CRITERIA FOR SELECTING THE BEST TREATMENT SOLUTIONS IN SMALL COMMUNITIES

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Abstract

While in larger and medium size communities wastewater treatment is achieved exclusively by the implementation of intensive technologies, in small populations a wider range of technologies can be applied for this aim. The implementation of one concrete system or flow diagram depends on multiple factors that comprise technical, economic and environmental issues. The selecting process of the most suitable technology for being implemented in a small population is, therefore, quite complex. The Centre for Studies and Experimentation of Public Works (CEDEX) and the Foundation Centre for New Water Technologies (CENTA) have prepared a "Manual for the implementation of treatment systems in small populations" that includes some criteria for supporting the decision making process. Some of those criteria are exposed in this paper.

Keywords: design; extensive technologies; intensive technologies; selection criteria; small WWTP.

Introduction

About 3-4 million persons equivalent (p.e.) in Spain, who live in communities with less than 2,000 p.e, are still not served by wastewater treatment facilities (CEDEX-CENTA, 2008). Although the non-treated load is not very large if compared with the total national load (more than 70 M p.e., OSE, 2009), it corresponds to above 6,000 settlements. For those small populations the current legislation (RD 11/95, based on the Directive EEC 91/271) establishes an adequate treatment but it does not define concrete discharge limits to the final effluent.

Treatment alternatives for small populations are multiple and includes both intensive (extended aeration, trickling filters, biodiscs, etc.) and extensive (constructed wetlands, lagooning, sand filters, etc.) systems. Each technology presents advantages and disadvantages. According to the local conditions and peculiarities of the small populations, some technologies shall be recommended and other, rejected by the responsible administration. In this sense, it is necessary to define some criteria for discerning when to implement each technology or, at least, determined on which conditions they

are suitable. In order to give advice for this aim, the Centre for Studies and Experimentation of Public Works (CEDEX) and the Foundation Centre for New Water Technologies (CENTA) have prepared a "Manual for the implementation of treatment systems in small populations", that includes several criteria for supporting the decision making process. In this work, some of the criteria identified are exposed.

Methods

The "Manual for the implementation of treatment systems in small populations", developed by CEDEX and CENTA, aims to establish standard criteria for implementing appropriate solutions for the treatment of the wastewater generated in small settlements. For this aim, different issues on each technology have been analysed: technical information (design and construction), implementation and operating cost, surface required for the implementation, O&M activities (and their complexity), typical flow diagrams and environmental impacts. During the Manual's elaboration the authors had the assistance of an expert panel for providing it universality and applicability.

Results and discussion

Three groups of criteria have been described: technical, environmental and economic. In the first group, the factors embraced are: the required effluent's quality, the population size, the surface available for the WTTP implementation and its characteristics, the origin and pollution load of the wastewater stream, the system's versatility, the climatology, the production rate and quality of the sewage sludge and the O&M complexity. In the Tables 1 and 2, a classification of technologies according to the level of treatment required is exposed.

Table 1. Levels of treatment and effluent's quality

Levels of treatment	Effluent quality (discharge limit /removal efficiency)				
	SS	BOD_5	COD	$N\text{-}NH_4^+$	Nutrients
Primary	> 50 %	> 20 %			
Secondary	< 35 mg/l or > 90 %	< 25 mg/l or > 70 %	< 125 mg/l or > 75 %		
Secondary with nitrification	< 35 mg/l or > 90 %	< 25 mg/l or > 70 %	< 125 mg/l or > 75 %	< 15 mg/l or > 70 %	
Secondary with nitrogen removal	< 35 mg/l or > 90 %	< 25 mg/l or > 70 %	< 125 mg/l or > 75 %	< 15 mg/l or > 70 %	Nt< 15 mg/l or > 70 %
Secondary with phosphorous removal	< 35 mg/l or > 90 %	< 25 mg/l or > 70 %	< 125 mg/l or > 75 %		Pt < 2 mg/l or > 80 %

Table 2. Level of treatment achieved by technologies

Technology	Level of treatment
Septic tank or Imhoff tank	Primary
Primary clarifier	Primary

Lagooning	Secondary (except SS)
Horizontal Subsurface flow CW	Secondary
Vertical Subsurface flow CW	Secondary with nitrification
Peat filters	Secondary with nitrification
Intermittent Sand filter (without recirculation)	Secondary with nitrification
Intermittent Sand filter with recirculation	Secondary with nitrification
Infiltration-Percolation	Secondary with nitrification
Biological Rotating Contactor	Secondary or Secondary with nitrification
Trickling filter	Secondary or Secondary with nitrification
Extended aeration	Secondary or Secondary with nitrification or secondary with nitrogen removal
Sequential Batch Reactors (SBR)	Secondary or Secondary with nitrification or secondary with nitrogen removal
Moving bed biofilm reactors (MBBR)	Secondary or Secondary with nitrification or secondary with nitrogen removal

According to the quality objectives required for the receiving masses of water, which are defined by the Framework Water Directive (2000/60/EC), the technologies listed above would be more or less appropriate for their implementation.

Table 3 shows the recommended technologies according to the population size. The gray striped area indicates the optimum population range where each technology is applicable, while the striped one indicates where it also could be applicable.

Table 3. Suggested application range of different treatment technologies

Technology	Population equivalent served			
	50 – 200	200 - 500	500 – 1,000	1,000 – 2,000
Septic tank				
Imhoff Tank				
Primary clarifier				
Anaerobic pond				
Lagooning				
Constructed Wetlands				
Peat filters				
Intermittent Sand Filter (no R)				
Intermittent Sand Filter (R)				
Infiltration- percolation				
Rotating biological contactor				
Trickling filters				
Extended Aeration				
SBR				
MBBR				

Among the potential environmental impacts associated to WWTP, three issues have been considered of relevance for the selecting process: the production of bad odours, the noise generation and the landscape integration. In this sense, all the systems that include an anaerobic/anoxic step are expected to produce bad smells. In addition, those systems which need electromechanical accessories (air supply pumps, for instance) shall produce noise. Finally, the extensive or natural technologies show fewer problems for their landscape integration.

Both the operating and the implementation costs shall also be taken into account in the decision making process. In table 4, the treatment units are classified according to their operating costs.

Table 4. Classification of technologies according to the O&M costs

O&M costs	Technologies
≤ 10 €/ p.e.	Lagooning
10–20 € / p.e.	Constructed wetlands, Peat filters, Sand filters, Infiltration–percolation, CBR and Trickling filters
> 20 € / p.e.	Extended aeration

Conclusions

In this study, multiple criteria for selecting the most suitable treatment solution for small populations have been exposed. The next step is the definition of weighting parameters associated to each of the criteria and the creation of an evaluation matrix or another tool for supporting the decision making process.

References

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