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Design of Agitation System Components Formulas

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List of 18 Design of Agitation System Components Formulas

Design of Agitation System Components

1) Critical Speed for Each Deflection

Open Calculator

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

ex $$13378.46\text{rev/min} = \frac{946}{\sqrt{0.005\text{mm}}}$$

2) Diameter of Hollow Shaft Subjected to Maximum Bending Moment

Open Calculator

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

ex $$18.41035\text{mm} = \left(\frac{34000\text{N*mm}}{\left(\frac{\pi}{32}\right)\cdot(200\text{N/mm}^2)\cdot\left(1-(0.85)^2\right)}\right)^{\frac{1}{3}}$$

3) Diameter of Solid Shaft based on Equivalent Bending Moment

Open Calculator

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

ex $$6.338406\text{mm} = \left(5000\text{N*mm}\cdot\frac{32}{\pi}\cdot\frac{1}{200\text{N/mm}^2}\right)^{\frac{1}{3}}$$

4) Diameter of Solid Shaft based on Equivalent Twisting Moment

Open Calculator

fx $$\text{Diameter}_{\text{solidshaft}} = \left(\text{T}_{\text{e}} \cdot \frac{16}{\pi} \cdot \frac{1}{\text{f}_{\text{s}}}\right)^{\frac{1}{3}}$$

ex $$21.55009\text{mm} = \left(900000\text{N*mm} \cdot \frac{16}{\pi} \cdot \frac{1}{458\text{N/mm}^2}\right)^{\frac{1}{3}}$$

5) Diameter of Solid Shaft Subjected to Maximum Bending Moment

Open Calculator

fx $$\text{d}_{\text{solidshaft}} = \left(\frac{\text{M}_{\text{solidshaft}}}{\left(\frac{\pi}{32}\right) \cdot \text{f}_{\text{b}}}\right)^{\frac{1}{3}}$$

ex $$5.733114\text{mm} = \left(\frac{3700\text{N*mm}}{\left(\frac{\pi}{32}\right) \cdot 200\text{N/mm}^2}\right)^{\frac{1}{3}}$$

6) Equivalent Bending Moment for Hollow Shaft

Open Calculator

fx $$\text{Me}_{\text{hollowshaft}} = \left(\frac{\pi}{32}\right) \cdot (\text{f}_{\text{b}}) \cdot \left(\text{d}_{\text{o}}^3\right) \cdot \left(1 - \text{k}^4\right)$$

ex $$75083.08\text{N*mm} = \left(\frac{\pi}{32}\right) \cdot (200\text{N/mm}^2) \cdot \left(20\text{mm}^3\right) \cdot \left(1 - (0.85)^4\right)$$

7) Equivalent Bending Moment for Solid Shaft

Open Calculator

fx $$\text{Me}_{\text{solidshaft}} = \left(\frac{1}{2}\right) \cdot \left(\text{M}_{\text{m}} + \sqrt{\text{M}_{\text{m}}^2 + \text{T}_{\text{m}}^2}\right)$$

ex $$34160.29\text{N*mm} = \left(\frac{1}{2}\right) \cdot \left(34000\text{N*mm} + \sqrt{(34000\text{N*mm})^2 + (4680\text{N*mm})^2}\right)$$

8) Equivalent Twisting Moment for Hollow Shaft

Open Calculator

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

$$150166.2\mathrm{N*mm} = \left(\frac{\pi}{16}\right) \cdot \left(200\mathrm{N/mm^2}\right) \cdot \left(20\mathrm{mm^3}\right) \cdot \left(1 - (0.85)^4\right)$$

9) Equivalent Twisting Moment for Solid Shaft

Open Calculator

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

$$34320.58\mathrm{N*mm} = \left(\sqrt{\left((34000\mathrm{N*mm})^2\right) + \left((4680\mathrm{N*mm})^2\right)}\right)$$

10) Force for Design of Shaft Based on Pure Bending

Open Calculator

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

$$83.31108\mathrm{N} = \frac{4680\mathrm{N*mm}}{0.75 \cdot 74.9\mathrm{mm}}$$

11) Maximum Bending Moment subject to Shaft

Open Calculator

$$\mathrm{M_m} = \mathrm{l} \cdot \mathrm{F_m}$$

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

12) Maximum Deflection due to Each Load

Open Calculator

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

$$0.033252\text{mm} = \frac{19.8\text{N} \cdot (100\text{mm})^3}{(3 \cdot 195000\text{N/mm}^2) \cdot \left(\frac{\pi}{64}\right) \cdot (12\text{mm})^4}$$

13) Maximum Deflection due to Shaft with Uniform Weight

Open Calculator

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

$$0.005668\text{mm} = \frac{90\text{N} \cdot (100\text{mm})^4}{(8 \cdot 195000\text{N/mm}^2) \cdot \left(\frac{\pi}{64}\right) \cdot (12\text{mm})^4}$$

14) Maximum Torque for Hollow Shaft

Open Calculator

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

$$199640.4\text{N*mm} = \left(\left(\frac{\pi}{16}\right) \cdot \left((20\text{mm})^3\right) \cdot (458\text{N/mm}^2) \cdot \left(1 - (0.85)^2\right)\right)$$

15) Maximum Torque for Solid Shaft

Open Calculator

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

$$155395.7\text{N*mm} = \left(\left(\frac{\pi}{16}\right) \cdot \left((12\text{mm})^3\right) \cdot (458\text{N/mm}^2)\right)$$

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

Open Calculator

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

$$8.10661\text{mm} = \left((5000\text{N*mm}) \cdot \left(\frac{32}{\pi} \right) \cdot \frac{1}{(200\text{N/mm}^2) \cdot \left(1 - (0.85)^4\right)} \right)^{\frac{1}{3}}$$

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

Open Calculator

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

$$27.56185\text{mm} = \left((900000\text{N*mm}) \cdot \left(\frac{16}{\pi} \right) \cdot \frac{1}{(458\text{N/mm}^2) \cdot \left(1 - (0.85)^4\right)} \right)^{\frac{1}{3}}$$

18) Rated Motor Torque

Open Calculator

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

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

Variables Used

- **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)*
- 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)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- 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

Check other formula lists

- **Design of Agitation System Components Formulas**
- **Design of Key Formulas**
- **Design of Shaft Based on Critical Speed Formulas**
- **Design of Stuffing Box and Gland Formulas**
- **Impeller Blade Design Formulas**
- **Power Requirements for Agitation Formulas**
- **Shaft Couplings Formulas**
- **Shaft Subjected to Bending Moment Only Formulas**
- **Shaft Subjected to Combined Twisting Moment and Bending Moment Formulas**

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