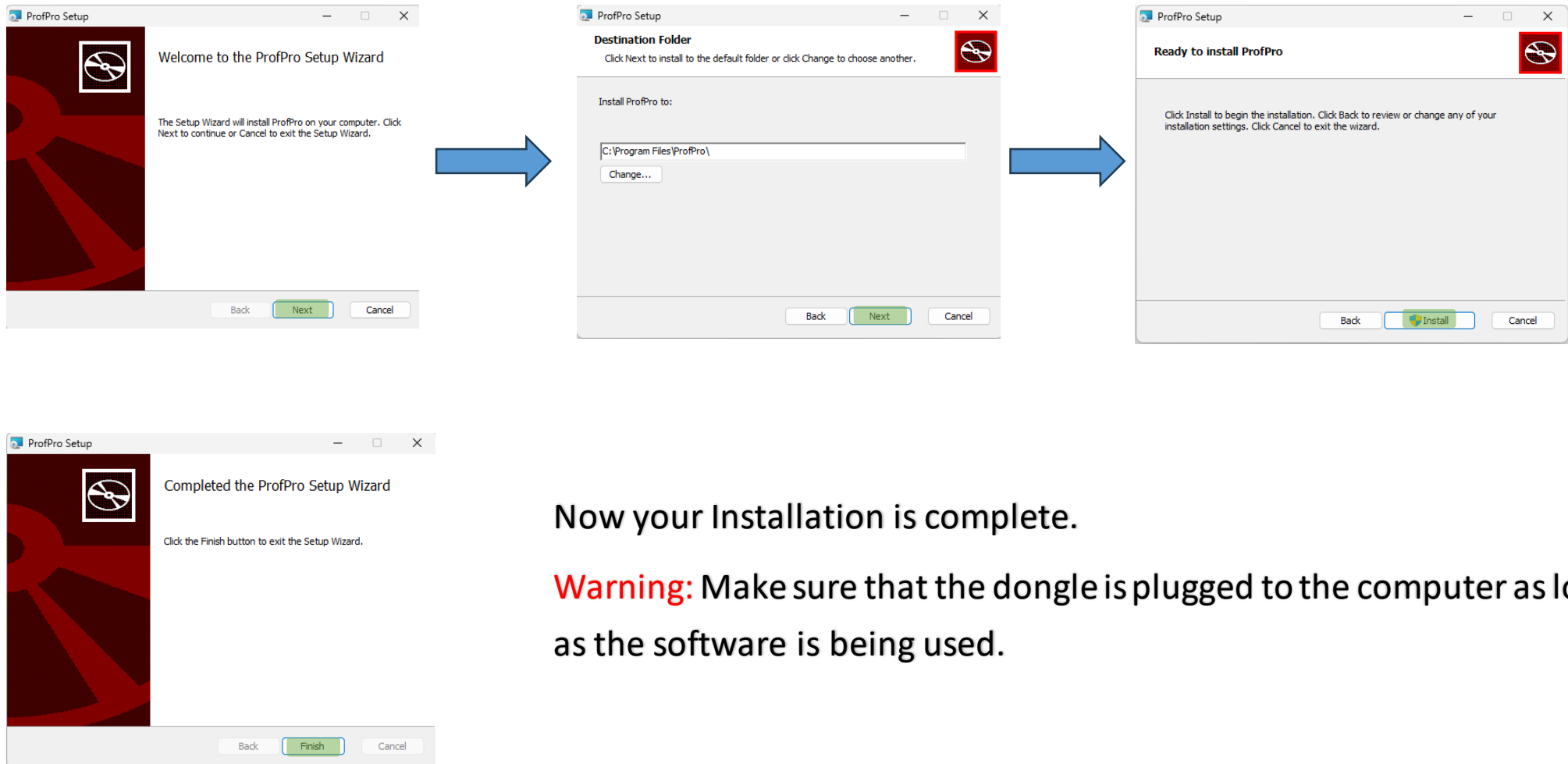




ProfPRO Manual

Installation of Software:

The software is supplied in a dongle USB in which the installation file exists. When the executive file “ProfPro-1.0.0” is double clicked, Installer Screen will appear. You might be asked to give privileged permissions to move on. The screenshots will guide the user for further steps.



Now your Installation is complete.

Warning: Make sure that the dongle is plugged to the computer as long as the software is being used.

CONTENTS

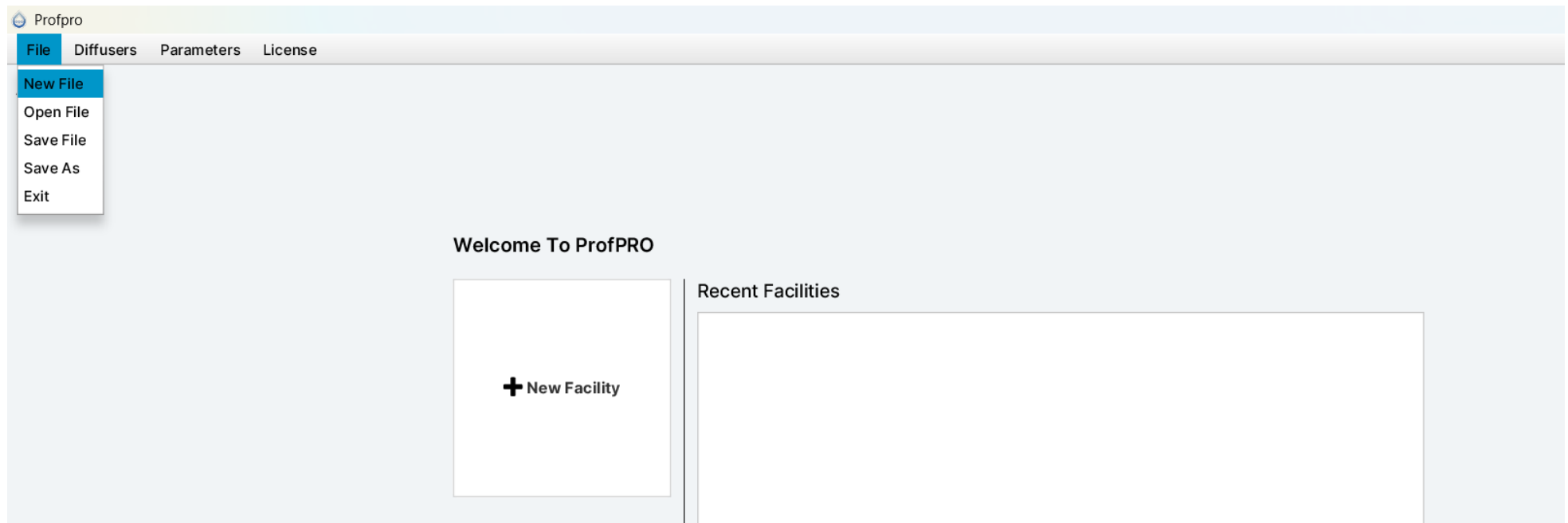
1- Installation of Software:

Hardware Requirements:

ProfPRO runs on all operating systems.

Java 21 SE must be installed

2-Main Screen and its Components



From this tab, you can form a new file and open an existing one. You can also save your work or exit from the ProfPRO software.

Diffusers:

Before starting up the software, at least one diffuser SOTE graph should be introduced. In order to do this task, SOTE graph equation estimation has to be accomplished as precise as possible.

The steps of uploading a diffuser brand are explained below;

1) SSOTE or SSTOR graph is obtained from the manufacturers. Generally, manufacturers supply the SSOTE or SSTOR data of their products in terms of $\text{gO}_2/\text{Nm}^3/\text{m} - \text{\%1/m}$ (Y-axis) against Air Flow Rate per diffuser (Nm^3/h) (X-axis). If the graph is not in that form, you should convert that curve in one of either form.

2) The common general formula of diffusers matched the parabolic equation:

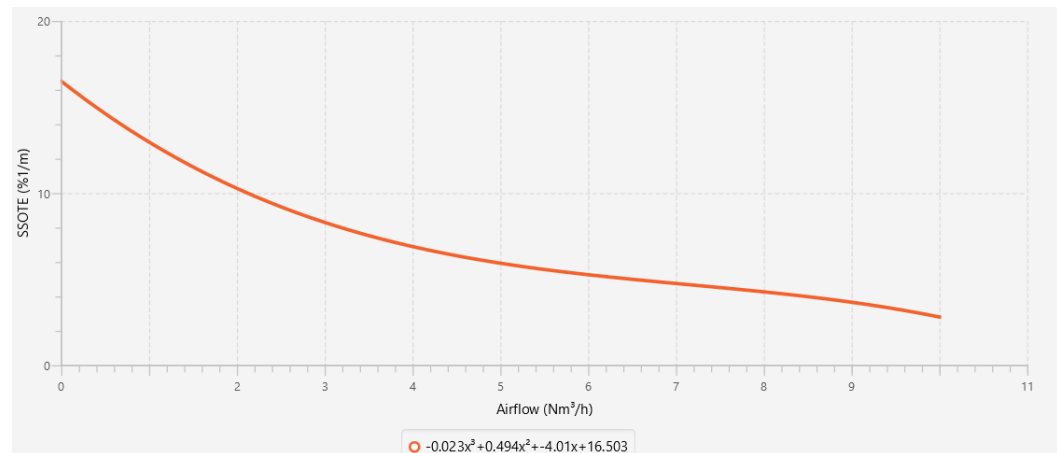
SSTOR-SSOTE ($\text{gO}_2/\text{Nm}^3/\text{m}$ or $\text{\%1/m}$) = Y-axis

Diffuser Air Flow per diffuser (Nm^3/h) = X-axis

$$Y = A \cdot x^3 + B \cdot x^2 + C \cdot x + D$$

For example;

The SSOTE of the following graph is;



Once you get the original curves of any manufacturer, you can form the parabolic curve equation by using relevant software like Excel or etc.

You can upload as many curves as you like. This feature of the software allows the user flexibility in choosing the most economic diffusers and comparing them with each other.

To add a new diffuser brand, select “New Diffuser” from the Diffuser tab and fill the following page;

Diffuser Brand
$$y = \boxed{}x^3 + \boxed{}x^2 + \boxed{}x + \boxed{}$$

☐ $\text{gO}_2/\text{Nm}^3/\text{m}$ ☐ $\%1/\text{m}$

Y Min

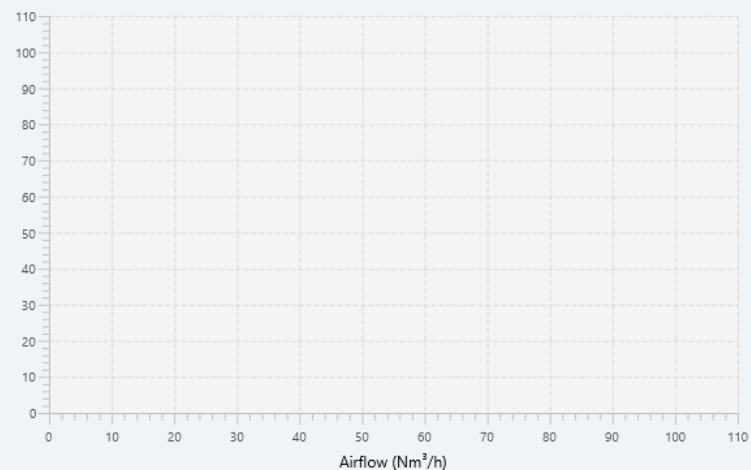
Y Max

X Min

X Max

Minimum SOTR-SSOTE Per Unit

Maximum Air Flow Per Unit



Clear

Add

[illegible]

After filling all the required fields click add and it will appear in the diffuser list.

Parameters:

The parameters section is very important for process calculation. For every **“New Project”**, it is advised to check these parameters before diving into calculations. It contains the fractions of raw wastewater characterization which directly effects the sizing of volumes, oxygen requirements and sludge productions.

Parameters		Reset To Defaults
SCOD,inert,IAT/CCOD,IAT (0,05-0,10)-fs	0.05	XN,BM/XCOD,BM
Xinorg,SS,I/Xss (0,2-0,3)-fB	0.3	XorgN,I/XCOD,i
XCOD,inert,IAT/XCOD,IAT (0,20-0,35)-fA	0.3	XP,BM/CCOD,IAT
CCOD,la,IAT/Cdeg,IAT-fCOD (0.15-0.25)	0.2	XP,BioP/CCOD,IAT
COD of Organic Dry Matter gCOD/VSS	1.6	XP,BioP/CCOD,IAT (*)
		(*) Pre-Denitrification W/O Anaerobic Tank
		Ycod,dos Methanol
		Ycod,dos Ethanol
		Ycod,dos Acetic Acid
		Ycod,deg
		Nitrifying Bac. Growth Rate
		Save

Among them, the extremely important ones are;

Xinorg,SS,I/Xss (0,2-0,3)-fB	0.3	i
XCOD,inert,IAT/XCOD,IAT (0,20-0,35)-fA	0.3	i

These fractions above directly affect the sludge quantity and consequently the biological reactor volume and the sizes of sludge treatment units . Both fractions should be determined very carefully according to the real measurements in the raw wastewater or after primary sedimentation if it is a part of design.

CCOD,la,IAT/Cdeg,IAT-fCOD (0.15-0.25)	0.2
SCOD,inert,IAT/CCOD,IAT (0,05-0,10)-fs	0.05

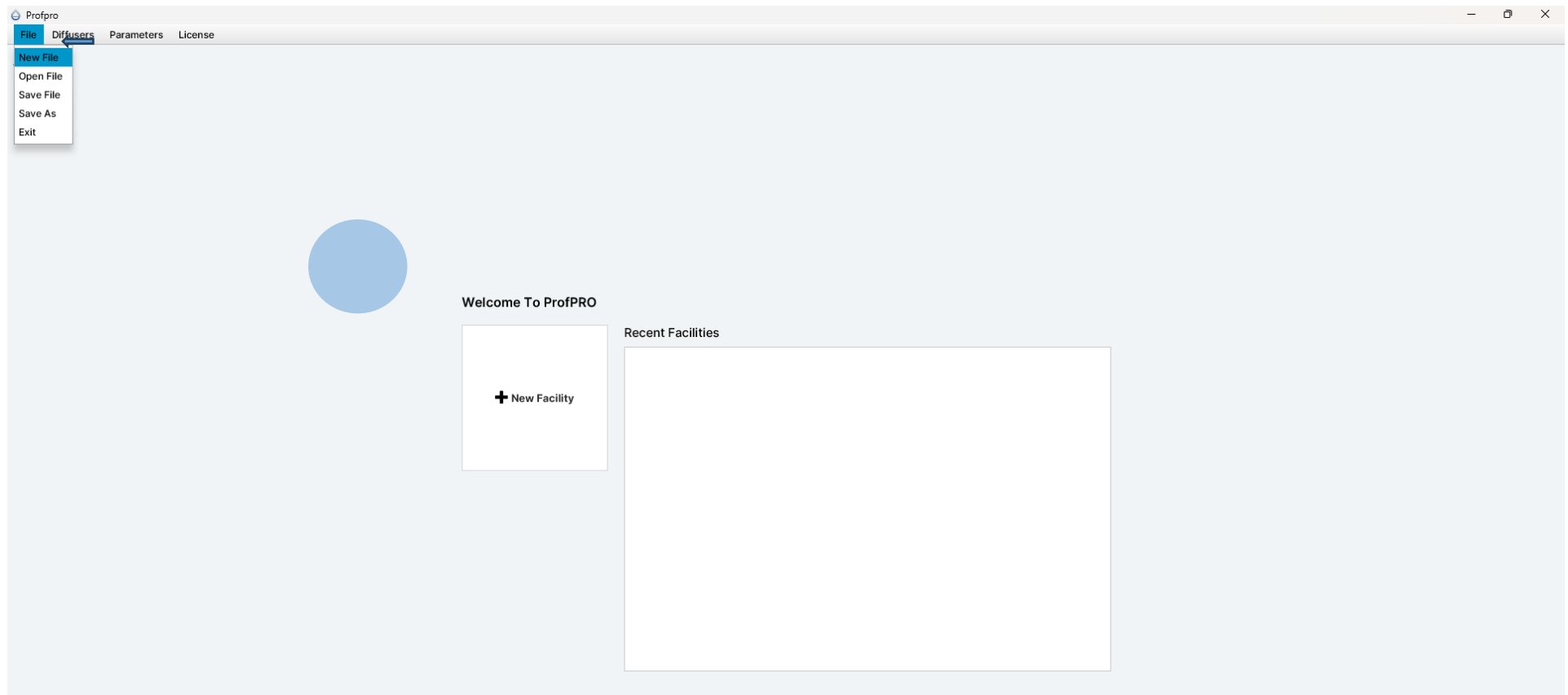
This fraction is important for biological phosphorus removal and denitrification.

This fraction of COD is not affected by biological processes and remains the same in the influent and effluent.

The other parameters are relevant in ATV 131 E (2016)

3-How To Form a New File:

Create New Project File:



This is the welcome screen of ProfPRO, you can either select “**+New Facility**” or “**New File**” from the File tab to create a new project.

After you create or open a project, it will appear in the Recent Facilities section in the welcome screen for quick access.

Once you choose new file the following screen appears;

New Facility

Create a New Facility

Facility Name:

New Facility

Flow Rates Concentrations Parameters

Dry Weather Flow Rate (Qdw): Enter value

Maximum Dry Weather Flow Coefficient (2-Hour): Enter value

Wet Weather Hourly Flow Coefficient: Enter value

Create Cancel

There are 3 tabs in the new project creation screen to be filled by user. The facility name is the name of the project, flow rates and corresponding coefficients are determined by user.

ATV 198 – E (Standardization and Derivation of Dimensioning Values for Wastewater Facilities) can be used for determining the “Maximum Dry Weather Coefficient” and “Wet Weather Hourly Flow Coefficient”.

In general approach, $Q_{DW,d} \text{ (m}^3\text{/day)} = Q_{dom,d} + Q_{ind,d} + Q_{inf,d}$

$Q_{DW,d} \text{ (m}^3\text{/day)} = \text{Average daily dry weather flow rate.}$

$Q_{dom,d} \text{ (m}^3\text{/day)} = \text{Average daily domestic flow rate.}$

$Q_{ind,d} \text{ (m}^3\text{/day)} = \text{Average daily industrial flow rate.}$

$Q_{inf,d} \text{ (m}^3\text{/day)} = \text{Average daily constant infiltration flow rate.}$

$Q_{DW,24hAve} \text{ (m}^3\text{/h)} = \text{24 hour average hourly flowrate.}$

In order to calculate maximum 2 hourly flow rate “ $Q_{DW,h}$ ”, the following graph can be used according to ATV 198 -E.

$$Q_{DW,max}, Q_{DW,h,max} \text{ resp. } Q_{DW,2h,max} = \frac{24 \cdot Q_{WW,aM}}{x_{Qmax}} + Q_{inf,aM} \quad [l/s] \quad (11)$$

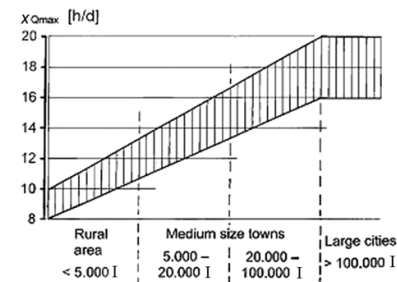


Fig. 2: Divisor x_{Qmax} dependent on the size [number of residents] of the [catchment] area [Authors' afternotes]

In other word, $Q_{DW,h} = Q_{DW,d} / x$ and it is totally dependent of the size of the treatment plant. In the past advisory documents, x values change as in the following table;

Treatment Plant Capacity (PE)	Corresponding x-factor
>200.000	20
>50.000	18
>20.000	16
>5.000	14
<5.000	12

The maximum 2 hourly flow rate “ $Q_{DW,h}$ ” ($m^3/hour$), is the design flowrates of the following units;

- 1- Primary Sedimentation Tank Volume (m^3)
- 2- Grit and Grease Chamber design check for grease loading. (qA) (m/h)
- 3- Anaerobic Biological Phosphorus Removal Tank Volume (m^3)
- 4- Internal Recirculation Pump Capacity (m^3 / h)
- 5- Return Sludge Pump Staging. (m^3 / h)

Wet Weather Flow (Maximum Hourly Flow) $Q_{WW,h}$ (m^3/h) is totally dependent on the sewerage collection network which can be either separated or collective system. Wastewater treatment plants cannot be designed to treat the whole stormwater flow. In many countries, $Q_{WW,h}$ is equal to maximum 2 - 2.5 x $Q_{DW,24hAve}$.

The wet weather flow rate “ $Q_{WW,h}$ ” (m^3/h), is the design flowrates of the following units;

- 1- Coarse and fine screens
- 2- Inlet pumping stations
- 3- Grit and grease chamber
- 4- Return sludge pumping stations
- 5- Open channels
- 6- Secondary sedimentation tanks

$Q_{DW,d}$ (m^3/day) = Average daily dry weather flow rate is the design flowrate for calculation of pollutant loads and therefore for sizing the biological reactor volume.

New Facility

Create a New Facility

Facility Name:

Flow Rates
 Concentrations
 Parameters

Chemical Oxygen Demand, $C_{COD,I}$	Enter value
Suspended Solids Concentration, $X_{SS,I}$	Enter value
Total Kjeldahl Nitrogen Concentration, $C_{TKN,I}$	Enter value
Phosphorus Concentration, $C_{TP,I}$	Enter value
Ammonium Nitrogen Concentration, $S_{NH_4,I}$	Enter value
Nitrate Nitrogen Concentration, $S_{NO_3,I}$	Enter value
Alkalinity, $S_{ALK,I}$	Enter value

Create

Cancel

On the Concentrations Tab, you identify **THE CONCENTRATIONS OF INFLUENT IN THE RAW WASTEWATER AFTER GRIT AND GREASE CHAMBER AND BEFORE PRIMARY SEDIMENTATION TANK.**

New Facility

Create a New Facility

Facility Name:

New Facility

Flow Rates Concentrations Parameters

SCOD,inert,IAT/CCOD,IAT (0,05-0,10)-fs	0,05	XN,BM/XCOD,BM	0,07	Ycod,dos Methanol	0,45	g COD/g COD
Xinorg,SS,i/Xss (0,2-0,3)-fB	0,3	XorgN _i /XCOD _i	0,03	Ycod,dos Ethanol	0,42	g COD/g COD
XCOD,inert,IAT/XCOD,IAT (0,20-0,35)-fA	0,3	XP,BM/CCOD,IAT	0,005	Ycod,dos Acetic Acid	0,42	g COD/g COD
CCOD,Ia,IAT/Cdeg,IAT-fCOD (0,15-0,25)	0,2	XP,BioP/CCOD,IAT	0,007	Ycod,deg	0,67	g COD/g COD
COD of Organic Dry Matter gCOD/VSS	1,6	XP,BioP/CCOD,IAT (*)	0,005	Nitr. Bac. Growth Rate	0,47	1/d

(*) Pre-Denitrification W/O Anaerobic Tank

Reset To Defaults Save

Create Cancel

Before starting the WWTP design calculations, you are able to change the parameters, or you can just accept the default values.

Here is an example of a treatment plant which has flowrates of; $Q_{DW,d} = 50.000 \text{ m}^3/\text{day}$, $Q_{DW,h} = 2.750 \text{ m}^3/\text{h}$, $Q_{WW,h} = 3.850 \text{ m}^3/\text{h}$

New Facility

Create a New Facility

Facility Name:
Example-1

Flow

Flow Rates Concentrations Parameters

Dry Weather Flow Rate (Q_{dw}): 50,000

Maximum Dry Weather Flow Coefficient (2-Hour): 1.32

Wet Weather Hourly Flow Coefficient: 1.4

New Facility

Create a New Facility

Facility Name:
Example-1

Raw Influent Concentrations

Flow Rates Concentrations Parameters

Chemical Oxygen Demand, $C_{COD,i}$: 600

Suspended Solids Concentration, $X_{SS,i}$: 400

Total Kjeldahl Nitrogen Concentration, $C_{TKN,i}$: 55

Phosphorus Concentration, $C_{TP,i}$: 10

Ammonium Nitrogen Concentration, $S_{NH_4,i}$: 35

Nitrate Nitrogen Concentration, $S_{NO_3,i}$: 0

Alkalinity, $S_{ALK,i}$: 7.1

New Facility

Create a New Facility

Facility Name:
Example-1

Parameters

Flow Rates Concentrations Parameters

SCOD _{inert,IAT/CCOD,IAT (0.05-0.10)-fs}	0.05	XN _{BM/CCOD,BM}	0.07	Y _{cod,dos Methanol}	0.45	g COD/g COD
X _{inorg,SS,i/Xss (0.2-0.3)-fB}	0.3	X _{orgNi/XCOD,i}	0.03	Y _{cod,dos Ethanol}	0.42	g COD/g COD
XCOD _{inert,IAT/XCOD,IAT (0.20-0.35)-fA}	0.3	XP _{BM/CCOD,IAT}	0.005	Y _{cod,dos Acetic Acid}	0.42	g COD/g COD
CCOD _{la,IAT/Cdeg,IAT-fCOD (0.15-0.25)}	0.2	XP _{BioP/CCOD,IAT}	0.007	Y _{cod,deg}	0.67	g COD/g COD
COD of Organic Dry Matter gCOD/VSS	1.6	XP _{BioP/CCOD,IAT (*)}	0.005	Nitr. Bac. Growth Rate	0.47	1/d

(*) Pre-Denitrification W/O Anaerobic Tank

Reset To Defaults Save

Create Cancel

Once filled all empty fields, press “**Create**” button then the project file is formed for further calculations, and “**Flowrates**” and “**Concentrations**” tabs screen appears;

Example-1

Flowrates & Concentrations

Design

Process Train

Flowrates

Concentrations

Dry Weather Flow Rate $Q_{DW,d}$	50,000	m^3/d
24-Hour Average Dry Weather Flow Rate Q_{DW}	2,083	m^3/h
2-Hour Maximum Dry Weather Flow Coefficient	1.32	
2-Hour Maximum Dry Weather Flow $Q_{DW,h}$	2,750	m^3/h
Maximum Hourly Flow Coefficient	1.4	
Maximum Hourly Flow (Wet Weather Flow), $Q_{ww,h}$	3,850	m^3/h
Maximum Hourly Flow (Wet Weather Flow), $Q_{ww,d}$	92,400	m^3/d

Daily and hourly flow rates, which will be the reference data for relevant units in WWTP, is shown in the “**Flowrates**” tab.

“Concentrations” tab is the second section in this page.

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train >

Flowrates Concentrations

Raw Wastewater Concentrations

Chemical Oxygen Demand, C_{COD} 600 mg/L

Particulate COD Concentration, X_{COD} 448 mg/L

Suspended Solids Concentration, X_{SS} 400 mg/L

Total Kjeldahl Nitrogen Concentration, C_{TKN} 55 mg/L

Phosphorus Concentration, C_{TP} 10 mg/L

Ammonium Nitrogen Concentration, S_{NH_4} 35 mg/L

NH_4 / C_{TKN} Ratio 0.64

Nitrate Nitrogen Concentration, S_{NO_3} 0 mg/L

Alkalinity, S_{ALK} 7.1 mmol/L

Biological Reactor Inlet Concentrations

Chemical Oxygen Demand, $C_{COD,IAT}$ 420 mg/L

Particulate COD Concentration, $X_{COD,IAT}$ 246 mg/L

Suspended Solids Concentration, $X_{SS,IAT}$ 200 mg/L

Total Kjeldahl Nitrogen Concentration, $C_{TKN,IAT}$ 50.00 mg/L

Phosphorus Concentration, $C_{TP,IAT}$ 9.00 mg/L

Ammonium Nitrogen Concentration, $S_{NH_4,IAT}$ 35.00 mg/L

$NH_4,IAT / C_{TKN,IAT}$ Ratio 0.70

Nitrate Nitrogen Concentration, $S_{NO_3,IAT}$ 0.00 mg/L

Alkalinity, $S_{ALK,IAT}$ 7.10 mmol/L

Primary Sedimentation Tank YES Retention Time 1 h

	Hydraulic retention time as a function of the annual mean dry weather flow rate $Q_{DW,AM}$		
η in %	0,75 h – 1 h	1,5 h – 2 h	> 2,5 h
C_{COD}	30	35	40
X_{COD}	45	55	60
X_{SS}	50	60	65
C_{KN}	10	10	10
C_P	10	10	10

Removal Percents %

Parameters

C COD 30

X COD 45

X SS 50

C KN 10

C P 10

COD FRACTIONS

$S_{COD,IAT}$ 174 mg/L

$X_{COD,IAT}$ 246 mg/L

$S_{COD,inert,IAT}$ 21.00 mg/L

$X_{COD,inert,IAT}$ 73.80 mg/L

$C_{COD,deg,IAT}$ 325 mg/L

$S_{COD,deg,IAT}$ 153 mg/L

$X_{COD,deg,IAT}$ 172 mg/L

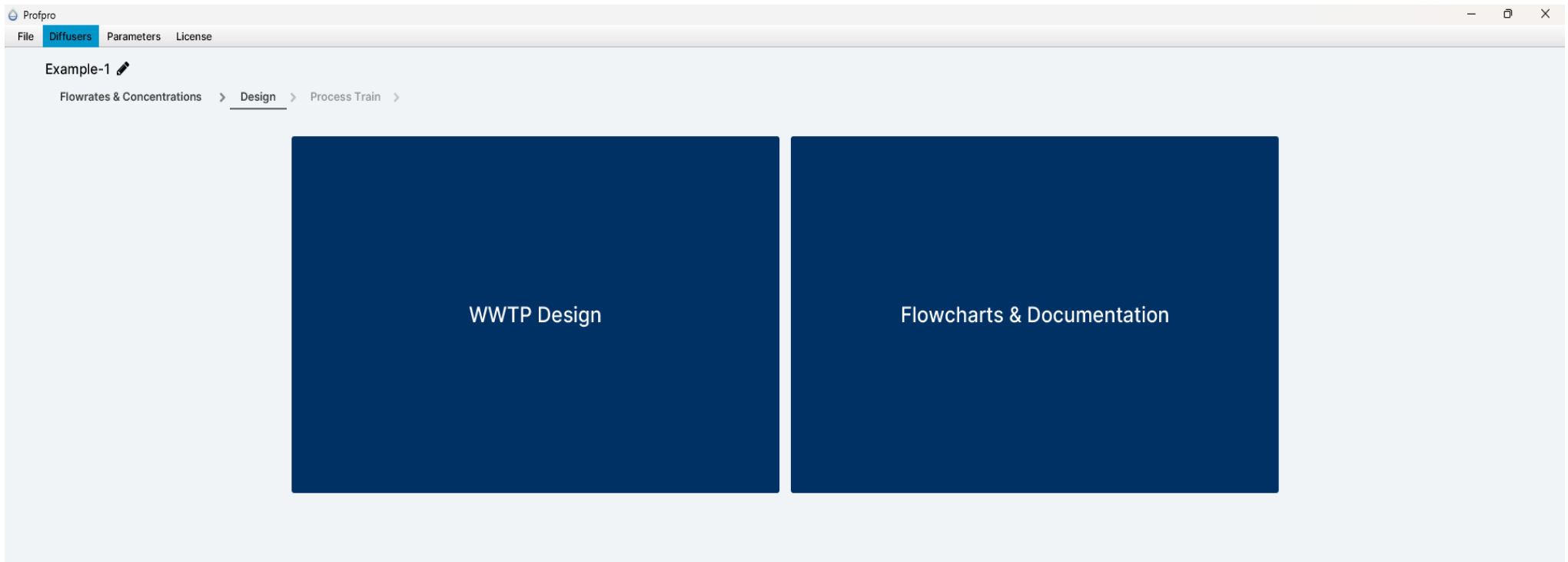
Biological Reactor COD and SS Fractions		
PERCENTAGE(%) (Based on Inlet COD)	INLET COD CONCENTRATION PARAMETERS	INLET CONCENTRATION VALUES IN TERMS OF COD
5.00	$S_{COD,inert,IAT}$	21.00
36.43	$S_{COD,deg,IAT}$	153
41.00	$X_{COD,deg,IAT}$	172
17.57	$X_{COD,inert,IAT}$	73.80
PERCENTAGE(%) (Based on Inlet SS)	INLET INORGANIC SS CONCENTRATION PARAMETER	INLET INORGANICS CONCENTRATION VALUE (mg/L)
23.13	$X_{SS,inorg,IAT}$	46.25

Save Next

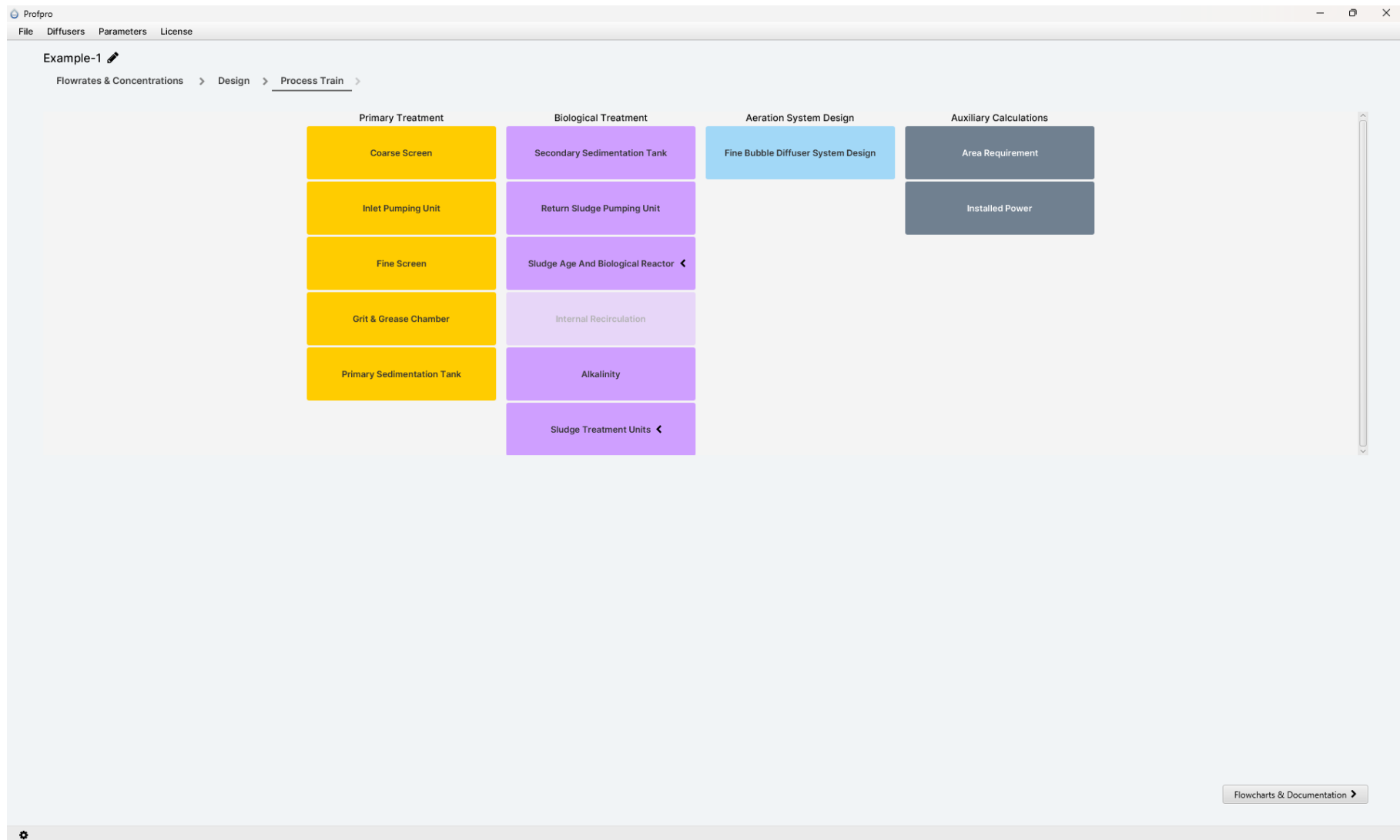
Here the concentrations are calculated based on the choice of primary sedimentation tank and its retention time according to ATV 131-E (2016) Table 2. There are 3 options for primary sedimentation tank (“YES”, “NO” and “CUSTOM”). In the custom selection, removal percentages can be determined by the user, which allow the user to choose his/her own measured percentages.

The COD fractions are calculated according to the fractions already identified in the “**Parameters**” section.

Click “**Next**” for further steps. After clicking “**Next**”, the user will see the following screen;



Now, the user should press on “**WWTP Design**” button to design the units one by one. After clicking “**WWTP Design**” button following page appears;



This is the main design module of all units. Designing all units in each line (Primary Treatment-Biological Treatment-Aeration System Design-Auxiliary Calculations) is explained one by one in the sections below;

Primary Treatment Line:

Coarse Screen:

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Coarse Screen

← Coarse Screen

Wet Weather Flow	3,850	m ³ /h	
Number of Units	2	amount	
Flow Rate per Screen	0.53	m ³ /s	
Manning Coefficient	0.013		
Selected Width, b	1	m	
Selected Water Height, h	1	m	
R	0.33	m	
Slope Denominator	4,782.94		
S (Slope)	0.00020908	1/m	
V	0.53	m/s	
Q	0.53	m ³ /s	
Froude Number	0.17	≤1	Laminar Flow ✓
Bar Spacing	50	mm	
Bar Thickness	10	mm	
Inclination Angle	70	°	
Number of Bars, n	16.00	amount	
Adjusted Spacing between Bars	49.4	mm	
Total Spacing between Bars, bf	0.84	m	
Head Loss Coefficient for Screen, β	2.42		
Head Loss, Δh _{max}	0.01	m	Kirschner Formula
Ac	1.00	m ²	
As	1.06	m ²	
Anet	0.89	m ²	
Velocity between Bars, vb	0.60	m/s <1.2	✓
Head Loss, Δh _{max}	0.01	m	Continuity Formula
Bar Blockage Ratio	40	%	
Blockage Time Total Cross-Sectional Area between Bars, Af	0.53	m ²	
Flow Velocity between Bars, Vf	1.01	m/s <1.2	✓

Clear

Save

Once filled the empty fields, coarse screen design is completed. The selected water height is determined based on the hydraulic profile of downstream weir height.

DIN EN12255-3 Preliminary treatment is the reference document.

Inlet Pumping Unit:

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Inlet Pumping Unit

← Inlet Pumping Unit

Inlet Pumping Unit 1 × +

Maximum Hourly Flow, Q _{ww,h}	3,850	m³/h
Maximum Hourly Flow, Q _{ww,d}	92,400	m³/d
Design Flow Coefficient	1	
Influent Pumping Design Flow	92,400	m³/d
Influent Pumping Design Flow	3,850	m³/h
Q _{pm}	1,069	L/s
Number of Pumps	3	amount
Number of Shafts, Z	6	amount
Wet Volume of Pump Room, V _{min}	160	m³
Water Level Difference for Activation	0.5	m
Minimum Operating Level of Pumps	1.2	m
Design Chamber Surface Area, S	57.29	m²
Required Active Wet Volume	286	m³
Desired Maximum Water Level	5	m
Design Total Water Head	5.00	m
Installed Power		
Maximum Hourly Flow, Q _{ww,h}	3,850	m³/h
Manometric Elevation, H	15	m
Liquid Density, ρ	1	kg/L
Hydraulic Power, P _{hydraulic}	157	kW
Pump Efficiency, η	0.75	
Shaft Power, P_{shaft}	210	kW
Power Margin Factor	1.1	
Installed Pump Power, P_{installed}	231	kW
Number of Pumps	3.00	amount
Installed Power for Each Pump	76.93	kW
Total Installed Power	231	kW

Area m² W 6.37 m L 9 m D 9 m

Max Water Level 5.00 m
0.50 m Shaft Space
Min Water Level 1.20 m

Clear

Save

Suction line and pressure line head losses, which might be estimated or calculated properly, can be added to the Manometric Head value to calculate the power more precisely. ATV 134 E “Planning and Construction of Wastewater Pumping Stations” (2000) is the reference document.

Fine Screen:

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Fine Screen

← Fine Screen

Maximum Hourly Flow (Wet Weather Flow), Q _{ww,h}	3,850	m³/h	
Number of Units	3	amount	
Flow Rate per Screen	0.36	m³/s	
Manning Coefficient	0.013		
Width (W)	1	m	
h (Water Height)	1	m	
R	0.33	m	
Slope Denominator	10,761.62		
S (Slope)	0.00009292	1/m	
V	0.36	m/s	
Q	0.36	m³/s	
Froude Number	0.11	≤1	Laminar Flow ✓
Bar Spacing	10	mm	
Bar Thickness	10	mm	
Inclination Angle	70	°	
Number of Bars, n	50.00	amount	
Adjusted Spacing between Bars	9.80	mm	
Total Spacing between Bars, t _f	0.50	m	
Head Loss Coefficient for Screen, β	2.42		
Head Loss, Δh _{max}	0.02	m	Kirschner Formula
A _c	1.00	m²	
A _s	1.06	m²	
A _{net}	0.53	m²	
Velocity between Bars, v _b	0.68	m/s <1.2	✓
Head Loss, Δh _{max}	0.03	m	Continuity Formula
Bar Blockage Ratio	40	%	
Blockage Time Total Cross-Sectional Area between Bars, A _f	0.32	m²	
Flow Velocity between Bars, V _f	1.13	m/s <1.2	✓

Clear

Save

The methodology is the same as Coarse Screen Unit. The selected water height is determined based on the hydraulic profile of downstream weir which is located generally after grit-grease chamber unit. *DIN EN12255-3 Preliminary treatment is the reference document.*

Grit & Grease Chamber:

ProfPRO automatically calculates the sizing of the Grit and Grease Chamber Unit by “Auto Calculate” button.

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Grit & Grease Chamber

Grit And Grease Chamber

2-Hour Maximum Dry Weather Flow QDW,h	2,750	m³/h
Grit and Grease Chamber Design Flow Rate	3,850	m³/h
Number of Grit and Grease Chamber Tanks	2	
Design Flow Rate for Each Grit and Grease Chamber	1,925	m³/h
Total Air Pressure Loss	50	hPa
<button>Auto Calculate</button>		

W=bSF+bFF		m	(2.5 - 7.0 m)
bFF/bSF Ratio			0,5 - 1
Width of the Grease Chamber, bFF		m	
Width of the Grit Chamber, bSF		m	
bSF/hSF Ratio			0,8-1
Total Depth, hSF		m	
Middle Wall Submerged Height, hMW		m	0,2xh _{SF}
Wastewater Depth Above Diffuser, hBel		m	h _{SF} -0,3m
Slope of the Grease Chamber, α		°	35° - 45°
Length, LSF		m	
Length of Grease Collection Pit	2.00	m	
Length, LFF		m	
Diffuser Subheight		m	
Hopper Angle, β		°	
Bottom Width of Sand Collection Chamber, h,hop		m	0,15 h _{SF}
Bottom Depth of Sand Collection Chamber, h,hop		m	h hop Modifier 0,15 - 0,25 bSF
w1		m	
w2		m	
w3		m	
Bottom Wall Depth of Grease Chamber, hyag,bottom		m	
Upper Wall Depth of Grease Chamber, hyag,top		m	
Total Depth hSF + h,hop			

Clear

Save

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Grit & Grease Chamber

← Grit And Grease Chamber

2-Hour Maximum Dry Weather Flow QDW/h	2,750	m ³ /h
Grit and Grease Chamber Design Flow Rate	3,850	m ³ /h
Number of Grit and Grease Chamber Tanks	2	
Design Flow Rate for Each Grit and Grease Chamber	1,925	m ³ /h
Total Air Pressure Loss	50	hPa
	Auto Calculate	
W=bSF+bFF	5.85	m (2.5 - 7.0 m)
bFF/bSF Ratio	1.00	0.5 - 1
Width of the Grease Chamber, bFF	2.93	m
Width of the Grit Chamber, bSF	2.93	m
bSF/hSF Ratio	0.8	0.8-1
Total Depth, hSF	2.34	m
Middle Wall Submerged Height, hMW	0.47	m 0,2xh _{SF}
Wastewater Depth Above Diffuser, hBel	2.13	m h _{SF} -0,3m
Slope of the Grease Chamber, α	35.00	° 35° - 45°
Length, LSF	48.00	m
Length of Grease Collection Pit	2.00	m
Length, LFF	50.00	m
Diffuser Subheight	0.21	m
Hopper Angle, β	30.00	°
Bottom Width of Sand Collection Chamber, h _{hop}	0.35	m 0,15 h _{SF}
Bottom Depth of Sand Collection Chamber, h _{hop}	0.64	m h hop Modifier 0.22 0,15 - 0,25 bSF
w1	0.30	m
w2	1.12	m
w3	2.97	m
Bottom Wall Depth of Grease Chamber, h _{yag,bot}	2.08	m
Upper Wall Depth of Grease Chamber, h _{yag,top}	0.26	m
Total Depth hSF + h _{hop}	2.98	2.98

Clear

Save

Total Air pressure loss is the total head loss except for water height pressure loss. Once Pressed “**Auto Calculate**”, ProfPRO automatically calculates the grit chamber design. Now you can adjust your own design choices by changing the values already calculated by the software.

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Grit & Grease Chamber

Grit And Grease Chamber

2-Hour Maximum Dry Weather Flow QDW,h	2,750	m³/h	
Grit and Grease Chamber Design Flow Rate	3,850	m³/h	
Number of Grit and Grease Chamber Tanks	2		
Design Flow Rate for Each Grit and Grease Chamber	1,925	m³/h	
Total Air Pressure Loss	50	hPa	
<button>Auto Calculate</button>			
W=bSF+bFF	5	m	(2.5 - 7.0 m)
bFF/bSF Ratio	0.7		0.5 - 1
Width of the Grease Chamber, bFF	2.06	m	
Width of the Grit Chamber, bSF	2.94	m	
bSF/hSF Ratio	0.8		0.8-1
Total Depth, hSF	2.35	m	
Middle Wall Submerged Height, hMW	0.47	m	0.2xh _{SF}
Wastewater Depth Above Diffuser, hBel	2.14	m	h _{SF} -0.3m
Slope of the Grease Chamber, α	35.00	°	35° - 45°
Length, LSF	25	m	
Length of Grease Collection Pit	2.00	m	
Length, LFF	27.00	m	
Diffuser Subheight	0.21	m	
Hopper Angle, β	30.00	°	
Bottom Width of Sand Collection Chamber, h _{hop}	0.35	m	0.15 h _{SF}
Bottom Depth of Sand Collection Chamber, h _{hop}	0.65	m	h hop Modifier 0.22 0.15 - 0.25 bSF
w1	0.30	m	
w2	1.12	m	
w3	2.11	m	
Bottom Wall Depth of Grease Chamber, hyag _{bottom}	1.47	m	
Upper Wall Depth of Grease Chamber, hyag _{top}	0.88	m	
Total Depth hSF + h_{hop}	3.00	3.00	

Cross-Sectional Area, A1	6.89	m²	1-15	✓
Horizontal Flow Velocity	0.05	m/sec	≤0.20	✓
Surface Flow Velocity of Grease Chamber, qA _{FF}	24.74	m/h	≤25	✓
Total Volume	186	m³		
Retention Time, tR	348	sec	≥300sec	✓
Specific Air Input	1.1	Nm³/h/m³		
Air Requirement per Sand Trap	205	Nm³/h		
Total Blower Capacity	409	Nm³/h		
Water Height Pressure Loss	210	hPa		
Total Pressure Loss	260	hPa		

Clear

Save

Parameter	Recommended Range of Values
Horizontal flow velocity	$\leq 0.20 \text{ m/s}$
Width/depth ratio b_{SF}/h_{SF}	0.8–1.0
Cross-sectional area A_L (without grease trap)	$1 \text{ m}^2 - 15 \text{ m}^2$
Detention time t_R	$\geq 300 \text{ s}$
Tank length L_{SF}	$> 10 \times b_{SF} < 50 \text{ m}$
Submergence depth h_{Bel}	$h_{SF} - 0.3 \text{ m}$
Specific air input (related to tank volume, without grease trap chamber)	$0.5\text{--}1.3 \text{ m}^3/(\text{m}^3 \times \text{h})$
Immersion depth of the middle wall (without installations) h_{MW}	approx. $0.2 \times h_{SF}$
Bottom cross slope of grease trap chamber α	$35^\circ\text{--}45^\circ$
Width of grease trap chamber b_{FF}	$0.50 \text{ to } 1.00 \times b_{SF}$
Surface load of the grease trap chamber $q_{A,FF}=Q_t/A_{FF}$	$\leq 25 \text{ m/h}$ (for dry weather inflow)
Grit channel: depth	approx. $0.15 \times h_{SF}$
Grit channel: top width	$0.15 \text{ to } 0.25 \times b_{SF}$

The table above is included in the document of *Grit Chambers – Requirements, Systems and Dimensioning Work Report of DWA Technical Committee (2008)* as constraints and recommendations in the grit & grease chamber design.

Primary Sedimentation Tank:

Profpro

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Example-1

Flowrates & Concentrations > Design > Process Train > Primary Sedimentation Tank

← Primary Sedimentation Tank

Circular

Design Primary Sedimentation Flow Rate 2,750 m³/h

Number of Primary Sedimentation Tanks 2 amount

Flow Rate per Primary Sedimentation Tank 1,375 m³/h

Primary Sedimentation Retention Time 1 h

Volume per Primary Sedimentation Tank 1,375 m³

Retention Time at Maximum Flow Rate 42.86 min 20 < t₁₀ < 120 ✓

Surface Loading Rate (2.5-4) 3 m/h

Surface Area per Primary Sedimentation Tank 458 m²

Diameter per Primary Sedimentation Tank 24.16 m

Average Primary Sedimentation Height 3.00 m

Primary Sludge Calculations

Dry Weather Flow Rate Q_{DW,d} 50,000 m³/d

Primary Sludge Concentration 30 kg/m³

Primary Sludge Load 10,000 DS/d

Primary VS. Organic 6,313 kg/d

Primary FS. Inorganic 3,688 kg/d

X_{inorg,ps} / X_{SS,ps} 0.37

Primary Sludge Volume 333 m³/d

Biological Reactor Inlet SS Calculations

X_{SS,org,IAT} 7,688 kg/d

X_{SS,inorg,IAT} 2,313 kg/d

X_{SS,inorg,IAT} / X_{SS,IAT} 0.23

Parameters	Initial Concentrations (mg/L)	Removal Efficiency (%)	Concentration After PST (mg/L)	Load After PST (kg/d)
Chemical Oxygen Demand, C _{COD}	600	30	420	21,000
Particulate COD Concentration, X _{COD}	448	45	246	12,300
Suspended Solids Concentration, X _{SS}	400	50	200	10,000
Total Kjeldahl Nitrogen Concentration, C _{TKN}	55.00	10	50.00	2,500
Phosphorus Concentration, C _{TP}	10.00	10	9.00	450

Clear

Save

In “Primary Sedimentation Tank” the user first chooses the shape (“Circular” or “Rectangular”). Once the user fills all the empty fields, pollutant loads after primary sedimentation tank and the primary sludge calculations is made by ProfPRO.

ATV 131 E (2016) and DWA Topics – Design of wastewater treatment plants in hot and cold climates (May 2019) are the reference documents.

Biological Treatment Line:

Secondary Sedimentation Tank:

Circular Sedimentation Tank Design Example;

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Secondary Sedimentation Tank

Secondary Sedimentation Tank

Return Sludge Concentration Calculation

SVI	110	L/kg
t, Th	2.00	h
RS	0.75	
SS _{BS}	11.45	kg/m ³
SS _{RS} / SS _{BS}	0.70	
SS _{RS}	8.02	kg/m ³
SS _{AT,max}	3.44	kg/m ³
SS _{AT}	3.00	kg/m ³
DSV	330	L/m ³

Shape: Circular

Surface Area Calculations

Q _{ww,h}	3,850	m ³ /saat
Minimum Surface Area	2,541	m ²
Number of Final Settling Tanks	4.00	amount
Final Settling Surface Area Per Unit	635	m ²
Minimum Final Settling Diameter	28.75	m
Selected Final Settling Diameter	30.00	m
Design Final Settling Surface Area Per Unit	693	m ²
Total Design Final Settling Surface Area	2,772	m ²
qA Design	1.39	m/h
qsv Design	458	L/m ² ·h

Average Height Calculations

h ₁	0.68	m
h ₂₃	2.54	m
h ₄	1.27	m
Total Minimum Average Height	4.32	m
Selected Average Height	4.50	m

Inlet Structure

Retention Time	110	sec
Q*(1+RS)	0.47	m ³ /s
Vinlet	51.47	m ³
Diameter of Inlet Structure	4.19	m
Inlet Structure Depth, h _{in}	3.74	m
Height of Culvert, h _{slot}	0.60	m (0.3 - 0.6)
Area Utilization Percentage	85.00	%
Available Area	6.71	m ²
Culvert Total Width	11.18	m
Number of Culverts	4.00	amount
Width per Culvert, b _{slot}	2.80	m
Space Between Culvert	0.66	m
Inlet Pipe Diameter	800	mm
Inlet Pipe Surface Area	0.50	m ²
Pipe Inlet Velocity	0.93	m/s

Wastewater Temperature: 12.00 °C

Results

Vinlet	51.47	m ³
Diameter of Inlet Structure	4.19	m
Power Input	203	Nm/s
G	56.58	1/sec
Fr	0.91	

Weir Load Calculations

Double Weir

Weir Channel Width	1.00	m
Outer Weir Wall Distance	1.00	m
Outer Weir Length	352	m
Inner Weir Length	327	m
Flow Per Tank	963	m ³ /h
Total Weir Length	679	m
Weir Load	5.67	m ³ /m/h

Scraper and Bridge Properties

aST,Dim	1.5	
rST,Dim	15.00	m
LBST,Dim	22.50	m
Ar,Dim	884	m ²
hSR,Dim (0.4-0.6 m)	0.50	m
vSR,Dim (72-144 m/h)	110	m/h
nSR,Dim	1.17	1/h
fSR,Dim	1.50	
Qr,Dim	1,375	m ³ /h
Qshort,Dim	1,513	m ³ /h
Qshort,Dim / QRS,Dim (0.4-0.8)	0.52	
tSR,Dim	0.86	h
Qsr,Dim Min	1,625	m ³ /h
Qsr,Dim	1,650	m ³ /h
Qsr,Dim ≥ Qsr,Dim Min	✓	

Diagram: Circular Sedimentation Tank Design

Diagram 1: Top view of the circular tank showing a diameter of 4.19 m. It includes two rectangular inlet structures with width b_{slot} and height h_{slot}. The total width of the inlet structures is 13.16 m, with a central gap of 11.18 m and side gaps of 1.97 m each. The height of the tank is 3.74 m.

Diagram 2: Cross-section of the tank showing the vertical zones and heights. The total height is h_{tot} ≥ 3.0 m. The zones and their heights are: Clean water and return flow zone (h₁: 0.68 m), Separation and storage zone (h₂₃: 2.54 m), and Thickening and sludge removal zone (h₄: 1.27 m). The height of the inlet structure is h_{slot} = 0.60 m. The height of the water column above the inlet is h = 1-1.5 m. The partial radius for surface area A_{ST} is indicated.

Save

Rectangular Sedimentation Tank Design Example;

Profpro
File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Secondary Sedimentation Tank

Secondary Sedimentation Tank

Return Sludge Concentration Calculation

SVI	110	L/kg
t, Th	2.00	h
RS	0.75	
SS _{BS}	11.45	kg/m ³
SS _{RS} / SS _{BS}	0.70	
SS _{RS}	8.02	kg/m ³
SS _{AT,max}	3.44	kg/m ³
SS _{AT}	3.00	kg/m ³
DSV	330	L/m ³

Shape
Rectangular

Surface Area Calculations

Q _{ww,h}	3,850	m ³ /saat
Minimum Surface Area	2,541	m ²
Number of Final Settling Tanks	8	amount
Final Settling Surface Area Per Unit	318	m ²
Tank Width	10	m
Minimum Final Settling Length	31.76	m
Selected Final Settling Length	32.00	m
Design Final Settling Surface Area Per Unit	320	m ²
Total Design Final Settling Surface Area	2,560	m ²
q _A Design	1.50	m ³ /h
q _{sv} Design	496	L/m ³ *h

Average Height Calculations

h ₁	0.57	m
h ₂₃	2.75	m
h ₄	1.38	m
Total Minimum Average Height	4.63	m
Selected Average Height	4.7	m

Inlet Structure

Retention Time	110	sec
Q*(1+RS)	0.23	m ³ /s
Vinlet	25.73	m ³
Req. Length of Inlet Structure	0.77	m
Inlet Structure Depth, h _{in}	3.32	m
Height of Culvert, h _{slot}	0.6	m (0.3 - 0.6)
Area Utilization Percentage	85.00	%
Available Area	5.10	m ²
Inlet Pipe Diameter	600	mm
Inlet Pipe Surface Area	0.28	m ²
Pipe Inlet Velocity	0.83	m/s

Wastewater Temperature
12.00 °C

Results

Vinlet	25.73	m ³
Req. Length of Inlet Structure	0.77	m
Power Input	80.08	Nm/s
G	50.30	1/sec
Fr	0.60	

Weir Load Calculations

Number of Tanks	8.00	
Flow Per Tank	481	m ³ /h
Weir Load	5.67	m ³ /m/h
Min. Weir Length Per Tank	84.88	m

Scraper and Bridge Properties

vSR	100	m/h
v _{ret}	300	m/h
f _{SR}	0.8	
h _{SR}	0.8	m
L _{SL}	12.00	
tSR	0.60	h
tS	0.17	h
LRW	32.00	
nSR	1.68	
nST	8.00	
Number of Sludge Storage	1	
Q _{r,Dim}	1,287	m ³ /h
Q _{Short,Dim}	1,600	m ³ /h
Q _{Short,Dim} / Q _{RS,Dim}	0.55	(0.4-0.8)
Q _{SR,min}	1,602	m ³ /h
Q _{SR,actual}	1,609	m ³ /h

Dry Solids Balance Achieved ✓

Diagrams:

Clear

Save

Design calculations of the secondary sedimentation tanks is made according to equations and constraints published in the documents of *ATV 131-E (2016)* and *Working Report of the ATV Special Committee Sedimentation Processes*.

Return Sludge Pumping Unit:

ATV
134
E

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Return Sludge Pumping Unit

← Return Sludge Pumping Unit

Return Sludge Pumping Unit 1 ×

Maximum Hourly Flow, $Q_{ww,h}$	3,850	m^3/h
Return Sludge Ratio, RS_{ww}	1.00	
Total Return Sludge Pump Capacity	3,850	m^3/h
Total Return Sludge Pump Capacity	92,400	m^3/d
Q_{pm}	1,069	L/s
Number of Pumps	3.00	amount
Number of Shafts, Z	6.00	amount
Wet Volume of Pump Room, V_{min}	160	m^3
Water Level Difference for Activation	0.50	m
Minimum Operating Level of Pumps	1.20	m
Design Chamber Surface Area, S	39.13	m^2
Required Active Wet Volume	246	m^3
Desired Maximum Water Level	6.30	m
Design Total Water Head	6.30	m
Installed Power		
Maximum Hourly Flow, $Q_{ww,h}$	3,850	m^3/h
Final Sedimentation Tank Shape	Rectangular	
Final Sedimentation Slope	0.07	typical 1/15 (0.067)
Final Sedimentation Average Height	4.70	m
Final Settling Length	32.00	m
Final Sedimentation Central Height	6.19	m
Return Sludge Head Difference	0.75	m
Manometric Elevation, H	6.94	m
Liquid Density, ρ	1.00	kg/L
Hydraulic Power, $P_{hydraulic}$	72.84	kW
Pump Efficiency, η	0.75	
Shaft Power, P_{shaft}	97.12	kW
Power Margin Factor	1.10	
Installed Pump Power, $P_{installed}$	107	kW
Number of Pumps	3.00	amount
Installed Power for Each Pump	35.61	kW Duty Point
Total Installed Power	107	kW

Area m^2 W 5.59 m L 7.00 m

D 7 m

Max Water Level 6.30 m
Shaft Space 0.50 m
Min Water Level 1.20 m

Final Sedimentation Central Height < Desired Maximum Water Level

Save

"Planning and Construction of Wastewater Pumping Stations" (2000) is the reference document.

Sludge Age and Biological Reactor:

Treatment Options:

Example-1

Flowrates & Concentrations > Design > Process Train > Treatment Options

← Treatment Options

Clear

Denitrification Type

	Wastewater Temp.	fN	N% Recharge	fC
Design				
Lowest Temp.				
Maximum Temp.				
Avg. Conditions				
Special Conditions				

Copy

Save Next

User selects treatment objectives by marking relevant process options shown above. The options are;

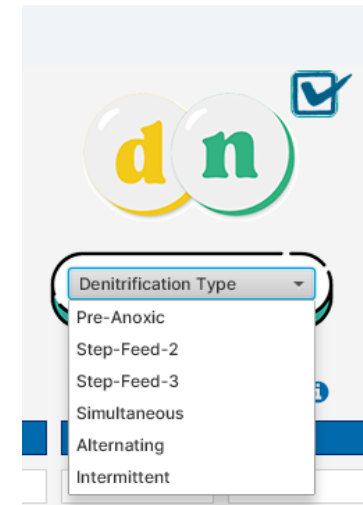
- 1- Carbon Only (No marking in the tick box)
- 2- C + N (Carbon + Nitrification)
- 3- C + P (Carbon + Phosphorous Removal)
- 4- C + N + P (Carbon + Nitrification + Phosphorus Removal)
- 5- C + N + dN + P (Carbon + Nitrification + Denitrification + Phosphorus Removal)

Phosphorous Removal can be biological, chemical or both.

If denitrification process is chosen, 6 types of denitrification process can be selected from the dropdown menu. Among them, pre-anoxic, step feed 2 and step feed 3 denitrification processes have internal recirculation unit. In this section the user must identify wastewater temperature, f_N , N recharge from the backflows and f_C values. These values are determined with the procedures of ATV 198-E or default values can be taken from the table. (ATV 131E)

Table 7: Peak factors for oxygen demand

	Required sludge retention time SRT_{dim} in d					
	4	6	8	10	15	25
f_C	1,3	1,25	1,2	1,2	1,15	1,1
f_N^{-1} for $L_{d,COD,I} \leq 2.400 \text{ kg/d}$				2,4	2,0	1,5
f_N^{-1} for $L_{d,COD,I} > 12.000 \text{ kg/d}$			2,0	1,8	1,5	
NOTE f_N^{-1} as a substitute when no measurements of f_N are available Parameter.						



Example Calculation:

Table C-4: Example for the determination of the peak factor for the nitrogen load

Date	Parameter	Unit	10 - 12 h	12 - 14 h	14 - 16 h	24-h mean	Maximum 2-h load	Max. 2-h load/ 24-h mean
1	2	3	4	5	6	7	8	9
10.2. Wed	$Q_{DW,2h} (Q_{DW,d})$	m^3/h	789	957	896	623	55.5	1.65
	C_{TKN}	mg/l	67	58	61	54		
	$B_{2h,TKN} (B_{d,TKN})$	kg/h	52.9	55.5	54.7	33.6		
4.3. Thur	$Q_{T,2h} (Q_{T,d})$	m^3/h	870	1023	977	678	62.4	1.80
	C_{TKN}	mg/l	65	61	58	51		
	$B_{2h,TKN} (B_{d,TKN})$	kg/h	56.6	62.4	56.7	34.6		
	$Q_{T,2h} (Q_{T,d})$	m^3/h						
	C_{TKN}	mg/l						
	$B_{2h,TKN} (B_{d,TKN})$	kg/h						
Mean							59.3	1.77

If “Only Carbon” Removal is selected, the screen below appears.

Example-1

Flowrates & Concentrations > Design > Process Train > Only Carbon

← Only Carbon

	Wastewater Temp.	Min. Nitrification Sludge Age	
Design	15.00	3.40	Nitrification Warning !
Lowest Temp.	12.00	4.57	
Maximum Temp.	25.00	1.28	Nitrification Warning !
Avg. Conditions	18.00	2.54	Nitrification Warning !
Special Conditions	20.00	2.09	Nitrification Warning !

Clear

Design Lowest Temp. Max Temp. Avg. Conditions Special Conditions

Required Min. Sludge Age for C Removal 4.00 d Design Sludge Age d

Nitrogen Balance

Effluent Organic Nitrogen Concentration mg/L

N Return Load From Sludge 30.00 %

XCOD BM Deg mg/L

XCOD Inert BM Deg mg/L

C_{TKN,IAT} mg/L

N Recharge mg/L

Effluent Organic Nitrogen Concentration mg/L

Xorg,N,BM mg/L

Xorg,N,inert mg/L

Effluent Ammonium NH₄ Concentration mg/L

Phosphorus Balance

Inlet Phosphorus Concentration 9.00 mg/L

Normal Phosphorus Uptake 2.10 mg/L

Effluent TP Concentration, TPest 6.90 mg/L

Previous Save Next

Sludge Age And Biological Reactor ▼

✓ Treatment Options

Only Carbon

Nitrogen Removal

Phosphorus Removal

Sludge Production

As seen from the page shown above, according to the wastewater temperatures defined in “Treatment Options”, the software warns the user for the possible nitrification occurrences. In those circumstances, it is advised that the aeration design should be made as if nitrification takes place.

If **"Carbon Removal + Nitrification"** process is selected, the screen below appears.

ProPro

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Example-1

Flowrates & Concentrations

Design

Process Train

Nitrogen Removal

← Nitrogen Removal Nitrification

Clear

Design

Lowest Temp.

Max Temp.

Avg. Conditions

Special Conditions

Wastewater Temperature

15.00 °C

▶ SET Reactor Volume

IN

Effluent Nitrification Monitoring Alternatives

▼

Organic Nitrogen Concentration, N-Org,est

mg/L

Ammonium Nitrogen Concentration, NH4-N,est

mg/L

N Return Load From Sludge

30.00 %

Parameters for Nitrogen Removal

Current PF

Minimum Sludge Age for Nitrification

Sludge Production from COD Sources

Ccod,deg,IAT

FT

b

Ycod,deg

Xcod,BM,deg

Xcod,inert,BM,deg

d

Design PF

Design Sludge Age

Nitrogen Balance

C_{TKN}

mg/L

N Recharge

mg/L

X_{orgN_{inert}}

mg/L

X_{orgN_{BM}}

mg/L

N_{org,EST}

mg/L

NH_{4,EST}

mg/L

Nitrogen to be Nitrified, S_{NH₄-N}

mg/L

Inlet Nitrate Nitrogen Concentration , S_{NO₃,IAT}

mg/L

Nitrate NO₃ in the Effluent

mg/L

Phosphorus Balance

Inlet Phosphorus Concentration

9.00 mg/L

Normal Phosphorus Uptake

2.10 mg/L

Effluent TP Concentration, TPest

6.90 mg/L

Previous

Save

Next

A screenshot of a software interface. At the top, a purple header bar contains the text 'Sludge Age And Biological Reactor' followed by a downward arrow icon. Below this, a dropdown menu is open, showing a list of options: 'Treatment Options' (with a green checkmark icon to its left and a trash can icon to its right), 'Only Carbon', 'Nitrogen Removal', 'Phosphorus Removal', and 'Sludge Production'. The 'Treatment Options' item is highlighted with a light purple background.

If “Carbon Removal + Nitrification + Denitrification” process is selected, the screen below appears.

The screenshot shows the 'Profpro' software interface for 'Example-1'. The navigation bar includes 'File', 'Diffusers', 'Parameters', and 'License'. The main menu shows 'Flowrates & Concentrations' > 'Design' > 'Process Train' > 'Nitrogen Removal'. The sub-header is 'Nitrogen Removal Nitrification + Denitrification'. The 'Design' tab is active, showing a table of parameters for nitrogen removal and sludge production. The table includes columns for 'Current PF' and 'Design PF'. The 'Design PF' column is highlighted in blue. The 'Design Sludge Age' is also highlighted in blue. The 'Internal Circulation Calculations' section is at the bottom right, showing 'Minimum Total Recirculation' and 'Design Total Recirculation'.

The sidebar shows the 'Sludge Age And Biological Reactor' section. It has a dropdown menu with 'Treatment Options' selected. Below it are five buttons: 'Treatment Options' (with a green checkmark), 'Only Carbon', 'Nitrogen Removal', 'Phosphorus Removal', and 'Sludge Production'.

Whether “C”, “C + N” or “C + N + dN” processes are selected, the relevant pages of these processes are to be calculated in **two steps**. **Firstly**, the user must fill the blanks and proceed to the “**Sludge Production**” page. **Secondly**, after biological tank volume is selected in the “**Sludge Production**” page, further calculations are proceeded by returning to the “**Only Carbon**” or “**Nitrogen Removal**” pages.

The summary of the steps explained below;

- 1- Treatment Objective is identified in the **“Treatment Options”** page.
- 2- Design and other wastewater temperatures, fN, N-Recharge, fC values are typed.
- 3- Depending on the choice of treatment objective **“Only Carbon”** or **“Nitrogen Removal”** pages filled in **“Design Temperature”** tab.
- 4- If **“Phosphorus Removal”** option is selected and marked, the following page should be filled.

Example-1

Flowrates & Concentrations > Design > Process Train > Phosphorus Removal

← Phosphorus Removal

Denitrification Type: Pre-Anoxic

Design Wastewater Temperature: 15.00 °C

Anaerobic Tank: [Dropdown]

Chemical Oxygen Demand, $C_{COD,IAT}$: 420 mg/L

Inlet Phosphorus Concentration, $C_{P,IAT}$: 9.00 mg/L

Total Outlet Set Concentration, TP_{SET} : [Input] mg/L

Calculated Total Outlet Concentration, TP_{EST} : [Input] mg/L

Chemical Dosing Requirement: [Input] mg/L

Chemical Phosphorus Removal Calculations

$X_{P,Prec}$: [Input] mg/L

P_{Prec} : [Input] kg/d

Required Fe: [Input] kg/d

Required Al: [Input] kg/d

Select Chemical: [Dropdown]

Density: [Input] ton/m³

Active Ingredient Amount: [Input] kg/ton

Required Chemical Quantity: [Input] L/day

Pump Safety Factor, SF: [Input]

Number of Pumps: [Input] amount

Total Dosing Pump Flow Rate: [Input] L/h

Anaerobic Tank Volume Calculation

HCT (0.5 - 0.75): [Input] h

$Q_{DW,h}$: [Input] m³/h

Anaerobic Tank Volume: [Input] m³

Phosphorus Balance

Inlet Phosphorus Concentration: 9.00 mg/L

Normal Phosphorus Uptake: [Input] mg/L

$X_{P,BioP}$: [Input] mg/L

TP_{SET} : [Input] mg/L

$X_{P,Prec}$: [Input] kg/d

Required Fe: [Input] kg/d

Sludge Production due to Phosphorus Removal

$X_{P,BioP}$: [Input] mg/L

Sludge Formation from Biological Phosphorus Removal, $SP_{d,BioP}$: [Input] kg/d

Sludge Formation from Chemical Phosphorus Removal, $SP_{d,Pprec}$: [Input] kd/d

Clear

Previous Save Next

- 5- Depending on biological, chemical or both process choices, the software calculates the relevant process calculations.
- 6- The next step is to go into the **“Sludge Production”** page. Once moved to this page, the following screen appears:

Example-1

Flowrates & Concentrations > Design > Process Train > Phosphorus Removal

← Sludge Production

Wastewater Temperature	15.00 °C	Total Sludge Production	
PF	NaN	XSS,inorg	46.25 mg/L
Sludge Age		SP,Xinorg	2,313 kg/d
Required Min. Sludge Age for Nitrification + Denitrification	0.00 d	Xcod,inert,IAT	73.80 mg/L
Design Sludge Age for Nitrification + Denitrification	0.00 d	SP-XCOD,inert,IAT	2,774 kg/d
Sludge Production from Carbon Removal		Xcod BM + Xcod BM,inert	0.00 mg/L
Sludge Production from Carbon Removal, SP _{d,C}	5,087 kg/d	SP-Xcod BM + Xcod,BM,inert	0.00 kg/d
Sludge Production From Additional Carbon Sources SP _{d,C,Ext}	0.00 kg/d	C removal	5,087 kg/d
Sludge Production from Phosphorus Removal		Xcod BM,ExtC	0.00 mg/L
Sludge Production from Biological Phosphorus Removal SP _{d,BioP}	0.00 kg/d	SP, Xcod, Ext	0.00 kg/d
Sludge Production from Chemical Phosphorus Removal SP _{d,Pprec}	0.00 kg/d	SPdx,Bio	0.00 kg/d
Total Sludge Production		SPdx,prec	0.00 kg/d
Total Sludge Production, SP _{d,tot}	5,087 kg/d	Total	5,087 kg/d
Organic Sludge Production, SP _{d,org}	2,774 kg/d		
Inorganic Sludge Production, SP _{d,inorg}	2,313 kg/d		
MLVSS/MLSS Ratio			
MLVSS/MLSS	54.54 %		
Biological Reactor Volume Calculations			
Total Sludge Quantity in the Reactor, M _{SS,AT}	0.00 kg		
Design MLSS Concentration in Wet Weather, MLSS(SS _{AT})	kg/m ³	Reset	
Biological Reactor Volume, V _{AT}	m ³	Select Minimum	
Denitrification Tank Volume, V _D	m ³		
Nitrification Tank Volume, V _N	m ³		
Design Biological Reactor Volume Calculations			
Design Biological Reactor Volume	m ³		
Design Sludge Age	d		
Sludge Mass in the Tank, M _{SS}	kg		
Sludge Mass Formed	kg		
Design Nitrification Tank Volume	m ³		
Design Denitrification Tank Volume	m ³		

- 7- In this page, **design temperature MLSS concentration** and design **Biological Tank Volume** is determined and the page is saved.

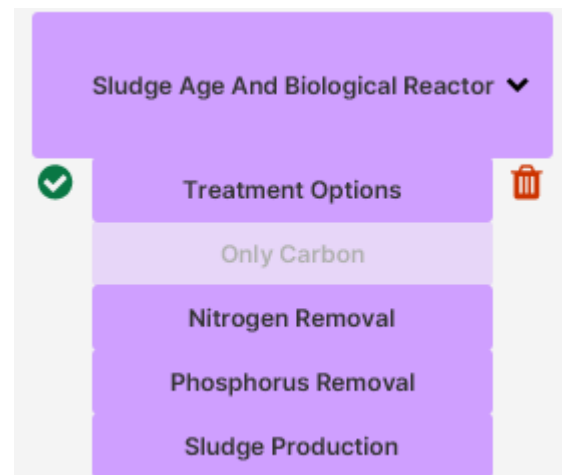
Step 1 - 2

- 8- After this step is completed, the user should go back to the “**Only Carbon**” or “**Nitrogen Removal**” pages.
- 9- Process calculations in different temperature cases and internal recirculation flow rate calculations are completed step by step.

Here is an example of a pre-anoxic denitrification + phosphorous (chemical+biological) removal enabled treatment plant is shown:

The interface shows a process selection bar at the top with icons for Carbon (c), Nitrogen (n), Denitrification (dn), and Phosphorus (p). Checkmarks are present next to the Nitrogen, Denitrification, and Phosphorus icons. Below the bar is a dropdown menu set to "Pre-Anoxic".

	Wastewater Temp.	IN	N% Recharge	IC ⓘ	
Design	15.00	1.70	30.00	1.15	Copy
Lowest Temp.	12.00	1.70	30.00	1.15	
Maximum Temp.	25.00	1.70	30.00	1.15	
Avg. Conditions	18.00	1.70	30.00	1.15	
Special Conditions	20.00	1.70	30.00	1.15	



Step 3

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Example-1

Flowrates & Concentrations > Design > Process Train > Nitrogen Removal

Disabled tabs: These tabs will be activated after design MLSS and Biological Tank Volume is determined.

← Nitrogen Removal Nitrification + Denitrification

Design Lowest Temp. Max. Temp Avg. Conditions Special Conditions

Effluent Nitrification Monitoring Alternatives

10 mg NH4(2 hour)

Average Nitrogen Concentration

10 mg NH4(2 hour)

5 mg NH4(2 hour)

Wastewater Temperature 15.00 °C

fN 1.70

Effluent Nitrification Monitoring Alternatives

10 mg NH4(2 hour)

Parameters for Nitrogen Removal

Current PF 1.50 Design PF

V_D / V_{AT} 0.5

Minimum Sludge Age for Nitrification 5.11 d 5.11 Design Sludge Age For Nitrification

Minimum Sludge Age for Nitrification + Denitrification 10.21 d Design Sludge Age

Sludge Production from COD Sources

Additional Carbon Source

None

Additional Carbon Concentration 0.00 mg/L

Ycod,dos 0.00

Ccod,deg,IAT 325 mg/L

FT 1.00

b 0.17

Ycod,deg 0.67

Xcod,BM,deg 79.63 mg/L

Xcod,inert,BM,deg 27.65 mg/L

Xcod,BM,ExtC 0.00 mg/L

Xcod,inert,ExtC 0.00 mg/L

Xcod,BM,tot 79.63 mg/L

Xcod,inert,BM,tot 27.65 mg/L

Additional Carbon Source

None

Methanol

Ethanol

Acetic Acid

None

SET Reactor Volume

Nitrate Nitrogen Concentration, NO_3-N_{est} 8 mg/L

Organic Nitrogen Concentration, $N-Org_{est}$ 2 mg/L

Ammonium Nitrogen Concentration, NH_4-N_{est} 0 mg/L

N Return Load From Sludge 30.00 %

Nitrogen Balance

C_{TKN} 50.00 mg/L

N Recharge 1.67 mg/L

$XorgN_{inert}$ 3.04 mg/L

$XorgN_{BM}$ 5.57 mg/L

$Norg_{EST}$ 2.00 mg/L

NH_4_{EST} 0.00 mg/L

Nitrogen to be Nitrified, S_{NH_4-N} 41.05 mg/L

Inlet Nitrate Nitrogen Concentration, $S_{NO_3,IAT}$ 0.00 mg/L

Effluent NO_3N_{set} 8.00 mg/L

Denitrification Cap Needed, $S_{NO_3,D}$ 33.05 mg/L

Available Denitrification Capacity S_{NO_3} 37.78 mg/L

Effluent Nitrate Concentration NO_3,Cal 3.27 mg/L

Minimum Required Total Circulation Rate 413 %

S_{NO_3} Denitrified with Additional Carbon 0.00 mg/L

S_{NO_3} Denitrified by Carbon in Wastewater 37.78 mg/L

Internal Circulation Calculations

Minimum Total Recirculation 413 %

Design Total Recirculation 450 %

Minimum Denitrification Efficiency 80.51 %

Design Denitrification Efficiency 81.82 %

Effluent Nitrate Nitrogen Concentration $NO_3,Design$ 8.00 mg/L

Maximum Denitrification Capacity 92.03 %

Total Internal Circulation Pump Capacity 9,625 m3/h

Number of Internal Circulation Pump 3 amount

Internal Circulation Capacity Per Pump 3,208 m3/h

Biological Reactor Volume is Not Selected!

Phosphorus Balance

Inlet Phosphorus Concentration 9.00 mg/L

Normal Phosphorus Uptake 2.10 mg/L

$Xp,BioP$ mg/L

Effluent TP Concentration, $TPest$ 6.90 mg/L

Previous

Save Next

Press Next or Save

Step 4 - 5

ATV 202E "Chemical-Physical Methods for the Removal of Phosphorous from Wastewater" (2004) and ATV 131 E (2016) standards are the reference documents.

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Example-1

Flowrates & Concentrations > Design > Process Train > Phosphorus Removal

Phosphorus Removal

Denitrification Type: Pre-Anoxic

Design Wastewater Temperature: 15.00 °C

Anaerobic Tank: YES

Chemical Oxygen Demand, $C_{COD,IAT}$: 420 mg/L

Inlet Phosphorus Concentration, $C_{P,IAT}$: 9.00 mg/L

Total Outlet Set Concentration, TP_{SET} : 1 mg/L

Calculated Total Outlet Concentration, TP_{EST} : 1.00 mg/L

Chemical Dosing Requirement: YES

Chemical Phosphorus Removal Calculations

$X_{P,Prec}$: 2.96 mg/L

P_{Prec} : 148 kg/d

Required Fe: 401 kg/d

Required Al: 193 kg/d

Select Chemical: Fe(3)

Required Fe(3): 401 kg/d

Density: 1.41 ton/m³

Active Ingredient Amount: 135 kg/ton

Required Chemical Quantity: 2,107 L/day

Pump Safety Factor, SF: 2

Number of Pumps: 2 amount

Total Dosing Pump Flow Rate: 87.78 L/h

Anaerobic Tank Volume Calculation

HCT (0.5 - 0.75): 0.75 h

$Q_{DW,h}$: 2,750 m³/h

Anaerobic Tank Volume: 4,125 m³

Phosphorus Balance

Inlet Phosphorus Concentration: 9.00 mg/L

Normal Phosphorus Uptake: 2.10 mg/L

$X_{P,BioP}$: 2.94 mg/L

TP_{SET} : 1.00 mg/L

$X_{P,Prec}$: 2.96 kg/d

Required Fe(3): 401 kg/d

Sludge Production due to Phosphorus Removal

$X_{P,BioP}$: 2.94 mg/L

Sludge Formation from Biological Phosphorus Removal, $SP_{d,BioP}$: 441 kg/d

Sludge Formation from Chemical Phosphorus Removal, $SP_{d,Pprec}$: 1,003 kd/d

Anaerobic Tank

YES

YES

NO

Chemical Selection Table

Chemical	Density	Active Ingredient
	ton/m3	kg/ton
FeCl2 (Fe2)	1.24-1.37	86-135
FeCl3 (Fe3)	1.41-1.43	135-138
Fe2(SO4)3 (Fe3)	1.5	118
Al2(SO4)3	1.27	24

Select Chemical

Fe(3)

Fe(2)

Fe(3)

Al(3)

No Chemical

Previous

Save Next

Press Next or Save

Step 6 - 7

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Example-1

Flowrates & Concentrations > Design > Process Train > Sludge Production

← Sludge Production

Wastewater Temperature	15.00	°C		
PF	1.69			
Sludge Age				
Required Min. Sludge Age for Nitrification + Denitrification	10.21	d		
Design Sludge Age for Nitrification + Denitrification	11.47	d		
Sludge Production from Carbon Removal				
Sludge Production from Carbon Removal, $SP_{d,C}$	9,016	kg/d		
Sludge Production From Additional Carbon Sources $SP_{d,C,Ext}$	0.00	kg/d		
Sludge Production from Phosphorus Removal				
Sludge Production from Biological Phosphorus Removal $SP_{d,BioP}$	441	kg/d		
Sludge Production from Chemical Phosphorus Removal $SP_{d,Pprec}$	1,003	kg/d		
Total Sludge Production				
Total Sludge Production, $SP_{d,tot}$	10,459	kg/d		
Organic Sludge Production, $SP_{d,org}$	7,144	kg/d		
Inorganic Sludge Production, $SP_{d,inorg}$	3,315	kg/d		
MLVSS/MLSS Ratio				
MLVSS/MLSS	68.31	%		
Biological Reactor Volume Calculations				
Total Sludge Quantity in the Reactor, $M_{SS,AT}$	120,000	kg		
Design MLSS Concentration in Wet Weather, $MLSS(SS_{AT})$	3.00	kg/m ³	Reset	
Biological Reactor Volume, V_{AT}	40,000	m ³	Select Minimum	
Denitrification Tank Volume, V_D	20,000	m ³		
Nitrification Tank Volume, V_N	20,000	m ³		
Design Biological Reactor Volume Calculations				
Design Biological Reactor Volume	40,000	m ³		
Design Sludge Age	11.47	d		
Sludge Mass in the Tank, M_{SS}	120,000	kg		
Sludge Mass Formed	120,000	kg		
Design Nitrification Tank Volume	20,000	m ³		
Design Denitrification Tank Volume	20,000	m ³		

Previous

Save

Clear

Step 8 - 9

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Example-1

Flowrates & Concentrations > Design > Process Train > Nitrogen Removal

← Nitrogen Removal Nitrification + Denitrification

Design Lowest Temp. Max. Temp. Avg. Conditions Special Conditions

Wastewater Temperature 15.00 °C

fN 1.70

Effluent Nitrification Monitoring Alternatives
10 mg NH4(2 hour)

Parameters for Nitrogen Removal

Current PF 1.50 1.69 Design PF

V_D / V_{AT} 0.50

Minimum Sludge Age for Nitrification 5.11 d 5.74 Design Sludge Age For Nitrification

Minimum Sludge Age for Nitrification + Denitrification 10.21 d 11.47 Design Sludge Age

Sludge Production from COD Sources
Additional Carbon Source
None

Additional Carbon Concentration 0.00 mg/L

$Y_{cod,dos}$ 0.00

$C_{cod,deg,IAT}$ 325 mg/L

FT 1.00

b 0.17

$Y_{cod,deg}$ 0.67

$X_{cod,BM,deg}$ 73.85 mg/L

$X_{cod,inert,BM,deg}$ 28.81 mg/L

$X_{cod,BM,ExtC}$ 0.00 mg/L

$X_{cod,inert,ExtC}$ 0.00 mg/L

$X_{cod,BM,tot}$ 73.85 mg/L

$X_{cod,inert,BM,tot}$ 28.81 mg/L

SET Reactor Volume

Nitrate Nitrogen Concentration, NO_3-N_{est} 8.00 mg/L

Organic Nitrogen Concentration, $N-Org_{est}$ 2.00 mg/L

Ammonium Nitrogen Concentration, NH_4-N_{est} 0.00 mg/L

N Return Load From Sludge 30.00 %

Nitrogen Balance

C_{TKN} 50.00 mg/L

N Recharge 1.55 mg/L

$X_{orgN_{Aert}}$ 3.08 mg/L

$X_{orgN_{BM}}$ 5.17 mg/L

$N_{org,EST}$ 2.00 mg/L

NH_4,EST 0.00 mg/L

Nitrogen to be Nitrified, S_{NH_4-N} 41.30 mg/L

Inlet Nitrate Nitrogen Concentration, $S_{NO_3,IAI}$ 0.00 mg/L

Effluent $NO_3_{N,set}$ 8.00 mg/L

Denitrification Cap Needed, $S_{NO_3,D}$ 33.30 mg/L

Available Denitrification Capacity S_{NO_3} 38.54 mg/L

Effluent Nitrate Concentration NO_3,Cal 2.76 mg/L

Minimum Required Total Circulation Rate 416 %

S_{NO_3} Denitrified with Additional Carbon 0.00 mg/L

S_{NO_3} Denitrified by Carbon in Wastewater 38.54 mg/L

Internal Circulation Calculations

Minimum Total Recirculation 416 %

Design Total Recirculation 450 %

Minimum Denitrification Efficiency 80.63 %

Design Denitrification Efficiency 81.82 %

Effluent Nitrate Nitrogen Concentration $NO_3,Design$ 8.00 mg/L

Maximum Denitrification Capacity 93.31 %

Total Internal Circulation Pump Capacity 9,625 m3/h

Number of Internal Circulation Pump 3.00 amount

Internal Circulation Capacity Per Pump 3,208 m3/h

Phosphorus Balance

Inlet Phosphorus Concentration 9.00 mg/L

Normal Phosphorus Uptake 2.10 mg/L

$X_{p,BioP}$ 2.94 mg/L

TP (Effluent) 1.00 mg/L

XP_{prec} 2.96 kg/d

Required Metal 401 kg/d

Previous Save Next

Step 8 - 9

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Example-1

Flowrates & Concentrations > Design > Process Train > Nitrogen Removal

← Nitrogen Removal Nitrification + Denitrification Clear

Design Lowest Temp. Max. Temp. Avg. Conditions Special Conditions

Wastewater Temperature	12.00 °C	Nitrate Nitrogen Concentration, $\text{NO}_3\text{-N}_{\text{est}}$	8 mg/L	Phosphorus Balance	
TN	1.70	Organic Nitrogen Concentration, $\text{N-Org}_{\text{est}}$	2.00 mg/L	Inlet Phosphorus Concentration	9.00 mg/L
Parameters for Nitrogen Removal		Ammonium Nitrogen Concentration, $\text{NH}_4\text{-N}_{\text{est}}$	0.00 mg/L	Normal Phosphorus Uptake	2.10 mg/L
V_D / V_{AT}	0.5	N Return Load From Sludge	30.00 %	X_p, BioP	2.94 mg/L
Lowest Temperature Sludge Age	11.07 d	Nitrogen Balance		TP (Effluent)	1.00 mg/L
Design MLSS Concentration in Wet Weather	3.00 kg/m ³	C_{TKN}	50.00 mg/L	X_p, prec	2.96 kg/d
Lowest MLSS Concentration in Wet Weather	3 kg/m ³	N Recharge	1.81 mg/L	Required Metal	401 kg/d
Biological Reactor Volume, VAT	40,000 m ³	$X_{\text{orgN}, \text{inert}}$	3.00 mg/L	Sludge Production	
Sludge Mass in the Tank	120,000 kg	$X_{\text{orgN}, \text{BM}}$	6.03 mg/L	C removal	9,394 kg/d
Current PF	1.21	Norg_{EST}	2.00 mg/L	SPdc, Bio	441 kg/d
Design PF	1.69	NH_4, EST	0.00 mg/L	SPdc, prec	1,003 kg/d
Design Sludge Age	11.47	Nitrogen to be Nitrified, $S_{\text{NH}_4\text{-N}}$	40.77 mg/L	$\text{SP}, \text{XCOD}, \text{Ext}$	0.00 kg/d
Sludge Production from COD Sources		Inlet Nitrate Nitrogen Concentration, $S_{\text{NO}_3\text{-IAT}}$	0.00 mg/L	Total	10,837 kg/d
Additional Carbon Source	None	Effluent $\text{NO}_3\text{-N}_{\text{set}}$	8.00 mg/L		
Additional Carbon Concentration	0.00 mg/L	Denitrification Cap Needed, $S_{\text{NO}_3\text{-D}}$	32.77 mg/L		
$Y_{\text{cod}, \text{dos}}$	0.00	Available Denitrification Capacity S_{NO_3}	36.93 mg/L		
$C_{\text{cod}, \text{deg}, \text{IAT}}$	325 mg/L	Effluent Nitrate Concentration NO_3, Cal	3.85 mg/L		
FT	0.81	Minimum Required Total Circulation Rate	410 %		
b	0.17	S_{NO_3} Denitrified with Additional Carbon	0.00 mg/L		
$Y_{\text{cod}, \text{deg}}$	0.67	S_{NO_3} Denitrified by Carbon in Wastewater	36.93 mg/L		
$X_{\text{cod}, \text{BM}, \text{deg}}$	86.19 mg/L				
$X_{\text{cod}, \text{inert}, \text{BM}, \text{deg}}$	26.34 mg/L				
$X_{\text{cod}, \text{BM}, \text{ExtC}}$	0.00 mg/L				
$X_{\text{cod}, \text{inert}, \text{ExtC}}$	0.00 mg/L				
$X_{\text{cod}, \text{BM}, \text{tot}}$	86.19 mg/L				
$X_{\text{cod}, \text{inert}, \text{BM}, \text{tot}}$	26.34 mg/L				

Previous Save Next

These parameters can be changed by user. Then process calculations are executed accordingly.

Warning!

When altering V_D/V_{AT} ratio current PF must be above 1.2

PF (Process Factor) is a safety coefficient for growth of nitrification bacteria and it is used for calculation of the minimum sludge age for different temperatures. *ATV 131 – E (2016) strongly advises that this coefficient must be at least 1.2.*

Step 8 - 9

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Example-1

Flowrates & Concentrations > Design > Process Train > Nitrogen Removal

← Nitrogen Removal Nitrification + Denitrification Clear

Design Lowest Temp. Max. Temp Avg. Conditions Special Conditions

Wastewater Temperature	25.00	°C	Nitrate Nitrogen Concentration, NO ₃ -N,est	8	mg/L	Phosphorus Balance	
fN	1.70		Organic Nitrogen Concentration, N-Org,est	2.00	mg/L	Inlet Phosphorus Concentration	9.00 mg/L
Parameters for Nitrogen Removal			Ammonium Nitrogen Concentration, NH ₄ -N,est	0.00	mg/L	Normal Phosphorus Uptake	2.10 mg/L
V_D / V_{AT}	0.55		N Return Load From Sludge	30.00	%	Xp,BioP	2.94 mg/L
Max. Temperature Sludge Age	12.70	d	Nitrogen Balance			TP (Effluent)	1.00 mg/L
Design MLSS Concentration in Wet Weather	3.00	kg/m ³	C _{TKN}	50.00	mg/L	XP,prec	2.96 kg/d
Lowest MLSS Concentration in Wet Weather	3	kg/m ³	N Recharge	0.86	mg/L	Required Metal	401 kg/d
Biological Reactor Volume, VAT	40,000	m ³	XorgN _{inert}	3.28	mg/L	Sludge Production	
Sludge Mass in the Tank	120,000	kg	XorgN _{BM}	2.86	mg/L	C removal	8,007 kg/d
Current PF	4.47		Norg _{EST}	2.00	mg/L	SPdc,Bio	441 kg/d
Design PF	1.69		NH ₄ ,EST	0.00	mg/L	SPdc,prec	1,003 kg/d
Design Sludge Age	11.47		Nitrogen to be Nitrified, S _{NH4} -N	42.72	mg/L	SP,XCOD,Ext	0.00 kg/d
Sludge Production from COD Sources			Inlet Nitrate Nitrogen Concentration, S _{NO3} ,IAT	0.00	mg/L	Total	9,451 kg/d
Additional Carbon Source	None		Effluent NO ₃ ,set	8.00	mg/L		
Additional Carbon Concentration	0.00	mg/L	Denitrification Cap Needed, S _{NO3} ,D	34.72	mg/L		
Ycod,dos	0.00		Available Denitrification Capacity S _{NO3}	45.35	mg/L		
Ccod,deg,IAT	325	mg/L	Effluent Nitrate Concentration NO ₃ ,Cal	0.00	mg/L		
FT	2.00		Minimum Required Total Circulation Rate	434	%		
b	0.17		S _{NO3} Denitrified with Additional Carbon	0.00	mg/L		
Ycod,deg	0.67		S _{NO3} Denitrified by Carbon in Wastewater	42.72	mg/L		
Xcod,BM,deg	40.91	mg/L					
Xcod,inert,BM,deg	35.40	mg/L					
Xcod,BM,ExtC	0.00	mg/L					
Xcod,inert,ExtC	0.00	mg/L					
Xcod,BM,tot	40.91	mg/L					
Xcod,inert,BM,tot	35.40	mg/L					

Previous Save Next

User can evaluate 5 different scenarios with different temperatures, V_D/V_{AT} ratios and MLSS concentrations.

Internal Recirculation

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Example-1

Flowrates & Concentrations > Design > Process Train > Internal Recirculation

← Internal Recirculation

2-Hour Maximum Dry Weather Flow Q_{DWH} 2,750 m³/h

Design Total Recirculation, TR %

Total Internal Circulation Pump Capacity 9,625 m³/h

Number of Internal Circulation Pumps amount

Internal Circulation Pump Capacity Per Unit 2,406 m³/h

Installed Power

Number of Internal Circulation Pumps 4.00 amount

Internal Circulation Pump Capacity Per Unit 2,406 m³/h

Transfer Head Loss m

Manometric Elevation, H m

Liquid Density, ρ kg/L

Hydraulic Power, P_{hyd} 13.11 kW

Pump Efficiency, η

Shaft Power, P_{shaft} 17.48 kW

Power Margin Factor

Installed Pump Power, $P_{installed}$ 20.11 kW

Pump Number 4.00

Pump Installed Power Per Unit, P_{pump} 5.03 kW

Clear

Save

This page is enabled in only “Pre-Anoxic”, “Step 2” and “Step 3” denitrification types.

The important point is that maximum 2 hourly dry weather flow is used in determining design capacities of the pumps.

TR (Total Circulation Ratio) = RS + IR

RS = 100% (Dry weather return sludge ratio)

IR = Internal circulation ratio.

ATV-131E (2016) standard is the reference document.

Alkalinity

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Example-1

Flowrates & Concentrations > Design > Process Train > Alkalinity

← Alkalinity

$S_{ALK,IAT}$	7.10	mmol/L
$S_{ALK,IAT}$	291	mg/LCaCO ₃
$C_{COD,IAT}$	420	mg/L
$C_{TKN,IAT}$	50.00	mg/L
NH ₄ -N Concentration	35.00	mg/L
NH ₄ -N/TN Concentration	0.70	

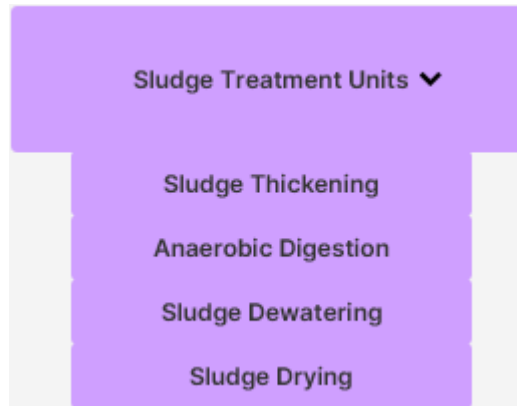
	Design	Lowest Temp.	Max Temp.	Avg. Conditions	Special Conditions	
Wastewater Temperature	15.00	12.00	25.00	18.00	20.00	°C
N _{Org,EST}	2.00	2.00	2.00	2.00	2.00	mg/L
N _{H4,EST}	0.00	0.00	0.00	0.00	0.00	mg/L
S _{NO3D}	33.30	36.93	34.72	33.79	34.09	mg/L
S _{Fe(3)}	8.02	8.02	8.02	8.02	8.02	mg/L
X _{PREC}	2.96	2.96	2.96	2.96	2.96	mg/L
Alkalinity Gained by Ammonification	1.05	1.05	1.05	1.05	1.05	mmol/L
Alkalinity Decreased by Organic Nitrogen Formation	-0.50	-0.56	-0.34	-0.45	-0.41	mmol/L
Alkalinity Decreased by Nitrification	-5.78	-5.71	-5.98	-5.85	-5.89	mmol/L
Alkalinity Gained by Denitrification	2.33	2.58	2.43	2.37	2.39	mmol/L
Alkalinity Decreased by Chemical Phosphorus Removal	-0.39	-0.39	-0.39	-0.39	-0.39	mmol/L
Effluent Alkalinity	3.80	4.07	3.87	3.83	3.84	mmol/L

Save

$$S_{ALK,EAT} = S_{ALK,IAT} - [0,07 \cdot (S_{NH4,IAT} - S_{NH4,EST} + S_{NO3,EST} - S_{NO3,IAT}) + 0,06 \cdot S_{Fe3} + 0,04 \cdot S_{Fe2} + 0,11 \cdot S_{Al3} - 0,03 \cdot X_{P,Pre}]$$

Alkalinity changes are calculated according to *ATV-131E (2016) standard*. $S_{ALK,EAT}$ (mmol/L) is the alkalinity value at the effluent of the aeration tank.

Sludge Treatment Units



There are four types of sludge treatment units which are most commonly found in any WWTP.

Sludge Thickening and Sludge Dewatering calculations are based on centrifugal mechanical thickeners. In these sections of the software, the user can also design polymer pump capacities and polymer preparation tank volumes properly.

Anaerobic Digestion is another important unit for dimensioning. When primary sedimentation tank unit exists in the design, it is strongly advised that anaerobic digestion should be a part of it.

Thermal type of drier design section is included in the software.

Sludge Thickening

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File Diffusers Parameters License

Example-1 

Flowrates & Concentrations > Design > Process Train > Sludge Thickening

← Sludge Thickening

Primary Sedimentation Tank YES

Primary Tank Retention Time 1.00 h

Primary Thickening Unit YES

Primary Sludge

XSS Inorganic / Organic Ratio 0.37

Primary Sludge Concentration 30.00 kg/m³

Primary Sludge Load 10,000 kg/d

Primary VS. Organic Load 6,313 kg/d

Primary FS. Inorganic Load 3,688 kg/d

Primary Sludge Volume 333 m³/d

Operating Hours Per Day 16 h

Number of Mechanical Thickener 1 amount

Hydraulic Capacity per Thickener 20.83 m³/h

Dry Matter Capacity per Thickener 625 kg DS/h

Number of Transfer Pumps 1.00 amount

Capacity For Each Transfer Pump 20.83 m³/h

Polymer Concentration 2 kg/m³

Polymer Dosage 2 kg /ton DS

Polymer Tank Retention Time 1 h

Number of Polymer Pump 1.00 amount

Capacity For Each Polymer Tank 625 L/h

Required Polymer Tank 625 L

Sludge Concentration After Thickener 60 kg/m³

Sludge Volume After Thickener 167 m³/d

Filtrate Flow Rate 167 m³/d

Secondary Thickening Unit YES

Secondary Sludge

Secondary Sludge Concentration 8.02 kg/m³

Secondary Sludge Load 10,837 kg/d

Secondary VS. Organic Load 7,403 kg/d 68.31 VS. %

Secondary FS. Inorganic Load 3,434 kg/d

Secondary Sludge Volume 1,351 m³/d

Operating Hours Per Day 16 h

Number of Mechanical Thickener 2 amount

Hydraulic Capacity per Thickener 42.23 m³/h

Dry Matter Capacity per Thickener 339 kg DS/h

Number of Transfer Pumps 2.00 amount

Capacity For Each Transfer Pump 42.23 kg/m³

Polymer Concentration 2 kg/m³

Polymer Dosage 2 kg/ton DS

Polymer Tank Retention Time 1 h

Number of Polymer Pump 2.00 amount

Capacity For Each Polymer Pump 339 L/h

Required Polymer Tank 677 L

Sludge Concentration After Thickener 60 kg/m³

Sludge Volume After Thickener 181 m³/d

Filtrate Flow Rate 1,171

Primary + Secondary Sludge

Primary + Secondary Sludge 20,837 kg/d

Primary + Secondary VS. Organic 13,715 kg/d

Primary + Secondary FS. Inorganic 7,122 kg/d

Primary + Secondary Sludge Concentration 60.00 kg/m³

Primary + Secondary Sludge Volume 347 m³/d

Clear

Save Next

User can select YES or NO option in the dropdown menu

Anaerobic Digestion

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Anaerobic Digestion

← Anaerobic Digestion

The WWTP has an anaerobic digester

YES

Clear

Total Sludge	20,837	kg/d
VS-Primary and Secondary	13,715	kg/d
FS-Primary and Secondary	7,122	kg/d
Sludge Concentration After Thickener	60.00	kg/m ³
Inlet Sludge Volume	347	m ³ /d
Anaerobic Tank Retention Time	20	day
Total Anaerobic Tank Volume	6,946	m ³
Number of Anaerobic Tanks	2	amount
Volume per Anaerobic Tank	3,473	m ³
Organic Matter Degradation Rate (35-50% Typical 45%)	45	%
Organic Substance to be Degraded	6,172	kg VS/d
Organic Matter After Degradation	7,543	kg VS/d
Total SS After Degradation	14,665	kg SS/day
Sludge Concentration After Degradation	42.23	kg SS/m ³
CH ₄ -(Methane) - Gas Formation (Typical 0.49)	0.49	m ³ /kgVSS
CH ₄ -(Methane) - Gas Formation	3,024	m ³ /d
CH ₄ -(Methane)- Gas Formation (0 °C -1013 hPa)	2,917	Nm ³ /d
CH ₄ -(Methane) - Ratio in Biogas	65	%
Biogas Volume	4,488	Nm ³ /d
Biogas Energy Potential (kWh/day)	28,620	kW/day
Biogas Energy	6.38	kWh/Nm ³

Previous

Save Next



User can select YES or NO option in the dropdown menu

In “Anaerobic Digestion” page, basic process design calculations of anaerobic digesters can be completed. ATV-368E “*Biological Stabilization of Sewage Sludge Advisory Leaflet*” (2003) is the reference document.

Sludge Dewatering

Profpro
File Diffusers Parameters License

Example-1
Flowrates & Concentrations > Design > Process Train > Sludge Dewatering

← Sludge Dewatering

Dry Matter Ratio After Dewatering	25	%
Total Sludge	14,665	kg/d
Total Sludge Volume	347	m³/d
VS Total	7,543	kg/d
FS Total	7,122	kg/d
VS Total Percentage	51.44	%
FS Total Percentage	48.56	%
Specific Gravity Of Solid	1.41	ton/m³
Specific Gravity Of Sludge	1.08	ton/m³
Sludge Volume After Dewatering	54.39	m³/d
Centrate	293	m³/d
Operating Hours per Day	16	h
Number of Mechanical Dewatering Units	1	amount
Flow per Mechanical Dewatering Units	21.71	m³/h
Dry Solids Capacity per Mechanical Dewatering	917	kgDM/hour
Poly Concentration	2	kg/m³
Poly Dosage	8	kg Poly / Tons DM
Required Poly	7.33	kg/h
Number of Polymer Pumps	1.00	amount
Capacity For Each Polymer Pump	3,666	L/h
Polymer Tank Retention Time	0.75	h
Required Polymer Tank	2,750	L

Sludge Drying (Thermal)

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Sludge Drying

← Sludge Drying

Thermal Drying

Does Sludge Drying Exist?

YES

Total Sludge 14,665 kg/d
 Dewatered Sludge Volume 54.39 m³/d
 Water to be Evaporated 44.00 ton/d
 Heat Energy Req. to Evaporate 1 ton of Water 1000 kWh/ton (800 - 1140)
 Daily Heat Energy Req. 43,995 kWh/d
 Electrical Energy Req. to Evaporate 1 ton of Water 110 kWh/ton (70 - 110)
 Daily Electricity Energy Req. 4,839 kWh/d
 Natural Gas Energy Content 10 kWh/Nm³
 Boiler Efficiency 90 %
 Natural Gas Requirement 4,888 Nm³/d
 Water Evaporation Capacity per Dryer 25 ton/day
 Number of Dryers 2.00 amount
 Power per Dryer 115 kW
 Total Installed Power 229 kW

Previous

Save

Clear

User can select YES or NO option in the dropdown menu

ATV 379 E "Drying of Sewage Sludge" (2004) and DIN- Fachbericht CEN/TR 15473(Characterization of Sludge-Good Practice for Sludge Drying) (2007) documents are the reference documents.

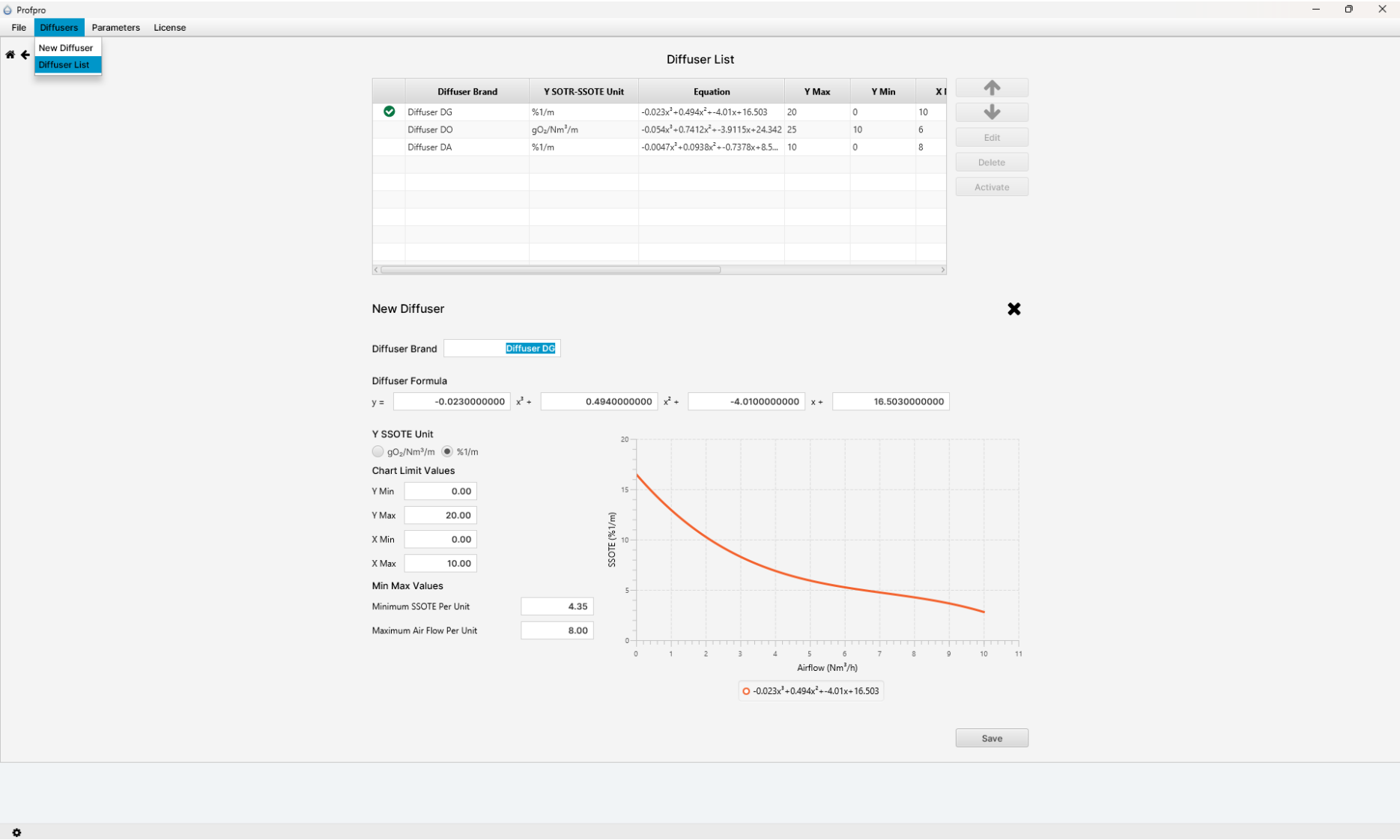
Aeration System Design

Fine Bubble Diffuser System Design

Once all the biological treatment process design is completed, aeration system design menu can be opened.



Diffuser List



It can be defined as many diffusers as that the user desire. This feature of ProfPRO allow users to select the most economical and efficient diffusers and corresponding air flow rates.

Oxygen Demand

Once “Fine Bubble Diffuser System Design” button is pressed, the following screen appears;

Example-1

Flowrates & Concentrations > Design > Process Train > Fine Bubble Diffuser System Design

← Fine Bubble Diffuser System

Oxygen Demand | Diffuser Selection and Diffuser Quantity Calculations | Blower Capacity and Power Calculations

Carbon Respiration Peak Factor, f_c 1.15

Ammonium Oxidation Peak Factor, f_n 1.70

OU_C 223 mg/L

$S_{NO_3,D}$ 33.30 mg/L

X 1.16

$S_{NO_3,D-Den.cap.}$ 38.54 mg/L

Daily Oxygen Demands - Design Temperature

Oxygen Uptake Requirement for Carbon Removal, $OU_{d,C}$ 11,127 kg/d

Oxygen Uptake Requirement for Nitrification, $OU_{d,N}$ 8,880 kg/d

Oxygen Reduction due to Denitrification, $OU_{d,D}$ 4,762 kg/d

Design Hourly Oxygen Requirement, OU_d 15,245 kg/d

Hourly Oxygen Demand

OU_{h-FC} 675 kg/h

OU_{h-FN} 894 kg/h

$OU_{h,Design,Temp.}$ 894 kg/h

	Design	Lowest Temp.	Max. Temp.	Avg. Cond.	Special Cond.
$OU_{d,C}$	11,127	10,634	12,445	11,580	11,856
$OU_{d,N}$	8,880	8,766	9,185	8,985	9,049
$OU_{d,D}$	4,762	5,280	4,965	4,832	4,874
OU_d	15,245	14,119	16,665	15,733	16,030
OU_h	894	844	962	918	932
			OU_h Design		

COD Balance Diagram			
INFLUENT COD CONCENTRATION PARAMETERS		EFFLUENT T Dim COD Fractions	
$Scod,inert,IAT$	21.00	21.00	$Scod,inert,IAT$
$Scod,deg,IAT$	153	249	OUC
$Xcod,deg,IAT$	172	40.91	xbm
		35.40	xbm,inert
$Xcod,inert,IAT$	73.80	73.80	$Xcod,inert,IAT$

Save

User will find automatically calculated daily and hourly oxygen demand values in a table form as shown above. In this menu there are three different steps to complete the fine bubble aeration system design. ProfPRO calculates and chooses the maximum hourly oxygen demand ($OU_{h, design}$ kgO₂/h) by using f_c and f_n coefficients which has been already defined in the “Treatment Options” page. Another unique property of ProfPRO is to show COD Balance Diagram based on the design *Oxygen Utilization (OU_h Design) scenario*.

Diffuser Selection and Diffuser Quantity Calculations

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Fine Bubble Diffuser System Design

← Fine Bubble Diffuser System

Oxygen Demand Diffuser Selection and Diffuser Quantity Calculations Blower Capacity and Power Calculations

Maximum Wastewater Temperature 25.00 °C

Design Hourly Oxygen Demand, OU_h 962.25 kg/h

V_D / V_{AT} 0.55

V_{AT} 40,000 m³

Physical Conditions

Elevation Above Sea Level, Hgeo 500 m

Water Elevation Above Diffuser, HD 6.5 m

Oxygen Concentration at Standard Conditions, C_{ST} 8.26 mg/L

Salinity Concentrations

Salinity Concentration in Diffuser Test Water, $S_{TDS,S}$ 0.35 g/L

Salinity Concentration in Wastewater, $S_{TDS,\alpha}$ 2 g/L

β Factor Calculations

$\beta\alpha$ Salinity Factor in Wastewater C_s 0.98

$f_{s,\alpha}$ - Salinity Factor for k_La in Wastewater 1.16

Operating Parameters

k_La Wastewater / k_La Clean Water, α 0.65

Aeration Tank Dissolved Oxygen Concentration, C_x 2 mg/L

Standard Oxygen Transfer Rate, SOTR (OC) 1,730 kgO₂/h

Select Diffuser

Diffuser DG

Minimum SSOTE 4.35 %/m

Maximum Airflow for Each Diffuser 8.00 Nm³/h

Minimum Number of Diffusers 2,557 amount

Minimum QL_N 20,456 Nm³/h

Selected Number of Diffusers 6000 amount

Design QL_N 7,198 Nm³/h

Vd 55% Vat 45%

Area 2,647 m²

Diffuser Density 8.39 %

Mechanical Energy Density 5.87 W/m³

Diffuser Selection

$q_{L,Diff,actual}$ 1.20 Nm³/h/diffuser

$q_{L,Aeration}$ 0.40 m³N/(m³·h)

Effective Surface Area of Diffuser 0.037 m²/amount

a_{Ges} 222 m²

Water Height Below Diffuser 0.3 m

Total Aeration Basin Area (ABB) 2,647 m²

Diffuser Density 8.39 % (m²/m²) (5- 25)

Mechanical Energy Density 5.87 W/m³ (2- 5)

Design SSOTE 12.36 %/m

Warnings:

1- This amount (6000) represents only maximum OU_h scenario, for different V_D/V_{AT} ratios additional diffuser should be installed.

2- Calculated Air Flow ($Q_{L,N}$) excludes the fouling factor and wearing of the diffusers in time. So, the user should take into consideration of enough spare blower units.

Diffuser DG

Diffuser DG

Diffuser DO

Diffuser DA

Pre-defined diffuser brands can be selected.

Save

All calculations is executed according to equations and constraints published in the document of DWA-M 229-1 Systeme zur Belüftung und Durchmischung von Belebungsanlagen. (Aeration and mixing systems for activated sludge plants) (September 2017)

Blower Capacity and Power Calculations

Profpro

File Diffusers Parameters License

Example-1

Flowrates & Concentrations > Design > Process Train > Fine Bubble Diffuser System Design

← Fine Bubble Diffuser System

Oxygen Demand Diffuser Selection and Diffuser Quantity Calculations **Blower Capacity and Power Calculations**

Reset Values

Water Elevation Above Diffuser, HD 6.5 m

Elevation Above Sea Level, Hgeo 500 m

Blower Pressure Loss Calculations

Silencer and Check Valve Pressure Loss	25.00	hPa
Control Elements Pressure Loss	5.00	hPa
Tank Pressure Loss	15.00	hPa
Branch Distribution Line Pressure Loss	5.00	hPa
Descent to Tank and Pressure Loss at Tank Bottom	5.00	hPa
Diffuser Throttling Element Pressure Loss	20.00	hPa
Membrane Loss	10.00	hPa
Safety Margin	5.00	hPa
Total Pressure Loss	90.00	hPa
Water Height Pressure Loss	638	hPa
Required Blower Pressure ΔP	728	hPa
Design Blower Pressure ΔP	750	hPa

Q₁ - Q₀ Calculations

Maximum Air Temperature, TL,1	40	°C
Maximum Relative Humidity, ϕ	60	%
Suction Side Pressure Loss, ΔP_1	30	hPa
Number of Blowers	2	amount
Design QL,N	7,198	Nm³/h
QL,N per Blower	3,599	Nm³/h
Air Suction Volume, Q ₁	79.14	m ³ /min
Pressure Loss at 100 hPa, Qv100	1.08	m ³ /min
Theoretical Suction Volumetric Flow Rate, Q ₀	82.47	m ³ /min

Blower Power Calculations

Air Compression Power, Pth	103	kW
Power Loss (Pv, 4% of Pk), Pv	4.30	kW
Clutch Performance, Pk	107	kW
Frequency Converter Efficiency η_{FU}	0.95	
Drive Motor Efficiency, η_{Mot}	0.95	
Overall Efficiency, η_{ges}	0.90	
Blower Power Per Unit	119	kW

Warning:

Blower Pressure loss calculations can be calculated or assumed. ProfPRO helps user by default pressure Loss values .

Theoretical Suction Volumetric Flow Rate can be provided from manufacturer.

Save

All calculations is executed according to equations and constraints published in the document of *DWA-M 229-1 Systeme zur Belüftung und Durchmischung von Belebungsanlagen. (Aeration and mixing systems for activated sludge plants) (September 2017)*

Auxiliary Calculations

Profpro

FileDiffusersParametersLicense

Example-1

Flowrates & Concentrations > Design > Process Train >

Primary Treatment

Coarse Screen

Inlet Pumping Unit

Fine Screen

Grit & Grease Chamber

Primary Sedimentation Tank

Biological Treatment

Secondary Sedimentation Tank

Return Sludge Pumping Unit

Sludge Age And Biological Reactor

Treatment Options

Only Carbon

Nitrogen Removal

Phosphorus Removal

Sludge Production

Internal Recirculation

Alkalinity

Sludge Treatment Units

Aeration System Design

Fine Bubble Diffuser System Design

Auxiliary Calculations

Area Requirement

Installed Power

Flowcharts & Documentation



Area Requirement

After the whole process calculations are finished, the user can take a look at how much area (net and gross) is needed for the WWTP. This feature of the software gives an idea to the user depth selections, diameter selections in order to match available project area. In **“Area Requirement”** page ProfPRO calculates the units areas except for the areas needed for laboratories, warehouses, administrative buildings etc. The user can compensate missing areas to estimate the final area requirement with a safety factor.

[illegible]

Installed Power

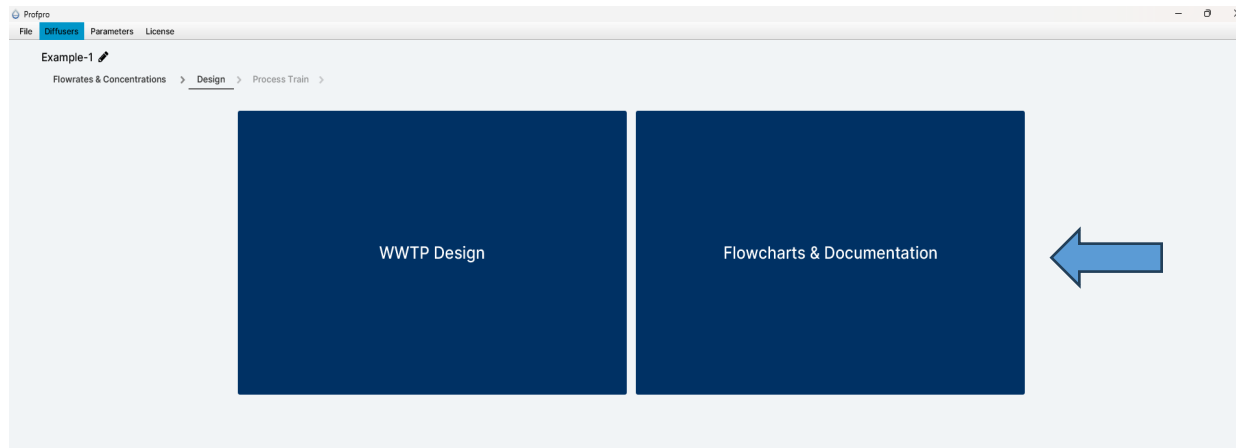
In this section, user can estimate installed electrical power of the designed WWTP. These units listed below are the ones consuming the electricity of more than 80 percentage of total electrical power in any WWTP. The rest of the units and spare installed power calculation can be compensated by safety factor. For 100% percent accuracy, the real equipment powers has be taken into consideration. *“Installed Power” section is aimed to give an idea to the user about estimated total power of the designed units. This feature of ProfPRO enables the user to make energy optimisation. For example, choosing optimum water heights in aeration tanks, diffuser numbers, aeration tank volumes and secondary sedimentation tank heights as well as the deciding “YES” OR “NO” some sludge treatment units.*

Total Approximate Installed Power		
Inlet Pumping Station Installed Pump Power	231	kW
Return Sludge Installed Pump Power	107	kW
Total Mixing Installed Power	159	kW
Total Internal Recirculation Power	24.00	kW
Total Installed Blower Power	240	kW
Primary Sludge Thickening Installed Power	25.00	kW
Secondary Sludge Thickening Installed Power	90.00	kW
Sludge Dewatering Installed Power	35.00	kW
Total Dryer Installed Power	229	kW
Total	1,140	kW
SF	1.10	
Plant Installed Power	1,254	kW

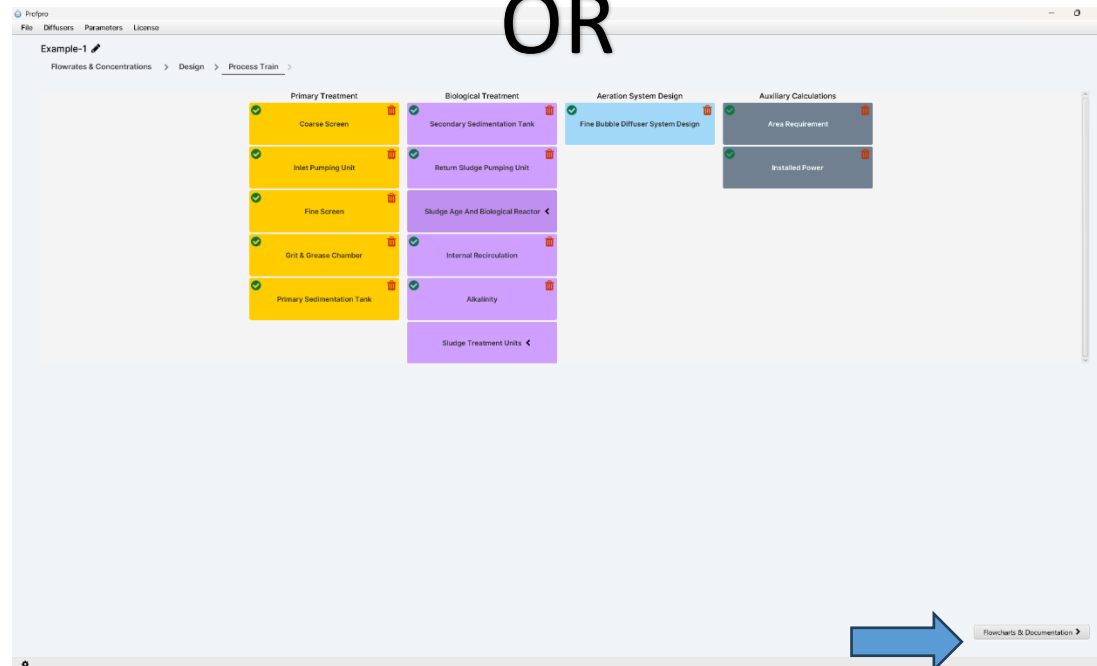
Save

Once the “WWTP Design” section is over, ProfPRO automatically prepares the process design report. The second part of the software is “Flowcharts & Documentation” section. In this section, flowchart of the designed WWTP and process report is included.

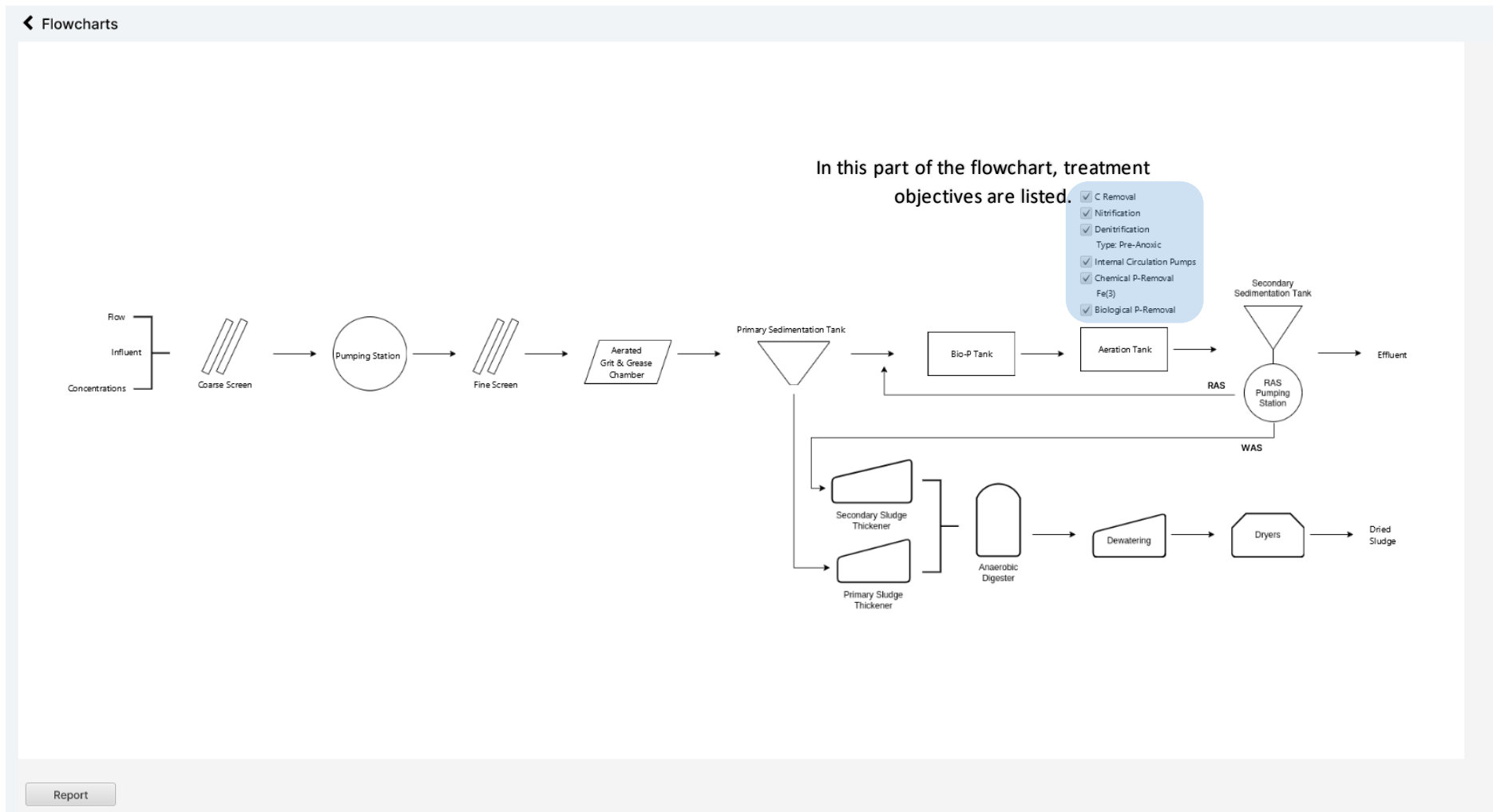
To access this section, press “Flowcharts & Documentation” buttons;



OR



Once, the button is pressed, the user will see the screen below.



If Report button is pressed, the software generates a finalized design report of the selected units and processes.

This screen lists the summary of the units that has been already designed by user. ProfPRO allows the user to form a “Process Report “which can include all the designed units or the only units that is chosen by user.

Report

☒ **Select All**

☒ Primary Treatment	☒ Biological Treatment	☒ Aeration System Design	☒ Auxilliary Calculations
☒ Coarse Screen	☒ Secondary Sedimentation Tank	☒ Fine Bubble Diffuser System Design	☒ Area Requirement
☒ Inlet Pumping Unit	☒ Return Sludge Pumping Unit		☒ Installed Power
☒ Fine Screen	☒ Treatment Options		
☒ Grit & Grease Chamber	☐ Only Carbon		
☒ Primary Sedimentation Tank	☒ Nitrogen Removal		
	☒ Phosphorus Removal		
	☒ Sludge Production		
	☒ Internal Recirculation		
	☒ Alkalinity		
	☒ Sludge Thickening		
	☒ Anaerobic Digestion		
	☒ Sludge Dewatering		
	☒ Sludge Drying		

Cancel Report

The finalized design report can be previewed on this screen, exported to PDF or sent to printer directly. Here are the sample pages of the process report;

✕Export PDFPrint

**ProfPRO**
Easy Fast Accurate Design

Facility Name: **Example-1**Date: 01.05.2025

☒ C Removal

☒ Nitrification

☒ Denitrification
Type: Pre-Anoxic

☒ Internal Circulation Pumps

☒ Chemical P-Removal
Fe(3)

☒ Biological P-Removal

☒ Primary Treatment

☒ Biological Treatment

☒ Aeration System Design

☒ Auxilliary Calculations

☒ Coarse Screen

☒ Secondary Sedimentation Tank

☒ Fine Bubble Diffuser System Design

☒ Area Requirement

☒ Inlet Pumping Unit

☒ Return Sludge Pumping Unit

☒ Treatment Options

☒ Installed Power

☒ Fine Screen

☐ Only Carbon

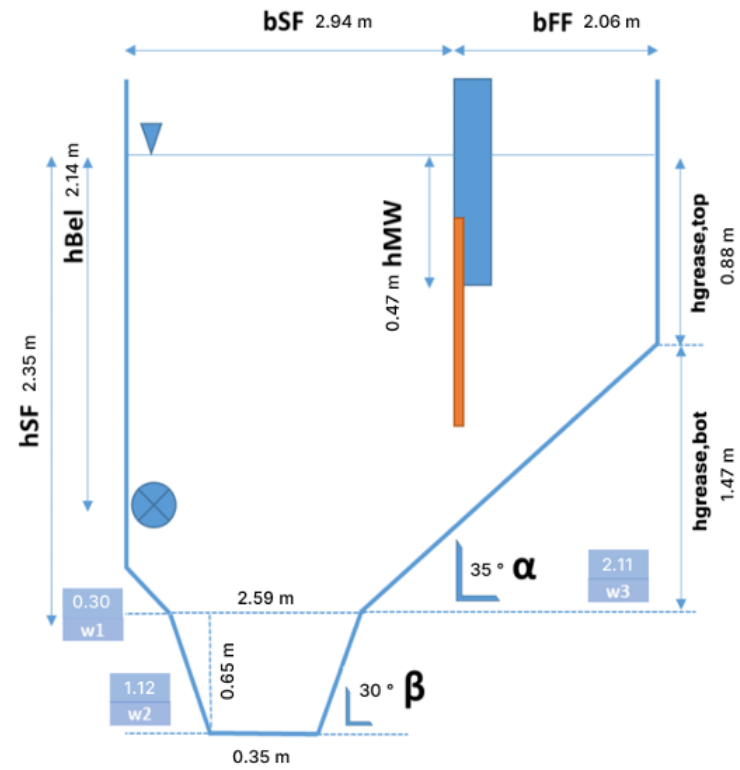
☒ Grit & Grease Chamber

☒ Nitrogen Removal

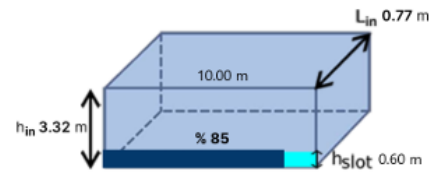
☒ Primary Sedimentation Tank

Flowrates & Concentrations					
Dry Weather Flow Rate, $Q_{DW,d}$	50,000	m ³ /d	$S_{COD,inert,IAT} / C_{COD,IAT-fs}$	0.05	
24-Hour Dry Weather Flow, $Q_{DW,ave}$	2,083	m ³ /h	$X_{inorg,SS,i} / X_{SS-fb}$	0.30	
2-Hour Maximum Dry Weather Flow, $Q_{DW,h}$	2,750	m ³ /h	$X_{COD,inert,IAT} / X_{COD,IAT-fA}$	0.30	
Maximum Hourly Flow, $Q_{WW,h}$	3,850	m ³ /h	$C_{COD,la,IAT} / C_{deg,IAT-fCOD}$	0.20	
Maximum Hourly Flow, $Q_{WW,d}$	92,400	m ³ /d			
Primary Sedimentation Tank YES Retention Time 1.00 h					
	Raw Wastewater		Biological Reactor Inlet		
Chemical Oxygen Demand, C_{COD}	600		420	mg/L	
Particulate COD Concentration, X_{COD}	448		246	mg/L	
Suspended Solids Concentration, X_{SS}	400		200	mg/L	
Total Kjeldahl Nitrogen Concentration, C_{TKN}	55.00		50.00	mg/L	
Phosphorus Concentration, C_{TP}	10.00		9.00	mg/L	
Ammonium Nitrogen Concentration, S_{NH_4}	35.00		35.00	mg/L	
NH_4 / C_{TKN} Ratio	0.64		0.70		
Nitrate Nitrogen Concentration, S_{NO_3}	0.00		0.00	mg/L	
Alkalinity, S_{ALK}	7.10		7.10	mmol/L	
COD Fractions					
$S_{COD,IAT}$	174	mg/L	$C_{COD,deg,IAT}$	325	mg/L
$X_{COD,IAT}$	246	mg/L	$S_{COD,deg,IAT}$	153	mg/L
$S_{COD,inert,IAT}$	21.00	mg/L	$X_{COD,deg,IAT}$	172	mg/L
$X_{COD,inert,IAT}$	73.80	mg/L			
Biological Reactor COD and SS Fractions					
PERCENTAGE(%) (Based on Inlet COD)	INLET COD CONCENTRATION PARAMETERS		INLET CONCENTRATION VALUES IN TERMS OF COD		
5.00	$S_{COD,inert,IAT}$		21.00		
36.43	$S_{COD,deg,IAT}$		153		
41.00	$X_{COD,deg,IAT}$		172		
17.57	$X_{COD,inert,IAT}$		73.80		
PERCENTAGE(%) (Based on Inlet SS)	INLET INORGANIC SS CONCENTRATION PARAMETER		INLET INORGANICS CONCENTRATION VALUE (mg/L)		
23.13	$X_{SS,inorg,IAT}$		46.25		

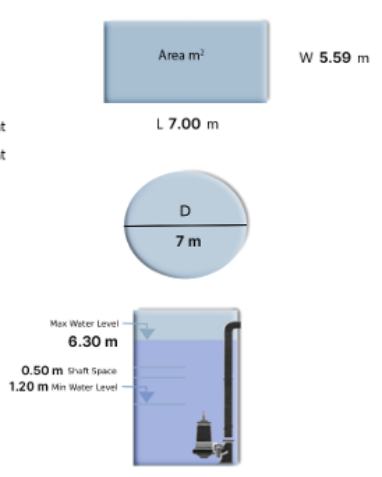
Grit & Grease Chamber



Secondary Sedimentation Tank - Inlet Structure



Retention Time	110	sec
$Q^*(1+RS)$	0.23	m^3/s
Vinlet	25.73	m^3
Length of Inlet Structure, L_{in}	0.77	m
Inlet Structure Depth, h_{in}	3.32	m
Height of Culvert, h_{slot}	0.60	m
Area Utilization Percentage	85.00	%
Available Area	5.10	m^2
Inlet Pipe Diameter	600	mm
Inlet Pipe Surface Area	0.28	m^2
Pipe Inlet Velocity	0.83	m/s
Wastewater Temperature	12.00	$^{\circ}C$
Power Input	80.08	Nm/s
G	50.30	$1/sec$
Fr	0.60	

Return Sludge Pumping Unit 1			Return Sludge Pumping Unit 1 Diagram	
Maximum Hourly Flow, $Q_{ww,h}$	3,850	m^3/h		
Return Sludge Ratio, RS_{ww}	1.00			
Total Return Sludge Pump Capacity	3,850	m^3/h		
Total Return Sludge Pump Capacity	92,400	m^3/d		
Q_{pm}	1,069	L/s		
Number of Pumps	3.00	amount		
Number of Shafts, Z	6.00	amount		
Wet Volume of Pump Room, V_{min}	160	m^3		
Water Level Difference for Activation	0.50	m		
Minimum Operating Level of Pumps	1.20	m		
Design Chamber Surface Area, S	39.13	m^2		
Required Active Wet Volume	246	m^3		
Desired Maximum Water Level	6.30	m		
Design Total Water Head	6.30	m		
Installed Power				
Maximum Hourly Flow, $Q_{ww,h}$	3,850	m^3/h		
Final Sedimentation Tank Shape	Rectangular			
Final Sedimentation Slope	0.07			
Final Sedimentation Average Height	4.70	m		
Final Settling Diameter	32.00	m		
Final Sedimentation Central Height	6.19	m		
Return Sludge Head Difference	0.75	m		
Manometric Elevation, H	6.94	m		
Liquid Density, ρ	1.00	kg/L		
Hydraulic Power, $P_{hydraulic}$	72.84	kW		
Pump Efficiency, η	0.75			
Shaft Power, P_{shaft}	97.12	kW		
Power Margin Factor	1.10			
Installed Pump Power, $P_{installed}$	107	kW		
Number of Pumps	3.00	amount		
Installed Power of Each Pump, P_{pump}	35.61	kW		

Nitrogen Removal (Nitrification + Denitrification)

Wastewater Temperature 15.00 °C

fN 1.70

Effluent Nitrification Monitoring Alternatives 10 mg NH4(2 hour)

Parameters for Nitrogen Removal

Current PF	1.50	Design PF	1.69
V_D / V_{AT}	0.50		
Min. Sludge Age for Nitrification	5.11	d Design Sludge Age For Nitrification	5.74
Min. Sludge Age for Nitrification + Denitrification	10.21	d Design Sludge Age	11.47
Additional Carbon Source	None		
Additional Carbon Concentration $S_{COD,Ext}$	0.00	mg/L	

Nitrogen Balance

C_{TKN}	50.00	mg/L
N Recharge	1.55	mg/L
$X_{orgN_{inert}}$	3.08	mg/L
$X_{orgN_{BM}}$	5.17	mg/L
$N_{org,EST}$	2.00	mg/L
$NH_{4,EST}$	0.00	mg/L
Nitrogen to be Nitrified, S_{NH_4-N}	41.30	mg/L
Inlet Nitrate Nitrogen Concentration $S_{NO_3,IAT}$	0.00	mg/L
Effluent NO_3N_{set}	8.00	mg/L
Denitrification Capacity Needed $S_{NO_3,D}$	33.30	mg/L
Available Denitrification Capacity	38.54	mg/L
Effluent Nitrate Concentration, NO_3	2.76	mg/L
Minimum Required Total Circulation Rate	416	%
S_{NO_3} Denitrified with Additional Carbon	0.00	mg/L
S_{NO_3} Denitrified by Carbon in Wastewater	38.54	mg/L

Phosphorus Removal		
Denitrification Type	Pre-Anoxic	
Design Wastewater Temperature	15.00	°C
Anaerobic Tank	YES	
C _{COD,IAT}	420	mg/L
C _{P,IAT}	9.00	mg/L
TP _{SET}	1.00	mg/L
TP _{EST}	1.00	mg/L
Chemical Dosing Requirement	YES	
Anaerobic Tank Volume Calculation		
HCT (0.5 - 0.75)	0.75	h
Q _{DW,h}	2,750	m ³ /h
Anaerobic Tank Volume	4,125	m ³
Phosphorus Balance		
C _{P,IAT}	9.00	mg/L
Normal Phosphorus Uptake	2.10	mg/L
X _{P,BioP}	2.94	mg/L
TP _{SET}	1.00	mg/L
X _{P,Prec}	2.96	kg/d
Required Fe(3)	401	kg/d
Chemical Phosphorus Removal Calculations		
X _{P,Prec}	2.96	mg/L
P _{Prec}	148	kg/d
Required Fe	401	kg/d
Required Al	193	kg/d
Selected Chemical	Fe(3)	
Fe(3)	401	kg/d
Density	1.41	ton/m ³
Active Ingredient Amount	135	kg/ton
Required Chemical	2,107	L/d
Pump Safety Factor, SF	2.00	
Number of Pumps	2.00	amount
Dosing Capacity For Each Pump	87.78	L/h
Sludge Production due to Phosphorus Removal		
X _{P,BioP}	2.94	mg/L
Sludge Production from Biological Phosphorus Removal, SP _{d,BioP}	441	kg/d
Sludge Production from Chemical Phosphorus Removal, SP _{d,Pprec}	1,003	kg/d

Sludge Production		
Wastewater Temperature	15.00	°C
PF	1.69	
Sludge Age		
Required Min. Sludge Age for Nitrification + Denitrification	10.21	d
Design Sludge Age for Nitrification + Denitrification	11.47	d
Sludge Production from Carbon Removal		
Sludge Production from Carbon Removal, $SP_{d,C}$	9,016	kg/d
Sludge Production From Additional Carbon Sources $SP_{d,C,Ext}$	0.00	kg/d
Sludge Production from Phosphorus Removal		
Sludge Production from Biological Phosphorus Removal $SP_{d,BioP}$	441	kg/d
Sludge Production from Chemical Phosphorus Removal $SP_{d,Pprec}$	1,003	kg/d
Total Sludge Production		
Total Sludge Production, SP_d	10,459	kg/d
Organic Sludge Production, $SP_{d,org}$	7,144	kg/d
Inorganic Sludge Production, $SP_{d,inorg}$	3,315	kg/d
MLVSS/MLSS Ratio		
MLVSS/MLSS	68.31	%
Biological Reactor Volume Calculations		
Total Sludge in the Reactor, $M_{SS,AT}$	120,000	kg
Design MLSS Concentration in Wet Weather, $MLSS(SS_{AT})$	3.00	kg/m ³
Biological Reactor Volume, V_{AT}	40,000	m ³
Denitrification Tank Volume, V_D	20,000	m ³
Nitrification Tank Volume, V_N	20,000	m ³
Design Biological Reactor Volume Calculations		
Design Biological Reactor Volume	40,000	m ³
Design Sludge Age	11.47	d
Sludge Mass in the Tank, M_{SS}	120,000	kg
Design Nitrification Tank Volume	20,000	m ³
Design Denitrification Tank Volume	20,000	m ³

Sludge Thickening

Primary Sedimentation Tank **YES**

Primary Tank Retention Time **1.00** h

Primary Sludge

Primary Thickening Unit	YES	
XSS Inorganic / Organic Ratio	0.37	
Primary Sludge Concentration	30.00	kg/m ³
Primary Sludge Load	10,000	kg/d
Primary VS. Organic Load	6,313	kg/d
Primary FS. Inorganic Load	3,688	kg/d
Primary Sludge Volume	333	m ³ /d
Operating Hours Per Day	16.00	h
Number of Mechanical Thickener	1.00	amount
Hydraulic Capacity per Thickener	20.83	m ³ /h
Dry Matter Capacity per Thickener	625	kg DS/h
Number of Transfer Pumps	1.00	amount
Capacity For Each Transfer Pump	20.83	m ³ /h
Polymer Concentration	2.00	kg/m ³
Polymer Dosage	2.00	kg/ton DS
Polymer Tank Retention Time	1.00	h
Number of Polymer Pump	1.00	amount
Capacity For Each Polymer Pump	625	L/h
Required Polymer Tank	625	L
Sludge Concentration After Thickener	60.00	kg/m ³
Sludge Volume After Thickener	167	m ³ /d
Filtrate Flow Rate	167	m ³ /d

Secondary Sludge

Secondary Thickening Unit	YES	
Secondary Sludge Concentration	8.02	kg/m ³
Secondary Sludge Load	10,837	kg/d
Secondary VS. Organic Load	7,403	kg/d
Secondary FS. Inorganic Load	3,434	kg/d
Secondary Sludge Volume	1,351	m ³ /d
Operating Hours Per Day	16.00	h
Number of Mechanical Thickener	1.00	amount
Hydraulic Capacity per Thickener	42.23	m ³ /h
Dry Matter Capacity per Thickener	339	m ³ /h
Number of Transfer Pumps	2.00	amount
Capacity For Each Transfer Pump	42.23	m ³ /h
Polymer Concentration	2.00	kg/m ³
Polymer Dosage	2.00	kg/ton DS
Polymer Tank Retention Time	1.00	h
Number of Polymer Pump	2.00	amount
Capacity For Each Polymer Pump	339	L/h
Required Polymer Tank	677	L
Sludge Concentration After Thickener	60.00	kg/m ³
Sludge Volume After Thickener	181	m ³ /d
Filtrate Flow Rate	1,171	m ³ /d

Primary + Secondary Sludge

Primary + Secondary Sludge	20,837	kg/d
Primary + Secondary VS. Organic	13,715	kg/d
Primary + Secondary FS. Inorganic	7,122	kg/d
Primary + Secondary Sludge Concentration	60.00	kg/m ³
Primary + Secondary Sludge Volume	347	m ³ /d

Anaerobic Digestion

The WWTP has an anaerobic digester	YES	
Total Sludge	20,837	kg/d
VS-Primary and Secondary	13,715	kg/d
FS-Primary and Secondary	7,122	kg/d
Sludge Concentration After Thickener	60.00	kg/m ³
Inlet Sludge Volume	347	m ³ /d
Anaerobic Tank Retention Time	20.00	d
Total Anaerobic Tank Volume	6,946	m ³
Number of Anaerobic Tanks	2.00	amount
Volume per Anaerobic Tank	3,473	m ³
Organic Matter Degradation Rate	45.00	%
Organic Substance to be Degraded	6,172	kg VS/d
Organic Matter After Degradation	7,543	kg VS/d
Total SS After Degradation	14,665	kg DS/d
Sludge Concentration After Degradation	42.23	kg/m ³
CH ₄ -(Methane) - Gas Formation (Typical 0.49)	0.49	m ³ /kgVSS
CH ₄ -(Methane) - Gas Formation	3,024	m ³ /d
CH ₄ -(Methane) - Gas Formation (0 °C-1013hPa)	2,917	Nm ³ /d
CH ₄ -(Methane) - Ratio In Biogas	65.00	%
Biogas Volume	4,488	Nm ³ /d
Biogas Energy Potential	28,620	kWh/d
Biogas Energy Content	6.38	kWh/Nm ³

Fine Bubble Diffuser System - Oxygen Demand

Peak Factor for Carbon Load, fC	1.15	
Peak Factor for Nitrogen Load, fN	1.70	
OU _C	223	mg/L
S _{NO3,D}	33.30	mg/L
X	1.16	
S _{NO3,D-Den.cap.}	38.54	mg/L

Daily Oxygen Demands - Design Temperature

Oxygen Uptake Requirement for Carbon Removal, OU _{d,C}	11,127	kg/d
Oxygen Uptake Requirement for Nitrification, OU _{d,N}	8,880	kg/d
Oxygen Reduction due to Denitrification, OU _{d,D}	4,762	kg/d
Design Hourly Oxygen Requirement, OU _d	15,245	kg/d

Hourly Oxygen Demand

OU _h -fC	675	kg/h
OU _h -fN	894	kg/h
OU_h,Tdesign	894	kg/h

	Design	Lowest Temp.	Max. Temp.	Avg. Cond.	Special Cond.
OU _{d,C}	11,127	10,634	12,445	11,580	11,856
OU _{d,N}	8,880	8,766	9,185	8,985	9,049
OU _{d,D}	4,762	5,280	4,965	4,832	4,874
OU _d	15,245	14,119	16,665	15,733	16,030
OU _h	894	844	962	918	932
			OU_h Design		

COD Balance Diagram			
INFLUENT COD CONCENTRATION	INFLUENT CONCENTRATION	EFFLUENT T Dim COD Fractions	
S _{COD,inert,IAT}	21.00	21.00	S _{COD,inert,IAT}
S _{COD,deg,IAT}	153	249	OU _C
X _{COD,deg,IAT}	172		
		40.91	X _{BM}
		35.40	X _{BM,inert}
X _{COD,inert,IAT}	73.80	73.80	X _{COD,inert,IAT}

Fine Bubble Diffuser System - Blower Capacity and Power Calculations

Blower Pressure Loss Calculations

Silencer and Check Valve Pressure Loss	25.00	hPa
Control Elements Pressure Loss	5.00	hPa
Tank Pressure Loss	15.00	hPa
Branch Distribution Line Pressure Loss	5.00	hPa
Descent to Tank and Pressure Loss at Tank Bottom	5.00	hPa
Diffuser Throttling Element Pressure Loss	20.00	hPa
Membrane Loss	10.00	hPa
Safety Margin	5.00	hPa
Total Pressure Loss	90.00	hPa
Water Height Pressure Loss	638	hPa
Required Blower Pressure ΔP	728	hPa
Design Blower Pressure ΔP	750	hPa

$Q_1 - Q_0$ Calculations

Maximum Air Temperature, $T_{L,1}$	40.00	°C
Maximum Relative Humidity, ϕ	60.00	%
Suction Side Pressure Loss, ΔP_1	30.00	hPa
Number of Blowers	2.00	amount
Design $Q_{L,N}$	7,198	Nm ³ /h
$Q_{L,N}$ Per Blower	3,599	Nm ³ /h
Air Suction Volume, Q_1	79.14	m ³ /min
Pressure Loss at 100 hPa, Q_{v100}	1.08	m ³ /min
Theoretical Suction Volumetric Flow Rate, Q_0	82.47	m ³ /min

Blower Power Calculations

Air Compression Power, P_{th}	103	kW
Power Loss (P_v , 4% of P_k), P_v	4.30	kW
Clutch Performance, P_k	107	kW
Frequency Converter Efficiency η_{FU}	0.95	
Drive Motor Efficiency, η_{Mot}	0.95	
Over Efficiency, η_{ges}	0.90	
Power For Each Blower	119	kW