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Algae removal characteristics by Light Irradiation Using Natural Coagulants

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Abstract. This study was performed to investigate the characteristics of algae removal using natural coagulants and light irradiation. As a result of experiment, chlorophyll-a and turbidity showed a tendency to decrease as the natural coagulant dosage increased, and an increase in irradiation dose contributed to improving the chlorophyll-a removal efficiency. However, there was no significant change in turbidity.

Keywords: algae, light irradiation, natural coagulants, eutrophication

1 Introduction

There have been frequent outbreaks of algae due to eutrophication in rivers of Korea, and many methods have been developed for removal of algae [1]. Korea has two physicochemical algae removal techniques such as a physical method for removing algae using clay and minerals as algicides and a coagulation and sedimentation technology including natural coagulants [2].

The cell membrane of algae is generally hydrophilic, and it is difficult to remove the highly hydrophilic substance with coagulants. Autotrophic phytoplankton produce organic matter in the process of photosynthesis, most of which is metabolic product and is mainly discharged in the form of extracellular organic matter (EOM) up to 60-70% of the carbon within the cell [3]. In case EOM emissions due to the algae increase during summer months and the target material of the coagulant covers the surface, the induced stabilization of the particles leads to an increase in the coagulant dosage. In addition, the reduction of carbon dioxide in water due to the photosynthesis of algae raises the pH and increases the solubility of the coagulant, thus inhibiting floc formation [4].

There are variety of overseas technologies for algae removal, which include an ozone treatment method, bottom dredging operations, nano-filtration technology, and algae removal techniques using ultrasound and plasma. Of these, the method by

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flocculation floatation is considered to be effective in terms of removing nutrients in water. Therefore this study investigated the algae removal characteristics using natural coagulants and light reaction of algae.

2 Experimental materials and methods

For the specimen used in the experiment, raw water was collected in the Han River, and then algae were cultured with appropriate nutrients. In Jar-test, a 1-liter container was filled with raw water containing algae, and then the specimen was collected from the bottom of the algae after operations with a fast speed of 150 rpm for 2 minutes and slow speed of 30 rpm for 15 minutes. The natural coagulant used in the experiment was composed of natural raw materials, including a plant material such as a chestnut and a mineral material such as zeolite.

The experiment was conducted to investigate the changes in chlorophyll-a and turbidity according to natural coagulant dosage, algae change according to light irradiation dose, and algae removal according to the dose of Kaolin acting as condensation nuclei.

3 Results and discussion

3.1 Algae removal according to natural coagulant dosage

Fig. 1 shows changes in chlorophyll-a and turbidity according to natural coagulant dosage. The algae in raw water was 60 μg/L, Kaolin was injected at a dose of 30 mg/L, and light intensity ranged from 3700 to 5100 lux. The algae removal efficiency according to changes in natural coagulants was investigated in the experiment. According to the experimental results, chlorophyll-a and turbidity showed a tendency to decrease as the natural coagulant dosage increased, and the chlorophyll-a removal efficiency was 79.1-86.9%, and the turbidity removal efficiency was 74.6-88.2%, respectively.

Fig. 2 shows changes in surface area of particles according to natural coagulant dosage. The total surface area of particles was reduced by about 65% at a dose of 20 mg/L, compared to that of the initial specimen, and the number of 2~5 μm increased the most, and the decrement of more than 5 μm was the least. At a dose of 100 mg/L, the total surface area was about 82%, and the decrement of more than 5 μm was greatest.

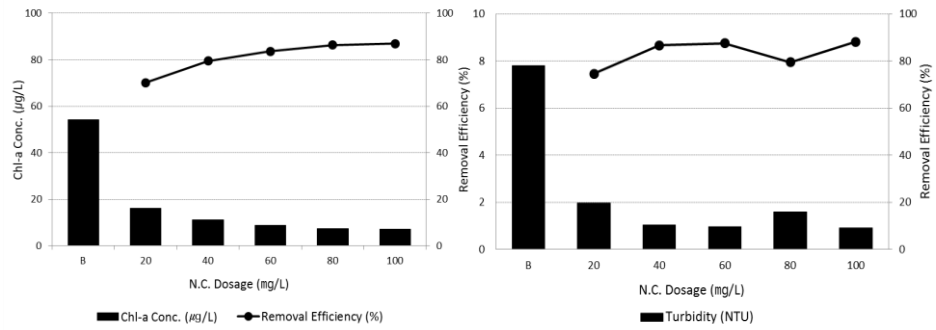

Fig. 1. Changes in chlorophyll-a and turbidity according to natural coagulant(NC) dosage

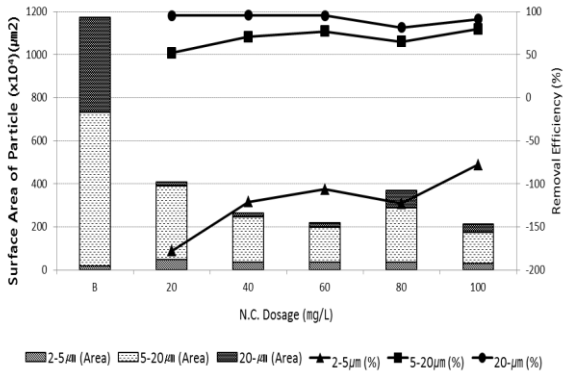

Fig. 2. Changes in surface area of particles according to natural coagulant(NC) dosage

3.2 Algae removal according to irradiation dose

Fig. 3 shows changes in chlorophyll-a concentration and turbidity according to irradiation dose of natural coagulants. As the irradiation dose increased, the chlorophyll-a treatment efficiency also increased, and the removal efficiencies were 17.9, 19.4, 25.4, 28.4 and 34.4% under light intensities of 2000, 4000, 6000, 8000 and 10000 lux, respectively. In the case of turbidity, an increase in irradiation does did not have a significant effect on the changes in turbidity, and the turbidity was found to be slightly increased from 5.2 to 6 NTU as the light intensities increased from 2000 to 10000 lux.

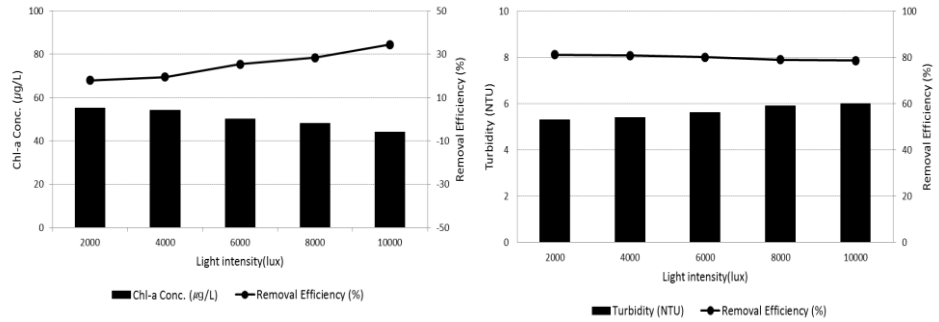

Fig. 3. Changes in chlorophyll-a and turbidity according to light irradiation

3.3 Algae removal according to Kaolin dose

Fig. 4 shows changes in chlorophyll-a concentration and turbidity according to the dosage of Kaolin used as concentration nuclei. Without Kaolin, the initial concentration was 15.3 μg/L, and as Kaolin dosage increased, chlorophyll-a concentration decreased. In the case of Kaolin 20 mg/L, chlorophyll-a concentration decreased to 92.0%, and chlorophyll-a concentration was reduced to 10 μg/L or less at the Kaolin dosage of 80 mg/L.

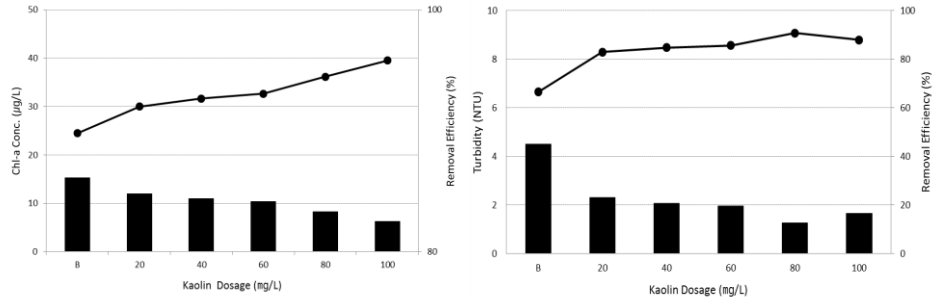

Fig. 4. Changes in chlorophyll-a and turbidity according to Kaolin dosage

4 Conclusion

This study investigated the changes in chlorophyll-a concentration, turbidity and surface area of particles according to the natural coagulant dosage. According to the results, chlorophyll-a and turbidity showed a tendency to decrease as the natural coagulant dosage increased, and an increase in irradiation dose contributed to improving the chlorophyll-a removal efficiency. However, there was no significant change in turbidity.

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