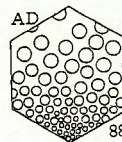


Removal of pathogenic micro-organisms from UASB reactor effluent by chlorination



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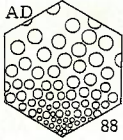
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SUMMARY

The treatment of domestic sewage by UASB reactors does not remove pathogens efficiently. Chlorination of the effluent was tested with a system consisting of three contact tanks in series. Hydraulic retention times were 20, 40 and 60 minutes and NaClO was applied at dosages of 5 and 15 mg Cl₂/l. It was concluded that, at test conditions, application of 15 mg Cl₂/l and 20 minutes contact time will allow discharging the effluent to receiving waters.

INTRODUCTION

Brazil is a country that stands out extremely bad living conditions and no sewerage at all. 1980's National Census reported that only 28% of the houses had sewerage (without sewage treatment however), 16% had septic tanks, 29% had latrines and 22% didn't have any kind of excreta disposal. As a consequence, public health status is one of the worst in Latin America, prevailing high mortality and morbidity rates. There is an urgent need for appropriate low cost sanitation technologies and sewage anaerobic treatment may partly satisfy this necessity. These technologies, however, must accomplish its fundamental role which is to protect public health. In other words, it's essential to remove



pathogens. CETESB, the environment protection agency for São Paulo State is working on UASB reactor application for domestic sewage. Post treatment studies look for alternatives for disinfection. This poster presents the results obtained with chlorination.

MATERIALS AND METHODS

The chlorination system used consisted of three contact tanks in series with a net capacity of 80 liters each. Figure 1 shows a schematic diagram. Each

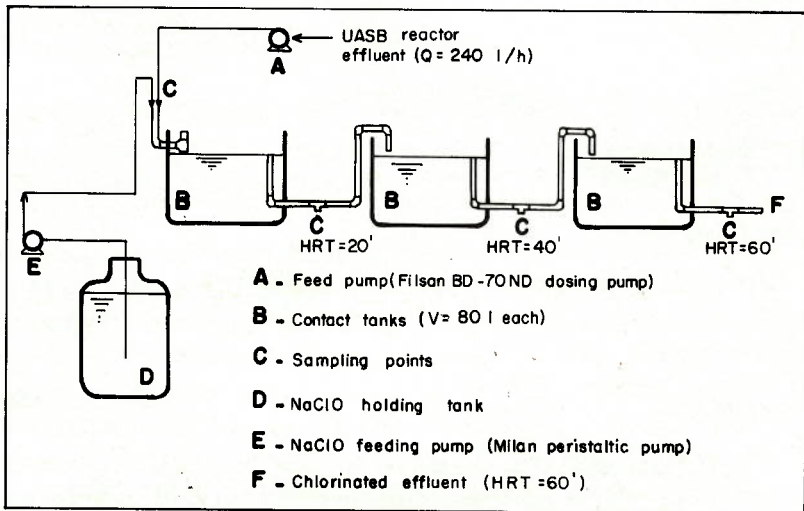


Figure 1- Schematic diagram of the chlorination system

Table 1- UASB effluent and chlorinated effluents average results at 5 mg Cl₂/l dosage

Parameter	UASB reactor effluent	5 mg Cl ₂ /l dosage		
		HRT= 20'	HRT= 40'	HRT= 60'
pH	6.4	6.4	6.5	6.6
Total BOD ₅ (mg/l)	51	53	47	43
Total COD (mg/l)	126	146	152	119
Tot. susp. solids (mg/l)	45	38	42	33
Total coliforms*	1.73x10 ⁷	0.64x10 ⁷	0.64x10 ⁷	5.25x10 ⁶
Fecal coliforms*	3.33x10 ⁶	0.92x10 ⁶	0.92x10 ⁶	0.71x10 ⁶
Fecal streptococci*	1.48x10 ⁶	1.48x10 ⁶	0.51x10 ⁶	0.87x10 ⁶
<i>C. perfringens</i> *	6.05x10 ⁴	6.10x10 ⁴	6.32x10 ⁴	3.03x10 ⁴
<i>Salmonella</i> sp.	present	rare	rare	rare
Coliphages**	1.45x10 ⁵	6.98x10 ⁴	5.10x10 ⁴	4.89x10 ⁴
Parasites (nº/500 ml)	2	absent	absent	absent

* MPN/100 ml

** PFU/100 ml

HRT = hydraulic retention time

Table 2- UASB effluent and chlorinated effluents average results at 15 mg Cl₂/ℓ dosage

Parameter	UASB reactor effluent	15 mg Cl ₂ /ℓ dosage					
		HRT = 20'		HRT = 40'		HRT = 60'	
		effluent	% remov.	effluent	% remov.	effluent	% remov.
pH	6.6	6.7	-	6.7	-	6.8	-
Total BOD ₅ (mg/ℓ)	35	29	17	28	20	26	26
Total COD (mg/ℓ)	113	105	7	107	5	91	19
Total susp.solids (mg/ℓ)	48.	27	44	28	42	22	54
Turbidity (N.T.U.)	17	21	-	21	-	20	-
Colour (mg Pt/ℓ)	33	35	-	33	-	36	-
Surfactants (mg/ℓ)	3.79	3.74	-	3.88	-	4.02	-
Sulfides (mg S/ℓ)	0.64	0.44	31	0.51	20	0.49	23
Total nitrogen (mgN/ℓ)	39	38	-	38	-	38	-
Ammon.nitrogen (mgN/ℓ)	29	28	-	28	-	26	-
Total phosphorus (mgP/ℓ)	4.36	4.51	-	4.83	-	4.69	-
Chloroform (µg/ℓ)	traces	1.5	-	2.5	-	2.0	-
Total coliforms (MPN/100mℓ)	1.28x10 ⁷	0.88x10 ³	99.993	0.28x10 ³	99.998	0.11x10 ³	99.9991
Fecal coliforms (MPN/100mℓ)	3.27x10 ⁶	0.23x10	99.9999	0.20x10	99.9999	0.23x10	99.9999
Fecal streptoc. (MPN/100mℓ)	1.70x10 ⁶	0.58x10	99.9997	0.23x10	99.9999	0.49x10 ²	99.997
<i>C.perfringens</i> (MPN/100mℓ)	3.84x10 ⁵	6.25x10 ⁴	84	7.82x10 ⁴	80	9.40x10 ⁴	76
<i>Salmonella</i> sp.	rare	absent	-	absent	-	absent	-
Coliphages (PFU/100mℓ)	1.08x10 ⁵	2.97x10 ³	97	1.18x10 ³	99	7.85x10 ²	99
Parasites (n♀/500mℓ)	2.5	absent	-	absent	-	absent	-

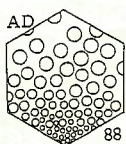
HRT = hydraulic retention time

tank was baffled into ten compartments to allow a flow pattern similar to plug flow. The effluent for disinfection was provided by a 120 m³ UASB reactor running with raw domestic sewage. Hydraulic retention times (HRT) were 20, 40 and 60 minutes and sodium hypochlorite was applied at dosages of 5 and 15 mg Cl₂/ℓ. UASB reactor effluent and NaClO were mixed at the entry of the first contact tank. The system was operated for 2.5 months, from 8:00 am to 15:30 pm and composite samples were taken from noon to 15:00 pm. After daily operation the unit was washed with water. Samples preservation procedures and analytical methods were according to Standard Methods for the Examination of Water and Wastewater (1985), except for parasitologic analyses (Faust method).

RESULTS AND CONCLUSIONS

Analyzed parameters and average results are shown on Table 1 (5 mg Cl₂/ℓ) and Table 2 (15 mg Cl₂/ℓ). Chlorination was inefficient at 5 mg Cl₂/ℓ dosage. Nevertheless, a suspended solids removal of 7-27% was observed, probably due to sedimentation inside the contact tanks.

At 15 mg Cl₂/ℓ a small removal of total COD (5-19%) and total BOD₅ (17-26%) was observed and no removal of turbidity, colour, surfactants and nutrients was noticed. Sulfides were removed by 20-31% and total suspended solids by 42-54% (probably part of the removal due to settling). Chloroform formation was negligible (1.5-2.5 µg/ℓ). Total coliforms survival in the chlorinated effluent ranged from 110 to 880 MPN/100mℓ (removals of 99.993% to 99.999%). Fecal coliforms ranged from 20 to 23 MPN/100 mℓ (99.9999% removal) and fecal streptococci survival was 2.3-49 MPN/100 mℓ (99.997% to 99.9999% removal). *Clostridium perfringens*, a spore-



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forming persistent bacterium, survived well the disinfection (6.25×10^4 - 9.40×10^4 MPN/100 ml in the effluent, 76-84% removal). It was observed also a fair removal of coliphages (97-99%, survival of 785-2970 PFU/100 ml). *Salmonella sp.* was absent in the disinfected effluent and it was noticed no eggs and larvae of helminths and protozoa cysts after chlorination. As a matter of fact, parasites were well removed in the UASB reactor itself.

It was concluded that, at test conditions, the application of 15 mg $\text{Cl}_2/\%$ and 20 minutes contact time will allow discharging the disinfected effluent to receiving waters. It is suggested reducing suspended solids levels before chlorination.

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TREATMENT OF ANAEROBIC EFFLUENTS
