

Chapter 14

Industrial Wastewater Treatment: Recycled Paper Mill Effluent Treatment Using Modified Anaerobic Hybrid Baffled (MAHB) Bioreactor

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ABSTRACT

The development of effective and simple methods for treating wastewater is a challenging task for environmental engineers. In this chapter, a novel modified anaerobic hybridized baffled (MAHB) bioreactor, which is a combination of regular suspended-growth and fixed biofilm systems together with the modification of baffled-reactor configurations, was proven to be a modest bioreactor for wastewater treatment rather than the commercial anaerobic baffled reactor (ABR). The significant advantages of this bioreactor were its ability to nearly realize the multi-stages anaerobic theory, allowing different bacterial groups to develop under more favourable conditions, reduced sludge bed expansion, no special gas or sludge separation required, and high stability to organic and toxic shock loads. The compartmentalization of this bioreactor results in a buffering zone between the primary acidification zone and active methanogenesis zone, and provided the strong ability to resist shock loads which broaden the usage of multi-phase anaerobic technology for industrial wastewater treatment.

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INTRODUCTION

With the rapid change of world economic conditions and human populations, water resources are becoming progressively deficient and the quality of environment in the world is constantly becoming worse in most regions. Disposal of wastewater directly into the lands and rivers is presently one of the serious environmental problem contributors. Therefore, there is a dire need to develop reliable technologies for wastewater treatment. In general, anaerobic process has been extensively applied to treat wastewater due to its design simplicity, high treatment efficiency, low excess sludge production and low operating cost (Moawad et al., 2009; Vicentin et al., 2019). In addition, it involves biological conversions in a stepwise fashion of organic materials to various end-products including methane (CH_4) and carbon dioxide (CO_2). A well-managed anaerobic digestion system has the ability to produce maximum methane production without discharging any gases into the atmosphere (Paolini et al., 2018). There are various types of anaerobic reactors, such as up-flow anaerobic sludge blanket (UASB), expanded granular sludge bed (EGSB), strengthened circulation anaerobic reactor (SCAR), anaerobic membrane bioreactors (An MBRs), anaerobic sequential batch reactor (ASBR), anaerobic side-stream reactor (ASSR) and anaerobic baffled reactor (ABR) have been employed to process dyeing wastewater. Their results demonstrated that the treatment on the dyeing wastewater by pilot-scale could be achieved chemical oxygen demand (COD) removal rate around 10 – 45.8% with an organic loading rate (OLR) at 0.53–7.4 kg COD/(m³.h) (Li et al., 2017; Qi et al., 2019; Yang et al., 2018). Among these technologies, ABR takes advantage of the baffle structure to form several separate compartments up to eight inside the reactor, where the flow regime in which is mainly plug flow. It also forms multiphase anaerobic environment, and has the fine buffer capability resistant to shock loads and adaptability to influent toxicants. It uses two-way direction (up and down) of water stream to stir anaerobic sludge to mix with wastewater make a certain microorganism community cultivated in each of its compartments. Thus, better biological population distribution will be formed to improve treatment efficiency and operation stability due to the unique structure and flow regime of the reactor. However, most ABR reactors displays large solid loss and slow start-up period (usually more than a month) due to slow-degree adaptation of anaerobic microorganisms (Hassan et al., 2013b). Successful start-up period in the shortest time is an important indicator of a successful start-up process of an anaerobic reactor. Moreover, various trophic groups may not be in balance during the start-up process and the reactor may fail. Hence, the development of the optimum start-up condition is a very crucial. During start-up, external fluctuations such as pH, temperature and hydraulic retention time (HRT) must be avoided whilst organic loading rates (OLR) must be fixed. In the initial phase of start-up, the loading rate must be in the low region of 0.1 g CODgVSS⁻¹d⁻¹, which corresponds to 1.2 g CODL⁻¹d⁻¹ for a system with biomass of 12 g VSS L⁻¹ (Barber & Stuckey, 1998). Some modification on the ABR is required to treat wastewater in a very short of time. Besides that, there is a combination of both suspended and attached-growth processes in a single reactor such as hybrid anaerobic filters (HAF) like plastic media, are designed to take advantage of huge solid loss (Hassan et al., 2013a). The improvement of the structure led to the adherence of the microorganisms on the packing to form biofilms, and further increased the microbial richness and diversity (Donlan, 2002). Therefore, in this chapter, a modify ABR reactor with a combination of regular suspended growth and fixed biofilm systems, together with the modification of baffled-reactor configurations was developed to treat effluent from local recycled paper mill industry.

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