

TWENTY YEARS OF SLUDGE ACCUMULATION IN CARRIÓN DE LOS CÉSPEDES (SPAIN) STABILIZATION PONDS SYSTEM.

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ABSTRACT

After twenty years of operation of urban wastewater treatment system by Stabilization Ponds (Anaerobic, Facultative and Maturation Ponds) in Southern Spain, the present paper describes the sludge accumulation rates and its characteristics after this time. The rate of sludge accumulation was lower than previously reported by other authors due to the effects of degradation and consolidation. The measured distribution of total solids and moisture content showed that the sludge consistency varied from liquid to pasty, at the same time that vertical distributions of TS and VS indicate a consolidation and mineralization of sludge with depth.

Keywords: sludge accumulation, sludge distribution, Stabilization Ponds, sludge rates, sludge characteristics.

INTRODUCTION

Wastewater Stabilization Ponds (WSPs) are a simple low-cost and low-maintenance process for treating urban wastewater effluents. A typical system consists of several constructed ponds operating in series. Treatment of the wastewater occurs as constituents are removed by sedimentation or transformed by biological and chemical processes. In the bottom of the ponds, a sludge layer forms due to the sedimentation of influent suspended solid as well as algae and bacteria that grow in the pond. Sludge accumulation is greatest in primary ponds and can impact performance by altering the pond's effective volume and charges the space of the bottom surface (Peña et al., 2000).

The present paper shows data about sludge accumulation and mineralization rates and its horizontal and vertical variation in a stabilization ponds system located at the Carrión de los Céspedes Experimental Plant (PECC), Seville, Spain after twenty years operation.

METHODS

Description of the experimental pond system

This investigation was carried out at the Experimental Wastewater Treatment Plant at Carrión de los Céspedes (PECC) – Centre of New Water Technologies Foundation (CENTA), located in Carrión de los Céspedes, Seville, Spain, coordinates 37° 21' 38"N, 6° 20' 4"W. The experimental plant receives

untreated wastewater for Carrión de los Céspedes with approximately 2500 people. Part of the influent is directed to the system investigated after pretreatment system. The studied system consists of three Stabilization Ponds: one Anaerobic Pond, a Facultative Pond and two Maturation Ponds operated in series also. The general characteristics of these ponds are presented in Table 1.

Pond type	Volumen (m ³)	Surface area (m ²)	Pond depth (m)	HRT (days)
Anaerobic Pond	75	25	3	2.1
Facultative Pond	1220	982	1.5	34.3
Maduration Pond I	295	400	0.9	8.4
Maduration Pond II	201	291	0.9	5.7

Table 1. General characteristics of the ponds that make up the system.

Sampling and analysis method

Sludge sampling was performed in winter 2010 during bathymetric surveys of the distribution of sludge in the ponds after 15 years of operation in Anaerobic Pond and 20 years in Facultative and Maturation Ponds.

In order to characterize accumulation and mineralization rates during its operation periods, 12 sampling points were located throughout the system, two in Anaerobic Pond (influent and effluent), four in the Facultative Pond (influent, effluent, center right, center left) and three in each Maturation Pond (influent, center and effluent).

Sludge cores were collected from a rowboat in all locations using a PVC tube with an “open–closed” system at one of the extremities. Samples from Anaerobic Pond were divided into 3 different sub-samples in order to study the vertical differences in the properties of sludge.

Basic physical and chemical properties of the sludge samples were measured, including pH, conductivity, total solids, fixed solids and volatile solids according to Standard Methods (APHA/AWWA/WEF, 2005). Sludge density and percentage of water content were also measured.

RESULTS AND DISCUSSION

Sludge distribution and accumulation

After 15 years of operation the volume of sludge in Anaerobic Pond was measured representing 55.8% of the pond volume. This percentage is slightly higher than that (one–third full of sludge) recommended by Mara (2004) for anaerobic pond desludging. Facultative and Maturation Ponds volume of sludge

was measured representing 11.1%, 25.7% and 21.3% of the pond volume respectively after twenty years of operation.

With an organic load equivalent to 250 PE, the sludge accumulation rate for the Anaerobic Pond was calculated to be 0.011 m³/ capita year (0.03 L/capita day), that is significantly lower than the value of 0.04 m³/ capita year reported by Mara (2004) in warm climates, 0.05 m³/ capita year reported by Pena et al. (2000) in Columbia, and 0.052 m³/ capita year reported by Goncalves (2002) in Brazil. This low rate of sludge generation could be due to a combination between degradation and consolidation as reported Nelsol & Yang (2004).

Facultative and Maduration Ponds accumulations rates were 0.027 m³/ capita year, 0.015 m³/ capita year, 0.009 m³/ capita year respectively.

Sludge characteristics

Data on sludge characteristics are shown in Table 2.

	Anaerobic	Facultative	Maduration I	Maduration II
pH	6.6±0.2	6.6 ± 0.0	6.5±0.1	6.6±0.1
ORP (mV)	-335.3±20.5	-317.0±12.1	-360.3±41.7	-334.0±92.5
Water content (%)	83.3±5.6	86.8±1.7	78.7±3.8	82.7±2.5
Total solids TS (%)	16.7±5.6	13.2±1.7	21.3±3.8	17.3±2.5
Fixed solids (% TS)	65.0±1.4	63.2±1.5	81.7±2.1	83.7±3.1

Table 2. General characteristics of the ponds that make up the system.

The ranging values of water content (76.0% - 90.0%) show that the sludge consistency ranged from liquid to pasty foms. The highest values for water content were observed in the first 25 centimeter depths starting at the top of the pood.

As can be seen, these materials have a high percentage of fixed solids with increases along the process. The average values found for fixed solids of more than 50% indicated the sludge was well digested. The lower values for fixed solids were observed in the first 25 centimeter depths starting at the top of the sludge.

The pH and ORP are virtually constant throughout the system.

CONCLUSIONS

In this study the rate of sludge accumulation in an Anaerobic Pond in a mediterranean climate was estimated to 0.011 m³/ capita year (0.031 L/capita day), 0.027 m³/ capita year in Facultative Pond, 0.015 m³/ capita year and 0.009 m³/ capita year in Maturation Ponds respectively. This low rate of sludge generation could be due to a combination between degradation and consolidation.

The measured distribution of total solids and moisture content showed that the sludge consistency varied from liquid to pasty.

The vertical distributions of total solids and fixed solids indicate a consolidation and mineralization of sludge with depth.

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