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Investigation of Hydrogen Sulfide Production in a Polluted Estuary using a Vertical Column Simulator

Nguyen Pham Huong Huyen

[Introduction]

An estuary of a regional river located in the center of Tokyo (Japan) has had a hydrogen sulfide problem for years, especially in summer. So far, air injection has been chosen to solve sulfide problem in rivers and sewer systems. However, the river's biochemical condition from the surface of the water column until the bottom sediment under different conditions of the aeration treatment for sulfide production has not been well understood. Therefore, the laboratory scale simulator was set up in order to preliminarily investigate the effect of aerated artificial sewage supply positions to hydrogen sulfide production and the alteration of microbial consortia vertically.

Besides, biochemical properties of river samples were also analyzed to compare with simulator samples. In addition, chemical and biological oxidation of sulfide was also investigated to depict the effect of oxygen injection. Although this simulator just mimicked partly the physicochemical and biological phenomena in the polluted estuary of the river; based on this result, the large scale of oxygen injection to the surface of the river sediment was conducted.

[Materials and Methods]

Based on the properties of the polluted estuary of this river; this system consisted of a combination of sewage-filled and packed-bed columns inoculated with sediment taken directly from the river.

During operation, we carried out chemical and biological analysis to elucidate the vertical distributions of sulfide concentration, dissolved oxygen concentration, oxidation/reduction potential, and microbial consortia.

[Results and Discussions]

Changing the position of the aerated artificial sewage supply resulted in significant differences in chemical characteristics, and generated two distinct zones with characteristic bacterial profiles.

In condition 1, although DO concentrations in all units were stable versus time, when hydrogen sulfide was being produced at high levels, the ORPs of units 3–6 were reduced significantly. In addition, the restriction on oxygen transport lead to anaerobic conditions in the packed-bed units. Moreover, profile of sulfide concentration showed that in condition 1, H₂S was formed mostly in suboxic zone (unit 5) with the relatively high concentration.

However, under condition 2, after the change of position of the aerated artificial sewage supply, the sulfide concentration in all units was decreased to less than 0.1 mgL⁻¹; therefore, the ORPs of the packed-bed units were also increased significantly.

Furthermore, under each of these two conditions, pyrosequencing revealed that the microbial consortia differed significantly following the change of aerated sewage supply position. Besides, the diversity of the bacterial community in the simulator was significantly lower compared with river samples. In the investigation of sulfide oxidation under air injection, due to the low abundance of

Thiobacillus species in river, biological rate was lower than chemical rate. Based on these results, purging oxygen at the border of water column and sediment could help to solve sulfide problem more effectively and enhance the growth of bacteria involved in sulfide oxidation process.

[Publications]

H. Nguyen-Pham, R. Tan, K. Miyanaga, Y. Tanji. Investigation of Hydrogen Sulfide Production in a Polluted Estuary using a Vertical Column Simulator. Chemical Engineering of Japan, in press (2013)