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GENERAL SCHEME OF WASTEWATER TREATMENT PROCESS

Wastewater Treatment Technology- course

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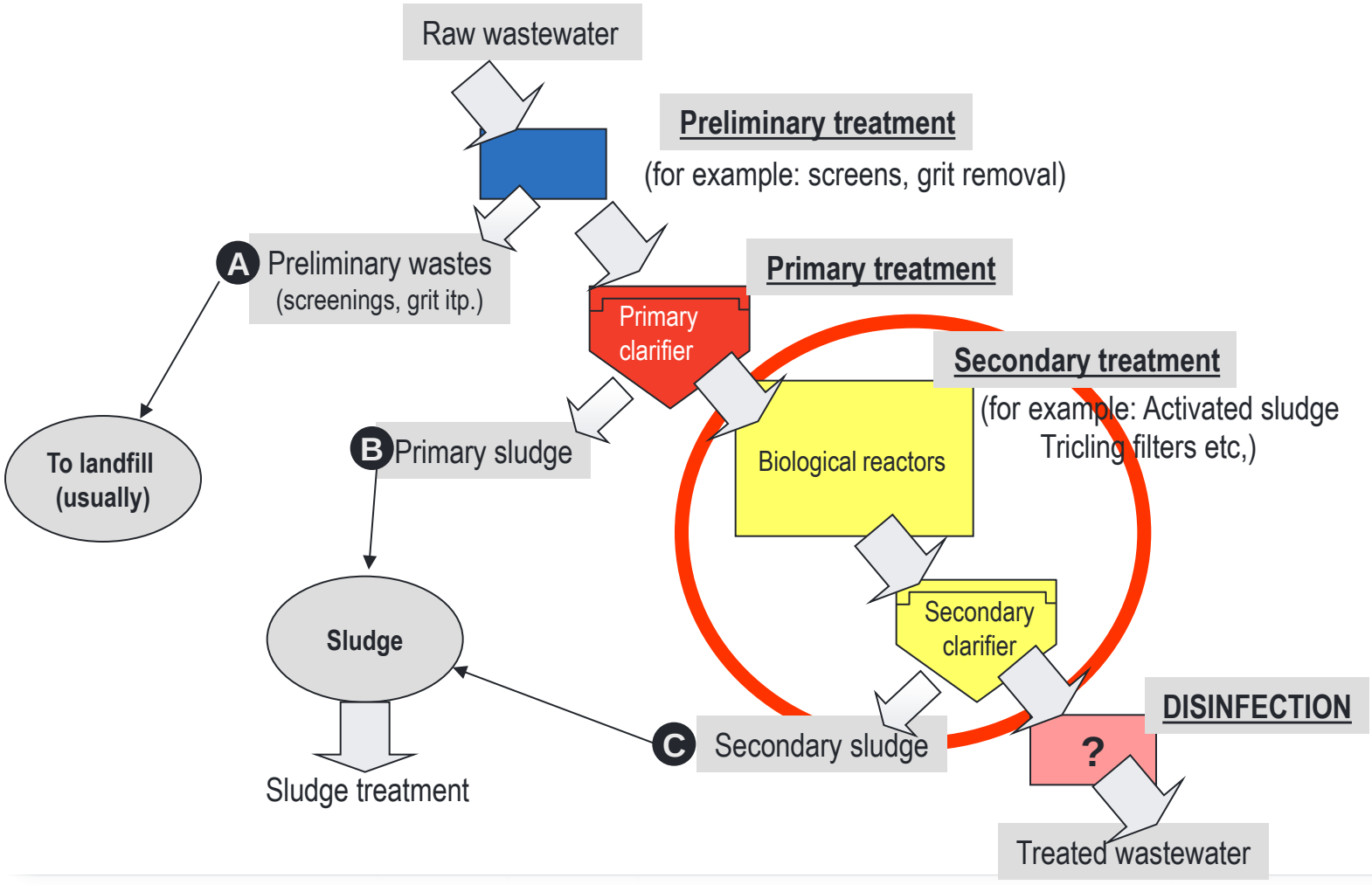
Presentation plan

1. General scheme of wastewater treatment process
2. Influent composition and amount
3. Population equivalent
4. Effluent quality
5. Control questions

General scheme of wastewater treatment process

Most important element of wastewater treatment plant



Influent composition and volume

Domestic wastewater

Organic compounds

Parameter	Symbol	Unit	Wastewater character			
			Concentrated	Average	Diluted	Very diluted
$BOD_T = BOD_\infty$	$C_{BOD\infty}$	g O_2/m^3	530	380	230	150
BOD_5	C_{BOD5}	g O_2/m^3	350	250	150	100
BOD_7	C_{BOD7}	g O_2/m^3	400	290	170	115
Dissolved	S_{BOD5}	g O_2/m^3	140	100	60	40
- VFA	$S_{BOD5,A}$	g O_2/m^3	70	50	30	20
Suspended	X_{BOD5}	g O_2/m^3	210	150	90	60
BOD_5 aft 2h sed.	S_{BOD5} (2h)	g O_2/m^3	250	175	110	70

Domestic wastewater

Organic compounds

Parameter	Symbol	Unit	Wastewater character			
			Concentrated	Average	Diluted	Very diluted
Total	C_{COD}	g O_2/m^3	740	530	320	210
- dissolved	S_{COD}	g O_2/m^3	300	210	130	80
- suspended	X_{COD}	g O_2/m^3	440	320	190	130
After 2 h of sedimentation	C_{COD} (2h)	g O_2/m^3	530	370	230	150
Biologically unbiodegradable	C_I	g O_2/m^3	180	130	80	50
- dissolved	S_I	g O_2/m^3	30	20	15	10
- suspended	X_I	g O_2/m^3	150	110	65	40
Biologically biodegradable		g O_2/m^3	560	400	240	160
- easily biodegradable	S_S	g O_2/m^3	180	130	75	50
- VFA	S_A	g O_2/m^3	90	60	40	25
- slowly biodegradable	X_S	g O_2/m^3	290	210	125	85
- heterotrophs	X_H	g O_2/m^3	120	90	55	35
- denitrifiers	$X_{H,D}$	g O_2/m^3	80	60	40	25
- autotrophs	X_A	g O_2/m^3	1	1	0.5	0.5

Domestic wastewater

Nitrogen compounds

Parameter	Symbol	Unit	Wastewater character			
			Concentrated	Average	Diluted	Very diluted
- Total nitrogen	N_{tot}	g N/m^3	~80	~50	~30	~20
- Ammonium nitrogen	S_{NH}	g N/m^3	50	30	18	12
- Organic nitrogen	N_{org}	g N/m^3	30	20	12	8
- Total Kiejdahl nitrogen	TKN	g N/m^3	80	50	30	20
- Nitrites	S_{NO2}	g N/m^3	0.1	0.1	0.1	0.1
- Nitrates	S_{NO3}	g N/m^3	0.5	0.5	0.5	0.5

Domestic wastewater

Phosphorus compounds

Parameter	Symbol	Unit	Wastewater character			
			Concentrated	Average	Diluted	Very diluted
- Total phosphorus	P_{tot}	g P/m^3	23 (14)[4)]	16 (10)	10 (6)	6 (4)
- Phosphates	S_{PO4}	g P/m^3	14 (10)	10 (7)	6 (4)	4 (3)
- Poliphosphates	S_{p-PO4}	g P/m^3	5 (0)	3 (0)	2 (0)	1 (0)
- Organic phosphorus	P_{Porg}	g P/m^3	4 (4)	3 (3)	2 (2)	1 (1)

[4)] **The values in parentheses refer to sewer catchments where phosphate-based detergents are not used.**

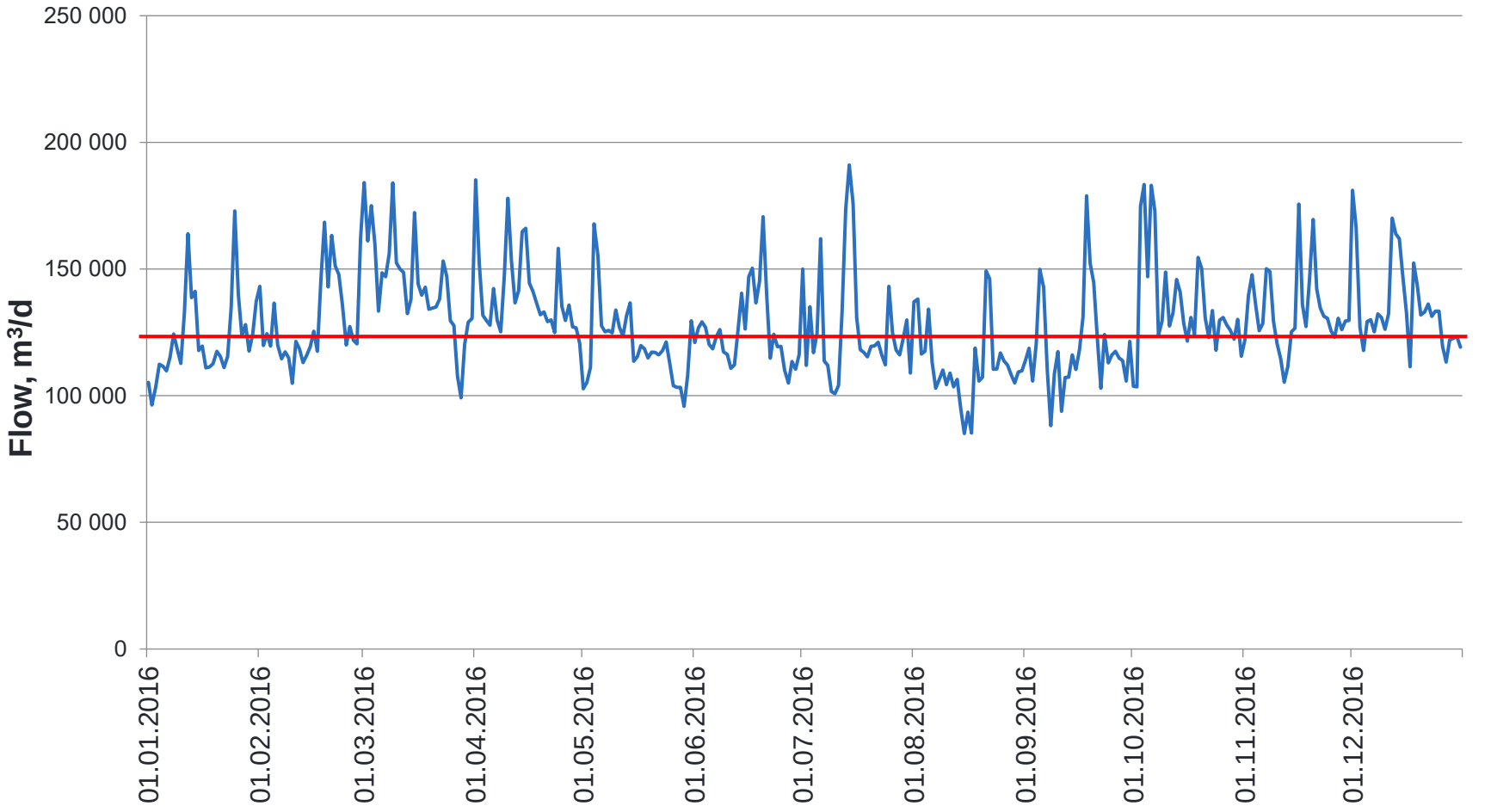
Wastewater composition

What happens when we dont have data?

Parameter	Value, g/Mk·d
Flow (L/Mk·d)	120
BOD_5	60
COD	120
N_{tot}	11
N-NH	5.5
P_{tot}	1.8
Suspended solids	70

Variation in volume and composition

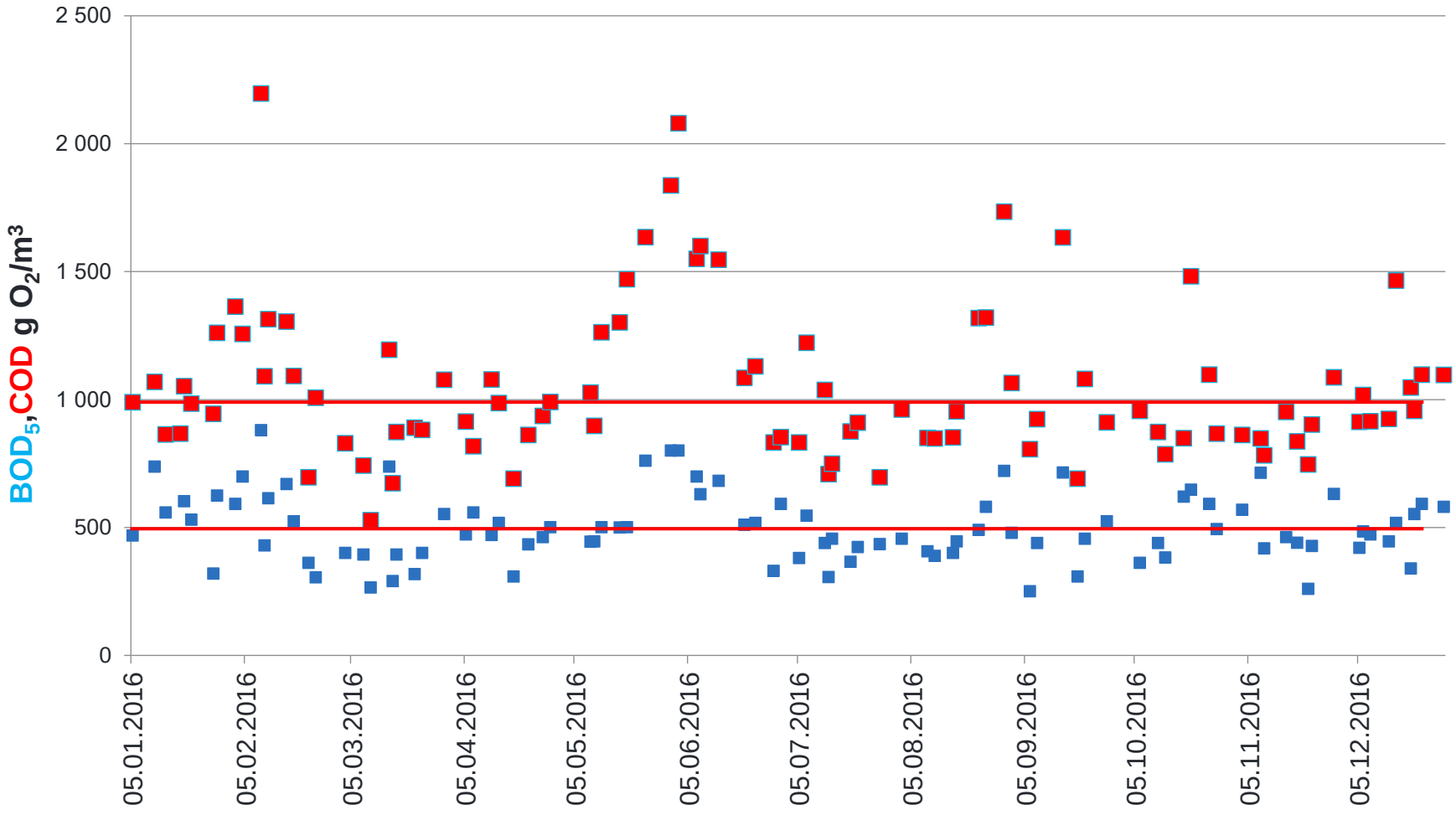
Real data



Without rain events

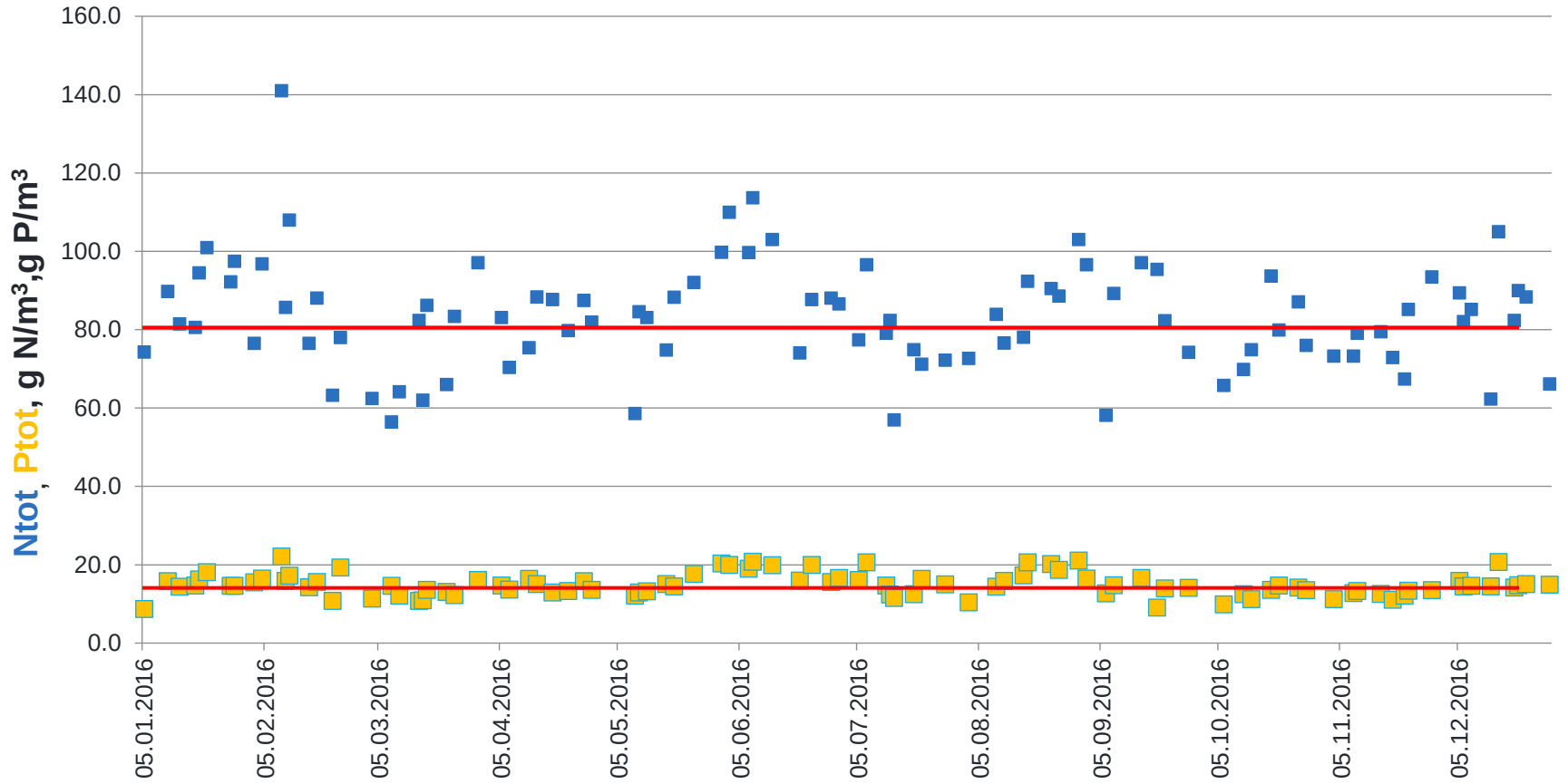
Variation in volume and composition

Real data



Variation in volume and composition

Real data



Population equivalent

Population equivalent

Definition

„A number expressing the multiple of the pollution load contained in wastewater in relation to the unit pollution load in wastewater discharged by a single resident per day”

It is assumed that unitary load l_{BZT5} = 60 g BOD_5/pe·d

$$PE = \frac{L_{BOD5}}{l_{BOD5}} \cdot 1000$$

$$PE = \frac{L_{BOD5}}{l_{BOD5}} \cdot 1000 = \frac{10746 \frac{kgO2}{d}}{60 \frac{gO2}{pe} d} \cdot 1000 = 179\,100\ pe$$

Effluent quality

Effluent quality

Different countries

Country	BOD_5 (mg/L)	COD (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)
Poland	25	125	≤ 10-15	≤ 1-2	35
France	25	125	≤ 15	≤ 2	35
Portugal	25	125	≤ 15	≤ 2	35
Turkey	25	125	≤ 10-15	≤ 1-2	35
Indonesia	30	100	≤ 10	≤ 2	30

Homework: check if it is true!

Effluent quality

Polish regulations

Indicator Name	Unit	2000 - 9999 PE	10000 - 14999 PE	15000 - 99999 PE	100000+ PE
Five-day Biochemical Oxygen Demand (BOD_5) at 20°C, with nitrification inhibitor	mg O_2/L	125 or 70-90%	25 or 70-90%	15 or 90%	15 or 90%
Chemical Oxygen Demand (COD), determined by dichromate method	mg O_2/L	125 or 75%	125 or 75%	125 or 75%	125 or 75%
Total Suspended Solids (TSS)	mg/L	35 or 90%	35 or 90%	35 or 90%	35 or 90%
Total Nitrogen (sum of Kjeldahl Nitrogen (Norg + NH_4-N), nitrate nitrogen, and nitrite nitrogen)	mg N/L	15[1]	15	10 or 70-80%	10 or 70-80%
Total Phosphorus (TP)	mg P/L	2[2]	2	1 or 80%	1 or 80%

[1] The value of **15 mg N/L** applies only when required to protect receiving waters.
[2] The value of **2 mg P/L** applies only when required to protect receiving waters.

Regulation of the Minister of Maritime Economy and Inland Navigation of July 12, 2019, on substances particularly harmful to the aquatic environment and the conditions to be met when discharging wastewater into water or soil, as well as when discharging stormwater or meltwater into water or water facilities.

Control questions

1. What are the basic components of the wastewater treatment process in a sewage treatment plant?
2. What are the approximate parameters of raw wastewater?
3. What is PE (Population Equivalent)?
4. What factors influence and what are the general requirements for the quality of treated wastewater?