Characterization of the effluent from livestock farm and full-scale Natural Treatment Systems for Wastewater (NTSW) in Gran Canaria.

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Abstract

The effluents from livestock farms represent a strong environmental and sanitary impact, with special emphasis on those coming from pigs. This impact is amplified in island territories. To select and project the most suitable treatment systems, it is necessary to know the parametric values of effluents, flow rates and their capability to be reused as a fertilizer.

The objective of this work is to characterize the effluent coming from a pig farm and the effluent obtained from the natural treatment systems (NTSW) placed in the farm in the Island of Gran Canaria. Slurry management is performed within these NTSW, which are operated under normal conditions of livestock farm, and based on elements such as, first generation bio-digesters, subsurface flow constructed wetlands (SSFCW) and facultative ponds.

Characterized parameters (141 samples from 2008 to 2015) have allowed us to know the performance of the system, to test the solution and a better reuse. There have been found correlations between the different variables that can be useful to improve the management of the residues even in isolated or difficult to access livestock farms. Regarding the flows, in case they are not known, it has been verified that the criterion that best adapts to the real one is the relative one to the consumption of dry material.

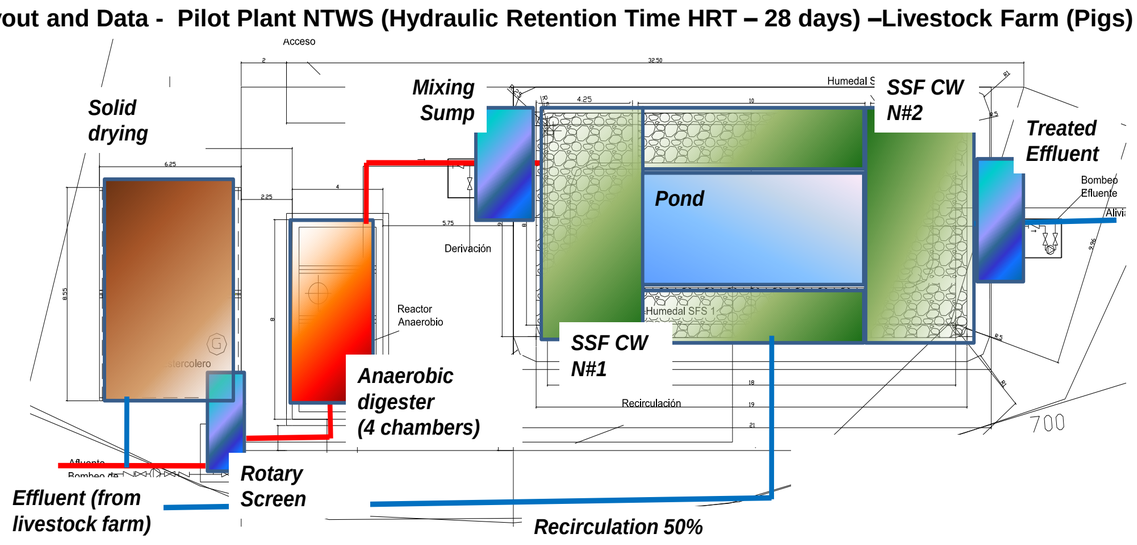
In the effluent from livestock farm, it came up that there were relationships between several pairs of parameters: number of bristles and total COD or effluent flow, TDS and Conductivity (EC), Volatile Solids (VS) and Total Organic Carbon (TOC), Outdoor Temperature and VS, days of laboratory analysis with Total Nitrogen. In the effluent from NTSW, we found also correlation between total COD and particulate COD, particulate COD and VS, soluble COD and Fixed Solid (FS), FS and conductivity and Total Solids (TS) and conductivity (EC).

Keywords

Natural systems, bio-digester, slurry management, wastewater treatment, constructed wetlands, ponds, low-cost treatment, characterization effluent, fertilizer, reuse.

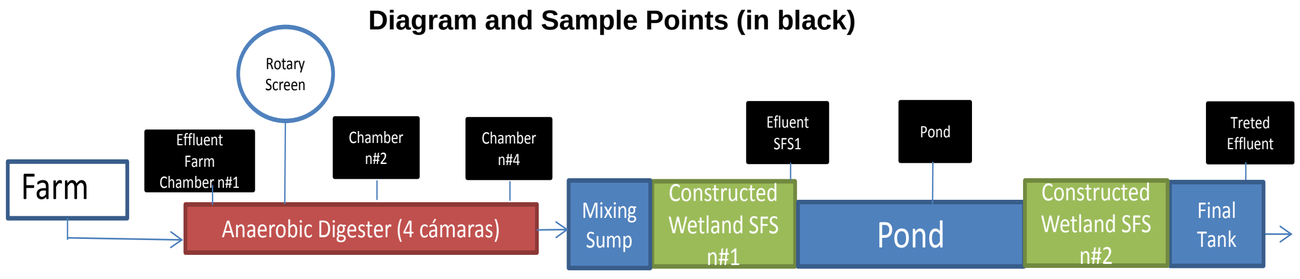
Materials and Methods

Layout and Data - Pilot Plant NTWS (Hydraulic Retention Time HRT – 28 days) –Livestock Farm (Pigs)

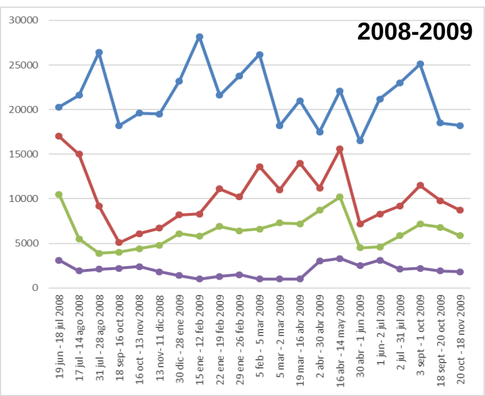


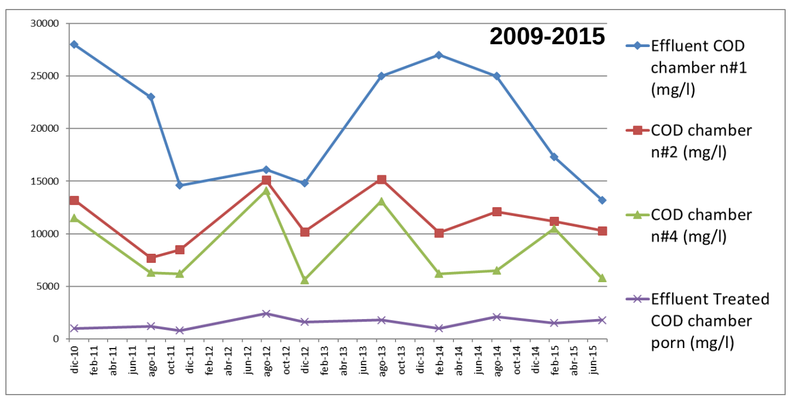
	COD effluent from farm (mg/l)	Flow Effluent from fram (m³ /day)	Nº (Bristles) – (Total animals - pigs) / year	Reception Tank (m³)-(HRT days)	Anaerobic Digester (m³)-(HRT days)	Constructed wetland SFS (m³)-(HRT days)	Pond (m³-HRT days)
Pilot Plant	35000	8,70	(160)-(1432)	(10)-(1-2)	(103)-(11)	(46)-(5)	(90)-(10)

Diagram and Sample Points (in black)



Steady-state operation (2008 – 2015) – non stop





Results

Treated Effluent - SOLID (from NTWS) - Characterization

Parameters	Max	Min	Mean	Standart Dev.
Humity (%)	25,40	31,50	29,03	2,58
Dry Part (%)	68,50	74,60	71,23	2,54
Total Nitrogen (%)	1,68	2,26	1,92	0,25
P_2O_5 (%)	2,54	6,41	4,12	1,64
K_2O (%)	0,46	0,66	0,54	0,09
CaO (%)	4,39	7,70	6,45	1,45
MgO (%)	0,52	0,78	0,66	0,13
S (%)	0,49	0,53	0,51	0,02
Na (%)	0,13	0,28	0,20	0,07
B (mg/kg)	26,00	39,00	32,25	5,38
Cu (mg/kg)	79,00	99,00	90,50	9,29
Fe (mg/kg)	1248,00	1591,00	1414,50	165,80
Mn (mg/kg)	382,00	740,00	554,75	148,17
Zn (mg/kg)	300,00	364,00	332,50	27,15
Organic Material (%)	59,00	71,60	64,70	6,09

Solid Temperature (62ºC) and samples

Effluent (Livestock Farm) - Characterization

Std. Methods - Paramaters	Min	Max	Mean	Standart Dev.
Flow (m³/d)	5,20	8,70	6,42	1,25
Outdoor Temperature (ºC)	10,15	22,70	17,48	4,18
Indoor Temperature (ºC)	15,10	25,20	20,47	3,63
pH	7,00	7,70	7,39	0,23
Nº bristles (livestock)	80,00	160,00	111,00	30,71
Density(kg/m³)	850,00	1100,00	951,00	83,19
Conductivity (EC) (dS/m)	14,20	23,20	17,27	2,85
Organic Material (mg/l)	3800,00	7800,00	5700,00	1609,69
COD total (mg/l O_2)	13200,00	28000,00	20300,00	5819,89
COD particulate (mg/l O_2)	11000,00	23300,00	16910,00	4707,31
COD soluble (mg/l O_2)	1000,00	2200,00	1590,00	519,51
COD innert (mg/l O_2)	1000,00	2600,00	1800,00	616,44
TOC (mg/l C)	3000,00	6200,00	4530,00	1291,90
Total Solid (TS) (mg/l)	24700,00	36000,00	28240,00	3414,41
Total Suspension Solid (TSS) (mg/l)	15000,00	21000,00	17170,00	2067,23
Total Disolved Solid (TDS) (mg/l)	9100,00	15000,00	11070,00	1867,29
Volatile Suspension Solid (VSS) (mg/l)	3200,00	5000,00	3840,00	566,08
Fixed Suspension Solid (FSS) (mg/l)	10200,00	16500,00	13330,00	1953,37
Volatile Solid (VS) (mg/l)	1200,00	2400,00	1780,00	446,72
Fixed Solid (FS) (mg/l)	6900,00	12600,00	9290,00	1.60,38
B (mg/l)	1,10	4,00	2,71	1,12
Cu (mg/l)	2,00	4,00	3,30	0,95
Fe (mg/l)	13,00	25,00	19,22	4,68
Mn (mg/l)	3,00	6,00	4,50	0,85
Zn (mg/l)	8,00	23,00	15,30	5,16
Total Nitrogen (g/100 ml)	0,03	0,24	0,17	0,06
Phosphor (g/100 ml P_2O_5)	0,03	3,00	2,31	0,83
Potasium (g/100 ml K_2O)	0,12	0,18	0,16	0,02
Calcium (g/100 ml CaO)	0,05	0,06	0,06	0,01
Magnesium (g/100 ml MgO)	0,01	0,01	0,01	0,00
Sulfur (g/100 ml S)	0,01	0,01	0,01	0,00
Sodium (g/100 ml Na)	0,05	0,08	0,07	0,01

Treated Effluent (from NTWS) - Characterization

Std. Methods – Parameters	Min	Max	Mean	Standart Dev.
Flow (m³/d)	5,20	8,70	6,42	1,25
pH	7,70	8,50	8,12	0,24
Nº bristles (livestock)	80,00	160,00	111,00	30,71
Conductivity (EC) (dS/m)	3,20	10,80	6,44	3,43
Organic Material (mg/l)	500,00	2100,00	1260,00	516,83
COD total (mg/l O_2)	800,00	2400,00	1520,00	520,26
COD particulate (mg/l O_2)	100,00	1.100,00	590,00	394,97
COD soluble (mg/l O_2)	100,00	300,00	170,00	63,25
COD innert (mg/l O_2)	500,00	1200,00	720,00	209,76
TOC (mg/l C)	400,00	1.600,00	995,00	391,90
Total Solid (TS) (mg/l)	2700,00	10300,00	6770,00	2915,11
Total Suspension Solid (TSS) (mg/l)	400,00	1.000,00	680,00	209,76
Total Disolved Solid (TDS) (mg/l)	300,00	600,00	380,00	103,28
Volatile Suspension Solid (VSS) (mg/l)	100,00	700,00	300,00	169,97
Fixed Suspension Solid (FSS) (mg/l)	2100,00	9500,00	6090,00	2829,39
Volatile Solid (VS) (mg/l)	100,00	500,00	300,00	124,72
Fixed Solid (FS) (mg/l)	1700,00	9200,00	5590,00	2692,15
B (mg/l)	0,50	2,00	1,14	0,57
Cu (mg/l)	0,20	1,00	0,57	0,37
Fe (mg/l)	1,00	5,00	2,90	1,52
Mn (mg/l)	0,10	1,00	0,59	0,45
Zn (mg/l)	0,20	4,00	1,89	1,49
Total Nitrogen (g/100 ml)	0,01	0,01	0,01	0,00
Phosphor (g/100 ml P_2O_5)	0,01	0,03	0,01	0,01
Potasium (g/100 ml K_2O)	0,07	0,11	0,09	0,02
Calcium (g/100 ml CaO)	0,01	0,02	0,02	0,01
Magnesium (g/100 ml MgO)	0,01	0,01	0,01	0,00
Sulfur (g/100 ml S)	0,01	0,01	0,01	0,00
Sodium (g/100 ml Na)	0,01	0,05	0,03	0,01

Example of curve-regression generated.

R^2	Type	Curve-regression Effluent from Livestock farm
0,686	Lineal	*CODt (mg/l)=3246,643+154,535* (Nºbristles)*
0,943	Cuadratic	*CODt (mg/l)=16021,445-6,920*(CODs)+0,006*(CODs)²*
0,958	Cubic	*FS (mg/l) =- 12466,827+1833,34*(EC)-32,42*(EC)²*
0,951	Cubic	*Flow (m³/d) =4,425+3,029e-7*(Nº bristles)³*
0,876	Cuadratic	*VS (mg/l) =2134,633-0,420*(TOC)+5,861e-5*(TOC)²*
R^2	**Type**	**Curve-regression Treated Effluent from NTSW**
0,750	Exponential	*CODt (mg/l) =903,153+0,61e^CODp*
0,852	Cubic	*CODp (mg/l)=1076,509-4,620*(TOC)+0,006*(TOC)²-2,24e-6*(TOC)³*
0,953	Cubic	*FS (mg/l) = - 2054,572+1359,122*(EC)-79,202*(EC)²+2,464*(EC)³*
0,996	Lineal	*TS (mg/l) = 509,427+1,028*(FSS)*

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General view - pilot plant

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