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Mesophilic and thermophilic aerobic batch biodegradation, utilization of carbon and nitrogen sources in high-strength wastewater

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ABSTRACT

This study compares organic and nitrogen removals of thermophilic and mesophilic aerobic processes. The experiments were performed in three 7.2 L sequential batch reactors (SBRs) operated at 30, 47 and 60 °C. Molasses based synthetic wastewater consisting chemical oxygen demand (COD): 11,200 mg/L, total kheljal nitrogen (TKN): 770 mg/L, ammonical nitrogen (NH_4): 560 mg/L was the feed medium. Biokinetic parameters, COD, NH_4^+ and TKN removal efficiencies were compared under six different operating conditions. Five times lower sludge production and similar COD removal were observed in thermophilic SBRs compared to mesophilic SBR under 8.25 kg COD/m^3 d loading rate. However at 24.75 kg COD/m^3 d there were no differences in terms of sludge production while COD removals were varied as 59%, 80% and 82% at 30, 47 and 60 °C respectively. A mechanism was developed to understand the varying behaviors of thermophilic aerobic process. Stripping is the major mechanism for nitrogen removal in thermophilic SBRs.

1. Introduction

In treatment of industrial effluents, especially those with high temperature, thermophilic aerobic biological wastewater treatment process has potential benefits such as accelerated biodegradation, low net biomass production, elimination of cooling requirements for high temperature wastes (Tripathi and Allen, 1999), enhanced solubility of low soluble substrates (Becker et al., 1999) and rapid inactivation of pathogens (Surucu et al., 1975). However to obtain the advantages of thermophilic aerobic process in wastewater treatment, it is important to understand the relevant design and operational parameters. The physical, chemical and biological characteristics of thermophilic aerobic process are so different from conventional process that the knowledge-base from conventional operations is unusable (LaPara and Alleman, 1999).

The applicability of thermophilic aerobic process is described in literature indicates that possibility of treating efficiently various high-strength wastewaters at increased temperatures. Promising results have been reported for the biodegradation of potato slops from potato distilleries (Cibis et al., 2002; Krzywonos et al., 2008), the bioremediation of dairy wastes (Kosseva et al., 2001), the biodegradation of olive oil and lipid-rich wool scouring wastewater (Becker et al., 1999), and the utilization of the effluents from potato processing (Lasik and Nowak, 2007). Apart from the above applications, the aerobic treatment of wastewater under thermophilic conditions has received growing interest due to elimination of cooling of high temperature effluents such as palm oil mill effluent. It would be more economical if high temperature effluent is treated thermophilically, as then cooling facilities prior to biological treatment can be eliminated (Chan et al., 2010). Then the treated hot water effluent can be recycled into the industrial process if the treatment technology could meet the required water quality.

Thermophilic SBRs were reported to having operational issues such as difficulties of maintaining higher biomass concentrations in SBRs due to higher biomass washout (Tripathi and Allen, 1999; LaPara, 1999; Suvilampi et al., 2005) and excessive foaming (LaPara and Alleman, 1999) causing operational issues such as malfunction of level controllers and possible process upsets. For successful operation of thermophilic aerobic wastewater treatment plants these operational issues should be addressed.

Previous studies on thermophilic aerobic biological wastewater treatment process mainly focused on organic removal, since last few years the concerns on TKN removal and ammonia removal (Kurian et al., 2005; Visvanathan et al., 2007; Krzywonos et al., 2008) were increased in thermophilic aerobic wastewater treatment studies. The removal mechanisms of TKN and ammonia in thermophilic process can be different from conventional

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