# LAW CAPACITY WASTEWATER TREATMENT PLANTS

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**Abstract**

The question of small water users having no centralized wastewater collecting, cleaning and discharging system is of maximal actuality in Romania. Therefor economically efficient solutions are looked for. For disperse mountain villages, farms, or detached households traditional systems, with high maintenance expences because of long networks for small flows, can be economicaly not advantageos. Very small capacity treatement plants are a solution for such cases. The aim of the experimental part of the present work is to simulate situations, damages which can occur during running of a low capacity wastewater treatement plant. Low capacity hosehold wastewater treatement plants are economic alternatives which remove the disadvantages of emptyable basins namely the high costs, the frequvent empying operations, with unpleasant smelling, continous danger of groundwater infection, need for massive and expensive concrete buildings. The proposed plants are based on a classical treatement technology and need emptying of the exess mud only once or twice a year. In opposition with the case of classical plants, the mixture extracted from the proposed low cost systems does not smell and has a relatively low content of solid matter.

**Keywords:** plant, wastewater treatment, consumer, influent, emissary

## 1. Introduction

The question of the small water users having not any centralized collecting, transport, cleaning and discharging system is of maximal actuality in Romania. Therefor rapid, technically and economically efficient solutions are looked for. Such way a suitable rural infrastructure is intended to be developed, according to the today comfort and hygiene standards (Dima M., 1998).

The public sewage system with a centralized treatment plant is the most advantageous solution for small and medium sized settlements with a high density of buildings and inhabitants connected to the system. But for settlements, such as disperse mountain villages, farms, or detached households such a system can be economicaly not advantageos, with high maintenance expences because of the long networks for small flows (Ianculescu O., Racoviteanu R., 2001).

Collecting wastewater in emptiable basins is nowadays accepted in more and more countries at least inside the European Union. These basins need a very large constructed volume (minimum $3m^3$ for each equivalent inhabitant according to the Austrian law and at least $5m^3$ for each equivalent inhabitant according to the German law). This also is an unhandy solution with massiv and expensive buildings, involving erection restrictions, polluting danger for the environment, for soil and for underground water if leakages appear. Also it can be disagreeable to people due to the large size of required devices (Negulescu C., 2004).

Small and very small capacity treatement plants are a solution that is used in Europe beginning with the last years. More treatement technologies used in various types of low and very low capacity treatement plants are now outlined. Legislation existing in some European countries comprises financing programs or just confering subventions to promote these technologies.

One of the advantages of the small and very small capacity treatement plants is that they are very simple, easy to be achieved, and that they are not difficult to be started up. The main disadvantage of such plants is the high acquisition price and the need of periodical surway that must be carried out by qualified personell (Ianculescu D.O., 2002).

Treatment plants are classified according to more criteria, namely the inlet flow, the number of equivalent inhabitants, the ammount of organic substances (BOD) in the plant inlet. The equivalent inhabitant concept was introduced by the 91/271/EEC Directive in 1991 as a reply to the need for a universal comparative measure of plant capacity (so one unit of equivalent population is 60 mg BOD/day according to the 91271/EEC directive).

A clasification of wastewater treatement plants according to their maximal daily flow is comprised in table 1.

Table 1.

Classification of treatement plants according to the maximal daily flow

| Nr. | Type of the plant | Daily maximal flow rate of wastewater inlet | Equivalent inhabitants |
|---|---|---|---|
| 1 | Very small plants | $Q \leq 5$ l/s | $\leq$ 2.500 |
| 2 | Small plants | Q = 5 l/s....50 l/s | 2.500 ... 25.000 |
| 3 | Medium sized plants | Q = 50 l/s . . .250 l/s | 30.000 ... 125.000 |
| 4 | Large sized plants | Q > 250 l/s | > 125.000 |

Source: Self processing based on directive 91/271/EEC

## 2. Specific problems of the small capacity treatment plants

Treating the household wastewater resulting in small colectivities envolve a number of specific problems, so in erecting as in achieving and in leading them. This is due to any or more of the following:

- the low flows passing through;
- the high variation in flows and in the maximalflow/minimal flow ratio;
- intermittent as regards running;
- they are in work without a continous supervision, the qualified personel carries ounly a periodical inspection of the plants;
- the treated water is discharged in a low capacity receiver or in a receiver without flow;
- the receiver is of a very high quality.

## 3. Specific needs towards the small capacity treatment plants

The needs concerning the efficiency of the low capacity wastewater treatement plants are in accordance with the the domain of their use, namely:

- minimal costs in investments and use;
- to have robust, fiable and simple machineries, equipment, and installations;
- to have a complex automatisation and data transmiting system;
- a low energy use;
- the materials used in construction and erection must be resistant and corrosionless;
- the equipment must be compact and to accupy the posible smallest area;
- the flow and pollutant charge shocks must be avoided and the necessary means must be provided for a continous running with a steady flow (basin for making flow uniform).

Situations in which micro-plants are suitable to be used are as follows:

- localities, quarters, or streets where no sewage network exists (for instance villages or periferial quarters, even rezidential ones);
- lonely buildings in places where no waste water nerwork exists (parkings, motels, hotels, inns, sanatoriums, military buildings, monasteries a.s.o.);
- places where situation is propitious for achieving and using such micro-plants even if a sewage network already exists (for instance in case of autonome hoseholds, or of micro-zonal water supply and sewage systems);
- places where a quick and qualitative development of rural infrastructure is desired (Ianculescu D.O., Molnar A., 2001).

Taking into account the above conditions, micro-plants can be recommended for beneficiaries as follows:

- those who want to improve their confort conditions and want to live in a clean environment;
- those who want to achieve savings;
- those who are openminded for that what is new, whant to experience, have a techical sense and are not too easy-going;

-those who have option for a not centralized managing of energetic resources, of water and of sewage;

-those who use water in a rational way, by high performing, small ammount of water consuming washing devices (both for vessel and linen);

-those who use ecologic, biologically degradable detergents;

-peasants' hoseholds with agrotouristic activities, with a need for a higher confort level;

-those who have no water resourses for agriculture.

**4. Research methods**

The aim of the experimental part of the work is to simulate different damage situations, which can occur during running of a low capacity wastewater treatement plant, namely electrical sut down, damages of the pomp serving in water oxygenation a.s.o.

Experiments were carried out on an ORM 5 type small calacity treatement plant that was erected for a 5 l/s flow, and was placed inside the treatment plant of Timisoara municipality (www.agir.ro). The profile of the plant is prezented in fig. 1.

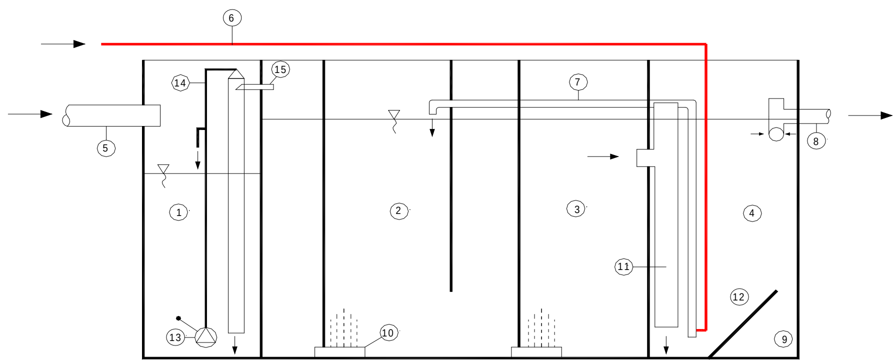


Fig. 1. The profile of the ORM 5 type plant

Source: Self processing

The components of the ORM type plant are listed below:

1. Reception tank and first step settler
2. Activating basin - compartment 1
3. Activating basin - compartment 2
4. Secondary settler
5. Inlet of the influent
6. Aer supply
7. Gaslift pipe
8. Efluent outlet
9. Mud storage compatiment
10. Aeration plate
11. Second settler feeding pipe
12. Shield
13. Feeding and recicling pump
14. Driving back pipe
15. Aeration basin feeding connection

The technologic flowsheet of the ORM5 type treatment plant is presented in fig. 2. The ORM treatment plant consists of the following compartments:

- compartment 1: storing, bulk separation, equalizing and flow distribution;
- compartment 2 and 3: biological oxydation and nitrification;
- compartment 4: final settlement and mud recycling.

The compact ORM treatment plants are designed and built for wastewater resulting in communities with 5 – 500 inhabitants, the rainwater being totally excuded.

One of the pilot experiments aimed to determine the dissolved oxygen concentration in the aeration basin after the aeration was shut down. Samples were taken with a frequency of one per ten minutes with a Sigma pump. The analyses were carried out with Merck kits. The results can be seen in table 2 and are represented in graph fig. 1.

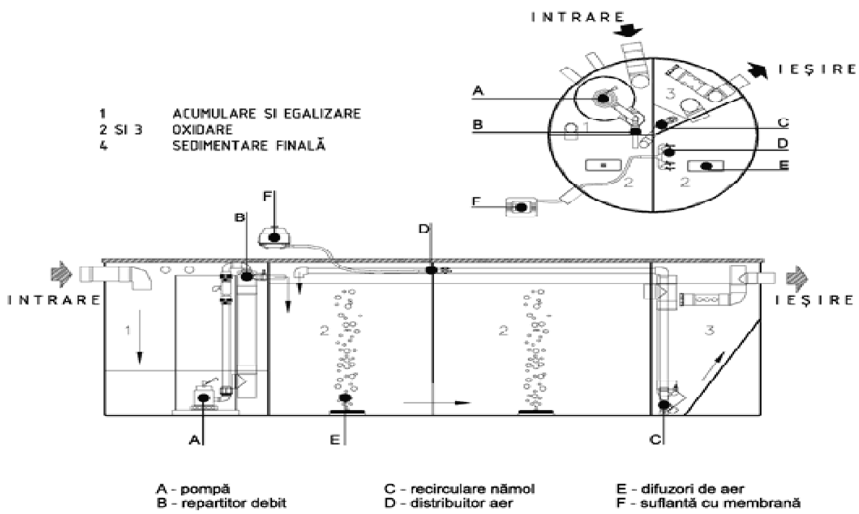


Fig. 2. Technological diagram of the ORM 5 treatment plant

Tab. 2.

Dissolved oxygen concentration at different deepth in the aeration settler versus time

| Nr. | Time (s) | Dissolved oxygen concentration (mg/l) |
|---|---|---|
| 1 | 5 | 3.0 |
| 2 | 10 | 3.0 |
| 3 | 20 | 2.8 |
| 4 | 30 | 3.2 |
| 5 | 40 | 3.3 |

Source: self processing

The second experiment carried out on the pilot installation aimed to examine the changes in dissolved oxygen concentration after shutting down the aeration, at different depths in the settler, so in water as in mud. Samples were taken simultaneously, ten minutes after the aeration was stopped; a Sigma type pump was used. Sampling was carried out by use of a device with six flexible pipes diposed at different depthes, namely at 20cm, 40cm, 60cm, and 100cm above the bottom. The automatique sampling took place in six different vessels. After sampling, the following indicatores were determined: dissolved oxygen concentration, suspended matter, and the age of the mud. The results are represented in table 2 and in figures 4, 5, 6, and 7.

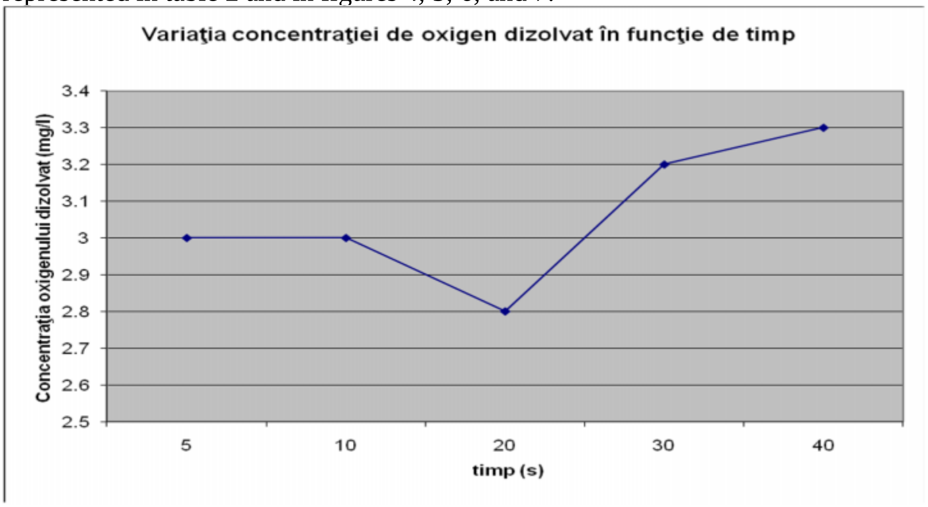


Fig. 3. Variation of oxygen concentration versus time

Source: self processing

Tab. 3.

Concentration of settable matter, of suspended matter and of dissolved oxygen in the aerator at different depthes

| Depth cm | Settlable substances (after five minutes) mg/l | Settlable substances (after 30 seconds) mg/l | O2 concent. mg/l | Suspended matter mg/l | Volatility index of the mud |
|---|---|---|---|---|---|
| 0 | 4,00 | 5,0 | 3,2 | 286 | 17,4 |
| 20 | 4,50 | 5,0 | 3,6 | 295 | 16,9 |
| 40 | 0,20 | 1,3 | 4,3 | 78 | 16,6 |
| 60 | 0,10 | 0,7 | 3,2 | 52 | 13,4 |
| 80 | 0,05 | 0,2 | 2,6 | 48 | 4,1 |
| 100 | 0,20 | 0,2 | 5,1 | 42 | 4,7 |

Source: self processing

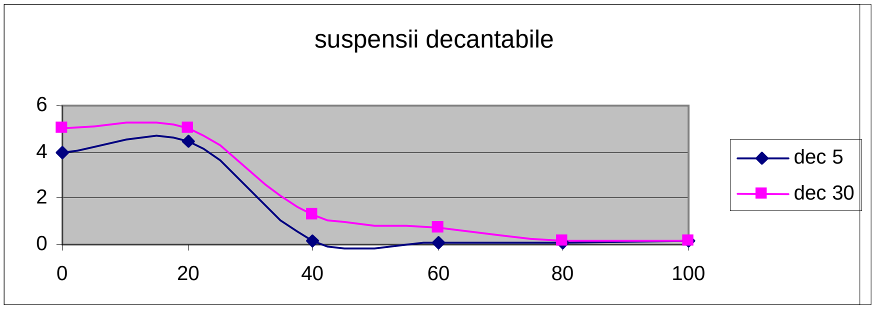


Fig. 4. Variation of the settlable matter concentration after 5 and 30 minutes at different depthes in the aeration tank

Source: self processing

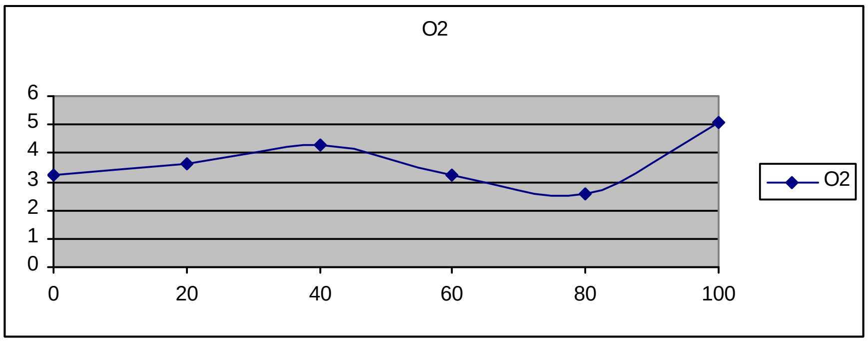


Fig. 5. Variation of the concentration of dissolved oxygen at different depthes in the aeration tank

Source: self processing

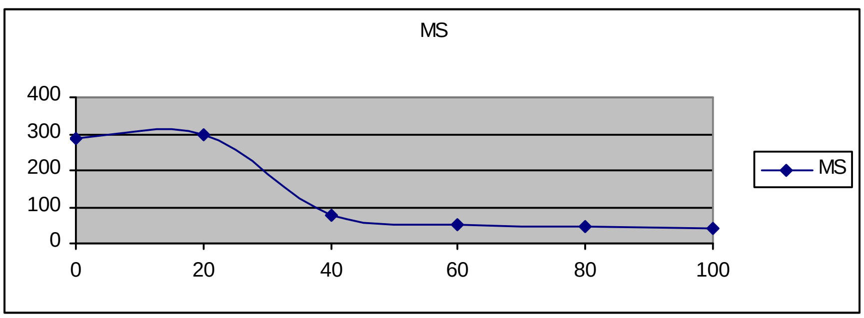


Fig. 6. Variation of the concentration of suspended matter at different depthes in the aeration tank

Source: self processing

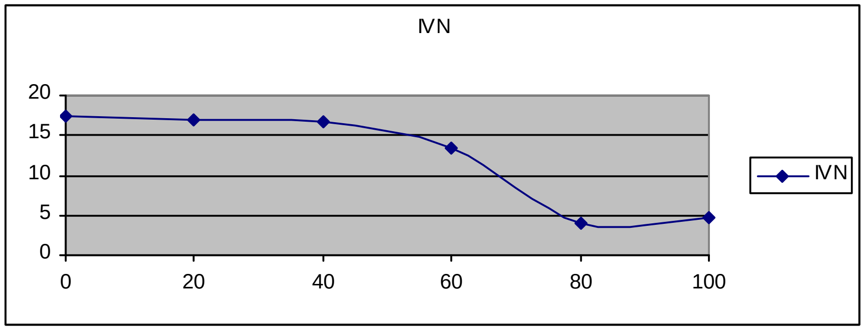


Fig. 7. The age of mud at different depths in the aeration tank

Source: self processing

**5. Results and discution**

Figure 2 represents the variation of settlable substance concentration in the aeration tank at different depthes. Analyses of settlable mattter both for 5 seconds and for 30 seconds were carried out for making results more conclusive. The results leds to the conclusion that settlable matters are present in a constant concentration in the settler in the 0 – 20 cm depth range, a significant decrease follows inside the 20 – 40 cm depth, a steady decrease appears between 40 – 100 cm at a 30 second long period, and a decrease of concentration close to 0 at the 40 – 100 cm depth interval, the sample being collected inside a five seconds long period.

In figure 3 a small increase in oxigen concentration can be seen in the 0 – 40 cm deep layer, followed by a relatively steady decrease in the layers that follow. The presence of a higher ammount of disolved oxigen in the 20 – 40 cm layer compared to that situated at 0 – 20 cm can lead to the conclusion that there is a tendency of oxigen to access outside the system, followed by a relatively constant decrease of concentration at 40 cm.

Concentrations of suspended matter are presented in fig. 4 and it can be seen that in the 0 – 20 cm domain the concentration remains relatively constant. Afterwards an important decrease follows in the 20 – 40 cm and in the domain that follows the decrease is relatively less intensive, a relatively onstant value, round 48 mg/l, being registerd.

Fig. 5 presents variations of the volumetric index versus the changes in sampling heigth in the aeration tank. It appears that in the 0 – 40 cm depth a very small decrease in mud index appears. It is followed by an important decrease in the 40 – 80 cm interval and, afterwards, a fluctuation with a steady increas of concentration was registered in the intervals that follow.

The experiments were carried out for better and profund knowing the physical and biological processes that take place in the mini treatment plant for assuring the best conditions for its optimal run. It can be concluded that the most significant processes in mud settling take place in the 20 – 60 cm depth range.

## 6. Conclusions and recomandations

Hosehold wastewater treatement plants with low capacity are a modern economic alternative that definitively remove all the disadvantages of emptyable basins namely the need for frequvent empying operations, unpleasant smelling, continous danger of groundwater infection, massive and expensive concrete buidings, restrictions in erection. These plants are based on a well known classical treatement technology and needs the emptying of the exess mud only once or max. twice a year. In opposition with the situation existing in the case of classical fossae or Imhoff type reservoirs, the mixture extracted from the systems presented above does not smell and has a relatively low content of solid matter.

Biomass aeration is carried out with compressed air produced by a blower with membrane that is characterized by small dimensions and low energy use and also by a low noise level that is not perceptible even during the night. Oxygen solving is assured by porous diffusers that were studied and homologated specially for this size of the tank. Recirculating of biologic mud is achieved by a special air-lift which lifts the mud. The air-lift, patented and achieved by ORM not only lifts the water – mud mixture, but also contributes to its oxygen content by 3-4 mg/l, such way it being alreay reactivated when returned to the aeration tank.

The compressed air for the air-lift is delivered by the blower which is used for oxidation.

The water resulting in the process observes the European norms and the national norm NTPA 001, such way being possible discharge into any natural emissary - receiver such as rivers, channels, lakes, sea a.s.o.

## Literature

Dima M., 1998, *Epurarea apelor uzate urbane*, Editura Junimea, Iaşi;

Ianculescu D. O., Molnar A., David C., 2002, *Staţii de epurare de capacitate mică*, Ed. Matrix Rom, Bucureşti;

Ianculescu O., Racoviţeanu R., Ionescu Gh., 2004, *Epurarea apelor uzate*, Ed. Agrotehnica, Bucureşti;

Negulescu C., 2004, *Exploatarea staţiilor de epurare a apelor uzate orăşeneşti*, Ed. AgroTehnica, Bucureşti;

Nistreanu V., 2000, *Procese unitare de tratare a apelor*, Editura AGIR, Bucureşti;

Rojanschi V., 1996, *Cartea operatorului din staţiile de tratare a apelor,* Editura Tehnică, Bucureşti;

Rojanschi V., 1997, *Cartea operatorului din staţiile de tratare a apelor*, Editura Tehnică, Bucureşti;

*** Directive of the European Council 91/271/CEE Concerning the Treatment of Urban Wastewater;

*** The Romanian Law of Water 107/1996, published in the Romanian Official Monitor nr. 244/Oct. 08, 1996;

*** The Decision of the Romanian Gouvernment 188/2002, supplemented by the Decision 352/205, containing the Normative concerning the limits for the pollutant content of the wastewater discharged to water resources NTPA 001 and the Normative concerning the limits for the pollutant content of the wastewater discharged to the wastewater networks of localities NTPA 002;

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