Ionic behavior of treated water at a water purification plant

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Abstract

Water at each processing stage in a water purification plant was extracted and analyzed to investigate changes of water quality. Investigations of water at each processing stage at the water purification plant are discussed herein.

Key words: water purification plant, processing stage, temperature, pH, chemical amount

1. Introduction

Water purification plants are important public facilities, but it remains unclear "How treatment is to be done in how many processing stages to obtain what level of quality" at each purification process. Processes in different system environments were analyzed chemically in a laboratory to resolve unknown aspects of water purification processes.

Some results obtained for different systems, processing stages, and seasons are described herein. Furthermore, this report presents results of our examinations of temperature, pH, and chemical contents of processed water at different stages

2. Experimental Outline

This water supply plant has three purification systems, each with mainly four treatment processes except for complete-treatment process. (**Table 1**) Consequently, the plant has four treatment method facilities: coagulation sedimentation at the first stage (step), rapid sand filtering at the second, ozone contact processing at the third, and activated carbon particulate adsorption at the fourth. (**Table 2**)

At each treatment facility, 2-liter volumes of water were extracted for sampling. These samples were brought to the laboratory for analyses. Measured items were temperature, pH, and ion concentrations. Ion concentrations were mainly obtained using a spectrophotometer. This paper is consisted with results from one of systems.

Table 1 Experimental outline

Purification system	3 systems (A , B , C)
Treatment process	4 processes (1st - 4th)
Season	summer autumn
Main measurement item	ion concentration, temperature, pH

A : This paper is consisted with results from system A

Table 2 Treatment process of system

Water-intake (raw water)	
Stage (step)	**Treatment process**
First	coagulation sedimentation
Second	rapid sand filtering
Third	ozone contact processing
Fourth	activated carbon particulate adsorption
Complete - treatment process	
Supply	

3. Results

3.1 Nitrite nitrogen (NO_2)

Comparing results obtained during summer with those obtained in autumn, nitrite nitrogen shows a decline and similar behaviors depending on the processing stage. Measurement results of autumn showed lower overall concentrations. These results are attributable to differences of seasons and particularly to the changing of temperatures.

Ammonium nitrogen is transformed to nitrite nitrogen by nitrite bacteria oxidation. Because the water temperatures of autumn are lower than those of summer, it is conceivable that the activity of microbial communities is lower than that of summer, and that the amount of ammonium nitrogen oxidation is lower. In fact, the activity of microbes in autumn is less than that in summer. (**Fig. 1**)

3.2 Nitrate nitrogen (NO_3)

The oxidation quotient from nitrite nitrogen to nitrate nitrogen in autumn is higher than in summer. At lower temperatures, the activity of microbes is less. In general, oxidation from nitrite nitrogen to nitrate nitrogen is done by nitrite bacteria. Therefore, oxidation occurs in proportion to the activity of aerobic bacteria, and the reverse reaction (reduction) is attributable to anaerobic bacteria. The rate of reduction is higher in summer, but lower in autumn. Therefore, anaerobic bacteria are more numerous in summer, producing more nitrate nitrogen during autumn than during summer. (**Fig. 2**)

3.3 Difference of NO_2 and NO_3

Nitrite nitrogen reacts for nitrate nitrogen by nitrite bacteria, as shown in **Figs. 3**. In addition, the ammonium nitrogen reacts with nitrite nitrogen by nitrobacter, as shown in **Fig. 4**. The existence of aerobic bacteria can be confirmed, but it is conceivable that reduction is performed by nitrate reduction also.

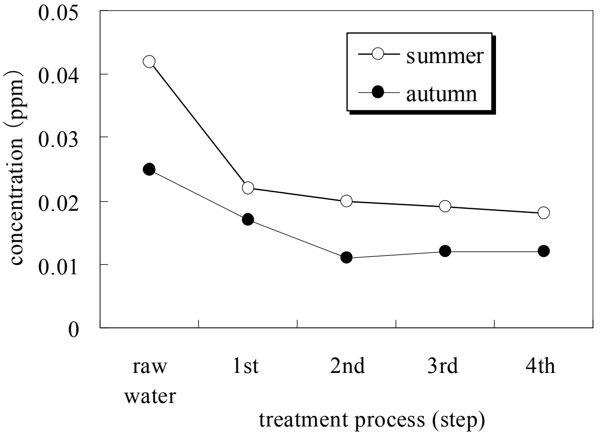

Fig. 1 Nitrite nitrogen concentration under treatment processes of system A

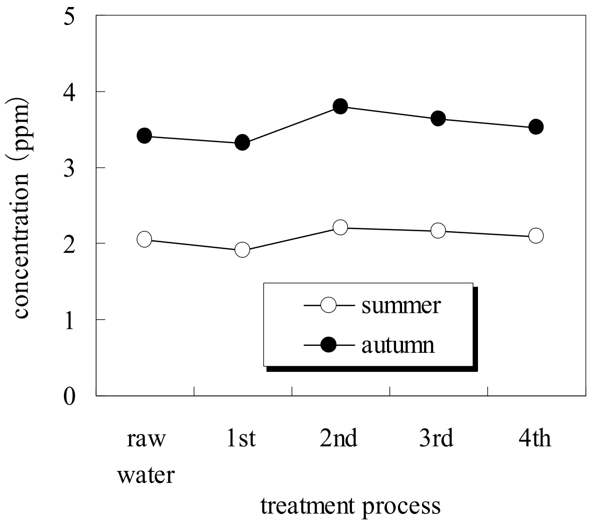

Fig. 2 Nitrate nitrogen concentration under treatment processes of system A

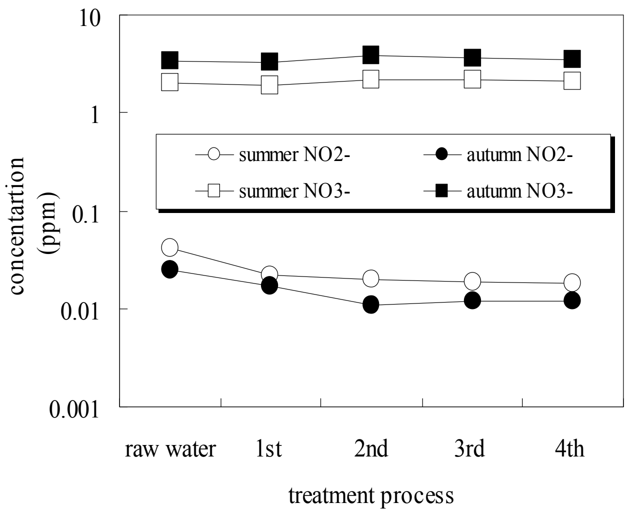

Fig. 3 Nitrite nitrogen and nitrate nitrogen concentrations of respective seasons

3.4 Nitrogen systems in water

In general, nitrogen, which is present in the forms of ammonia, nitrous acid, and nitric acid in water, is transformed to other forms of nitrogen through nitrification. However, not just oxidation, but reduction causes transformation as well. Processing stages of systems which are included in the growth of algae present the possibility of oxidation and reduction according to differences of seasons. Therefore, we estimated the different environmental effects.

3.5 Phosphorus

To prevent eutrophication, phosphorus must be removed. The load of phosphorus in water is artificial, not natural. The main sources of phosphorus discharge are solifluction, fertilizer, domestic wastewater, sewage, commercial effluents, and livestock-related wastewater.

Phosphorus removal methods are coagulation processes and biological treatment processes. The coagulation process uses poly aluminum chloride (PAC). The optimum pH of PAC with phosphorus is about 6 [1]. Phosphorus removal using coagulation processes with raw water in flocculent sedimentation basins was conducted. (**Fig. 5**) The contribution of flocculants was assessed. In addition, considering that the effluent standard in the Water Pollution Control Law is 16 ppm or less, detection of 0.2 ppm in raw water is proof that water treatment has been done.

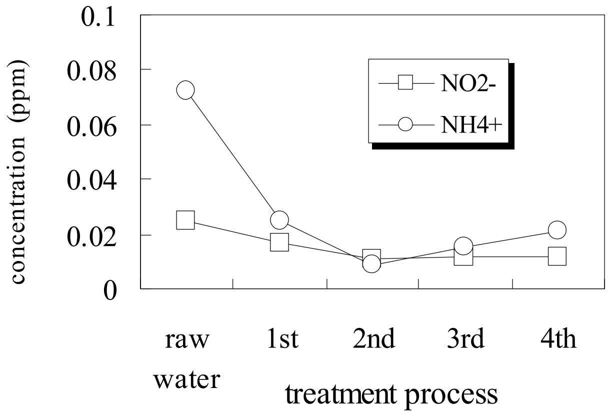

Fig. 4 Ammonium nitrogen and nitrite nitrogen concentrations of processes (autumn)

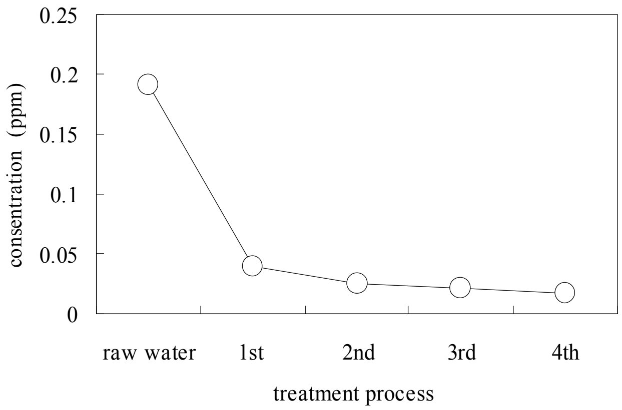

Fig. 5 Phosphorus concentrations in system

3.6 COD (potassium permanganate)

It is conceivable that volatile substances are included because values of the COD measurement results obtained in autumn are lower. In addition, results obtained in the laboratory roughly agree with purification facility results, and measurements of both show good accuracy. However, the results of the COD sampled in summer have uniformity that is shown to increase and decrease, conceivably because organic matter reproduced and underwent photosynthesis by having time free from water sampling until measurement and increase of COD followed. Therefore, the existence of microbes that have undergone photosynthesis from water sampling in summer and autumn was proved. (**Fig. 6**)

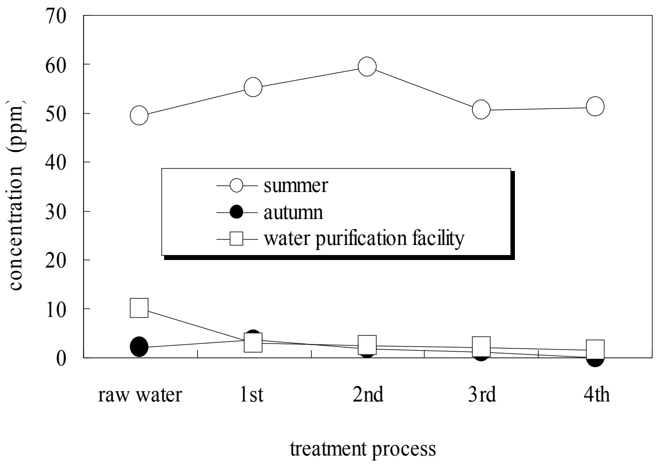

Fig. 6 COD concentrations in respective processes

3.7 Potassium

Potassium is one of three major phytoplankton nutrients. However, phytoplankton performs photosynthesis subject to sunlight intensity and time. Actually, summer sunlight has an extremely strong effect on their activity. Because phytoplankton affect the occurrence of algae, activity in summer creates much algae [2]. Therefore measurement results of summer show that the phytoplankton consume potassium. The optimum temperatures for activity of nitrate-reducing bacteria are 25–30°C. At such times, potassium was detected at low concentrations.

However, phytoplankton activity is worse in seasons other than summer because the temperatures of autumn are lower than those of summer. Furthermore, the activity of nitrate-reducing bacteria decreases greatly, as does the consumed potassium. Consequently, it is conceivable that the concentrations of potassium in water are higher than in summer. (Fig. 7)

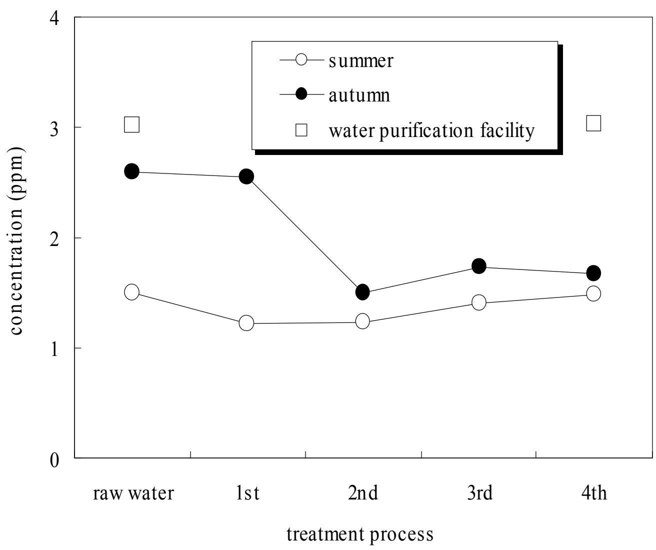

Fig. 7 Potassium concentrations in respective processes

3.8 Aluminum

Aluminum is a constituent element of poly aluminum chloride, which is used as a flocculant.

Results obtained in the laboratory differ greatly from measurement results obtained at water purification plants. A probable reason is the effect of time until measurement from water sampling by differences in summer and autumn. The temperatures of water sampling were 33°C in summer and 21°C in autumn: a difference of about 10°C. Therefore, it is conceivable that the difference explains measurement results obtained in summer and autumn.

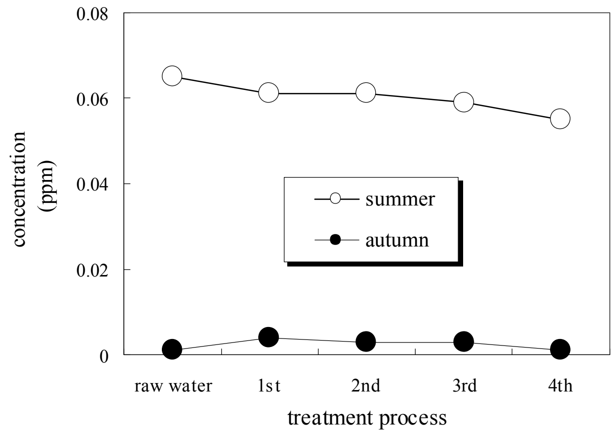

Fig. 8 Aluminum concentrations in processes

3.9 Change of pH with time

Results show that nitrite bacteria exist to a great degree because the oxidation quotient from nitrite nitrogen to nitrate nitrogen in measurement results of nitrate nitrogen in autumn is greater than in those in summer. Hydrogen carbonate ions in nitrifying bacteria emit hydrogen ions in direct proportion to the absorption of ammonia.

Therefore, the main cause of increasing pH is considerable photosynthesis attributable to bacterial activity.

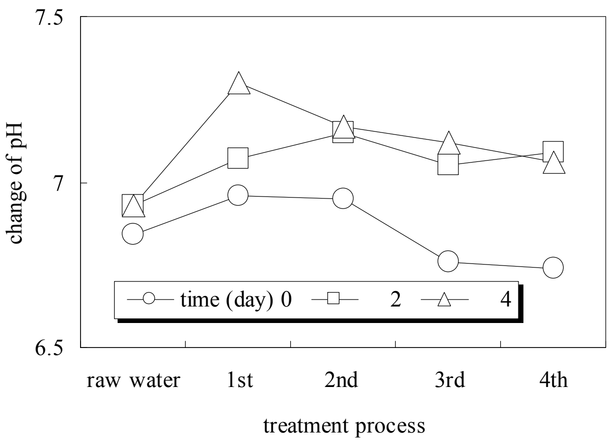

Fig. 9 Change of pH with time

4. Conclusions

This report describes some results obtained from field and laboratory experiments. The following conclusions were reached.

(1) Some ionic behaviors are affected by seasonal differences.

(2) Activity of microorganisms is inferred to affect ionic behaviors. These phenomena are expected to depend on the water environment.

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References

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