## Design of the conventional wastewater treatment plant using Design2treat

Table 1: Inflow in the municipal treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Inflow in the municipal wastewater treatment plant | Parameter | Value | Unit |
| Inhabitants | 30,000 | [E] |
| Factor | 100 | [%] |
| Bypass for pretreatment | 0 | [%] |
| Specific wastewater generation (w\_s) | 0.125 | [m3/(E∙d)] |
| External water (w\_f) | 938 | [m3/d] |
| Peak discharge factor for wastewater (x\_s) | 12 | [h/d] |
| Peak discharge factor for external water (x\_f)~~ | 24 | [h/d] |
| rain (Q\_s) / dry weather for wastewater (Q\_s)~~ | 2 | [-] |
| rain (Q\_f) / dry weather for external water (Q\_f)~~ | 1 | [-] |
| Dry weather inflow (Q\_T) | 352 | [m³/h] |
| Mixed water inflow (Q\_M) | 664 | [m³/h] |
| External water inflow (Q\_f) | 39 | [m³/h] |
| Daily inflow (Q\_d) | 4,688 | [m³/d] |
| Q\_M / Q\_T | 1.89 | [-] |
| Q\_f / Q\_s | 0.13 | [-] |
| Concentrations | BSB5 | 0.384 | [kg/m3] |
| TS0 | 0.448 | [kg/m3] |
| NH4-N | 0.045 | [kg/m3] |
| N org. | 0.026 | [kg/m3] |
| KN | 0.07 | [kg/m3] |
| NO3-N | 0 | [kg/m3] |
| Pges | 0.01 | [kg/m3] |
| C\_CSB\_Z | 0 | [kg/m3] |
| X\_CSB\_inert\_Z | 0 | [kg/m3] |
| S\_CSB\_Z | 0 | [kg/m3] |
| X\_CSB\_Z | 0 | [kg/m3] |
| X\_inorg\_TS\_Z | 0 | [kg/m3] |
| S\_CSB\_inert\_Z | 0 | [kg/m3] |
| Loads | BSB5 | 1,800 | [kg/d] |
| TS0 | 2,100 | [kg/d] |
| NH4-N | 210 | [kg/d] |
| N org. | 120 | [kg/d] |
| KN | 330 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 45 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_inorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_Z | 0 | [kg/d] |
| Resident-specific values | BSB5 | 0.06 | [kg/(E∙d)] |
| TS0\*\*\* | 0.07 | [kg/(E∙d)] |
| NH4-N\*\*\* | 0.007 | [kg/(E∙d)] |
| N org.\*\*\* | 0.004 | [kg/(E∙d)] |
| KN | 0.011 | [kg/(E∙d)] |
| NO3-N\*\*\* | 0 | [kg/(E∙d)] |
| Pges.\*\*\* | 0.0015 | [kg/(E∙d)] |
| C\_CSB\_Z | 0 | [kg/(E∙d)] |
| X\_CSB\_inert\_Z | 0 | [kg/(E∙d)] |
| S\_CSB\_Z | 0 | [kg/(E∙d)] |
| X\_CSB\_Z | 0 | [kg/(E∙d)] |
| X\_inorg\_TS\_Z | 0 | [kg/(E∙d)] |
| S\_CSB\_inert\_Z | 0 | [kg/(E∙d)] |
| Backloads | Share of KN in ÜS (rX) | 0.5 | [-] |
| KN Chargeback in rX | 25.2 | [kg/d] |
| Fcktor | 100 | [%] |
| Bypass for pretreatment | 0 | [%] |
| BSB5 | 0 | [kg/d] |
| TS0 | 0 | [kg/d] |
| NH4-N | -31 | [kg/d] |
| N org. | 0 | [kg/d] |
| KN | -31 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 0 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_inorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_AN | 0 | [kg/d] |

Table 2: Pretreatment stage in the municipal wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Pretreatment stage | Parameter | Value | Unit |
| Type of pretreatment | Primary sedimentation |  |
| Volume of primary sedimentation | 352 | [m³] |
| Mean flow time at Q\_T\*\*\* | 1 | [h] |
| Inflow loads at the pretreatment stage | Q\_d | 4,688 | [m³/d] |
| Q\_T | 352 | [m³/h] |
| Q\_M | 664 | [m³/h] |
| BSB5 | 1,800 | [kg/d] |
| TS0 | 2,100 | [kg/d] |
| NH4-N | 210 | [kg/d] |
| N org. | 120 | [kg/d] |
| KN | 330 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 45 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_inorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_AN | 0 | [kg/d] |
| Backloads at the pretreatment stage | BSB5 | 0 | [kg/d] |
| TS0 | 0 | [kg/d] |
| NH4-N | -31 | [kg/d] |
| N org. | 0 | [kg/d] |
| KN | -31 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 0 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_inorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_AN | 0 | [kg/d] |
| Total inflow of the pretreatment stage | Q\_d | 4,688 | [m³/d] |
| Q\_T | 352 | [m³/h] |
| Q\_M | 664 | [m³/h] |
| BSB5 | 1,800 | [kg/d] |
| TS0 | 2,100 | [kg/d] |
| NH4-N | 179 | [kg/d] |
| N org. | 120 | [kg/d] |
| KN | 299 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 45 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_inorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_AN | 0 | [kg/d] |
| Efficiency of the pretreatment stage | BSB5 | 24.75 | [%] |
| TS0 | 50 | [%] |
| NH4-N | 0 | [%] |
| N org. | 24.75 | [%] |
| KN | 0 | [%] |
| NO3-N | 0 | [%] |
| Pges | 14.85 | [%] |
| C\_CSB\_Z | 0 | [%] |
| X\_CSB\_inert\_Z | 50 | [%] |
| S\_CSB\_Z | 0 | [%] |
| X\_CSB\_Z | 50 | [%] |
| X\_inorg\_TS\_Z | 50 | [%] |
| S\_CSB\_inert\_Z | 0 | [%] |
| Outflow at the pretreatment stage | Q\_d | 4,688 | [m³/d] |
| Q\_T | 352 | [m³/h] |
| Q\_M | 664 | [m³/h] |
| BSB5 | 1,355 | [kg/d] |
| TS0 | 1,050 | [kg/d] |
| NH4-N | 179 | [kg/d] |
| N org. | 90 | [kg/d] |
| KN | 269 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 38 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_anorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_AN | 0 | [kg/d] |

\*Bypasses around the pretreatment stage=Factors and bypasses are included in these loads.

\*Inflow #1 bypass around the pretreatment stage; All inflows and loads = zero.

\*Backloads bypass around the pretreatment stage; All inflows and loads = zero.

\*Sum of bypasses around pretreatment stage; All inflows and loads = zero.

\*No external carbon source used

\*Loads BB\_inflow with no backloads through rX.

Table 3: Lodas at aeration basins

|  |  |  |  |
| --- | --- | --- | --- |
|  | Parameter | Value | Unit |
| Inflow loads of aerationbasins with no backloads through rX. (BB\_inflow) | Q\_d | 4,688 | [m³/d] |
| Q\_T | 352 | [m³/h] |
| Q\_M | 664 | [m³/h] |
| BSB5 | 1,355 | [kg/d] |
| TS0 | 1,050 | [kg/d] |
| NH4-N | 179 | [kg/d] |
| N org. | 90 | [kg/d] |
| KN | 269 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| Pges | 38 | [kg/d] |
| C\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_inert\_Z | 0 | [kg/d] |
| S\_CSB\_Z | 0 | [kg/d] |
| X\_CSB\_Z | 0 | [kg/d] |
| X\_inorg\_TS\_Z | 0 | [kg/d] |
| S\_CSB\_inert\_AN | 0 | [kg/d] |
| Concentrations of aeration-basins with no backloads through rX | Q\_d | 4,687.50 | [m³/d] |
| Q\_T | 351.6 | [m³/h] |
| Q\_M | 664.1 | [m³/h] |
| BSB5 | 0.289 | [kg/m3] |
| TS0 | 0.224 | [kg/m3] |
| NH4-N | 0.0382 | [kg/m3] |
| N org. | 0.0193 | [kg/m3] |
| KN | 0.0575 | [kg/m3] |
| NO3-N | 0 | [kg/m3] |
| Pges | 0.00.2 | [kg/m3] |
| C\_CSB\_Z | 0 | [kg/m3] |
| X\_CSB\_inert\_Z | 0 | [kg/m3] |
| S\_CSB\_Z | 0 | [kg/m3] |
| X\_CSB\_Z | 0 | [kg/m3] |
| X\_anorg\_TS\_Z | 0 | [kg/m3] |
| S\_CSB\_inert\_AN | 0 | [kg/m3] |
| Outflow values | Monitoring values |  | [kg/m3] |
| Monitoring values N inorg. | 0.018 | [kg/m3] |
| Monitoring values NH4-N | 0.01 | [kg/m3] |
| Monitoring values P tot. | 0.001 | [kg/m3] |
| Design values calculated according to recommendations of LANUV NRW |  | [kg/m3] |
| Design value N org. on average | 0.002 | [kg/m3] |
| Rated value NH4-N in the peak | 0.01 | [kg/m3] |
| Rated value NH4-N on average | 0.002 | [kg/m3] |
| Rated value NO3-N on average | 0.01 | [kg/m3] |

Table 4: Core numbers of aeration basins in the wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Aeration basins | Parameter | Value | Unit |
| Design approach | University group approach (HSG) |  |
| Type of the plant | Upstream denitrification |  |
| BB Volume without BioP = V\_tot. | 5,189 | [m³] |
| Volume of nitrification (V\_ni) | 3,285 | [m³] |
| Volume of denitrification  (V\_deni) | 1,905 | [m³] |
| V\_deni / V\_tot. | 0.367 | [-] |
| V\_BB-Volumen per inhabitant | 0.173 | [m³]/E] |
| V\_ni per inhabitant | 0.1095 | [m³]/E] |
| V\_deni per inhabitant | 0.0635 | [m³]/E] |
| Design temperature | 12 | [°C] |
| Aerobic sludge age | 8.77 | [d] |
| Total sludge age | 13.86 | [d] |
| Outlet total solids concentratrion of aeration basins | 3.39 | [kg/m³] |
| Mean total solids concentratrion in the aeration basins | 3.39 | [kg/m³] |
| Mean biological dry solids concentration | 2.98 | [kg/m³] |
| Sludge load BTS (BSB) | 0.077 | [kg BSB /(kg TS∙d)] |
| Sludge load BTS (CSB) | 0 | [kg CSB /(kg TS∙d)] |
| Rate of denitrification | 0.276 | [kg N /(kg TS∙d)] |
| Preset maximum feedback ratio | 6 | [-] |
| Calculated feedback ratio | 3.81 | [-] |
| Respiration increase factor | 1.27 | [-] |
| Acid capacity in the outflow | 55,000 | [mmol/ m³] |
| Sludge fractions | X\_H | 0.887 | [kg/m³] |
| X\_H\_BSB | 0.887 | [kg/m³] |
| X\_H\_CSB\_ext | 0 | [kg/m³] |
| XA | 0.067 | [kg/m³] |
| X\_I | 2.026 | [kg/m³] |
| XF | 0.413 | [kg/m³] |
| Excess sludge production | 1,270 | [kg/d] |
| Excess sludge fractions |  |  |
| X\_H | 332 | [kg/d] |
| XA | 25 | [kg/d] |
| X\_I | 758 | [kg/d] |
| XF | 155 | [kg/d] |
|  | Specific sludge production of Carbon | n.a. | [kg/d] |
| Sludge from Phosphorous elimination | n.a. | [kg/d] |
| Denitrification capacity A 131 BSB | n.a. | [-] |
| OV C-Value BSB | n.a. | [kg O2/kg BSB5] |
| OV Ni-Value BSB | n.a. | [kg O2/kg BSB5] |
| OV Deni-Value BSB | n.a. | [kg O2/kg BSB5] |
| Denitrification capacity A 131 CSB | n.a. | [-] |
| OV C-Value CSB | n.a. | [kg O2/kg CSB] |
| OV Ni-Wert CSB | n.a. | [kg O2/kg CSB] |
| OV Deni-Wert CSB | n.a. | [kg O2/kg CSB] |
| Fluctuating factor HSG | 2 | [-] |
| SF Sludge age A 131 | 1.8 | [-] |
| Suggestion SF sludge age A 131 | 1.76 | [-] |

Table 5: Phosphorus elimination in the wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Phosphorus elimination | Parameter | Value | Unit |
| Precipitation with | Eisen(III) - Salt |  |
| Spec. precipitant dose | 1.8 | [kg Metall / kg P] |
| Spec. precipitant products | 2.5 | [kg TS / kg Metall] |
| Spec. Alkaline demand | 60 | [mol / g Metall] |
| Spec. FH content | 0 | [kg Metall/kg FM] |
| Molar ratio ß~~ | 1.5 | [mol/mol] |
| Precipitant dose | 0.0132 | [kg/m³] |
| Precipitant demand (nur Metall) | 61.87 | [kg Metall/d] |
| Precipitant demand | 0 | [kg FM/d] |
| Precipitant products | 154.68 | [kg/d] |

Table 6: Phosphorus and nitrogen balances in the wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Phosphorous balance | Inflow | Value | Unit |
| P tot. | 38.3 | [kg/d] |
| Outflow |  |  |
| P tot. reached | 4.7 | [kg/d] |
| P incorporated (cell growth) | 10.7 | [kg/d] |
| P incorporated (Bio-P) | 0 | [kg/d] |
| P precipitated | 22.9 | [kg/d] |
| Total | 38.3 | [kg/d] |
| Nitrogen balance | Inflow |  |  |
| NH4-N | 179 | [kg/d] |
| N org. | 90.3 | [kg/d] |
| NO3-N | 0 | [kg/d] |
| KN chargeback from rX | 25.2 | [kg/d] |
| Total | 294.5 | [kg/d] |
| Outflow |  |  |
| NH4-N | 9.4 | [kg/d] |
| N org. | 9.4 | [kg/d] |
| NO3-N | 46.9 | [kg/d] |
| N2 through BSB or CSB | 178.5 | [kg/d] |
| N2 by ext. carbon source | 0 | [kg/d] |
| KN Incorporated | 50.4 | [kg/d] |
| Total | 294.5 | [kg/d] |

Table 7: Aerator design Impact factors in the wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Aerator sizing Apply impact factors individually (fC=X;fN=1 | fC=1;fN=Y) | Parameter | Value | Unit |
| O2 - Konzentration | 0.002 | [kg/m3] |
| alpha - value | 0.7 | [-] |
| Impact factor fC | 1.5 | [-] |
| Impact factor fN | 1.2 | [-] |
| Air pressure | 101.3 | [kPa] |
|  |  |  |
| Load case 1 | Ni/Deni bei 10°C |  |
| Design temperature  O2-entry | 10 | [°C] |
| Decisive | Impact factor fC |  |
| O2- Saturation Conc. | 0.011.28 | [kg/m3] |
| OVC - Value | 1.19 | [kg O2/kg BSB5] |
| OVN - Value | 0.38 | [kg O2/kg BSB5] |
| OVDN - Value | n.a. | [kg O2/kg BSB5] |
| OB - Value | 2.64 | [kg O2/kg BSB5] |
| Hourly peak O2 demand | 213.24 | [kg/h] |
| Daily demand O2 | 3,712.47 | [kg/d] |
|  |  |  |
| Load case 2 | Ni/Deni at 20°C |  |
| Design temperature O2-entry | 20 | [°C] |
| Decisive | Impact factor fC |  |
| O2- Saturation Conc | 0.00908 | [kg/m3] |
| OVC - Value | 1.33 | [kg O2/kg BSB5] |
| OVN - Value | 0.38 | [kg O2/kg BSB5] |
| OVDN - Value | n.a. | [kg O2/kg BSB5] |
| OB - Value | 3.06 | [kg O2/kg BSB5] |
| Hourly peak O2 demand | 246.61 | [kg/h] |
| Daily demand O2 | 4,262.92 | [kg/d] |
|  |  |  |
| Lastfall 3 | Nitri/Deni bei Bemessungstemperatur | |
| Design temperature O2-entry | 12 | [°C] |
| Decisive | Stoßfaktor fC |  |
| O2- Saturation Conc | 0.01077 | [kg/m3] |
| OVC - Value | 1.23 | [kg O2/kg BSB5] |
| OVN - Value | 0.38 | [kg O2/kg BSB5] |
| OVDN - Value | n.a. | [kg O2/kg BSB5] |
| OB - Value | 2.73 | [kg O2/kg BSB5] |
| Hourly peak O2 demand | 220.02 | [kg/h] |
| Daily demand O2 | 3,824.12 | [kg/d] |

Table 8: Calculation of the secondary settling tanks in the wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| NKB-Group1 | Calculation of secondary sedimentation tanks | Dimensioning according to ATV-DVWK-A 131 (5/2000) | |
| NKB - Type | Horizontal flow basins | |
| Parameter | Value | Unit |
| Default surface | n.a. | [m²] |
| Surface | 541 | [m²] |
| Share of feed | 0 | [%] |
| NKB – Feeding at Q\_M | 664 | [m³/h] |
| Surface feeding q\_A | 1.23 | [m/h] |
| Sludge volume index ISV | 120 | [l/kg] |
| Sludge volume feed q\_SV | 500 | [l/(m²\*h)] |
| Thickening time te | 2.5 | [h] |
| RV at Q\_M | 0.75 | [-] |
| Average RV bei Q\_M | 0.75 | [-] |
| Ratio TS\_RS / TS\_BS | 0.7 | [-] |
| TS in RS | 7.92 | [kg/m³] |
| TS in the effluent of the aeration basins | 3.39 | [kg/m³] |
| Delta TS [TS\_BB - TS\_AB] | 0 | [kg/m³] |
| TS in the influent of the secondary sedimentation tanks | 3.39 | [kg/m³] |
| Default 2/3 depth | n.a. | [m] |
| 2/3 depth | 4.71 | [m] |
| Clear water zone h1 | 0.5 | [m] |
| Separation zone h2 | 1.81 | [m] |
| Storage zone h3 | 0.79 | [m] |
| Thickening and clearing zone h4 | 1.61 | [m] |

Table 9: Kinetic parameters in the wastewater treatment plant

|  |  |  |  |
| --- | --- | --- | --- |
| Kinetic Parameter | Parameter | Value | Unit |
| µ max,A~~ | 0.52 | [1/d] |
| KN~~ | 0.0007 | [kg N/m3] |
| b\_A~~ | 0.05 | [1/d] |
| b\_H~~ | 0.17 | [1/d] |
| f\_T,A~~ | 1.103 | [-] |
| f\_T,bA~~ | 1.09 | [-] |
| f\_T,bH~~ | 1.073 | [-] |
| Y\_A~~ | 0.15 | [kgTS/kgN] |
| Y\_H~~ | 0.75 | [kgTS/kgBSB5] |
| f\_D~~ | 0.75 | [-] |
| f\_P~~ | 0.6 | [-] |
| i\_B~~ | 0.12 | [-] |
| i\_I~~ | 0.01 | [-] |
| i\_P~~ | 0.03 | [-] |
| f\_I~~ | 0.2 | [-] |
| f\_OV,S~~ | 0.56 | [-] |
| f\_OV,e~~ | 0.2 | [kgO2/(kgTS∙d)] |
| f´~~ | 1.25 | [-] |
| Eta BSB5~~ | 0.95 | [-] |
| N incl./BSB5 (A 131)~~ | 0.043 | [-] |
| N incl./CSB (A 131)~~ | 0.021 | [-] |
| P incl./BSB5 (A 131)~~ | 0.01 | [-] |
| P incl./CSB (A 131)~~ | 0.005 | [-] |

\*Factors and bypasses are not included in these values.

\*\*\*entered by the user

~~corresponds to the default value

n.a. not applicable