THE EVOLUTION OF THE SEWAGE TREATMENT PROCESS IN ROMANIA IN THE LAST 30 YEARS: CASE STUDY RÂMNICU VÂLCEA

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ABSTRACT. – The evolution of the sewage treatment process in Romania in the last 30 years: case study Râmnicu Vâlcea. Most studies made at national level in the domain of hydrology target the surface water topic, analyzing the hydrometric and hydrologic characteristics and the quality of the water for certain catchment areas. This paper aims instead the relatively new field of urban hydrology, more exactly the urban wastewater treatment process. The study is based on the observations made in the first half of the year 2010 at the wastewater treatment plant from Râmnicu Vâlcea and on the analysis of some relevant wastewater quality indicators before and after the treatment process for the period between 2005 and 2011. The study revealed the importance of the new treatment processes and technologies introduced in Romania after the year 2000 in the urban wastewater treatment process efficiency.

Keywords: sewage treatment plant, primary treatment, secondary treatment, tertiary treatment, efficiency.

1. INTRODUCTION

The urban wastewater represents a mixture of domestic water, industrial water and rainwater produced on the territory of a city and collected by a sewerage network which transports and evacuates it out of the city. If the urban wastewater is discharged into the surface water without proper treatment, it becomes an important factor of environmental pollution (Ianculescu et al., 2001).

The urban wastewater is treated in specialized facilities called sewage treatment plants, located only in cities and towns with centralised sewerage systems. The operation principle of these treatment plants has not change in the last three decades, the purpose being to fulfil the requirements for wastewater discharge into the environment.

A water treatment plant that complies with regulations regarding the protection of surface water and groundwater includes two distinct technological flows, namely the water flow and the sludge flow. This study takes into consideration only the water flow, respectively the one that has known the most significant evolution in the last three decades. At national level, this evolution can be divided into two periods separated for guidance purposes by the year 2000. In the last ten years, the sewage treatment process from Romania has experienced an important evolution supported by the necessity of complying with the European

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legislation in the field of water, mainly the Council Directive 91/271/EEC of May 1991 concerning urban waste – water treatment, amended by the Commission Directive 98/15/EC of February 1998 and transposed in the national legislation by the Government Resolution no. 188/2002 concerning the approval of rules regarding the conditions of discharging wastewater into the aquatic environment, supplemented and amended by the Government Resolution no. 325/2005 (www.rowater.ro).

The mentioned evolution determined a significant improvement of the situation in the field of wastewater in Romania. However, the country failed to meet the first two intermediate deadlines for the implementation of the Council Directive 91/271/EEC. The length of the country's sewerage network at December 31, 2010 was of 22,196.34 km, the percentage of the population connected to this network being of 54.28 %. 43 human agglomerations with over 2,000 inhabitants had a population connection percentage of over 95 %. At the same date, 420 sewage treatment plants were operational in the whole country and 43.24 % of the total population was connected to them. 32 of those treatment plants had a connection rate of the population from the served human agglomerations of over 95 %. More than two thirds of the total generated wastewater was not properly treated before being discharged into the environment (www.rowater.ro).

By comparison, the length of the sewerage network from Râmnicu Vâlcea at December 31, 2010 was of 146.3 km and the percentage of the population connected to this network was of 75 % (Analiza managementului privind realizarea condiţiilor licenţei pentru serviciul public de alimentare cu apã şi canalizare, Partea I, 2011).

2. THE PERIOD BEFORE THE YEAR 2000

The sewage treatment plants built before the year 2000 had usually a technological flow that consisted in two treatment stages, namely a primary one and a secondary one. The primary treatment (or the mechanical treatment) removes from the water the large objects transported by this, the decanting impurities and those that are floating or can be transported in a floating state. In this stage, a pre-treatment of the wastewater is also made, operation which removes from the water certain substances (sand, fat) that can damage the installations of the secondary treatment process. The secondary treatment (or the biological treatment) assures the neutralization of the dissolved and the colloidal dispersed organic impurities that can not be removed from the water in the primary treatment process. These impurities are converted by a culture of microorganisms in harmless degradation products and in a new cell mass. Usually, this culture of microorganisms is dispersed in the reaction volume of the treatment installation, the process being called biological treatment with activated sludge.

Such a technological flow defined the wastewater treatment plant from Râmnicu Vâlcea from the moment it was completed (September 1979) until a new type of treatment plant replaced the old one (December 2009). During this time, the treatment plant underwent a single important resizing process, namely in 1989, when its treatment capacity was doubled, reaching 1,020 l/s. The most important components of the mechanical treatment process (fig. 1) were represented by two rare and two dense bar screens, that removed from the water the objects larger than 2 cm, three sand removal channels, a grease removal channel and two primary sedimentation tanks, which removed the decanting impurities and had a capacity of 3,000 m^3 each. The most important components of the biological treatment process (fig. 1) were two surface – aerated basins which provided the oxygen necessary for the microorganisms used in the technological flow and had a capacity of 3,000 m^3 each, and two secondary sedimentation tanks that removed the decanting degradation products and the cell mass created by the microorganisms, with a volume of 1,500 m^3 each (Regulament de funcţionare privind întreţinerea şi exploatarea Staţiei de epurare a Municipiului Râmnicu Vâlcea, 2007).

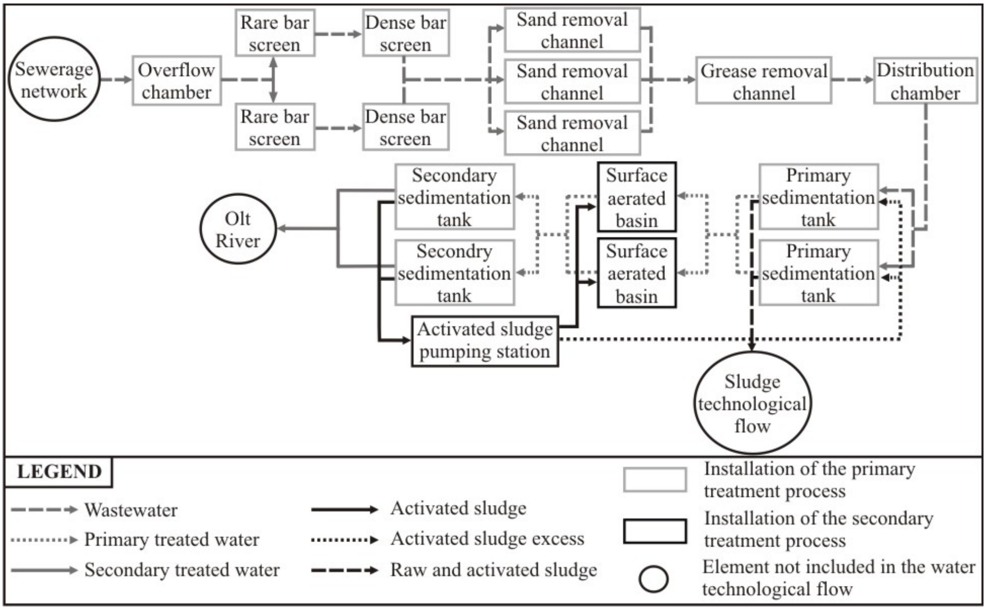

Fig. 1. ***Process flow diagram for the sewage treatment plant from Râmnicu Vâlcea in the period 1989 – 2009***

3. THE PERIOD AFTER THE YEAR 2000

A new and more efficient sewage treatment plant model, that complies with the European legislation in the field of water, bas been introduced in Romania for the last ten years. The new treatment plants are financed by European projects, which usually regard an upgrading of the existing treatment plants rather than building new ones. This model keeps, with some improvements, the primary and secondary treatment process specific to the previous type of sewage station, adding instead the tertiary treatment process, called also the chemical or the advanced treatment process. The new process removes the nutrients from the water (compounds based on nitrogen and phosphorus) and reduces the number of microorganisms contained in this.

The removal of nitrogen is effected through two separate processes, namely nitrification and denitrification. The first one is an aerobic process and the second one requires anoxic conditions. They are both made by specialized bacteria, often introduced in the water by the activated sludge process. Both nitrification and denitrification can be done inside the surface – aerated basins used in the secondary treatment. The removal of phosphorus is usually achieved with chemical precipitation using salts of iron or aluminium. The removal of a large part of the microorganisms contained in the water, or the disinfection process, is made with chlorine, ozone or ultraviolet light.

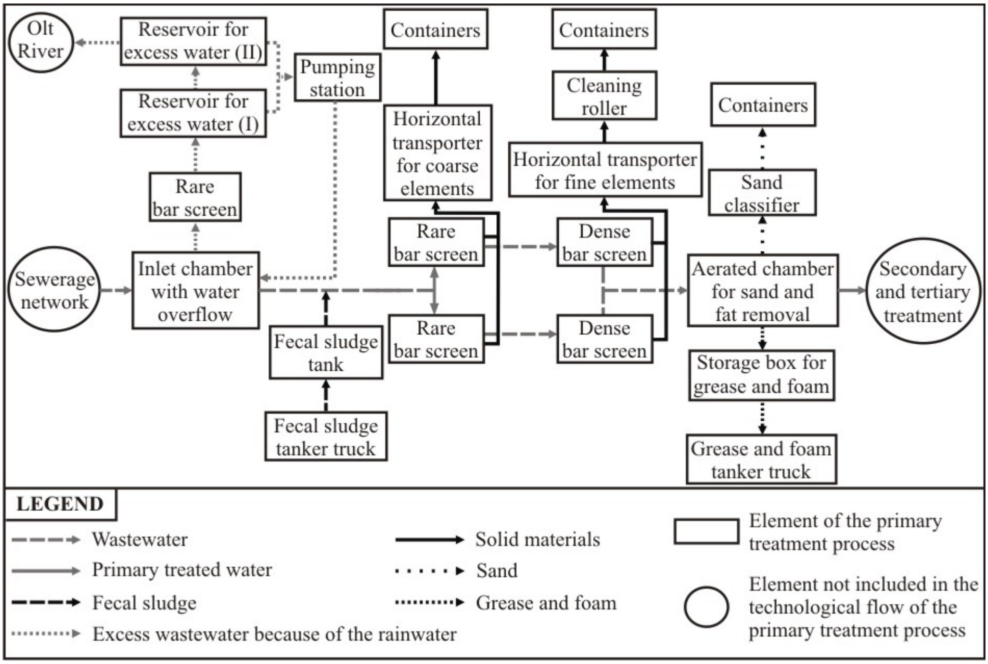

Fig. 2. ***Process flow diagram for the primary treatment stage from Râmnicu Vâlcea sewage treatment plant starting with the year 2010***

Such a treatment plant model was implemented in Râmnicu Vâlcea between 2008 and 2009, when the existing facility was upgraded to a more efficient one, which began to function effectively at January 1, 2010. It represents the result of the implementation of the project “The refurbishment of the sewage treatment plant from Râmnicu Vâlcea”, which involved an investment of 10.82 million Euro. 51.49 % of this amount was provided by The European Union as ISPA funds and 48.51 % of it represented a loan from the European Investment Bank (www.acvarim.ro).

The new treatment plant from Râmnicu Vâlcea has a capacity of 1,550 l/s. The primary treatment stage has important differences by comparison to the old sewage station (fig. 2). The removal of the sand and grease is made in a single structure represented by an aerated chamber, and the primary sedimentary tanks are eliminated from this stage, because of their low efficiency. In case of heavy rainfall, the amount of water which exceeds the capacity of the treatment plant is stored in two reservoirs of 8,800 m^3 total capacity. If this volume is exceeded, the water surplus is discharged into the Olt River without any treatment. The accumulated water in the two reservoirs is properly treated when the wastewater flow at the entry in the sewage station falls below a predetermined value (Manual de operare şi întreţinere al Staţiei de epurare a Municipiului Râmnicu Vâlcea, Ediţia revãzutã 03, 2009).

The secondary treatment stage of the new sewage treatment plant does not differ significantly from that of the old one (fig. 3). The only remarks refer to the larger surface – aerated basins, which have a capacity of 11,400 m^3 each and, more important, to the presence of the four final sedimentation tanks with a capacity of 13,000 m^3 each, which fulfil the function of both sedimentary tank types found in the old treatment plant case (Manual de operare şi întreţinere al Staţiei de epurare a Municipiului Râmnicu Vâlcea, Ediţia revãzutã 03, 2009).

The tertiary treatment stage is currently represented by the nitrogen and phosphorus removal processes (fig. 3).

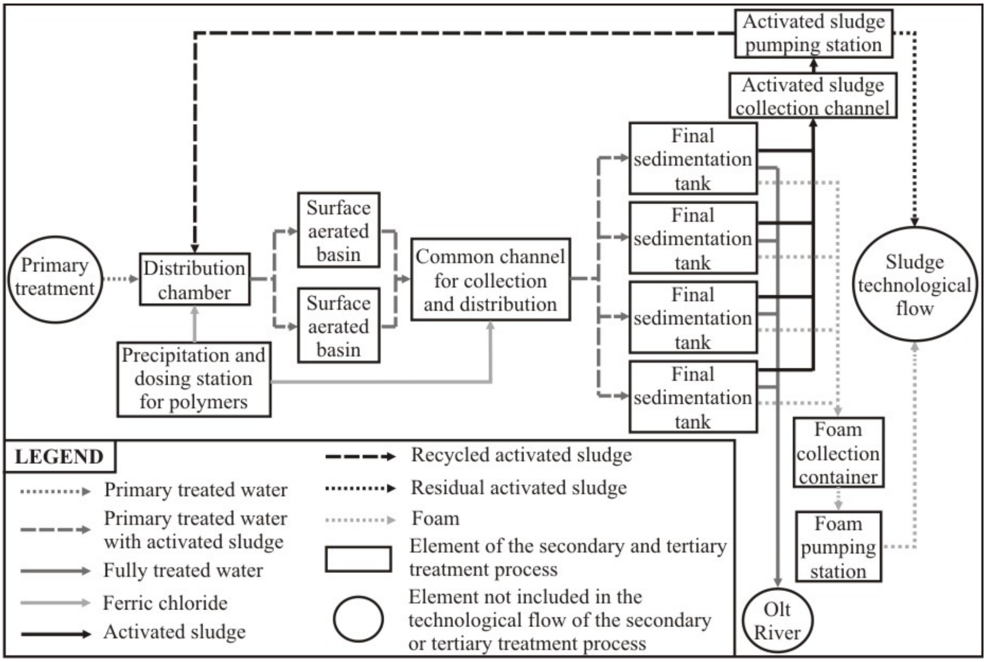

Fig. 3. ***Process flow diagram for the secondary and tertiary treatment stage from Râmnicu Vâlcea sewage treatment plant starting with the year 2010***

One part of the nitrogen removal is made in the upper surface – aerated basins (the nitrification part), rich in oxygen, while the other is made in the lower surface – aerated basins (the denitrification part), where the dissolved oxygen is completely used by the biomass. The phosphorus removal is effected through chemical precipitation, using a saline solution of ferric chloride ($FeCl_3$) with a concentration of 40 % $FeCl_3$. The company that operates the sewage treatment plant wants to include in this stage the water disinfection with chlorine and to increase the efficiency of the nutrient removal processes by removing the phosphorus with specialized bacteria (Manual de operare şi întreţinere al Staţiei de epurare a Municipiului Râmnicu Vâlcea, Ediţia revãzutã 03, 2009).

4. THE EFFICIENCY OF THE TREATMENT PROCESS

The best way to compare the efficiency of the two sewage treatment plant types presented in this paper is to analyze the evolution in a predetermined period of time of certain monitored water quality indicators. Those are determined by a certain methodology in the chemical laboratory from inside the treatment plant. This study uses the annual averages of 11 indicators for both the untreated water and the fully treated one. The overall efficiency for each indicator is obtained by the difference between the values characteristic to the two types of water. The period between 2005 and 2009 represents the old sewage treatment plant from Râmnicu Vâlcea, while the one between 2010 and 2011 represents the new one. The abbreviations used in the following paragraphs and images are: COD – Cr (chemical oxygen demand using potassium dichromate), COD – Mn (chemical oxygen demand using potassium permanganate) and BOD_5 (biochemical oxygen demand).

The technologies and equipments introduced with the new sewage plant model determine a significant overall improvement of the treatment process, fact indicated by the decrease of the values for nine indicators in 2010 by comparison with 2009 (fig. 4, fig. 5). The most important differences in terms of absolute values are found in the cases of COD – Mn and COD – Cr, because of the high numbers that usually characterise these indicators. The only parameters that are higher in 2010 are chlorides and filtered residue, fact that indicates a decreased efficiency of the new treatment plant in those directions.

The differences between the two models of sewage plants are more visible if we analyze the evolution of efficiency between 2005 and 2011 (fig. 6, fig. 7). Except chlorides and filtered residue, the efficiency increased in a substantial way in 2010 and 2011 for all the other indicators. In some cases, the differences between the two types of treatment plants (namely between 2009 and 2011) are very high, reaching 70 % for detergents and about 60 % for ammonium and sulphides, while in other cases the values are much lower (almost 7 % for pH) and even negative (about - 4 % for chlorides and filtered residue). While the efficiency in the case of the old treatment plant did not exceed the amount of 60 % for most indicators, the situation is completely reversed in the case of the new treatment plant, some indicators having values higher than 80 % and even 90 %. The efficiency from 2011 is even higher than the one from 2010 for most of the indicators, although the absolute values are generally higher in the first case due to an increase of the figures recorded at the entry of the water in the treatment plant.

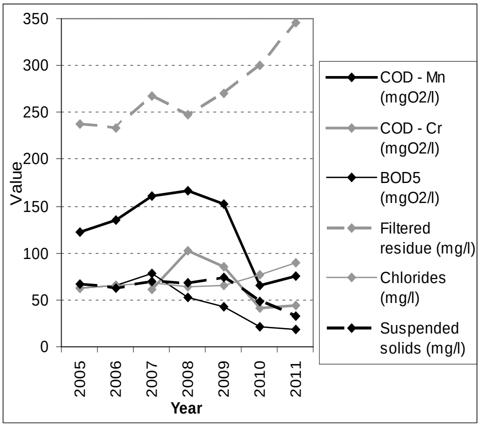

Fig. 4. ***The monitored parameters of the fully treated water (I)***

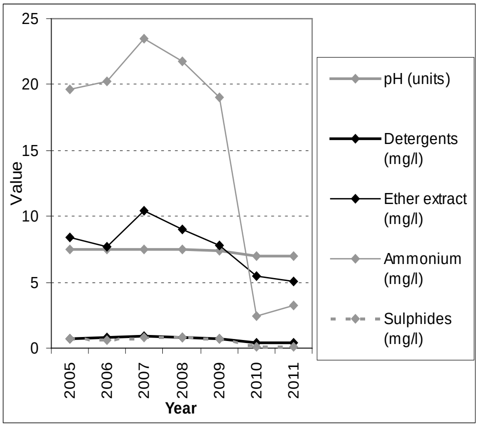

Fig. 5. ***The monitored parameters of the fully treated water (II)***

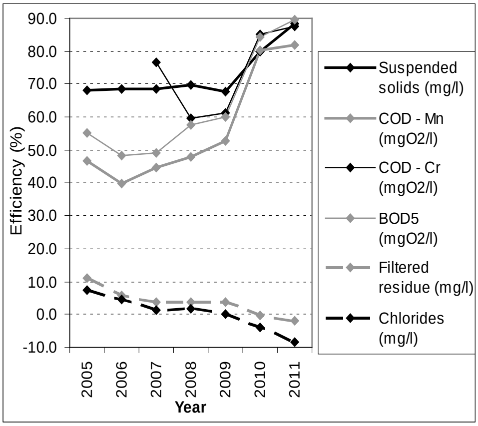

Fig. 6. ***The overall efficiency of the treatment process regarding the monitored parameters (I)***

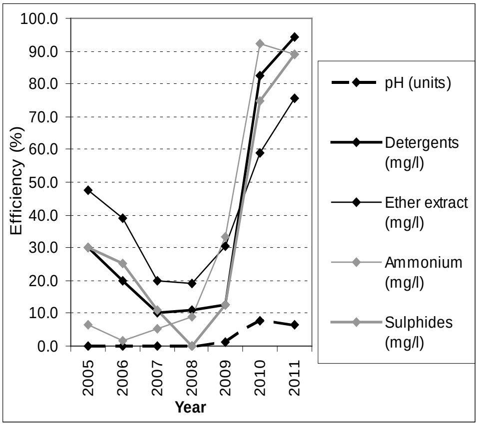

Fig. 7. ***The overall efficiency of the treatment process regarding the monitored parameters (II)***

An important difference between the primary treatment stages of the two sewage plant types is the removal of the primary sedimentation tanks from the technological flow. This measure is supported by the evolution of their efficiency between 2005 and 2009 (fig. 8). The fact is that the values decreased continuously and almost constantly in the considered period, dropping below 15 % in 2009. This decrease prevented a sustainable growth of the overall efficiency of the old treatment station, although the values for the secondary treatment stage increased on most cases along the analysed period.

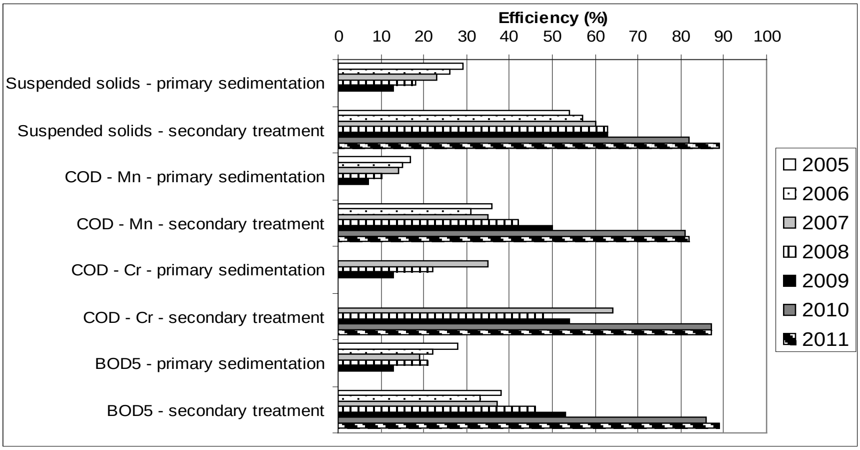

Fig. 8. ***The efficiency of the sewage plant on treatment stages***

5. CONCLUSIONS

The process of wastewater treatment has evolved substantially in Romania in the last three decades, being given an increasing importance to the protection of surface water and groundwater. A key moment to this evolution is represented by the transposing in the national legislation of the European directives in the field of water, which occur after the year 2000. This fact determined the refurbishment of many existing mechanical – biological treatment plants into facilities that include the advanced treatment stage and the construction of completely new facilities. All those sewage plants are more efficient than the precedent ones, especially in terms of nutrient content. The modernisation of this sector will continue until the deadline of implementing Directive 91/271/EEC, which is at the end of 2018.

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