Current Trends in the Use of Small Wastewater Treatment Plant

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Wastewater treatment is required to maintain a clean and healthy living environment. There is no conceivable today to an urban or rural area, lack of a centralized channel system. Septic tanks, infiltration ponds or dry toilets, cannot be considered as alternatives. Where it is not possible or not warranted creation of a public channel system, local solutions should be adopted by a high technical level, ensuring a quality treated water that can be reintroduced in natural cycles, without restrictions. For better management of existing water resources, it is necessary to control the quality and quantity of discharges for both high flow and low flow rates, seemingly insignificant, but which are some small local polluters (punctual). This category part isolated households, motels, hotels, campgrounds, parking lots equipped with toilets, and nursing of infectious diseases, industrial objectives of small capacity, farm animal breeding, other. The paper presents the main treatment technologies and how they can be applied to small capacity facilities. Tried, based on available data, presenting as many technical details and issues involved in the operation and maintenance of facilities.

Keywords: wastewater treatment, small wastewater treatment plants

Collection, transport and wastewater treatment presents a wide range of problems in rural areas. The rural area, village, is in constant transformation, aiming to diminish the great differences between the comforts of "civilized" life from the city and of the rural public utilities. By seeking recovery in agriculture, the loss of major industries in the city that managed to absorb a part of the labor force in the village and not least the still unpolluted living environment that it provides the village, there is an increase in recent years the rural population, (not necessarily due to growth of population growth rate, but rather a return to active and retired population of the city back to the village). Occurrence in our country a new industry of tourism, agrotourism, requires raising public utilities and hydro utility default to a new standard, namely the state of the art. That means hydro utility equipment to a level that allows supply with quality drinking water and disposal and treatment of wastewater of every village households. We can assimilate the countryside and consumers resorts, sanatoriums, motel and restaurant parking feature, monasteries, etc.

Wastewater treatment plants of small and very small capacity are a solution for extreme situations, such as for example isolated communities with roads that are not always practicable. The solution was imposed at European level in recent years, with a range of treatment methods and a multitude of constructive solutions to these stations. Legislation of European countries, such as Austria, provides grants to this solution.

The disadvantage of wastewater treatment plants of small and very small capacity is that they include in their construction a complex technique, usually not accessible to the beneficiary, sometimes occurring problems that may affect treatment performance. This disadvantage can be considered only temporarily, because the wide application of this solution is developed in parallel with the maintenance services. The estimated costs related to the implementation and operation of collection, transport and treatment of wastewater are shown in table 1 [4, 5]:

Wastewater quality of the influent and treated at wastewater treatment plants of small capacity

Wastewater quality of the influent are established:

- based on hydrochemical studies performed before design;
- by analyzing the database of existing wastewater treatment plants that must be expanded or refurbished;
- by assimilating the values of quality indicators registered in other wastewater treatment plants serving localities with channel system, public utilities, social and similar industrial activities, and a similar number of inhabitants;
- by calculating the main qualitative indicators based on specific load of pollutant (g/PT·day).

Noting that if small capacity water treatment plants, wastewater influent is predominantly of domestic nature.

The main quality indicators are:

-biodegradable dissolved organic matter or as suspended particles, usually expressed by biochemical oxygen demand (BOD);

- biodegradable and non-biodegradable organic material that can be chemically decomposed expressed by chemical oxygen demand COD;

Capacity	*Costs of implementation Euro/Pt**	*Costs of operation Euro/Pt*
5 PT	2123	92
10 PT	1465	77
25 PT	965	63
50 PT	765	53
100 PT	643	45
150 PT	593	40
200 PT	572	38

**) Total number of inhabitants and population equivalents (PT)*

Table 1
ESTIMATED COSTS OF IMPLEMENTATION AND OPERATION OF SMALL WASTEWATER TREATMENT

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Crt.no.	*Parameter*	*Specific load* g/PT·day
1	CBO_5 biochemical oxygen demand (BOD)	30-40
2	CCO chemical oxygen demand (COD)	55-75
3	MTS suspended solids (SS)	30-50
4	N organic	1-2
5	$N\text{-}NH_4$	3-6
6	N total	4-8
7	P total	1-4

Table 2
SPECIFIC LOAD OF WASTEWATER FROM SMALL COMMUNITIES

Parameter	RL 91/271/EWG**		1.AEVkA***				NTPA 001
	For all areas outside sensitive areas and those located above 1500m altitude	Sensitive areas	50-500	500-5000	5000-50000	>50000	For all areas
CBO_5 (mg/l)	25	25	25	20	20	15	20-25*
CCO (mg/l)	125	125	90	75	75	75	70-125*
NH_4-N (mg/l)	-	-	10	5	5	5	2(3)
N_{total}	-	15mg/l[1)] 10mg/l[2)] 70-80%[3)]	-	-	70% (>12°C)	70% (>12°C)	10(15)
P_{total} (mg/l)	-	2[1)] 1[2)]	-	2 (>1000 population equivalents)	-	-	1(2)

Table 3
COMPARISON BETWEEN LIMIT VALUES OF WASTEWATER LOADS ACCORDING RL 91/271/EWG, 1.AEVKA AND NTPA 001/2002

[1)].... for plants with 10000-100000 population equivalents served,
[2)].... for > 100000 population equivalents served,
[3)].... arithmetic average of minimum degree reduction in a year,
*..... for new stations, extension or refurbishment,
**.... European Union Council Directive on the load limits of municipal wastewater,
***.... Standard load limits on communal wastewater.

- inert suspended solids (SS), (sand, plastic, or other similar solid materials);
- nitrogen as ammonia, ammonium, organic nitrogen, (primarily urea), or oxidized nitrogen (nitrates and nitrites);
- organic and mineral phosphorus as phosphate;
- pathogenic germs (bacteria, viruses).

The main loads of wastewater from small communities are presented in table 2.

These load limits vary depending on the habits of living, climate, food, living, degree of civilization, how to ensure the drinking water, nature and importance of channelled objective, the price of water and others [2, 6].

A comparison between load limits of effluent wastewater treatment plants and sewage degrees minimum under European law, the Austrian and Romanian is shown in table 3. Note that towards NTPA 001, these discharge limits are based on the number of people served, i.e. wastewater flow, [9, 10].

Main treatment technologies adopted for small capacity stations

Biological wastewater treatment

In the biological wastewater treatment step occurs the reduction of the organic load by microorganisms mineralizes in the presence of oxygen and transformation of nitrogen compounds by nitrification, respectively their elimination by de nitrification. Even if nitrogen removal for these capabilities is not required, it will try, through technological devices, as advanced elimination thereof [1, 3, 7, 8].

Aeration plants with primary sedimentation

In the aeration plant ventilation occurs the mixture of wastewater and activated sludge, (fig. 1). The amount of oxygen required is infused through a ventilation facility, performing blowing and agitating the mixture in the tank. Useful volume of the activation tank should be at least $0.25m^3$/loc.

The amount of oxygen introduced into the activation tank must be in the operating conditions of at least $165gO_2$/(PT·day). The ventilation system should be so arranged that at the end of the aeration phase, the oxygen content in the activation tank does not fall below the level of 2.0mg/l, [1, 3, 7, 8].

Aeration plant with primary sedimentation

For this situation will provide solutions to compensate for fluctuations in flow. Useful volume of the activation tank should be at least $0.2m^3$/loc.

The amount of oxygen introduced into the activation tank must be in the operating conditions of at least $180gO_2$/(PT·day). The aeration plant should be so arranged that the end of the aeration phase, the oxygen content in the activation tank does not fall below the level of 2.0mg /l. These conditions are practically the same as at the aeration plant with primary sedimentation.

Aeration plant with primary sedimentation shall be provided with a sludge container. The capacity of the tank differs depending on the interval between two discharges, capacity will be no less than 1.50 mc [1, 3, 7, 8].

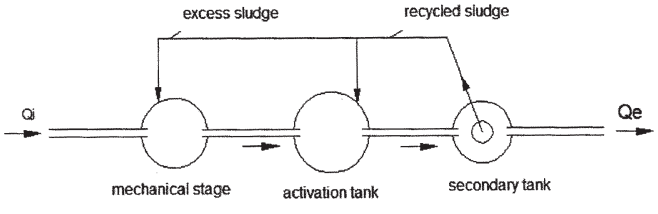

Fig. 1 Schematic of the activation tank installations and mechanical stage

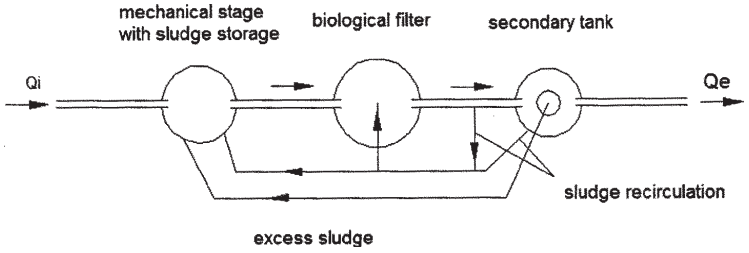

Fig. 2. Schematic of a plant with biofilter

Population equivalent served (PE)	*Number of test reports*
4-6	64
8-10	164
12-24	91
25-60	39
80	1
100	1
Total	360

Table 4
GROUPING OF SMALL WASTEWATER TREATMENT PLANTS ACCORDING TO THE NUMBER OF PEOPLE SERVED

Activation plants with accumulation

At the aeration plant with accumulation alternate working phases, admission, aeration, activated sludge settling and removal of treated water (by pumping or drainage free) once or several times a day. A secondary tank for sludge retention is therefore not necessary.

The chronological sequence of cycles may be conducted according to the amount or time. Setting individual phases will be adjusted to the achieving of maximum cleaning performance.

Activation basin can connect a primary sedimentation.

Useful volume of the activation tank must have for the minimum water level:

- with primary sedimentation: 0.25m^3/loc;
- without primary sedimentation 0.3025m^3/loc.

The duration of each phase of decantation must be at least one hour, thereby ensuring a sufficiently deep layer of clarified water for disposal, [1, 3, 7, 8].

Biofilter installations

At installations with biofilter clarified water is dropped over a large surface area of filler material, the particles of which is attached an biological film, figure 2. The oxygen supply is naturally or by artificial ventilation.

Biofilters are optimally exploited through water recirculation. The height of the filler material in the filter varies between 2 m and 3 m, depending on the recycle ratio. [1, 3, 7, 8].

Treatment plants with rotating biological contactor

Rotating contactors consist of cylinders made of a porous material whose surface is fixed on the biological membrane. These cylinders are partially immersed in the decanted wastewater, providing by a slow rotating both wetting and supply with oxygen of the microorganisms mineralizes. Through this colloidal and dissolved substances are converted into biomass, after they come off the contactor is retained in the secondary settlement.

Rotating contactor will run in cascade with at least two steps. For this system it is always necessary the primary treatment.

Useful area of rotating contactor must be at least 20m^2/pers. The travel time in the plant of the waste water, taking into account the submerged volume, (useful), of the contactor must not be less than 5 h, [1, 3, 7, 8].

Treatment technology	*Number of small wastewater treatment plants*				*% of total general*
	total technology	by size		% of total technology	
Aeration plant	274	4-6	43 (64)	15.69	76.111
		8-10	142 (164)	51.82	
		12-24	62 (91)	22.62	
		25-60	26 (39)	9.48	
		80	0 (1)	0	
		100	1 (1)	0.36	
Biofilter (percolating filter)	73	4-6	19 (64)	26.02	20.277
		8-10	16 (164)	21.91	
		12-24	27 (91)	36.98	
		25-60	11 (39)	15.06	
		80	0 (1)	0	
		100	0 (1)	0	
Rotating biological contactor	9	4-6	1 (64)	11.11	2.500
		8-10	4 (164)	44.44	
		12-24	1 (91)	11.11	
		25-60	2 (39)	22.22	
		80	1 (1)	11.11	
		100	0 (1)	0	
Wetlands	4	4-6	1 (64)	25.00	1,111
		8-10	2 (164)	50.00	
		12-24	1 (91)	25.00	
		25-60	0 (39)	0	
		80	0 (1)	0	
		100	0 (1)	0	
Total general	360	X	X	X	100

Table 5
SMALL WASTEWATER TREATMENT PLANTS GROUPING ACCORDING TO SIZE AND TREATMENT TECHNOLOGY ADOPTED

Wastewater treatment plans with filtration membrane

Immersed microfiltration membrane treatment technology allows the obtain of a hygienic effluent, without suspended matters and a high degree of reduction of BOD and COD. This effluent meets the quality requirements of bathing water, being able to reuse it for watering the garden or grass, can be recycled as toilet water discharge or other uses. This technology represents a highly qualitative step in treatment performance of decentralized technologies [1, 3, 7, 8].

Case study

For this study were evaluated 360 test reports containing finding files, of small wastewater treatment plants of Stuttgart area - Germany. The authors present in this paper, only some of the data in those records, relating to technologies used and installed capacities.

Analysis reports were grouped into six categories according to the number of population equivalent served, (table 4).

Treatment technologies of small wastewater treatment plants are according to table 5.

In parentheses is the total number of small wastewater treatment plants analyzed for respectively size (table 5).

Conclusions

Treatment plants with continuous supply activation tank are the first choice among the beneficiaries respectively of the operators concerned. This is due to the following:

- extensive experience gained in the field of design and operation of large capacity plants;
- plants can virtually size for any number of users. The large dimensions of over 30 population equivalent served, plants may consist of several modules of small capacity, allowing a gradual investment;
- buildings are underground, integrating well into the decor;
- plants have a simple geometry, usually running in cylinder variants, from which results a volume, respectively a minimal space occupied;
- the majority of manufacturers offer prefabricated plants, made of lightweight materials;
- are simple.

biological filters, the second option, compared to treatment plants with activated tank:

- are based on extensive experience gained with large capacity filters;
- space occupied is larger than the first and constructions are aboveground;
- in a small number of people served stability problems may arise;
- must necessarily execute variant covered and odor emissions are possible.

Treatment plants with rotating biological contactors:

- it is a technology less widespread, experience in the field being smaller than the first two technologies;
- horizontal constructions are developed, usually have large dimensions, plants are suitable for a large number of people served;
- must be executed in covered version, there are possible odor emissions;
- have disadvantages due to rotor, which by fixing biological film becomes very hard..

Treatment plants with plants - Wetlands, (not shown in the previous chapter):

- are more difficult to execute, because large areas occupied compared to other technologies;
- can be made from local materials;
- are very well integrated into the decor;
- are simple;
- experience is still very small.

In this paper, briefly presented, the authors try to eliminate retentions that are related to small wastewater treatment plants. The solutions are viable and widely adopted, even though not all EU countries. Also recommend researchers to try to achieve a pilot plant, for the experiment of one of the technologies presented or even a combination thereof.

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