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WATER POLLUTION AND ITS TREATMENT TECHNOLOGIES
PROBLEMS (II)

Problem 5.- A wastewater treatment plant treats an average daily flow of 91500 m^3 from a residential area. In this plant there is disused channel that could be exploited as a sand removal unit. It has the following dimensions: 9.10 m (length) x 1.50 m (width) x 2.10 m (height).

Particles size distribution is given in the table below. Determinations indicate that these particles' specific relative mass is 2.65.

% mass	40	25	20	10	5
diameter (mm)	2.0	1.0	0.5	0.3	0.2

a) This unit is expected to remove at least 80% of the sand. Is this channel adequate to fulfill this requirement?

b) Determine the mass of particles (in %) that would be removed in this channel.

Assume that the efficiency of collection is the ratio between the real length and the theoretical length to capture 100% of the particles of a specific diameter.

DATA Viscosity H_2O= 9.95 10^{-4} Pa·s

Problem 6.- A primary settling tank is to be designed for a daily average wastewater flow of 6000 m^3 to operate at a loading factor of 34 $m^3 \cdot m^{-2} \cdot d^{-1}$ and a hydraulic retention time of 1.5 hours. It is given that the raw wastewater contains 200 $mg \cdot L^{-1}$ of Suspended Solids (SS) and a 2% solid content (% by mass) in the sludge. Assuming that 40% of these SS are fixed solids and the specific gravity of the fixed and volatile fractions in the solids is 2.4 and 1.05, respectively, compute:

a) The diameter and the depth of the settling tank (in m)

b) The volume of primary sludge that will be produced by 60% removal efficiency of the tank (in $m^3 \cdot d^{-1}$).

Problem 7.- The daily wastewater generation of a city of 250000 inhabitants is 400 $L \cdot hab^{-1} \cdot d^{-1}$. This wastewater is collected and transported from the houses to the municipal wastewater treatment plant (MWWTP). Laboratory determinations are carried out periodically to determine the characteristics of the influent wastewater. The average values are detailed in the table below.

SS	320 $mg \cdot L^{-1}$
temperatur e	21ºC
pH	5.4
SS	1200 $kg \cdot m^{-3}$
BOD_1	60 mg $O_2 \cdot L^{-1}$
BOD_2	107.7 mg $O_2 \cdot L^{-1}$
k	0.23 d^{-1}

A circular settling tank (radius= 25 m and height= 5 m) is going to be tested for the primary treatment. It is expected to remove 80% of the Suspended Solids (SS) in this device. The settled SS would be collected in a hopper, whereas clarified water is sent to the secondary treatment in order to reduce the concentration of the organic matter. Currently, discharge standards require the value of the 5-day Biological Oxygen Demand (BOD_5) to be lower than 4 $mg \cdot L^{-1}$.

a) Determine the required BOD_5 removal (in %) to meet the effluent limit.

b) Find the loading factor in $m^3 \cdot m^{-2} \cdot d^{-1}$ and the hydraulic retention time (in hours) of the circular settling tank.

c) Estimate the production of primary sludge (in m^3) in the MWWTP. Assume that the primary sludge has a solid concentration of 4% by volume.

Problem 8.- A Municipal Wastewater Treatment Plant (MWWTP) receives a daily flow of 11250 m^3. The wastewater has a solid concentration of 300 $mg \cdot L^{-1}$. The primary treatment removes approximately 70% of the Suspended Solids (SS). The primary sludge is thickened and stabilized by an anaerobic digestion in which 60% of the Volatile Solids (VS) are destroyed. Considering that 0.35 m^3 of methane are produced per kilogram of VS digested and that the biogas is made up of methane (50%) and carbon dioxide (50%), calculate:

a) Stabilized sludge production per day (in t)

b) Biogas production (in m^3)

c) Volume of the tank for the anaerobic digestion (in m^3)

DATA

- Laboratory tests indicate that primary sludge is 2% solids by mass and, of these 70% are VS.
- The residence time digester is 25 days
- The percentage of dry solids remaining in the digested sludge is 5%