Example 4.2.

A waste water contains a COD concentration of 600 $mg.l^{-1}$ and a TKN concentration of 60 $mg.l^{-1}$. It is assumed that 10 percent of the influent COD is discharged with the effluent, 30 percent leaves the system in the excess sludge and the TKN concentration in the effluent is 3 $mg\ N.l^{-1}$. Determine the fraction of the oxygen consumption necessary for nitrogenous matter in the cases of (a) nitrification and (b) nitrification and denitrification.

Solution:

(1) Calculate the oxygen consumption for the removal of organic matter:

$O_c = (1 - mS_e - mS_{xv})\cdot S_{ti} = (1 - 0.1 - 0.3)\cdot 600 = 360\ mg\ O_2.l^{-1}$

(2) Calculate the nitrogen concentration (expressed as $mg\ N.l^{-1}$ of influent), leaving the system together with the excess sludge:

$N_l = f_n\cdot mE_v\cdot S_{ti} = 0.1\cdot(0.3/1.5)\cdot 600 = 12\ mg\ N.l^{-1}$

Calculate the nitrified TKN concentration:

$N_c = N_{ai} + N_{oi} - N_{ae} - N_{oe} - N_l = 60 + 0 - 3 - 12 = 45\ mg\ N.l^{-1}$

(4) Calculate the oxygen consumption for nitrification:

$O_n = 4.57\cdot N_c = 206\ mg\ O_2.l^{-1}$

(5) Calculate the equivalent oxygen recovered in the denitrification process:

$O_{eq} = 2.86\cdot N_c = 129\ mg\ O_2.l^{-1}$

It is concluded that in the case of nitrification, the total oxygen consumption is $O_t = O_c + O_n = 360 + 206 = 566\ mg\ N.l^{-1}$ of which a fraction $O_n/O_t = 206/566 = 0.36$ is consumed for the oxidation of ammonium. In the case of nitrification followed by denitrification, the oxygen consumption decreases to $O_t = O_c + O_n - O_{eq} = 360 + 206 - 129 = 437\ mg\ O_2.l^{-1}$ and the fraction of the oxygen consumed by the nitrogenous material would decrease to (437/360)/437 = 0.18. In Example 4.2 the inclusion of denitrification in the process configuration reduces oxygen consumption from 566 to 437 $mg\ O_2.l^{-1}$, or a reduction of 23 percent.