Flexibility of Hybrid Reed Bed System treating Milking Parlor Waste Water to Water Flow Fluctuations during Snow Melting Season in Northern Hokkaido

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1. Background and objectives

We operated a hybrid reed bed system for treating milking parlor waste water under extremely colder climate of northern Hokkaido from November 2006. This constructed wetland system was designed to purify maximum 4.5 m^3 day $^{-1}$ of waste water, but during snow melting season (March & April) it received much higher volumes of water because of mixing of snow melted water with influent. To assess system's efficiency and flexibility for waste water purification under high water flow fluctuations, regular sampling was carried out at final discharge point during snow melting season of year 2008. This paper describes the treated effluent quality during snow melting season compare to that of non-snow melting period.

2. Material and methods

The layout of the system is shown in Fig.1. For assessing the effluent quality during snow melting season, an automatic water sampler was fixed at S4 location for taking samples once in a day from 5th March to 17th April, 2008. Samples were analyzed for pH, EC, TN, TP, PO_4-P, TC and chloride. Water volume was measured at S1 and S4 locations.

3. Results

Mean average air temperature during the sampling period was recorded as 1.2 ^oC (min. -14.9, max.16.4 ^oC). Figure 2 shows the influent and effluent water volumes during snow melting season of 2008. Snow melt water mainly comes from snow deposited on the bed surfaces but some unintended inflow from surrounding area of sedimentation tank that is located before S1 siphon also mixed to influent. Total influent volume from 5th March-17th April, 2008 was 337.3 m^3. Assuming the average inflow from parlor as 2.26 m^3 d^{-1} which is calculated from the previous year's study, total waste water from milking parlor operations itself was 99.6 m^3 and rest 237.7 m^3 was estimated as snow melted water which was mixed with influent at sedimentation tank from nearby area. Total effluent volume was 717.6 m^3 containing 380.3 m^3 snow melted water from all beds of system. Figures 3 and 4 shows Cl^{-1} , TN, TC, TP, PO_4-P and organic P concentrations in finally treated effluent during snow melting season of 2008 and non-snow melting period (from November 2006 to February 2008 excluding March-April 2007). Bar lines in the graphs show minimum, maximum and average values of each water quality index. Table 1 shows the daily influent and effluent load and load removed by the system during both periods.

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4. Discussion and conclusion

Major nutrient purification mechanisms of constructed wetland systems are considered as filtration and sedimentation, adsorption and precipitation (for phosphorus), nitrification and/or denitrification (for nitrogen) etc. Most of these mechanism works with the flow of waste water in the system kept as sub-surface flow. But during snow melt season surface flow occurred at HF bed due to excessive snow melt water. This seems to decrease the removal load during this period. Although removal load was decreased compare to non-snow melting period, effluent quality was satisfactory to discharge into downstream water body. Furthermore, this system worked without stopping for a single day. System's performance can further be improved by avoiding mixing of unintended inflow from outside to parlor waste water and improving surface conditions of HF bed to maintain sub-surface flow for even snow melting season.

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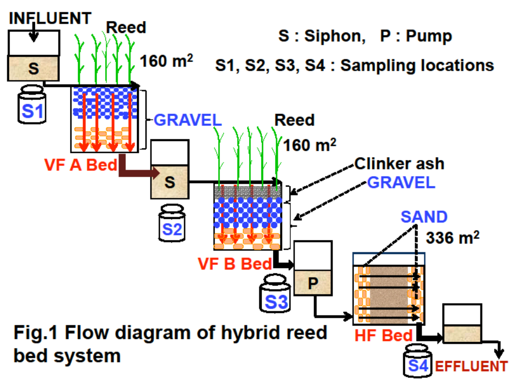

Fig.1 Flow diagram of hybrid reed bed system

Table 1: TN, TC, TP, PO_4-P, and organic P load in influent and effluent and load removal during snow melting and non-snow melting period.

		Load (g d^{-1})				
		TN	TC	TP	PO_4-P	Org.P
Snow melting period, 2008	Influent	820.0	5,601.0	113.0	83.0	31.0
	Effluent	568.0	2,358.0	98.0	70.0	28.0
	Load removed	252.0	3,243.0	15.0	13.0	3.0
Non-snow melting period	Influent	800.0	6612.2	123.0	101.0	21.9
	Effluent	177.0	976.0	25.3	20.1	5.5
	Load removed	623.0	5,636.0	98.0	81.5	16.4

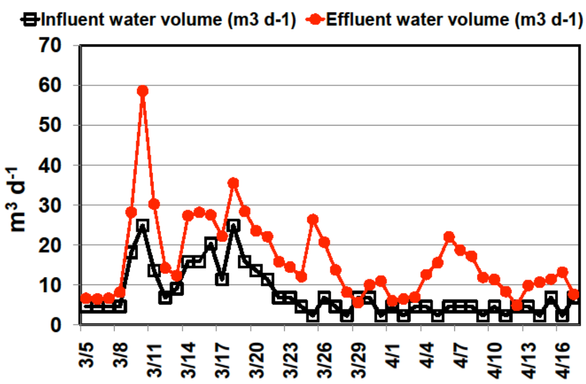

Fig.2 Influent and effluent water volume during snow melting season in 2008

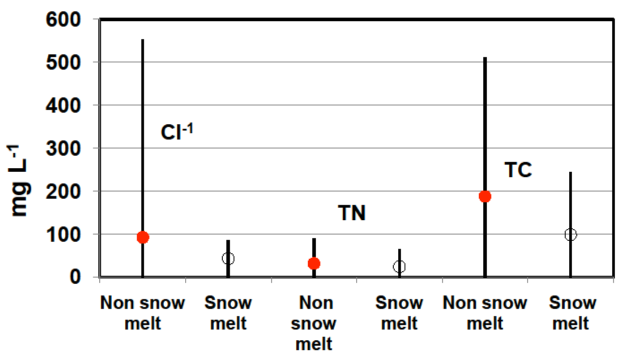

Fig.3 Concentration of Cl^{-1}, TN and TC in effluent during snow melting and non snow melting period

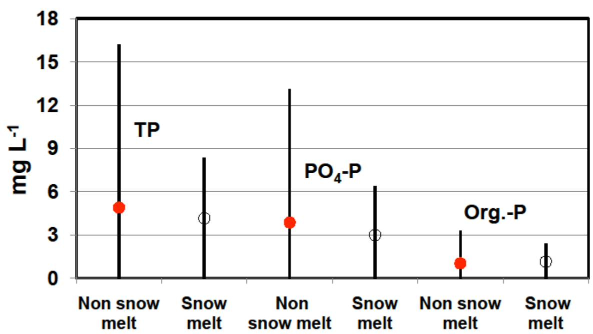

Fig.4 Concentration of TP, PO_4-P, and Organic P in effluent during snow melting and non snow melting period