

EVALUATION OF MUNICIPAL WASTEWATER TREATMENT PLANT WITH DIFFERENT TECHNOLOGIES AT EXTREMADURA (SPAIN)

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Abstract

Thirty municipal wastewater treatment plants were studied throughout one year in the autonomous region of Extremadura, southwest of Spain. Twenty one plants used the oxidation ditch (OD) process, five used extended aeration (EA), while the rest used conventional active sludge (CAS), Orbal process (ORBAL), Carrousel Oxidation Ditch (C-OD) and anaerobic/anoxic-oxic process (A-O). OD and EA had high removal efficiencies for ammonia, chemical oxygen demand (COD) and total nitrogen (TN). A survey of both biological bulking and foaming in active-sludge plants was carried out and showed that 70% of the samples analyzed presented and excessive quantities of filamentous bacteria due to management problems.

Introduction

Extremadura is an autonomous region in southwestern Spain. The total surface area is around 41.633 Km², ranking 5th in area among the Spanish autonomous regions. The total population is 1,086,373 inhabitants, with 50% located in urban areas. Decentralized treatment plants process most of the wastewater produced by this population. However, up to date the performance of these plants has not been evaluated.

In the last ten years, the number of municipal WWTPs (Colmenarejo, M.F., et al., 2006) has been greatly increased and a large demand of information about appropriate procedures and technologies has appeared. In this paper, a critical review about the unsatisfactory performances of the WWTPs surveyed is presented, which may give rise to the development of new engineering innovations, as well as the academic studies.

Methods

Thirty small-scale wastewater treatment plants were evaluated, 21 in the province of Badajoz and 9 in that of Cáceres. The evaluation of the plants was carried out throughout one year. Samples of influents and effluents of the plants were preserved at 4 °C while transport to the laboratory. Then they were immediately analysed to evaluate the total suspended solids (TSS), nitrites, nitrates, ammonia and chemical oxygen demand (COD). All the analyses were carried out following the Standard Methods for the Examination of Water and Wastewater (APHA, 1995).

Microscopic observations of filamentous microorganisms were made under phase contrast at 200x and 1000x magnifications. They were identified according to (Jenkins, D., et al., 2003).

Results and discussion

Typical biological nutrient removal (BNR) processes have been studied in this work for conventional active sludge (CAS), anaerobic/anoxic-oxic (A-O), oxidation ditch (OD), carousel oxidation ditch (C-OD), Orbal (ORBAL) and extended aeration (EA) processes.

Fig. 1 shows the set of WWTPs studied with their wastewater volumes treated in 2007. These statistic data covered respectively the 35 % and 55 % of the total WWTPs and treated volumes. Among the studied processes, OD and EA together accounted for 84% of WWTPs and 50% of the treated volume. The different studied processes were related to their distinct features, for example, easiness of operation and maintenance, instrumental requirements and energy consumptions, and also of great importance, related to information process available and easiness of upgrade. It could be expected that: (i) WWTPs numbers and treated domestic wastewater volumes of OD process would be continuously increased by strong potential for energy saving and BNR process in treatment between 2.000 to 10.000 PE. (ii) Upgraded WWTPs numbers would be continuously upgraded of Anaerobic-Anoxic-Oxic (AAO) process or Alternating Cycles (AC) process by the strong potential of the reformation of CAS process.

Table 1 shows the different performances of the major processes in 2007, including the influent concentrations and average removal rates of pollutants. The major processes showed similar performances in COD removal, although the best performance in COD and TN removal was provided by OD processes, which represent 64% of the treated volumes. The low performance in EA and CAS processes was associated with overloading, i. e., the reduction in the hydraulic retention time (HRT)

resulting from an increased flow and an insufficient capacity of aeration equipment to provide the amount of oxygen required by the ammonia oxidation.

It was found that 77% of the 30 WWTPs studied presented solid separation problems related to the presence of excessive quantities of filamentous organisms. With regard to the bulking and foaming problem, 14% performed well with high settling process efficiency, 23% performed moderately well as they were affected by filamentous bulking and 63 % performed poorly due to serious bulking and foaming problems. The most common filamentous microorganisms in mixed liquor were GALO (Gordonia Amarae like organisms) (25%); Microthrix parvicella (21%), Type 0675 (14%), Type 1863 (11 %), Type 0092 (11%), Type 1851 (11%) and Nostocoida limicola (7%). Even though a total of 17 species were found, few of them were observed as dominant.

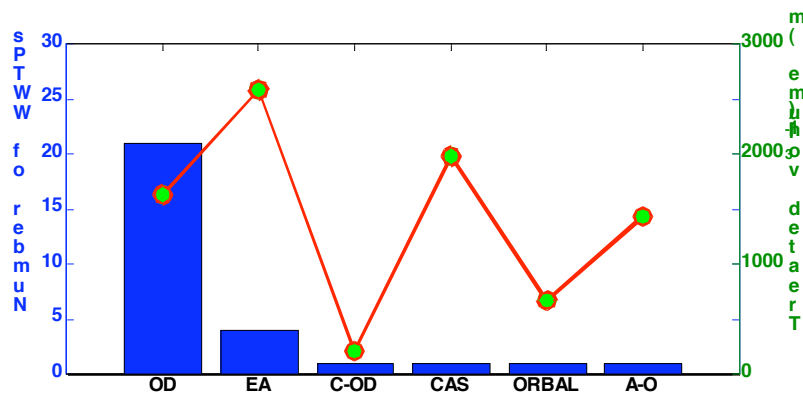


Figure 1. Typical processes applied in municipal WWTPs and their treated volume.

Table 1. Performance of major WWTP processes in Extremadura in 2007 (unit, mg/l)

	COD			NH ³ -N			NTK			PT		
	Mean _a	Range ^b	% ^c	Mean _a	Range ^b	% ^c	Mean _a	Range ^b	% ^c	Mean _a	Range ^b	% ^c
OD	591	252-1268	85-95	18	12-26	60-90	24	17-32	20-60	4.5	12-3	8-43
EA	828	286-2296	80-90	15	13-18	50-80	21	17-25	30-70	3.7	35-4	30-50
C-OD	261	130-686	85-95	15	3-30	55-75	19	6-35	30-60	3.1	2.9-4	8-30
CAS	464	157-1425	65-85	15	8.1-22	40-55	21	15-29.1	10-30	3.7	2-5.1	22
ORBAL	360	566-1284	77-95	15	8.1-20.4	30-90	20	14.3-25	40-80	3.1	2.7-4.9	25-80
A-O	660	303-1625	85-90	18	14-30	60-90	24	19-34	20-50	3.8	3.2-5	20-60

^a Average concentration of pollutants in raw influent to WWTPs; ^b 10 and 90 percentiles in the distribution of pollutant concentrations; ^cRemoval rates based on average values of WWTP influent and effluent.

Conclusions

The study of the bulking and foaming problems along with their relation with the settling process efficiency in municipal WWTPs in Extremadura points out that these problems are widespread. It is clear that the excessive quantities of filamentous organisms is related to problems with the management systems of the WWTPs induced by low aeration rates, inappropriate sludge retention time, wastewater feeding regime, especially intermittent, and changes in plant operating conditions. These facts, highlights the need to develop new management systems and new engineering solutions.

References

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