

Research Article



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굴패각에 의한 인 처리가 인공습지의 수명에 미치는 영향

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Effect of Phosphorus Removal by Oyster Shell on Longevity of Constructed Wetlands

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Abstract

BACKGROUND: Constructed wetlands are low-cost alternatives for treating domestic sewage. However, previous study has reported that the removal of phosphorus in constructed wetlands was limited. Therefore, a new alternative was needed to extend the life of the constructed wetlands. The purpose of this study was to evaluate the effect of total phosphorus removal by oyster shell on longevity of constructed wetlands for treating domestic sewage.

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METHODS AND RESULTS: The changes of total phosphorus concentration and treatment efficiency in two constructed wetlands (CWs) classified as system A (coarse sand 100%) and system B (coarse sand 90%+oyster shell 10%) were investigated for 6 years. The actual saturation time of total phosphorus in the systems A and B was estimated to be longer than that of theoretical saturation by adsorption isotherm experiment. In particular, the saturation pattern of phosphorus in system A was maintained at a certain concentration level in the initial stage of operation, and finally saturation was reached as the saturation gradually progressed from the breaking point. In system B, the saturation period of phosphorus was prolonged as compared with system A due to the addition of oyster shells. **CONCLUSION:** Our results suggest that the longevity of the constructed wetlands can be extended due to the

phosphorus saturation by adding the oyster shells to the coarse sands in constructed wetlands.

al., 1998)

, Seo *et al.* (2009)

Key words: Constructed wetland, Longevity, Oyster shell, Phosphorus

서 론

(Richardson and Craft, 1993; Mann,1997; Johansson, 1999).

가 (Vymazal, 2007), Seidel (1961) 가 VF (vertical flow)-HF (horizontal flow), VF (vertical flow)-VF (vertical flow), HF (horizontal flow)-VF (vertical flow) VF (vertical flow)-VF (vertical flow) 50~70% (Richardson, 1999; Kadlec and Wallace, 2009; Reddy and Delaune, 2008).

VF-HF BOD, COD, T-N T-P 94.3, 95.1, 68.4 94.3% 가 (Seo *et al.*, 2009).

(Greenway and Woolley, 1999), 가 (Newbold *et al.*, 1983; Reddy *et al.*, 1999), 가 (Diaz *et al.*, 1994) (Tanner *et al.*, 2005)가 (Lee *et al.*, 2003).

Table 1. Physicochemical characteristics of filter media used in the study

Items	Filter media in system A (Coarse sand only)	Filter media in system B (Coarse sand+Oyster shell)
<i>Physical property</i>		
Porosity (%)	37.0±1.08	37.5±1.02
Bulk density (g cm ⁻³)	1.58±0.67	1.20±0.89
D ₁₀ (mm)	1.50±0.21	1.50±0.13
D ₆₀ (mm)	3.00±0.18	2.95±0.21
Uniformity coefficient (D ₆₀ /D ₁₀)	2.00±0.24	1.96±0.37
<i>Chemical property</i>		
pH (1:5 H ₂ O)	7.9±0.87	7.6±0.98
EC (dS m ⁻¹)	0.05±0.01	0.05±0.01
O.M (%)	0.79±0.12	0.66±0.09
TN (mg kg ⁻¹)	8.50±2.37	70.8±3.4
TP (mg kg ⁻¹)	2.10±0.28	35.3±2.1
Ca (mg kg ⁻¹)	790±69.4	38,500±2,750
Mg (mg kg ⁻¹)	215±18.1	402±18
Al (mg kg ⁻¹)	1.97±0.2	1.82±0.3
Fe (mg kg ⁻¹)	750±37	710±54

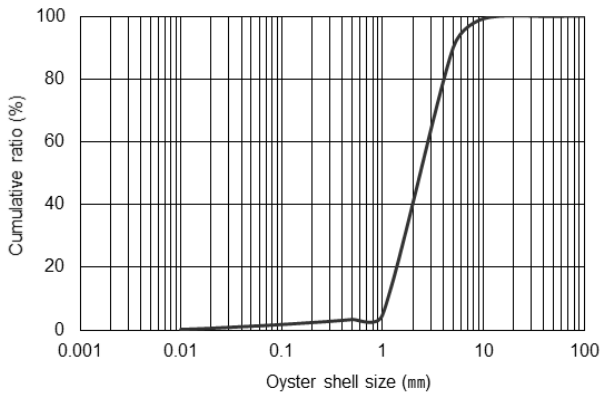


Fig. 1. Particle distributions of the oyster shell used.

VF-HF 6

가

재료 및 방법

공시재료

pH 7.09±0.14 EC 0.53 ±0.13 dS m⁻¹, BOD, SS, T-N T-P 75.5 ±51.5, 59.0±54.6, 38.83±20.26 3.8±2.1 mg L⁻¹.

2-3 가 lab-scale

Table 1

Fig. 1

VF-HF 조합형 인공습지의 설계 및 제작

Fig. 2

(VF; Vertical flow)

(HF;

Horizontal flow)

100% system A 9:1

system B

System B

가 가

가 가

2-4 mm

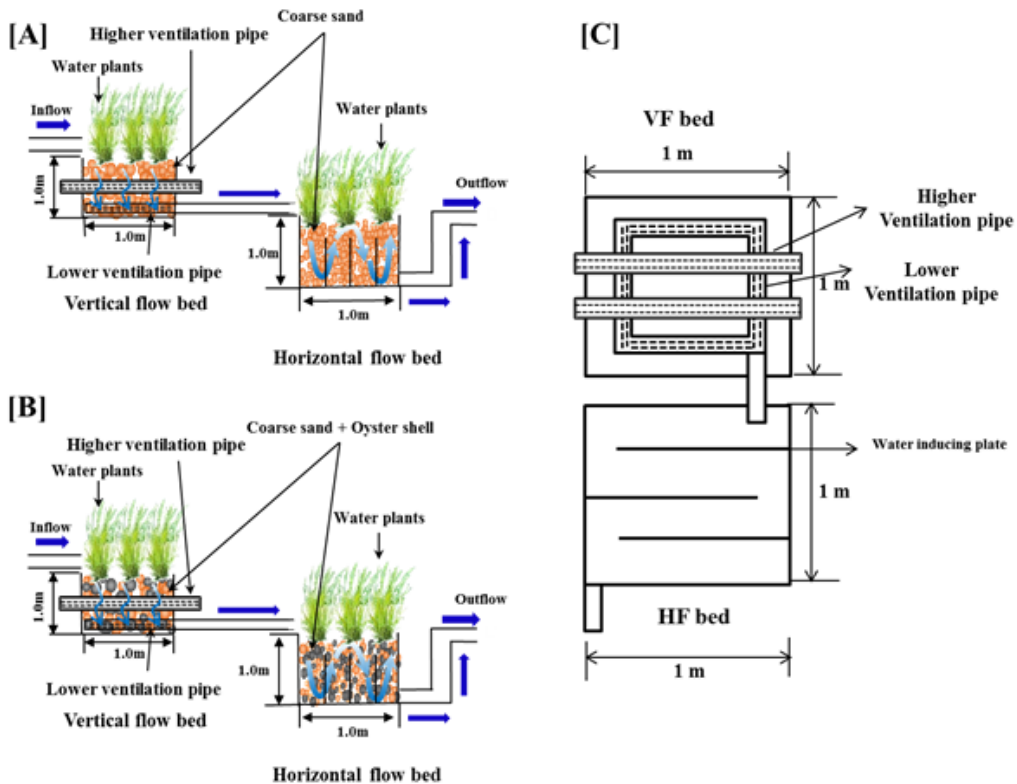


Fig. 2. Diagram of VF-HF hybrid constructed wetlands for treating domestic sewage produced from agricultural village.

가 Seo *et al.* (2005)
 Lee *et al.*
 (2003) 9 : 1
 1.5 mm
 1.0 m (width)×1.0 m (length)×1.0 m (height)
 1.0 m³
 (Hawkins *et al.*, 1997),
 50 cm
 5
Phragmites communis
pseudoacorus , *Iris*

실험방법

2012 1
 1 2017 12 31 6 1
 System A B
 1 () 2 ()
 6

가
 System A
 stage I, 가
 stage II, 가
 stage III

분석방법

method APHA standard (APHA, 2005).
 pH , EC EC meter (Orion, Model 160, Germany)
 BOD -
 , SS , T-N /가 -
 T-P /가
 pH , EC EC meter (Orion, Model 160, Germany) Tyurin ,
 Kjeldahl , Vanadomolybdate
 K, Ca, Mg Na
 ICP (OPTIMA

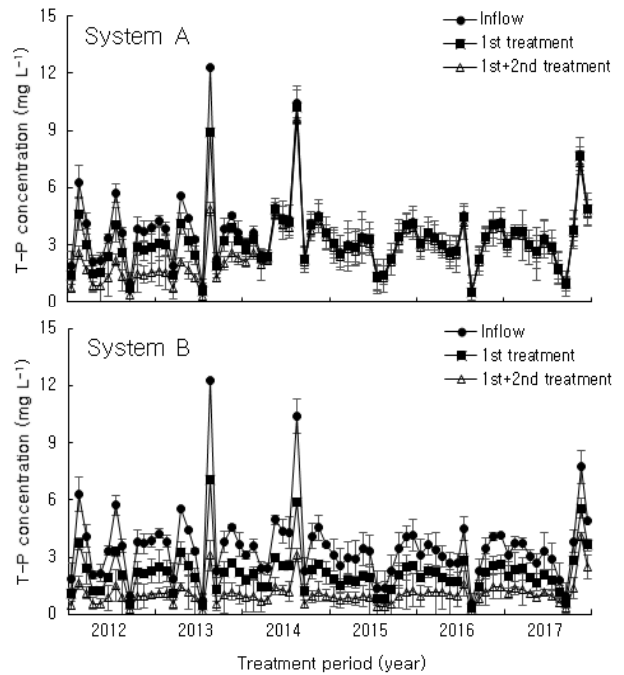


Fig. 3. The concentration of TP in system A and system B in the water in VF-HF hybrid CWs for treating domestic sewage under different years.

4300DV. PerkinElmer)

결과 및 고찰

연도별 인의 농도 변화

6 T-P Fig. 3
 T-P 0.53-12.3 mg L⁻¹
 가 , 3.56±1.82 mg L⁻¹
 T-P 2016 8 (0.53 mg L⁻¹) 가
 Seo *et al.* (2010)
 7 8
 가
 T-P 2013 9 (12.3 mg L⁻¹) 2014 9
 가
 , Seo *et al.* (2009)
 7.19~15.08 mg L⁻¹
 System A B T-P Fig. 4
 System A T-P 2012 2013
 61.10±1.39 (25.3 mg L⁻¹) 55.07±
 9.47% (28.3 mg L⁻¹)
 가 2014 system A T-P
 12.54±9.03%
 system B

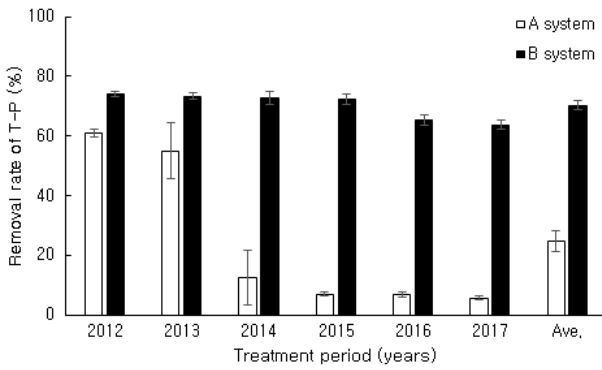


Fig. 4. The removal rates of TP in effluent in VF-HF hybrid CWs for treating domestic sewage under different years.

2012 73.91±0.85% (30.7 mg L⁻¹), 2013 73.35±1.11% (37.2 mg L⁻¹), 2014 72.82±2.21% (36.2 mg L⁻¹), 2015 72.32±1.68% (25.1 mg L⁻¹), 2016 65.26±1.63% (24.4 mg L⁻¹) 2017 63.75±1.48% (24.7 mg L⁻¹)

4

system

A . System A

2

. System B 10% 가

가 가 , batch (Lee et al., 2003).

Al-P, Mg-P Fe-P Ca-P

30-40%

(Seo et al., 2005).

Ca , Ca 10%

Ca 3.8% Al, Mg Fe

50 20,000

(Table 1), Al, Mg Fe , Ca 48 가

가 Ca 가

Ca-P hydroxyapatite (Seo et al., 2005)

2

(Lee et al., 2003) , Ca 가

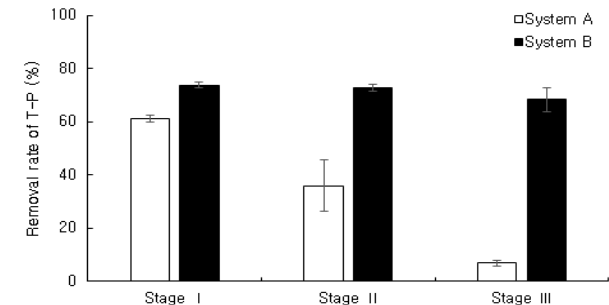
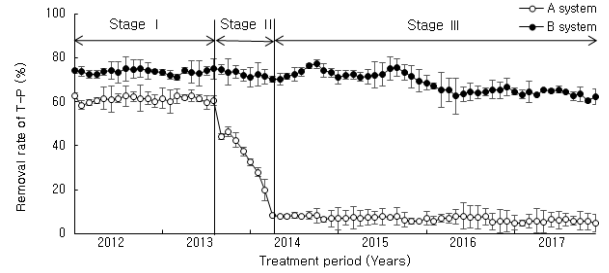


Fig. 5. The removal rates of TP in effluent in VF-HF hybrid CWs for treating domestic sewage under different operating stage.

가

인공습지에서 처리단계별 인 처리효율

System A system B T-P 가

3 stage T-P

Fig. 5 . 6 system A

B 24.69 70.23% system B

. Stage I system T-P

system A가 61.18% , system B가 73.67%

10% system B가

. Stage II system A 가

system A 35.81% , system B

72.86% stage I

가 가

. Stage III system A 6.74%

가 ,

system A system B 68.33%

6 가

kg 833 mg (Lee et al., 2003)

system A 10% system B가

System A system B BOD, COD, SS T-N

system A

97.9±2.1, 84.4±8.1, 98.9±1.3 56.9±28.4 mg L⁻¹

, system B 97.4±2.1, 90.1±4.8, 99.2±0.7
58.8±13.1 mg L⁻¹

system A 가
가

굴패각이 인 처리효율에 미치는 영향 평가

batch column
(9:1) g
(Lee *et al.*, 2003; Park *et al.*, 2017) g
가

batch
(Lee *et al.*, 2003; Park *et al.*, 2017)
system A 202 day

600 day
810 day 4
가 가

Batch
(Lee *et al.*, 2003; Park *et al.*, 2017)
system B 864 day , 6 2,160 day
가

(Richardson, 1999; Kadlec and Wallace, 2009; Mitsch and Gosselink, 2007).

batch column
가

요 약

VF-HF , 6

가
system A 4

가
가 가

system B , 가

Note

The authors declare no conflict of interest.

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