EXECUTIVE SUMMARY

BACKGROUND:

In terms of these design the procedures and kinetic models, in the bioreactor of the non-nitrifying aerobic activated sludge system the mixed liquor organic suspended solids is made up of three components: heterotrophic active biomass; endogenous residue; and inert material. The heterotrophic active biomass arises from synthesis of living heterotrophic organisms on biodegradable organic substrates and is "lost' via endogenous respiration/death processes; in the activated sludge system this mixed liquor component performs the biodegradation processes of COD removal and denitrification. Historically the mixed liquor suspended organic solids has been measured as a lumped parameter, via the VSS test or more recently, the COD test.

Currently, the heterotrophic active biomass exists only as a hypothetical parameter within the structure of the design procedures and kinetic models. The problem in measurement of this parameter has been the lack of suitable experimental techniques. In the literature, principally microbiological techniques have been proposed; for example, pour plate or other culturing techniques, ATP analysis and DNA analysis, using fluorescent probes. The active biomass is probably the most important process parameter and currently no reliable method exists to measure it. ATP is present in all microbes and can be measured with great sensitivity (Coetzee, 1999). Because ATP is rapidly lost following the death of cells, measuring ATP concentrations can be used to estimate living biomass (Holm-Hansen and Booth, 1966). The objective of this investigation was to use ATP as a method to determine the active biomass fraction in activated sludge.

SUMMARY OF MATERIALS AND METHODS:

Grab samples were taken from the aerobic zones of five activated sludge systems in and around Pretoria (i.e. Daspoort, Centurion, Baviaanspoort, Zeekoegat and Rooiwal). All samples were collected at the end of the aerobic zones. All samples were analysed within 8 h of sampling and all analyses were performed in triplicate.

ATP was measured on site as well as lab by means of the ATP Bioprobe (Hughes Whitlock) after 5 min homogenization. Total plate counts were done using the spread-plate technique on Nutrient Agar (NA) after 48h incubation at room temperature.

The following physicochemical analyses were conducted using standard procedures: MLSS, pH, NO_3^-, PO_4^{3-}, SO_4^{2-} and NH_4. The OUR and ATP experiments were done at UCT using their laboratory reactors. The OUR was measured on-line while ATP was measured using ATP Bioprobe after sonication of the sample for 5 min.

DISCUSSION

Orthophosphate removal was consistently high with higher biomass concentrations as measured by TPC and ATP. This supports the notion that the viable biomass fraction of the MLSS is the key to orthophosphate removal by activated sludge. However, maintenance of large fractions of viable biomass in activated sludge will select for smaller flocs, causing poor settling (Roe and Bhagat, 1982). It is thus important to find a situation of equilibrium between viable biomass and settling performance to optimize the activated sludge process.

The method has been shown in the current study to be superior to the traditionally used methods of TPC, MLSS and MLVSS for biomass determination. MLSS and MLVSS did not resemble the viable population as measured by ATP or TPC. ATP was also found to be a better biomass estimator than TPC due to higher (at least one log unit) bacterial counts and smaller standard deviations. It is a cheap, simple and fast method, not requiring special training for laboratory personnel and with a small capital input for a portable luminometer, giving on-the-spot results.

The ATP results followed the same trend as the OUR results. The OUR of the organisms increased slightly with time, and then decreased after a few hours of the experimental period. The ATP values also increased with time, but in this case the value increases sharply after 2 hours of incubation before dropping down again. This is an indication that there is an increase in viable biomass numbers as the organisms utilizes the substrate. The gradual increase in the ATP value could be an indication that after some time the organisms are well adapted to the conditions in the bioreactor and that can optimally utilize the substrate, resulting in increases in their numbers.

and hence an increase in the ATP and OUR values. This results indicate that ATP and OUR are good indicators of viable biomass numbers.

CONCLUSIONS:

- ATP proved to be a more reliable method for indicating the biomass concentration than TPC, due to the higher yield and a smaller standard deviation.
- Orthophosphate removal was consistently higher in the sludges with higher initial ATP and TPC values, indicating a relationship between viable biomass and orthophosphate removal.
- The MLVSS showed the same trend in orthophosphate removal as the MLSS, although always somewhat lower, due to it being the volatile fraction of the MLSS.
- Neither initial MLSS, initial MLVSS nor changes in the concentrations of these fractions could be directly linked to different orthophosphate uptake abilities of different sludges, indicating the unsuitability of MLSS and MLVSS to indicate viable biomass and/or differences in the viable biomass fraction in activated sludge.