

Exercises for final exam preparation

Applied wastewater engineering

Exercise 1: Backwashing of sand filters of organic micropollutants treatment

A wastewater treatment plant with 60'000 inhabitants connected to it is currently treating a COD-load (determined by the 85th percentile of the influent loads) of 8'500 kg/d. Each population equivalent generates 120 L of wastewater per day. Furthermore, the wastewater contains 40 % infiltration water. The maximum wastewater flowrate which can be accepted at the WWTP is 3.5 times the average dry-weather flowrate (dry weather includes infiltration water).

The treatment train of the wastewater treatment plant is as follows: pre-treatment, primary clarifier, biofilters, ozonation contactor, sand filters. The six sand filters are currently operated at a maximal filtration rate of 14 m/h (excluding the return of the backwash water). The sand filters are backwashed every second day (half of the sand filters per night) and generate 5.5 m³ backwash water per square meter of filter surface area. The backwash water is pumped back to the primary clarifier at a constant flowrate from 22:30 until 6 am.

- a) Draw a scheme containing all information required for solve exercise 3.
- b) What is the average dry weather and the maximum rain weather flowrate entering the wastewater treatment plant (both expressed in m³/h)?
- c) Compute the total surface area and the surface area of each sand filter.
- d) How much backwash water is generated each day? What is the maximum flowrate of backwash water entering the primary clarifier? Express both values in percent as compared to average daily dry weather flowrate and maximum rainy weather flowrate, respectively.
- e) What is the maximal filtration rate of the sand filters if one sand filter is being backwashed? Take into account that the backwash water is returned back into the primary clarifier at the same time.

Exercise 2: Chemical conditioning

1. In sludge treatment, when is chemical conditioning required?
2.
 - a) What are the most important substances used for chemical conditioning?
 - b) What is particular about these substances?
 - c) What is important for their correct preparation and use

Exercise 3: Chemical scrubbers for waste air treatment

A municipality operates chemical scrubbers for the waste air treatment at their wastewater treatment plant. It treats 220'000 m³/h of waste air, which has an average density of 1.2 kg/m³. The waste air contains an average concentration of 20 mg sulphide/m³. The scrubbant density is 1.0 kg/L.

- a) Estimate the volume of the packing material of the basic chemical scrubber. You know that the design was done using conservative values.

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- b) How much scrubbant water (dilute caustic soda) has to be pumped back up to the tower (m^3/h)? Compute this based on average design values (kg air flow through the scrubbant).
- c) What is the average yearly consumption of caustic soda (NaOH) in t/year (to simplify your computation you can assume a 100 % removal of sulphides in the scrubber)?