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NITROGEN CONTROL IN SEWAGE TREATMENT PLANTS

Robert-Cosmin CĂPĂȚÎNĂ[1], Emanuel-Daniel MIRCEA[1], Laurenţiu-Petrişor CIORICĂ[1], Nico LIPPI[2]

Scientific Coordinator: Lect. PhD Eng. Dragoş DRĂCEA[1]

[1]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: dragosdrac@yahoo.ro
[2]Università Politecnica delle Marche, Piazza Roma, 22, 60121 Ancona, Italy, Phone: (+39)071.220.1, Email: nico.lippi7@gmail.com

Corresponding author email: robert.capatina@yahoo.com

Abstract

Purification technologies have been rapidly evolving lately due to the large number of applications that have been made, both for city and industrial wastewater use. An important direction of evolution is related to the development of monitoring devices for the operation of sewage treatment plants. Applications that tracked performance parameters and quality indicators highlighted optimal exploitation technologies and technologies that ultimately led to increased efficiency and lower costs.
In purification, the critical process indicator is "nitrogen"; reducing and framing this indicator within the limits imposed by legislation implying the inclusion of all quality indicators. The development of continuous nitrogen monitoring devices has allowed the purification, nitrification and denitrification processes to be balanced, and the development of appropriate operating and adjustment programs. The control of the ammoniacal and nitrate nitrogen treatment is the best option for optimizing the operation of the treatment plants.
In the material are presented the process philosophies and the results obtained from the regulation of the functioning of the nitrogen treatment plants
Continuous monitoring and regulation ensures the reduction of impacts on water resources.

Keywords*: admissible limits, nitrogen control, water resources.*

INTRODUCTION

Wastewater treatment plants are important objectives in water management systems. Their efficient operation ensures the protection of the water sources and the increase of the water reuse. In the context of the increase of the water demand it is necessary to rehabilitate new objectives, the rehabilitation to ensure a degree greater purification.

Figure 1. Waste water treatment plant Glina

Short history

In the evolution of the technologies in the water treatment plants were pointed out the directions:

• Developing and optimizing processes
• Reactive reagents
• Equipment, reliable and efficient equipment

Initially, the treatment plants were developed into mechano-biological pathways capable of reducing suspended matter and carbon.

Along with these pollutants, all other water quality indicators, including nutrients, nitrogen and phosphorus, are also reduced.

MATERIALS AND METHODS

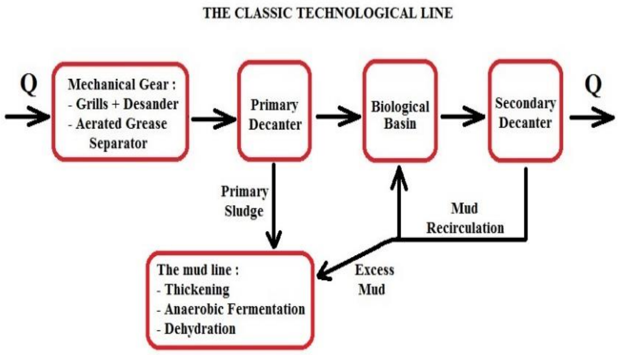

Figure 2. The classic tehnological line

Classical technology has not ensured the limitation of water pollution, as eutrophication processes have continued.

It was considered that the main indicator that influences the eutrophication process is phosphorus. For the reduction of phosphorus precipitation / coagulation processes have been proposed in the primary decantor and / or the secondary decanting biological reactor. The proposed technological variant involves the recirculation on the technological flow of important quantities of phosphorus and slurry recirculation of mud and sludge line. To eliminate the disadvantages, schemes were proposed with phosphorus precipitation in a final step.

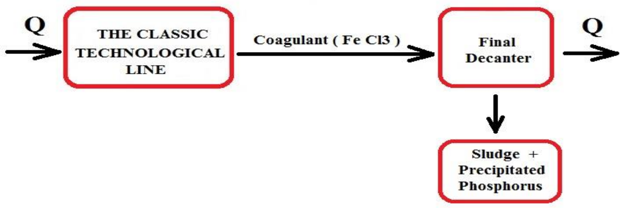

Figure 3. The classic technological line of the coagulant

The phosphorus balance for water sources and the malfunctioning of the treatment plants show that there are sufficient stocks and sources of phosphorus to ensure the development of eutrophication processes. In this context, there has been an increase in the amount of nitrogen purging, assurance and reduction.

Nitrogen reduction is especially accomplished in nitrification and denitrification processes. The organic bonded nitrogen is reduced in flocculation processes, but this represents about 20% of total nitrogen. Reduced nitrogen, ammonia, nitrate, nitrite, about 20 % is bacterially assimilated, and the largest share is metabolate.

NH4 Nitrification / O2, Bacteria = NO2 = NO3 = Denitrification / O2 ↓ Bacteria = N ↑

The logical succession of biological processes is nitrification -ditrification. The so-formed files did not function properly due to limitations:

-blocking the dentification process due to carbon deficiency

- carrying out the denitrification process and in the secondary decantor with the sludge flotation and entrainment of the slurries in the purified water.

The elimination of these disadvantages was achieved by:

- Ultimate aeration bottoms
- pre-legalization technology plant

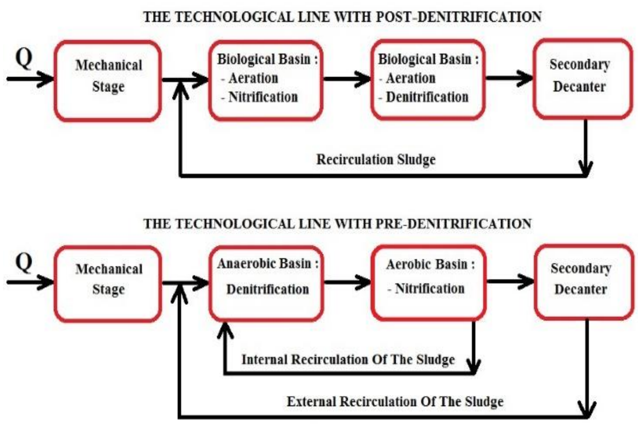

Figure 4. The tehnological line with post-denitrification

Ensures the post-containment of the denitrification blocking in the secondary decantor and efficiently uses the water used in the water. The main disadvantage of the chain is that of high recycling volumes, about 100%

of each of 8-10 mg / l of NH4. To reduce recirculation, various architectures based on successive or sequential phases have been developed.
For the sizing of biological basins the carbon / CBO5 / processing / unprocessed carbon rates were determined. The exploitation has highlighted that the critical process indicator is nitrogen, but in the present design norms that provide for clear design prescriptions in this respect.
The paper presents in situ a pilot plant for the rate of nitrogen processing in the active mud treatment plant.

RESULTS AND DISCUSSIONS

DETERMINATIONS OF THE PROCESS INDICATORS, NITROGEN, IN THE FUNCTIONING STORAGE STATIONS (STATION WITH AMONIACAL REDUCTION FILTER WITH PREDENITRIFICATION)

Figure 1 shows the aeration control in a carousel-type biological basin based on NH4 concentration. Measurements were made in the pre-nitrification treatment plant and sequential biological basin. The automation program allowed the regulation of the processes according to the concentrations of ammoniacal and nitrate nitrogen. A sequential type of technological flow was observed, in the evolution graph a evolution in the mirror, ammoniacal-nitrate nitrogen according to the base of the developed process:
-aeration, reduction of ammoniacal nitrogen involves the accumulation of nitrates;
- without aeration, so denitrification, nitrate reduction but ammoniacal nitrogen accumulation.

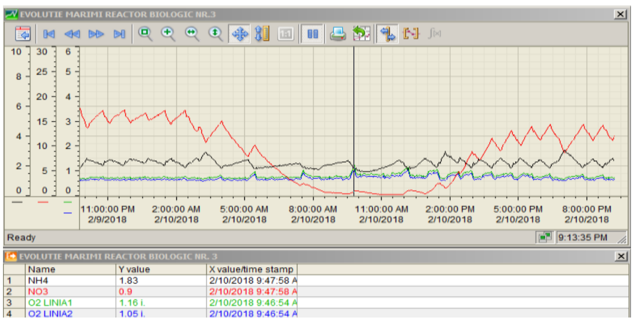

Figure 5. Evolution of nitrogen concentration values in the biological basin exploited timed with NH4 limits imposed

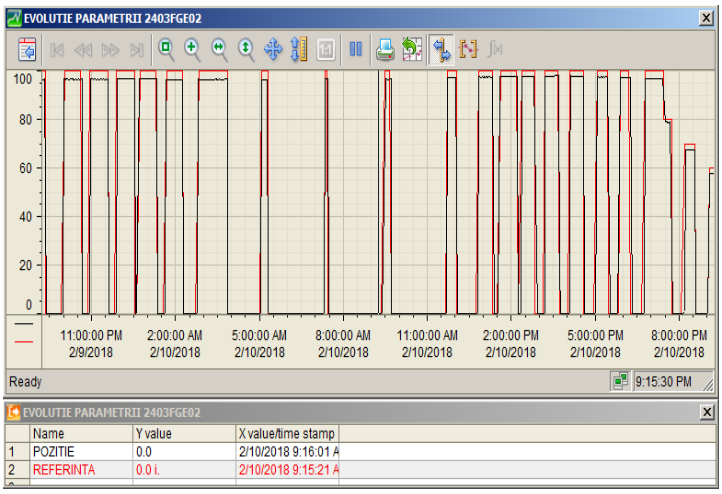

Figure 6. The degree of opening of the aeration valves corresponding to the NH4-timed operation

And in this situation, the low dissolved oxygen level below 1 mg / l is observed with nitrification and increases in consumption of reducing substances (NH4).
Using the graphs of the evolution of ammoniacal and nitrate concentrations results in processing rates.

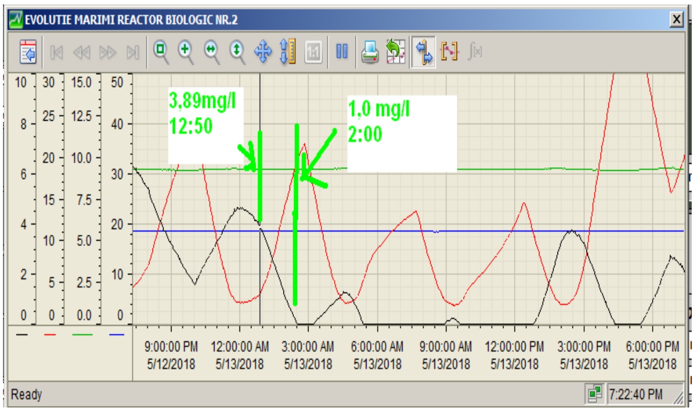

Figure 7. Detail of the evolution of nitrogen in the treatment plant for the determination of the ammoniacal nitrogen processing rate

From the detailed analysis of the results of the nitrogen processing rates (see graphs 2 and 3) according to the analyzed situations, the ammoniacal nitrogen processing rates of 2.9 mg / day of ammoniacal nitrogen and 2.5 mg / hour are obtained. Nitrification rate: 2.9 mg / l in about 70 minutes, 0.04 mg / min, 2.5 mg / hour. It is mentioned that the processing rate is calculated by neglecting the quantities entering and leaving the biological reactor, which can reach about 4mg / h or 4g / h and a reactor.

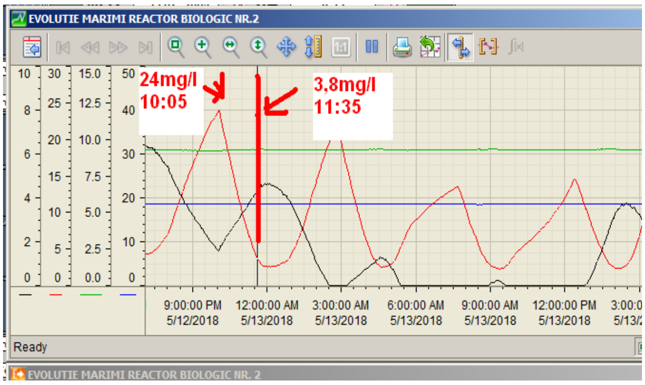

Figure 8. Amoniacal nitrogen details in nitrate processing fat stations

Denitrification rate: 20.2 mg / l in 90 minutes, 13.5 mg / l (3.2 mg / l N-NO3).
In the installations in operation there may be errors in the deteminations due to the irregularities of the flows and of the nitrogen concentrations. In the case analyzed the complexity of the station and the process may involve errors in the determination of the pollutant processing rates. Under these conditions, isolation of biological basins and of some pilot installations.

DETERMINATIONS ON PILOT STATIONS

A biological reactor primed was isolated in a ministerial purification plant fed with raw water until reaching an initial concentration in ammoniacal nitrogen. The biological reactor was automatically aerated according to the O2 concentration and determined at different moments the concentrations and the evolution ammoniacal nitrogen. In Table 1 are presented the results obtained which show the rate of nitrogen processing and reduction of the O2 requirement.
To highlight the nitrification rate, a SBR biological pool was isolated and the NH4 concentrations after the crude water feed.

Table 1

Hour	O_2(mg/l)	NH_4(mg/l)
14.30	2.1	1.78
14.45	2.8	1.43
15.00	3.3	1.38
15.15	3.7	1.12
15.30	Automatic	0.95
15.45	Automatic	0.77
16.00	Automatic	0.65
16.15	Automatic	0.31

In the case of the biological reactor, the NH4 concentration decrease correlation and O2 concentration increase at constant aeration. In this case the rate of nitrification was about 0.9 mg / h. An analysis on other types of stations showed average processing rates of 1.5 mg / l x h for active mud concentrations of 3000-4000 mg / l. Process rates depend on the amount and quality of active sludge.

CONCLUSIONS

Process optimization in wastewater treatment plants involves modern process technologies that allow for the adoption of various operating scenarios.
Monitor process indicators and determine correlations between them, ensure optimal process control and reduce energy consumption Monitoring and centralizing the results on the existing exploitation sites ensures the creation of databases and finally the adoption of procedures and normative designs close to the field requirements.
The obtained determinations have shown anthony nitrogen reduction rates of 0.9 mg / l x h in the pilot plant, and in the treatment plant approx. 2.9mg / l x h, and in case of denitrification of 2.5 mg / l. It is proposed to analyze several operational situations and to make design prescriptions related to the nitrogen indicator, which is also the critical purification indicator.

REFERENCES

Iancu P., Pienaru A., 1999. Sewage Systems and Wastewater Treatment, Globus Publishing House, ISBN 973-49-9718-X.
Racoviteanu G., 2003. The Theory of Water Sedimentation and Filtration, MATRIX ROM Publishing House, ISBN 973-685-541-4.
Guidelines no. 133-2013 for the Design, execution and operation of urban water supply and sewage systems.

SECTION 03
CADASTRE