

Smallwat11

3rd INTERNATIONAL CONGRESS

Sevilla, Spain April 25th to April 28th, 2011

HELMINTH OVA REMOVAL USING UASB REACTORS AT 4°C

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Introduction

- Helminth ova are **not very susceptible** for chemical disinfection or physico-chemical units like UV lamps.
- Helminth ova **are persistent** in agricultural fields.
- Owing to their relatively **large size** (20-100 μm) adequate removal can be attained by **filtration or settling**.
- However, their **different sizes, shapes** and physical properties, **complicate** the design of **compact** physical removal **units**.

Objective

- In this research we studied the **filtering capacity** of a UASB reactor for the **worm eggs** under varying **operational conditions**.

Material and Methods

- **Two sets** of experiments were done in order to study helminth ova removal :
 - Exp.1: **latex beads**, simulating helminth ova were used in clarified wastewater from Bennekom (The Netherlands).
 - Exp.2: **real eggs**. This experiment was done in the Research Center for Wastewater Treatment and Dangerous Solids (CITRARUNI) from the National University of Engineering-UNI (Lima-Peru)
- In order to only study the sludge filtration capacity, **biogas production was minimised** by performing all experiments at **4°C**.
- In both experiments the effect of the **upflow velocity** was studied. The **effect of the presence of sludge** and the **sludge volume** was studied in **Exp.1**

Material and Methods

Source of Inoculum

Exp. 1: **Digested primary sludge** of sewage treatment plant Bennekom, The **Netherlands**.

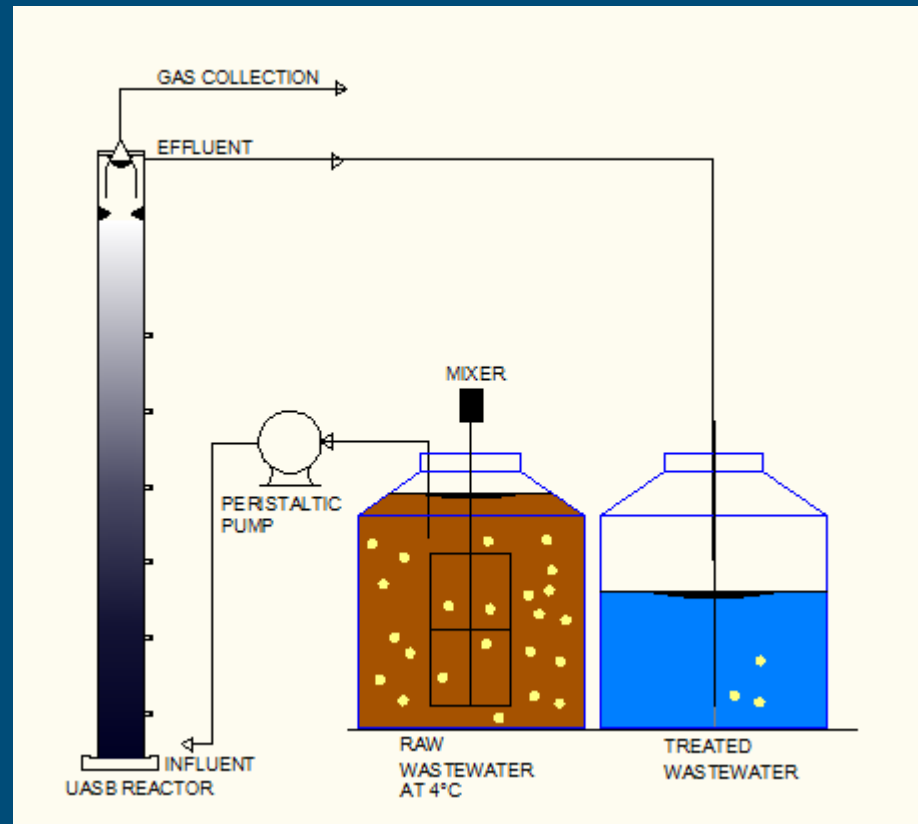
TSS: 52 g.L⁻¹

VSS: 33 g.L⁻¹.

Exp. 2: Excess sludge pilot-scale **UASB reactor** located at CITRARUNI, Lima **Peru**.

TSS: 283 g.L⁻¹

VSS: 254 g.L⁻¹



Biogas production was minimised by performing all experiments at 4°C.

Material and Methods

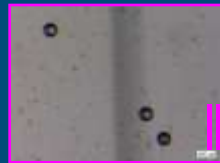
EXPERIMENT 1



Clarified wastewater from Bennekom

Particle 's characteristics:

- Latex beads Coulter® CC Size standard
- density of 1.05 mg/L
- L90: $\varnothing = 90 \mu\text{m}$



Source of wastewater containing latex beads were kept in a storage tank at 4°C before entering to reactors



Reactors

Material and Methods



Reactors

EXPERIMENT 2

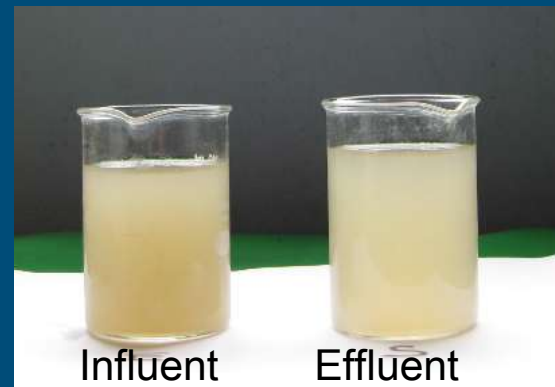


Source of wastewater containing real eggs were kept in a storage tank at 4°C



Ascaris lumbricoides

Source: Blanca Jimenez, Atlas of Medical Parasitology



Influent

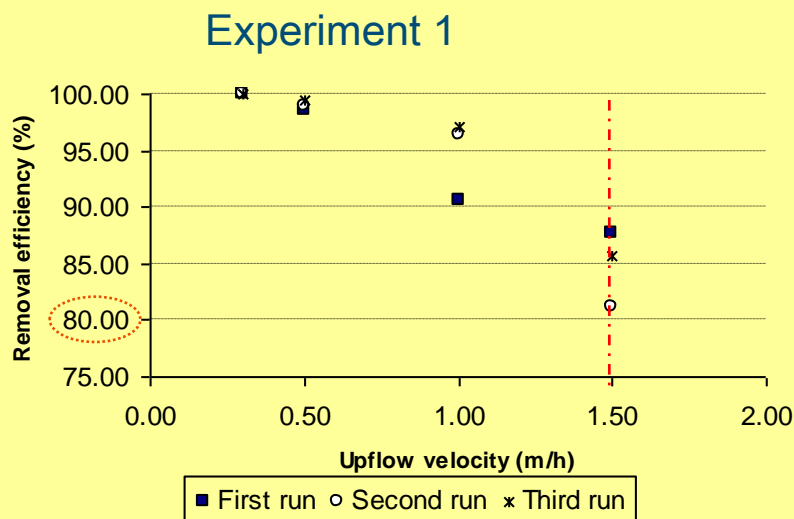
Effluent

Material and Methods

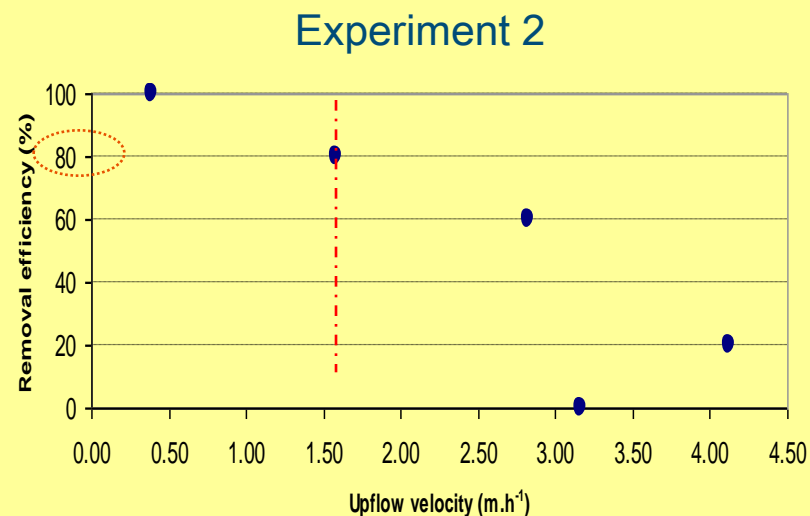
- For helminth ova analysis, the flotation method described by Ockert and Teichmann, WHO, IT-778, Geneva, 1989 was used.
- Total Coliforms were determined according to the Standard Total Coliform Fermentation Technique, Faecal coliforms were analysed according to the Faecal Coliform Procedure, (APHA,2005).
- Lab analysis of Total solids and volatile solids were performed according to Standard Methods (APHA,1998).
- Density of sludge was measured using a Gay-Lussac-Pycnometer of 24.822 ml (LMS, Germany). Viscosity of the sludge was studied using a viscometer FANN model 32, USA using a speed of 600rpm.

Results

- No significant effect was observed for different sludge volumes.
- At upflows exceeding $1.5 \text{ m}\cdot\text{h}^{-1}$, the presence of a sludge bed led to a 5% increase in removal efficiency compared to a control reactor with only clarified wastewater as medium.
- Exp.1 and Exp2 show a negative relation between the applied upflow velocity and Helminth ova removal efficiency. For upflow velocities less than 1.5 m/h the achieved helminth ova removal will be higher than 80%.



Latex beads removal efficiency as a function of the upflow velocity.



Helminth ova removal efficiency as a function of the upflow velocity . Tested upflow velocities were 0.39, 1.58, 2.83, 3.16 and 4.12 $\text{m}\cdot\text{h}^{-1}$ respectively.

Results

Table 1 Results of the experiment 2 using helminth ova conducted at CITRARUNI.

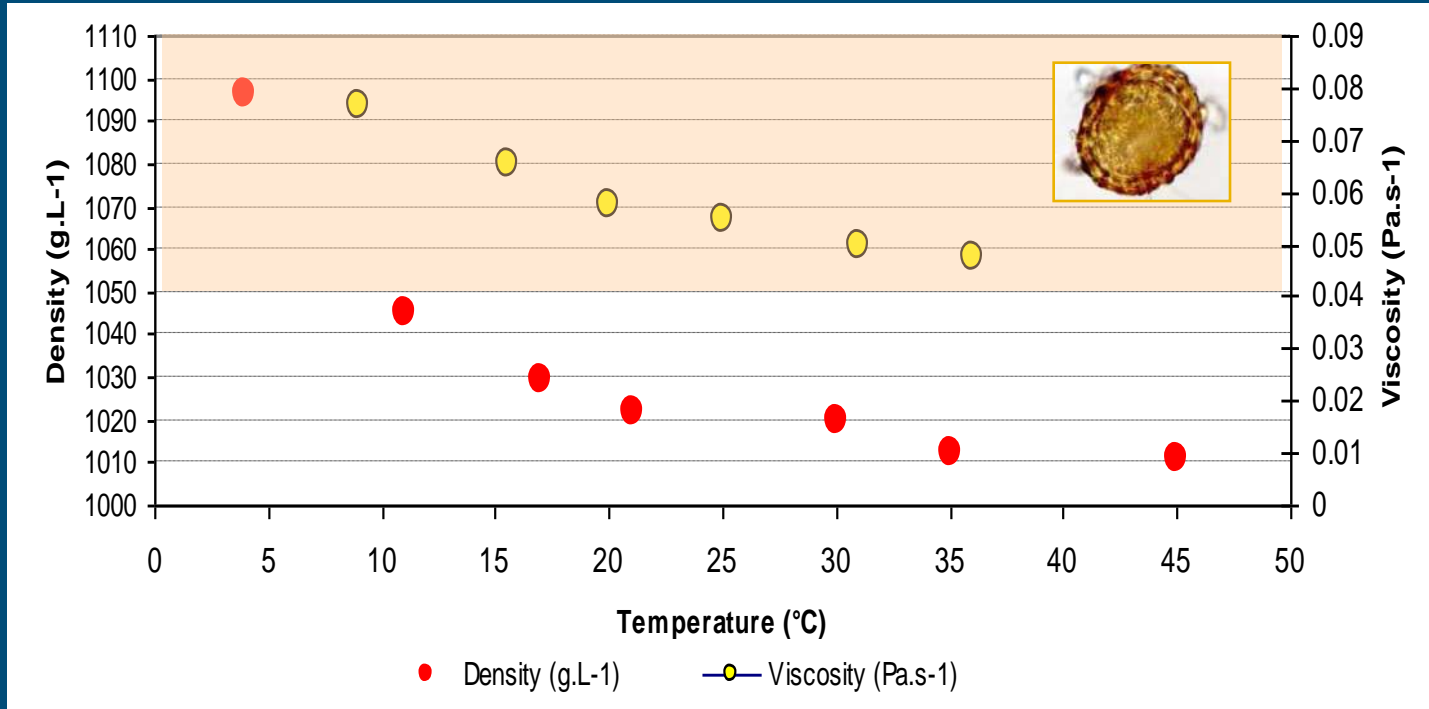
Flow	UV (*)	Helminth ova			COD		Faecal Coliforms		Total Coliforms	
		I	E	Name	I	E	I	E	I	E
m ³ /day	m.h ⁻¹	Ova.L ⁻¹	Ova.L ⁻¹		mg.L ⁻¹	mg.L ⁻¹	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL
0.0099	0.39	2	0	T, A	748	400	9.20x10 ⁷	1.60 x10 ⁷	9.20 x10 ⁸	1.60 x10 ⁸
0.0408	1.58	2	2	T,A	748	510	9.20 x10 ⁷	9.20 x10 ⁷	9.20 x10 ⁸	9.20 x10 ⁸
0.0729	2.83	5	2	T,A,S	866	704	5.40 x10 ⁷	3.50 x10 ⁷	5.40 x10 ⁷	5.40 x10 ⁷
0.0815	3.16	5	6	A	1016	641	1.60 x10 ⁷	1.60 x10 ⁷	1.60 x10 ⁸	1.60 x10 ⁸
0.1064	4.12	5	0	T,A,S	866	585	5.40 x10 ⁷	5.40 x10 ⁷	5.40 x10 ⁷	5.40 x10 ⁷

(*): The area of the UASB reactor was $1.075 \times 10^{-3} \text{ m}^2$

UV: Upflow velocity; I: Influent; E: Effluent; R: Removal efficiency; COD: Chemical Oxygen Demand; T: *Trichuris*; A: *Ascaris*; S: *Strongyloides*.

Results

Density and viscosity of the sludge as a function of the temperature

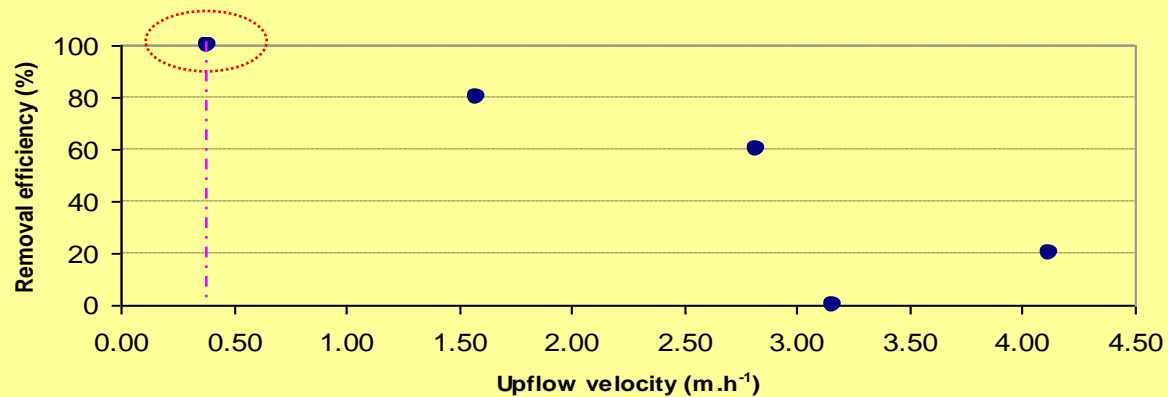


Results

- The **density** of the studied **sludge** of **1096 g.L⁻¹** was **very close** to the **density** of **helminth ova**, which varies between **1060-1150 g.L⁻¹** (Jimenez, 2007). Likely, **helminth ova** and **anaerobic sludge** stay in the **same layer** of the sludge bed in equilibrium with the prevailing conditions. Obviously, such equilibrium is susceptible for changes in upflow velocity, water temperature and helminth ova concentration.
- Lab Results also show that the most common helminth ova present in the wastewater was **Ascaris, Trichuris, and Strongyloides**.
- The efficiency of Total and **Faecal Coliforms** was also analysed during the experiment with helminthes ova. Tested upflow velocities were 0.39, 1.58, 2.83, 3.16 and 4.12 m.h⁻¹ respectively. **No significant efficiency** removal of both microbiological analysis.

Results

- The highest reported efficiency was 100% for an upflow velocity of 0.39 m.h⁻¹ and a HRT of 2.86 hours showing a decrease of one log of the reported value in the influent concentration. Velocities higher than 2.83 m.h⁻¹ showed values below 40%.



Helminth ova removal efficiency as a function of the upflow velocity . Tested upflow velocities were 0.39, 1.58, 2.83, 3.16 and 4.12 m.h⁻¹ respectively.

Conclusions

- Sludge filtration capacity is reciprocally correlated to the upflow velocity as well as to the Helminth ova concentration.
- At upflow velocities below 1.5 m.h^{-1} , about 80% of helminth eggs are removed.
- Removal efficiency of faecal and total coliforms was below 80% in all analysis.

Conclusions

- For complete pathogen removal, the UASB reactor **must be followed by an adequate post treatment** system for treating the possible remainder of helminth eggs and faecal coliforms.
- Adjustment of **hydraulic parameters in UASB** reactors can **significantly improve worm eggs removal**, thereby contributing to a higher cost-efficiency of wastewater treatment and protection of public health in developing countries.

Acknowledgments

- Càtedra UNESCO-Universitat Ramon Llul (**Spain**) supported bacteriological and physicochemical analysis
- Faculty of Environmental Engineering at National University of Engineering (**Peru**) provided the CITRARUNI's lab facilities
- Wageningen University (**The Netherlands**) provided the scholarship to R.E. Yaya Beas.

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