BEHAVIOR OF NITROGEN AND OTHER CHEMICAL SPECIES FROM LABORATORY SOIL COLUMNS WHEN SECONDARY SEWAGE EFFLUENT IS APPLIED

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1. Introduction

In studying the behavior of chemical contaminants in subsurface, it is important to understand the physical, chemical and biological processes of the species in the subsurface environment. In this experiment, a comparison of two soil column studies were conducted with the following objectives (1) to evaluate whether the thickness of the plow layer in columns affects the infiltration rate and (2) to determine the behavior of nitrogen and other chemical species.

Chemical and biological processes can influence the movement of chemical species and various forms of nitrogen in the subsurface environment. An understanding of the subsurface biochemical processes is fundamental to evaluating the influencing factors and fate of chemical contaminants. This column experiment examined the behavior of nitrogen and other chemical species from laboratory soil columns when secondary sewage effluent is applied.

2. Materials and Methods

Figure 1 illustrates the experimental column equipment. The experiment was conducted using two soil columns with different thickness of plow layers, 10 cm and 20 cm, respectively. Treated sewage water was supplied up to 5 cm at the top of the soil column in order to reproduce the redox condition. The flow rates of column effluents of both Column A and Column B were measured. Soil solution samples collected by porous cups and injection water were analyze for Na^+, K^+, Mg^{2+}, Ca^{2+}, Mn^{2+}, Fe^{2+}, NH_4^+-N and NO_3^--N concentrations, pH, EC (Electrical Conductivity) and ORP (Oxidation Reduction Potential) were also measured.

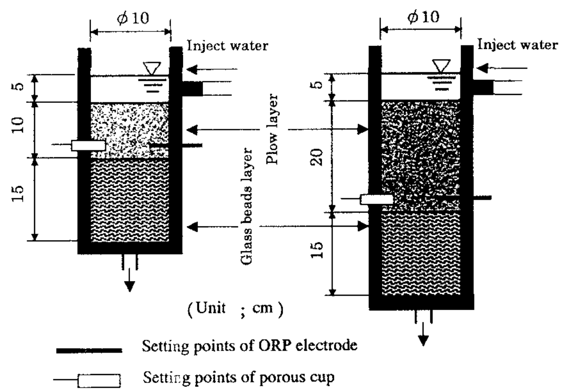

Fig. 1 Experimental column equipment

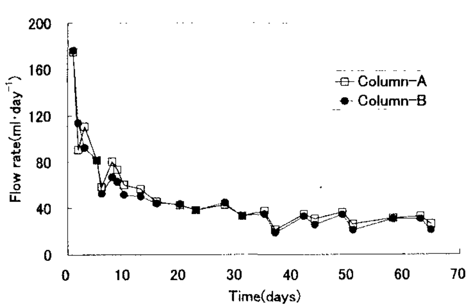

Fig. 2 Flow rate

3. Results and Discussion

3.1 Flow Rate

Figure 2 shows the flow rates in Column A and Column B. The flow rates of infiltration in Column A and Column B show almost the same values, this indicates that the thickness of the plow layer do not affect the flow rate of infiltration.

3.2 ORP

Figure 3 shows the variation of temporal ORP, Mn^{2+} and Fe^{2+} concentrations. The ORP of the injection water shows higher values than that of Column A. The ORP of Column A and Column B decrease for first ten days after the beginning of the experiment and thereafter show constant values (0.3V) throughout the period of experiment due to oxidized condition. Mn^{2+} and Fe^{2+} concentrations show higher values at the Column A and Column B compared to the concentrations of the injection water, this is due to the dissolution of Mn- and Fe-oxides during the water infiltration through the plow layer.

3.3 Electrical Conductivity (EC)

Figure 4 shows the variation of Na^+, K^+, Mg^{2+}, Ca^{2+} concentrations and EC. Ca^{2+} concentration shows higher values at Column A and Column B than that of injection water due to desorption of Ca^{2+} by Mn^{2+} and Fe^{2+}. EC correlated fairly well with the sum of cation concentration.

3.4 TOC, NO_3^--N, NH_4^+-N

Figure 5 shows the variation of NO_3^--N and NH_4^+-N concentrations and TOC. NO_3^--N concentration at Column A and Column B abruptly decrease after 10 days of the experiment and thereafter show decreasing values. NH_4^+-N concentration also shows decreasing values with time. It can be seen that NO_3^--N decreases with time due to denitrification. TOC concentration shows higher values in Column B than in Column A. The difference of TOC concentration is presumed due to the difference of the thickness of plow layer.

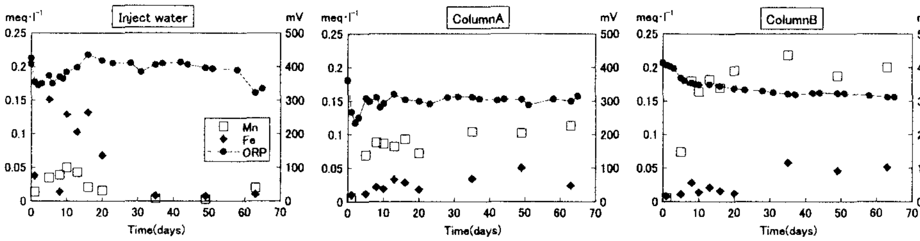

Fig.3. Variation of the temporal ORP, Mn^{2+} and Fe^{2+} concentrations

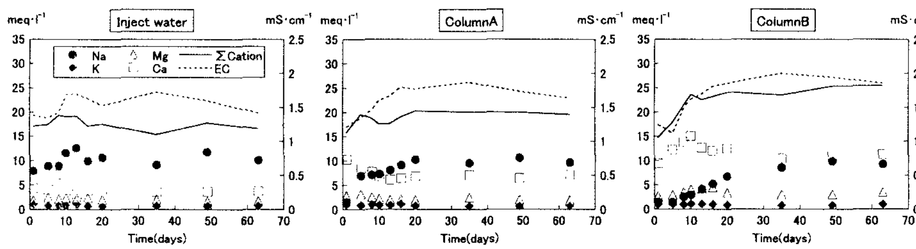

Fig.4. Variation of the temporal EC and Cation concentrations

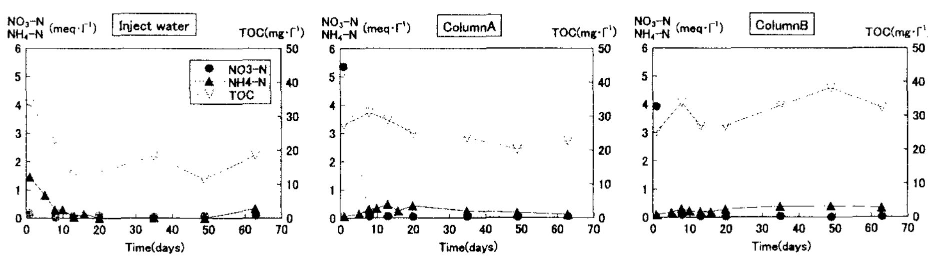

Fig.5. Variation of temporal TOC, NO_3^--N and NH_4^+-N concentrations.

4. CONCLUSION

In this study, in order to compare the infiltration rate of the treated sewage water and to determine the behavior of nitrogen and other chemical species, two soil columns experiment was conducted. The total nitrogen leaching to the bottom of plow layer of the two columns and the behavior of other chemical species at spatial distribution of the soil columns were also confirmed.

The major findings of the experiment are summarized as follows:

1. The flow rates of infiltration in Column A and Column B showed almost the same values, this indicates that the thickness of the plow layer did not affect the flow rate of infiltration.
2. The ORP values of the soil at Column A and Column B decreased for first ten days after the beginning of the experiment and thereafter showed constant values (0.3 V) throughout the period of experiment, due to reduced condition.
3. EC correlated fairly well with the sum of cation concentrations.
4. NO_3^--N decreases with time due to denitrification. TOC concentration showed higher values in Column B than in Column A. It is suggested that the difference of plow layer should be considered.

In this experiment, in order to understand the mechanism of multicomponent solute transport it is necessary to develop a solute transport model which will take into account both the biochemical reaction and cation exchange reaction.