Formulation of Guidelines for B-DASH Project (CO_2 separation / recovery / utilization, use of recycled water) (Study period: Fiscal 2015 and 2016)

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1. Introduction

Sewerage is essential social capital for the life of citizens, and as response to the global warming and tight supply of resources / energy, effective use of sewage resource is sought as well as measures for greenhouse gas reduction. For the effective use of sewage resources, sewage sludge is introduced in the Productivity Revolution Project as "Japan's original resource that can be used variously, such as biogas and sludge fuel, due mainly to the recent technical progress, although it had been disposed of as waste to be used for landfill, etc."

In addition, the "New Sewerage Systems Engineering Vision Acceleration Strategy" (August 2017, Sewerage and Wastewater Management Department, Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") also considers important efficient utilization of sewage resources (carbon dioxide, recycled water, etc.) and "improvement of added value by utilization of sewerage" based on such efficient use.

New technologies responding to such social and administration needs have begun to be developed but are less used in practice since many sewerage service providers are cautious about introduction. For this reason, the Sewerage and Wastewater Management Department of MLIT launched the "Breakthrough by Dynamic Approach in Sewage High Technology" (B-DASH) project in fiscal 2011, and the Water Quality Control Department of NILIM serves as an executing agency of this empirical project. The objective of B-DASH is to verify excellent innovative technologies and formulate guidelines for introducing them and then disseminate this technology in order to realize cost reduction in sewerage service, creation of renewable energy, etc.

2. Outline of the Guidelines

Guidelines were formulated for each technology based on the results of the empirical study and opinions of local governments and evaluated by experts. The guidelines (proposal) are composed as follows (**Table 1**). Next section hereof introduces a part of the content of the guidelines, including the outline of demonstration projects.

Table 1: Composition of Guidelines (proposal)

Chapter 1. General Provisions	Objective, scope of application, definitions of terms
Chapter 2. Outline of the Technology	Characteristics of the technologies, conditions of application, evaluation results
Chapter 3. Consideration of Introduction	Introduction examination method, examples for examination of introduction effect
Chapter 4. Planning and Design	Introduction plan, design
Chapter 5. Maintenance	Check items, frequency, etc.
Reference Data	Verification results, case study, etc.

3. Outline of the demonstrated technologies, etc.

(1) Empirical study on the technology for separation / recovery of CO_2 in biogas and application to microalgae culture (Joint Research Organization of Toshiba Corp., Euglena Co., Ltd., Nikkan Tokushu Co., Ltd., Nihon Suido Consultants Co., Ltd., Japan Sewage Works Agency, and Saga City)

This study demonstrated the performance of CO_2 separation / recovery, performance of producing microalgae, performance of removing nitrogen and phosphorus in dehydrated separated liquid, business potential of the entire system, etc. by separating / recovering CO_2 from biogas and culturing microalgae (euglena) using the recovered CO_2 and dehydrated separated liquid, etc. (Figure 1)

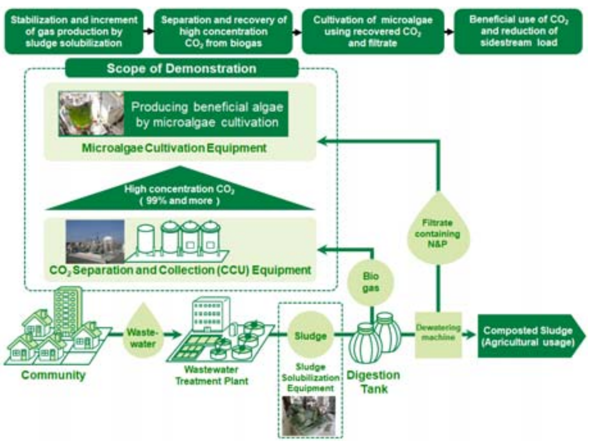

Figure 1: Technologies for CO_2 separation / recovery and application to culture of microalgae

Note that euglena is expected to be used as foodstuff, coloring matter, biofuel, etc. Considering such usability, we used euglena as microalgae in this empirical study.
In the "CO_2 separation / recovery technology," we verified that high concentration CO_2 (99% or more) is recoverable from biogas. With regard to "microalgae culture facilities," we also verified that culture of microalgae (euglena) is possible using CO_2 there and nitrogen / phosphorus in dehydrated separated liquid. We further verified that generation of biogas will increase by annexing "sludge solubilization facility." It is estimated from the trial calculation that when this technology is applied to a treatment facility capable to process 50,000 m^3/day, about 130 tons/year will be used effectively and about 75 tons of microalgae are producible.
This technology is expected to lead to shift in thinking from "Reduce CO_2" to "Utilize CO_2," and further contribution of future sewerage service to recycling society is expected from this technology.

(2) Empirical study on the regeneration system for sewage treatment water (Joint Research Organization of Nishihara Environment Co., Ltd., Tokyo Engineering Consultants Co., Ltd., Kyoto University, and Itoman City).
As a technology for supplying safe, stable and highly reliable sewage treatment water at low cost with energy saving by reducing pathogen risk on humans by virus etc. through combination of filtration with UF membrane (filtration membrane with pore size of 0.01 μm) and ultraviolet disinfection, we verified virus removal performance, life cycle cost, greenhouse gas emissions, etc. (**Figure 2**)
This technology is based on the combination of filtration with UF membrane (ultra-filtration) and ultraviolet disinfection. We set target assessment values for virus infection risk assuming the use of treatment water in urban areas where people may contact with the water and the use as agricultural

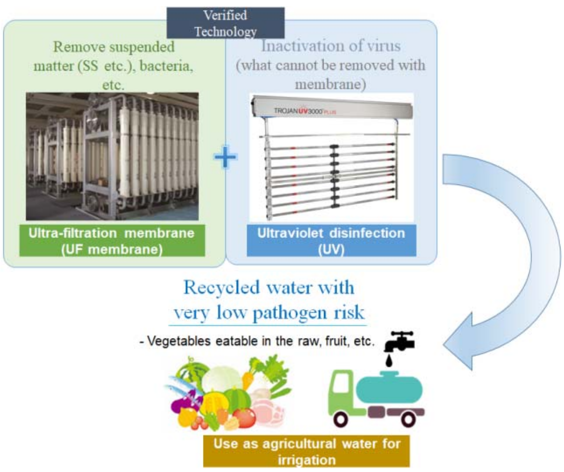

Figure 2: Flow of the recycling system

water for irrigation, and verified that target values can be achieved. It was also verified that life cycle cost and greenhouse gas emissions can be reduced 13.0% and 20.6% respectively more than the reduction by conventional technology (flocculant-added sand filtration + ultraviolet disinfection). In addition, we verified the operation management method to secure the reliability of the entire system.
This technology effectively uses the water potential of sewerage in areas where the supply and demand of water resources are tight, and is expected to contribute to establishment of a society that creates abundant water environment and new values through cooperation with various fields.

4. Utilization of results and future development
NILIM established guidelines based on the results of verification and, in order to introduce these guidelines to local governments and sewerage-related enterprises, etc., held the Guidelines Presentation at Tokyo Big Sight in August 2017, attended by about 80 people. Through the holding of such presentation etc., we intend to actively introduce the guidelines to disseminate the technology.

Photo: Guidelines presentation

☞**See the following for details.**
[Reference] Guidelines posted
http://www.nilim.go.jp/lab/ecg/bdash/bdash.htm