNDERGROUND WATERS WITH THE PURPOSE OF PRODUCING DRINKABLE WATER FOR COMMUNITIES WITH A SMALL NUMBER OF INHABITANTS

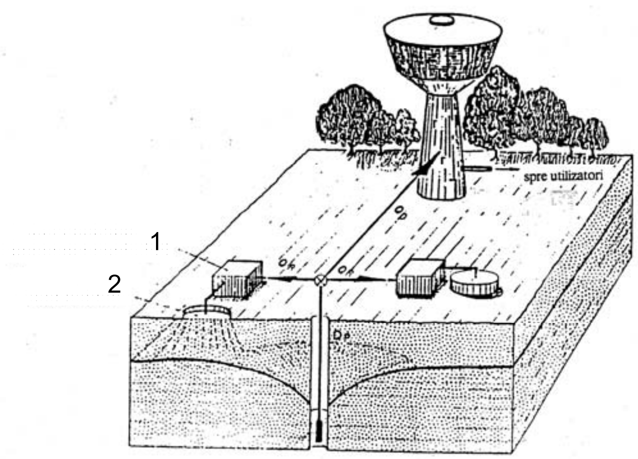
In rural areas, azotes pollution of the land is due to the diffuse pollution from agriculture. Autonomous collectivities with a small number of inhabitants are the first to the confronted with such problems in the supply of drinkable water. Water's "industrial" treatment for relatively modest consumptions (ex. 500-1000 $m^3$/ day) raises cost problem, especially in the case of rural installations which surrounds strictly necessary arrangements (drilling, pumps, water castle).

**Principle of the procedure**

A part of raw water pumped from drilling passes through a reactor with "denitrified mixture" and then returns through soil and underground towards drilling. This way will be realized a loop (circuit) layer- reactor-soil- layer from which will be overtaken a part of re cycled water. Dilution that takes place my mixture of raw water contribution from the water layer with recirculated waters, after passing through denitrified environment leads to an acceptable content, which will be framed in drinkable water norms.

Installation presented in Fig. 2 is composed of a central drilling from which a part of pumped water (Qp) is sent in distribution net (Qd), and the other part is lead in denitrified reactors (Qr). Water that exists from this is situated in the under layer, where takes place a supplementary purification in non saturated area, before reaching water and being taken into drilling.

Underground plays an important role in finishing treatment. In non saturated area was observed a fixing accompanied by mineralization of organic substance, as well as rests of bacteria that are involved by water which got out from the reactor. This lent filtration in the aerobe environment allows reaching some acceptable values for drinkable water. Return of recycled water through field is similar with purification process through bank of the river water whose efficiency is recognized from a long time; endogenous bacteria breathing which intervenes allows especially the demineralization of the organic debris. Protection perimeter of the capitation plays an important active role in water treatment.




***1- denitrified reactor; 2- filtration field.***

***Fig. 2. Principle of denitrifying.***

Denitrifying used is a anoxic heterotrophic denitrifying in which oxygen from nitrates replaces oxygen consumed by organic substances. After laboratory testing of several materials based on carbon of vegetal origin (turbe, celluloses, straws) was selected forcemeat straws after it was submitted to a chemical treatment for partial elimination of lignin fraction which must allow a easy accessibility of the celluloses biomass. Oxidation reaction of the cellulose by nitrates can be formulated this way:

$$5(C_6H_{10}O_5)_n + 24nNO_3^- \longrightarrow 6nCO_2 + 13nH_2O + 12nN_2 + 24nHCO_3^-$$

Diverse attempts made in laboratory on columns with filling, supplied with waters enriched artificially with nitrates, have been situated on the following main directions:

- characterization of biomass developed on the used carbon layer;
- laboratory study of the functioning parameters of the procedures;
- examination of water quality treated especially in what concerns the nature of the organic substance.

The results of these attempts have proved the feasibility of a procedure of water denitrifying.

## 3. CONCLUSIONS

In present moment, numerous countries are confronted with an increase of the nitrate concentration which damages surface water quality and underwater. Intensive use of fertilizers with azotes in agriculture is the main cause of the pollution of underground layers; meanwhile water surfaces are affected especially by water exhaust from towns and from industry. Attending in time the quality of waters for human supply shows that in the numerous content in nitrates increases rapidly, existed the fear that, in a short period of time, the maximum concentration admitted in European norms must be exceeded. To avoid risks that water consumption implies an increased content of nitrate, is necessary that useful techniques be available for their alienation.

The presence of nitrates in underground prevented in several circumstances the use of underground water as source of drinkable water. Through experiments realized up to present moment were updated several technologies which proved to be adequate for the solving of the problem to bring the level of nitrates to those of standards of European Community.

Denitrifying procedures of water based especially in ion exchange, biological purification and inverse osmoses become more reliable procedures and with large application.

In rural areas for the elimination of nitrates from underwater waters can be used simple technologies based on natural denitrifying procedures which take place in certain environments. In this purpose can be evaluated microbiological degradation phenomena which are produced at capitation and properties of soil filtration - purification.

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