



Universidade Federal do Ceará

DEHA - Depto. de Eng. Hidráulica e Ambiental

# A FULL-SCALE ANAEROBIC POND TREATING AN ALKALINE MIX OF INDUSTRIAL AND DOMESTIC WASTEWATERS

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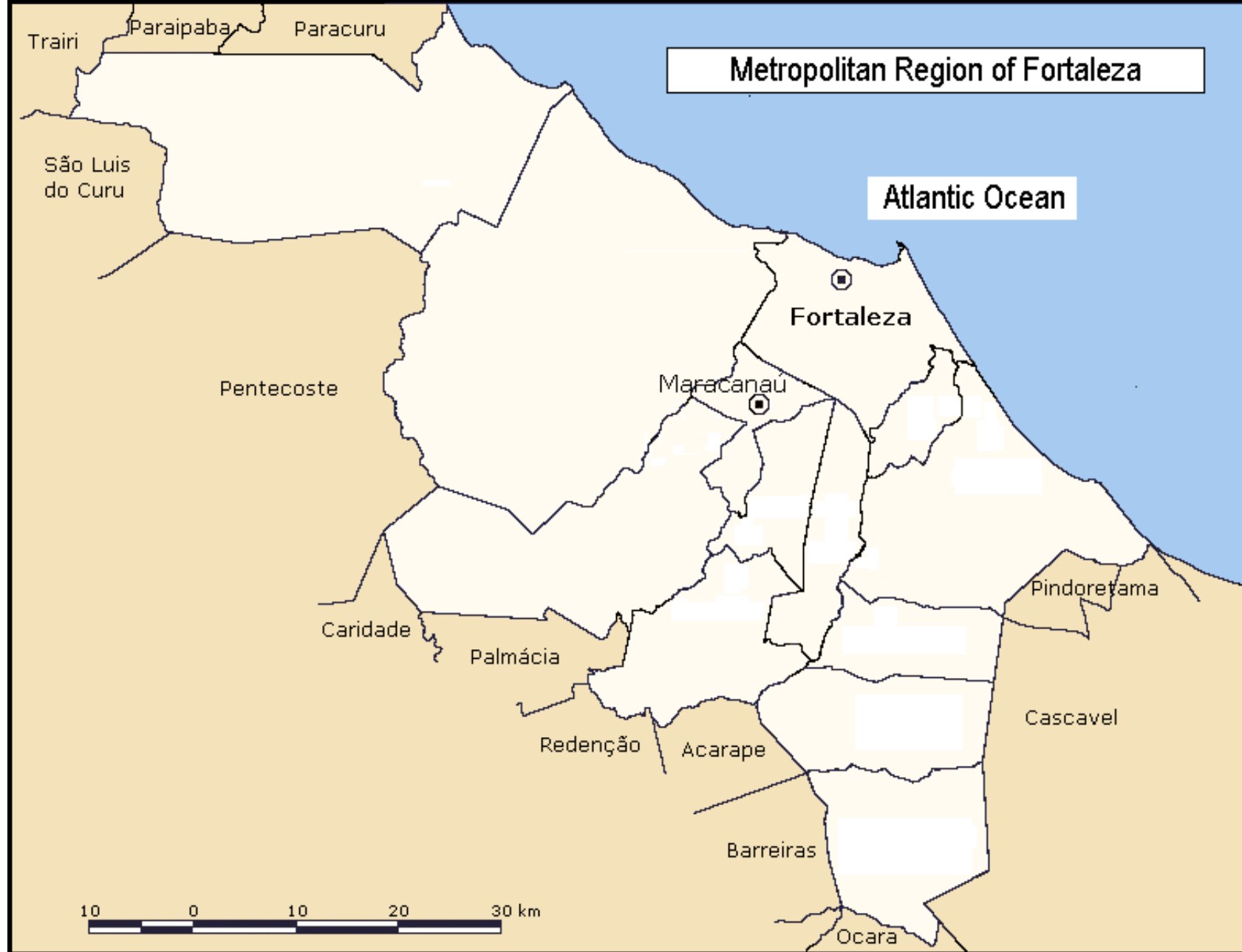
## Introduction

- Mixture of industrial wastewater with domestic type favors the biological treatment
- Anaerobic ponds are especially advantageous in the treatment of strong wastes (BOD and TSS > 300 mg/L)
- Organic chemicals may not be properly degraded under anaerobic conditions, but they are able to transform via combination of biotical and abiotical reactions into less toxic pollutants

- Methane fermentation is the rate-limiting step and methanogenic bacteria are sensitive to pH and alkalinity changes
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- Therefore, pH control is important for an adequate completion of anaerobic digestion and extreme values cause malfunction with increasing of sludge accumulation and decreasing of organic material removal
- A WSP system (AP + SFP + 3 MP) was commissioned in 1992 to treat the effluent from 56 industries and 7 housing estates in Maracanaú, Northeast Brazil
- The textile sector was the dominant industrial activity with 27 enterprises
- The present investigation has focus on the treatment of this predominantly alkaline wastewater in a full-scale anaerobic pond

# Methodology

- AP of the Maracanaú treatment plant (SIDI – Pond Plant)  
3°52'57" S, 38°37'35" W, 45 m a.m.s.l.
- Vol. = 126,600 m<sup>3</sup>; d = 4 m; W/L = 1:35
- Monitoring: 13 months, June/97 to June/98, weekly
- Grab samples at 10:00 am
- Parameters: BOD/BOD<sub>f</sub>, COD/COD<sub>f</sub>, TP, TAN NO<sub>3</sub><sup>-</sup>, TSS, SO<sub>4</sub><sup>2-</sup>, S<sup>2-</sup>, pH, and temperature
- Monthly: total Fe, Cu, Zn, Ni, Cr, Pb and Cd
- Recommendations of Pearson *et al.* (1987) and the analytical procedures by APHA (1992)
- Flow rate measurements: pumping stations PS1 and PS2

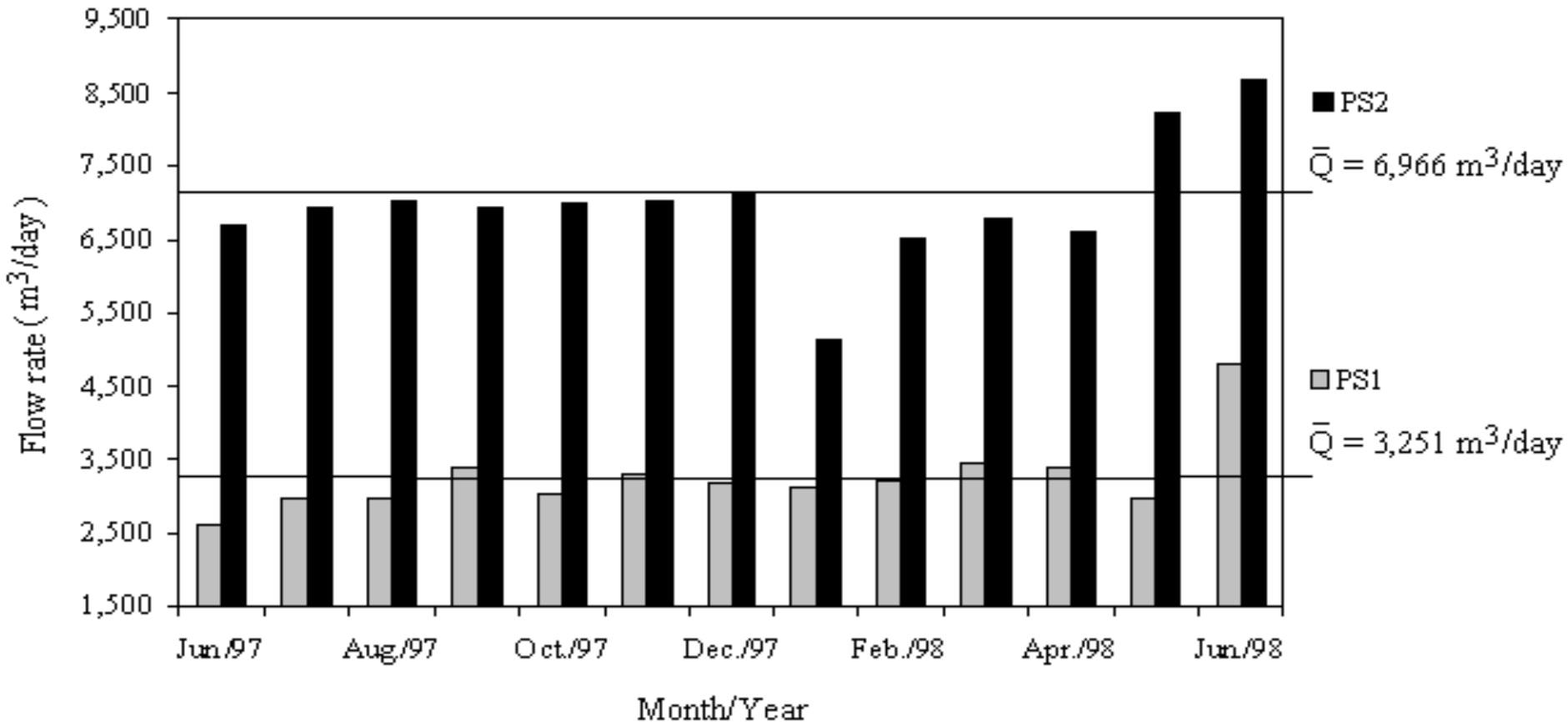


# SIDI – Pond plant



# Results and Discussion

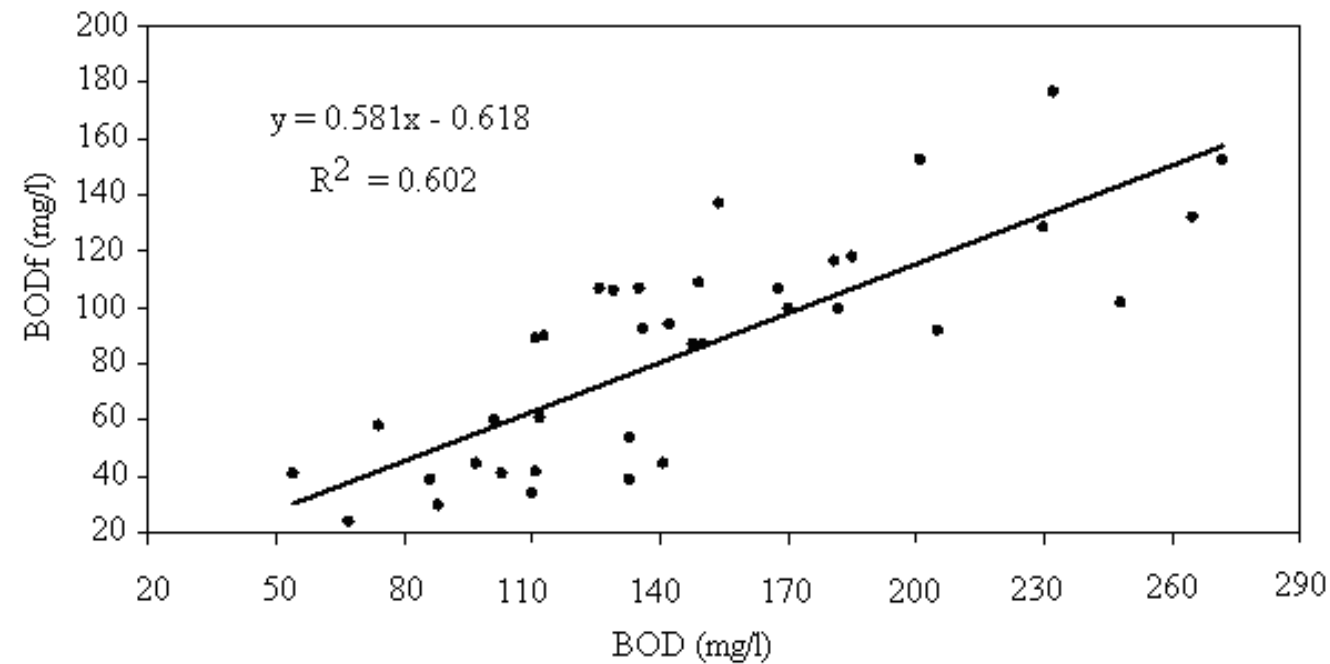
About 2/3 of the influent came from PS2 which had mainly industrial wastewater  
Mean flow rate around 7,000 m<sup>3</sup>/day . Average HRT of 12.6 days (116 litres/s ± 14)



- 30% of the samples had pH > 9.0
- Cotton dyeing and finishing textiles require large amounts of alkali salts (Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup> and Ca<sup>2+</sup>) for bleaching and washing
- The pH of the AP effluent was one unit above the neutral
- BOD and COD removal was about 60%
- This was a little less than findings of Silva *et al.* (1996) treating domestic wastewater (from 68 to 80%) in a temp. of 26.0° C, and HRT from 0.8 to 6.8 days
- The predominance of an alkaline industrial effluent with pH near 9.0 did not affect significantly pond performance

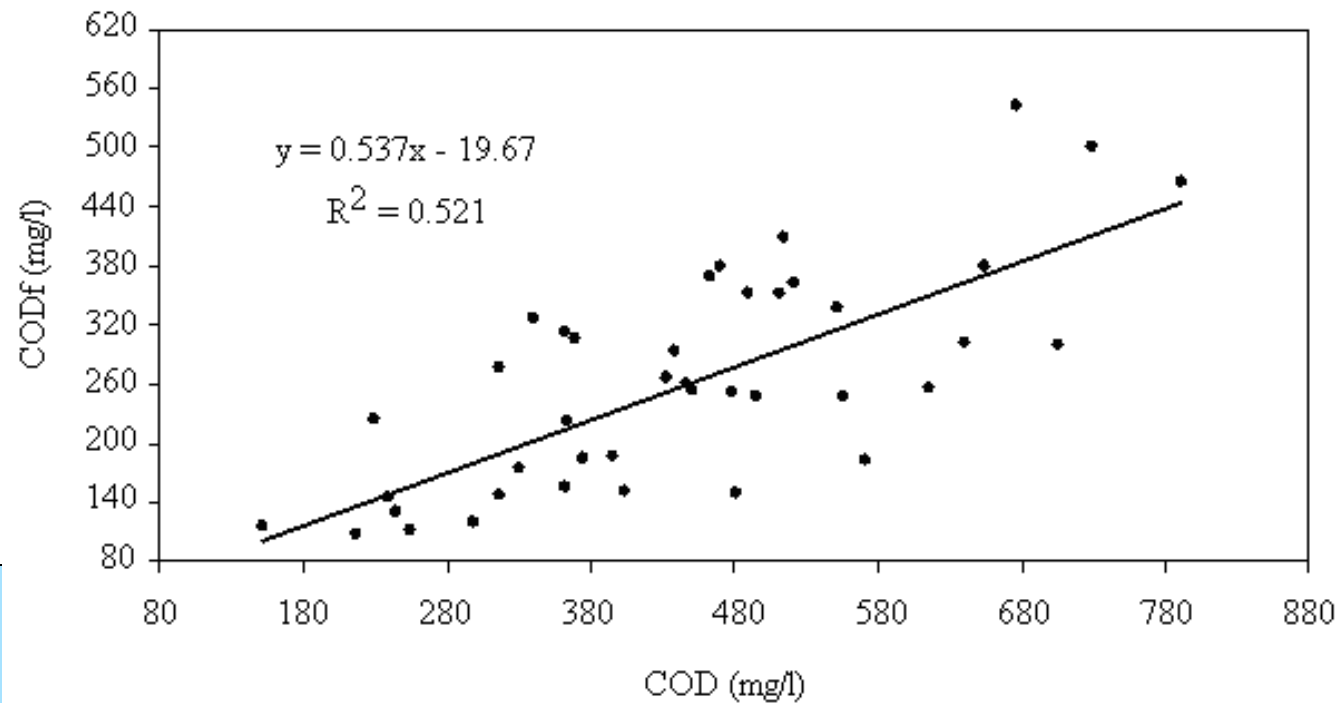
Table 1. Characteristics of the influent and effluent anaerobic pond of the Maracanaú system.

<i>Parameter</i>	<i>Raw wastewater</i>	<i>Anaerobic pond effluent</i>
	Mean (Min-Max)	Mean (Min-Max)
Temperature (° C)	31.7 (27.2 – 34.0)	29.3 (26.4 - 32.6)
pH (units)	8.75 (7.03 - 11.11)	7.99 (7.57 - 8.45)
BOD (mg/l)	373 (150 – 997)	147 (67-272)
COD (mg/l)	1,112 (371 – 3,572)	452 (18-177)
BOD <sub>f</sub> (mg/l)	163 (42 – 301)	87 (166-762)
COD <sub>f</sub> (mg/l)	348 (30 – 826)	266 (75-542)
TAN (mg N/l)	32.41 (12.00 - 68.00)	51.84 (22.50 - 88.80)
NO <sub>3</sub> <sup>-</sup> (mg N/l)	0.41 (0.02 – 3.94)	0.37 (0.01 - 1.48)
TP (mg P/l)	6.40 (1.93 - 11.12)	6.15 (3.87 - 9.45)
TSS (mg/l)	305 (24 – 777)	55 (17 – 91)
SO <sub>4</sub> <sup>2-</sup> (mg SO <sub>4</sub> <sup>2-</sup> /l)	134.53 (26.08 - 329.79)	85.3 (16.1 - 231.6)
S <sup>2-</sup> (mg S/l)	2.19 (0.06 - 13.05)	9.20 (1.35 - 22.10)



**BOD x BODf**

**COD x CODf**



- The wastewater blend provide nutrient balance Literature suggest ratios of COD:N:P of 250:5:1 for anaerobic treatment (e.g. MetCalf & Eddy, 1991; Henze *et al.* 1997)
- TAN was higher in the effluent than in the influent ( 60%) due to ammonification
- TP was virtually the same in the influent
- Sulphur compounds showed conversed results (as  $\text{SO}_4^{2-}$  decreased 37%,  $\text{S}^{2-}$  increased 320%)
- COD/sulphate-sulphur ratio exceeded 2.7 and acetotrophic methanogenic bacteria (AMB) predominate over sulphate-reducing bacteria (SRB) in competition for acetate. The balance between AMB and SBR is favored by sulphate reduction

- Metal concentrations in the influent were not too high for a wastewater with high industrial content
- Dilution effect and industrial contributions with low metal content caused the results
- Metal removal can be attributed mainly to the formation of sulphide insoluble complexes which precipitate and take part in the sediment
- Also, high pH may contribute to complex formation and precipitation (Tünay and Kabdasli, 1994)

**Table 3.** Metal concentration and removal in the anaerobic pond effluent of the Maracanaú system.

<i>Parameter</i>	<i>Metal concentration (<math>\mu\text{g/L}</math>)</i>						
	Fe	Cu	Zn	Ni	Cr	Pb	Cd
Mean	2,794	33	745	19	13	29	7
Median	1,996	32	150	17	12	21	6
Min - Max	1,326 - 6,270	20 - 67	71 - 5,583	1 - 59	1 - 31	13 - 83	1 - 17
$\sigma$	1,633	12	1,624	16	10	20	5
Removal (%)	79.0	60.8	95.3	64.1	71.9	87.3	67.5

# Conclusions

- The AP of Maracanaú treated a flow rate of 116 l/s ( $\pm 14$ ) of a mixture of industrial and domestic wastewater with characteristics similar to textile effluent
- Removal of BOD and COD, was around 60% and 77% for filtered samples
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- TSS removal was 82% due to settling (similar to domestic wastewaters)
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- The alkaline influent contributed to a high pH (8.0) in the bulk liquid of the pond
- This did not affect pond performance but may have impact on sludge digestion and accumulation
- Textile effluent can be properly treated in anaerobic ponds if blended with domestic wastewater

- The ammonification process caused an increase in the total ammonia concentration in the pond effluent
- There was also increase in sulphide concentrations due to bacterial sulphate reduction and organic sulphur compounds
- TP and nitrate concentrations were about the same observed in the influent
- Metal concentration in the influent was low compared to usual industrial wastewaters
- Metal removal in the anaerobic pond varied from 61 to 87% for the selected metals in the study
- Removal was probably due to the formation of sulphide complexes followed by precipitation and immobilization in the sediment.