PERFORMANCE OF WASTEWATER TREATMENT PLANTS IN SMALL COMMUNITIES LESS THAN 1500 P-E

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ABSTRACT
We present the results of the operation of 3 Wastewater Treatment Plants (WWTP) with activated sludge technologies and trickling filter installed in Galicia (Spain). In dry weather, has studied extensively the composition of raw sewage, the performance of biological processes and overall efficiency of each WWTP. Thus, there has been BOD_5 performance in the activated sludge systems 90 % and in the process of trickling filter of 42 % (56 % COD). However, the trickling filter has a 46 % nitrification. In the activated sludge systems $N\text{-}NH_4^+$ removal is 75% and 70% of total nitrogen.

Keywords: WWTP performance, municipal wastewater, small agglomerations.

INTRODUCTION

Aguas de Galicia in collaboration with the Group of Water Engineering and Environment (GIAMA in spanish) of the *Universidade da Coruña*, has developed "Guidelines for Sanitation in Rural Communities in Galicia (DSMRG in spanish)" (Suárez *et al.*, 2007) to guide planning and sanitation solutions in urban areas have less than 1000. These small communities are a priority in the new "National Plan for Water Quality: Sewage and Treatment 2007 - 2015" by the government of Spain and the Xunta de Galicia itself.

To validate the proposed methodology in DSMRG and to gather more information on technologies and operation and maintenance practices, and gain greater understanding of the performance and reliability of the wastewater treatment systems in small communities, it was considered appropriate to control and comprehensive monitoring of 5 WWTPs less than 1000 PE. The objectives of this work consisted of intensive characterization of flow and pollution loads in dry weather and the evaluation of the performance observed in the elimination of pollutants in the WWTPs.

METHODS

First there was intensive audits to 30 WWTPs. These WWTPs were chosen following as criteria: different ranges of populations, different treatment technologies (with or without energy consumption, with or without dehydration of sludge, municipal and private management and geographic dispersion). Subsequently, we selected 5 of the 30 audited WWTPs: 2 of activated sludge systems, 1 static trickling filter, 1 trickling filter with recycling and 1 rotating biological contactor system.

Criteria for selection of the 5 WWTPs

- Diversity of processes: activated sludge and biofilm.
- Systems with and without energy consumption
- Preferably municipal management.
- Nutrient removal.
- Systems that allow the analysis stage by stage.

Phases of monitoring

Previous phase: Analysis of O&M protocols. Detection of uncontrolled wastewaters discharges. Identification of specific problems.
Phase characterization: This phase included the measurement of influent flows during a period of 1 month or major. For 4 days the composition wastewaters was characterized (2 working days + 2 holidays). Every day 6 grab samples are taken every 4 hours. For each day, 24 h-composite samples were drawn proportional to the inflow rate. The characterization of wastewaters was realized during dry weather.

Pollutants: In each sample, grab and/or composite, were measured: pH, temperature, turbidity, conductivity, nitrate, ammonia, Total-N, Total-P, orthophosphate, BOD_5, COD, total and fecal coliforms.

Description of the WWTPs investigated

This work presents the results of 3 WWTPs, and which is still conducting the investigation of the other two. The 3 WWTPs investigated fully present process lines set out below:

WWTP of activated sludge 1 (AS-1) with a design population of 1150 p-e. The water line consists of the following stages and equipments: pumping well with coarse waste basket - coarse grid (manual) – step screen - aerated grit - biological reactor (tank anoxic - aerobic) – lamella clarifier. The sludge line consists of a gravity sludge thickener, rectangular. Once thickened sludge is taken to a larger plant, which is in the same municipality, which has a sludge line consists of a gravity thickener and a centrifuge.

WWTP of activated sludge 2 (AS-2) with a design population of 500 p-e. Water line: pumping well with coarse waste basket – rotator screen - aerated grit and degreasing - biological reactor (activated sludge) – secondary clarifier. The sludge line is a gravity thickener. The thickened sludge is removed by an authorized agent for further processing.

WWTP of static trickling filter (TF) with a design population of 250 p-e. Water line: Coarse screen – Imhoff tank - trickling filter (by gravity)_without secondary clarifier. No sludge line. The water distribution system is by gravity, the Imhoff tank outlet there is a container filled with water that is dump on its own axis and the force of water grabbing move the water distributor in the trickling filter

RESULTS AND DISCUSSION

The values in parentheses in Table 1 correspond to the minimum and maximum values of data recorded for each pollutant. The value outside the parentheses corresponds to the average of the data set. The wastewater influents presented low to moderate concentration, exhibiting a maximum BOD_5 = 248 mg/L and a minimum of BOD_5 = 37 mg/L.

In the 3 WWTPs AS-1, AS-2, and TF can see a nitrification, obtaining $N\text{-}NH_4^+$ performance of 78 %, 73 % and 46 % (Table 2), respectively. These values are comparable with those obtained by Gallego *et al*. (2008) for the activated sludge WWTP investigated.

The trickling filter investigated has lower BOD performance because of the raw wastewater concentrations are very low (Table 1). The trickling filter is operated to very low organic loading (0.07 kg $BOD/m^3/d$). Thus, the TF has no secondary clarifier.

The Table 2 presents the volumetric organic loading, L_V, of each of the biological processes and their performances in removing contaminants. AS-1 and TF processes worked to low L_V. AS-2 is operated to medium organic loading. The 2 activated sludge systems investigated show removal of TN by nitrification - denitrification.

Table 1.-Concentration of pollutants in the influent (IN) and effluent (OUT) of the WWTPs studied

	AS-1		AS-2		TF	
	IN	OUT	IN	OUT	IN	OUT
BOD_5 (mg/L)	108 (37 - 206)	15 (9 - 20)	191 (144 - 248)	20 (18 - 23)	68 (54 - 100)	40 (33 - 43)
COD (mg/L)	207 (77 - 385)	31 (23 - 48)	335 (266 - 397)	38 (27 - 48)	125 (96 - 141)	56 (45-70)
TSS (mg/L)	65 (15 - 123)	14 (9 - 28)	80 (44 - 127)	8 (2 - 16)	21 (14 - 27)	22 (14 - 30)
TN (mg/L)	28 (11 - 50)	19 (10 - 38)	35 (21 - 45)	9,7 (4 - 17)	19,8 (14 -25)	19,6 (15 - 23)
NH_4^+ - N (mg/L)	20 (7.5 -41)	4,3 (0.05 - 15)	24 (14 - 36)	7,9 (2.4 - 15)	16,7 (14 - 19)	8,95 (5.6 - 14)
NO_3^- - N (mg/L)	0.39 (0.07 – 0.8)	10.4 (0.46 - 14)	0.19 (0.1 – 0.28)	0.39 (0.05 – 1.4)	0.12 (0.05 – 0.17)	7.94 (6.5 – 8.7)

Table 2.-Performance process

	AS-1	AS-2	TF
Cv (kg $BOD_5/m^3.d$)	0.05	0.46	0.07
BOD_5 (%)	86	90	42
COD (%)	85	89	56
TN (%)	67	72	1.16
NH_4^+ (%)	78	73	46

CONCLUSIONS

With activated sludge systems are obtained very acceptable performance in organic matter and ammonia, but it is very important to keep in the rainy weather adequate internal sludge recycling to have stable mixed liquor concentration in the bioreactor, since having such diluted waters in these times the biomass suspension is lost. In the trickling filter that is not a major problem, and its performance is stable over time.

For best performance in the trickling filter must be maintained in proper conditions the water distributor arms and to control the sludge level in the Imhoff tank, but also raw wastewater should have a greater concentration.

All the WWTPs achieved a well clarified effluent, with a TSS concentration in the range of 8 to 22 mg/L. These values are below 35 mg/L that is the permit limit by Directive 91/271.

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