Biological sulphate reduction with primary sewage sludge in an upflow anaerobic sludge bed (UASB) reactor – Part 3: Performance at 20°C and 35°C

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Abstract

The performance of 2 biological sulphate reduction (BSR) upflow anaerobic sludge bed (UASB) reactors fed primary sewage sludge (PSS) and sulphate, one at 20°C (R2) and one at 35°C (R1) is described. To maintain the effluent sulphate concentration below 250 mgSO_4^{2-}/ℓ, the hydraulic retention time (HRT) and bed solids retention time (SRT or sludge age) both needed to be longer and the feed primary sewage sludge (PSS) COD to SO_4^{2-} ratio higher at 20°C than at 35°C, viz. 20.4 to 21.0 h, 24 d and 1.75 gCOD/gSO_4^{2-} at 20°C and 16.4 to 17.0 h, 21 d and 1.75 gCOD/gSO_4^{2-} at 35°C respectively. The longer HRT, SRT and higher feed PSS COD/ SO_4^{2-} ratio is a consequence of a slower PSS hydrolysis/acidogenesis rate at 20°C resulting in a lower biodegradable particulate organics conversion to volatile fatty acids (VFA). Solid liquid separation in both systems was good yielding average particulate and soluble organic COD concentrations of (150 and 100 mgCOD/ℓ for R1; 138 and 96 mgCOD/ℓ for R2). The sulphate reduction was >90% in both systems. The UASB reactor R1 (at 35°C) was also operated at an increased influent sulphate concentration (1 800 mgSO_4^{2-}/ℓ) to investigate the inhibition effect by un-dissociated hydrogen sulphide generated from the reduction of this high sulphate concentration. It was found that a high sulphate reduction (~ 92%) was maintained even at the relatively low HRT of 18.5 h. The COD and S mass balances above 95% were achieved over both systems indicating that the performance data obtained from them is reliable for developing and calibrating mathematical models.

Keywords: biological sulphate reduction, hydrolysis, hydraulic retention time, UASB reactor