Exercises V (answers): Treatment of wastewater solids I

Applied wastewater engineering

Exercise 1: Handling of screenings

A wastewater treatment plant with 22’000 population equivalents is equipped with a coarse screen (size of openings: 10 mm) which is followed by a fine screen (size of openings: 6 mm). Both screens have rectangular slots. The screenings collected have an average TS content of 12 % before treatment. The volume of the screenings are reduced to an average TS content of 35 % by a screenings compactor (density can be assumed equal to 1).

Table 1 : screenings production per capita at 8 % TS in function of type of screen and size of opening.

size of opening (mm)	screenings per capita at 8 % TS (L/PE·year)	
	rectangular slots	circular slots
0.5	49	135
1	41	117
3	26	50
6	14	21
8	9.0	16
10	6.5	14
20	4.5	-

1. Draw a scheme containing all information required for this exercise.

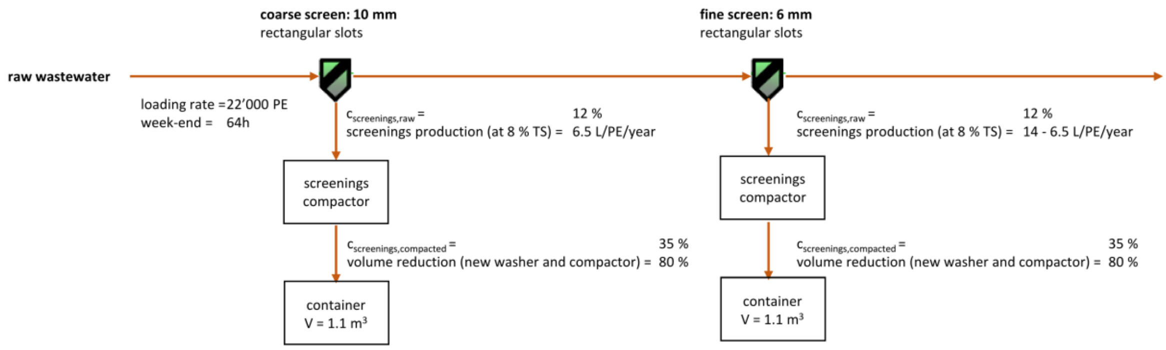

Figure 1 : Scheme of exercise 1.

2. What volume (in m^3) of untreated screenings does each screen in average produce per day?

Screenings produced per day by screen 1 (interspace 20 mm):

c_{ref} is the TS content given in the table, c_{real} is the TS content of the screenings of the wastewater treatment plant.

$$q_{real} c_{real} = q_{ref} c_{ref}$$

$$q_{real} = \frac{q_{ref} c_{ref}}{c_{real}}$$

$$q_{1,12\%} = nPE \times \frac{V_{ref,1}}{PE \cdot year} \times \frac{c_{ref}}{c_{real}} \times \frac{year}{365\ day} = 22'000PE \times \frac{6.5l}{PE \cdot year} \times \frac{8\ \%\ TS}{12\ \%\ TS} \times \frac{year}{365d} = \mathbf{261\ l/d}$$

Flow rate produced per day by screen 2 (interspace 6 mm):

$$q_{2,12\%} = nPE \times \frac{V_{ref,2}}{PE \cdot year} \times \frac{c_{ref}}{c_{real}} \times \frac{year}{365\ day} = 22'000PE \times \frac{(14-6.5)l}{PE \cdot year} \times \frac{8\ \%\ TS}{12\ \%\ TS} \times \frac{year}{365d} = \mathbf{301\ l/d}$$

Screen one produces 261 l/d and screen two 301 l/d of untreated screenings.

3. How many screenings waste containers of 1.1 m3 have to be evacuated per week?

Total screenings produced at 12 % TS: $q_{total,12\%} = q_{1,12\%} + q_{2,12\%} = 261l/d + 301l/d = 562l/d$

Screenings produced at 35 % TS:

$$q_{total,35\%} = q_{total,12\%} \times \frac{c_{initial}}{c_{final}} = 562l/d \times \frac{12\%\ TS}{35\%\ TS} = 193l/d$$

Number of containers filled per week:

$$\frac{q_{total,35\%}}{V_{container}} \times \frac{7d}{week} = \frac{193l/d}{1100l/container} \times \frac{7d}{1week} = \mathbf{1.2\ containers/week}$$

Per week about 1.2 containers need to be evacuated.

4. Is one waste container of 1.1 m3 enough over the weekend (weekend lasts from Friday evening 5 pm until Monday morning 9 am) for the second screen if it is already three quarters full on Friday evening? What do you suggest?

The weekend lasts from Friday evening 5 pm until Monday morning 9 am, which corresponds to 64 hours

Number of containers filled per weekend:

$$\frac{q_{2,12\%}}{V_{container}} \times \frac{c_{initial}}{c_{final}} \times \frac{1d}{24h} \times \frac{64h}{1weekend} = \frac{301l/d}{1100l/container} \times \frac{12\%\,TS}{35\%\,TS} \times \frac{1d}{24h} \times \frac{64h}{1weekend}$$
$$= \mathbf{0.25\ containers/weekend}$$

One container is enough during a normal weekend as it will be completely full on Monday morning. However, I would suggest emptying the containers on Friday evening. There needs to be sufficient space to be able to evacuate the screenings in case a rain event happens over the weekend. Otherwise, somebody will have to pass over the week-end to exchange the container.

5. The community considers buying new screenings washer and compactors (volume reduction of screenings ≥ 80 % compared to raw screenings). They want to know by how much (in percent) would the screenings flow rate reduce compared to the current compacted screenings. Would they have other benefits from such a modification?

Screenings flow rate using a screenings washer and compactor Q_{SWC}:

$$q_{SWC} = q_{total,12\%} \times (100\% - 80\%) = \frac{562l}{d} \times \left(\frac{100}{100} - \frac{80}{100}\right) = 112l/d$$

Percentage reduction in volume:

$$reduction(\%) = \frac{q\ reduction}{q_{total,35\%}} \times 100\% = \frac{(193l/d - 112l/d)}{193l/d} \times 100\% = \mathbf{42}\%$$

The flowrate reduction in percent of screenings to evacuate as compared to the current situation will be of 42 % for a new screenings washer and compactor.

Yes, they will have other benefits. The screenings washer removes organic material from the screenings and returns it to the wastewater treatment. The reduction of organic material in the screenings to evacuate greatly reduces the odour nuisances.

Exercise 2: Grit and grease removal

1. Why should you install a grit removal in a wastewater treatment train?

a) Grit has to be removed in order to protect aeration basins, digesters and pipelines from heavy deposits.
b) Furthermore, it reduces the abrasion of moving mechanical equipment further down in the treatment train (e.g. pumps, centrifuges, heat exchangers,…).

2. What are the advantages of an aerated grit and grease removal compared to a non-aerated?

a) *The aeration permits to better control the sedimentation of grit and avoid the deposition of other materials (organic material). In fact, the turbulences generated by the aeration avoid the deposition of relatively heavy organic material at low water flowrates.*
b) *Furthermore, the mixing due to aeration already separates part of the organic fraction from the grit and will not sediment in the aerated grit removal unit.*
c) *Finally, the turbulences generated due to the aeration allow the grease to accumulate in a separate chamber where it can be collected.*

3. What are the advantages of using a grit washing and drying unit?

a) *It reduces substantially the content of the organic fraction and hence reduces the bad odour generation during grit storage and permits disposal in landfills (low organic fraction required).*
b) *Additionally, it also reduces the water content of the collected grit, which reduces the final weight of the grit. Hence, less volume and weight have to be handled during disposal.*