Empirical Study on B-DASH Project (ICT-applied operation management / deterioration diagnosis)

YAMASHITA Hiromasa, Head, TAJIMA Atsushi, Senior Researcher, SHIGEMUARA Hiroyuki, Senior Researcher, MICHINAKA Atsuko (Dr. Eng.), Researcher, MATSUMOTO Ryu, Researcher, ITAKURA Mai, Researcher, YAMAGUCHI Shuji, Guest Research Engineer
Wastewater and Sludge Management Division, Water Quality Control Department,

(Key words) sewerage, water treatment, ICT, energy saving, operation management, maintenance, deterioration diagnosis, innovative technology

1. Introduction

Since fiscal 2011, the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") has been implementing the "Breakthrough by Dynamic Approach in Sewage High Technology" (B-DASH) project, and the NILIM has been serving as an executing agency of this empirical study. The objective of this project is to realize the reduction of cost and energy consumption, etc. in whole sewerage works by promoting disseminating and development of innovative technologies through demonstration, and to support the overseas development of the water business by Japanese enterprises.

In addition, ICT (Information and Communication Technology) is expected as means of solution in sewerage works, as known from the holding of the "Workshop on ICT Utilization in Sewerage" in fiscal 2012 by the MLIT.

This paper introduces the outlines of two empirical studies that started in fiscal 2014 for operation control technology using ICT and another two empirical studies that started in fiscal 2015 for technology to diagnose sewerage deterioration using ICT.

2. ICT-applied operation management technology for water treatment facilities

(1) Empirical study on efficient water-treatment operation management technology by process control and remote diagnosis using ICT (Joint Research Organization of Toshiba Corp., Japan Sewage Works Agency, Fukuoka Prefecture, and Public Interest Incorporated Foundation Fukuoka Prefecture Sewerage Management Center)

The technology discussed herein is a system with combination of three component technologies: (i) Aeration air-flow control technology using NH_4-N sensor, (ii) Control performance improvement technology, and (iii) Multivariate statistical process monitoring technology. Aeration air-flow control technology using NH_4-N sensor aims to reduce aeration air-flow while keeping the target water quality by utilizing dissolved oxygen (DO) sensor and NH_4-N sensor. Control performance improvement technology aims to reduce the operation risk such as water quality deterioration while enhancing control effect using NH_4-N sensor by conducting automatic diagnosis and adjustment of control parameters. Multivariate statistical process monitoring technology detects abnormal signs and estimates causes of abnormality by analyzing correlation of many process data in treatment facilities by statistical approach.

The fiscal 2014 empirical study achieved certain results for cost reduction and energy saving effects, etc. and in fiscal 2015, verification throughout the year is going on as well as verification of total effects on combination of the aforementioned three technologies.

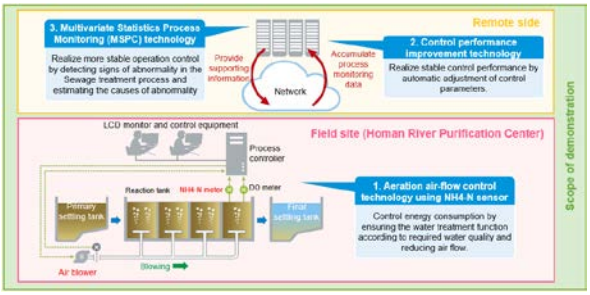

Figure 1: Process control and remote diagnosis technology

(2) Empirical study on technology for practical use of ICT-applied efficient operation control for nitrification (Joint Research Organization of Hitachi Ltd. and Ibaraki Prefecture)

This technology enables both stable processing and reduced aeration air flow in combination of feedforward (FF) control to forecast air flow required for processing and Feedback (FB) control to determine air flow based on difference between forecast and measured values by utilizing information measured by two ammonia meters, one of which was intalled at the upstream of the aerobic tank and the other, at the middle of aerobic tanks. The model used for mathematical operation is automatically updated every day based on the ammonia concentration processed while passing through the ammonia meters at two points and the value of accumulated air flow provided during the processing and consequently data on changes in the processing property caused by active sludge (microorganism) is continuously incorporated into FF control to continue demonstration for enhancing the efficiency of maintenance work.

The fiscal 2014 empirical study has achieved the target effect of air flow reduction while keeping treatment water quality. In fiscal 2015, year-round verification is going on.

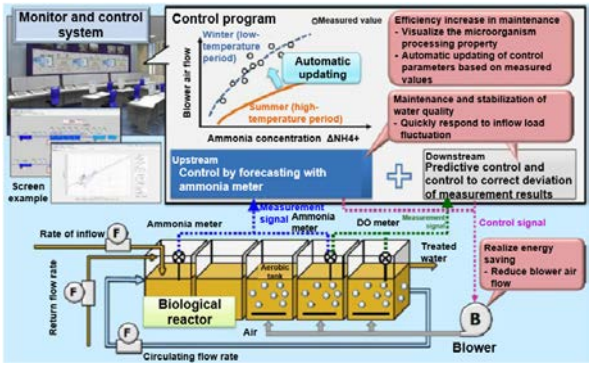

Figure 2: Outline of the monitoring and control system for nitrification operation

3. Technology to diagnose sewerage deterioration using ICT

(1) Empirical study on technology for grasping / diagnosing deterioration of sewerage facilities by vibration diagnosis and big data analysis (Joint Research Organization of Water Agency, NEC, Asahi Kasei Engineering, Japan Sewage Works Agency, Moriya City, and Hidaka City)

This technology is a combination of sensing technology and big data analysis technology. The sensing technology detects deterioration by continuous monitoring using vibration sensors installed on rotating equipment such as pumps and blowers. The big data analysis technology detects signs of abnormality and forecasts deterioration by conducting big data analysis using a large amount of operation data for all facilities and vibration sensor data ("big data"). Then, we demonstrate that promotion of efficient facility management by condition-based maintenance can be achieved by combination of the two technologies above.

In fiscal 2015, we are continuing demonstration in order to verify that the sensing technology can extend the overhaul interval of equipment and the big data analysis technology can detect signs of abnormality earlier as compared with the conventional technologies.

(2) Empirical study on technologies for deterioration diagnosis and equipment inspection by sensor continuous monitoring and cloud server concentration

(Joint Research Organization of Swing Corporation and Sendai City)

This technology is a combination of equipment state monitoring by sensor and tablet inspection system. Equipment state monitoring by sensor targets blowers and main pumps and continuously monitors vibration, temperature, and sound by sensor to transmit monitoring data to the cloud server. Tablet inspection aims to digitalize inspection record in normal daily inspections by introducing tablet system instead of recording in the conventional paper form.

Then, we demonstrate that combination of these two technologies will lead to establishment of an efficient equipment degradation diagnosis method and to effective use of accumulated diagnosis data to stock management. In fiscal 2015, we are working for collection of vibration data etc. by sensor and collection of data through tablet inspection.

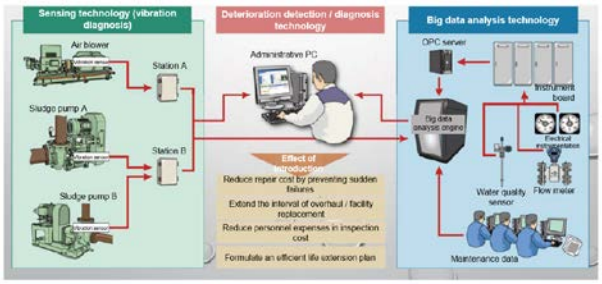

Figure 3: Sensing technology and big data analysis technology

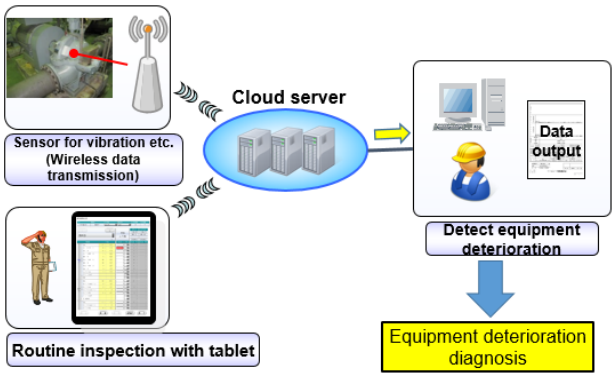

Figure 4: Technology for equipment deterioration diagnosis, etc. using sensor, etc.

4. Future development

The NILIM will continue to lead the B-DASH Project and formulate guidelines for innovative technology introduction based on results obtained from the Project and disseminate / promote such technologies. With these technologies, we endeavor to promote power saving in water treatment and improve the accuracy of deterioration diagnosis for sewerage facilities using ICT.

[Reference]

http://www.nilim.go.jp/lab/ecg/index.htm