Application of AOSD System as Energy Saving and Advanced Wastewater Treatment Technology to Vietnam and Spread to Asia

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Abstract

Automatic Oxygen Supply Device (AOSD) system is the latest environment renovation system which supplies only the necessary quantity of oxygen of the microorganism in the advanced sewage treatment with efficient electric power reduction. It also contributes to COP21 including a basin of lakes and marshes. In the sewage treatment process, optimal oxygen amounts required for organic matter removal, nitrogen nitrification-denitrification etc. are predicted by using some parameters such as water temperature and dissolved oxygen (DO), and efficiency of blowers and stirrers can be operated automatically. As the model project of Asia Water Environment Improvement by Ministry of the Environment of Japan, "Vietnam's sophistication of wastewater treatment and cost saving response control system dissemination project" has been carried out. By this project advanced BOD, nitrogen and phosphorus removal have been accomplished and verified with more than 50% electric power reduction in combination with AOSD system, simultaneously. It is important to spread to other Asian regions.

1. Introduction

For the restoration and preservation of lake areas, nitrogen and phosphorus removal and energy saving technologies are very important.

The energy for aeration in the aeration tank usually occupies large part of total energy consumption in wastewater treatment plants. An oxic-aeration blower usually needs its operation of 24 hours. Automatic Oxygen Supply Device (AOSD) system is one of the best ways for energy-saving equipment for improving advanced treated water quality. The application of this equipment will serve to improve water quality, reduce electricity cost by constantly sending to CPU-PLC information signals regarding temperature and dissolved oxygen to work out the nitrification-denitrification velocity and the proper aeration hours and the system off-aeration time. The time length for aeration depends on the load of inflowing organic substances. Automatic controls of aeration enable advanced sewage disposal, by maintaining pH for proper bio-treatment, depending on pH decrease by nitrification or pH increase by denitrification. Moreover, the Innovate AOSD system could confirm the stability of water treatment power reduction performance and best biota under on/off aeration, automatically.

In the last fiscal year, we created relationships with related government and companies in the verification, determined the candidate sites for demonstration with AOSD system which can improve performance of wastewater treatment and save cost for aeration, and investigated the conditions such as treatment method and water qualities. As a result, 4 sites were selected for the demonstration in this fiscal year as follows:

1）Binh Hung Wastewater Treatment Plant at Ho Chi Minh City managed by Steering Center of the Urban Flood Control Program;

2）Thu Dau Mot Wastewater Treatment Plant at Binh Duong Province managed by Binh Duong Water Supply – Sewerage – Environment Co., Ltd. (BIWASE);

3）Wastewater Treatment facility at industrial park at Binh Duong Province managed by Investment and Industrial Development Corporation (BECAMEX);

4）Wastewater Treatment facility for food processing factory at Mekong Delta area managed by a private company.

2. Materials and methods

AOSD systems have been introduced as a main target for Asian water environmental improvement, restoration and preservation.

The effect values on the introduction of AOSD system have been evaluated by the road map building of the spread development for environment protection revival plan in Asia.

Methods and procedures for analyzing advanced function and electric power cost reduction with the introduction of AOSD systems in different 4 sites treatment plants are shown in **Fig. 1.** An analysis was based upon ISO/IEC 17025. Electric energy measurement was calculated from measurement using an integrating wattmeter and the running time of the blower. The newly developed AOSD system was introduced to following four different demonstration sites which the treatment capacity reached 1) 140,000 m^3/day, 2) 17,000 m^3/ day for sewage-treatment plants, 3) 1,000m^3/day for industrial park processing institutions and 4) 500m^3/day fish processing effluent treatment facilities, respectively.

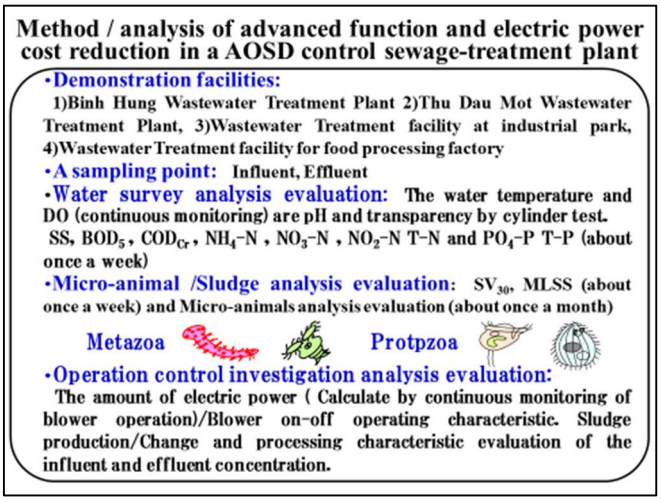

Fig. 1 Methods and analysis of advanced function and electric power cost reduction in AOSD control sewage-treatment plants

These results can be contributed to the restoration and preservation of the Lake Kasumigaura catchment in Japan too.

3. Results

The results carried out in four different demonstration sites can be summarized as follows.

AOSD system introduction at a sewage-treatment plant, about more than 30-60 % of electric power reduction, the effluent water quality below 10mg/L of T-N and the BOD were achieved by the base of the most suitable DO control. And it was found that a phosphorus outflow load can be reduced nearly about 50 % compared with the existence system.

In the case of introducing AOSD system for HRT about 2.8 hours of 141,000 m^3/ day, we changed the aeration cycle from former 2 hours for 1 cycle to 1 hour, nearly 60 % of power reduction effectiveness, and T-N and the BOD concentration less than 10mg/L was obtained. Continuous aeration for 24 hours has been caused and occurred dispersion of activated sludge in low loading in the time when that inflow large rain fall, reduction of inflow raw water volume and system trouble appears. But, aeration time has been reduced less than nearly 10 minutes for 1 cycle under the AOSD introduction system in comparison with conventional 60 minutes. And advantage of an artificial intelligence (AI) system was inspected. The results are shown in **Figs. 2** to **4** and **Tables 1** and **2**.

4. Discussion

4.1 Binh Hung Wastewater Treatment Plant

It succeeded that the performance of AOSD control was reproduced by the open and close of the air-flow valves on site without any influences to existing blower. And further reducing the amount of air for aeration was able to make the gently mixing under the anoxic condition. As a result, AOSD system could improve the performance of nitrification and denitrification, and the removal rate for nitrogen was higher than that in the existing system. The results indicated that AOSD system reduced 13% (5,587 kg) of the load of nitrogen discharged to the natural environment compared with existing system during the demonstration. The reduction ratio of electricity consumption calculated by the opening time and closing time of air-flow valves was 42~61% with high performance, although it fluctuated in consequence of seasonal change.

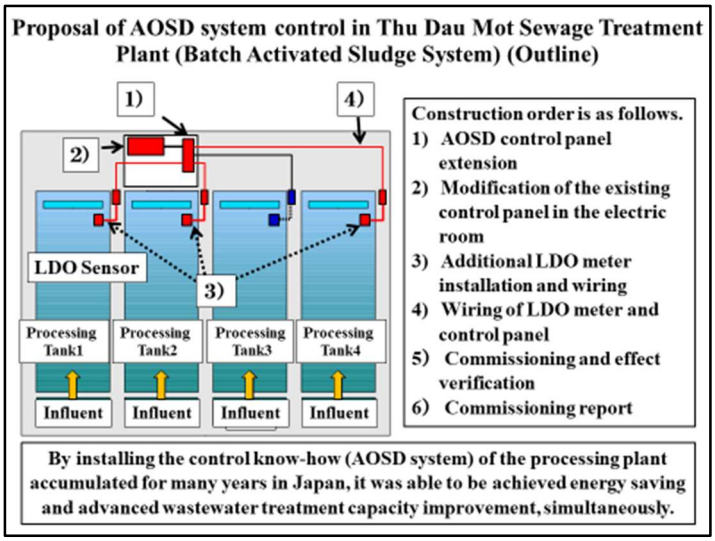

Fig. 2 Effectiveness of AOSD installation at the Thu Dau Mot Wastewater Treatment Plant

Table 1 Operation conditions at the Thu Dau Mot Wastewater Treatment Plant before installation of AOSD system

Operation	Time
Aeration	120min
Stirring	48min
Settle（Precipitation）	60min
Supernatant discharge	60min
Per 1 cycle	288min (4.8hr)
Per 1 day	288min * 5 cycle= 1,440min (24hr)

Table 2 Operation conditions at the Thu Dau Mot Wastewater Treatment Plant after installation of AOSD system

Operation	Time
Aeration	56min
Stirring	112min
Settle（Precipitation）	60min
Supernatant discharge	60min
Per 1 cycle	288min (4.8hr)
Per 1 day	288min* 5 cycle= 1,440min (24hr)

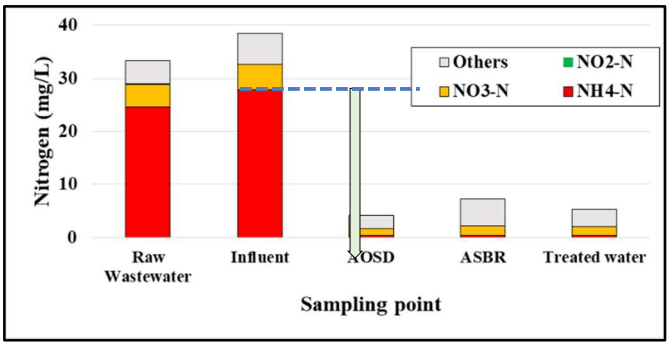

Fig.3 Trends of concentrations of NH_4-N, NO_2-N, NO_3-N in the Thu Dau Mot Wastewater Treatment Plant

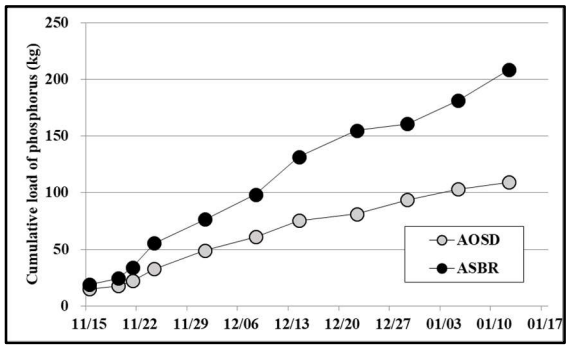

Fig.4 Reduction effect of phosphorus load

4.2 Thu Dau Mot Wastewater Treatment Plant

AOSD system carried out the improvement of wastewater treatment and saving electric consumption at the same time with higher performances even though the existing system was already installed PID control program to save electricity with DO sensor. In particular, 35.2 minutes of aeration time can be reduced, and reduction ratio of electricity consumption was 15.5% compared with existing system. High performances to treat organic pollutants such as BOD and COD and SS were maintained, and thus treatment of nitrogen was improved. It is particularly worth noting that phosphorus removal was improved dramatically compared with existing system. Therefore, AOSD system reduced 47.1% load of phosphorus discharged to natural environment compared with existing system during the demonstration (for 65 days). Additionally, we found that the performance of wastewater treatment by AOSD system was highly stable even though there has fluctuation of concentration of wastewater.

4.3 BECAMEX wastewater Treatment facility

Because of the raw water acceptance discharged from another wastewater treatment facility managed by BECAMEX, the facility subjected to have installed AOSD system needed to receive the wastewater and the amount became more than usual. Under the quantitative and qualitative fluctuation of wastewater, AOSD system maintained the performance of wastewater treatment. At the same time, 74.3% of aeration time was saved and estimated reduction ratio of electricity consumption was 53.0% compared with existing system. The saving electricity arises from the suitable control of amount of air required for removal of organic pollutant.

4.4 Mekong Delta wastewater Treatment facility

The quality of wastewater in Mekong Delta facility included high nitrogen and much fluctuation of raw water that is typical of industrial wastewater. Under the control of AOSD system, microbial reaction such as BOD oxidation and nitrification-denitrification maintained good condition and quality of treated water was stable. As a result, removals for BOD and COD were almost perfect. Regarding the treatment of nitrogen, nitrification ratio was 95.8% and removal ratio of nitrogen was 90.5%. Both high performance of wastewater treatment and reduction ratio of electricity consumption was 61.1% as average in demonstration period and 83.7% in lunar New Year holidays. We found that AOSD system could operate with

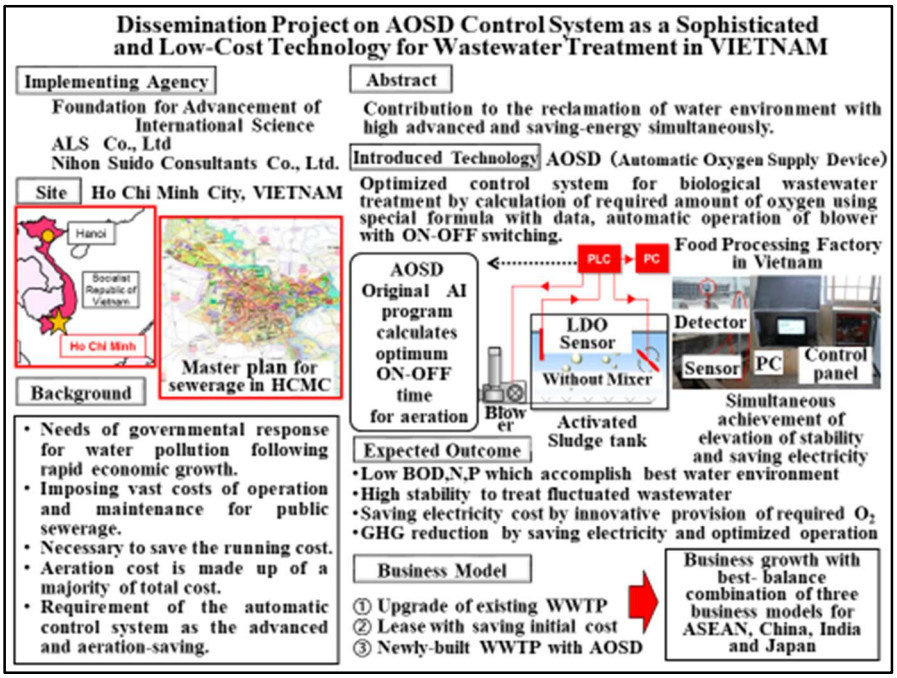

Fig.5 T he outline of this project and effects of AOSD system introduction to wastewater treatment facilities by Ministry of the Environment of Japan

the electricity saving not only daily operation but also big event such as long vacation.

4. 5 Cost evaluations

Based on the results of demonstration related to reduction of electricity, the cost evaluation was studied. Applied methods were B/C method as one of Present Value method, EIRR method as one of Internal Rate of Return method and Payback Period method. As a result, for example in case of Binh Hung Wastewater Treatment Plant, investment efficiency on introduction of AOSD system was high in all applied methods and it expects these results served as a great incentive to install the system.

Fig.5 shows the outline of this project and effects of the AOSD system introduction. **Figs. 6** show the activities for introducing AOSD systems and its spread in Vietnam and other regions.

Fig.6 AOSD System using Results of ETV on Vietnam Project

5. Conclusions

The new challenges emerged from the demonstration in this fiscal year has revealed through verification test with high accuracy. Based on the obtainable data, the project effect including the cost evaluation has been estimated and studied, and the business plan made from feasibility study in the last fiscal year has been readjusted for commercialization. Based on the result of summary, we strongly suggest for the policy maker to change the treatment technologies in the existing system in the waste treatment plants for energy saving and advanced treatment efficiency. In parallel to the establishment on business model, the enlargement of sales activities such as the installation of AOSD system to planned projects of sewerage system in Vietnam and the spread to Japanese private companies must be promoted strongly. Based on these both advanced treatment and electric power reduction results, we need to pursue the preparation to start the spread in other Asian regions. From fiscal year 2019, in the bottom of cooperation and support of JAPAN Important Friendly enterprise, we believe that introduction of AOSD system in the wastewater treatment plants can contribute to the restoration of accelerated pollution

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