Efficiency of hybrid reed bed system for treating milking parlor waste water under cold climate conditions of northern Hokkaido

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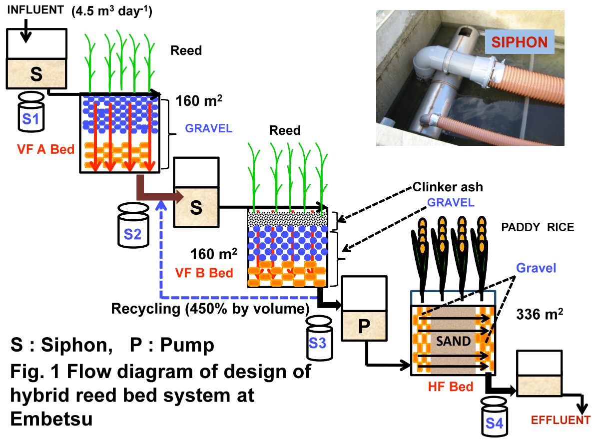
1. BACKGROUND AND OBJECTIVES

Presently in Japan, most livestock farmers with waste water of less than 50 m^3 day^{-1} either infiltrate it to underground or discharge into nearby river/pond without a prior treatment. This leads to both ground and surface water pollution. Milking parlor waste water is a mixture of wash off milk, urine and excreta, discarded milk, detergents and disinfectants that results into high COD value (1,000-5,000 mg L^{-1}) of these waste waters. We operated a hybrid reed bed system in Embetsu, northern Hokkaido from November 2006 to treat milking parlor waste water of a dairy farm. The primary objective of this study was to assess the treatment effects of hybrid reed bed system in treating milking parlor waste water.



S : Siphon, P : Pump

Fig. 1 Flow diagram of design of hybrid reed bed system at Embetsu

2. MATERIAL AND METHODS

Our system is of hybrid type and consists of three beds (VFA-VFB-HF) constructed in series. The layout of the system is shown in Fig.1. Four sampling locations, i.e., S1, S2, S3 and S4 were selected for collecting samples once in a month. The samples were analyzed for pH, EC, ORP, DO, TSS, BOD_5 , COD_{cr}, TP, PO_4-P, TN, NH_4-N, NO_3-N, total carbon and total coliform. The pH, EC, DO and ORP were measured at field.

Table 1. Average waste water concentration at S1,S2,S3 & S4 locations and purification rate of hybrid reed bed system

Parameter	Unit	S1(Influent)	S2	S3	S4(Effluent)	Purification rate(%)
TSS	mg L^{-1}	861	275	90	22	97
BOD	mg L^{-1}	1,722	1,058	427	158	91
COD	mg L^{-1}	4,851	1,885	956	412	92
TN	mg L^{-1}	192	105	67	36	81
NH_4-N	mg L^{-1}	73	67	51	24	67
NO_3-N	mg L^{-1}	0.5	4.5	1.6	1.3	
TP	mg L^{-1}	31	18	12	5	85
PO_4-P	mg L^{-1}	27	16	10	4	85
Total C	mg L^{-1}	1,635	677	385	204	88
Total coliform	no. ml^{-1}	111,484	87,370	14,543	872	99

3.RESULTS

Average concentration of influent, effluent and purification rate at each sampling point from December 2006 to January 2008 are shown in Table 1.Purification rate was calculated as the percentage of decrease of concentration divided by the influent concentration. From Figs. 2 to 5 the time sequence of influent and effluent load as well as removal rate is shown for TSS, COD $_{(Cr)}$, TP and TN respectively for the period of December 2006 to January 2009.Removal rate means percentage of removal load which can be calculated by dividing decrease of load (influent load-effluent load) by influent load.

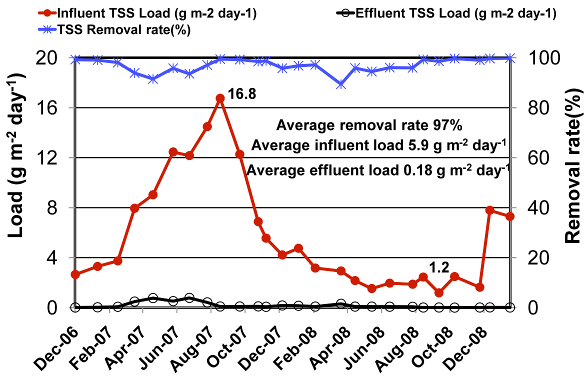


Fig.2 TSS load in influent and effluent and removal rate of hybrid reed bed system

Average volume of influent was calculated as 4.5 m^3 d^{-1}. The peak flow rate of 10.7 m^3 d^{-1} was measured at S4 in April 2008 which was caused by snow melting. The system continued its operation without stopping a single day and even worked during midwinter and heavy water flow (raining and snow melting) period.

Influent load was high during May 2007 to September 2007. In this period large amount of rejected milk was also dumped along with the waste water. High performance in both purification and removal rates was gained for TSS and COD $_{(Cr)}$. Compared to 2008, average influent loads in 2007 was much higher but the

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purification and removal rates have no significant difference for both years. Purification and removal rates for TN and TP were lower than TSS and COD $_{(Cr)}$ but still exceeding 80% in purification rate and 70% in removal rate. TN removal rate was low during April 2008 because of surface flow at HF bed. TP removal rate was low during July 2008.No significant reason could be found for decrease in removal rate during this period.

4. DISCUSSION

The existing hybrid reed bed system is efficiently treating the milking parlor waste water. VFA and VFB together contributed to 90 and 80 % removal of TSS and COD.VFA and VFB beds are gravel filled which acted as a good substratum in filtering the particulate organic matter from the waste water. TN and TP were eliminated to 81 and 83% by whole system. In March and April 2007 siphon at VFB inlet stopped working because of some mechanical failure and VFB bed suffered more anaerobic conditions due to continuous waste water inflow. Because of this purification efficiency of total system was decreased during this period. Low removal rates were observed during snow melting seasons because of occurrence of surface flow at HF bed. In winter months, December to March, all the beds were fully covered with snow, but reductions in nutrient load was still carried out by the system, most probably by filtration, adsorption and chemical precipitation processes. This shows that system is capable of giving promising results in terms of waste water purification even in cold climatic conditions.

5. CONCLUSION

This study evaluates the performance of hybrid reed bed system in treating the milking parlor waste water. Following conclusions can be drawn as:

- Hybrid systems could give more promising results in terms of nutrient reductions from waste waters. Arranging VFA and VFB beds before HF bed is found to be very effective in reducing the nutrient loads from milking parlor waste water.
- Hybrid reed bed system is capable of tolerating inflow load fluctuations without affecting its treatment efficiency. System did not stop for a single day and even worked in colder winter months.
- System operates automatically and does not require much manpower for its operation.

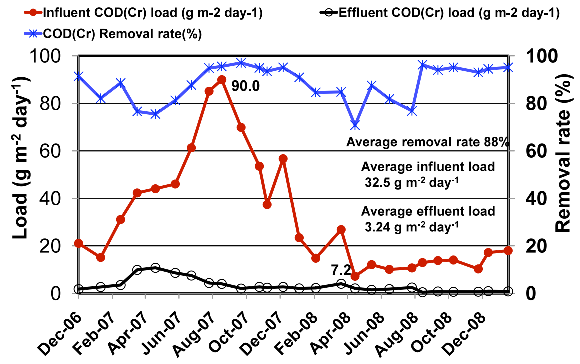

Fig. 3 COD$_{(Cr)}$ load in influent and effluent and removal rate of hybrid reed bed system

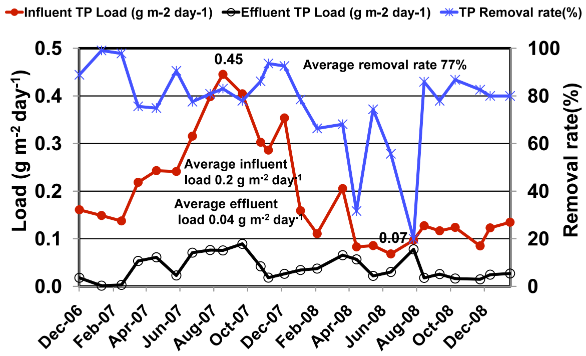

Fig.4 TP load in influent and effluent and removal rate of hybrid reed bed system

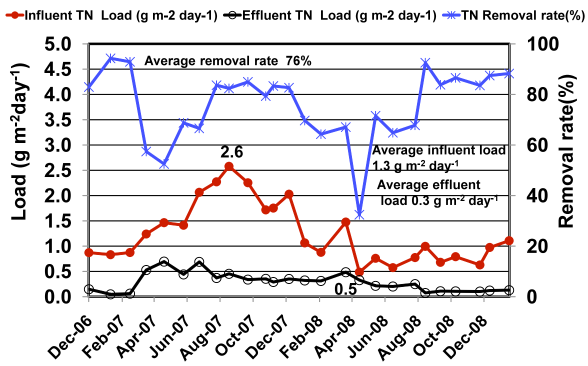

Fig. 5 TN load in influent and effluent and removal rate of hybrid reed bed system

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REFERENCES

Pradeep K. Sharma・井上京・加藤邦彦・吉友郁哉・家次秀浩・富田邦彦・長澤徹明; A report on two years' continuous operation of hybrid reed bed system in treating milking parlor waste water at Northern Hokkaido, 第 57 回農業農村工学会北海道支部研究発表会講演集、農業農村工学会北海道支部、pp.90-95（2008. 10）