A1.1 DETERMINATION OF THE OUR

The oxygen uptake rate (OUR, or in this book O_t) is a parameter used to evaluate the rate at which metabolic processes take place in activated sludge treatment processes with sludge in suspension. The main uses of the OUR test are to:

- Estimate the values of kinetic and stoichiometric parameters;
- Obtain data required to set up a mass balance of organic- and/or nitrogenous material;
- Evaluate the sludge activity in terms of the maximum substrate utilisation rate;
- Determine the degree of sludge stabilisation after aerobic digestion.

The principles involved in the execution of an OUR test are simple: the aeration of a mixed liquor batch is interrupted and the resulting decrease in the oxygen concentration is observed as a function of time. Preferably the oxygen analyser is connected to a recorder or a computer, so that a continuous profile can be obtained. The results of the OUR test are given in terms of mg $O_2.l^{-1}.h^{-1}$. If the volatile sludge concentration is determined at the same time, the OUR per unit mass of sludge or the specific OUR (mg $O_2.g^{-1}$ $VSS.h^{-1}$) can be calculated. For a reliable determination of the OUR, the oxygen consumption during the test should be at least 2 to 3 mg $O_2.l^{-1}$. In most activated sludge processes, the OUR will be in the order of 30 to 100 mg $O_2.l^{-1}.h^{-1}$ for low and high rate systems respectively, so the time required to carry out the test will be only a few minutes.

The OUR test may be carried out in the aeration tank itself or in bench scale reactors. The first option is only feasible if it is possible to keep the sludge in suspension while the aeration is interrupted (e.g. mixers), or if the time required for the test is so short that the effect of sludge settling may be ignored. However, in most aeration tanks the sludge is maintained in suspension by the agitation introduced by the aeration equipment.

Therefore, usually bench scale reactors or even beakers are often used. Sludge is taken from the aeration tank and influent is fed to this sample at proportionally the same rate as to the aeration tank. The OUR determination is sometimes carried out without simultaneous feeding of influent to the sludge sample (Standard methods, 1993), but this procedure leads to a significant underestimate of the actual OUR in the activated sludge system. This is due to the fact that part of the influent material (easily biodegradable material and ammonia) is utilised at a high rate, so that its concentration is low at any time. Therefore, if influent is not continuously supplied, it will rapidly be depleted in the batch reactor and the corresponding OUR will not be measured.

On the other hand, a batch OUR determination without continuous (proportional) feeding can be used if the objective is to measure the maximum specific activity of sludge, as in general a large amount of substrate will be added to the sludge batch. Similarly, when the endogenous respiration rate is to be determined, no external substrate is allowed at all and again the batch OUR measurement can be used.

The three methods for OUR measurement as described above are schematically represented in Fig. A1.1. Concerning the third method, presented in Fig. A1.1c, it is important that the OUR reactor is operated at the same hydraulic residence time as the aeration tank and that proportion between influent and return sludge is correct: i.e Q_i/q_i = Q_r/q_r.

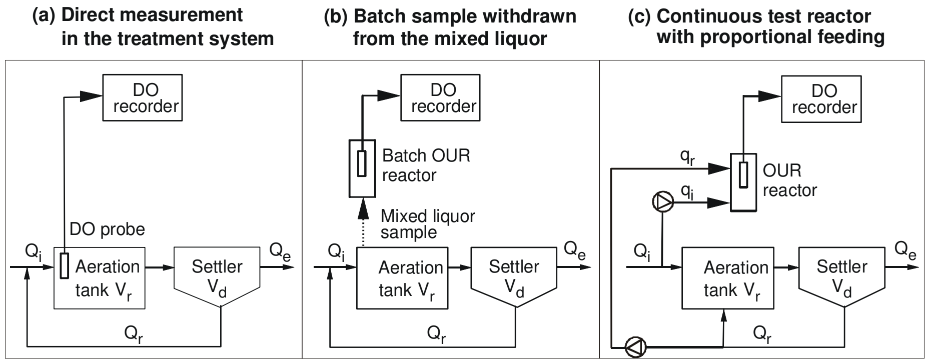

Figure A1.1 Schematic representation of different experimental set-ups for the determination of the OUR

In the simplest version of the OUR test, the only materials required are a dissolved oxygen meter with electrode and a stopwatch. The time period necessary for a decrease in the dissolved oxygen concentration from an initial value DO_1 to a lower value DO_2 is determined and the corresponding oxygen uptake rate is calculated as:

$$OUR_a = (DO_1 - DO_2)/(t_2 - t_1) \quad \text{(A1.1)}$$

Where:

OUR_a = apparent OUR
= observed rate of change of the dissolved oxygen concentration after the aeration of the mixed liquor is interrupted
$DO_{1,2}$ = initial respectively final dissolved oxygen concentration
$t_2 - t_1$ = time interval

As the measured dissolved oxygen concentration tends to oscillate slightly, it is preferable to record the dissolved oxygen concentration in time and subsequently draw the "best-fit" straight line. Alternatively, the data can be stored in a computer and standard software can be used to calculate the best-fit straight line through the data points.