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Design of an Anaerobic Digester Formulas

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List of 20 Design of an Anaerobic Digester Formulas

Design of an Anaerobic Digester

1) BOD in given Percent Stabilization

Open Calculator

fx $$\mathrm{BOD_{in}} = \frac{\mathrm{BOD_{out}} \cdot 100 + 142 \cdot \mathrm{P_x}}{100 - \%\mathrm{S}}$$

ex $$163.8777\mathrm{kg/d} = \frac{4.9\mathrm{kg/d} \cdot 100 + 142 \cdot 100\mathrm{kg/d}}{100 - 10.36}$$

2) BOD in given Quantity of Volatile Solids

Open Calculator

fx $$\mathrm{BOD_{in}} = \left(\frac{\mathrm{P_x}}{\mathrm{Y}}\right) \cdot (1 - \mathrm{k_d} \cdot \theta_c) + \mathrm{BOD_{out}}$$

ex $$163.9244\mathrm{kg/d} = \left(\frac{100\mathrm{kg/d}}{0.41}\right) \cdot (1 - 0.05\mathrm{d^{-1}} \cdot 6.96\mathrm{d}) + 4.9\mathrm{kg/d}$$

3) BOD in given Volume of Methane Gas Produced

Open Calculator

fx $$\mathrm{BOD_{in}} = \left(\frac{\mathrm{V_{CH4}}}{5.62}\right) + \mathrm{BOD_{out}} + (1.42 \cdot \mathrm{P_x})$$

ex $$163.9\mathrm{kg/d} = \left(\frac{95.54\mathrm{m^3/d}}{5.62}\right) + 4.9\mathrm{kg/d} + (1.42 \cdot 100\mathrm{kg/d})$$

4) BOD Out given Percent Stabilization

Open Calculator

$$BOD_{out} = \frac{BOD_{in} \cdot 100 - 142 \cdot P_x - \%S \cdot BOD_{in}}{100}$$

ex $$5.0096\text{kg/d} = \frac{164\text{kg/d} \cdot 100 - 142 \cdot 100\text{kg/d} - 10.36 \cdot 164\text{kg/d}}{100}$$

5) BOD Out given Quantity of Volatile Solids

Open Calculator

$$BOD_{out} = BOD_{in} - \left(\frac{P_x}{Y}\right) \cdot (1 - k_d \cdot \theta_c)$$

ex $$4.97561\text{kg/d} = 164\text{kg/d} - \left(\frac{100\text{kg/d}}{0.41}\right) \cdot (1 - 0.05\text{d}^{-1} \cdot 6.96\text{d})$$

6) BOD Out given Volume of Methane Gas Produced

Open Calculator

$$BOD_{out} = \left(BOD_{in} - \left(\frac{V_{CH4}}{5.62}\right) - (1.42 \cdot P_x)\right)$$

ex $$5\text{kg/d} = \left(164\text{kg/d} - \left(\frac{95.54\text{m}^3\text{/d}}{5.62}\right) - (1.42 \cdot 100\text{kg/d})\right)$$

7) BOD Per Day given Volumetric Loading in Anaerobic Digester

Open Calculator

$$BOD_{day} = (V_l \cdot V)$$

ex $$10.368\text{kg/d} = (0.000024\text{kg/m}^3 \cdot 5\text{m}^3\text{/s})$$

8) Endogenous Coefficient given Quantity of Volatile Solids

Open Calculator

$$k_d = \left(\frac{1}{\theta_c}\right) - \left(Y \cdot \frac{BOD_{in} - BOD_{out}}{P_x \cdot \theta_c}\right)$$

$$0.049955\text{d}^{-1} = \left(\frac{1}{6.96\text{d}}\right) - \left(0.41 \cdot \frac{164\text{kg/d} - 4.9\text{kg/d}}{100\text{kg/d} \cdot 6.96\text{d}}\right)$$

9) Hydraulic Retention Time given Volume Required for Anaerobic Digester

Open Calculator

$$\theta_s = \left(\frac{V_T}{Q_s}\right)$$

$$14400\text{s} = \left(\frac{28800\text{m}^3}{2\text{m}^3/\text{s}}\right)$$

10) Influent Sludge Flow Rate given Volume Required for Anaerobic Digester

Open Calculator

$$Q_s = \left(\frac{V_T}{\theta}\right)$$

$$2\text{m}^3/\text{s} = \left(\frac{28800\text{m}^3}{4\text{h}}\right)$$

11) Mean Cell Residence Time given Quantity of Volatile Solids

Open Calculator

$$\theta_c = \left(\frac{1}{k_d}\right) - \left(Y \cdot \frac{BOD_{in} - BOD_{out}}{P_x \cdot k_d}\right)$$

$$6.9538\text{d} = \left(\frac{1}{0.05\text{d}^{-1}}\right) - \left(0.41 \cdot \frac{164\text{kg/d} - 4.9\text{kg/d}}{100\text{kg/d} \cdot 0.05\text{d}^{-1}}\right)$$

12) Percent Stabilization

Open Calculator

$$\%S = \left(\frac{BOD_{in} - BOD_{out} - 1.42 \cdot P_x}{BOD_{in}}\right) \cdot 100$$

$$10.42683 = \left(\frac{164\text{kg/d} - 4.9\text{kg/d} - 1.42 \cdot 100\text{kg/d}}{164\text{kg/d}}\right) \cdot 100$$

13) Quantity of Volatile Solids Produced Each Day

Open Calculator

$$P_x = \frac{Y \cdot (BOD_{in} - BOD_{out})}{1 - k_d \cdot \theta_c}$$

$$100.0475\text{kg/d} = \frac{0.41 \cdot (164\text{kg/d} - 4.9\text{kg/d})}{1 - 0.05\text{d}^{-1} \cdot 6.96\text{d}}$$

14) Volatile Solids produced given Percent Stabilization

Open Calculator

$$P_x = \left(\frac{1}{1.42}\right) \cdot \left(BOD_{in} - BOD_{out} - \left(\frac{\%S \cdot BOD_{in}}{100}\right)\right)$$

ex

$$100.0772\text{kg/d} = \left(\frac{1}{1.42}\right) \cdot \left(164\text{kg/d} - 4.9\text{kg/d} - \left(\frac{10.36 \cdot 164\text{kg/d}}{100}\right)\right)$$

15) Volatile Solids produced given Volume of Methane Gas produced

Open Calculator

$$P_x = \left(\frac{1}{1.42}\right) \cdot \left(BOD_{in} - BOD_{out} - \left(\frac{V_{CH4}}{5.62}\right)\right)$$

ex $$100.0704\text{kg/d} = \left(\frac{1}{1.42}\right) \cdot \left(164\text{kg/d} - 4.9\text{kg/d} - \left(\frac{95.54\text{m}^3\text{/d}}{5.62}\right)\right)$$

16) Volume of Methane Gas Produced at Standard Conditions

Open Calculator

$$V_{CH4} = 5.62 \cdot (BOD_{in} - BOD_{out} - 1.42 \cdot P_x)$$

ex $$96.102\text{m}^3\text{/d} = 5.62 \cdot (164\text{kg/d} - 4.9\text{kg/d} - 1.42 \cdot 100\text{kg/d})$$

17) Volume Required for Anaerobic Digester

Open Calculator

$$V_T = (\theta \cdot Q_s)$$

ex $$28800\text{m}^3 = (4\text{h} \cdot 2\text{m}^3\text{/s})$$

18) Volumetric Flow Rate given Volumetric Loading in Anaerobic Digester

Open Calculator

fx $$V = \left(\frac{BOD_{day}}{V_l} \right)$$

ex $$4.822531 m^3/s = \left(\frac{10 kg/d}{0.000024 kg/m^3} \right)$$

19) Volumetric Loading in Anaerobic Digester

Open Calculator

fx $$V_l = \left(\frac{BOD_{day}}{V} \right)$$

ex $$2.3E\hat{}\text{-}5 kg/m^3 = \left(\frac{10 kg/d}{5 m^3/s} \right)$$

20) Yield Coefficient given Quantity of Volatile Solids

Open Calculator

fx $$Y = \frac{P_x \cdot (1 - \theta_c \cdot k_d)}{BOD_{in} - BOD_{out}}$$

ex $$0.409805 = \frac{100 kg/d \cdot (1 - 6.96 d \cdot 0.05 d^{-1})}{164 kg/d - 4.9 kg/d}$$

Variables Used

- **%S** Percent Stabilization
- **BOD_{day}** BOD per Day *(Kilogram per Day)*
- **BOD_{in}** BOD In *(Kilogram per Day)*
- **BOD_{out}** BOD Out *(Kilogram per Day)*
- **k_d** Endogenous Coefficient *(1 Per Day)*
- **P_x** Volatile Solids Produced *(Kilogram per Day)*
- **Q_s** Influent Sludge Flow Rate *(Cubic Meter per Second)*
- **V** Volumetric Flow Rate *(Cubic Meter per Second)*
- **V_{CH4}** Volume of Methane *(Cubic Meter per Day)*
- **V_l** Volumetric Loading *(Kilogram per Cubic Meter)*
- **V_T** Volume *(Cubic Meter)*
- **Y** Yield Coefficient
- **θ** Hydraulic Retention Time *(Hour)*
- **θ_c** Mean Cell Residence Time *(Day)*
- **θ_s** Hydraulic Retention Time in Seconds *(Second)*

Constants, Functions, Measurements used

- Measurement: **Time** in Day (d), Second (s), Hour (h)
  Time Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Day (m^3/d), Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Day (kg/d)
  Mass Flow Rate Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion
- Measurement: **First Order Reaction Rate Constant** in 1 Per Day (d^{-1})
  First Order Reaction Rate Constant Unit Conversion

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