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Design of an Aerobic Digester Formulas

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List of 15 Design of an Aerobic Digester Formulas

Design of an Aerobic Digester

1) Density of Air given Volume of Air Required

Open Calculator

fx $$\rho = \frac{W_{O2}}{V_{air} \cdot 0.232}$$

ex $$7183.908\text{kg/m}^3 = \frac{5\text{kg}}{0.003\text{m}^3 \cdot 0.232}$$

2) Density of Water given Volume of Digested Sludge

Open Calculator

fx $$\rho_{water} = \frac{W_s}{V_s \cdot G_s \cdot \%s}$$

ex $$1000\text{kg/m}^3 = \frac{20\text{kg}}{10.0\text{m}^3 \cdot 0.01 \cdot 0.20}$$

3) Digester Total Suspended Solids given Volume of Aerobic Digester

Open Calculator

fx $$X = \frac{Q_i \cdot X_i}{V_{ad} \cdot (K_d \cdot P_v + \theta)}$$

ex $$0.014468\text{mg/L} = \frac{5.0\text{m}^3/\text{s} \cdot 5000.2\text{mg/L}}{10\text{m}^3 \cdot (0.05\text{d}^{-1} \cdot 0.5 + 2.0\text{d})}$$

4) Initial Weight of Oxygen given Weight of Oxygen Required

Open Calculator

fx $$W_i = \frac{W_{O2} \cdot VSS_w}{VSS \cdot 2.3}$$

ex $$3.84058\text{kg} = \frac{5\text{kg} \cdot 5.3\text{kg/d}}{3\text{kg/d} \cdot 2.3}$$

5) Percent Solids given Volume of Digested Sludge

Open Calculator

fx $$\%s = \frac{W_s}{V_s \cdot \rho_{water} \cdot G_s}$$

ex $$0.2 = \frac{20\text{kg}}{10.0\text{m}^3 \cdot 1000\text{kg/m}^3 \cdot 0.01}$$

6) Solids Retention Time given Volume of Aerobic Digester

Open Calculator

fx $$\theta = \left(\frac{Q_i \cdot X_i}{V_{ad} \cdot X} - (K_d \cdot P_v) \right)$$

ex $$2.066882\text{d} = \left(\frac{5.0\text{m}^3\text{/s} \cdot 5000.2\text{mg/L}}{10\text{m}^3 \cdot 0.014\text{mg/L}} - (0.05\text{d}^{-1} \cdot 0.5) \right)$$

7) Specific Gravity of Digested Sludge given Volume of Digested Sludge

Open Calculator

$$G_s = \frac{W_s}{\rho_{water} \cdot V_s \cdot \%s}$$

$$0.01 = \frac{20\text{kg}}{1000\text{kg/m}^3 \cdot 10.0\text{m}^3 \cdot 0.20}$$

8) Volume of Aerobic Digester

Open Calculator

$$V_{ad} = \frac{Q_i \cdot X_i}{X \cdot ((K_d \cdot P_v) + \theta)}$$

$$10.33441\text{m}^3 = \frac{5.0\text{m}^3/\text{s} \cdot 5000.2\text{mg/L}}{0.014\text{mg/L} \cdot ((0.05\text{d}^{-1} \cdot 0.5) + 2.0\text{d})}$$

9) Volume of Air Required at Standard Conditions

Open Calculator

$$V_{air} = \frac{W_{O2}}{\rho \cdot 0.232}$$

$$0.003\text{m}^3 = \frac{5\text{kg}}{7183.90\text{kg/m}^3 \cdot 0.232}$$

10) Volume of Digested Sludge

Open Calculator

fx $$V_s = \frac{W_s}{\rho_{water} \cdot G_s \cdot \%s}$$

ex $$10m^3 = \frac{20kg}{1000kg/m^3 \cdot 0.01 \cdot 0.20}$$

11) VSS as Mass Flow Rate given Weight of Oxygen Required

Open Calculator

fx $$VSS = \frac{W_{O2} \cdot VSS_w}{2.3 \cdot W_i}$$

ex $$3.000453kg/d = \frac{5kg \cdot 5.3kg/d}{2.3 \cdot 3.84kg}$$

12) Weight of Oxygen given Volume of Air

Open Calculator

fx $$W_{O2} = (V_{air} \cdot \rho \cdot 0.232)$$

ex $$4.999994kg = (0.003m^3 \cdot 7183.90kg/m^3 \cdot 0.232)$$

13) Weight of Oxygen Required to Destroy VSS

Open Calculator

fx $$W_{O2} = \frac{VSS \cdot 2.3 \cdot W_i}{VSS_w}$$

ex $$4.999245kg = \frac{3kg/d \cdot 2.3 \cdot 3.84kg}{5.3kg/d}$$

14) Weight of Sludge given Volume of Digested Sludge

Open Calculator

fx $$W_s = (\rho_{water} \cdot V_s \cdot G_s \cdot \%s)$$

ex $$20kg = (1000kg/m^3 \cdot 10.0m^3 \cdot 0.01 \cdot 0.20)$$

15) Weight of VSS given Weight of Oxygen Required

Open Calculator

fx $$VSS_w = \frac{VSS \cdot 2.3 \cdot W_i}{W_{O2}}$$

ex $$5.2992kg/d = \frac{3kg/d \cdot 2.3 \cdot 3.84kg}{5kg}$$

Variables Used

- **%s** Percent Solids
- G_s Specific Gravity of Sludge
- K_d Reaction Rate Constant *(1 Per Day)*
- P_v Volatile Fraction
- Q_i Influent Average Flow Rate *(Cubic Meter per Second)*
- V_{ad} Volume of Aerobic Digester *(Cubic Meter)*
- V_{air} Volume of Air *(Cubic Meter)*
- V_s Sludge Volume *(Cubic Meter)*
- **VSS** Volume of Suspended Solid *(Kilogram per Day)*
- VSS_w Volatile Suspended Solid Weight *(Kilogram per Day)*
- W_i Weight of Initial Oxygen *(Kilogram)*
- W_{O2} Weight of Oxygen *(Kilogram)*
- W_s Weight of Sludge *(Kilogram)*
- **X** Digester Total Suspended Solids *(Milligram per Liter)*
- X_i Influent Suspended Solids *(Milligram per Liter)*
- **θ** Solids Retention Time *(Day)*
- **ρ** Density of Air *(Kilogram per Cubic Meter)*
- ρ_{water} Water Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Day (d)
  Time Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Volumetric Flow Rate** in 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), Milligram per Liter (mg/L)
  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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- **Design of a Circular Settling Tank Formulas**
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