Biological sulphate reduction with primary sewage sludge in an upflow anaerobic sludge bed (UASB) reactor – Part 4: Bed settling characteristics

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Abstract

The success of the UASB reactor depends largely on the settling properties and stability of the sludge bed which comprises the anaerobic active biomass. The solid-liquid separation behaviour of the sludge bed in 2 UASB reactors (R1 at 35°C and R2 at 20°C) fed with primary sewage sludge and sulphate was investigated because this appeared to be a retention time-defining feature of the system. Consequently, the settling rate of the various solids fractions in the sludge was measured in a settleometer to determine if bed expansion or sludge settleability was the capacity-limiting process. It was found that both sludges settled well and at an upflow velocity of up to 1.16 m/h 99% of the total sludge mass was retained. This upflow velocity was 9.1 and 13.7 times higher than the maximum operating upflow velocity of UASB reactors R1 (0.127 m/h) and R2 (0.085 m/h) respectively that caused system failure. Tests were also done to demonstrate the effect of upflow velocity (V_{up}) on the sludge bed expansion. Relative to the settled sludge volume at zero upflow, the R1 sludge expanded 1.8 times at a V_{up} of 0.127 m/h while R2 sludge expanded 2.0 times at a V_{up} 0.085 m/h. From the tests, R1 (35°C) sludge had a better settleability and expanded less compared to R2 (20°C) sludge for the same applied upflow velocity. Because in operating R1 and R2, the bed volume was kept constant, the mass of sludge removed from the system correspondingly increased as upflow increased and the bed expanded, causing a reduced sludge age and sludge bed mass to mediate the bioprocesses. It was concluded that the system failure was caused by bed expansion rather than by the sludge settleability.

Keywords: biological sulphate reduction, upflow unaerobic sludge bed reactor, sludge settleability, bed expansion