

Treatment of grain distillation wastewaters in an upflow anaerobic sludge bed (UASB) system

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Abstract

In operation of the full-scale upflow anaerobic sludge bed (UASB) system at the Stellenbosch Farmers' Winery (SFW) Wellington distillery, a problem encountered in the treatment of grain distillation wastewater was the accumulation of a floating scum layer. On occasion this was so severe that it forced shutdown of the UASB system to facilitate the physical removal of the scum. A preliminary investigation indicated that the scum-layer behaviour could be replicated at laboratory-scale. Thereafter, two laboratory-scale UASB systems were run in parallel: one (control) receiving wine distillation wastewater as influent, and the other (experimental) grain distillation wastewater at both high and low total suspended solids (TSS) concentrations. Scum-layer accumulation, COD removal and concentration profiles along the axis of flow through the reactors were compared. The scum layer developed only with grain distillation wastewater as influent, and its severity appeared to be linked to the TSS content of the grain wastewater. Reducing the TSS by drum filtration, settling or blending with wine wastewater could reduce, but not eliminate, the scum-layer accumulation. With wine distillation wastewater as influent, concentration profiles exhibited the typical three distinct zones of sludge bed behaviour. However, with grain distillation wastewater as influent, the concentration profiles were markedly different; the three zones of behaviour did not develop. This raises the question of the long-term viability of a UASB system treating grain distillation wastewaters.

Introduction

The upflow anaerobic sludge bed (UASB) system has found wide application in the treatment of industrial wastewaters, particularly those produced in agriculturally based industries (Britz et al., 1999). For example, UASB systems have been successfully applied to treat wastewaters from sugar, potato processing, slaughterhouse, meat packing, paper mill, fruit juicing, food and yeast industries (Lin and Yang, 1991). Also, the UASB system has been shown to be a feasible method for treatment of alcohol distillery effluents (Driessen et al., 1994); COD removal efficiencies in the range of 65 to 95% can be achieved, depending largely on the kind of raw material used and on the process conditions in the distillery (Driessen et al., 1994). Accordingly, in 1993, the SFW installed a BIOPAQ[®] UASB reactor at the SFW Wellington Distillery to treat all wastewaters produced in this distillery, before discharge of the treated effluents via the municipal sewer to the local municipal wastewater treatment works. This UASB system consists of two parallel reactors of 150 m³ and 300 m³ respectively and can be operated using either reactor individually, or both reactors simultaneously, at a peak loading of 15 kgCOD/m³ reactor volume/d (Laubscher et al., 2000).

The UASB system treats a variety of distillery wastewaters, which differ considerably as a result of the different raw materials used in the distillation and/or the distillation process implemented, to produce a variety of end-products. At the SFW Wellington Distillery, both column and pot distillation processes are used. Column distillation is employed in both absolute alcohol ($\pm 96.4\%$ ethyl alcohol/volume) and grain whisky spirit production. The former uses grape wine as raw material and the wastewater generated is referred to as *wine wastewater*. The latter uses fermented mash from maize meal ($\pm 9\%$ A/V), called "wort", as raw material and

the wastewater generated is referred to as *grain wastewater*. Pot distillation is used to produce brandy spirit with a superior quality of grape wine (called rebate wine) as raw material; the wastewater generated is also referred to as *wine wastewater*. Vodka and gin are also produced, but their production is relatively small and contributes negligibly to wastewater production.

All the distillery wastewaters above generally contain high concentrations of organic matter (COD), TSS and protein, particularly the grain wastewater. High TSS content has been found to be detrimental to UASB operation (Fourie, 1974; SRK, 1993). Thus, for distillery wastewaters, usually pretreatment stages are implemented for removal of TSS prior to biological treatment in the UASB system (Fourie, 1974; SRK, 1993). Pretreatment also has been implemented at the SFW Wellington Distillery: The grain wastewater undergoes decanting followed by centrifuging, while the wine wastewater undergoes centrifuging.

When commissioning the UASB system at the SFW Wellington Distillery during the 1995/1996 wine season, several operational problems were encountered. Some of these could be effectively resolved at the treatment plant. However, two major problems could not be resolved – formation of a scum layer when treating grain wastewater, and precipitation of struvite when treating wine wastewater.

With the treatment of grain wastewater, a scum layer accumulated on the liquid surface at the top of the UASB reactors. This scum layer was first observed in November 1995 when the small UASB reactor was fed grain wastewater only. The scum layer manifested as a thick highly viscous gelatinous layer which interfered with effluent overflow at the overflow launders. On occasion, the development of the scum layer was so severe that it forced operational shutdown of the UASB system for physical removal of the layer. The scum-layer formation proved persistent, as it manifested whenever grain wastewater was treated. This operational problem prompted an investigation at laboratory-scale into the treatment of grain distillation wastewater in the UASB

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Received 11 November 2000; accepted in revised form 13 June 2001.