Stock management and improvement of energy efficiency of wastewater systems

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1. Introduction

To deal with water pollution after a period of high economic growth, wastewater systems have been considered to be important water pollution control facilities, and have been actively developed. As a result, 77% of the population has adopted wastewater systems. The total cumulative length of wastewater systems is 460,000 km (corresponding to 11 times around the earth), and the number of sewage facilities has reached approximately 2,200. In the future, it is estimated that there will be an increase in the number of older pipes and facilities still in use a long time after their construction, which will make it necessary to perform appropriate stock management to maintain the functions of wastewater systems.

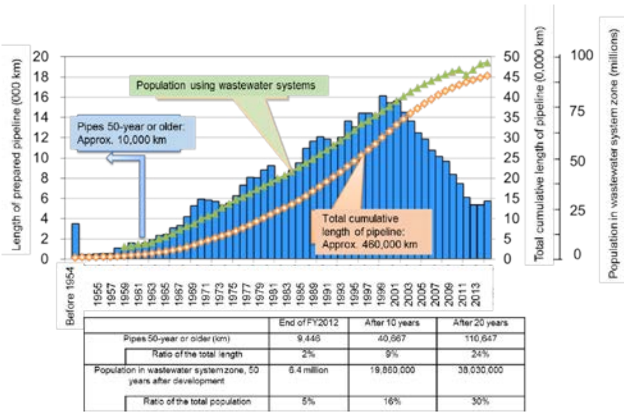
Along with the development of wastewater systems, three-quarters of domestic wastewater passes through the wastewater systems, and the total electric energy consumed by the wastewater systems is approximately seven billion kWh/year, making up approximately 0.7% of the total electric power consumption in Japan. While activities to improve the energy efficiency of wastewater systems are being conducted to prevent global warming, the effective use of the sewage sludge generated in the wastewater treatment process is limited, although this is a potential energy source. Thus, it is also important to develop technologies that allow the effective use of sewage sludge energy.

In addition, the Water Quality Control Department of the NILIM, as a national institute having wide and comprehensive views, manages the national technical policies of wastewater systems, toward which each local government has a direct responsibility.

2. Stock management of wastewater systems

Because wastewater pipelines, which have rapidly developed since around 1955 and will be aged in the future (Figure 1), may cause road cave-ins when corroded (Figure 2), we have to treat deteriorated wastewater pipelines appropriately.

However, the current investigation method only checks 1% of the total length of the pipelines per year. Therefore, (1) an effective new investigation method, (2) a deterioration judgment standard corresponding to the new investigation method, and (3) a selection method for appropriate repair and reconstruction technologies are required.



	End of FY2012	After 10 years	After 20 years
Pipes 50-year or older (km)	9,446	40,667	110,647
Ratio of the total length	2%	9%	24%
Population in wastewater system zone, 50 years after development	6.4 million	19,860,000	38,030,000
Ratio of the total population	5%	16%	30%

Figure 1: Development and total cumulative length of wastewater pipelines

Figure 2: Corroded wastewater pipeline (left) and cave-in of walkway (right)

Concerning (1), we will clarify factors affecting the deterioration using a pipeline information database, and set up a system to detect points needing early investigation. In addition, to promote a quick and inexpensive diagnosis after a deterioration investigation, we will develop, introduce, and evaluate research robots, etc. In addition, to detect air holes outside a wastewater pipeline to estimate its deterioration, we will utilize technology to detect the symptoms of road cave-ins with the "Breakthrough by Dynamic Approach in Sewage High Technology Project (B-DASH project)."

Concerning (2), we are waiting for a newly developed investigation method, and will create a deterioration judgment standard based on the relationship between the acquired data and deterioration levels. Concerning (3), we will set up a method to select an appropriate construction method based on the pipeline problems, considering the partial regeneration technology that has recently been developed.

As previously mentioned, we intend to prevent the road surface cave-ins and functional disorders caused by deteriorated wastewater systems, and contribute to a reduction of the public financial burden, and sustainable public services.

3. Improvement of energy efficiency of wastewater systems

The amount of energy consumed by sewage-treatment plants has been increasing, along with the increase in the amount of treated wastewater (Figure 3). Because the energy consumed for wastewater treatment makes up approximately 40% of the total electric power consumption, it is necessary to further improve the energy efficiency of the oxygen supply for wastewater treatment, in order to reduce the amount of energy consumption.

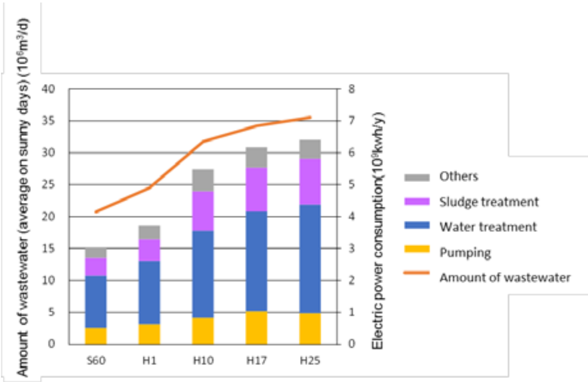


Figure 3: Transition in amount of wastewater and energy consumption in sewage-treatment plants

Nitrogen and phosphorus removal processes have recently caused an increased need for oxygen, and therefore consume much energy. In the B-DASH project, we will demonstrate technologies to continuously measure the dissolved oxygen (DO) and ammonium nitrogen (NH_4-N) concentrations in reactors to control the air supply, allowing an appropriate oxygen supply by avoiding its excess .

Moreover, although the biofilm process adopted by many small plants is losing ground because of problems such as turbidity in treated wastewater, its energy consumption is smaller than the activated sludge processes. Therefore, we will consider improving the pre- and post-treatment methods of the biofilm processes, along with optimization of the bioreactor maintenance method, and demonstrate an energy consumption reduction in the B-DASH project.

Concerning the energy recovery from sewage sludge, in order to support the development of a hydrogen society, we will demonstrate a technology to create hydrogen from digestion gas, along with a technology to effectively collect and use methane gas from multiple sewage-treatment plants in the B-DASH project.

With the technologies mentioned above, we intend to contribute to the prevention of global warming and the improvement of the management of wastewater systems by reducing their energy consumption.

4. Management of technology development of wastewater systems

Although wastewater projects are operated by local government, the following issues are important from a national comprehensive viewpoint.

○ To collect and analyze basic information regarding the wastewater systems in terms of their development, maintenance and disaster prevention, which should be the basis for national technical policies.

○ To clarify technical problems based on the analyzed information, and develop, introduce, and evaluate the required technologies

○ To determine the direction of future wastewater technologies, and manage the roles of industry, government, and academia for effective technology development

○ To analyze, evaluate, and introduce advanced knowledge for the development of future technologies

To support these goals, the Water Quality Control Department of the NILIM prepared the "Vision for wastewater technology" in FY2015, which provides the long- and mid-term orientation of the wastewater technologies.

The vision states that it is necessary as follow-ups to check the progress of the planned development and evaluate whether the promotion measures are working, and also to consider new topics corresponding to social changes, needs and demands for new technologies, and important programs and their goals. To meet these requirements, the Water Quality Control Department of the NILIM has taken an action of establishing a committee for technology development in wastewater fields consisting of industry, government, and academia, and will manage the follow-up of the vision and the improvement of the promotion measures for technology development, etc.