Course « Water and wastewater treatment », Fall 2025

Part I « Wastewater treatment »

Homework 3

Homework 3-1 : « Oxygen consumption due to chemical dephosphatation »

For simultaneous chemical dephosphatation, one uses on average 13 g_{Fe2+} m^{-3}. How much oxygen does the oxidation of the ferrous iron consume in comparison with a normally loaded urban wastewater?

Hint: Ferrous iron reacts with oxygen to form ferric iron and water.

Homework 3-2 : « Design of chemical dephosphatation »

A WWTP discharging its effluent into a lake is requested to install a dephosphatation in order to respect an effluent concentration of 0.5 g_P m^{-3}. The only indication given is that the WWTP treats wastewater of 35'000 capita.

a) How much iron chloride solution is approximately needed per day and how much will that cost ?

b) How much sludge (dry weight) will be produced per day and how does that compare to the sludge produced by the biomass ?

Some common numbers and range for average WW:
350 L/capita/day, 170 gBOD5 m^{-3}, 6 gTP m^{-3}, 200 gTSS m^{-3}

For (a), try to convert the result to the amount of (40% w/v) $FeCl_3$ solution needed as more practical reference. For (b), calculate and compare $SP_{c,P}$ and $SP_{c,\ BOD5}$. Take numbers from dimensioning example in lecture.

Homework 3-3 : « Design of nitrifying activated sludge WWTP »

An activated sludge WWTP has been designed to eliminate organic matter in a completely mixed reactor system and primary clarifiers. The three rectangular aeration tanks have each a length of 40 m, are 7 m wide, and 4.5 m deep. The WWTP is requested to respect an effluent quality with $NH_4\text{-}N_{eff} = 2$ g_N m^{-3} in the future.

The wastewater parameters are the following:

$Q_0 = 10'000$ m^3 d^{-1} $S_{BOD5} = 190$ g_{O2} m^{-3} $TSS_{inf} = 170$ g_{TSS} m^{-3}

$N_{TKN,inf} = 54$ g_N m^{-3} $NH_4\text{-}N_{inf} = 36$ g_N m^{-3}

a) What could be changed in the reactor configuration in order to reach the requested effluent quality with the existing installation ?

b) Is the total volume available sufficient to reach the requested effluent quality ?

Homework 3-4 : « Design of denitrifying activated sludge WWTP »

An activated sludge WWTP has been designed to eliminate part of the nitrogen by pre-denitrification. When in operation, less nitrogen removal than anticipated was observed on a regular basis. Verify with the wastewater parameters given below whether there have been errors in the design of the WWTP, and if so at what level.

The wastewater parameters used for the design have been the following:

$Q_0 = 5'000$ m^3 d^{-1} $S_{BOD5} = 260$ g_{O2} m^{-3} $TSS_{inf} = 195$ g_{TSS} m^{-3}

$N_{TKN,inf} = 63$ g_N m^{-3} $NO_3\text{-}N_{eff} = 25$ g_N m^{-3} $NH_4\text{-}N_{eff} = 2$ g_N m^{-3}

The three rectangular aeration tanks have a length of 50 m, are 6 m wide, and 4.5 m deep. On a length of 17.5 m the activated sludge tank is not equipped with the aeration system, they pump 4'000 m^3 d^{-1} return sludge from the secondary clarifier to the aeration tanks, and there is an internal recycling of water from the end of the aeration tank to the beginning of 0.5.