# Important Design of an Anaerobic Digester Formulas PDF

Formulas
Examples
with Units

## List of 20
### Important Design of an Anaerobic Digester Formulas

### 1) BOD in given Percent Stabilization Formula

Evaluate Formula

Formula

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

Example with Units

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

### 2) BOD in given Quantity of Volatile Solids Formula

Evaluate Formula

Formula

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

Example with Units

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

### 3) BOD in given Volume of Methane Gas Produced Formula

Evaluate Formula

Formula

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

Example with Units

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

### 4) BOD Out given Percent Stabilization Formula

Evaluate Formula

Formula

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

Example with Units

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

## 5) BOD Out given Quantity of Volatile Solids Formula

Evaluate Formula

Formula

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

Example with Units

$$4.9756\,\text{kg/d} = 164\,\text{kg/d} - \left(\frac{100\,\text{kg/d}}{0.41}\right) \cdot \left(1 - 0.05\,\text{d}^{-1} \cdot 6.96\,\text{d}\right)$$

## 6) BOD Out given Volume of Methane Gas Produced Formula

Evaluate Formula

Formula

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

Example with Units

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

## 7) BOD Per Day given Volumetric Loading in Anaerobic Digester Formula

Evaluate Formula

Formula

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

Example with Units

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

## 8) Endogenous Coefficient given Quantity of Volatile Solids Formula

Evaluate Formula

Formula

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

Example with Units

$$0.05\,\text{d}^{-1} = \left(\frac{1}{6.96\,\text{d}}\right) - \left(0.41 \cdot \frac{164\,\text{kg/d} - 4.9\,\text{kg/d}}{100\,\text{kg/d} \cdot 6.96\,\text{d}}\right)$$

## 9) Hydraulic Retention Time given Volume Required for Anaerobic Digester Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

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

## 11) Mean Cell Residence Time given Quantity of Volatile Solids Formula

Evaluate Formula

Formula

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

Example with Units

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

## 12) Percent Stabilization Formula

Evaluate Formula

Formula

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

Example with Units

$$10.4268 = \left(\frac{164\,\text{kg/d} - 4.9\,\text{kg/d} - 1.42 \cdot 100\,\text{kg/d}}{164\,\text{kg/d}}\right) \cdot 100$$

## 13) Quantity of Volatile Solids Produced Each Day Formula

Evaluate Formula

Formula

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

Example with Units

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

## 14) Volatile Solids produced given Percent Stabilization Formula

Evaluate Formula

Formula

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

Example with Units

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

## 15) Volatile Solids produced given Volume of Methane Gas produced Formula

Evaluate Formula

Formula

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

Example with Units

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

## 16) Volume of Methane Gas Produced at Standard Conditions Formula

Evaluate Formula

Formula

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

Example with Units

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

## 17) Volume Required for Anaerobic Digester Formula

Evaluate Formula

Formula

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

Example with Units

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

## 18) Volumetric Flow Rate given Volumetric Loading in Anaerobic Digester Formula

Evaluate Formula

Formula

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

Example with Units

$$4.8225\,\text{m}^3\text{/s} = \left(\frac{10\,\text{kg/d}}{0.000024\,\text{kg/m}^3}\right)$$

## 19) Volumetric Loading in Anaerobic Digester Formula

Evaluate Formula

Formula

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

Example with Units

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

## 20) Yield Coefficient given Quantity of Volatile Solids Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4098 = \frac{100\,\text{kg/d} \cdot \left(1 - 6.96\,\text{d} \cdot 0.05\,\text{d}^{-1}\right)}{164\,\text{kg/d} - 4.9\,\text{kg/d}}$$

## Variables used in list of Design of an Anaerobic Digester Formulas above

- **%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)*
- **$Q_s$** 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)*
- **$V_T$** Volume *(Cubic Meter)*
- **Y** Yield Coefficient
- **θ** Hydraulic Retention Time *(Hour)*
- **$θ_c$** Mean Cell Residence Time *(Day)*
- **$θ_h$** Hydraulic Retention *(Second)*

## Constants, Functions, Measurements used in list of Design of an Anaerobic Digester Formulas above

- 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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