Important Design of Agitation System Components Formulas PDF

Formulas
Examples
with Units

List of 18
Important Design of Agitation System Components Formulas

1) Critical Speed for Each Deflection Formula

Evaluate Formula

Formula

$$N_c = \frac{946}{\sqrt{\delta_s}}$$

Example with Units

$$13378.4603\,\text{rev/min} = \frac{946}{\sqrt{0.005\,\text{mm}}}$$

2) Diameter of Hollow Shaft Subjected to Maximum Bending Moment Formula

Evaluate Formula

Formula

$$d_o = \left(\frac{M_m}{\left(\frac{\pi}{32}\right) \cdot \left(f_b\right) \cdot \left(1 - k^2\right)} \right)^{\frac{1}{3}}$$

Example with Units

$$18.4103\,\text{mm} = \left(\frac{34000\,\text{N*mm}}{\left(\frac{3.1416}{32}\right) \cdot \left(200\,\text{N/mm}^2\right) \cdot \left(1 - 0.85^2\right)} \right)^{\frac{1}{3}}$$

3) Diameter of Solid Shaft based on Equivalent Bending Moment Formula

Evaluate Formula

Formula

$$d_{solidshaft} = \left(M_e \cdot \frac{32}{\pi} \cdot \frac{1}{f_b} \right)^{\frac{1}{3}}$$

Example with Units

$$6.3384\,\text{mm} = \left(5000\,\text{N*mm} \cdot \frac{32}{3.1416} \cdot \frac{1}{200\,\text{N/mm}^2} \right)^{\frac{1}{3}}$$

4) Diameter of Solid Shaft based on Equivalent Twisting Moment Formula

Evaluate Formula

Formula

$$\text{Diameter}_{\text{solidshaft}} = \left(T_e \cdot \frac{16}{\pi} \cdot \frac{1}{f_s} \right)^{\frac{1}{3}}$$

Example with Units

$$21.5501\,\text{mm} = \left(900000\,\text{N*mm} \cdot \frac{16}{3.1416} \cdot \frac{1}{458\,\text{N/mm}^2} \right)^{\frac{1}{3}}$$

5) Diameter of Solid Shaft Subjected to Maximum Bending Moment Formula

Evaluate Formula

Formula

$$d_{\text{solidshaft}} = \left(\frac{M_{\text{solidshaft}}}{\left(\frac{\pi}{32} \right) \cdot f_b} \right)^{\frac{1}{3}}$$

Example with Units

$$5.7331\,\text{mm} = \left(\frac{3700\,\text{N*mm}}{\left(\frac{3.1416}{32} \right) \cdot 200\,\text{N/mm}^2} \right)^{\frac{1}{3}}$$

6) Equivalent Bending Moment for Hollow Shaft Formula

Evaluate Formula

Formula

$$\text{Me}_{\text{hollowshaft}} = \left(\frac{\pi}{32} \right) \cdot \left(f_b \right) \cdot \left(d_o^{\,3} \right) \cdot \left(1 - k^4 \right)$$

Example with Units

$$75083.0827\,\text{N*mm} = \left(\frac{3.1416}{32} \right) \cdot \left(200\,\text{N/mm}^2 \right) \cdot \left(20\,\text{mm}^3 \right) \cdot \left(1 - 0.85^4 \right)$$

7) Equivalent Bending Moment for Solid Shaft Formula

Evaluate Formula

Formula

$$\text{Me}_{\text{solidshaft}} = \left(\frac{1}{2} \right) \cdot \left(M_m + \sqrt{M_m^{\,2} + T_m^{\,2}} \right)$$

Example with Units

$$34160.2914\,\text{N*mm} = \left(\frac{1}{2} \right) \cdot \left(34000\,\text{N*mm} + \sqrt{34000\,\text{N*mm}^2 + 4680\,\text{N*mm}^2} \right)$$

8) Equivalent Twisting Moment for Hollow Shaft Formula

Evaluate Formula

Formula

$$Te_{hollowshaft} = \left(\frac{\pi}{16}\right) \cdot \left(f_b\right) \cdot \left(d_o^{\,3}\right) \cdot \left(1 - k^4\right)$$

Example with Units

$$150166.1653\,\text{N*mm} = \left(\frac{3.1416}{16}\right) \cdot \left(200\,\text{N/mm}^2\right) \cdot \left(20\,\text{mm}^3\right) \cdot \left(1 - 0.85^4\right)$$

9) Equivalent Twisting Moment for Solid Shaft Formula

Evaluate Formula

Formula

$$Te_{solidshaft} = \left(\sqrt{\left(M_m^{\,2}\right) + \left(T_m^{\,2}\right)}\right)$$

Example with Units

$$34320.5827\,\text{N*mm} = \left(\sqrt{\left(34000\,\text{N*mm}^2\right) + \left(4680\,\text{N*mm}^2\right)}\right)$$

10) Force for Design of Shaft Based on Pure Bending Formula

Evaluate Formula

Formula

$$F_m = \frac{T_m}{0.75 \cdot h_m}$$

Example with Units

$$83.3111\,\text{N} = \frac{4680\,\text{N*mm}}{0.75 \cdot 74.9\,\text{mm}}$$

11) Maximum Bending Moment subject to Shaft Formula

Evaluate Formula

Formula

$$M_m = l \cdot F_m$$

Example with Units

$$34000\,\text{N*mm} = 400\,\text{mm} \cdot 85\,\text{N}$$

12) Maximum Deflection due to Each Load Formula

Evaluate Formula

Formula

$$\delta_{Load} = \frac{W \cdot L^3}{\left(3 \cdot E\right) \cdot \left(\frac{\pi}{64}\right) \cdot d^4}$$

Example with Units

$$0.0333\,\text{mm} = \frac{19.8\,\text{N} \cdot 100\,\text{mm}^3}{\left(3 \cdot 195000\,\text{N/mm}^2\right) \cdot \left(\frac{3.1416}{64}\right) \cdot 12\,\text{mm}^4}$$

13) Maximum Deflection due to Shaft with Uniform Weight Formula

Evaluate Formula

Formula

$$\delta_s = \frac{w \cdot L^4}{\left(8 \cdot E\right) \cdot \left(\frac{\pi}{64}\right) \cdot d^4}$$

Example with Units

$$0.0057\,\text{mm} = \frac{90\,\text{N} \cdot 100\,\text{mm}^4}{\left(8 \cdot 195000\,\text{N/mm}^2\right) \cdot \left(\frac{3.1416}{64}\right) \cdot 12\,\text{mm}^4}$$

14) Maximum Torque for Hollow Shaft Formula

Evaluate Formula

Formula

$$Tm_{hollowshaft} = \left(\left(\frac{\pi}{16}\right) \cdot \left(d_o^{\,3}\right) \cdot \left(f_s\right) \cdot \left(1 - k^2\right)\right)$$

Example with Units

$$199640.3592\,\text{N*mm} = \left(\left(\frac{3.1416}{16}\right) \cdot \left(20\,\text{mm}^{\,3}\right) \cdot \left(458\,\text{N/mm²}\right) \cdot \left(1 - 0.85^2\right)\right)$$

15) Maximum Torque for Solid Shaft Formula

Evaluate Formula

Formula

$$Tm_{solidshaft} = \left(\left(\frac{\pi}{16}\right) \cdot \left(d^3\right) \cdot \left(f_s\right)\right)$$

Example with Units

$$155395.739\,\text{N*mm} = \left(\left(\frac{3.1416}{16}\right) \cdot \left(12\,\text{mm}^{\,3}\right) \cdot \left(458\,\text{N/mm²}\right)\right)$$

16) Outside Diameter of Hollow Shaft based on Equivalent Bending Moment Formula

Evaluate Formula

Formula

$$d_{hollowshaft} = \left(\left(M_e\right) \cdot \left(\frac{32}{\pi}\right) \cdot \frac{1}{\left(f_b\right) \cdot \left(1 - k^4\right)}\right)^{\frac{1}{3}}$$

Example with Units

$$8.1066\,\text{mm} = \left(\left(5000\,\text{N*mm}\right) \cdot \left(\frac{32}{3.1416}\right) \cdot \frac{1}{\left(200\,\text{N/mm²}\right) \cdot \left(1 - 0.85^4\right)}\right)^{\frac{1}{3}}$$

17) Outside Diameter of Hollow Shaft based on Equivalent Twisting Moment Formula

Evaluate Formula

Formula

$$d_o = \left(\left(T_e\right) \cdot \left(\frac{16}{\pi}\right) \cdot \frac{1}{\left(f_s\right) \cdot \left(1 - k^4\right)}\right)^{\frac{1}{3}}$$

Example with Units

$$27.5618\,\text{mm} = \left(\left(900000\,\text{N*mm}\right) \cdot \left(\frac{16}{3.1416}\right) \cdot \frac{1}{\left(458\,\text{N/mm²}\right) \cdot \left(1 - 0.85^4\right)}\right)^{\frac{1}{3}}$$

18) Rated Motor Torque Formula

Evaluate Formula

Formula

$$T_r = \left(\frac{P \cdot 4500}{2 \cdot \pi \cdot N} \right)$$

Example with Units

$$2.2E{+}6\,\text{N*mm} = \left(\frac{0.25\,\text{hp} \cdot 4500}{2 \cdot 3.1416 \cdot 575\,\text{rev/min}} \right)$$

Variables used in list of Design of Agitation System Components Formulas above

- **d** Diameter of Shaft for Agitator *(Millimeter)*
- $d_{hollowshaft}$ Diameter of Hollow Shaft for Agitator *(Millimeter)*
- d_o Hollow Shaft Outer Diameter *(Millimeter)*
- $d_{solidshaft}$ Diameter of Solid Shaft for Agitator *(Millimeter)*
- $Diameter_{solidshaft}$ Diameter of Solid Shaft *(Millimeter)*
- **E** Modulus of Elasticity *(Newton per Square Millimeter)*
- f_b Bending Stress *(Newton per Square Millimeter)*
- F_m Force *(Newton)*
- f_s Torsional Shear Stress in Shaft *(Newton per Square Millimeter)*
- h_m Height of Manometer Liquid *(Millimeter)*
- **k** Ratio of Inner to Outer Diameter of Hollow Shaft
- **l** Length of Shaft *(Millimeter)*
- **L** Length *(Millimeter)*
- M_e Equivalent Bending Moment *(Newton Millimeter)*
- M_m Maximum Bending Moment *(Newton Millimeter)*
- $M_{solidshaft}$ Maximum Bending Moment for Solid Shaft *(Newton Millimeter)*
- $Me_{hollowshaft}$ Equivalent Bending Moment for Hollow Shaft *(Newton Millimeter)*
- $Me_{solidshaft}$ Equivalent Bending Moment for Solid Shaft *(Newton Millimeter)*
- **N** Speed of Agitator *(Revolution per Minute)*
- N_c Critical Speed *(Revolution per Minute)*
- **P** Power *(Horsepower)*
- T_e Equivalent Twisting Moment *(Newton Millimeter)*
- T_m Maximum Torque for Agitator *(Newton Millimeter)*

Constants, Functions, Measurements used in list of Design of Agitation System Components Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Measurement: **Length** in Millimeter (mm) *Length Unit Conversion*
- Measurement: **Pressure** in Newton per Square Millimeter (N/mm²) *Pressure Unit Conversion*
- Measurement: **Power** in Horsepower (hp) *Power Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Angular Velocity** in Revolution per Minute (rev/min) *Angular Velocity Unit Conversion*
- Measurement: **Torque** in Newton Millimeter (N*mm) *Torque Unit Conversion*
- Measurement: **Moment of Force** in Newton Millimeter (N*mm) *Moment of Force Unit Conversion*
- Measurement: **Bending Moment** in Newton Millimeter (N*mm) *Bending Moment Unit Conversion*
- Measurement: **Stress** in Newton per Square Millimeter (N/mm²) *Stress Unit Conversion*

- T_r Rated Motor Torque *(Newton Millimeter)*
- $Te_{hollowshaft}$ Equivalent Twisting Moment for Hollow Shaft *(Newton Millimeter)*
- $Te_{solidshaft}$ Equivalent Twisting Moment for Solid Shaft *(Newton Millimeter)*
- $Tm_{hollowshaft}$ Maximum Torque for Hollow Shaft *(Newton Millimeter)*
- $Tm_{solidshaft}$ Maximum Torque for Solid Shaft *(Newton Millimeter)*
- **w** Uniformly Distributed Load per Unit Length *(Newton)*
- **W** Concentrated Load *(Newton)*
- δ_{Load} Deflection due to each Load *(Millimeter)*
- δ_s Deflection *(Millimeter)*

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