4.1.3 Stoichiometrics of reactions with nitrogenous matter

4.1.3.1 Oxygen consumption

Only nitrification and denitrification are of interest when calculating the oxygen consumption by nitrogenous matter. Fig. 4.3 schematically shows the electron transfer in the nitrification- and the denitrification processes.

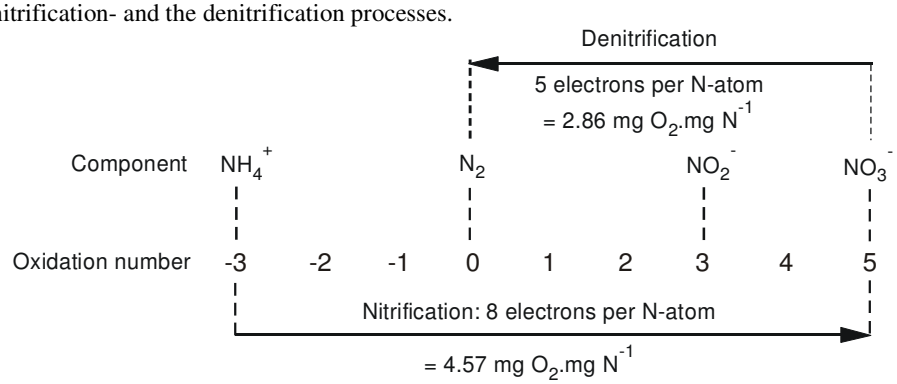

Figure 4.3 Variation of the nitrogen oxidation number in the processes of nitrification and denitrification.

In the nitrification process, the oxidation number of the nitrogen atom in ammonium increases from -3 to +5 by the transfer of 8 electrons to the electron acceptor (oxidant): i.e. oxygen. These electrons are accepted by two molecules (four atoms) of oxygen (thereby changing its oxidation number from 0 to -2). Hence, for the nitrification of 1 mol of ammonium nitrogen (14 g N), there is a demand for two moles (64 g) of oxygen, so that the stoichiometric oxygen consumption can be calculated as 64/14 or 4.57 mg $O_2 \cdot$mg N^{-1}.

In the denitrification process, nitrate (oxidation number +5) is reduced by organic matter to molecular nitrogen (oxidation number 0), so that 5 electrons are transferred per nitrogen atom. Hence, of the 8 electrons released by nitrogen in the nitrification process, 5 electrons are recovered when nitrate is reduced to nitrogen. Thus, in oxidimetric terms, the nitrate has an oxidation capacity of $^5/_8$ of the oxygen used in the production of the nitrate by nitrification.

In other words, a fraction of $^5/_8$ or 0.625 of the oxygen consumption in the nitrification process can be recovered as "equivalent oxygen" in the process, i.e. 0.625·4.57 = 2.86 mg $O_2 \cdot$mg N^{-1}. It can be concluded that there is a net oxygen consumption of 4.57 - 2.86 = 1.71 mg $O_2 \cdot$mg N^{-1} during complete biological removal of nitrogen.