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Study on rehabilitation and retehnologization of sewage treatment plant in Deta locality, Timis County

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Abstract: The purpose of the study is to analyse the efficiency of the WWTP's operation in a western locality. For this purpose, was studied the variation of water quality indicators at the entrance to the sewage treatment plant and the values of these parameters when evacuating to the emissary. Laboratory determinations for both raw water and purified water samples were performed in 2015 and May 2016 respectively, after the rehabilitation and refurbishment of domestic water. On the basis of these laboratory determinations the parameters for correction of the purified water quality and the efficiency of the treatment station in the domestic sewage system of the localities in the western part of the country were followed. The water quality is analysed by comparing the values of the quality indicators with the limits allowed by the legislation in the field (NTPA001 / 2004).
Keywords: wastewater treatment plant, rehabilitation, retehnologization, monitoring, water line, sludge line

1. INTRODUCTION

The effects of pollution of water resources are complex and varied depending on the nature and concentration of the contaminants.

The solution to these problems caused by water pollution is achieved by treatment, which ensures the necessary conditions for consumption.

Developing knowledge and increasing hygiene requirements have highlighted the danger of water pollution for public health. For the prevention of health hazards, wastewater treatment plants have been built in order to retain or remove a major part of the pollutants before discharge into the emissaries.

In recent years, it has become more and more imperative that water is not a gift of nature, without price. Today, clean water is achieved by considerable investment efforts (accumulations, transmission and distribution pipelines, treatment plants, etc.) and operating costs (energy, chemical reagents, operating personnel, etc.).

2. PRESENTATION OF EXISTING WASTEWATER TREATMENT PLANT FROM A LOCALITY IN TIMIS COUNTY

2.1. DESCRIPTION OF THE CURRENT SITUATION

The agglomeration of Deta has an area of 3.4 km^2 and a number of 5.874 inhabitants.

The main access routes are: DN 59 Timişoara - Moraviţa; DJ 59B Deta - Carpiniş; DJ 595A Deta - Ciacova.

The sewage treatment plant is located about 0.5 km from the city of Deta in the southwest direction. The site of the treatment plant is shown in the figure:

The sewage treatment plant for Deta was built between 1970 and 1972 and was put into operation in 1972.

The waste water is transported through the sewerage network to a SP1 pumping station where it is pumped into the main collector and from there it reaches the existing treatment plant. The main collector consists of concrete tubes with Dn 400 mm and has a total length of 1348 m. The main collector underlines the Birdanca River on a length of 49 m, representing two steel pipes (one reserve) with a diameter of Dn 250 mm.

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2.3. DESCRIPTION OF EXISTING TREATMENT TECHNOLOGY

The existing treatment plant comprises the following technology:

- a SP2 wastewater pumping station in reinforced concrete cheson. The underground compartment is designed for grates, under which there is a suction basin.
- reinforced concrete fireplace with 2 m diameter;
- sand removal facility 11 m long;
- fat removal facility 3.90 m long;
- 2 distribution halls;
- 2 aeration tanks connected to the final decanters;
- sludge pumping station;
- sludge stabilizer;
- sludge drying platforms.

Aeration tank

Secondary decanters

Sludge pumping station

Sludge drying platform

As a result of the analyses on the quality of waste water - the effluent, were excesses over the limits prescribed by law. To correct these indicators, it is recommended to build a new sewage treatment plant at Deta.

3. WATER QUALITY MONITORING AT THE ENTRANCE TO THE TREATMENT PLANT AND TO THE EVACUATION IN THE EMISSARY

The design polluting charges that have been used for sizing the treatment plant are shown in the table below.

In table no. 1, the loads from discharges of septic tanks were taken into account.

The quality of the treated waste water must be in compliance with the requirements stipulated in the Water Management Authorization No. 294 of 29.12.2010, as summarized in the table below:

Table No. 1 Charges at the entrance to the wastewater treatment plant

Pollutant parameter	**Designed polluted load**
Biochemical oxygen consumption (CBO5) (CBO_5)	425,3 kg/day
Oxygen Chemical Consumption (CCO-Cr)	638,0 kg/day
Total suspended material (TSS)	496,2 kg/day
Total nitrogen Kjeldahl (TKN)	70,9 kg/day
Ammonia nitrogen (NH4) (NH_4)	49,6 kg/day
Total phosphorus(P_{TOT})	7,1 kg/day

Table no. 2: Effluent quality criteria

Indicator name	**U.M.**	**Maximum admissible value**	**Frequency of sampling**	**Required level of compliance**
pH	pH units	6,5-8,5	Daily	93%
Biochemical oxygen demand in 5 days (CBO_5) determined by the addition of a nitrification inhibitor $^{1)}$	mg O_2/l	25	Daily	93%
Chemical oxygen demand (CCO-Cr) determined by the dichromate method $^{2)}$	mg O_2/l	125	Daily	93%
Total Suspended Material $^{3)}$	mg/l	60	Daily	93%
Total nitrogen $^{2)}$ / $^{4)}$ (sum of: Kjeldahl total nitrogen (N_{org} + N_{NH4}) nitrites and nitrates)	mg N/l	15	Daily	93%
Ammoniacal nitrogen (N-NH_4^+) $^{2)/4)}$	mg NH_4-N /l	2	Daily	93%
Total phosphorus $^{2)}$	mg P/l	2	Daily	93%
Total ionic iron (Fe^{2+} + Fe^{3+})$^{5)}$	mg/l	5	Weekly	93 %

In table no. 3 are presented the values imposed by the Water Basin Administration through Water Management Approval.

Table no. 3: Quality criteria related to the water management opinion

Indicator name	**U.M.**	**Limit values admitted**
pH	pH units	6,5-8,5
Biochemical oxygen consumption in 5 days (CBO_5) determined by the addition of a nitrification inhibitor[1)]	mg O_2/l	25
Chemical oxygen consumption (CCO-Cr) determined by the dichromate method [2)]	mg O_2/l	125
Total Suspended Material [3)]	mg/l	60
Total nitrogen [2) / 4)] (Total amount of Kjeldahl nitrogen (N_{org} + N_{NH4}) ; nitrites and nitrates)	mg N/l	15
Ammoniacal nitrogen (N-NH_4^+) [2) / 4)]	mg NH_4-N /l	2
Nitrates (NO_3^-)	mg/l	25
Nitrites (NO_2^-)	mg/l	1
Total phosphorus [2)]	mg P/l	2
Sulphates (SO_4^{2-})	mg/l	600
Extractable substances in petroleum ether	mg/l	20
Residue filtered at 105 ºC	mg/l	2000
Synthetic detergents	mg/l	0,5
Chloride Cl^-	mg/l	500

4. PROPOSAL FOR ACHIEVEMENT OF A WASTE WATER TREATMENT PLANTS IN THIS LOCALITY

Purification of domestic wastewater collected from the city of Deta is proposed to be accomplished through a rehabilitation and refurbishment of the existing treatment plant.

The main objective is to improve the performance and replacement of the existing treatment plant infrastructure in order to comply with the requirements of the Wastewater Directive 271/91 / EEC, transposed into Romanian legislation, GD 188/2002, as subsequently amended and supplemented.

The new wastewater treatment plant should consist of a tertiary stage (to remove phosphorus and nitrogen) and is located within the existing wastewater treatment plant.

The sewage treatment plant in Deta has to be sized for a capacity of 7,089 PE. The sewer system in Deta is divisive (separating).

The effluent of the wastewater treatment plant will be discharged into the Birdeanca River via an effluent discharge pipe about 30 m long.

The wastewater treatment plant must be sized at the following rates: Qu day med = 13,19 l/s = 1.140,00 mc/day; Qu day max = 15,58 l/s = 1.346,00 mc/day; Qu or max = 32,78 l/s = 118,00 mc/h.

The rehabilitated wastewater treatment plant of Deta has the following components:

Water line

- Access raw water + by-pass
- Rare grabs (2 independent lines)
- Wastewater pumping station
- Compact installation for mechanical sewage treatment (site, desander, grease separator)
- Homogenisation / clearing buffer
- SBR bioreactor feed pumping station
- SBR-type bioreactors (2 independent lines)
- Blower station
- Guest to download

The sludge line

- Excess slurry pumping station from SBR basins
- Sludge pool
- Solar dehydration station with polymer dosing
- Warehouse covered dewatered mud

Related works:

- Water technology pumping station, recovered from purified water
- Fat storage basin
- Pavilion of operation and laboratory
- Check-heater + Workshop + Electric room
- Cabin gate
- Transformation post
- Emergency generator
- Access road, alleys and platforms
- Unclosing and access gates

Rare grills

Further, there are two independent lines with rare grids with a distance of 50 mm bars, where the coarse materials are retained in the suspension.

The rare grills are planar and are mounted in special grooving channels with a 750 inclination to the base. The capacity of the grate will be: 125 mc / h of waste water (Qh max = 118 mc / h). The installation ensures automatic grid cleaning by means of a tooth rake, powered by two chains.

The rarely grille will be made of stainless steel.

Rare grid operation is automatic, depending on the level sensor readings located upstream and downstream on each line.

Coarse materials collected by grates are discharged to the upper part of a compaction and retention flush installation with two entrances for the two rare grate lines.

The sorted material is cleaned of organic substances and coarse materials by washing with water in the special installation, after which the coarse material is dehydrated to a concentration of 40% and discharged into a mobile container.

The washing waters resulting from this phase are conducted together with the raw water treated preliminarily to the homogenisation basin.

Both rare grid channels are provided upstream and downstream with the electrical grids that isolate a line - by closing the stacks on a line or both lines - by closing the upstream slopes.

Intermediate pumping station

After crossing the rare grates, the water enters the suction basin of the SP1 intermediate pumping station. Rare gravel vat and pumping station are part of the structure of the technological hall + homogenization pool. The pumping station will be equipped with (2 + 1) submersible pumps

Compact installation for mechanical sewage treatment plant

Mechanical sewage treatment is carried out on two independent lines, through two compact installations, consisting of: frequent grate for retaining fine materials (5mm site), integrated sanding, sand washing plant and grease separator.

The mechanical sewage treatment lines operate in 1 + 1 mode (one in operation + one in reserve).

A compact installation for mechanical treatment includes:

- automatic sieve, washing and pressing the retained material
- a desander coupled with a grease separator, aerated, with sand washing and dehydration
- blower for aeration.

All phases of mechanical water treatment are integrated into a stainless steel container.

At the entrance the fine suspensions are retained on the 5 mm webs. The holds are dehydrated and compacted by the integrated press and are transported out of the mechanical sewage treatment plant. After mechanical sewage treatment, the dry matter content of the restraints is 40%.

Dewatering water returns to flow, thus avoiding concentration variations in CBO5 of wastewater.

After sowing, waste water flows to the grease disassembly and separation system where sand deposition and separation of fats takes place by flotation with compressed air. Through the turbulence created by counter current transport of sand particles, they are washed by organic matter before deposition. In the sandbox integrated into the plant, the sand is dehydrated and transported in a 1.1 mc container.

The floated fat is collected and transported to the fat storage tank, located below the technological hall.

Homogenisation - compensation basin

The clearing and homogenization basin collects sewage wastewater, mechanically treated. For the homogenization of the influent, the basin must be equipped with mechanical agitation system (2 mixers).

Clearance basin cutter has a uniform slope to the bumper where the pumps are installed.

Wastewater is pumped with submersible pumps to the SBR reactors 1 and 2. The useful volume of the basin is dimensioned for the final stage (7.089 LE), V = 400 mc.

In order to optimize the wastewater treatment capacity of the plant, both in the early years of the sewerage system development and the final stage, the technological process is conducted in such a way as to ensure in all conditions the admissible evacuation values according to the rules in force (especially P_{tot} And N_{tot}). This compensating basin therefore serves to fill the SBR basins in batches. Pump capacity and sequential operation consider this requirement.

At the beginning of the sewage treatment phase, a defined and adjustable quantity is introduced into SBR, depending on the daily waste water flow rate.

To ensure sedimentation and a drainage without transverse streams, no wastewater is introduced into the sedimentation and clear water outlet.

An automatic sampling unit is placed in the technological hall, which draws water from the homogenization tank.

The pumping station SP2is provided in the homogenisation tank, which sends the waste water in bioreactors.

SBR1 and SBR2 basins

Biological sewage treatment with proposed technology: *SBR (Sequencing Batch Reactor) or „Sequencing Reactor”* is done in a single basin, in the presence of oxygen introduced artificially by aeration and activated sludge in the bioreactors (the process does not require recirculation of the sludge) . It is specific to this technology that the aeration, settling and aerobic sludge stabilization process takes place in the same tank, but staged (offset, sequentially) over time.

The SBR process is a discontinuous process that takes place in predefined time phases. In the SBR process, the technological steps in a conventional biological sludge treatment plant with activated sludge (the biological step followed by post-rinse) are performed in a single basin. Thus, within a time frame, the SBR reacts as an aeration tank, and in the next time it functions as a secondary decanter.

The technological phases are sequentially and cyclically adjusted, depending on the volume of influent flows.

Hydromechanical equipment as well as electronic measuring, routing and control technology ensures such operation. Through an optimal management of the sewage treatment process, the SBR type system provides a number of advantages over the conventional flow process.

The discontinuous / batch operation of the SBR contains the sequence of the following phases over a proposed 8 hour cycle:

1. Reaction phase, T = 5.9 hours, consisting of:

- 1.1 filling;

Purpose: addition of nutrient substrate (mechanically treated waste water)

Increase the water level in the pool.

The duration is T1 = 1 hour V water = 230.91 mc / SBR, Qpump = 232 mc / h.

Phase may extend up to max. 1.5 hours, or drop to 0.5 hours. Phase duration is set at the start of the station during the sample and adjustment period. The maximum flow rate of 492.6 mc / cycle, possibly in limit situations (with one single SBR basin in operation), it is possible to ensure that the second pump provided as a reserve, the water level in SBR rising, in this case, at 5.5 m.

- 1.2. water aeration

Purpose: to continue and complete the biochemical reactions that was initiated during the filling phase

The duration is **T2 ~ 3.9 hours**

2. sedimentation

Purpose: Separation of solids from water to clarify the water

The duration is **T3 = 1.1 hours**

3. drain water evacuation

Purpose: clear water evacuation

Duration is **T4 = 1.0 hour**

4. sludge evacuation

Purpose: excess sludge is discharged at the end of each cycle

The duration is about 5% of the duration of a cycle and overlapping the end of phase 4 **T5 = 0.4 hours.**

Sludge basin

Excess sludge produced in the biological phase is extracted from SBR reactors through excess sludge pumps located at the base of basins. Extraction of excess sludge occurs during the exhaustion phase of the purified water.

From the calculation book it follows that the sludge discharged from the SBR reactors is 11.17 mc / cycle, respectively 76.46 kg SU / cycle. It results a volume of 67.02 mc / day drained excess sludge.

Excess sludge extracted from the SBR basins is pumped into the sludge basin that has the role of static sludge thickening and thick sludge storage basin.

The mudguard is dimensioned to achieve a sludge concentration of 3.5%.

The thickened sludge from the bottom of the basin is pumped to the dewatering plant by means of progressive cavity pumps.

1 +1 thickened sludge discharge pumps are located inside the technological halls.

The clarified water from the surface of the basin is extracted by means of submersible pumps (1A + 1R) and discharged into the homogenization - clearing tank.

In the sludge basin we have an ultrasonic level sensor that measures permanently the water level in the basin and which can control the start-up of the pumps.

The sludge basin is provided with an overflow (Dn 150) which is connected to the homogenisation basin and which ensures the supernatant discharge if the supernatant pump is not working.

Dehydration of sludge

Dehydration occurs during the normal service of the sewage plant personnel. The sizing of mechanical dehydration of sludge is based on the hypothesis that dehydration occurs during 8 hours a day in 5 days of work. An automatic compact installation is provided to provide dewatering. In order to optimize the dehydration process, the sludge is treated with polyelectrolyte coagulation reagents, prepared as solutions and dosed by a suitable installation.

The sludge dehydration up to a concentration of 35% is provided by the following equipment: Compact sludge dewatering installation; Polyelectrolyte preparation / dosing installation; Var storage facility (silo type); Var carrier; Var micropowder; Sludge mixer + var and Screw conveyor for dewatering dewatered sludge.

These machines will be installed in the technological hall

The polyelectrolyte preparation / dosing installation

The process of preparing and dosing the flocculants is accomplished by means of a compact installation consisting of: a reservoir; electric mixer; funnel with water pipe connection; tank drain valve and pump for dosing the flocculants.

The polyelectrolyte solution preparation plant is connected to the drinking water supply network. Only potable water should be used in the process of preparing the polyelectrolyte solution.

The efficiency of sediment dehydration is mainly due to the application of polyelectrolyte's (flocculants). Polyelectrolytes thicken the sediment and significantly increase the separation of water.

Choosing the flocculant is done by testing. Testing should be performed under laboratory conditions. The test shall determine: the type of flocculant; dosage and concentration.

The sludge dewatering plant

The sludge dewatering unit is designed as a compact monoblock and the design allows the equipment to be placed in heated buildings. The sludge dewatering unit is made up of a special aggregate with a profiled screw. The dehumidification system will be connected to the technological water supply network for washing the machine.

The water resulting from the dewatering process is collected and discharged into the homogenisation-compensation tank, located under the technological hall.

Var storage / dosing plant

To reach the 35% dehydration degree, a var storage / dosing installation was provided, consisting of the following: Vibratory conveyor for var dosing; Screw conveyor; Var microdose; Dewatered sludge mixer + var and slurry helical conveyor

Dewatering sludge storage platform

For the storage of dehydrated sludge there is provided a concreted platform, covered, with two compartments with dimensions 6.5 x 4.0 m, with a total storage capacity of 90 days. On 3 sides the platform is delimited by reinforced concrete walls of 2.0 m high.

On the side where access to the platform is provided, a grid-covered collecting channel is provided for collecting and discharging the water from dehydrated sludge. The platform slopes is 2% to a water collection gutter that drains into the sewerage.

5. CONCLUSIONS

The purpose of the study was to analyse the efficiency of the operation of the existing wastewater treatment plant in Deta, Timis County.

The wastewater treatment plant must process raw waste water and convert it into conventionally clean waters, respecting the quality indicators imposed by NTPA -001/2002 and the water management permit, so that they can be discharged directly into the Birdeanca River.

Technological or quality indicators of waste water measured were: CCO, CBO5, MTS, NO3 and P.

Existing wastewater treatment plants have resulted in exceedances of the wastewater quality indicators (CBO5, MTS and P total exceed the permissible limits and the total N exceeds the allowed value by 75%), requiring the rehabilitation and refurbishment of the sewage treatment plant for wastewater in Deta locality.

After the rehabilitation and retehnologization of the wastewater treatment plant (due to the technological scheme adopted), the quality indicators calculated at the exit from the WWTP will be within the limits set in accordance with the legislation in force, in order to comply with the requirements of the Waste Water Directive 271/91 / EEC, transposing into Romanian legislation, GD 188/2002, with subsequent amendments and completions.

In conclusion, with the rehabilitation and refurbishment of the wastewater treatment station in Deta, a safe operating system will be developed.

6. REFERENCES

[1] M., Negulescu, Canalizări, Technical Publishing House, Bucureşti, 1978;
[2] M., Dima, Epurarea apelor uzate urbane, Junimea Publishing House, 1998;
[3] M., Giurconiu, I., Mirel, A., Carabet, D., Chivereanu, C., Florescu, C., Stăniloiu, Construcţii şi instalaţii hidroedilitare, West Publishing House, Timişoara 2002;
[4] I., Mirel, Consideraţii cu privire la alcătuirea şi retehnologizarea staţiilor de epurare în raport cu cerinţele impuse prin normele naţionale şi europene –ECOTIM, 2000;
[5] Waste Water Directive 271/91/EEC;
[6] European Council Directive 83/1998 on water quality;
[7] NTPA 001/2002;
[8] NTPA 002/2004;
[9] NP 133/2013 – volume 2;
[10] The Normative ATV 131;
[11] Construction of the WWTP in Deta - Beneficiary - AQUATIM S.A.