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Domestic sewage treatment in a pilot-scale anaerobic sequencing batch biofilm reactor (ASBBR)

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Abstract

This paper presents and discusses data obtained from 125 days of operation of an anaerobic sequencing batch biofilm reactor (ASBBR) containing biomass immobilized in inert support (polyurethane foam cubes) applied for the treatment of domestic sewage. The reactor, with a total volume of 1.2 m^3, was operated in 8-hour cycles treating 0.65 m^3 per batch. Each batch cycle comprised feeding (2 h), reaction (5 h), discharge (0.5 h) and idle (0.5 h). The reactor took approximately 20 days to reach operational stability, confirming that anaerobic fixed film reactors require a shorter start-up period than anaerobic suspended growth reactors. Under stable operating conditions after the startup period, the mean values of COD removal efficiency and effluent total COD achieved 66% and 133 (±39) mg l^{-1}, respectively, demonstrating the potential applicability of this reactor configuration for treating domestic sewage. Even so, a post-treatment unit is required as occurs generally when anaerobic reactors are applied for domestic sewage treatment.

Keywords: Anaerobic process; Batch reactors; Domestic sewage; Immobilized biomass; Polyurethane foam

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Nomenclature

BA	bicarbonate alkalinity ($mgCaCO_3\,l^{-1}$)
COD	chemical oxygen demand ($mg\,l^{-1}$)
OLR	organic loading rate ($kg\,COD\,m^{-3}\,d^{-1}$)
ORP	oxidation-reduction potential (mV)
TS	total solids ($mg\,l^{-1}$)
TVS	total volatile solids ($mg\,l^{-1}$)
TSS	total suspended solids ($mg\,l^{-1}$)
VSS	volatile suspended solids ($mg\,l^{-1}$)
TVA	total volatile acids concentration ($mgHac\,l^{-1}$)

1. Introduction

Anaerobic sequencing batch reactors (ASBR) have been considered a potential alternative for treatment of several types of wastewater and research groups have studied this reactor configuration since 1992 (Dague et al., 1992). The main advantages of ASBR reactors over other configurations are the possibility of achieving high solids retention (high solids retention time) and a high organic matter removal efficiency. Moreover, this type of reactor provides better effluent quality control and possibility of suitable process control.

Anaerobic sequencing batch reactors operate in four steps. The first step is feeding, and its duration defines the batch mode or fed-batch (the reaction step occurs while the reactor is being fed. In the second step (reaction), continuous or intermittent agitation puts the biomass in contact with the organic matter. In the third step, agitation is suppressed to permit sludge sedimentation, preventing the loss of biomass with the effluent during the subsequent step, when the treated supernatant liquid is discharged. Therefore, the loss of biomass depends on the sedimentation step, whose effectiveness depends on the formation of biomass with good settling characteristics, mainly granular sludge (Sung and Dague, 1995).

According to Sung and Dague (1995), this type of anaerobic reactor offers distinct advantages over continuous reactor configurations: there is no liquid short-circuiting, influent distribution system at the bottom is not required and no external or internal device for separating solids is involved. The feasibility of sequencing batch reactors to treat low-strength wastewaters was analyzed by Brito et al. (1997) and Rodrigues et al. (2003). Those studies indicated that the use of ASBR to treat low-strength wastewater, even at low temperatures, allows for the treatment of industrial and municipal wastewaters at lower costs than those of aerobic systems.

Additionally, the use of inert supports to immobilize cells in sequencing batch reactors appears to be a promising method to improve solids retention, suppressing the settling step and thus reducing the total cycle time. Moreover, the immobilization of biomass in an inert support eliminates uncertainties about sludge granulation.

The anaerobic sequencing batch biofilm reactor (ASBBR) containing biomass immobilized in an inert support, confined in a basket-like container inside the system, was proposed