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Estimation of Seasonal and Annual Change of Treatment Performance with Reference to Temperature Dependency for Multistage Hybrid Wetland Systems Treating Swine and Dairy Wastewater

Kunihiko Kato[1], Takashi Inoue[2], Hidehiro Ietsugu[3], Yasuhide Sugawara[4], Xiaomeng Zhang[2] , Hayato Izumoto[2]

[1] NARO Tohoku Agricultural Research Center, Shimo-Kuriyagawa, Morioka, Iwate, 020-0198, JAPAN (katokuni@affrc.go.jp), [2] Graduate School of Agriculture, Hokkaido University, N9W9, Kita-ku, Sapporo, Hokkaido, 060-8589, JAPAN (tino@env.agr.hokudai.ac.jp), 3 TUSK Co., Ltd., 2-8, Midorimachi-minami, Nakashibetsu-cho, Hokkaido, 086-1166, JAPAN (h_ietsugu@tusk-net.com), 4 NARO Hokkaido Agricultural Research Center, Hitsujigaoka-1, Toyohira-ku, Sapporo, Hokkaido, 062-8555, JAPAN (yachanm@affrc.go.jp)

Abstract

Microbial processes are known to be temperature dependent, and therefore display seasonality and pollutant reduction are expected to change with season of the year (Kadlec and Reddy 2001). And treatment performance of wetland system are thought to be dependent on aging. So, we tried to estimate seasonal and annual change of treatment performance by adjusting temperature coefficient of modified Arrhenius temperature dependent equation for multistage hybrid wetland systems treating swine and dairy wastewater.

More than eight multi-stage hybrid constructed wetland systems have been evaluated in cold climates in Hokkaido, northern Japan since 2005.With using the relations of load to oxygen transfer rate (OTR), COD to ammonium from the monitoring data of evaluated systems, and the Arrhenius temperature-dependent equation, we are able to estimate effluent water quality (Kato et al. 2013). By using theserelationships, we estimated seasonal and annual changes of treatment performance of two multi-stage hybrid systems to treat swine urine (Pig urine O) and dairy wastewater (Dairy G), and compared the difference between estimated and measured water

quality. Dilution of wastewater was considered using precipitation data and evapotranspiration data that was calculated using Penman method with the meteorological data of Japan Meteorological Agency. And temperature co-efficient of modified Arrhenius equation was adjusted for each systems to minimize standard deviation for the difference of estimated and measured water quality.

Seasonal and annual change of estimated and measured COD and NH_4-N are close to each other throughout the years.In case of Dairy G, twenty percent of organic nitrogen in the influent was assumed changed into ammonium nitrogen, considering low ratio of NH_4-N / Org-N in the influent of dairy wastewater.

In the case of Pig urine O, temperature coefficient $\Theta = 1.031$ gave the minimum standard deviation for difference of estimated and measured effluent water quality. Whereas in the case of Dairy G, temperature coefficient $\Theta = 1.004$ gave the minimum standard deviation. The difference of temperature coefficient Θ between Pig urine O and Dairy G supposed to be attributed to the difference of influent wastewater temperature and amount of organic deposit layer accumulated on the 1stvertical flow bed.In case of Pig urine O, the temperature of influent urine changes according to air temperature seasonally. On the other hand, in Dairy G, the influent dairy wastewater temperature was relatively stable throughout the year. And the amount of organic deposit layer on the 1st bed is heavier in Dairy G than in Pig urine O.