Characterization of Organic Matters in Filtrate Water of Drinking Water Treatment Sludge

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1. Introduction

In water purification plants with rapid sand filtration process, sludge from sedimentation basin is discharged to the thickener tank. The sludge is usually dewatered using various methods, and in some plants, the filtrate water with other wastewater including backwash water is pumped back to the receiving well of raw water. This system is known as a closed system. The filtrate water of sludge can contain many substances including organic matters that may affect purified water quality in terms of residual chlorine consumption. A long-term storage of the sludge under various conditions of temperature or redox potential may vary the filtrate characteristics. In this study, dissolved organic carbon (DOC) characteristics in filtrate water of drinking water treatment sludge was examined in terms of chlorine consumption after one-week incubation of the sludge under both aerobic and anaerobic conditions in different temperatures.

2. Methodology

Sludge was collected at Owari-Toubu water purification plant in Aichi prefecture. Sludge was settled in the sedimentation basin and was discharged to the thickener tanks and filter press is used to filter water from solid phase. The filtrate water obtained from sludge was pumped back as returned water to the receiving well of primary treatment and the solid phase discharged to the cake yard to be dried. The sludge sample were transferred immediately to the laboratory and the sludge was incubated for 7 days under aerobic (A) and anaerobic (An) condition at temperature of 5°C, 20°C and 40°C. After 7 days incubation, the sludge sample was filtrated and the filtrate water was used as sample to be analyzed for UV absorbance, dissolved organic carbon (DOC), SUVA and residual chlorine consumption rate under 20°C.

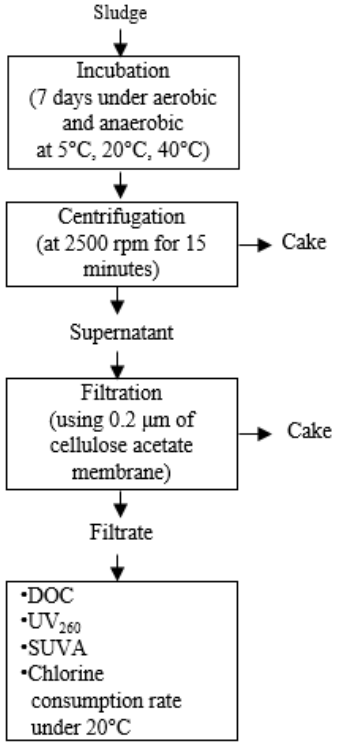

Fig. 1 Flow chart for the filtrate water of sludge analysis

3. Results and Discussion

As shown in Fig. 2, DOC concentration of filtrate water of sludge under anaerobic condition at 5°C (An 5°C) and 20°C (An 20°C) tends to have similar values at 7 mg/L, while DOC concentration under anaerobic condition at 40°C (An 40°C) increased at 15 mg/L, indicating that the biodegradable compounds increased at higher temperature under anaerobic condition regarding to the degradation of the organic matter in the filtrate water and the microorganisms released the organic compound from their cells (He et al., 2011). As for aerobic condition, DOC concentration of filtrate water at 20°C (A 20°C) decreased at 5 mg/L while other two conditions of aerobic at 5°C (A 5°C)and 40 °C (A 40°C) showed the similar value at 8 mg/L. The decreasing of DOC under A 20°C condition probably due to the endogenous metabolisms of microorganisms, and some organic compounds were oxidized to carbon dioxide (He et al., 2011).

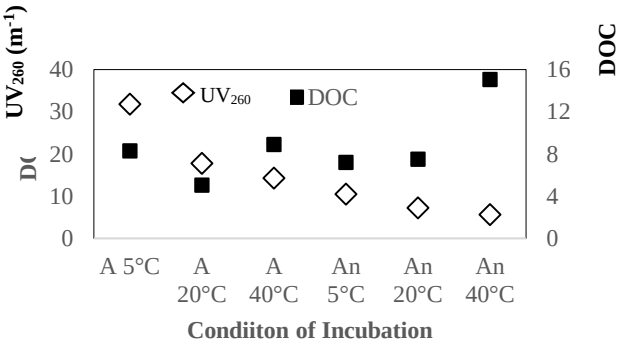

Fig. 2 DOC concentration and UV_{260} distribution of the filtrate water of sludge under incubation condition

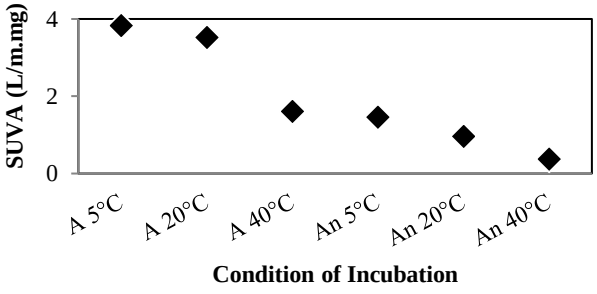

Fig. 3 SUVA distribution of the filtrate water of sludge under incubation condition

UV absorbance was used to define the content of aromatic structure within the dissolved organic matter samples, and SUVA was an indicator of the aromaticity. As shown in Fig. 2, UV_{260} of filtrate water of sludge showed the highest absorbance at 32 m^{-1} and the lowest at 6 m^{-1} under A 5°C and An 40°C condition, respectively. Fig. 3 shows the ratio of UV_{260} and DOC, SUVA, of filtrate water of sludge. Higher SUVA values (> 4) indicate higher aromatic carbon content in organic matter in hydrophobicity and relatively low SUVA value (0.4 L/m.mg of An 40°C) also implied that non-aromatic components of the filtrate water of sludge might be ascribed to the abundant existence of non-aromatic carbon chains, polysaccharides and fatty acids within the filtrate water (Chu, et al., 2008). Since the value of SUVA is under 4 for all conditions, it can be concluded that the organic matter was mainly comprised of the non-aromatic compounds and were predominant in filtrate water of sludge.

Fig. 4(a) shows the correlation of time and chlorine concentration of filtrate water of sludge. It has been observed the kinetics of chlorine decay showed two reaction stages, rapid initial consumption followed by slower consumption. The initial fast decay of residual chlorine can be referred to as highly reactive organic matter in the filtrate water. The second slower consumption is attributed to several competitive reactions, as well as chlorine self-decomposition and humic substances, a major component of natural organic matter, is responsible for the production of organochlorine compound (Thurman, 1985). As results shown in Fig. 4(b), the chlorine consumption rate obtained approximate to the first-order reaction equation. The coefficient showed that the filtered water of sludge incubated under anaerobic condition contains substances with relatively high chlorine consumption properties. It was suggested that filtered water of sludge under An 40°C has the highest chlorine consumption rate at 0.017 hr^{-1} and it was thought that organic matter was generated under anaerobic condition at higher temperature which consumes much chlorine.

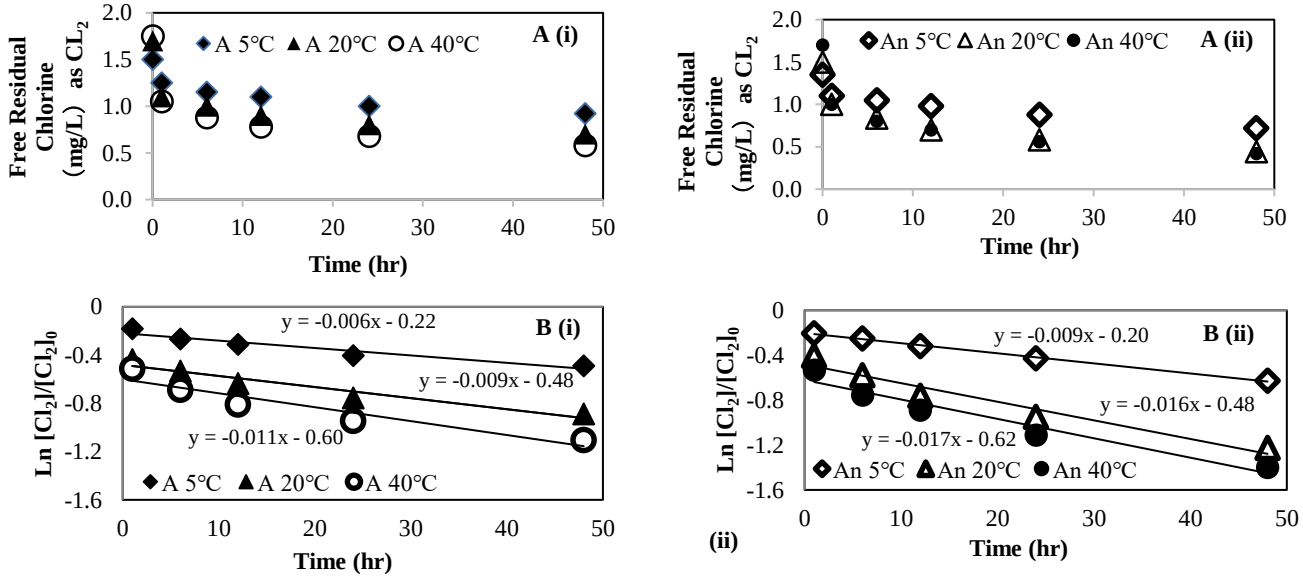

Fig 4. (A) Trends of free residual chlorine concentrations in filtrates of sludge incubated under aerobic **(i)** and anaerobic **(ii)** condition. **(B)** Trends of logarithm of ratio of residual chlorine concentration to the initial concentration in filtrates under aerobic **(i)** and anaerobic **(ii)** condition.

4. Conclusion

In laboratory experiments of sludge incubation, it was showed that much organic matters can be generated in filtrates of drinking water treatment sludge when the sludge was incubated under anaerobic condition at relatively high temperature, 40°C, and it may include highly chlorine consumptive substances. Further studies are needed to identify the substances as well as the mechanism of chlorine consumption by them in water.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number JP17K06616.

References

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