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Overall performance evaluation of shallow maturation ponds in series treating UASB reactor effluent: ten years of intensive monitoring of a system in Brazil

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INTRODUCTION

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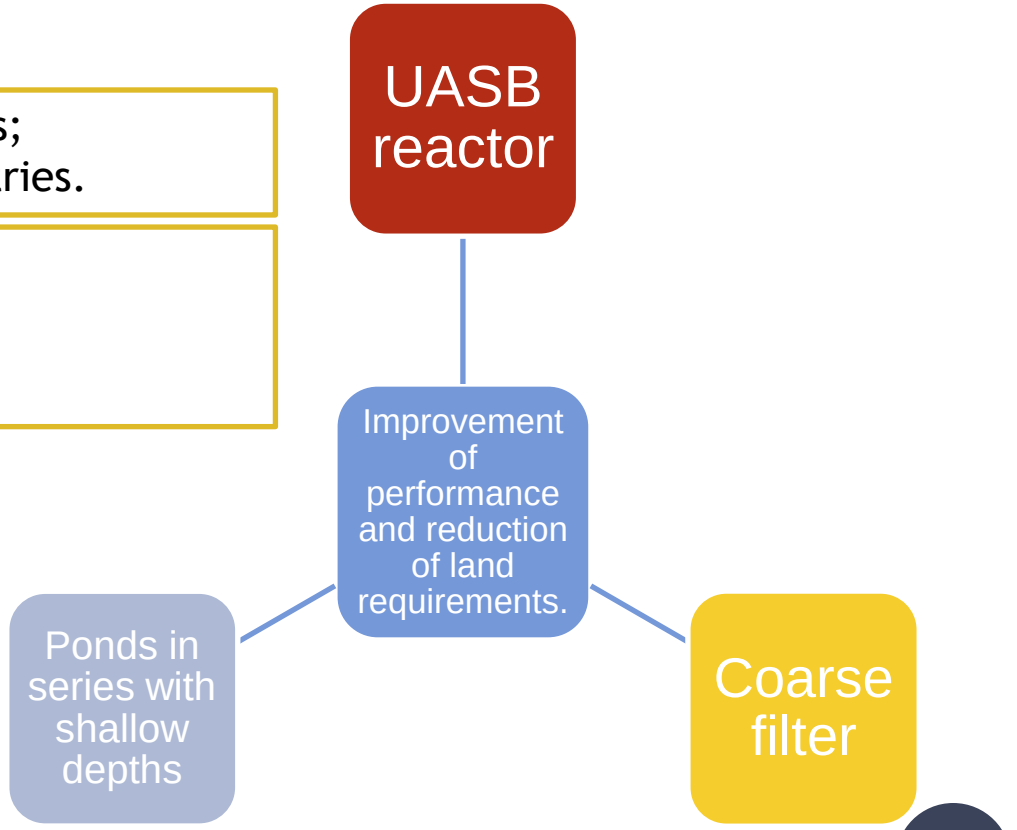
Maturation ponds

- Temperate Countries;
- Warm-climate Countries.

Operating conditions can be optimal

- > Temperatures;
- > Sunlight radiation.



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INTRODUCTION

Assunção & von Sperling (2013), Chiatti & von Sperling (2011), Oliveira & von Sperling (2010), Chernicharo et al (2010), von Sperling et al (2010),

Godinho et al (2011), Araujo et al (2010), von Sperling et al (2008), von Sperling & Andrada (2006),

von Sperling & Mascarenhas (2005),von Sperling et al (2005) and Possmoser-Nascimento et al. (2013).

Extensive evaluation of one system with this configuration operating in southeast Brazil over a period of 10 years (2002 to 2012), consolidating results

- Literature cover single studies over a limited period of time;
- few reports that encompass together several performance variables over a long period;
- compare the performance during dry/cool and wet/warm periods;
- maturation ponds treating UASB reactor effluents are not widely covered in the literature and that these ponds operated with shallower depths compared to usual maturation ponds.

METHODS

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- The experiments were undertaken at the Centre for Research and Training in Sanitation UFMG-Copasa, which receives sanitary sewage from the city of Belo Horizonte, Brazil.
- Mean annual temperature of 22.1 ºC and mean annual rainfall of 1540 mm/year

TWO SEASONS

- April to September (dry and cool, with mean temperatures of 20.9 ºC and mean rainfall of 33 mm/month).
- October to March (wet and warm, with mean temperatures of 23.4 ºC and mean rainfall of 254 mm/month).

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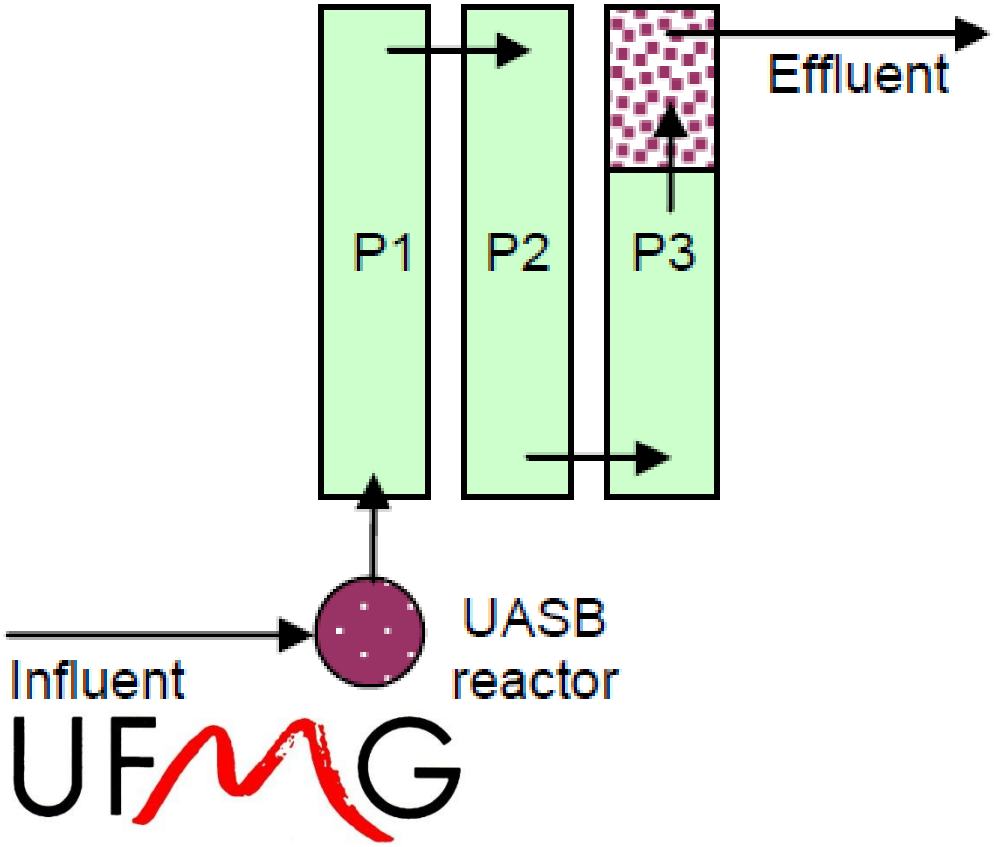
METHODS

Source: Google Maps®

METHODS

First Arrangements (2002) →four in series, three in series, or two sets in series/parallel (6 months).

Second Arrangement (May 2002 – February 2013) → ponds 1, 2 and 3 operated in series (9,5 months). In October 2004 the third pond was split in two zones, with the first 2/3 of the area remaining as a pond, and the final 1/3 being converted into a coarse rock filter



- **UASB:**

volume = 14.2 m^3, height = 4.5 m, diameter = 2.0 m

- **Pond's 1 & 2:**

length = 25.00 m, width = 5.25 m

- **Pond 3 and coarse rock filter:**

length = 16.54 m, width = 5.25 m
length = 8.44 m; width = 5.25 m (grain size between 32 and 150 mm)

RESULTS AND DISCUSSION (HRT)

- Influent flow varied, with a mean value of 33.0 m^3/d;
- The depth was changed in order to investigate its influence on the system behaviour, with values ranging from 0.40 to 0.80 m;
- In ponds 1 and 2 HRT varied between 2.0 and 6.0 days;
- In Pond 3 HRT was lower (range between 0.8 and 2.5 days) → Coarse Rock Filter;
- Even when HRT was very low in each pond[1], the performance was good for many constituents, especially when the ponds were shallower;
- The rock filter operated with surface loading rates between 1.0 and 1.5 $m^3/m^2.d$.

NOTES: [1]Below the recommendations of a minimum value of 3.0 days, given by Mara, 2003

RESULTS AND DISCUSSION (BOD & COD)

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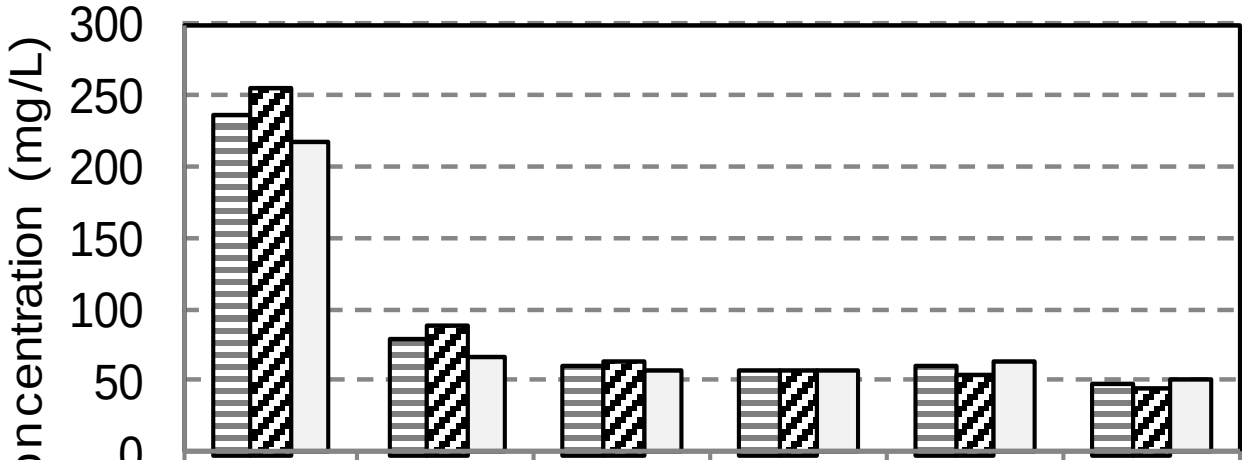
Total BOD - mean values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	235	78	60	57	59	48
Dry	254	88	63	55	54	44
Wet	216	67	58	58	65	52

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✓ Wet vs dry → significantly different;

RESULTS AND DISCUSSION (BOD & COD)

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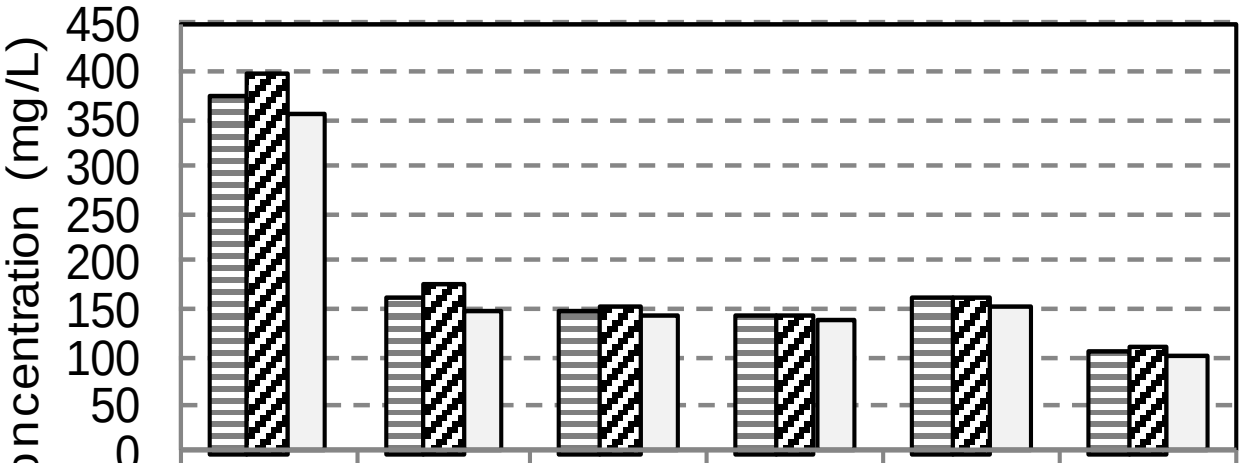
Total COD - mean values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	373	161	147	140	158	103
Dry	394	173	152	140	162	107
Wet	354	149	143	140	155	99

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RESULTS AND DISCUSSION (TSS)

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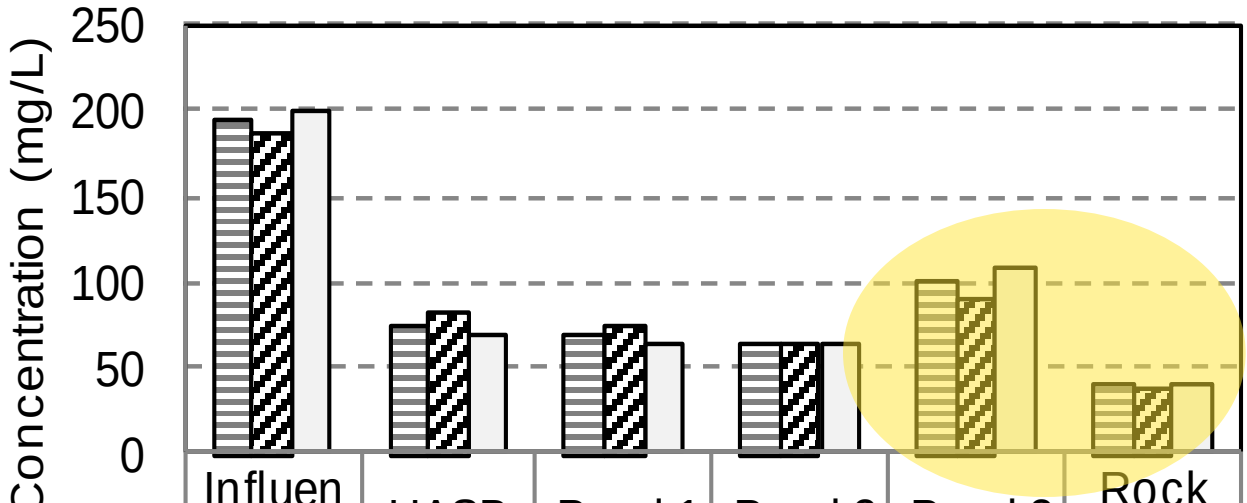
TSS - mean values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	194	74	68	63	100	39
Dry	186	81	72	63	89	37
Wet	200	68	64	63	109	41

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RESULTS AND DISCUSSION (NITROGEN)

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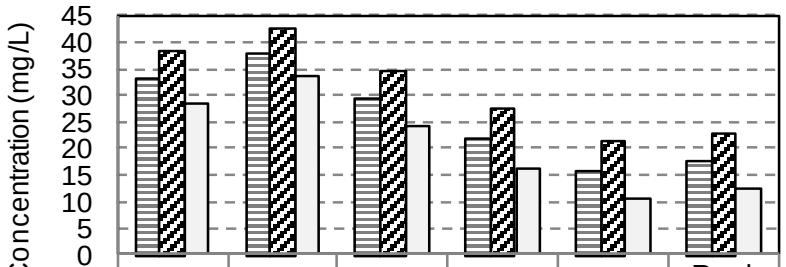
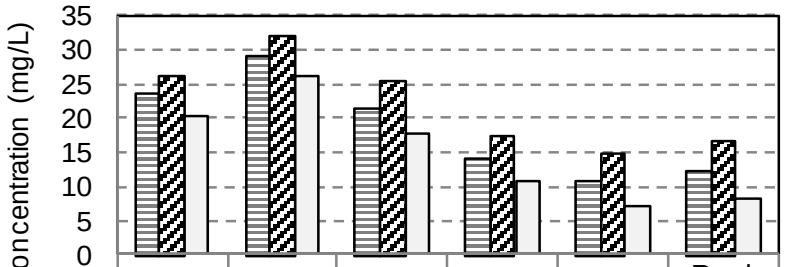
Total N - mean values



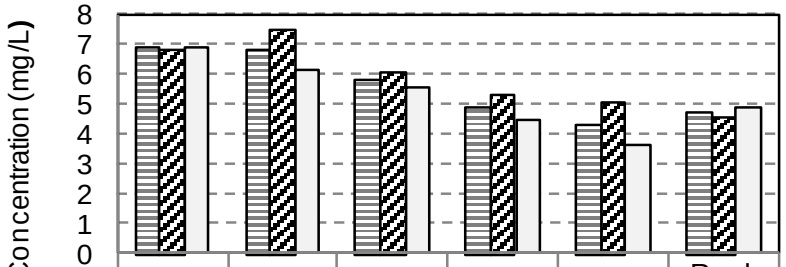
	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	33	38	29	22	15	18
Dry	38	42	34	27	21	22
Wet	28	34	24	16	10	12

Ammonia - mean values



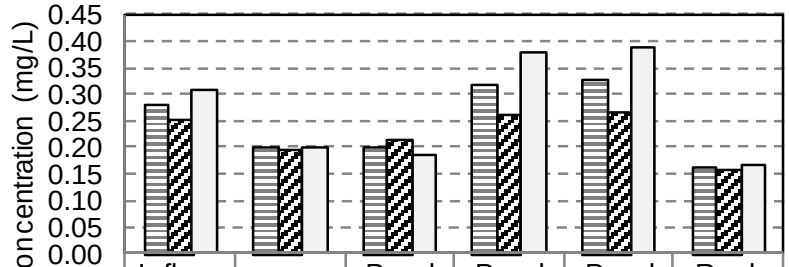
	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	23	29	21	14	11	12
Dry	26	32	25	17	15	16
Wet	20	26	18	11	7	8

Org N - mean Values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	7	7	6	5	4	5
Dry	7	7	6	5	5	5
Wet	7	6	6	4	4	5

Nitrate - mean values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	0.28	0.20	0.20	0.32	0.32	0.16
Dry	0.25	0.19	0.21	0.26	0.26	0.16
Wet	0.31	0.20	0.19	0.38	0.39	0.17

✓ Wet vs dry (TN & Ammonia) → significantly different;

RESULTS AND DISCUSSION (PHOSPHORUS)

- Virtually no change in concentration of total phosphorus along the treatment line.

RESULTS AND DISCUSSION (PATHOGENIC ORGANISMS)

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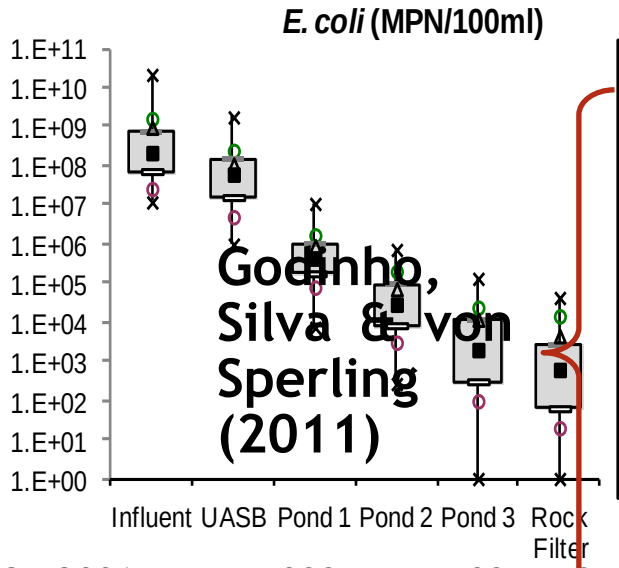


Godinho, Silva & von Sperling (2011)

Polishing ponds in series have as their main goal the removal of pathogenic organism such as *Escherichia coli* (*E. coli*) and helminth eggs

tos &

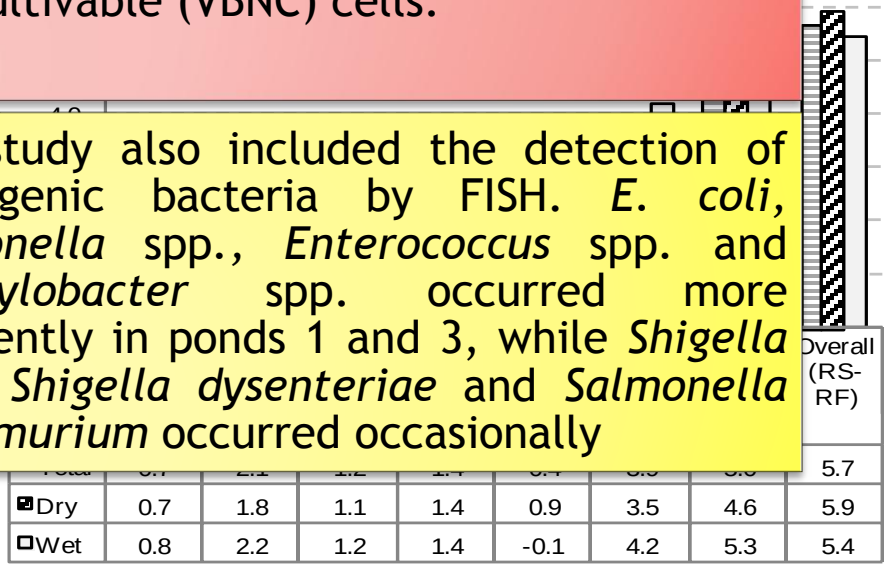
- Quantification of *E. coli* → (FISH) and (Colilert®) techniques in the same pond system.
- The study concluded that the chromogenic substrate technique was the recommended method for monitoring E. coli in the ponds, since the FISH technique could increase the quantification of E. coli through viable but not cultivable (VBNC) cells.

(WHO, 2006) → < 1000 MPN/100mL for
and a mean counting of helminth eggs
than 1 egg/L → complies for unres
irrigation.

Achieved with HRT sometimes < 2.0 days
ponds , highlighting the importance
shallow depths.

Godinho *et al.*, 2010, 2011

- The study also included the detection of pathogenic bacteria by FISH. *E. coli*, *Salmonella* spp., *Enterococcus* spp. and *Campylobacter* spp. occurred more frequently in ponds 1 and 3, while *Shigella* spp., *Shigella dysenteriae* and *Salmonella Typhimurium* occurred occasionally



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RESULTS AND DISCUSSION (ORGANIC MICROPOLLUTANTS, SURFACTANTS AND SULPHIDES)

There is very little data in the literature about this topic, since it has not been a subject of concern in developing countries for this type of wastewater treatment train.

Analyse the removal of specific constituents such as surfactants, diethylphthalate (DEP), bis(2ethylhexyl)phthalate (BEHP) and bisphenol A (BPA).

Chernicharo *et al.* (2010)

Surfactant → < 50%
DEP → 53%,
BEHP → 69%
BPA → 99%

Sulphide removal 100% (first pond of the series).

RESULTS AND DISCUSSION (ENVIRONMENTAL CONDITIONS IN THE PONDS)

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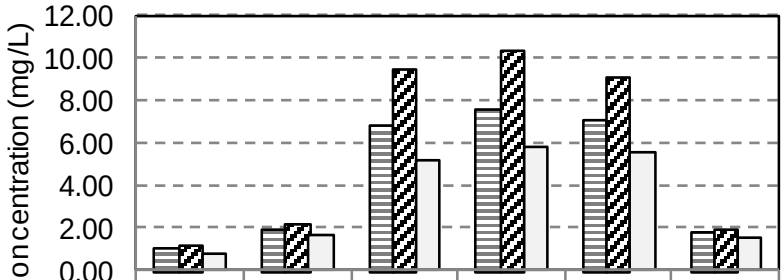
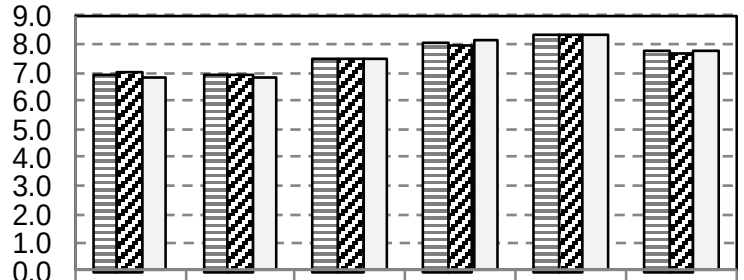
DO - mean values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	0.95	1.90	6.80	7.49	7.05	1.70
Dry	1.18	2.11	9.48	10.25	9.04	1.86
Wet	0.75	1.72	5.18	5.85	5.61	1.56

pH - mean values



	Influent	UASB	Pond 1	Pond 2	Pond 3	Rock Filter
Total	6.9	6.8	7.4	8.0	8.3	7.7
Dry	7.0	6.9	7.5	7.9	8.3	7.7
Wet	6.8	6.8	7.4	8.1	8.3	7.7

- First pond receives a higher organic load, it is still able to have high concentrations of DO;
- The ponds prevailed in aerobic conditions.

- Values of pH also increased along the ponds, accompanying the DO values, due to photosynthetic removal of carbon dioxide.
- Thus, algae indirectly affects and elevates pH values, making the medium in the ponds less favourable for pathogenic organisms.

RESULTS AND DISCUSSION (SLUDGE ACCUMULATION)

Possmoser-Nascimento *et al.* (2013, 2013a)

- Studied the sediment after more than 10 years of operation;
- 92% of total mass of solids were present in pond 1
- Most solids were of an inorganic nature
- Irregular distribution near the inlets and outlets of the ponds;
- Effective volume occupied:
  - Pond 1 → 53%
  - Pond 2 → 11%
  - Pond 3 → 23%
- Suggesting sludge removal or raising the water level may be necessary in the short term → Pond 1;
- Sludge removal frequency are variable (higher in Pond 1, compared with typical facultative ponds).

CONCLUSIONS AND FINAL REMARKS

CONCLUSIONS AND FINAL REMARKS

Asante Sana/Thank you for your attention!

For additional information please contact

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