

A1.2.1 Critical dissolved oxygen concentration

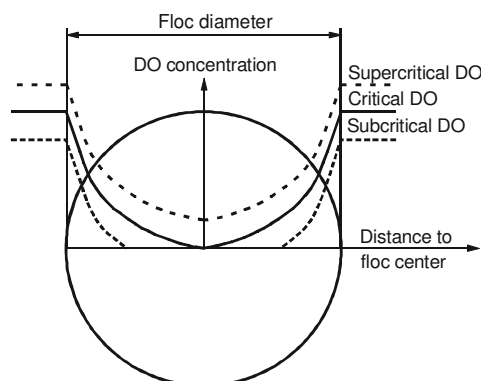


Figure A1.2
Oxygen profiles within sludge flocs as functions of the distance to the floc centre

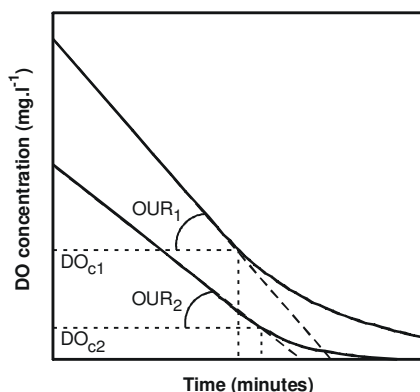


Figure A1.3
Schematic representation of the determination of the critical dissolved oxygen concentration

Oxygen consumption mainly occurs within the sludge flocs, so there is a tendency for the dissolved oxygen concentration to decrease from the periphery of the floc (where it is assumed to be equal to the bulk concentration) towards the floc centre. Fig. A1.2 schematically shows the resulting profile of the dissolved oxygen concentration (a spherical floc is assumed). Depending on the applied bulk dissolved oxygen concentration, a zone without oxygen (either anoxic or anaerobic) may develop in the central region of the flocs. As no oxygen is consumed in this region the overall OUR will decrease.

The minimum concentration of dissolved oxygen in the bulk mixed liquor that is required to avoid oxygen becoming a limiting factor inside the sludge flocs is called the critical dissolved oxygen concentration. Its numerical value depends on several factors, of which the OUR value and the stirring intensity (which influences the floc size) are the most important.

The critical dissolved oxygen concentration may be determined experimentally by observing the decrease in the dissolved oxygen concentration with time until all oxygen is consumed: providing the availability of external substrate does not change during the test, there will be a constant oxygen consumption rate as long as the dissolved oxygen concentration is above the critical value. At the critical concentration the rate of oxygen consumption starts to decrease gradually, resulting in a subsequent decrease in the slope of the line of dissolved oxygen concentration versus time.

Figure A1.3 shows how the critical dissolved oxygen concentration can be determined in practice. Naturally, the OUR should be determined in the dissolved oxygen concentration range above the critical value.

In practice this critical value is seldom more than 0.5 to $1 \text{ mg O}_2 \cdot \text{l}^{-1}$ for organic material utilisation and 1 to $2 \text{ mg O}_2 \cdot \text{l}^{-1}$ for nitrification. The value of the critical dissolved oxygen concentration is of considerable practical importance, as it is in principle the optimal dissolved oxygen concentration in the aeration tank. A smaller concentration will reduce the available treatment capacity of the plant, while a higher dissolved oxygen concentration leads to unnecessary aeration costs (because at higher concentrations energy consumption for aeration increases).