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SMOOTH AND POROUS BIOFILM CARRIERS FOR THE TREATMENT OF LANDFILL LEACHATE

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Introduction

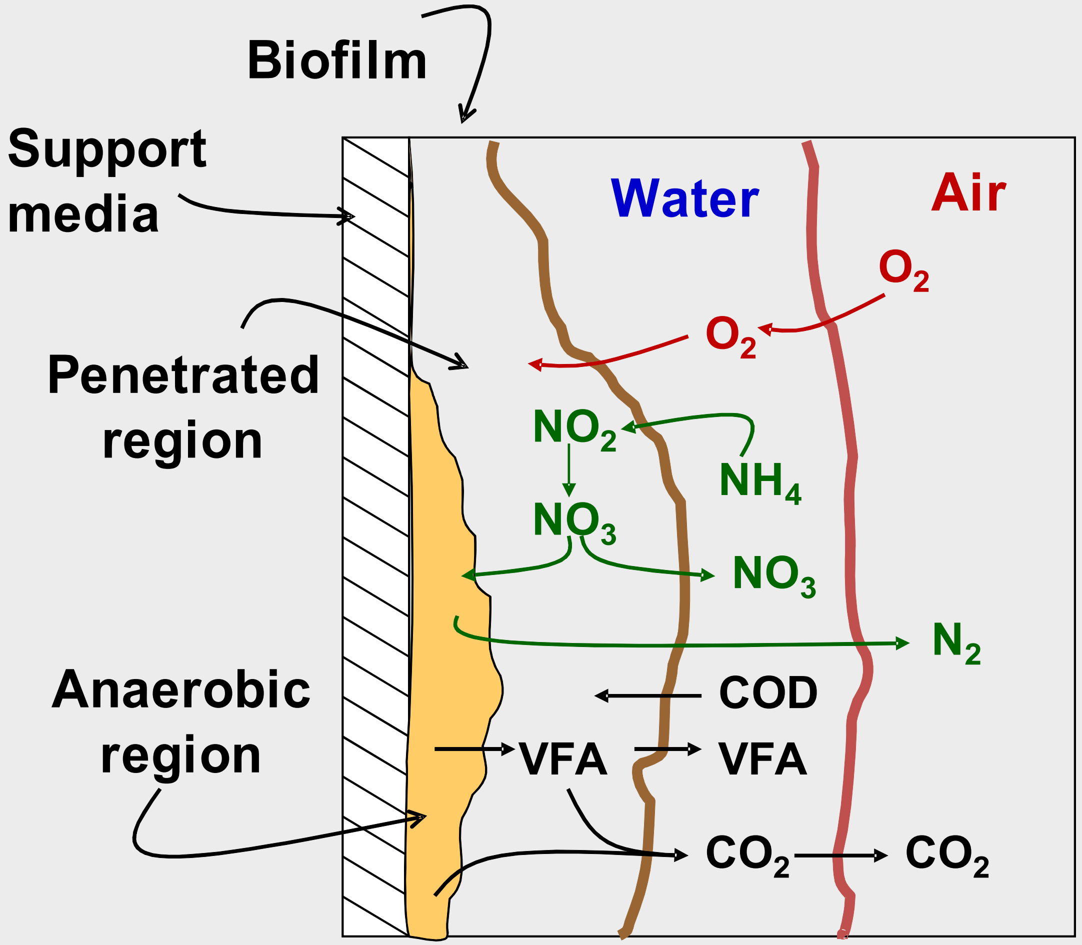
- Biofilms are usual for biological wastewater treatment in small settlements
- Moving bed systems (operated as SBR) are popular
- Attached biofilm systems are also popular and more common than moving bed systems (package plants). STABLE SYSTEMS
- Designers and producers prefer their "own" system based on rough or smooth surfaces
- Biofilms are a subject of discussion:

Thin or thick biofilms are better?

In many countries landfill leachate is treated in conventional wastewater treatment plants mixed with municipal wastewater (Wiszniowski *et al*, 2006)

In the countries members of the European Union, mixing of leachate with wastewater is not allowed mainly because of the presence of recalcitrant organic compounds and other toxic substances (Welander *et al*, 1997; Dollerer and Wilderer, 1996)

Main biofilm transformations



In thicker biofilms more intense anaerobic and anoxic processes are expected

Proposal

Hypothesis

Using a biofilm support that allows the substances to diffuse through the biofilm to deeper layers must have a more diverse microbial community than a shallow one and, while under different oxygen concentrations at different biofilm depths, the treatment of complex substances is better.

Proposal

This work proposes the treatment of landfill leachate combined with wastewater using two different types of biofilm support materials: One with a smooth surface impervious to diffusion through the support media and the other with a porous matrix allowing the nutrients and other substances to diffuse through the biofilm and the support media.

Method

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Method

- Two lab-scale SBR, 8 liter volume each.
- One with polyurethane (plastic foam) sheets and another with high density polyethylene sheets (usual for biofilm growth).
- 8-hour cycles. Fill 4 min, draw 24 min and the rest aerobic reaction.
- Three stages: 1) start-up, 2) operation with synthetic wastewater and 3) operation with synthetic wastewater and leachate.
- Leachate from the landfill “Bordo Poniente”, the largest in Mexico (13.000 ton/d).
- Leachate was added to synthetic wastewater at 0.5, 1.0, 1.5, 2.0, 2.5, and 3.5% in volume.
- Temperature was controlled between 22 and 25 ºC.
- Dissolved oxygen was maintained between 3 and 5 mg/L.
- High density polyethylene sheets 15x15x0.1 cm, roughness factor Ra=1.61 (very smooth).
- Plastic foam (polyurethane) sheets 15x15x0.5 cm, porosity 98% and 575 pores/cm^2
- Total surface area exposed to microorganisms growth 0.42 m^2 in each reactor.

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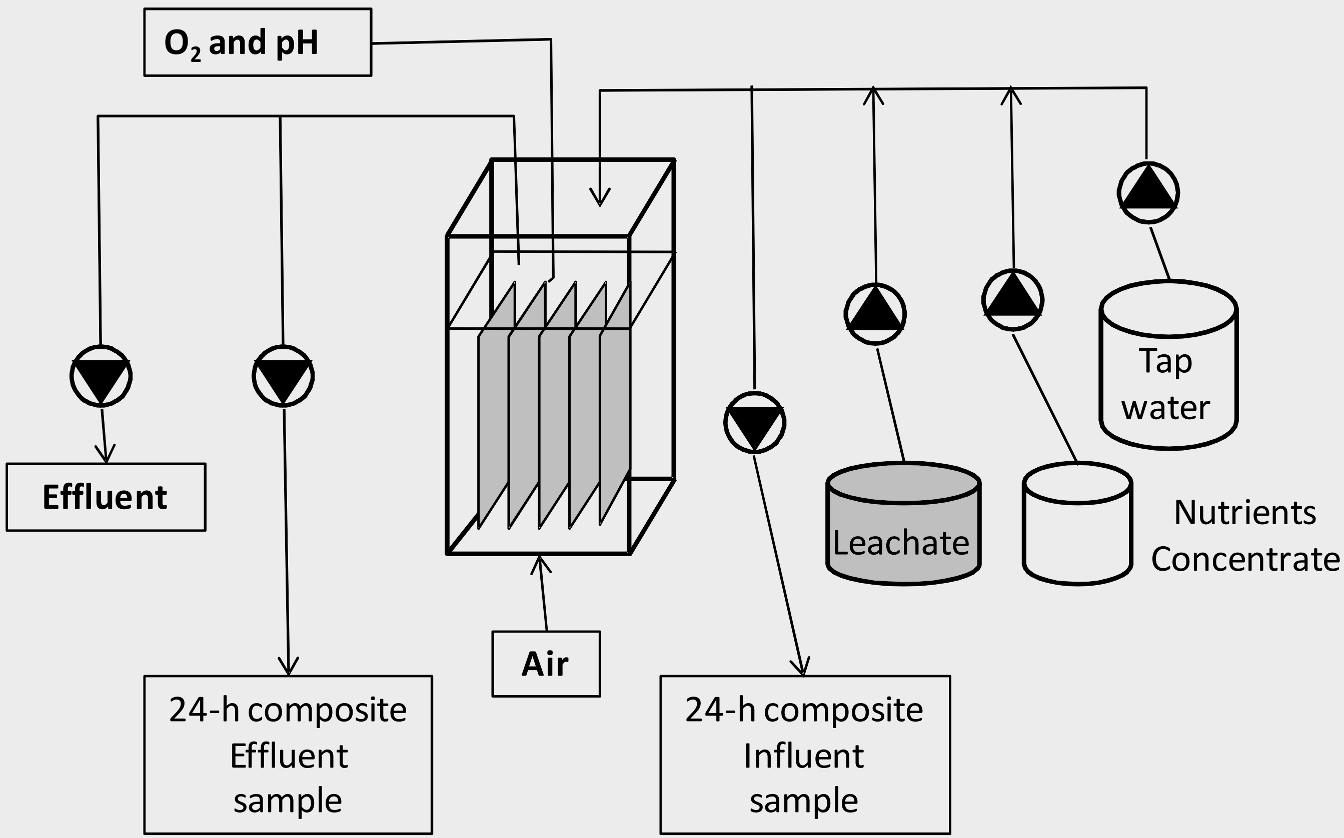
Schematics of the lab reactors



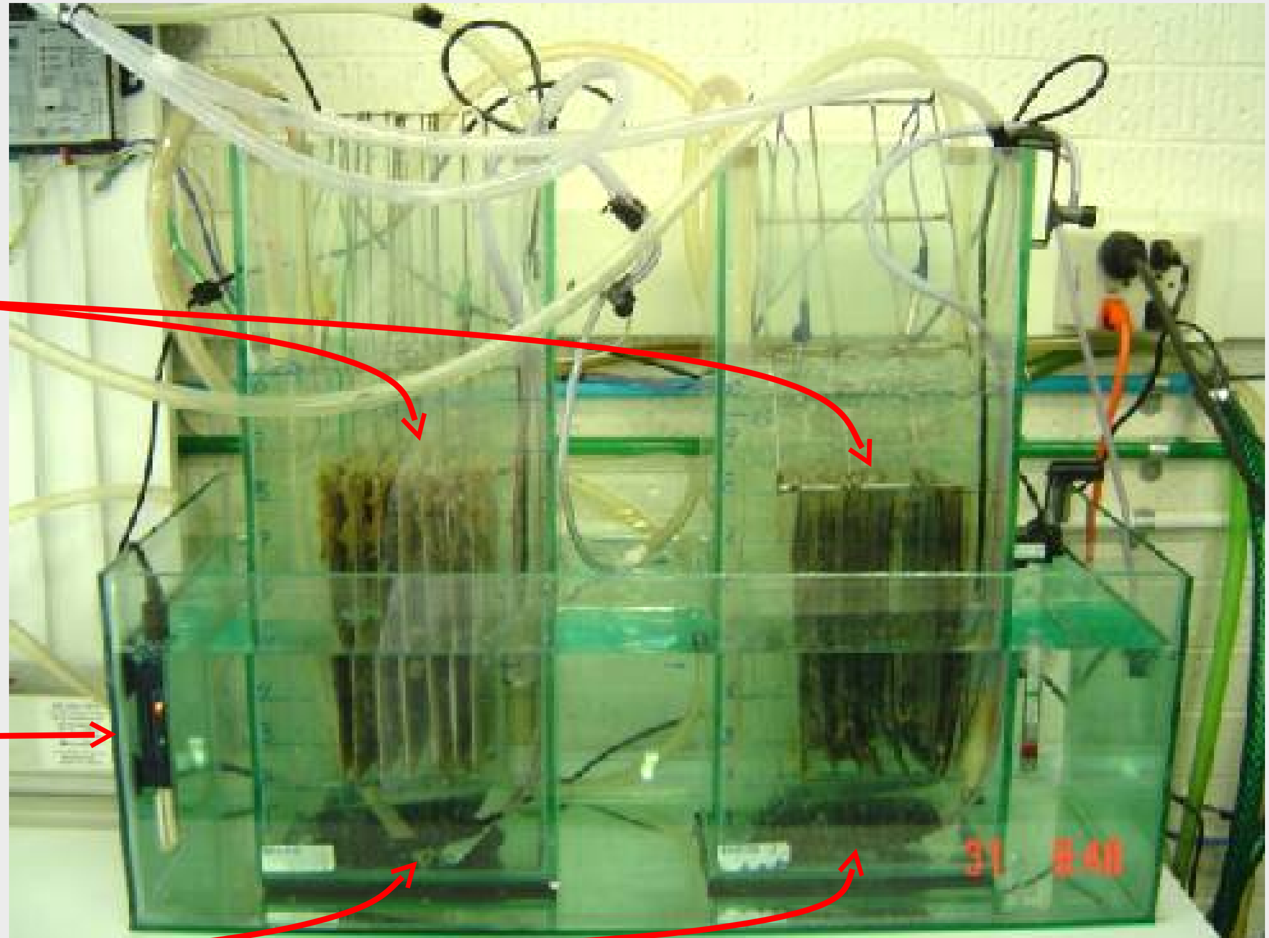
The organic load during the stages 1 (start-up) and 2 was adjusted to 5.5 gCOD/m^2·d in both reactors

The lab-scale reactors

Plastic sheets with biofilm on both sides

Water bath and temperature control

Diffusers



Polyurethane (porous surface)

Polyethylene (smooth surface)

Synthetic wastewater composition

Substance	Concentration
Maltodextrin	50 mgCOD/L
Hydrolyzed vegetal protein	50 mgCOD/L
NH_4Cl	25 mgNH_4-N/L
K_2HPO_4	5 mgPO_4-P/L
Tap water	Trace elements

According to previous experiments, this composition closely resembles municipal wastewater

Leachate characteristics

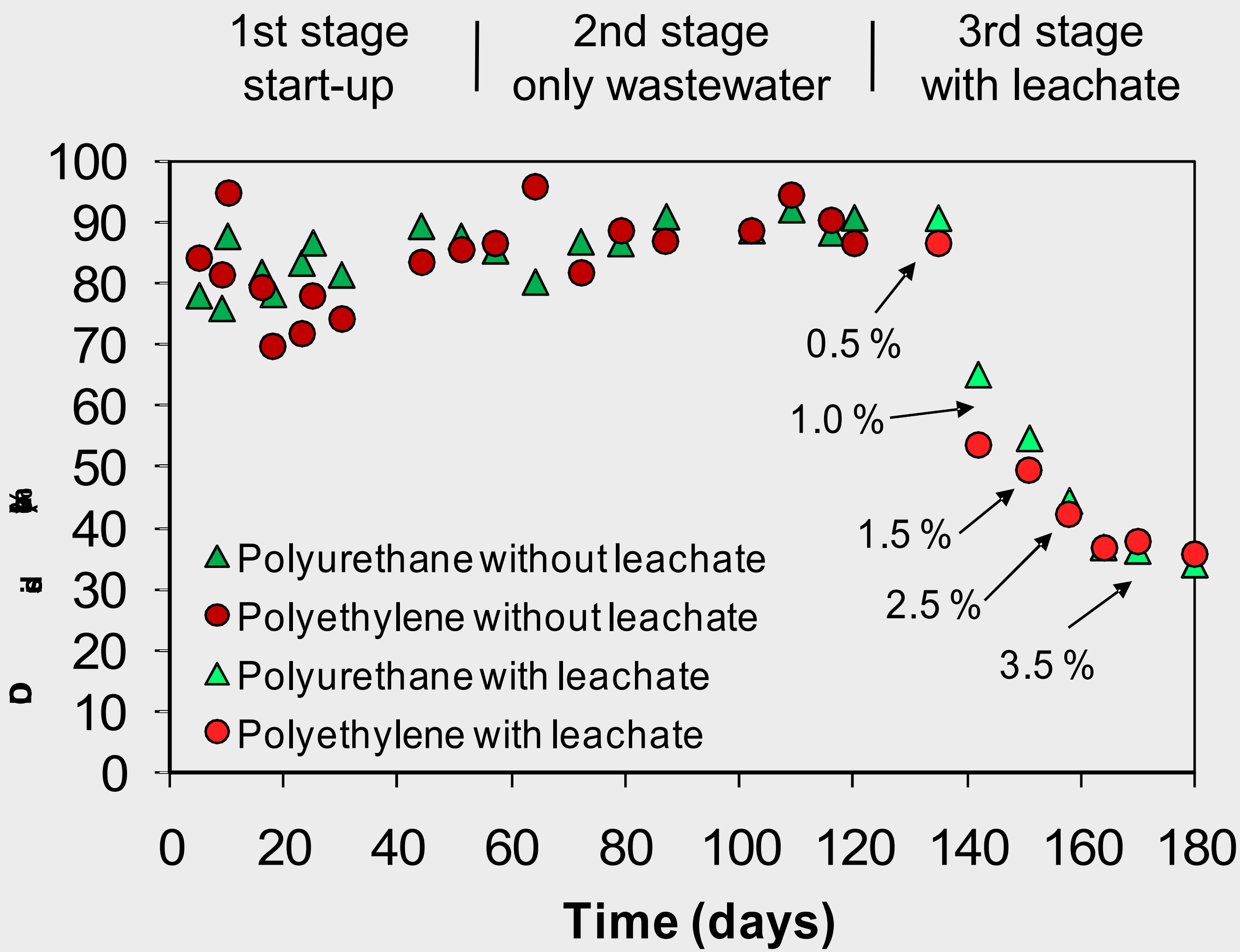
Parameter	Value
pH	8.0 (-)
Hardness as $CaCO_3$	2,200 mg/L
Total alkalinity	18,300 mg/L
COD total	5,500 mg/L
COD dissolved	4,950 mg/L
NH_4-N	2,100 mg/L
Total solids	17,437 mg/L
TSS	85 mg/L
TDS	17,352 mg/L
TVS	4,116 mg/L
BOD	1,300 mg/L
BOD/COD	0.25 (-)

Experimental procedure

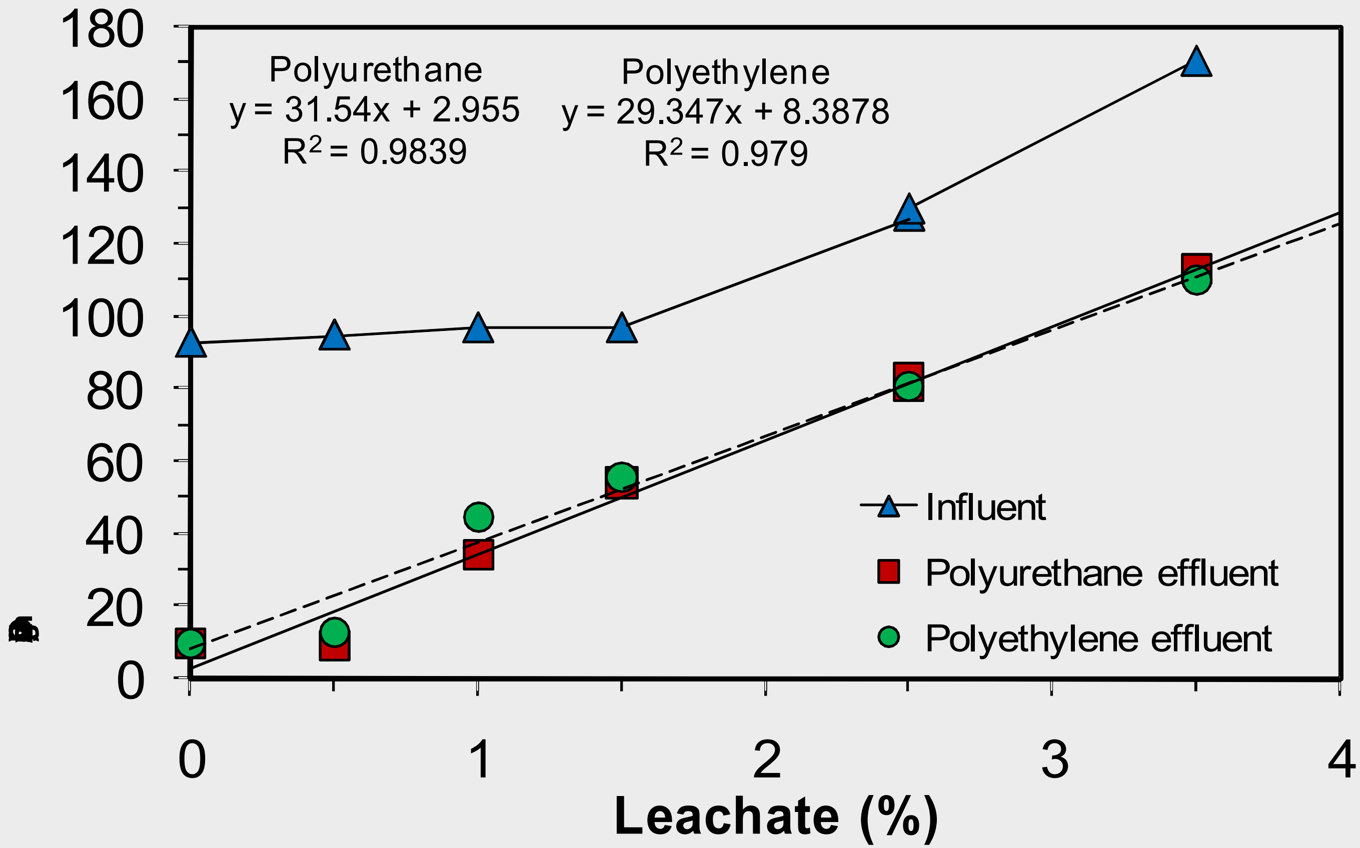
Phase	Leachate (% volume)	Leachate COD (mg/L)	Wastewater COD (mg/L)	Combined COD (mg/L)	Organic load ($gCOD/m^2\cdot d$)
Start-up	0	0	100	100	5.5
2	0	0	100	100	5.5
3	0.5	25	75	100	5.5
	1.0	50	50	100	5.5
	1.5	75	25	100	5.5
	2.5	125	25	150	7.5
	3.5	175	25	200	10.0

Results

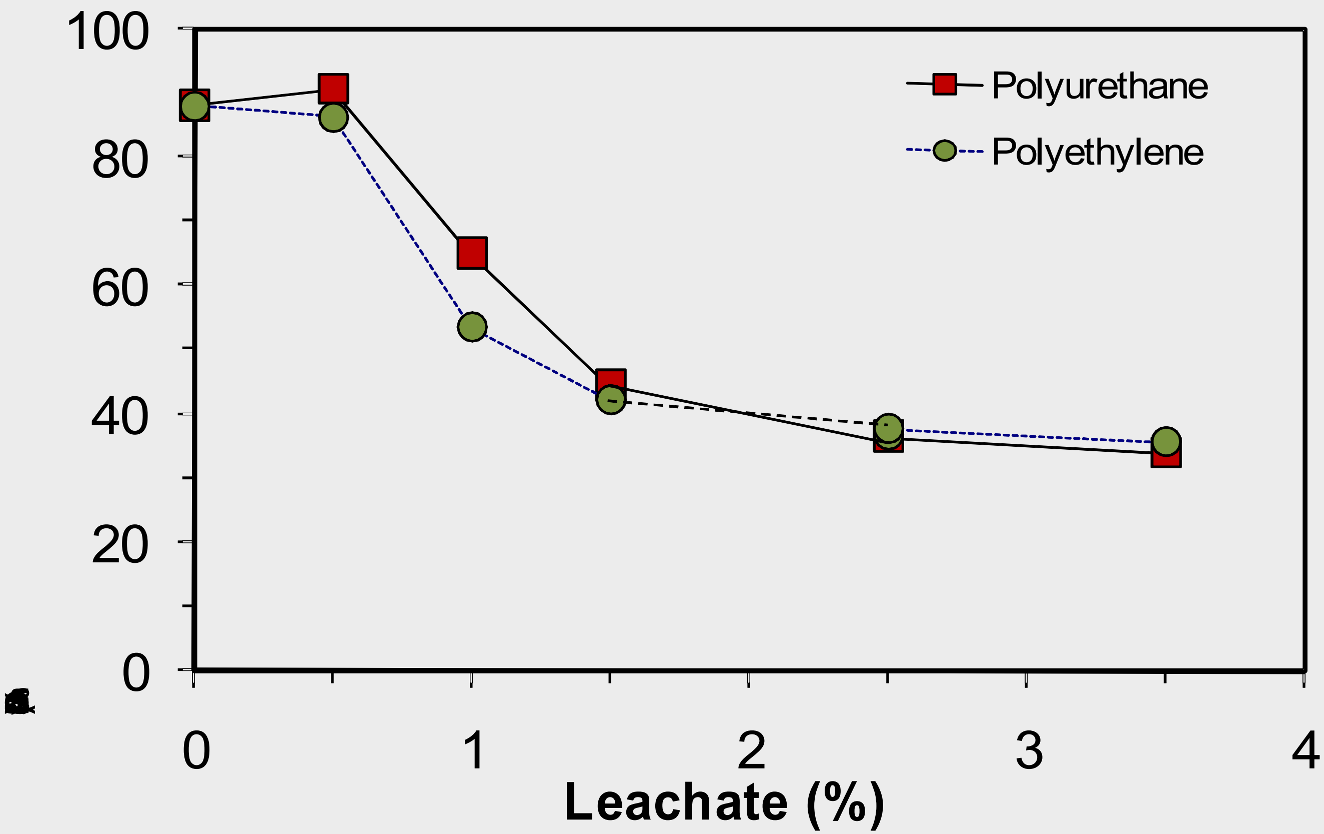
COD removal with time



COD at influent and effluent



COD removal and leachate concentration



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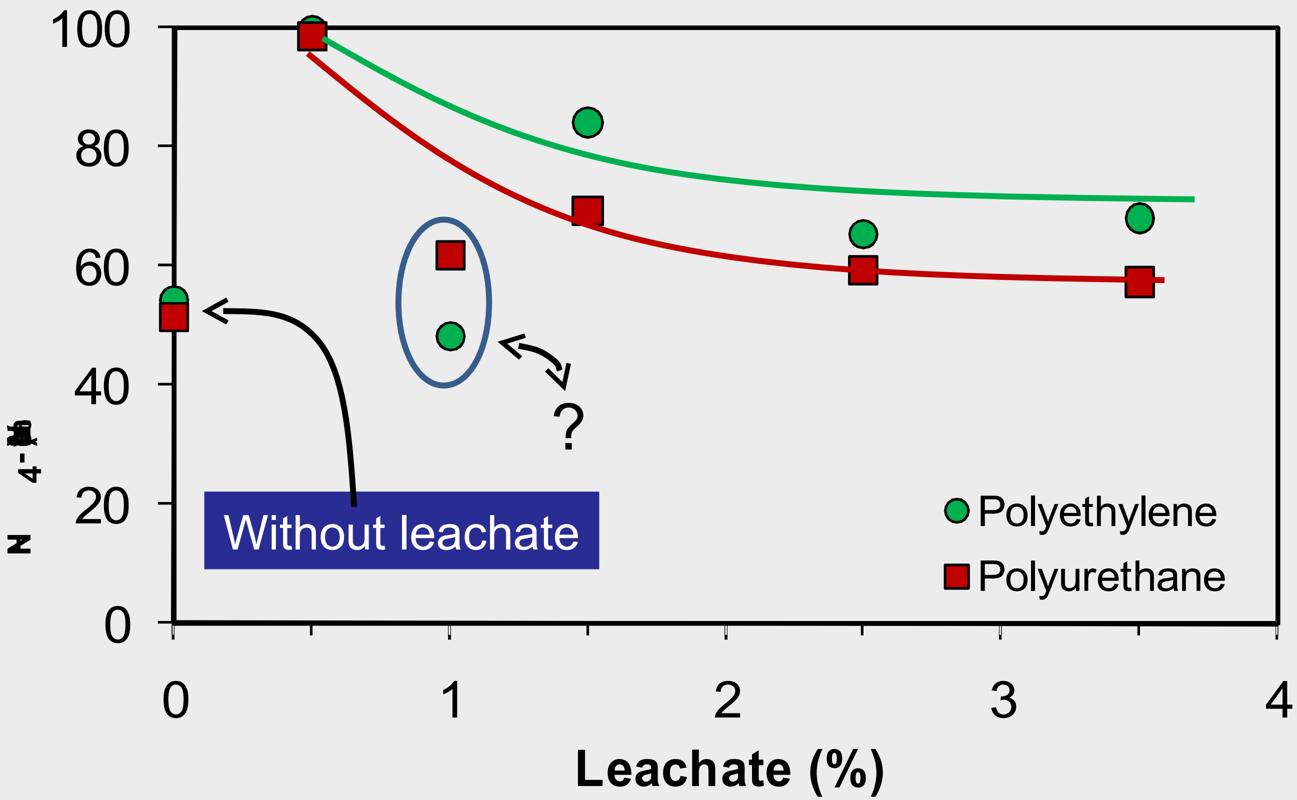
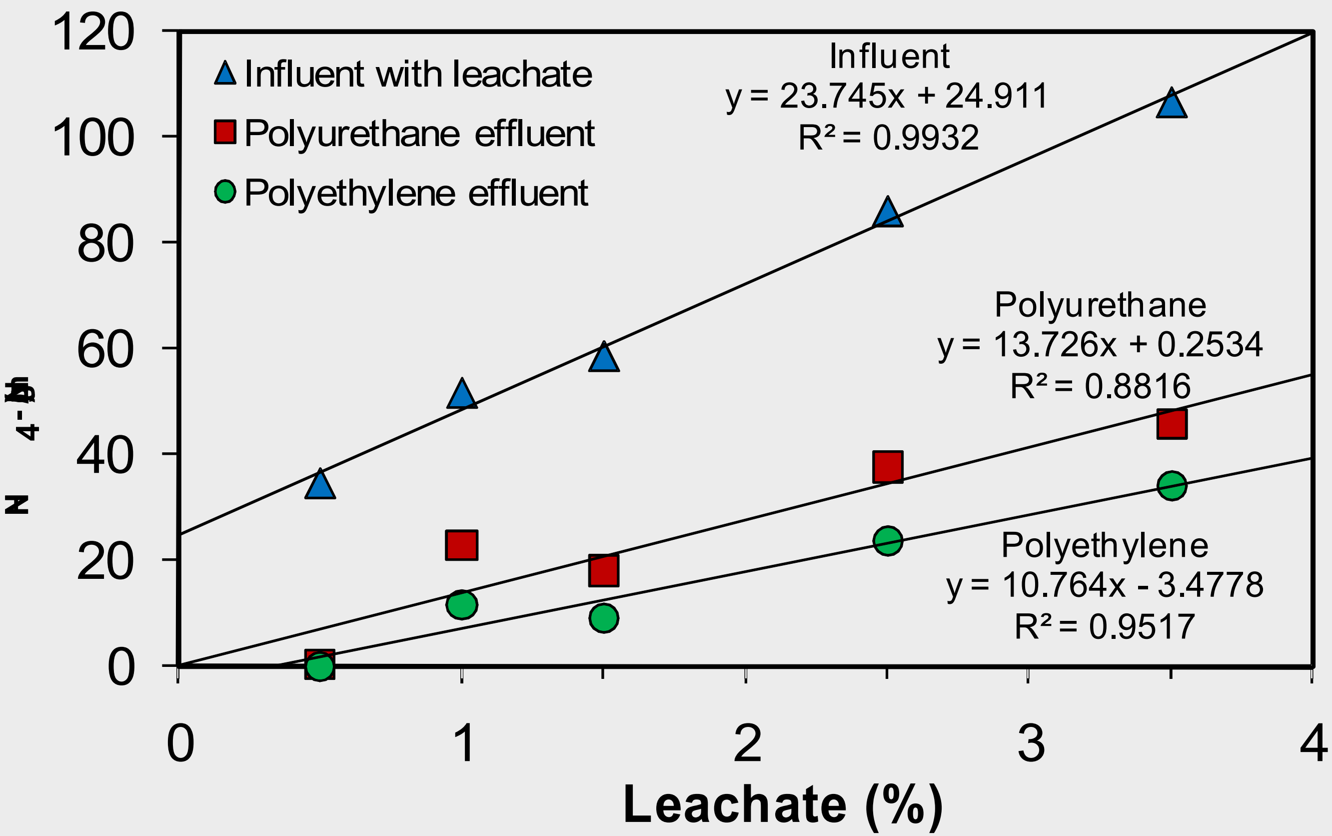
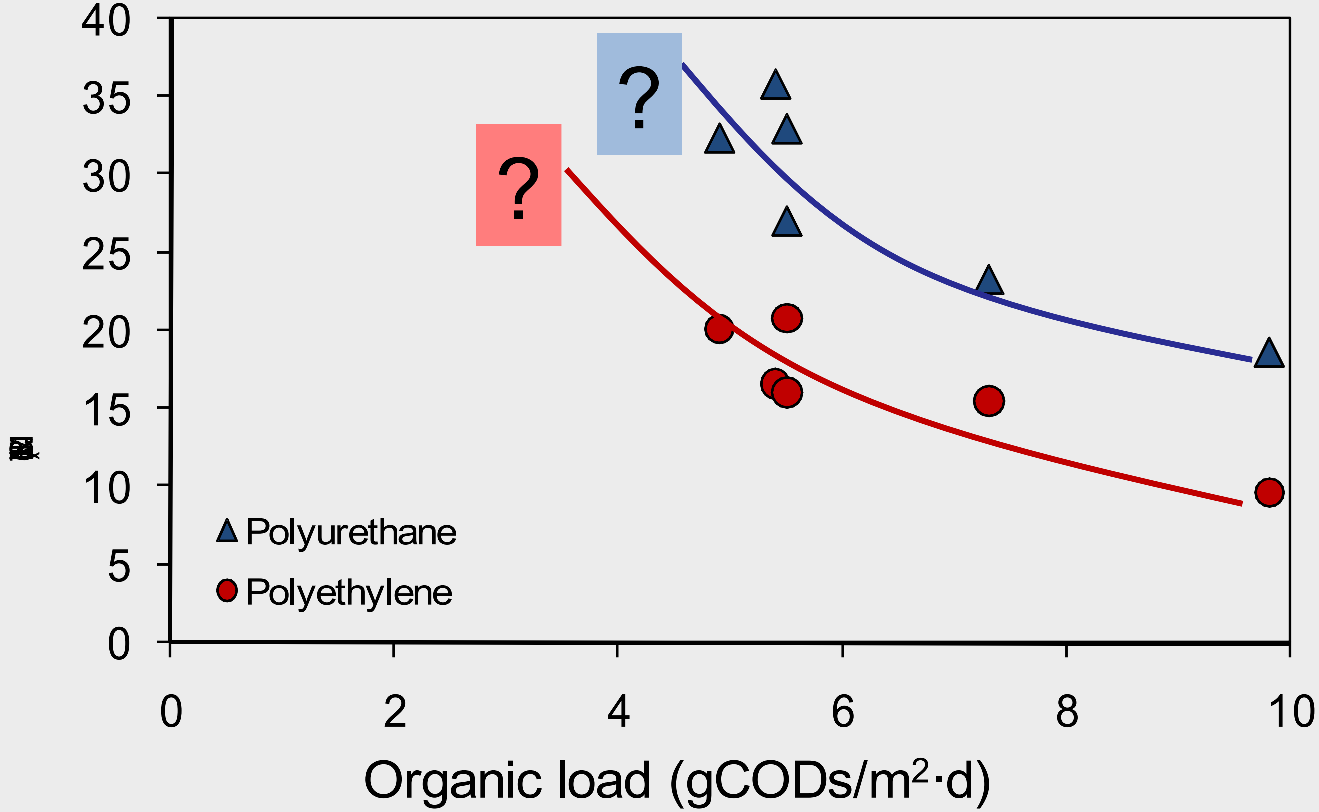
Ammonia nitrogen removal and leachate concentration



Ammonia nitrogen and leachate concentration



Mean cellular retention time and organic load



Conclusions

- COD removal in both reactors (>85%) proves that biofilms represent a good choice to treat diluted landfill leachate when combined with municipal wastewater. The best results (86 to 91% COD removal) were obtained when diluting 0.5% of leachate in wastewater.
- The best ammonia nitrogen removal (near 100% for both reactors) was achieved with 0.5% leachate. Ammonia nitrogen removal decreased with leachate concentration.
- Influent and effluent ammonia nitrogen concentrations behave linearly with the leachate fraction in the wastewater. The reactor with smooth surface carrier (polyethylene) performed slightly better for ammonia removal than that the one with porous surface carrier (polyurethane).
- The polyurethane allowed higher biomass concentration (38 g/m^2) than polyethylene (27 g/m^2). This resulted in higher average mean cellular residence times for polyurethane (28 d) than for polyethylene (17 d).
- No significant differences were observed between the two biofilm systems.