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Mitsubishi Electric Develops AI-based Aeration Control Technology for Biological Wastewater Treatment

Will realize highly energy-efficient wastewater treatment

TOKYO, January 22, 2020 – Mitsubishi Electric Corporation (TOKYO: 6503) announced today that it has developed aeration control technology to reduce the electric power consumption for supplying air (aeration) to biological reactors[1] which is essential for biological wastewater treatment. By leveraging the company's Maisart®[2] artificial-intelligence (AI) technologies, the system accurately predicts the quality (ammonia concentration) of the water flowing into the reactor over the following few hours.

The control of aeration levels at individual section of the reactor will achieve approximately 10 %[3] reduction in the total amount of aeration,compared to the conventional methods.This will lead to a reduction in the power consumption of biological wastewater treatment plants, which consume about 7 billion kWh of electricity annually, equivalent to about 0.7% of total electric power consumption in Japan.

The company is aiming to commercialize operation control systems using the new technology within fiscal year ending in March 2021.

[1] In general wastewater treatment, oxidation treatment using microorganisms is carried out to remove ammonia and organic matters.
[2] Mitsubishi Electric's AI creates the State-of-the-ART in technology.
[3] Based on the results of simulations using actual wastewater treatment data.

Maisart

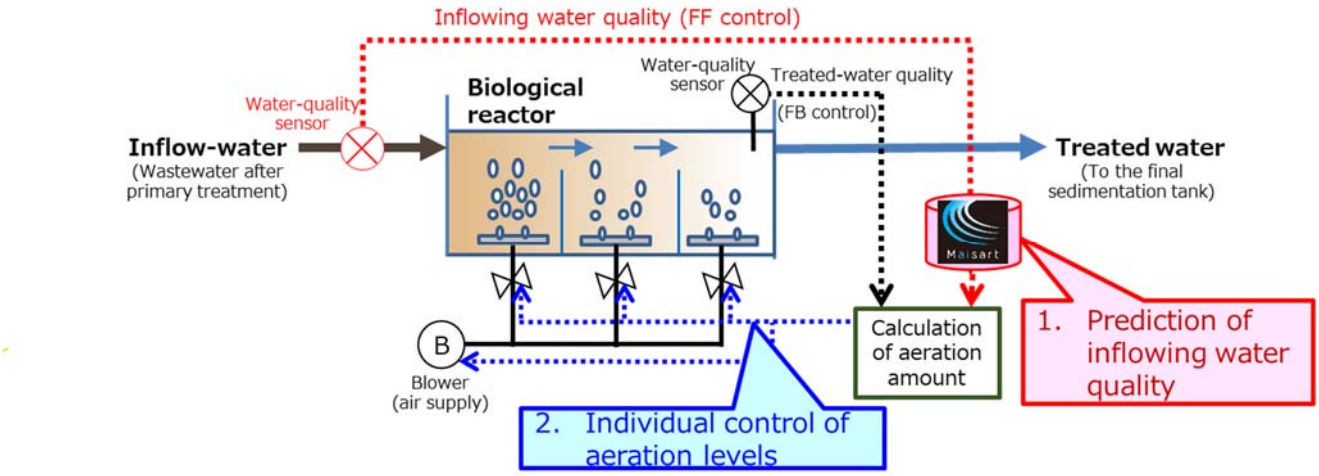

Fig. 1 AI-based Aeration Control Technology

Key Features

1) AI-based aeration control by highly accurate prediction of quality of the water flowing into the reactor

Even in clear weather where the quality of the water flowing into the reactor is relatively stable, the ammonia concentrations of the water may fluctuate by as much as 50 percent. In conventional systems, in order to maintain the quality of treated water, an excessive amount of air has to be supplied owing to delays in the aeration control, and thus the ammonia concentration may temporarily decrease by more than needed, resulting in excessive aeration. (Fig.2)

In order to improve responsiveness, FF (feed forward) control based on the quality (ammonia concentration) of the water flowing into the reactor, is combined with conventional FB (feedback) control based on the measured value of the quality of the treated water. The company's new algorithm further improves responsiveness by utilizing AI to predict the quality of the inflowing water over the following few hours.It achieves this by analyzing the current fluctuation patterns using an accumulated database. By searching for multiple data patterns that resemble the current fluctuations and calculating a predicted value using those patterns, the system can select the optimal data on which to base its predictions. This makes the prediction less susceptible to abnormal data caused by factors such as heavy rain or instrument failure. In addition, the database can be automatically updated to maintain accurate predictions. This technology is particularly effective when the flowrate and/or ammonia concentration of water flowing into the reactor gradually decreases.

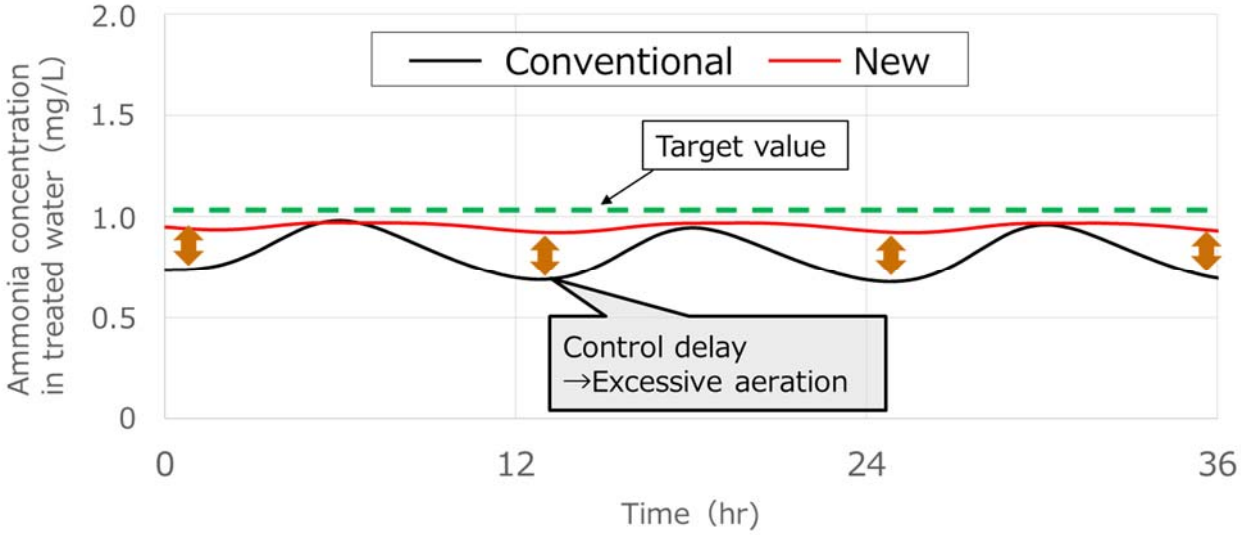

Fig. 2 Suppressing effect of control delay (simulation results)

2) Aeration control at individual section of the reactor realizes approximately 10% reduction in overall aeration levels

In conventional processing plants, the aeration levels across the all sections of the reactor is uniformly controlled, resulting in uneven treated water quality and excessive aeration. The new algorithms accurately adjust aeration levels by applying weighting to the control parameters for each section. As a result, overall the aeration levels can be reduced by approximately 10 percent compared to conventional methods, while the quality of the treated water is maintained.

Overview

	Method	Features
Conventional	FB control based on treated water quality	・ Control based on quality sensor values of the treated water ・ Control delay due to fluctuation of inflowing water quality ・ Excessive aeration due to the uniform control of aeration levels across all sections of the reactor
New	Combination of FF control based on the predicted value, and FB control based on the treated water quality	・ AI predicts the inflowing water quality several hours ahead, based on the sensor value of inflowing water quality ・ Improved responsiveness to water quality fluctuations ・ Reduces aeration levels by 10% through individual control of each section of the reactor

Background

Wastewater treatment in Japan uses about 7 billion kWh of electricity annually, which is equivalent to approximately 0.7% of the total electricity consumption or the electricity consumption of 1.68 million households annually in Japan. In general wastewater treatment plant, microorganisms are used in reactors to remove ammonia and organic matters from the primary-treated water, and the aeration which supplies oxygen necessary for the microbial reaction accounts for approximately one half of the total power consumption of the plant. In a trend of global warming prevention, maintaining the high quality of the treated water and reducing the electric power consumption needs to be realized at the same time.

Contribution to the Environment

The new technology has the potential to be deployed in both activated sludge processes[4] already widely used in wastewater treatment plants, and in membrane bioreactors[5], use of which is expected to expand in the future. It enables highly efficient and high quality water recycling and water supply, and will contribute to the realization of a sustainable society as a result of energy conservation it will facilitate at wastewater treatment plants in Japan and around the world.

[4] Water treatment method that separates treated water by sedimentation after oxidizing and decomposing ammonia and organic matters by microorganisms
[5] Water treatment method that separates treated water by membrane filtration after oxidizing and decomposing ammonia and organic matters by microorganisms

About Maisart

Maisart encompasses Mitsubishi Electric's proprietary artificial intelligence (AI) technology, including its compact AI, automated design deep-learning algorithm and extra-efficient smart-learning AI. Maisart is an abbreviation for "Mitsubishi Electric's AI creates the State-of-the-ART in technology." Under the corporate axiom "Original AI technology makes everything smart," the company is leveraging original AI technology and edge computing to make devices smarter and life more secure, intuitive and convenient.

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About Mitsubishi Electric Corporation

With nearly 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Embracing the spirit of its corporate statement, Changes for the Better, and its environmental statement, Eco Changes, Mitsubishi Electric endeavors to be a global, leading green company, enriching society with technology. The company recorded a revenue of 4,519.9 billion yen (US$ 40.7 billion*) in the fiscal year ended March 31, 2019. For more information visit:
www.MitsubishiElectric.com
*At an exchange rate of 111 yen to the US dollar, the rate given by the Tokyo Foreign Exchange Market on March 31, 2019