Biological Aerated Filters:

Oxygen Transfer and Possible Biological Enhancement

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(ABSTRACT)

A submerged-media biological aerated filter (BAF) has been studied to 1) evaluate oxygen transfer kinetics under conditions without biological growth and 2) determine the influence of biological growth on the rate of oxygen transfer. Collectively, the study evaluates the rates of supply and consumption of oxygen in BAFs. The mass-transfer characteristics of a submerged-media BAF were initially determined over a wide range of gas and liquid flow rates without the presence of bacteria. The mass-transfer coefficients ($K_La_{(T)}$) were measured using a nitrogen gas stripping method and were found to increase as both gas and liquid superficial velocities increase, with values ranging from approximately 40 to 380 h^{-1}. The effect of parameters including the gas and liquid velocities, dirty water to clean water ratio, and temperature dependence was successfully correlated within $\pm$ 20% of the experimental K_La value. The effects of the media size and gas holdup fractions were also investigated. Stagnant gas holdup did not significantly influence the rate of oxygen transfer. Dynamic gas holdup and the difference between total and stagnant gas holdup were found to increase with an increase in gas velocity. Neither liquid velocity nor liquid temperature was determined to have a significant impact on gas holdup.

A tertiary nitrification BAF pilot unit was then operated for 5 months downstream of a secondary treatment unit at a domestic wastewater treatment facility. The study investigated the oxygen transfer capabilities of the nitrifying unit with high oxygen demand requirements through a series of aeration process tests and explored the presence of oxygen transfer enhancements by further analyzing the actual transfer mechanism limitations. It was determined that (assuming OTE = 20%) aerating the BAF pilot unit based on the stoichiometric aeration demand resulted in overaeration of the unit, especially at lower pollutant loading rates. Endogenous respiration contributed to only 2 – 7% of the total oxygen demand with regions of biomass activity changing with varying loading conditions.

An enhanced oxygen transfer factor was determined in the biologically active pilot. Although it cannot be definitively concluded that the observed oxygen transfer factor is either due to biological activity or not simply an artifact of measurement/analysis techniques, the enhancement factor can be mathematically accounted for by either an increase in the K_La factor or the associated driving force using a proposed enhanced bubble theory.

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