

avasilopoulou

Ταχυνάριος 2021

"Ταχυνάριος Πόδας"

Ταχυνάριος 2019

$$H = 91 \text{ m}$$

$$V = 470 \text{ km}^3$$

$$\tau = 6,7 \text{ y}$$

$$\rho_0 = 914 \text{ g/L}$$

$$L = 15,3 \text{ g/m}^2 \text{ y}$$

$$k_s = 0,005/\text{d}$$

1. Ισοδύναμο S.S., με την αρχή μείωσης

$$\frac{dV}{dt} = Q \cdot P_{in} - Q \cdot P - k_s \cdot V \cdot P \Rightarrow \frac{dP}{dt} = \frac{Q \cdot P_{in}}{V} - \frac{Q \cdot P}{V} - k_s \cdot P \Rightarrow \tau = \frac{V}{Q}$$

$$\Rightarrow \frac{dP}{dt} = \frac{P_{in}}{\tau} - \frac{P}{\tau} - k_s \cdot P \Rightarrow \frac{dP}{dt} + P \left(\frac{1}{\tau} + k_s \right) = \frac{P_{in}}{\tau}$$

2. $P_{ss} = ?$ $t_{95\%} = ?$

$$\frac{dP}{dt} = 0 \Rightarrow \frac{P_{in}}{\tau} = P_{ss} \left(\frac{1}{\tau} + k_s \right) \Rightarrow P_{ss} = \frac{P_{in}}{1 + k_s \cdot \tau}$$

Το ποσό που $W = L \cdot A$ και $\frac{P_{in}}{\tau} = \frac{W_{in}}{V} \Rightarrow W_{in} = \frac{P_{in} \cdot V}{\tau} = \frac{\tau \cdot V}{Q} P_{in} \cdot Q \Rightarrow$

$$Q \cdot P_{in} = L \cdot A \Rightarrow P_{in} = \frac{L \cdot A}{Q} = \frac{15,3 \frac{\text{g}}{\text{m}^2 \text{ y}} \cdot \frac{470 \cdot 10^9 \text{ m}^3}{91 \text{ m}}}{\frac{470 \cdot 10^9 \text{ m}^3}{6,7 \text{ y}}} = 1,13 \text{ g/m}^3$$

Αρα $P_{ss} = \frac{1,13 \text{ g/m}^3}{1 + 0,005/\text{d} \cdot 6,7 \text{ y} \cdot \frac{365 \text{ d}}{\text{y}}} = 0,086 \text{ g/m}^3$

Δ $\frac{P - P_0}{P_{ss} - P_0} = 0,95 \Rightarrow P = 0,95 P_{ss} + 0,05 P_0$

$$e^{-\left(\frac{1}{\tau} + k_s\right) t_{95}} = 0,05 \Rightarrow -\left(\frac{1}{\tau} + k_s\right) \cdot t_{95} = \ln 0,05 \Rightarrow t_{95\%} = \frac{\ln 0,05}{-\left(\frac{1}{6,7 + 365} + 0,005\right)} = 554 \text{ d} \cdot \frac{1 \text{ y}}{365 \text{ d}} = 1,5 \text{ y}$$

3. $L' = L - 0,5L = L(1 - 0,5) = 0,5 \cdot L$

$$P_{in}^{new} = \frac{0,5 \cdot P_{in}}{1 + k_s \cdot \tau} = 0,043 \text{ g/m}^3$$

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Exercises 2015 (1)

$$\textcircled{1} \frac{dVc}{dt} = Q_m C_m - Q_c C - k_s V \cdot C \Rightarrow \frac{1}{\tau} V, \tau = \frac{V}{Q}$$

$$\frac{dC}{dt} = \frac{Q_m}{V} C_m - \frac{C}{\tau} - k_s C \Rightarrow$$

$$\frac{dC}{dt} + C \left(\frac{1}{\tau} + k_s \right) = \frac{Q_m}{V} C_m$$

② Τυφίδια έχουν 12-αγνους ως φορείς

$$y' + P(x)y = q(x)$$

Εύρηκτα λύση:

$$y = y_0 \cdot e^{-P(x)} + e^{-P(x)} \int e^{P(x)} q(x) dx$$

$$\text{Οπου } P(x) = \int P(x) dx \Rightarrow P(x) = \frac{1}{\tau} + k_s \Rightarrow P(t) = \int \left(\frac{1}{\tau} + k_s \right) dt \Rightarrow P(t) = \left(\frac{1}{\tau} + k_s \right) t$$

$$\text{και } q(x) = \frac{Q_m}{V}$$

Αντικαθιστώντας και ολοκληρώνοντας:

$$C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + e^{-\left(\frac{1}{\tau} + k_s\right)t} \int_0^t e^{\left(\frac{1}{\tau} + k_s\right)t} \cdot \frac{Q_m}{V} dt \Rightarrow C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + \frac{Q_m}{1 + k_s \tau} \left(1 - e^{-\left(\frac{1}{\tau} + k_s\right)t} \right)$$

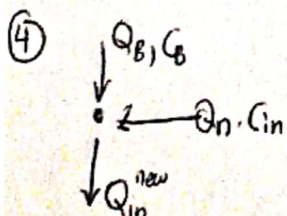
$$\textcircled{3} \frac{Q_m}{V} - \frac{C}{\tau} = k_s \cdot C \Rightarrow k_s = \frac{Q_m - C}{\tau \cdot C} = \frac{24 - 15}{5 \cdot 15} = 0,12 / d \quad \textcircled{5} C_{ss} = \frac{Q_m}{1 + k_s \tau} = \frac{24 / \text{g/L}}{1 + 0,12 \cdot 5} =$$

$$\tau = \frac{V}{Q} = \frac{10^6 \text{ m}^3}{200.000 \frac{\text{m}^3}{\text{y}}} = 5 \text{ y}$$

$$C_{ss} = 26,25 \text{ g/L}$$

$$\textcircled{6} \frac{C - C_0}{C_{ss} - C_0} = 0,95 \Rightarrow C = 0,05 C_0 + 0,95 C_{ss}$$

$$e^{-\left(\frac{1}{\tau} + k_s\right)t_{95}} = 0,05 \Rightarrow t_{95} = \frac{-\ln 0,05}{\frac{1}{5} + 0,12} = 3,4 \text{ y}$$



$$C_{in}^{new} = \frac{Q_B C_B + Q_m C_m}{Q_{in}^{new}}$$

$$= \frac{200.000 \frac{\text{m}^3}{\text{y}} \cdot 60 \text{ g/L} + 200.000 \frac{\text{m}^3}{\text{y}} \cdot 24 \text{ g/L}}{400.000 \frac{\text{m}^3}{\text{y}}} = 42 \text{ g/L}$$

$$⑤ \quad C_s^{new} = \frac{C_{in}^{new}}{1 + K_s \cdot C} = \frac{42 \mu\text{g/L}}{1 + 0,12 \cdot 5} = 26,25 \mu\text{g/L}$$

$$⑥ \quad \frac{C - C_0}{C_{ss} - C_0} = 0,95 \Rightarrow C = 0,05 C_0 + 0,95 C_{ss}, \quad 0,05 = e^{-(\frac{1}{5} + 0,12) t_{95}} \Rightarrow t_{95} = \frac{-\ln 0,05}{\frac{1}{5} + 0,12} = 9,4 \text{ y}$$

$$⑦ \quad Q \cdot C_{in} - Q \cdot C - K_s \cdot V \cdot C = 0 \Rightarrow \Delta t \cdot Q_{in}^{new} \cdot [C_{in} - C_{ss}] = M \Rightarrow M = 5 \text{ y} \cdot 400.000 \frac{\text{m}^3}{\text{y}} (42 - 26,25) \frac{\mu\text{g}}{\text{L}} \frac{10^{-3} \text{ L}}{1 \text{ m}^3} = 31,5 \text{ Kg}$$

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Συνολικός 2021 ① Σημειώσεις Διαφορών Ποσοτήτων

$$A) \frac{dV}{dt} = Q_{in} - Q_{out} - k_s \cdot V \cdot C \xrightarrow{V, C = \frac{V}{A}} \frac{dC}{dt} = \frac{Q_{in}}{V} - \frac{C}{\tau} - k_s \cdot C \Rightarrow \frac{dC}{dt} = \frac{Q_{in}}{V} - C \left(\frac{1}{\tau} + k_s \right)$$

$$\frac{Q_{in}}{V} = C \left(\frac{1}{\tau} + k_s \right) \Rightarrow C = \frac{Q_{in}}{1 + k_s \tau} \Rightarrow Q_{in} = 0.4 Q_{in} (1 + k_s \tau) \Rightarrow 1 + k_s \tau = 2.5 \Rightarrow C = \frac{2.5 - 1}{k_s} \quad (2)$$

$$\hookrightarrow m_{out}(255) = 0.4 \text{ min}(255)$$

$$\bullet k_s = 0.8 \frac{m}{d} \Rightarrow k_s' = \frac{k_s}{H} = \frac{0.8 \text{ m/d}}{3} = 0.27/d \quad (1)$$

$$\textcircled{2} \xrightarrow{(1)} \tau = \frac{1.5}{0.27} = 5.6d$$

$$\hookrightarrow \tau = \frac{V}{Q} \Rightarrow V = \tau \cdot Q = 5.6d \cdot 0.1 \frac{m^3}{s} = 0.56 m^3 \frac{d}{s} \cdot \frac{24h}{1d} \cdot \frac{60min}{1h} \cdot \frac{60s}{1min}$$

$$\Rightarrow V = 48.384 m^3 ?$$

$$\hookrightarrow A = \frac{V}{H} = \frac{48.384 m^3}{3m} = 16.128 m^2$$

B) Διαφορές δύο Διαφορών

$$C_2 = \frac{Q_{in}}{(1 + k_s \tau)^2} \Rightarrow 0.4 \frac{Q_{in}}{(1 + k_s \tau)^2} \Rightarrow \dots \Rightarrow 1 + k_s \tau = 1.58 \Rightarrow C = \frac{0.58}{k_s} \Rightarrow C = 2.2d$$

$$k_s' = 0.27/d$$

$$\hookrightarrow \tau = \frac{V}{Q} \Rightarrow V = \tau \cdot Q = 2.2d \cdot 0.1 \frac{m^3}{s} \cdot \frac{60s}{1min} \cdot \frac{60min}{1h} \cdot \frac{24h}{1d} = 19.008 m^3$$

$$\hookrightarrow A = \frac{V}{H} = \frac{19.008}{3} = 6.336 m^2$$

γ) Ποια η ταχύτητα ροής

$$v_{\text{avg}} = 2 \cdot v_2 < v_1$$

και

$$v_{\text{avg}} = 2 \cdot v_2 < v_1$$

$$W' = LA, W = Q \cdot C$$

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① S.S., mass analysis

$$\frac{dC}{dt} = Q_{in} \cdot C_{in} - Q_{out} \cdot C$$

$$\frac{dm}{dt} = m_{in} - m_{out} - m \cdot k_s$$

$$\frac{dVC}{dt} = Q_{in} \cdot C_{in} - Q_{out} \cdot C - k_s \cdot V \cdot C$$

$$\left[\frac{dC}{dt} = \frac{Q_{in}}{V} - \frac{C}{\tau} - k_s \cdot C \right] \Rightarrow \frac{dC}{dt} = \frac{Q_{in}}{V} - C \left(\frac{1}{\tau} + k_s \right) \Rightarrow$$

$$\frac{dC}{dt} + C \left(\frac{1}{\tau} + k_s \right) = \frac{Q_{in}}{V}$$

~~Other~~ Repetition from 1st course

ans. happens $y' + y \cdot P(x) = q(x)$

Ans. given: $C = C_0 \cdot e^{-P(t) \cdot t} + e^{-P(t) \cdot t} \cdot \int e^{P(t) \cdot t} \cdot q(t) dt$

$P(t) = \int P(t) dt$ then $P(x) = \frac{1}{\tau} + k_s \Rightarrow P(t) = \left(\frac{1}{\tau} + k_s \right) t$

now $q(t) = \frac{Q_{in}}{V}$

$$C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + e^{-\left(\frac{1}{\tau} + k_s\right)t} \cdot \int e^{\left(\frac{1}{\tau} + k_s\right)t} \cdot \frac{Q_{in}}{V} dt$$

$$C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + \frac{Q_{in}}{\frac{1}{\tau} + k_s} \cdot \left(e^{\left(\frac{1}{\tau} + k_s\right)t} - 1 \right)$$

$$C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + \frac{Q_{in}}{\frac{1}{\tau} + k_s} \cdot \left(1 - e^{-\left(\frac{1}{\tau} + k_s\right)t} \right)$$

$$C = \frac{V}{Q}$$

$$win = \frac{Q_{in} \cdot V}{\tau} = Q_{in} \cdot Q$$

$$\boxed{\frac{Q_{in}}{\tau} = \frac{win}{V}}$$

$$C = C_0 \cdot e^{-(\frac{1}{z} + k_d) \cdot t} + \frac{W_p}{\frac{1}{z} + k_d} \cdot (1 - e^{-(\frac{1}{z} + k_d) \cdot t})$$

$$\textcircled{3} \quad \frac{dC}{dt} - C \left(\frac{1}{z} + k_d \right) = \frac{C_{in}}{z}$$

$$C_{ss} = \frac{W_p}{\frac{1}{z} + k_d}$$

$$z = \frac{V}{Q} = \frac{10^7 \text{ m}^3}{5 \cdot 10^4 \text{ m}^3/\text{y}} = 0,2 \text{ y} = 0,2 \cdot \frac{12 \text{ mth}}{1 \text{ y}} \cdot \frac{30 \text{ d}}{1 \text{ mth}} = 12 \text{ d}$$

$$C_{ss} = \frac{\frac{5000 \cdot \text{kg/y}}{10^7 \text{ m}^3}}{\left(\frac{1}{72} + 0,01 \right) \frac{1}{\text{d}}} = \frac{500 \frac{\text{mg}}{\text{y} \cdot \text{m}^3}}{0,010939 \frac{1}{\text{d}} \cdot \frac{30 \cdot 12}{1 \text{ y}}} = 2098,23256 \text{ mg/m}^3 = 58,14 \frac{\text{mg}}{\text{m}^3}$$

$$C_{ss}^{\text{new}} = \frac{\frac{2500 \cdot \text{kg/y}}{10^7 \text{ m}^3}}{\left(\frac{1}{72} + 0,01 \right) \frac{1}{\text{d}}} = 29,07 \text{ mg/m}^3$$

Εφ' όσον $C > 20 \text{ mg/m}^3$ ευρωπαϊκή

$$C < 10 \mu\text{g/L} \text{ επιδοσφορίση}$$

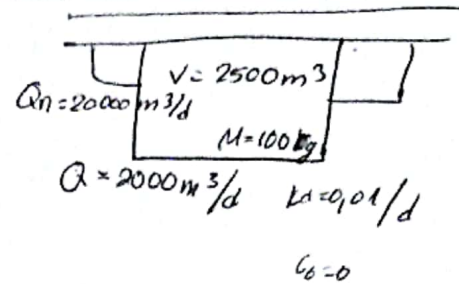
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Ayrouros 2017 (2), Iavayrios 2019 (1)

$$\frac{dC}{dt} = Q_{in} C^{in} - Q_{out} C$$

$$\frac{dC}{dt} = -\frac{C}{\tau} \Rightarrow \frac{dC}{C} = -\frac{1}{\tau} dt$$

$$\Rightarrow C = C_0 \cdot e^{-\frac{1}{\tau} t}$$



$$C_0 = \frac{M}{V} = \frac{100 \text{ kg}}{2500 \text{ m}^3} = 0.04 \cdot \frac{\text{kg}}{\text{m}^3} \cdot \frac{10^3 \text{ g}}{1 \text{ kg}} \cdot \frac{10^3 \text{ mg}}{1 \text{ g}} \cdot \frac{1}{\text{m}^3} \cdot \frac{1 \text{ m}^3}{10^3 \text{ L}} = 40 \text{ mg/L}$$

$$\tau = \frac{V}{Q} = \frac{2500 \text{ m}^3}{2000 \text{ m}^3/\text{d}} = 1.25 \text{ d} \Rightarrow \frac{1}{\tau} = 0.8 \frac{1}{\text{d}}$$

$$C = 40 \cdot e^{-0.8 \cdot t}$$

$\frac{t}{\tau}$	C
0	
1	
2	
3	

$X = \frac{20.000 \cdot 40}{20.000} = 400 \text{ mg/L}$

$X = \frac{20.000 \cdot 10}{2.000} = 100 \text{ mg/L}$

$$X = 100 \text{ mg/L}$$

$$X = 100 \text{ kg} \cdot \frac{1 \text{ kg}}{100 \text{ kg}} \cdot 2500 =$$

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Ταχιδιότυπος 2021 Ευρωπαϊκός "Ταχυγράφοι Απας"

$W_p = 250.000 \text{ kg/y}$

A. Ισοαξιο Μαζας

$Q_{in} = Q_{out} = Q$

$Q = 5 \cdot 10^7 \text{ m}^3/\text{y}$

$\frac{dVp}{dt} = Q \cdot P_{in} - Q \cdot P - k_s \cdot P \cdot V \Rightarrow \frac{dP}{dt} = \frac{P_{in}}{\tau} - \frac{P}{\tau} - k_s \cdot P$

$V = 10^7 \text{ m}^3$

B. Αναλυτική Λύση

$k_s = 0.001 / \text{d}$

$\frac{dP}{dt} + P \left(k_s + \frac{1}{\tau} \right) = \frac{P_{in}}{\tau}$

$P_0 = 10 \mu\text{g/L}$

Γραμμική Έξισωση 1ης τάξης της μορφής: $y' + P(x)y = q(x)$

Αναλυτική Λύση: $y = y_0 \cdot e^{-P(x)} + e^{-P(x)} \cdot \int e^{P(x)} \cdot q(x) dx$

Οπου $P(t) = \int P(x) dt \Rightarrow P(x) = \frac{1}{\tau} + k_s \Rightarrow P(t) = \int \left(\frac{1}{\tau} + k_s \right) dt = \left(\frac{1}{\tau} + k_s \right) t$

$q(t) = \frac{P_{in}}{\tau}$

Αντικαθιστώντας και ολοκληρώνοντας:

$P = P_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + e^{-\left(\frac{1}{\tau} + k_s\right)t} \cdot \int e^{\left(\frac{1}{\tau} + k_s\right)t} \cdot \frac{P_{in}}{\tau} dt \Rightarrow P = P_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + e^{-\left(\frac{1}{\tau} + k_s\right)t} \cdot \frac{P_{in}}{1 + k_s \cdot \tau} \int e^{\left(\frac{1}{\tau} + k_s\right)t} dt$

$\Rightarrow P = P_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + e^{-\left(\frac{1}{\tau} + k_s\right)t} \cdot \frac{P_{in}}{1 + k_s \cdot \tau} \left[e^{\left(\frac{1}{\tau} + k_s\right)t} - 1 \right] \Rightarrow P = P_0 \cdot e^{-\left(\frac{1}{\tau} + k_s\right)t} + \frac{P_{in}}{1 + k_s \cdot \tau} \cdot \left(1 - e^{-\left(\frac{1}{\tau} + k_s\right)t} \right)$

Γ. $P_{ss} = ?$, Τροφική Κατάσταση

$\frac{dP}{dt} = \frac{P_{in}}{\tau} - P \left(k_s + \frac{1}{\tau} \right) \Rightarrow \frac{P_{in}}{\tau} = P_{ss} \left(k_s + \frac{1}{\tau} \right) \Rightarrow P_{ss} = \frac{P_{in}}{1 + k_s \cdot \tau} \rightarrow P_{ss} = \frac{10 \mu\text{g/L}}{1 + 0.001/\text{d} \cdot 73\text{d}} = 9.32 \mu\text{g/L} < 10 \mu\text{g/L}$

$\tau = \frac{V}{Q} = \frac{10^7 \text{ m}^3}{5 \cdot 10^7 \text{ m}^3/\text{y}} = \frac{1}{5} \text{ y} \cdot \frac{365 \text{ d}}{1 \text{ y}} = 73 \text{ d}$

Δ. $P_{ss}^{\text{new}} = ?$, μετά το φάρμακο

$P_{in}^{\text{new}} = \frac{W_p}{Q} \Rightarrow P_{in}^{\text{new}} = \frac{250.000 \text{ kg/y}}{5 \cdot 10^7 \text{ m}^3/\text{y}} = 5 \cdot 10^{-3} \frac{\text{kg}}{\text{m}^3} \cdot \frac{1 \text{ m}^3}{10^3 \text{ L}} \cdot \frac{10^9 \mu\text{g}}{1 \text{ kg}} = 5000 \mu\text{g/L}$

$P_{ss}^{\text{new}} = \frac{5000 \mu\text{g/L}}{1 + 0.001/\text{d} \cdot 73} = 4.660 \mu\text{g/L} > 20 \mu\text{g/L}$ Ευφραριστική

Ε. $W_D = ?$, για $P_{ss} \leq 20 \mu\text{g/L}$

$20 = \frac{P_{in}}{1 + 0.001/\text{d} \cdot 73} \Rightarrow P_{in} = 21.46 \mu\text{g/L}, W_p = Q \cdot P_{in} = 5 \cdot 10^7 \frac{\text{m}^3}{\text{y}} \cdot 21.46 \mu\text{g/L} = 1.073 \cdot 10^{12} \frac{\mu\text{g}}{\text{y}}$

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Γενεθλίοριος 2018 (1), Γενεθλίοριος 2019 19

① Υπολογίστε συγκεριμω BOD

$$(Q \cdot BOD)_n + (Q \cdot BOD)_B = (Q_n + Q_B) \cdot BOD$$

$$\frac{dc}{dt} = -u \frac{c}{c_0} - kd \cdot c$$

$$C = C_0 \cdot e^{-kt}$$

$$10^7 \frac{m^3}{y} \cdot \frac{3 mg}{L} + 30.000 \frac{kg}{y} = (10^7 + 10^6) \frac{m^3}{y} \cdot BOD$$

$$\frac{dc}{dt} = -u \frac{c}{c_0} - kd$$

$$3 \cdot 10^{10} \frac{mg}{y} + 3 \cdot 10^{10} \frac{mg}{y} = (10^7 + 10^6) \frac{m^3}{y} \cdot BOD$$

$$t = \frac{x}{u} = \frac{Q}{A}$$

$$BOD = \frac{(3 \cdot 10^{10} + 3 \cdot 10^{10}) \frac{mg}{y}}{(10^7 + 10^6) \frac{m^3}{y}} = 5.454,55 \frac{mg}{m^3} \frac{1 m^3}{10^3 L} = 5,46 mg/L$$

② Τοποθ BOD οτο νοταφ να οαφθερααα φιωο και S.S.

$$\frac{dc}{dt} = -u \frac{c}{c_0} - kd \cdot c \Rightarrow C = C_0 \cdot e^{-kd \cdot t}$$

③ Υπολογίστε εν συγκεριμω BOD ηπιφ φινει οτο νερα θηκω

$$kd = 0,3 /d$$

$$C_0 = 5,46 mg/L$$

$$t = \frac{x}{u} = \frac{15 km}{11 \cdot 10^3 \frac{kg}{y}} = 0,01364 y \approx 5d$$

$$u = \frac{Q}{A} = \frac{(10^7 + 10^6) \frac{m^3}{y}}{10 m^2} = 1,1 \cdot 10^6 \frac{m}{y} = 1,1 \cdot 10^3 \frac{km}{y}$$

$$C = 1,2 mg/L$$

④ Τοποθ BOD ηθικω

$$\frac{dvc}{dt} = Q_{in} C_{in} - Q \cdot C - kd \cdot v \cdot C \Rightarrow \frac{dC}{dt} = \frac{C_{in}}{t} - \frac{C}{t} - kd \cdot C \Rightarrow C = C_0 \cdot e^{-kd \cdot t}$$

⑤ Υπολογίστε εν συγκεριμω BOD οον ηθικω

$$C = C_0 \cdot e^{-kd \cdot t} + \frac{C_{in}}{1 + kd \cdot t} \cdot (1 - e^{-kd \cdot t}) = \dots 0,19 mg/L$$

$$t = \frac{v}{Q} = \frac{10^6 m^3}{(10^7 + 10^6) \frac{m^3}{y}} \approx 33d$$

Μεθοδ 1. Υπολογιστε τη συγκέντρωση των βαρυθίων

$$C = \frac{M}{V} = \frac{500 \text{ kg}}{500 \text{ m} \cdot 10^3 \text{ m}^3} = 10^{-3} \frac{\text{kg}}{\text{m}^3} \cdot \frac{10^6 \text{ mg}}{1 \text{ kg}} \cdot \frac{1 \text{ m}^3}{10^3 \text{ L}} = 100 \text{ mg/L}$$

2. Ισοδύναμο βαρυθίων στο ποτάμι για επιβεβαίωση και S.S., ΜΓαν πριν θίξη

$$C = C_0 \cdot e^{-k_d \cdot t}$$

$$t = \frac{x}{u} \approx 5 \text{ d}$$

$$k_d = 0.3/\text{d}$$

$$C_0 = 100 \text{ mg/L}$$

$$\left. \begin{array}{l} C = C_0 \cdot e^{-k_d \cdot t} \\ t = \frac{x}{u} \approx 5 \text{ d} \\ k_d = 0.3/\text{d} \\ C_0 = 100 \text{ mg/L} \end{array} \right\} \rightarrow C = 22.31 \text{ mg/L}$$

$$C = \frac{M}{V} \Rightarrow M = C \cdot V \approx 22.31 \text{ mg} \cdot 5000 \text{ m}^3$$

$$M = 111.55 \text{ kg}$$

3. Ισοδύναμο βαρυθίων θίξη

$$\frac{dC}{dt} = Q \cdot C_0 - Q \cdot C - k_d \cdot V \cdot C \Rightarrow \frac{dC}{dt} = -\frac{C}{\tau} - k_d \cdot C \Rightarrow \frac{dC}{dt} = -C \left(\frac{1}{\tau} + k_d \right)$$

$$\Rightarrow \int \frac{1}{C} dC = \int -\left(\frac{1}{\tau} + k_d \right) dt$$

$$= C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_d \right) \cdot t}$$

4. Υπολογιστε τη συγκέντρωση βαρυθίων στη θίξη μετά $t=16 \text{ d}$

$$\tau = 33 \text{ d}$$

$$C_0 = \frac{M}{V} = \frac{111.55 \text{ kg}}{10^6 \text{ m}^3} \approx 0.11 \text{ mg/L} \left. \right\} C = 0.11 \cdot e^{-\left(\frac{1}{33} + 0.3 \right) \cdot 16} = 0.003 \text{ mg/L}$$

5. Ορα τοξικότητας 1 mg/L , $t=;$

$$0.1 = 0.11 \cdot e^{-\left(\frac{1}{33} + 0.3 \right) \cdot t}$$

$$\Rightarrow \ln \frac{1}{0.11} = -\left(\frac{1}{33} + 0.3 \right) \cdot t \Rightarrow t =$$

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Λαμβάνει 2019 (2), Λαμβάνει 2021 (1)

$$H = 91 \text{ m}$$

$$V = 470 \text{ m}^3$$

$$z = 6.7 \text{ y}$$

$$P_0 = 9 \text{ kg/L}$$

$$L = 15.3 \text{ g/m}^2 \cdot \text{y}$$

$$k_s = 0.005/\text{d}$$

① Το υπό Μάκας Πυρροπού

$$\frac{dVP}{dt} = Q_{in}P_{in} - Q \cdot P - k_d \cdot V \cdot P \Rightarrow$$

$$\frac{dP}{dt} = \frac{Q_{in} \cdot P_{in}}{V} - \frac{Q \cdot P}{V} - k_d \cdot P \Rightarrow \frac{c}{Q}$$

$$\frac{dP}{dt} = \frac{P_{in}}{z} - P \cdot \left(\frac{1}{z} + k_d \right) \Rightarrow$$

$$\frac{dP}{dt} + P \left(\frac{1}{z} + k_s \right) = \frac{P_{in}}{z}$$

Ισάζειται για ενόφθαλμο

$$Q_{in} = Q_{out} = Q$$

② S.S., $P_{ss} = ?$, $t_{95} = ?$

$$\text{Επομένως S.S. } \frac{dP}{dt} = 0 \Rightarrow P_{ss} = \frac{P_{in}}{1 + k_d \cdot z}$$

$$\frac{\frac{\text{g}}{\text{m}^3} \cdot \text{m}^2}{\frac{\text{m}^3}{\text{y}}} = \frac{\text{g}}{\text{m}^3}$$

$$\triangleright \text{Το ύψος ορα } W = L \cdot A \Rightarrow Q \cdot P_{in} = L \cdot A \Rightarrow P_{in} = \frac{L \cdot A}{Q}$$

$$\triangleright A = \frac{V}{H} = \frac{470 \cdot 10^9 \text{ m}^3}{91 \text{ m}} = 5.164.835,165 \text{ m}^2$$

$$\triangleright z = \frac{V}{Q} \Rightarrow \frac{Q}{z} = \frac{V}{z} = \frac{470 \cdot 10^9 \text{ m}^3}{6.7 \text{ y}} = 7.015 \cdot 10^{10} \text{ m}^3/\text{y}$$

$$\Rightarrow P_{in} = 1.13 \text{ g/m}^3 = 1.13 \frac{\text{g}}{\text{m}^3} \frac{10^3 \text{ m}^3}{\text{kg}} \frac{1 \text{ m}^3}{10^3 \text{ L}}$$

$$P_{in} = 1.13 \text{ mg/L}$$

$$\Rightarrow P_{ss} = \frac{1.13 \text{ mg/L}}{1 + 0.005 \cdot 6.7365} = 45620.085 \text{ mg/L}$$

$$\textcircled{3} \frac{P - P_0}{P_{ss} - P_0} = 0.95 \Rightarrow P - P_0 = 0.95 P_{ss} - 0.95 P_0 \Rightarrow P = 0.95 P_{ss} + 0.05 P_0$$

$$P = P_0 \cdot e^{-\left(\frac{1}{z} + k_d\right)t} \dots \Rightarrow 0.05 = e^{-\left(\frac{1}{6.7 \cdot 365} + 0.005\right) \cdot t_{95}} \Rightarrow t_{95} = 1.5 \text{ y}$$

$$\textcircled{3} P_{in}^{\text{new}} = 0.5 P_{in}$$

$$P_{ss} = \frac{0.5 \cdot 1.13}{1 + 0.005 \cdot 6.7 \cdot 365} = 0.043 \text{ mg/L}$$

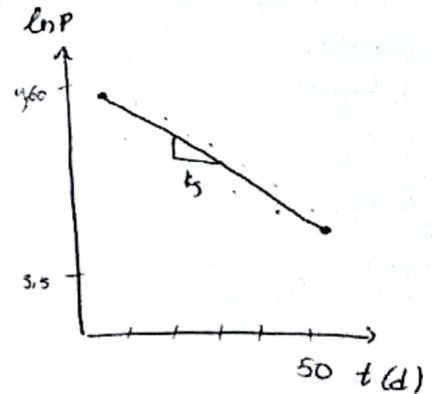
Σεπτεμβρίου 2021 (2)
 Ιανουαρίου 2019 (3)
 Ιανουαρίου 2021 (2)
 Σεπτεμβρίου 2020 (1)

"Ανδραγωγεία"

$H = 5,5 \text{ m}$

$k_d (\text{m/d}) =$

Ιαύλαση Η/εφα	$P (\mu\text{g/L})$	$\ln P$
250 (1)	97	4,58
254 (2)	90	4,50
264 (3)	86	4,45
270 (4)	72	4,28
275 (25)	51	3,93
280 (30)	57	4,04
290 (40)	62	4,13
295 (45)	55	4,01
300 (50)	46	3,83



Batch : $Q_{in} = Q_{out} = Q$
 ΠΑΡΟΥΣΙΑ ΑΡΑΓΜΕΝΟΥ $\left. \begin{array}{l} \Rightarrow \ln \frac{dP}{dt} = -k_s \cdot P \Rightarrow \frac{dP}{dt} = -k_s P \end{array} \right\}$

$$\Rightarrow \frac{1}{P} dP = -k_s dt \Rightarrow \int \frac{1}{P} dP = -k_s dt \Rightarrow \ln P - \ln P_0 = -k_s \cdot t$$

$$\Rightarrow k_s = \frac{\ln P_0 - \ln P}{t} = \frac{4,58 - 3,83}{50} = 0,015 / \text{d}$$

$$k_s' = H \cdot k_s = 0,015 \cdot 5,5 = 0,08 \text{ m/d}$$

$$Q_{in} = Q_{out} = 30 \text{ m}^3/\text{d}$$

$$C_{in} = 0 \text{ mg/L}$$

$$\tau = 10 \text{ d}$$

$$k_d = 0,2/\text{d}$$

1. Ισοδυναμία Μαζών, Αναζωογόνηση, SS, καθαρισμός

$$\frac{dC}{dt} = Q_{in} C_{in} + Q_B C_B - Q_{out} C - k_d \cdot C \cdot V \quad \dot{V}, C = \frac{V}{Q}$$

$$\frac{dC}{dt} = \frac{Q_B \cdot C_B}{V} - \frac{C}{\tau} - k_d \cdot C \Rightarrow \frac{dC}{dt} = \frac{Q_B \cdot C_B}{V} - C \left(\frac{1}{\tau} + k_d \right)$$

$$\frac{dC}{dt} + C \left(\frac{1}{\tau} + k_d \right) = \frac{Q_B \cdot C_B}{V}$$

Γραμμική Εξίσωση 1ης τάξης μες μορφής: $y' + P(x) \cdot y = q(x)$

$$\text{Αναζωογόνηση Μάζας: } X = y_0 \cdot e^{-P(x)} + e^{-P(x)} \int e^{P(x)} \cdot q(x) dx$$

$$\text{Οπου: } P(t) = \int p(t) dt \Rightarrow P(x) = \frac{1}{\tau} + k_d \Rightarrow P(t) = \int \left(\frac{1}{\tau} + k_d \right) dt = \left(\frac{1}{\tau} + k_d \right) \cdot t$$

$$q(t) = \frac{Q_B \cdot C_B}{V}$$

$$\text{Αναζωογόνηση και Ολοκλήρωση: } C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_d\right)t} + e^{-\left(\frac{1}{\tau} + k_d\right)t} \int_0^t \left(e^{\left(\frac{1}{\tau} + k_d\right)t} \cdot \frac{Q_B \cdot C_B}{V} \right) dt \Rightarrow$$

$$\Rightarrow C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_d\right)t} + \frac{Q_B \cdot C_B}{V} \cdot \frac{1}{\frac{1}{\tau} + k_d} \cdot e^{-\left(\frac{1}{\tau} + k_d\right)t} \cdot \left[e^{\left(\frac{1}{\tau} + k_d\right)t} \right]_0^t \Rightarrow$$

$$C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_d\right)t} + \frac{Q_B \cdot C_B}{Q + k_d \cdot V} \left(e^{\left(\frac{1}{\tau} + k_d\right)t} - 1 \right) \Rightarrow C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_d\right)t} + \frac{Q_B \cdot C_B}{Q + k_d \cdot V} \left(1 - e^{-\left(\frac{1}{\tau} + k_d\right)t} \right)$$

2. Υπολογισμός συγκέντρωσης οργανικής ουσίας $t = 5 \text{ d}$

$$C = \frac{M}{V} = \frac{500 \text{ kg}}{300 \cdot 10^3 \text{ L}} = 1,67 \cdot 10^3 \text{ mg/L}$$

$$\tau = \frac{V}{Q} \Rightarrow V = \tau \cdot Q = 10 \text{ d} \cdot 30 \frac{\text{m}^3}{\text{d}} = 300 \text{ m}^3 = 300 \cdot 10^3 \text{ L}$$

$$\left. \begin{array}{l} Q_{in} + Q_B = Q_{out} \Rightarrow Q_B = 0 \\ \text{Αρα } C_B = C_0 \end{array} \right\}$$

$$C = 1,67 \cdot 10^3 \cdot e^{-\left(\frac{1}{10} + 0,2\right) \cdot 5} = 372,63 \text{ mg/L}$$

3. Σε ποιο χρόνο θα μειωθεί σε 50 mg/L;

$$C = C_0 \cdot e^{-\left(\frac{1}{\tau} + k_d\right)t} \Rightarrow \frac{C}{C_0} = e^{-\left(\frac{1}{\tau} + k_d\right)t} \Rightarrow \ln C - \ln C_0 = -\left(\frac{1}{\tau} + k_d\right)t \Rightarrow \frac{\ln C_0 - \ln C}{\left(\frac{1}{\tau} + k_d\right)} = t$$

$$\Rightarrow t = \frac{\ln 1,67 \cdot 10^3 - \ln 50}{\frac{1}{10} + 0,2} = 11,70 \Rightarrow t \approx 12 \text{ d}$$

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Ιανουάριος 2021 Μαρέττα (2)

$$Q_A = 2 \cdot 10^6 \text{ m}^3/\text{y}$$

$$C_Z = 500 \text{ mg/L CE}$$

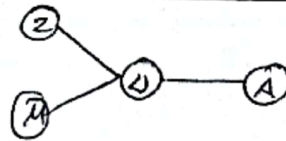
$$C_M = 10 \text{ mg/L CE}$$

$$C_A \leq 70 \text{ mg/L CE}$$

1. Υδρολογικό Ισοδύναμο

Είσοδες: Ζαφίριος + Μελωνιάνα

Εξοδός: αέρωση



2. Ισοδύναμο Μάζας χημικών ουσιών

$$\frac{dC}{dt} = Q_Z \cdot C_Z + Q_M \cdot C_M - Q_A \cdot C_A - k \cdot C \cdot V$$

3. Μέγιστος Ρυθμός αναρρίξεως

$$C_{SS} = \frac{M_Z}{\frac{1}{k} + t_d}, \quad C_{SS} = \frac{M_M}{\frac{1}{k} + t_d}$$

$$\frac{Q_M}{Q_Z} = ;$$

Ιανουάριος 2020 2. (2) "Γενοκαταστροφή"

Ιανουάριος 2021 2(2) (1) "Ασχημά με φωτογραφικό σε αέριο"

$$V = 10^6 \text{ m}^3$$

$$t = 0,25 \text{ y}$$

$$k = 0,01/\text{d}$$

$$V_B = 10 \text{ m}^3$$

$$C_{\text{φορ}} = 500 \text{ kg/m}^3$$

1. Ισοδύναμο μάζας, Αναρρίξεση αέριου

$$\frac{dC}{dt} = Q \cdot C_{\text{in}} - Q \cdot C - k \cdot V \cdot C \Rightarrow \frac{dC}{dt} = \frac{Q_{\text{in}}}{V} - \frac{C}{t} - kC \Rightarrow \frac{dC}{C} = \left(\frac{1}{t} + k \right) dt$$

$$\int_0^C \frac{1}{C} dC = \int_0^t \left(\frac{1}{t} + k \right) dt \Rightarrow C = C_0 \cdot e^{-(\frac{1}{t} + k)t}$$

2. Max συγκέντρωση φωτογραφικού

$$M_{\text{φορ}} = V_B \cdot C_{\text{φορ}} = 10 \text{ m}^3 \cdot 500 \frac{\text{kg}}{\text{m}^3} \Rightarrow M_{\text{φορ}} = 5.000 \text{ kg}$$

Επομένως η μέγιστη συγκέντρωση φωτογραφικού είναι εκεί που γίνεται το αέριο

$$C_{\text{max}} = C_0 = \frac{M}{V} = \frac{5.000 \text{ kg}}{10^6 \text{ m}^3} \cdot \frac{10^6 \text{ mg}}{1 \text{ kg}} \Rightarrow C_{\text{max}} = 5 \text{ mg/L}$$

3. Ρυθμός μείωσης συγκέντρωσης για καλές διαβρώσεις

Αποδόμηση $\frac{dC}{dt} = -k \cdot C$, όπου $k = 0,01/\text{d} \cdot 365 \text{ d/y} = 3,65/\text{y}$, Άρα $\frac{dC}{dt} = -3,65 \cdot C \left(\frac{\text{mg}}{\text{L} \cdot \text{y}} \right) = -18,25 \frac{\text{mg}}{\text{L} \cdot \text{y}}$

Γενίωση $\frac{dC}{dt} = -\frac{1}{t} \cdot C \Rightarrow \frac{dC}{dt} = -\frac{1}{0,25} \cdot C \Rightarrow \frac{dC}{dt} = -4 \left(\frac{\text{mg}}{\text{L} \cdot \text{y}} \right) \Rightarrow \frac{dC}{dt} \Big|_{\text{max}} = -4 \cdot 5 = -20 \frac{\text{mg}}{\text{L} \cdot \text{y}}$

Μεγαλύτερο ρυθμό μείωσης έχει το γενίωμα

Σε novo xporo $C \leq 0,1 \text{ mg/L}$

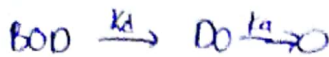
$$t = \frac{\ln(-\ln C)}{-(\frac{1}{t} + k)} = \frac{\ln 0,01 - \ln 15}{-(\frac{1}{0,25 \times 5} + 0,01)} = 0,98 \text{ y} \cdot \cdot \cdot$$

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Javara

2εεεεεεεεεε 2020, Javaraεεεεεεεεεε 2015 BOD DO εεεεεεεεεε (εεεεεεεεεε)

A)



$$k_r = k_d + k_s$$

↓ k_s

Ifn/εε

$$\text{BOD} \div \frac{dV_L}{dt} = -k_r \cdot V_L \Rightarrow$$

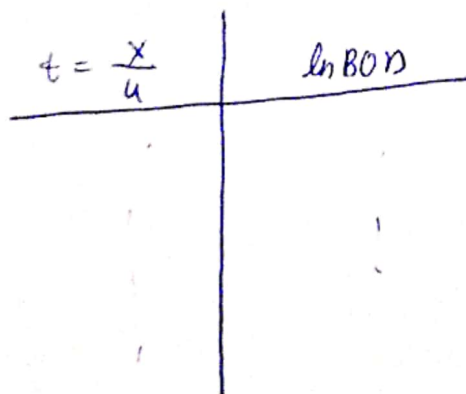
$$\frac{dL}{dt} = -k_r L \Rightarrow$$

$$\begin{aligned} \blacktriangleright \ln L - \ln L_0 &= -k_r \cdot t \Rightarrow \ln L = \ln L_0 - k_r \cdot t \\ &\Rightarrow L = L_0 \cdot e^{-k_r \cdot t} \end{aligned}$$

$$\blacktriangleright \frac{dD}{dt} = -u \frac{dD}{dx} - k_a D + k_d L \xrightarrow{\text{S.S}} \frac{dD}{dx} + \frac{k_a}{u} \cdot D = \frac{k_d}{u} \cdot L_0 \cdot e^{-k_r \cdot t}$$

B) $k_d = ;$

$$u = 0,3 \text{ m/s} = 0,3 \cdot 10^{-3} \text{ km/s}$$



$$-k_d = \frac{\ln L - \ln L_0}{t}$$

$$k_d = \frac{\ln L_0 - \ln L}{t} = \frac{\text{12,9 BOD} - \text{2,9 BOD}}{\text{14,5 m} - 0}$$

$$\text{r)} \quad k_d = \frac{12,9 - 2,9}{14,5} = 0,69$$

avasthaponu

Januaris 2022

$$\text{100400} \text{ (1)} C = C_0 \cdot e^{-(\frac{1}{t} + kd)t} + \frac{Q_0 \cdot C_0}{Q + kd \cdot V} (1 - e^{-(\frac{1}{t} + kd)t})$$

$$\text{(2)} C_{max} = ;$$

$$C = \frac{M}{V} = \frac{1000 \text{ kg}}{20.000 \text{ m}^3} \cdot \frac{10^6 \text{ mg}}{1 \text{ kg}} \cdot \frac{1 \text{ m}^3}{10^3 \text{ L}} = 50 \text{ mg/L} \quad \text{(3)} t=5d \rightarrow C = 50 e^{-(\frac{1}{10} + 0,1)5} = 18,4 \text{ mg/L}$$

$$z = \frac{V}{Q} = \frac{20.000 \text{ m}^3}{2.000 \frac{\text{m}^3}{d}} = 10d$$

$$\text{(4)} 0,1 = 50 \cdot e^{-(\frac{1}{10} + 0,1)t} \Rightarrow \frac{\ln 50 - \ln 0,1}{0,2} = t \Rightarrow t = 31,07d \Rightarrow t \approx 31d$$

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① Ioddyio Matas kai avasthaponu Aion

$$\frac{dV_L}{dt} = -kd \cdot V_L$$

$$D = D_0 \cdot e^{-kd \cdot t} + \frac{kd \cdot L_0}{La - kd} \cdot [e^{-kd \frac{x}{u}} - e^{-ka \frac{x}{u}}]$$

$$\frac{dD}{dt} = -u \frac{dD}{dx} - ka D + kd \cdot L$$

$$L = L_0 \cdot e^{-kd \frac{x}{u}}$$

② BOD au A, B, r

$$A \rightarrow L_0 = \frac{2 \cdot 10 + 25 \cdot 9}{12} = 5,8 \text{ mg/L}$$

$$L = L_0 \cdot e^{-kd \frac{x}{u}}$$

$$L_0 x = 5.000m \quad u = 0,1 \frac{m}{s} \cdot \frac{60s}{1min} \cdot \frac{60min}{1h} \cdot \frac{24h}{1d} = 8640m/d$$

$$B \rightarrow L_0 = \frac{5,47 \cdot 12 + 25 \cdot 4}{16} = 10,25 \text{ mg/L}$$

$$r \rightarrow L_0 = \frac{10,4 - 10,4 \cdot e^{-0,1 \cdot \frac{5000}{8640}}}{0,1} = 9,46 \text{ mg/L}$$

Φορτίο 1		Φορτίο 2	
Q1 = 2.000 m³/d	A	Q2 = 4.000 m³/d	B
BOD1 = 25 mg/L		BOD1 = 25 mg/L	
D01 = 5 mg/L		D01 = 5 mg/L	
Q = 10.000 m³/d		kd = 0,1 /d	
BOD = 2 mg/L		La = 0,2 /d	
D0 = 10 mg/L		U = 0,1 m/s	

$$L = 5,8 \cdot e^{-0,1 \cdot \frac{5000}{8640}} = 5,47 \text{ mg/L} \quad Q = 12.000 \text{ m}^3/d$$