Performance evaluation of UASB-DHS–A_2SBR for municipal sewage treatment

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I. INTRODUCTION

The complimenting system of Upflow Anaerobic Sludge Blanket (UASB) and Down flow Hanging Sponge (DHS) has been considered as an advantageous system over the conventional wastewater treatment technologies especially activated sludge system [1][2]. But unfortunately, this system could not treat nutrients well and there is a need for the post treatment system for nutrient treatment. Therefore, a combination of UASB-DHS-A_2SBR has been proposed as an appropriate solution for overall treatment of municipal wastewater.

Anaerobic/anoxic Sequencing Batch Reactor (A_2SBR) is a single tank, same sludge based sequencing batch reactor. Under alternating anaerobic and anoxic conditions, Denitrifying Phosphorus Accumulating Organisms (DNPAOs) in A_2SBR take up volatile fatty acids and store them as Polyhydroxyalkanoates (PHAs) through hydrolysis of intracellular polyphosphate and glycolysis of glycogen [3]. Considering the state of art of UASB-DHS and A_2SBR, the overall performance was assessed in this study.

II. MATERIALS AND METHODOLOGY

A pilot-scale experimental setup of UASB-DHS-A_2SBR reactor was installed in Nagaoka Sewage Treatment Center (Fig.1). The municipal sewage after screening and grit removal was received from the combined sewer in a sewage tank and simultaneously pumped to 1178 L of UASB reactor (HRT: 8hrs) and 857 L of DHS reactor (HRT: 6hrs). A_2SBR was installed on 350th day of UASB-DHS operation. The performance of the whole system was monitored by the routine analysis of 24 hours composite samples of sewage and UASB and grab samples of DHS and A_2SBR. The analysis was carried out twice a week according to the standard methods [4]. Similarly, the seasonal variation was determined by selecting the ambient temperature range of 16°C–30°C for summer and 8°C-15°C as winter.

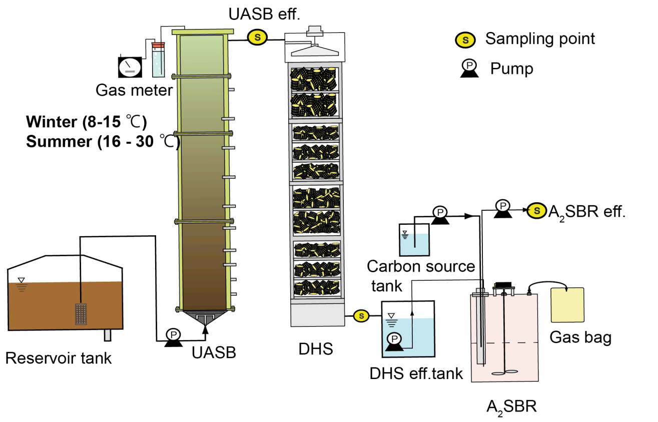

Fig. 1. Schematic diagram of a pilot-scale experimental setup of UASB-DHS-A_2SBR reactor installed in Nagaoka Sewage Treatment Center.

III. RESULTS AND DISCUSSIONS

A. Performance of UASB-DHS reactor for organic removal

The organic removal by UASB was not so prominent and incapable to produce effluent that can meet the discharge standards of developing countries. But after being treated by DHS, significant organic removal took place showing average SS of 6 mg/L, total BOD of 4 mg/L and total COD of 21 mg/L. Similarly, average removal percentage of SS, total BOD and total COD by UASB-DHS in summer were 83%, 90% and 82% while in the winter, removal rate decreased to 66%, 82% and 74% respectively. Excellent organic removal efficiency in summer was partly contributed by conversion of organic matter into methane gas in UASB and largely by DHS due to the entrapment and adsorption of SS in the sponges. Besides, longer SRT (Sludge Retention Time), ample dissolved oxygen, endogenous respiration, micro-faunal activity and good F/M (Food/Microorganism) ratio are also the other factors that favors good organic removal in DHS [5]. After the installation of A_2SBR, SS, total BOD and total COD_{Cr} removal rates in summer (winter) increased to 95% (81%), 94% (88%) and 87% (78%) respectively.

B. Performance of A_2SBR for nutrient removal

Monitoring of UASB-DHS for 350th day did not show any improvements in the nutrient treatment. High concentration of nutrient could cause eutrophication and threat for aquatic life. Considering this, A_2SBR was installed for nutrient treatment. During the initial operating days, the removals of phosphorus and nitrogen were satisfactory. As, nitrification is sensitive to pH changes and occurs at pH 7.5 and 9.0 as well as the optimum pH for the denitrification is between 7.0 and 8.0, pH of A_2SBR was adjusted to 7.4 ± 0.2 [8]. In this retrospect, acetic acid was used as an organic carbon source in A_2SBR to attain high substrate affinity. There was significant decrease in phosphorus concentration in final effluent below 1 mg-P/L and total nitrogen concentration less than 5 mg-N/L when the corresponding average influent concentrations were 4 ± 1.2 mg-P/L and 19.8 ± 5.3 mg-N/L respectively. These values were in accordance with Japanese discharge standards (T-P ≦ 1.0 mg-P/L, T-N ≦ 10 mg-N/L). Moreover, the total system achieved 83% of phosphorus removal rate and 77% of total nitrogen removal rate.

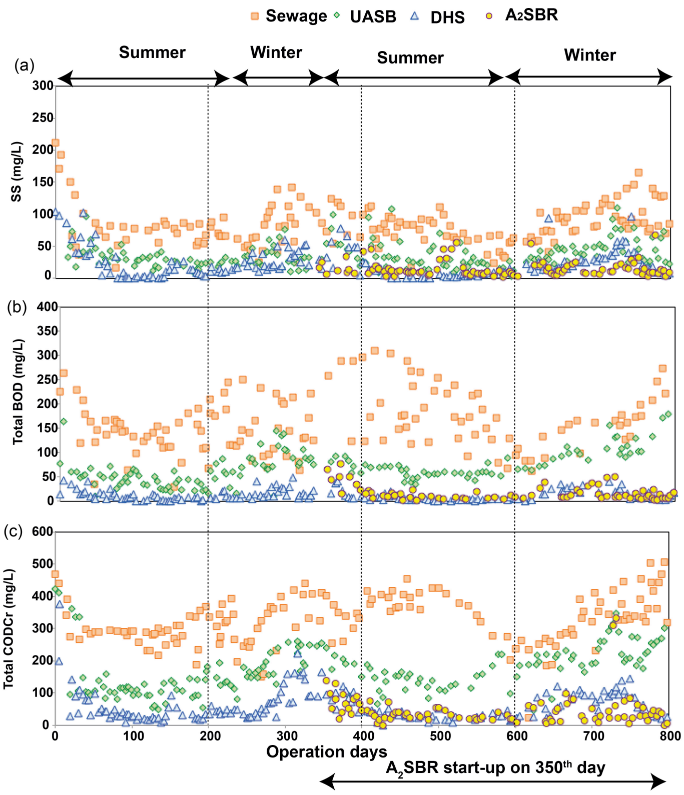

Fig. 2. Time course of (a) Suspended solids (SS), (b) total BOD and (c) Total COD.

IV. Conclusion

Based on the finding of this assessment, it can be concluded that combined system of UASB-DHS-A_2SBR can be used for municipal sewage treatment for high SS, total BOD and total COD_{Cr} removal to 95%, 94% and 87%. Besides, it can also be used for significant nitrogen and phosphorus removal at low concentrations of approximately 5mg/L and 1mg/L under temperature range of 16ºC to 30ºC and pH of 7.4±0.2 respectively. Despite the slight reduction in performance during the winter season, it still produced the final effluent of acceptable discharge limits and outperformed the conventional sewage treatment systems. This combination unambiguously ensures reliable organic and nutrient removal capacity and therefore could be proposed for effective sewage treatment.

V. References

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