Hybrid Adsorption and Biological Treatment Systems (HABiTS): An Alternative Approach for Onsite Wastewater Treatment

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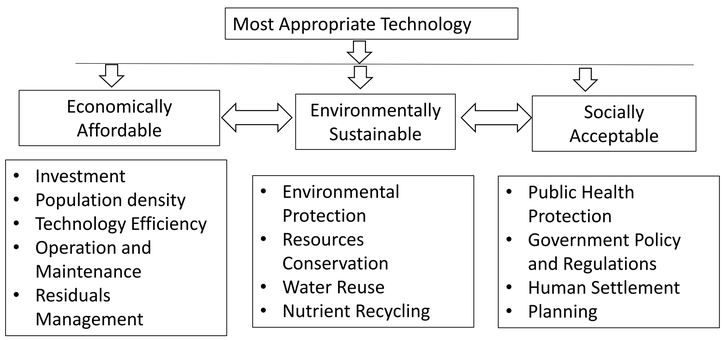
Introduction

Conventional onsite wastewater treatment systems (OWTs) provide little nitrogen (N) removal and contribute nearly 50% of the N loading to ground waters in some Florida springsheds. The enhancement of the treatment within these systems is imperative due to their limited nitrogen (N) removal and the high pollution impact to the watershed. Hybrid Adsorption and Biological Treatment Systems (HABiTS) are emerging as an alternative approach to decentralized wastewater treatment that passively remove N from septic tank effluent. HABiTS combine ion exchange (IX) and biological N removal (BNR) to enhance the performance of passive N removing OWTs. Combining IX and BNR allows these systems to overcome the challenge of highly transient loadings in OWTs while maintaining the simplicity, low maintenance and low energy inputs that are characteristic of conventional OWTs. This project includes both experimental studies, performance evaluation and cost-benefit analysis that will help to identify the tradeoffs among: 1) conventional OWTs, 2) sewerage and centralized systems and 3) passive N removal using HABiTS.

Tradeoffs between centralized and Decentralized Wastewater treatment system

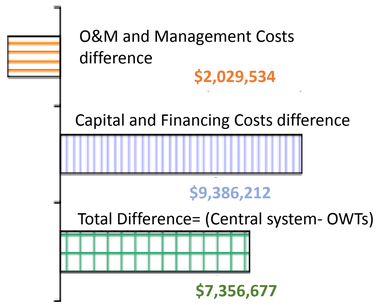


Features of OWTs

- Appropriate for low-density communities and varying site conditions.
- More cost effective than centralize system.
- Keep collection component of the wastewater management system as minimal as possible.
- Onsite wastewater reuse.

Features of Centralized system

- Appropriate for urban and densely populated areas.
- Can reach very high treatment efficiencies with high cost.(UNEP/GPA, 2000)
- The pollution of ground water and natural water system can be avoided.
- Can accommodate all waste water



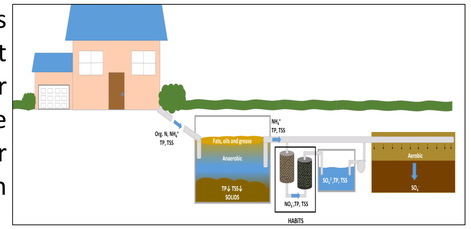
Total Lifecycle Costs Pinkham et al. (2004)

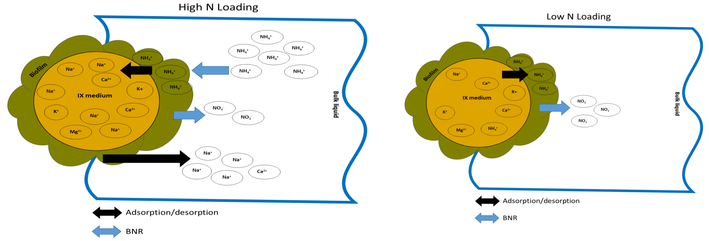
WQ Parameters	Septic Tank Effluent Quality	Soil Water Quality at 1.2 m
TKN (mg/l)	19-53	0.25-2.10
NO_3-N (mg/l)	0.01-0.16	2-29
TP (mg/l)	7.2-17	0.02-1.8
BOD (mg/l)	46-156	<1
F. Coli (log# per 100 ml)	3.6-5.5	<1

Performance analysis of a Typical OWTs

HABiTS

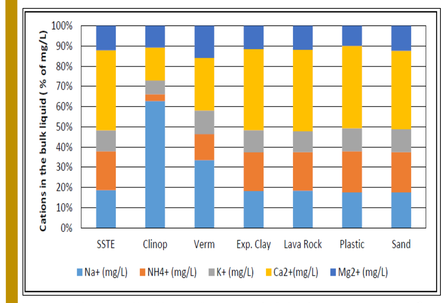
This hybrid treatment is expected to buffer transient loads, sustain and recover from long periods of idle time and a potential for reactor size reduction, which in turn will result in lower costs.

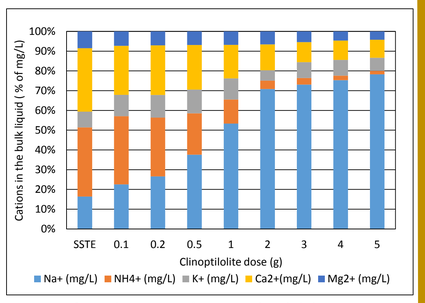




Media Characterization

Objective: Determine NH_4^+ adsorption capacity of zeolitic material clinoptilolite for HABiTS application.





- Clinoptilolite showed 83% removal of NH_4^+ and cations exchanged within clinoptilolite were Na^+.
- 2gram of clinoptilolite removed >80% of NH_4^+.

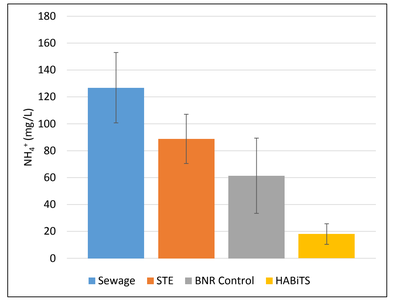
Bench-scale HABiTS

Objective: Compare the performance of HABiTs enhanced OWTs with biological nitrogen removal reactors with a control reactor under transient loading conditions.

Nitrification Phase

Treatment	Stage-1: Nitrification		Stage-2: Denitrification	
HABiTS	48%	Expanded clay (0.51-0.58 cm)	83%	Tire Scraps (1-1.5 cm)
	32%	Expanded clay (0.38-0.51 cm)	13%	Sulfur Pellets (0.2-0.34 cm)
	20%	Clinoptilolite (0.51-0.58 cm)	4%	Oyster Shells (>0.6cm)

Parameter	Nitrification
Area (sf)	9.62
D (in)	3.5
Q (L/d)	2.1
LR (mL/in^2-d)	218.7



Conclusions

- There is no specific treatment system that can achieve all the criteria.
- LCA is required for most appropriate technology of wastewater treatment system.
- Clinoptilolite showed efficient NH_4^+ IX performance with a maximum adsorption capacity of 14 mg/g NH_4^+ of clinoptilolite.
- HABiTS Stage 1 was designed with a combination of non-adsorptive material expanded clay (80%) and IX material clinoptilolite (20%).
- Demonstration of Field based HABiTs can validate the system in future.
- More future work is required for the nutrient removal of OWTs.

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