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PRACTICAL ASPECTS FOR THE REHABILITATION OF ADVANCED, LOW CAPACITY WASTEWATER TREATMENT PLANTS CASE STUDY: WASTEWATER TREATMENT PLANT ON THE ZIMANDU NOU INDUSTRIAL PLATFORM

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Abstract: The case in study is the rehabilitation of a small-scale treatment plant with a maximum capacity of 19.44 m3/day, which did not reach the parameters (NTPA001) in commissioning. Small-scale treatment plants have certain particularities mainly due to small dimensions of pipelines and equipment. Another particular aspect relates to the advanced treatment of domestic wastewaters from industrial objectives and office buildings, which are characterized by different concentrations of pollutants compared to those proposed by the normative for domestic wastewater.
Keywords: advanced wastewater treatment, environment protection, sewage

1. INTRODUCTION

Our country's potential water resources are limited, the need for resource protection is inherent to ensure the continuity of future generations. The protection of a body of water involves limiting the discharge of pollutants that will prevent its use by the population [4].

Due to the need to remove nutrients, advanced treatment of domestic and industrial wastewater is necessary.

Advanced wastewater treatment or tertiary stage is the technological solution for the removal of nitrogen and phosphorus, as well as other pollutants that are not retained and eliminated in a conventional treatment plant.

The elimination of nitrogen from wastewater by advanced wastewater treatment is realized by ensuring the natural conditions necessary for converting ammonia nitrogen into nitrate in aerobic environment, and by converting nitrate into gaseous nitrogen in the anoxic environment [1] by specialized bacteria.

The removal of phosphorus and its compounds can be biologically achieved at reduced concentrations. At higher concentrations the phosphorus that could not be treated biologically should be treated chemically.

The chemical precipitation of phosphorus consists in adding coagulants at the end of the biological stage to ensure the necessary degree of treatment. The precipitation results in a chemical sludge that generally mixes with the organic one.

The function of a Sewage Treatment Plant is for treating collectively any wastes of the kind that are ordinarily discharged from toilets, water closets, baths, showers, sinks, basins and other sanitary and kitchen fitments.

The main concerns on small sewage treatment plants relate both to the adequacy of the treatment processes proposed and to the uncertainty in ensuring proper long-term operation and maintenance and hence the possibility of discharge of substandard effluent.

A challenge in designing a functional small-scale sewage treatment plant that is serving a production facility or an office building, is related with the unusual flows and concentrations of the influent. Concentration and flows of the sewage waters differ from standard due to different behaviour of the population served.

2. CASE STUDY: REHABILITATION OF THE WASTEWATER TREATMENT PLANT OF ZIMANDU NOU INDUSTRIAL PLATFORM

The initial situation: The initial sewage treatment plant is no longer within the limits imposed by the water management authorisation, requiring the identification of problems and their remedy.

The designed daily flow exceeded the designed value due to an increase in hired personnel.

The existing technological scheme (Figure 1) consists in: coarse solids separation, electrolysis tank, small biological filter, secondary filtration and sterilization.

Manual coarse screen: The distance between the bars is not sufficient to remove the solids. Part of the solids pass and clog the downstream treatment steps. Manual cleaning of the screen is difficult and unsanitary.

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Electrolysis tank: Requires manual operation of the bottom sludge valve and foam tray. This requires the presence of an operator 24 hours/day.

Biological filter: The biological filter is small, and the chosen technology does not remove enough nitrogen to reach the imposed limits.

Secondary filtration: The filter is easily clogged and doesn't have backwash.

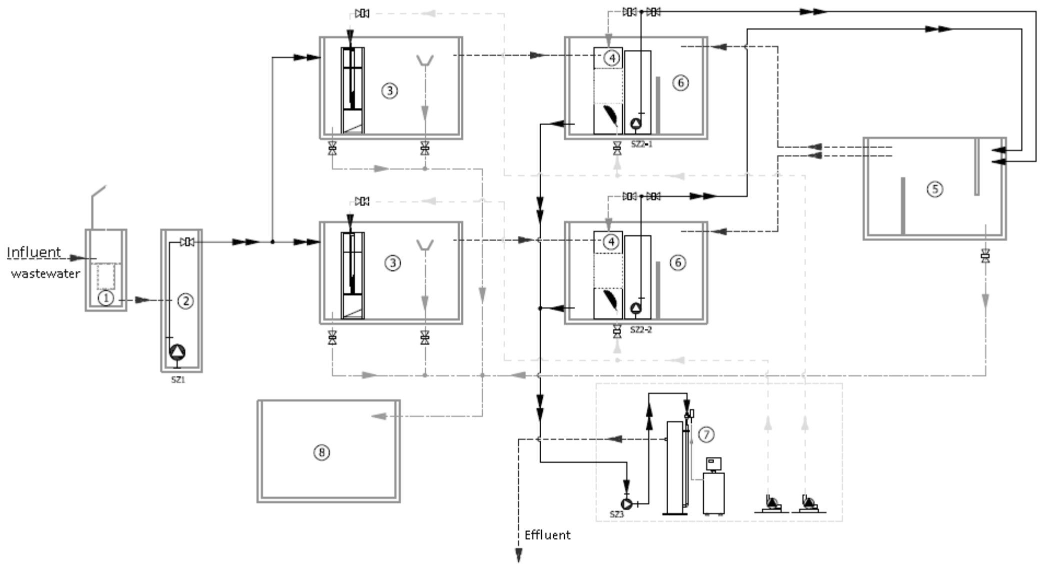

Figure 1. Existing technological scheme. 1- Coarse screen pit, 2-Pumping station, 3-Electrolysys Tanks, 4-Biological filter, 5-Clarifier, 6-Secondary filters,7-Desinfection unit, 8- Sludge holding tank.

Rehabilitation -technology and works:

For refurbishment, the decommissioning of all existing equipment and the use of existing concrete basins has been considered. The purpose of each basin was redefined according to the new proposed treatment scheme (Figure 2).

Since the wastewater treatment plant serves a factory and the consumption of water is different than a household, it was decided to evaluate the debit consumed by the employee based on the consumption recorded for 6 months at the same location. Wastewater concentration was determined by chemical analysis of the influent.

The daily water consumption measured for one employee was 32 l/day.

The total designed flow was 26 m^3/day for 800 persons.

The measured concentrations and the equivalent load are presented in table 1.

Table 1. Wastewater concentration and load

Parameter	Concentration mg/l	Daily load kg/day	Theoretical daily load kg/day based on 800 P.E.
COD	605	15.7	96
BOD_5	424	11.02	56
TSS	370	9.62	64
Pt (total phosphorus)	15	0.39	4.8
Nt (total nitrogen)	163	4.24	12

As can be observed (table 1) the organic carbon load is not sufficient for the denitrification. Additional carbon source dosing was considered in the new technological scheme. The standard population equivalent (PE) definition does not apply in this situation due to different behavior patterns of the beneficiaries.

Description of the technological process.

The new technological process includes the following steps:

Mechanical treatment that includes grinding of the large solids by grinder pumps to prevent the clogging of the piping from the two pumping stations to the sewage treatment plant. A parabolic screen with the hole aperture size of 2 mm. A screening compacting and washing system is reducing the humidity and volume of the solids separated by the screen. To equalize the flow and the concentration of the incoming wastewater the first electrolysis tank was transformed in a buffer tank equipped with mixer and pumps. The additional carbon source (sugar) is dosed in the buffer tank proportionally with the incoming flow measured with an electromagnetical flowmeter.

The biological treatment consists in the former filtration tanks and the clarification tank transformed in activated sludge tank. An internal recirculation pump is ensuring the homogenization of the loading in the three tanks.

To maintain a sufficiently high concentration of dissolved oxygen in the tanks, the contents of the tank are aerated. The air under pressure from two blowers is injected through fine bubble diffusers installed at the bottom of the tank.

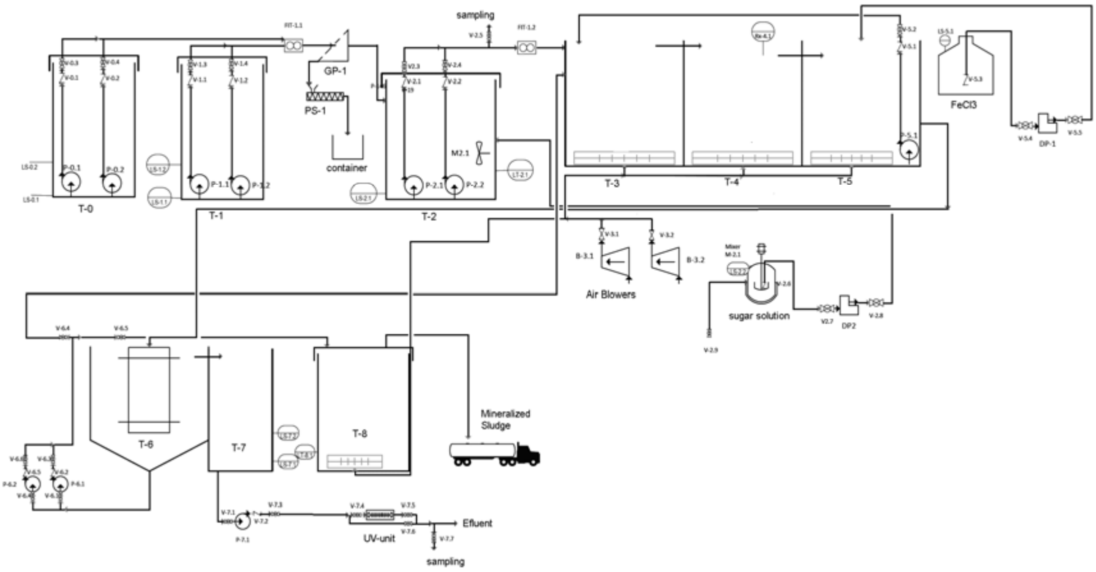

Figure 2. New technological scheme.

To provide nitrification and denitrification the aeration is operated ON/OFF, in the same way as in the Sequence Batch Reactor (SBR) case. The starting and stopping of the air blowers is controlled by means of a redox sensor.

Denitrification is made by heterotrophic bacteria in the absence of oxygen to a redox potential under -50 mV. The blowers will function alternatively depending on the value of the redox potential. When the blowers operate, the redox value will grow to a certain point where the entire amount of ammonia nitrogen is oxidized into nitrates. Then the blowers will stop and operate in pulses to ensure that the contents of the tanks are homogenized. During this time, anoxic conditions will be created in the aeration basins and the denitrification process will begin. During the denitrification process, the redox value decreases. When the whole amount of nitrate has been transformed into molecular nitrogen gas, the blowers will again start to operate continuously to oxidize the ammonia nitrogen.

The specific rate of denitrification depends on the existence of an easy biodegradable carbon source. The ideal ratio of macronutrients carbon (C), nitrogen (N), phosphorus (P) for optimum development of the biological substrate is C: N: P = 100:5:1. If the carbon source is not available, as in this case (C: N: P = 100:40:4), the rate of denitrification is significantly reduced. To obtain the necessary denitrification ratio additional carbon source (30% sugar solution) is dosed in the buffer tank.

The decrease in phosphorus concentration can be resolved in the simplest way by chemical precipitation of the phosphates.

A phosphate ion (PO_4^{3-}) consumes 1.5 iron ion (Fe^{3+}) or aluminium (Al^{3+}).

Basically, the consumption of reagents varies between 2.0-3.5 g Fe^{3+} and 1.2-2.5 g of Al^{3+} for every gram of phosphorus depending on the specific technology.

Excessive consumption is due to the fact that the respective reagents also have a coagulation effect. Therefore, metallic salts not only precipitate phosphorus, but also improve treatment efficiency.

Ferric chloride ($FeCl_3$) is dosed using a pump in the last aeration tank (T5). Ferric chloride consumption may fluctuate according to specific influent and process conditions. Adjusting of the dosage is done by weekly chemical analyses of the treated effluent.

From the aeration tanks, the mixture of biomass and wastewater then flows into the final clarifier. The treated effluent is collected at the surface through the V-notch channel and flows in the effluent pumping tank (T-7).

The treated effluent is pumped through an UV-sterilization unit to remove the potential pathogens and to comply with the coliform bacteria limit imposed.

The sedimentation tank has a reverse pyramid shape (Dortmund-type) and its surface is thus calculated to ensure the effective separation of the solid-liquid mixture.

The activated sludge settles and is pumped back in the first aeration tank (T-3) with two pumps (one running and one stand-by). When necessary, the excess biological sludge is removed into the existing sludge storage tank (T-8).

All metal parts of the sedimentation tank are made of stainless steel.

The sludge holding tank is equipped with fine bubbles diffusers to provide the necessary oxygen for the aerobic stabilisation of the excess activated sludge.

The level in the sludge holding tank is monitored with a hydrostatic level transmitter to indicate the operator when to organize the transport of the sludge. The emptying of the tank is done by vacuum pump tanker truck from an authorized company.

3. RESULTS DURING THE COMMISIONING

During the commissioning and the start-up of the wastewater treatment plant, the effluent chemical analyses results were progressively improving while the activated biological sludge was forming and adjusting of the operation parameters (figure 3).

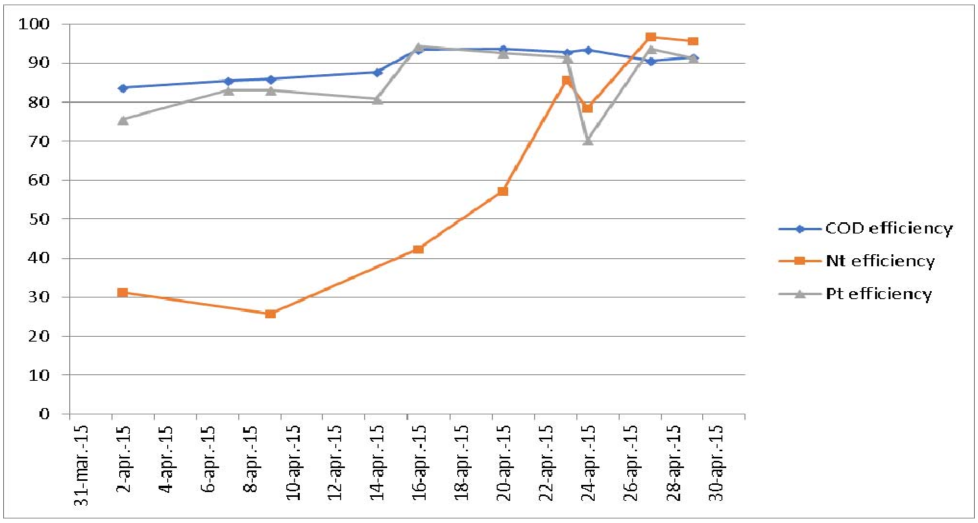

Figure 3. Efficiency during start-up

A follow-up monitoring was done during the first half of 2017 to establish the state of the wastewater treatment plant and the quality of the effluent at designed flow. The high degree of automation and the measurement equipment ensure easy and constant operation of the plant and good results with a minimum operation effort.

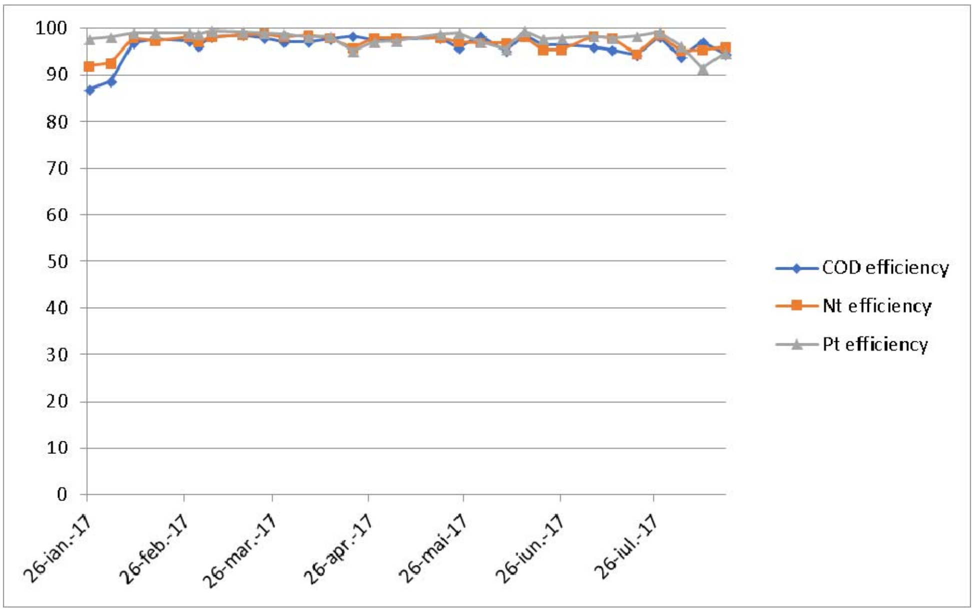

Figure 4. Efficiency during first half of 2017

Based on the measured parameters, the solution proved to be successful. The merging of technical solutions in biological treatment can produce good results of the effluent and reduce the investment by using certain elements of the existing plant.

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