A1.2.2 Hydraulic effects

Apart from metabolic processes, the oxygen concentration may change because of other factors. In the case of a reactor with influent entering and mixed liquor leaving continuously, the rate of change of the dissolved oxygen concentration due to this hydraulic effect must be taken into consideration:

$$OUR_h = (dDO/dt)_h = (DO_e - DO_i)/R_h \quad \text{(A1.2)}$$

A1.2.3 Absorption of atmospheric oxygen

In the case of a low OUR, absorption of atmospheric oxygen may interfere with the determination of the rate parameter. The rate of oxygen absorption from the air depends on several factors:

- Size of the liquid-air interface: this area may be reduced by placing floating material on the surface or using a closed vessel;
- Dissolved oxygen concentration of the mixed liquor;
- Mixing intensity: if mixing is intense and surface renewal frequent, more oxygen will be absorbed.

The absorption effect on the dissolved oxygen concentration can be determined when water without dissolved oxygen is placed in the OUR reactor and the increase in the dissolved oxygen concentration in time is observed. The rate of change of the dissolved oxygen concentration due to absorption can be expressed as:

$$OUR_{abs} = (dDO/dt)_a = k_{abs} \cdot (DO_s - DO) \quad \text{(A1.3)}$$

The solution of the differential equation is:

$$\ln[(DO_s - DO)/(DO_s - DO_0)] = k_{abs} \cdot t \quad \text{(A1.4)}$$

Where:

OUR_{abs} = rate of change of the DO concentration due to absorption of atmospheric oxygen
DO_s, DO_0 = saturated and initial dissolved oxygen concentration in the water
DO = dissolved oxygen concentration at time “t”
t = absorption time
k_{abs} = absorption constant

With the aid of Eq. (A1. 4) the value of the absorption constant k_{abs} can be determined using the following steps:

- Remove the dissolved oxygen in the water in the OUR reactor with Na_2SO_3 and a trace (10 $mg.l^{-1}$) of $CoCl_2$;
- While mixing at the same intensity as during regular OUR determinations, determine the increase of the dissolved oxygen concentration in time;
- Plot data of $\ln[(DO_s - DO)/(DO_s - DO_0)]$ as a function of the absorption time: the slope of the resulting straight line is equal to k_{abs}.

As oxygen absorption is higher at increasing mixing intensity, it is important that during the OUR determination the applied mixing intensity is low and only sufficient to maintain the sludge in suspension. The absorption effect is more pronounced for smaller reactors, because of the relatively large surface area. In Fig. A1.4 an example is given of the graphical determination of the constant k_{abs}. The experimental dissolved oxygen values are plotted as a function of time in Fig. A1.4a. The saturation concentration was determined as 7.7 mg $O_2.l^{-1}$. In Fig. A1.4b the corresponding values of $\ln[(DO_s - DO)/(DO_s - DO_0)]$ are plotted as a function of time (the value of $DO_0 = 0$).

The value of k_{abs} is calculated from the slope of the best-fit straight line through the experimental values: $k_{abs} = 0.39\ h^{-1}$. So, when this test reactor is operating at a dissolved oxygen of 3 mg $O_2.l^{-1}$, under the specified conditions the rate of oxygen absorption is calculated as $OUR_{abs} = 0.39 \cdot (7.7 - 3) = 1.6$ mg $O_2.l^{-1}.h^{-1}$.

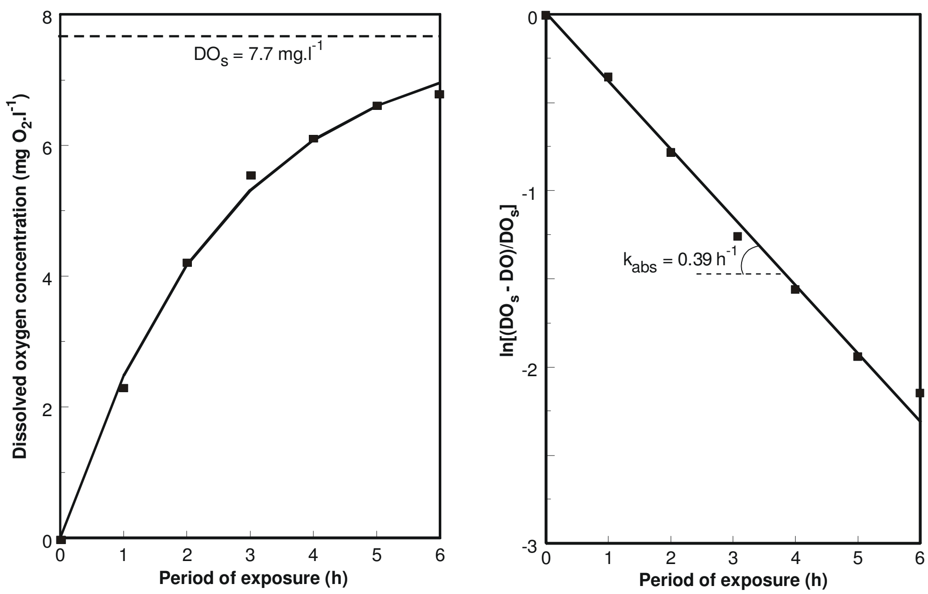

Figure A1.4 Experimental determination of the absorption constant

The apparent OUR (the observed rate of change of the dissolved oxygen concentration in the reactor) is a result of the combination of the three effects described above:

$$OUR_a = OUR + OUR_h - OUR_{abs} \text{ or}$$

$$OUR = OUR_a - (DO_i - DO)/R_h + k_{abs} \cdot (DO_s - DO) \quad \text{(A1.5)}$$

Equation (A1.5) shows how the observed or apparent OUR value should be corrected for the hydraulic effects and the absorption of atmospheric oxygen. The importance of these corrections in practice will depend on the relative values of OUR, OUR_h and OUR_{abs}.