Total nitrogen reduction in agricultural wastewater by passive aeration

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Constant growth in food demand has led to an increase in intensive farming. Often, farms are concentrated in a small area. The strict regulations regarding nutrients levels applied on land with the ever increase in fuel costs has led to a sharp increase in spreading costs, promoting onsite treatment solutions for nutrient reduction.

In optimizing the onsite solution one should bring in mind (A) simplicity - the farmer expertise is growing animals and not manure treatment (B) operational cost – the operations costs are often high due to the electricity demand in the aerobic treatment stage (C) treatments goals – each farmer has different nutrient reduction goals for total nitrogen and phosphate due to his land availability.

Recently a new biological treatment for total nitrogen reduction, named TAYA, has been developed to meet the special requirements of the agricultural sector. The new approach is based on attached growth bacteria which are passively aerated. The attached bacteria are less sensitive to operation failures and the passive aeration sharply reduces the electricity costs.

TAYA technology – each TAYA unit is composed of two basins filled with plastic vertical flow media. The two basins are connected with a pumping chamber with two propeller pumps facing each other (boxer arrangement). The wastewater are constantly circulated between the basins. As the first basin is full, and the second empty, the filling pump stops and the basins are leveled by gravitation. Then, the other pump starts working in order to fill the previously empty basin. In this manner the wastewater is constantly circulated between the two basins. Each time a basin is filled, ammonia is supplied to the biofilm growing on media. Once drained, oxygen is supplied to the bacteria in the biofilm for Nitrification. Denitrification occur while filling the basin. The entire process requires only two propeller pumps. Using propeller pumps, known for their low energy demand, enables supplying the high oxygen required to the bacteria while maintaining operational costs substantially lower compared to traditional aeration methods.

The calculated electricity demand of a TAYA system is 0.9 kwh/kg-N reduced (presented in table 1). The kwh/kg-N reduced units have been chosen due to the high diversity in pig manure characteristics presented in literature. Table 1 presents also the electricity demand of other biological treatment units treating pig manure

as published in literature. The low cost is mostly due to passive aeration method preferred over the use of intensive aeration systems.

Case Study – A pilot plant has been operated for the last three years treating pig manure after a solid separation unit with chemical dosage (FO4490 SHH, SNF FLOERGER). Average influent concentrations were: COD-20,000 mg/l, TN-3300 mg/l, NH_4-2800 mg/l, TSS-1600 mg/l. While effluent average concentrations were: COD-2700 mg/l, TN-260 mg/l, NH_4-110 mg/l, TSS-580 mg/l. These results present over 90% reduction in total nitrogen.

Table 1: electricity demand for different biological TN reduction treatment units.

System	TAYA	Nitrification-denitrification (Riaño et al,2014)	Super soil 2nd generation (Vanotti et al, 2009)
Electricity demand for biological TN reduction (kwh/kg-N reduced)	0.9	9.2	5.98

References

B. Riaño, M.C. García-González. (2014). On-farm treatment of swine manure based on solid-liquid separation and biological nitrification-denitrification of the liquid fraction. Journal of Environmental Management 132, 87-93.

M. B. Vanotti, A. A. Szogi, P. D. Millner, J. H. Loughrin. (2009). Development of a second-generation environmentally superior technology for treatment of swine manure in the USA. Bioresource Technology 100, 5406–5416.