II－469 Effect of reactor configuration of iron-packed column on phosphorus removal for on-site small scale treatment

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1. Introduction

Three types of iron-packed column have been used to remove phosphorus as a main objective. The column aims to use as a compact system in combination with membrane process for on-site small scale domestic wastewater treatment. Moreover,the use of iron waste from manufacturing process would be advantageous due to its low cost.

2. Experimental Sets-up and Methods

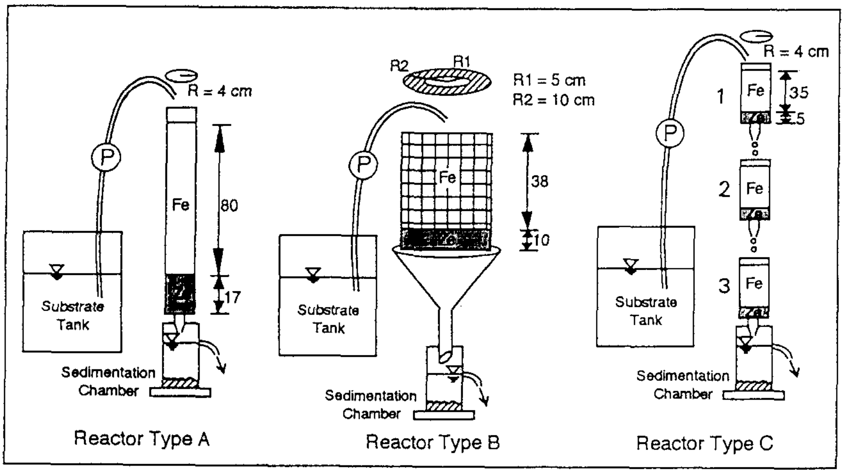

Fig.1 Experimental Sets-up of three types of reactors

Type A was a long column of 80 cm - iron bed, type B was a hollow cylindrical steel net column of 38 cm-iron bed and type C was three short columns of 35 cm-iron bed in series. The same surface hydraulic loading of 0.20 $l/cm^2/d$ was applied to all types of reactors. However, for reactor type B,the surface hydraulic loading was changed to 0.02 $l/cm^2/d$ after 10 days of operation.Synthetic wastewater containing Na_2HPO_4 was used. All types of reactors receieved the same influent pH of 7.6 and provided the effluent pH range of 7.0-9.0 (normal range 7.5-8.5). The experiment was done under ambient temperature.

Table 1. Operating conditions of three patterns of iron-packed column

Operation condition	Reactor Type A	Reactor Type B	Reactor Type C
surface hydraulic loading($l/cm^2/d$)	0.20	0.20,0.02	0.20
contact time (hrs)	9.7	4.7,39.8	12.7
mass of iron material used (g)	1681	3689	1711
packing density (g/cm^3)	0.42	0.41	0.32

3. Results and discussion

Performance of reactor type A

Fig.2 shows that within 35 days of operation, the concentration of effluent phosphorus increased to above 1.5 mgP/l. This might be caused by poor oxygen penetration in the lower part of the column. It was suggested by the appearance of brown oxidized iron at the upper part and black deoxidized iron at the lower part of the column. To solve this problem, aeration was provided to the column. It was found that effluent quality was significantly improved and the regeneration of oxidized form of iron surface layer could fix more phosphorus. However, the iron rust leached out a lot and possibly accumulated at the bottom part of the column.This caused hydraulic resistance, resulting in water logging inside.Then gradual deterioration of effluent quality was observed after 20 days of aeration and finally clogging occurred.

Performance of reactor type B

From the aforementioned result, it seems that oxygen supply is important to phosphorus removal by the iron material. Therefore, hollow cylindrical steel net column was used to provide natural air supply from both outside and inside of the reactor. The water distribution system here was a rubber tube made in a circle shape. From Fig.3 , it shows that with initial surface hydraulic loading of 0.2 l/cm^2/d, phosphorus removal could not be obtained well. The reason is that the water distribution system was not uniform,which brought about some parts of iron beds received high amount of flow and some parts had no water penetrated.Thus effective use of iron material was not acheieved. This resulted in decrease in TP removal efficiency earlier. Then low surface hydraulic loading of 0.02 l/cm^2/d was applied instead after 10 days and then concentration of effluent phosphorus became lower than 0.5 mgP/l until 50 days of operation.

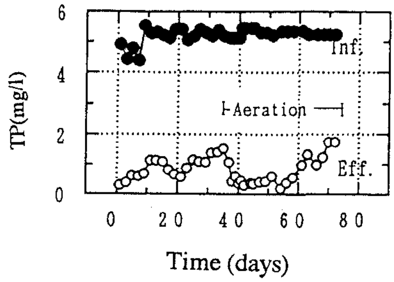

Fig.2 The performance of TP removal by reactor type A

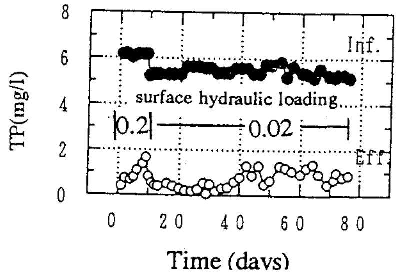

Fig.3 The performance of TP removal by reactor type B

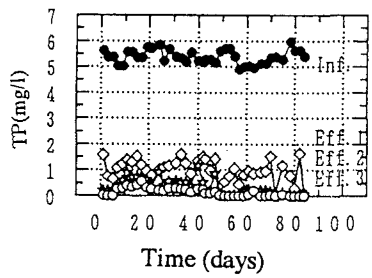

Fig.4 The performance of TP removal by reactor type C

Performance of reactor type C

Three short columns with packing density of 0.32 g/cm^3 in series were designed instead of one long column. From Fig.4, it appears that better effluent quality could be obtained by increase in the number of columns. Table 2. shows that average TP concentrations of effluent after the second and the third column were 0.35 and 0.14 mgP/l respectively, which were better than that of other types of reactors. In addition, phosphorus removal capacity of reactor type C was the highest among three types of reactors. It is possible that sufficient oxygen supply is available for short column with lower packing density rather than long column. Therefore, short columns in series could be a promising system for phosphorus removal.

Table 2. Summary of performance of TP removal by three types of packed iron column

Performance	Reactor Type A	Reactor Type B	Reactor Type C			
			col.1	col.2	col.3	Total
mgP applied/gFe/d	0.031	0.023	0.095	0.018	0.006	0.032
mgP removed/gFe/d	0.025	0.020	0.078	0.011	0.004	0.031
avg. eff.P conc.(mgP/l)	0.82	0.71	1.01	0.35	0.14	0.14