ABSTRACT

Start-up is one major problem that has been identified in the operation of UASB and other high rate anaerobic systems. This is related to the availability of seed material and the time required to develop the required high bacterial biomass. At present it is difficult to obtain a large amount of seed material to start-up a full scale UASB reactor because full scale operational reactors are located in only a limited number of places. Therefore the use of other seed materials is essential. In this thesis start-up of UASB reactors using abattoir wastewater stabilisation pond sludge was examined. Enhancing the rate of start-up with non-granular sludge is consequently a problem, because the dispersed nature of non-granular sludge limits its amount within a reactor making it easier to washout. This can result in a long period of start-up because the organic loading is highly dependent on the amount of sludge in the reactor. The use of centrifuged sludge may overcome this problem. It was hypothesised that the solids particles would be agglomerated and this would improve sludge retention, resulting in a greater number of the right type of microorganisms retained in the reactor. A study was carried out to examine the feasibility of using centrifuged sludge in the start-up of UASB reactors to test the above hypothesis and to follow the development of the sludge during start-up.

Three sets of experiments were carried out. The first set of experiments was employed to determine if the methanogenic activity of abattoir wastewater stabilisation pond sludge deteriorated due to centrifugation. Initially the sludge from different ponds in the treatment facilities was tested for methanogenic activity. The results show that the best source of sludge was the third pond in a series of 3. The amount of methane producing bacteria was estimated and found to constitute around 13% of volatile suspended solids. The sludge from pond 3 was then subjected to centrifugation and tested for
methanogenic activity. The results show that the methanogenic activity of centrifuged sludge was similar to non-centrifuged sludge. The results clearly indicate that centrifugation did not affect the activity of the microbial population.

The effect of non-centrifuged and centrifuged sludge on UASB start-up was tested in the second set of experiments. The overall results show that centrifuged sludge was better than non-centrifuged sludge in the start-up of UASB reactor. The performance of centrifuged sludge was more consistent when compared to non-centrifuged sludge. The average COD removal obtained at the end of these experiments was 80 % ± 10 % for centrifuged sludge and 56 % ± 32 % for non-centrifuged sludge. The difference in performance was related to the better retention of centrifuged sludge in the reactor, because it occupied less space and the agglomerated particles were not easily dispersed at the onset of operation. The retention of centrifuged sludge consequently resulted in a high number of bacteria in the reactor. Estimation of bacterial numbers in the sludge was carried out using several methods, with scanning electron microscopy (SEM) found to be the more appropriate. The SEM micrograph also revealed that the microbial population in the seed material influenced the selection and predominant growth of bacteria in the reactor during start-up. The sludge developed was mainly composed of filamentous type of bacteria (probably Methanothrix) which was initially present in the seed material. Although the sludge developed in the reactor was not granulated, its settleability was high.

In the third set of experiments the parameters affecting the use of centrifuged sludge in the start-up of UASB reactors were studied. The results established that the rate of start-up was enhanced by using a high initial sludge concentration but was limited to 30 g VSS/L of reactor, mainly because of excessive solids washout in the reactor configuration employed. A COD loading of 15 g/L of reactor-day was attained within a period of 3 weeks with 79% COD reduction. Start-up did not appear to be greatly
affected by starting with either high HRT (24 hr and high strength feed) or low HRT (6 hr and low strength feed). The results also showed that the growth of predominant bacteria was affected by the initial amount of sludge used in start-up as well as organic loading. The predominant growth of bacteria (morphologically of the Methanosarcina type) was observed in reactors initially containing 10 g VSS/L of reactor. A mixture of bacteria (morphologically of the Methanosarcina and Methanothrix type) was observed in reactors containing 30 to 60 g VSS/L of reactor.

The present study indicates that non-granular sludge can be concentrated by centrifugation without affecting the activity of the microbial population, and the use of centrifuged sludge is an option to enhance the rate of UASB start-up. A high number of bacteria are retained in the reactor and this allows a high loading condition in a short period of time. The strategy for start-up is to inoculate a UASB reactor with 30 g VSS/L of reactor of centrifuged sludge, and then to operate starting from a low HRT (12 hr) and decreasing it stepwise down to 4 hr with a low strength feed.