

# Experimental Water Treatment Plant from Agrozootechnical Farm

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**Abstract.** According to the existing statistical data at the country level, over 65% of the wastewater (rural from agricultural livestock farms) is discharged without purification, 61% are insufficiently purified and only 10-15% are properly purified. The pollution effect of wastewater not purified or insufficiently purified on surface waters, is mainly manifested by the content of suspended matter, of organic matter, in nutritional salts, ammonium and in pathogenic microorganisms. It is well-known that the nutritional salts of nitrogen and phosphorus cause the eutrophication of surface waters, with the effect of consuming the dissolved oxygen needed to sustain the aquatic life. Ammonia is particularly toxic to aquatic life. Unsaturated or insufficiently purified wastewater pollutes groundwater, among others with nitrates, ammonium and bacteriologically. From the presented results, the purification of waste water is an essential requirement of the development of human civilization. Being a necessity with special social and ecological implications, the unitary regulation and the general provision of the necessary infrastructure is a priority, in this sense an article will be presented in an experimental treatment station that performs the collection of waste water from an agrozootechnical farm. The purification of water within this experimental model of treatment plant will be done autonomously from an energy point of view (electricity supply is carried out through a hybrid system based on photovoltaic panels and wind turbine), and the recovery. The use of purified water is done in a greenhouse, using a mixed irrigation system (dripping / spray irrigation).

## 1 Introduction

In the current stage of economic and social development, characterized by unprecedented dynamics, on the one hand, and the limited nature of natural resources, on the other hand, water, one of the most important natural resources, must be well managed, for to prevent the "water crisis", a term that appears more and more frequently in the forecasts of international organizations. The warning of scientists about a possible water crisis at the planetary level, has determined the United Nations to establish March 22 as

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"World Water Day", the goal being an action plan at the individual, national, regional and international level for use water rational, [1,2]. The concern for rational water management is due to the characteristics of the water, as a natural resource:

- water resources are limited; the water resources of a river basin (or of a region, country) are periodically restored, but they cannot grow over time;
- the water resources have an unequal distribution in time and space; they are differentiated from the distribution in time and space of water requirements;
- the water resources have limited possibilities (from a technical-economic point of view) to be transferred between different regions or hydrographic basins;
- surface waters are strongly influenced by man, both from a quantitative point of view (captures) and qualitatively (the discharge of more or less purified waste water);
- water is a reusable resource; the same quantity of water can be used - if qualitatively it corresponds - by several users, through successive catches and refunds;
- water is an important environmental factor; his good management is an obligation that derives from the requirements arising from the environmental protection legislation.

Water purification - a complex process of retention and neutralization of dissolved harmful substances, in colloidal or suspended state, present in industrial and urban wastewater, which are not accepted in the aquatic environment in which the treated water is discharged and which allow the restoration of physical properties - water chemicals before use, [3,4].

Wastewater treatment comprises two broad categories of successive operations, namely:

- the retention or neutralization of harmful or recoverable substances present in wastewater;
- processing of the material resulting from the first operation.

Thus, the treatment has as final results the waste water, in different degrees, poured into the emissary or that can be used in irrigation or other purposes and sludge, which are processed, stored, decomposed or used. The main wastewater treatment methods differ depending on the pollutants present. They can be classified, first of all, according to the mechanism that leads to the reduction of the pollutant by "conventional" physico-mechanical, physico-chemical, biochemical or biological methods. The combination of these methods allows for advanced purification, and the effluent can be re-introduced into the economic circuit, [5,6].

The agriculture currently practiced is largely polluting, and the phenomenon of pollution is largely known by specialists in the field of environmental protection. The main aspects of the environmental pollution caused by the agricultural activities can be summarized in:

- the evacuation of several million cubic meters of wastewater, not purified or incompletely purified, coming from the breeding complexes in the industrial system of pigs, birds and cattle, in surface areas and in the drying network. To these are added the infiltration of wastewater into the depths, during the storage period in ponds, battles and basins, affecting the quality of groundwater used as a source of drinking water supply in many rural localities.
- use on agricultural land, for dual purposes, of fertilization and irrigation, of sludge and waste water from livestock farmers, containing harmful salts and pathogens contaminating soil, plants, animals and humans.
- the administration on agricultural lands bordering the zootechnical complexes of exaggerated norms of manure (over 100 t / ha), at intervals of 2-3 years, which far exceed the needs of the plants and determine the accumulation of nitrates in fodder, as well as the leaching of nitrates in the groundwater.

- the use of chemical fertilizers (especially nitrogen) in doses too high and at times not correlated with the consumption in different phases of development of the cultivated plants.
- application of chemical products (pesticides), with the purpose of combating diseases, insects, rodents, nematodes and weeds in agricultural crops and apple orchards, by poorly trained people.
- the uncontrolled storage of manure and the lack of manure collection basins from the animals belonging to numerous private households have as negative effects their leakage into the running water, as well as the nitrate infestation of the groundwater.

The establishment of animal farms can be done only by observing very strict rules, especially regarding the neighbourhood, but also the conditions for the storage of waste, [7]. At EU level, but also in Romania, there are certain regulations that prohibit the placing of livestock farms at short distances from the inhabited areas. In these conditions, it becomes necessary to make some inventions in order to ensure the water and sewage needs. In order to ensure the sewerage in some situations, the agrozootechnical farm can be connected to the sewerage system of the locality, but in order to achieve this, the water discharged from the farm must comply with the norm of NTPA 002. As the evacuation of a water that is included in this norm is most often impossible, the farmer has to create, on the territory of his farm, a water treatment plant that will bring water at least within the parameters specified by the NTPA 002. In most cases, however, the agrozootechnical farm is located at very far from the centralized sewerage system the farmer being forced to find alternative solutions. Thus, a solution is the relocation of wastewater treatment technologies and the reuse of this water in agriculture.

The chemical characteristics of wastewater are basic elements in the characterization of wastewater. The chemical composition of wastewater is influenced by the specific consumption of water per capita. The higher the consumption of water per capita, the more diluted the waste water, because, in general, the amount of waste water discharged is relatively constant, [8, 9]. Important for the design of the treatment plants is the value and the state of the materials contained in the water, respectively the quantity of the solid organic matter that is suspended and separable by decanting, solid organic materials and dissolved in the water, as well as other materials specific to the waste water, such as: nitrogen under all forms of chemical combinations, chlorides, sulphides, hydrogen sulphide, etc.

## **2 Material and method**

In order to carry out the researches presented in this article, an experimental wastewater treatment plant was used, the water treatment within this energy-independent wastewater treatment plant (powered by electricity produced by a hybrid system based on photovoltaic panels and wind turbine), and the use of purified water within an agricultural land, through the use of an irrigation system. Water quality was monitored to determine the efficiency of the system. Figure 1 presents the final technical drawing, which faithfully represents the real situation, from the field.

The treatment plant is supplied by a pump mounted in the technical room. The unit is supplied with constant flow, while the blower supplies almost continuous air to the aerobic reactor. The feed pump discharges waste water transported to the first compartment (bioreactor) of the unit. The biological treatment stage has the following sequence of compartments:

- a bioreactor with SAM technology with a slow mixer for denitrification and reduction of organic material;

- the second bioreactor with intensive aeration with SAM technology for nitrification and reduction of organic matter;
- a decanting pond with lamellar decanter;
- a sludge recirculation system.

The technical characteristics of the agro-zootechnical wastewater treatment plant are the following:

- diameter of the upper module of the water treatment plant: 2500 mm;
- length of the above ground module of the water treatment plant: 5580 mm;
- volume of the purified water storage tank: 1 m<sup>3</sup>;
- electricity supply: renewable sources of electricity, solar panels and fully autonomous wind turbine, 230 V.c.a. and a nominal frequency of the 50 Hz network, and the power supply for control, trigger, alarm and signalling installations is 24 VAC.

The irrigation system it is composed of a system of pumping the water treatment from the retention tank that uses a surface solar electric pump and a distribution network for drip irrigation of agricultural land. The surface solar electric pump works with two 12 V, 240 W. photovoltaic panels.



**Fig. 1.** Installation for the recovery of waste water from small agrozootechnical farms

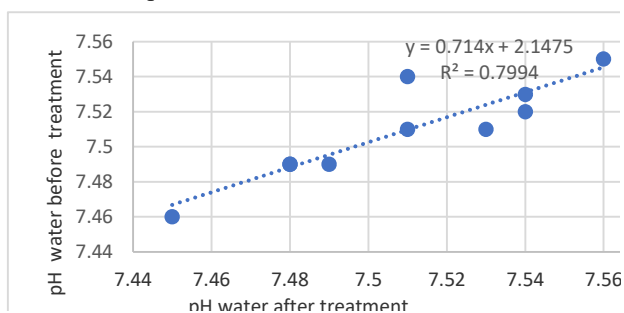
The irrigation method chosen was that of drip which is made localized with small flows. Drip irrigation and / or fertigation ensures the needs of the present without compromising future resources. This type of irrigation has a conservative character, offered by reducing the amount of fertilizers and chemicals needed, reducing the water consumption due to the increased capacity of the roots to retain and store water, reducing the risk of propagating diseases and pests, reducing or avoiding them. if some chemical treatments, reducing pollution, reduced leakage of chemicals in the freshwater reserve, eliminating soil erosion, applying nutrients can be controlled at the precise time when they are needed and in the desired amount, reduced costs. The irrigation was carried out inside a greenhouse and the culture that was thus irrigated was one of vegetables.

### 3 Results and discussions

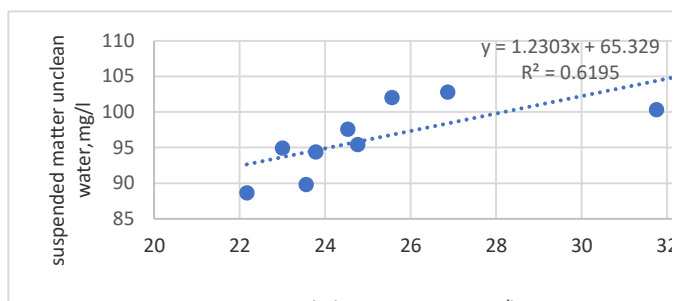
Water quality indices. During the 3 months of the experiment were collected 10 samples of waste water and purified water, which were analyzed. Analysis of pH, suspended matter, biochemical oxygen consumption, CCOCr, nitrates, nitrites and total phosphorus were performed. Next, we have represented in graphical form by using the program Excel, the linear variation of the variation of the analyzed quantities. The biochemical oxygen consumption (CBO) is an indicator that is defined as the amount of oxygen consumed for the biochemical decomposition in aerobic conditions of the total organic solid materials in

compliance with the conditions in the standards. The result of the determination is influenced by the water temperature and the duration of the determination. The most common determination is that made at 20 °C for 5 days and it is noted, CBO<sub>5</sub>. Another indicator of appreciation of the state of the water is the so-called chemical consumption or the immediate consumption of oxygen, which represents the amount of oxygen that is consumed in the combinations of reduction of organic substances, but without the intervention of microorganisms. Usually, this determination lasts one hour. There is a high consumption of chemical oxygen in the wastewater that has a high content of hydrogen sulphide, as well as in the sludge on the bottom of the standing water, slightly agitated. Biochemical oxygen consumption indirectly appreciates the amount of organic matter that can be decomposed and directly the oxygen consumption required by the microorganisms that produce the decomposition. In urban wastewater the biochemical oxygen consumption indicator, CBO<sub>5</sub> varies between 100 and 400mg / dm<sup>3</sup>, while for industrial wastewater the CBO<sub>5</sub> indicator does not exceed 50 mg / dm<sup>3</sup>, except for industrial wastewater from food companies, where the values can even exceed 50 times the normal values.

Nitrates (RNO<sub>2</sub>) and nitrates (RNO<sub>3</sub>), wherein R represents: K, Na, etc., are contained in fresh waste water in extremely small quantities. Nitrites are unstable and can either be reduced to ammonia or oxidized to nitrates. Therefore, the presence of nitrites indicates fresh waste water being transformed. Nitrites can also occur naturally in rainwater or in snow melt. The maximum quantities of nitrites in wastewater do not exceed 0.1 mg / l. Nitrates are the most stable form of organic nitrogenous matter and generally indicate a stable water from a transformation point of view. The presence of nitrates in rivers, between certain limits is desirable, because they represent an oxygen source, in that they stimulate the growth of algae and green plants containing chlorophyll and through photosynthesis enrich the water in oxygen. In the case of treatment plants, respectively in the active sludge basins, the presence of nitrates indicates a large amount of sludge and a long time of the water treatment process.

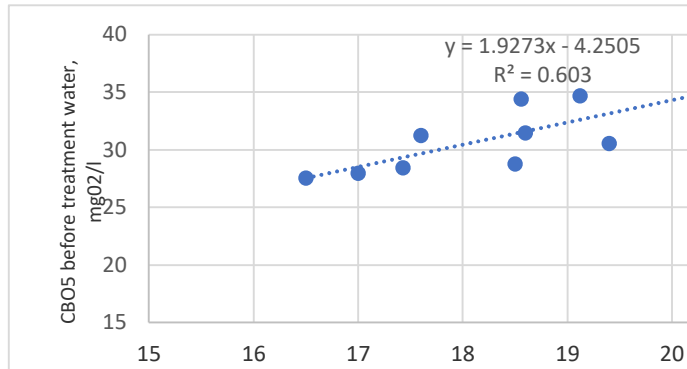


**Fig.2.** The evolution of pH in the water treatment

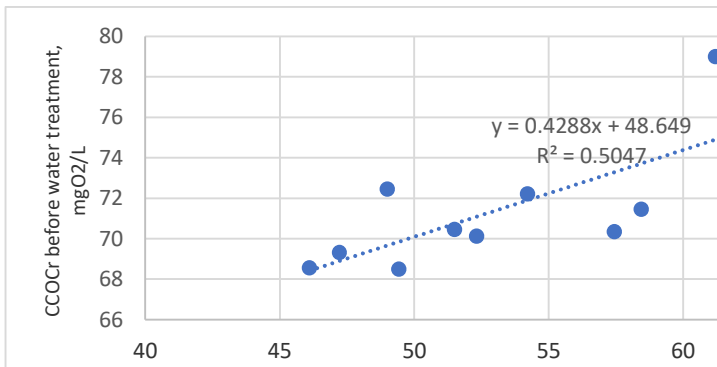


**Fig.3.** The evolution suspended matter

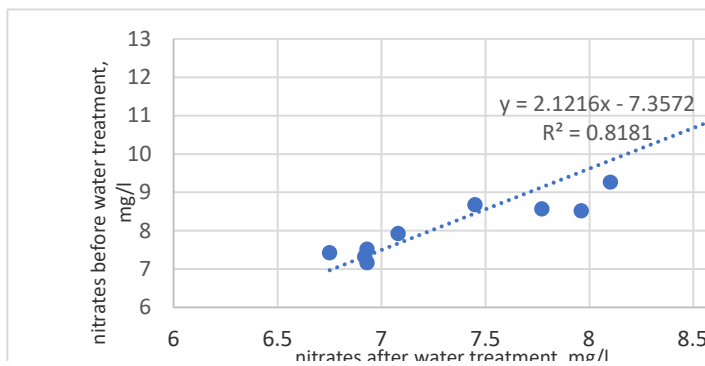
The biological filters of a well-functioning sewage treatment plant are characterized by a flow of nitrate-containing streams and nitrites in very small quantities or places. In raw wastewater, nitrate amounts range from 0.1 to 0.4 mg / l. The acidity or alkalinity of the wastewater represents their ability to neutralize acidic bases respectively. Generally, domestic wastewater is weakly alkaline, while industrial wastewater has a pronounced acidic or basic character. For the optimal conditions of the wastewater treatment process it is desirable that they be weakly alkaline, especially for the proper development of the biological treatment.



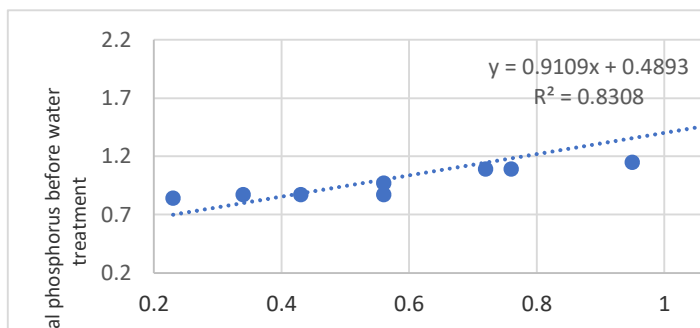
**Fig.4.** The evolution CBO<sub>5</sub>



**Fig.5.** The evolution CCOCr



**Fig.6.** The evolution nitrites



**Fig.7.** The evolution total phosphorus

Also, a rule of irrigation was established for the greenhouse vegetable cultivation, the results obtained being presented in the following table.

**Table 1.** Results for the irrigation system

Nr. variant	Moisture before watering, %	Moisture after watering, %	Theoretical norm, ( $n_c$ ) m <sup>3</sup> /ha	Determined norm ( $n_v$ ) m <sup>3</sup> /ha	Deviation $c = (n_c - n_v) / n_p$
I	4.1	27.5	830.34	536.76	0.55
II	8.2	34.5	778.68	447.30	0.74
III	11.1	32.8	742.14	468.72	0.58
IV	11.4	30.8	738.36	493.92	0.49
V	10.3	37.3	752.22	412.02	0.83
VI	7.4	36.2	788.76	425.88	0.85

## 4. Conclusions

Following the comparative analysis of the water input data with those from the exit of the experimental station model of **agro-zootechnical wastewater treatment with the maximum allowed values of the quality indicators provided in the NTPA 001 norm can be drawn the following conclusions:**

- the values of pH obtained at the exit from the station fall within the reference range 6.5-8.5, the average value obtained being 7.5.
- the suspended materials at the exit of the water from the station are below the reference value of 35 mg / l, the average value being 25.84 mg / l.
- the dissolved oxygen consumption of the water in the station was exceeded only for an analysis of the 10 performed, the average value obtained is 18.3 mg O<sub>2</sub> / l, the indicator value of NTPA 001 being 20 mg O<sub>2</sub> / l.
- the CCOCr values obtained at the exit from the station are located only the reference value from the normative of 70 mg O<sub>2</sub> / l, the average value for all 10 samples analyzed being 52.68 mg O<sub>2</sub> / l.
- nitrates at the outlet of water from the station are below the reference value of 25 mg / l, the average value being 7.45 mg / l.
- nitrites at the exit of the water from the station are below the reference value of 1 mg / l, the average value being 0.77 mg / l.
- the total phosphorus content of the water in the station was exceeded only for 2 analyses out of the 10 performed, the average value obtained being 0.67 mg / l, the indicator value in NTPA 001 being below 1 mg / l.

Regarding the deviation of the determination of the irrigation norm, it is found that it is within the limits of the range of humidity available for plants according to the agrotechnical requirements.

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