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WATER POLLUTION AND ITS TREATMENT TECHNOLOGIES
PROBLEMS (III)

Problem 9.- The characteristics of the wastewater effluent of an industrial process are detailed in the table below. The 75% of Suspended Solids (SS) are removed in circular settling tank. The loading factor and hydraulic retention time of this tank are 1.25 m^3m^{-2} h^{-1} and 2 hours, correspondingly. The resulting sludge (2% solids by volume) is collected and sent to the solids handling processes.

Flow rate (Q)	35 $L{\cdot}s^{-1}$
Chemical Oxygen Demand (COD)	800 mg $O_2{\cdot}L^{-1}$
Suspended Solids (SS)	300 $mg{\cdot}L^{-1}$
Methanol (CH_4O)	200·mg L^{-1}
Butanol ($C_4H_{10}O$)	100 $mg{\cdot}L^{-1}$

Based on this information, calculate:

a) The influence of SS on the COD. Express the result in mg $O_2{\cdot}L^{-1}$.

b) Diameter and height of the primary settling tank (in m).

c) The annual production of primary sludge (in m^3). Assume that the density of SS is 1100 kg m^{-3}.

d) The concentration of SS in the effluent of the primary settling tank (in $mg{\cdot}L^{-1}$)

Problem 10.- The average hourly flow to a wastewater treatment plant is 1200 $m^3{\cdot}h^{-1}$. The influent contains 600 mg·L-1 of Suspended Solids (SS), 100 $mg{\cdot}L^{-1}$ of palmitic acid (CH_3-$(CH_2)_{14}$-COOH) and 95 $mg{\cdot}L^{-1}$ of phosphates. The effluent limitations are as follows: SS ‹ 35 $mg{\cdot}L^{-1}$; BOD ‹ 25 mg $O_2{\cdot}L^{-1}$ and phosphates ≤ 0.2 $mg{\cdot}L^{-1}$.

The plant comprises the following treatment units: pretreatment, a primary treatment, a secondary aerobic treatment plus the precipitation of phosphates with aluminum chloride.

Based on this information and assuming that palmitic acid is totally degraded by biological means to carbon dioxide and water, calculate:

a) The daily production of primary sludge (in tons). The humidity of these biosolids is of approximately 40% by mass.

b) The BOD of the wastewater (in mg $O_2 \cdot L^{-1}$)

c) The removal requirement for the biological aerobic treatment (in %) in order to meet the effluent permit limit for the BOD.

d) The concentration of the phosphates after precipitation (in ppm). Does this value exceed the limit value? Is it acceptable?

DATA $K_{ps}\ AlPO_4 = 1.3 \cdot 10^{-20}$

Problem 11.- The wastewater generation of a city of 400000 inhabitants is 225 $L \cdot hab^{-1} \cdot d^{-1}$. A gravity thickener is to be designed to increase the solid content of sludge generated in the primary treatment of the Municipal Wastewater Treatment Plant (MWWTP). The operating parameters of this plant are:

Concentration of solids in the influent of the primary settling tank	210 $mg \cdot L^{-1}$
Solids removal efficiency of the primary settling tank	60%
Solid content in the primary sludge	3% (mass)
Surface loading rate of the thickener	180 kg solids$\cdot m^{-2} d^{-1}$
Hydraulic retention time in the thickener	8 h

Calculate:

a) The daily production of raw primary sludge (in m^3) assuming that the density of the sludge is 1000 $kg \cdot m^{-3}$

b) The hydraulic load rate for the thickener (in $m^3 \cdot m^{-2} \cdot d^{-1}$)

c) The diameter and depth of the thickener (in m)

Problem 12.- Factories in an industrial park discharge 50000 $m^3 \cdot d^{-1}$ of wastewater containing 300 $mg \cdot L^{-1}$ of Suspended Solids (SS). In the industrial wastewater treatment plant, this wastewater passes through a primary settling tank where 70% of SS are removed. The solids content in the primary sludge is 2% by mass.

This sludge is fed to an anaerobic digester where approximately 60% is digested. In this system, the destruction of 100 kg of sludge results in 0.8 kg of CO_2 and the concentration of this gas in the produced biogas is three times the concentration of the CH_4 (in mass). Estimate:

a) The mass of raw primary sludge (in kg) that would be produced per day.

b) The amount of CO_2 emitted to the atmosphere (in $kg \cdot d^{-1}$), taking into consideration that the biogas is burnt in a burner and that the combustion efficiency of CH_4 is of 100%.

c) The concentration of SS in the effluent of the primary settling tank (in $mg \cdot L^{-1}$)