

ORDRE DES INGÉNIEURS DU QUÉBEC
MAY 2012 SESSION

Open book examination
Non-programmable calculators: only authorized models
Duration : 3 hours

Water Supply and Wastewater Treatment

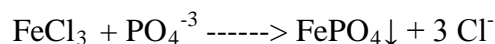
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QUESTION 1 BIOCHEMICAL OXYGEN DEMAND (4 POINTS)

A paper mill discharges its waste into a river flowing with a velocity of 2 km/d. After mixing with the waste, the ultimate BOD_u (carbon only) of the river water is 50 mg/L. The value of the biodegradability constant k (base e) is $-0,05 \text{ d}^{-1}$. Compute the BOD₅ (carbon only) of the river water after complete mixing as well as the BOD_u and BOD₅ 10 km downstream. Neglect atmospheric reoxygenation.

QUESTION 2 PHOSPHORUS REMOVAL (3 POINTS)

All 8 mg/L phosphorus (PO₄-P) in the 200 000 m³/d influent to the sewage treatment plant is soluble. It can be extracted by precipitation with ferric chloride according to the following equation :



Compute, in kg, the daily quantity of ferric chloride required to decrease to 1 mg/l the concentration of PO₄-P if ferric chloride efficiency is 76,5 %.

QUESTION 3 NITRITES AND NITRATES (4 POINTS)

Chemical analysis show that the drinking water of your municipality contains, per liter, 0,850 mmol (millimoles) of (NO₃-N + NO₂-N). Moreover regulations require that the total concentration of (NO₃-N + NO₂-N) be below 10 mg/L to avoid metemoglobinemia (baby blue syndrom) among children

- a) Compute the concentration of NO₃ + NO₂ in mg/L-N
- b) Does this concentration comply with regulations
- c) Compute the concentration of NO₃+ NO₂ in ppm as N
- d) Compute the concentration of NO₃ + NO₂ in equivalent/L

QUESTION 4 SOLUBILITY (1 POINT)

Compute in moles/L and in mg/L the dissolved oxygen concentration in pure water at 25°C in equilibrium with atmosphere . At this temperature Henry's constant for oxygen is $1,29 \times 10^{-3}$ moles / (L-atm).

QUESTION 5 PRESSURE (1 POINT)

How many meters of water at 5°C is equivalent to a pressure 125 kN/m²

QUESTION 6 PUMPING STATION (4 POINTS)

The average sewage inflow to a small pumping station is 100 000 L/day. The minimum and maximum flows are respectively 15 000 and 400 000 L/day. There are 2 identical 400 000 L/day submersible pumps operated alternatively.

- a) Compute the maximum volume (V) of the wet well if pumps must not operate more than 2 minutes (pumping time or t_p) per pumping cycle during which the water level is lowered from its highest to its lowest level ? For this question use minimum flow.
- b) What is the longest time required to fill up the wet well ?

Wet well : the sewage is received in a reservoir of the pumping station, the wet well, from which it is pumped out.

QUESTION 7 ARCHIMEDES FORCES (3 POINTS)

A reinforced concrete sewage outfall, 457 mm in real inside diameter and weighing 350 kg per linear meter has been installed on a river bottom where water is brackish. Then it has been covered with 1 meter thick backfill weighing 1685 kg/m³. Taking into account a 10 % security factor evaluate the stability of this structure when it is emptied out for maintenance purpose. The wall thickness of the pipe is 6,35 cm and concrete weighs 2400 kg/m³.

GOOD LUCK