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Packing Formulas

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List of 56 Packing Formulas

Packing

Bolt Loads in Gasket Joints

1) Actual Cross-sectional Area of Bolts given Root Diameter of Thread

Open Calculator

fx $$A_b = \frac{2 \cdot \pi \cdot y_{sl} \cdot G \cdot N}{\sigma_{sbat}}$$

ex $$126.6466\text{mm}^2 = \frac{2 \cdot \pi \cdot 3.85\text{N/mm}^2 \cdot 32\text{mm} \cdot 4.1\text{mm}}{25.06\text{N/mm}^2}$$

2) Bolt Load in Design of Flange for Gasket Seating

Open Calculator

fx $$W_{m1} = \left(\frac{A_m + A_b}{2}\right) \cdot \sigma_{sbat}$$

ex $$15612.38\text{N} = \left(\frac{1120\text{mm}^2 + 126\text{mm}^2}{2}\right) \cdot 25.06\text{N/mm}^2$$

3) Bolt load under operating condition

Open Calculator

fx $$W_{m1} = H + H_p$$

ex $$15486\text{N} = 3136\text{N} + 12350\text{N}$$

4) Bolt Load under operating condition given Hydrostatic End Force

Open Calculator

fx $$W_{m1} = \left(\left(\frac{\pi}{4}\right) \cdot (G)^2 \cdot P\right) + (2 \cdot b \cdot \pi \cdot G \cdot P \cdot m)$$

ex $$15486.8\text{N} = \left(\left(\frac{\pi}{4}\right) \cdot (32\text{mm})^2 \cdot 3.9\text{MPa}\right) + (2 \cdot 4.2\text{mm} \cdot \pi \cdot 32\text{mm} \cdot 3.9\text{MPa} \cdot 3.75)$$

5) Deflection of Spring Initial Bolt Load to Seal Gasket Joint

Open Calculator

fx $$y_{sl} = \frac{W_{m2}}{\pi \cdot b \cdot G}$$

ex $$3.801245\text{N/mm}^2 = \frac{1605\text{N}}{\pi \cdot 4.2\text{mm} \cdot 32\text{mm}}$$

6) Gasket Width given actual Cross-sectional Area of Bolts

Open Calculator

fx $$N = \frac{\sigma_{sbat} \cdot A_b}{2 \cdot \pi \cdot y_{sl} \cdot G}$$

ex $$4.079069\text{mm} = \frac{25.06\text{N/mm}^2 \cdot 126\text{mm}^2}{2 \cdot \pi \cdot 3.85\text{N/mm}^2 \cdot 32\text{mm}}$$

7) Hydrostatic Contact Force given Bolt Load under Operating condition

Open Calculator

fx $$H_p = W_{m1} - \left(\left(\frac{\pi}{4}\right) \cdot (G)^2 \cdot P\right)$$

ex $$12349.43\text{N} = 15486\text{N} - \left(\left(\frac{\pi}{4}\right) \cdot (32\text{mm})^2 \cdot 3.9\text{MPa}\right)$$

8) Hydrostatic end force

Open Calculator

fx $$H = W_{m1} - H_p$$

ex $$3136\text{N} = 15486\text{N} - 12350\text{N}$$

9) Hydrostatic End Force given Bolt Load under Operating condition

Open Calculator

fx $H = W_{m1} - (2 \cdot b \cdot \pi \cdot G \cdot m \cdot P)$

ex $3135.771\text{N} = 15486\text{N} - (2 \cdot 4.2\text{mm} \cdot \pi \cdot 32\text{mm} \cdot 3.75 \cdot 3.9\text{MPa})$

10) Initial Bolt Load to seat Gasket Joint

Open Calculator

fx $W_{m2} = \pi \cdot b \cdot G \cdot y_{sl}$

ex $1625.586\text{N} = \pi \cdot 4.2\text{mm} \cdot 32\text{mm} \cdot 3.85\text{N/mm}^2$

11) Load on bolts based on hydrostatic end force

Open Calculator

fx $F_b = f_s \cdot P_t \cdot A_m$

ex $18816\text{N} = 3 \cdot 5.6\text{MPa} \cdot 1120\text{mm}^2$

12) Stress Required for Gasket Seating

Open Calculator

fx $\sigma_{sbat} = \dfrac{2 \cdot \pi \cdot y_{sl} \cdot G \cdot N}{A_b}$

ex $25.18859\text{N/mm}^2 = \dfrac{2 \cdot \pi \cdot 3.85\text{N/mm}^2 \cdot 32\text{mm} \cdot 4.1\text{mm}}{126\text{mm}^2}$

13) Stress Required for Gasket Seating given Bolt Load

Open Calculator

fx $\sigma_{sbat} = \dfrac{W_{m1}}{\frac{A_m + A_b}{2}}$

ex $24.85714\text{N/mm}^2 = \dfrac{15486\text{N}}{\frac{1120\text{mm}^2 + 126\text{mm}^2}{2}}$

14) Test pressure given Bolt Load

Open Calculator

fx $$P_t = \frac{F_b}{f_s \cdot A_m}$$

ex $$5.401786\text{MPa} = \frac{18150\text{N}}{3 \cdot 1120\text{mm}^2}$$

15) Total cross-sectional area of bolt at root of thread

Open Calculator

fx $$A_{m1} = \frac{W_{m1}}{\sigma_{sbd}}$$

ex $$297.8077\text{mm}^2 = \frac{15486\text{N}}{52\text{N/mm}^2}$$

16) Width of U Collar given Initial Bolt Load to Seat Gasket Joint

Open Calculator

fx $$b = \frac{W_{m2}}{\pi \cdot G \cdot y_{sl}}$$

ex $$4.146813\text{mm} = \frac{1605\text{N}}{\pi \cdot 32\text{mm} \cdot 3.85\text{N/mm}^2}$$

Elastic Packing

17) Diameter of Bolt given Frictional Force exerted by Soft packing on Reciprocating rod

Open Calculator

fx $$d = \frac{F_{friction}}{.005 \cdot p}$$

ex $$13.86792\text{mm} = \frac{294\text{N}}{.005 \cdot 4.24\text{MPa}}$$

18) Fluid pressure by soft packing exerted by frictional force on reciprocating rod

Open Calculator

fx $$p = \frac{F_{friction}}{.005 \cdot d}$$

ex $$4.2\text{MPa} = \frac{294\text{N}}{.005 \cdot 14\text{mm}}$$

19) Fluid Pressure given Friction Resistance

Open Calculator

fx $$p = \frac{F_{friction} - F_0}{\mu \cdot A}$$

ex $$4.20202\text{MPa} = \frac{294\text{N} - 190\text{N}}{0.3 \cdot 82.5\text{mm}^2}$$

20) Fluid Pressure given Torsional Resistance

Open Calculator

fx $$p = \frac{M_t \cdot 2}{.005 \cdot (d)^2}$$

ex $$4.204082\text{MPa} = \frac{2.06\text{N} \cdot 2}{.005 \cdot (14\text{mm})^2}$$

21) Friction resistance

Open Calculator

fx $$F_{friction} = F_0 + (\mu \cdot A \cdot p)$$

ex $$294.94\text{N} = 190\text{N} + (0.3 \cdot 82.5\text{mm}^2 \cdot 4.24\text{MPa})$$

22) Frictional force exerted by soft packing on reciprocating rod

Open Calculator

fx $$F_{friction} = .005 \cdot p \cdot d$$

ex $$296.8\text{N} = .005 \cdot 4.24\text{MPa} \cdot 14\text{mm}$$

23) Seal resistance

Open Calculator

fx $$F_0 = F_{friction} - (\mu \cdot A \cdot p)$$

ex $$189.06\text{N} = 294\text{N} - (0.3 \cdot 82.5\text{mm}^2 \cdot 4.24\text{MPa})$$

24) Torsional Resistance given Fluid Pressure

Open Calculator

fx $$M_t = \frac{.005 \cdot (d)^2 \cdot p}{2}$$

ex $$2.0776\text{N} = \frac{.005 \cdot (14\text{mm})^2 \cdot 4.24\text{MPa}}{2}$$

25) Torsional resistance in rotary motion friction

Open Calculator

fx $$M_t = \frac{F_{friction} \cdot d}{2}$$

ex $$2.058\text{N} = \frac{294\text{N} \cdot 14\text{mm}}{2}$$

Metallic Gaskets

26) Frictional Force given Minor diameter of bolt

Open Calculator

fx $$F_\mu = \frac{\left(d_2 - \left(\frac{\sqrt{\left((d_1)^2 - (d_{gb})^2\right) \cdot p_{seal}}}{\sqrt{(i \cdot F_c)}}\right)\right) \cdot 3.14 \cdot i \cdot F_c}{4}$$

ex

$$560.3676\text{N} = \frac{\left(9.5\text{mm} - \left(\frac{\sqrt{\left((34\text{mm})^2 - (11.5\text{mm})^2\right) \cdot 4.25\text{MPa}}}{\sqrt{(2 \cdot 24.18\text{N/mm}^2)}}\right)\right) \cdot 3.14 \cdot 2 \cdot 24.18\text{N/mm}^2}{4}$$

27) Minor Diameter of Bolt given Working Strength

Open Calculator

fx $$d_2 = \left(\frac{\sqrt{\left((d_1)^2 - (d_{gb})^2\right) \cdot p_{seal}}}{\sqrt{(i \cdot 68.7)}}\right) + \frac{4 \cdot F_\mu}{3.14 \cdot i \cdot 68.7}$$

ex $$10822.58\text{mm} = \left(\frac{\sqrt{\left((34\text{mm})^2 - (11.5\text{mm})^2\right) \cdot 4.25\text{MPa}}}{\sqrt{(2 \cdot 68.7)}}\right) + \frac{4 \cdot 560.36\text{N}}{3.14 \cdot 2 \cdot 68.7}$$

Self Sealing Packing

28) Diameter of bolt given Radial ring wall thickness

Open Calculator

fx $$d_{bolt} = \frac{\left(\frac{h}{6.36 \cdot (10^{-3})}\right)^1}{.2}$$

ex $$36949.69\text{mm} = \frac{\left(\frac{47\text{mm}}{6.36 \cdot (10^{-3})}\right)^1}{.2}$$

29) Radial ring wall thickness considering SI units

Open Calculator

fx $$h = 6.36 \cdot (10^{-3}) \cdot (d_{bolt})^{.2}$$

ex $$2.479166\text{mm} = 6.36 \cdot (10^{-3}) \cdot (9\text{mm})^{.2}$$

30) Radial Ring Wall Thickness given Width of U shaped collar

Open Calculator

fx $$h = \frac{b}{4}$$

ex $$1.05\text{mm} = \frac{4.2\text{mm}}{4}$$

31) Width of U collar

Open Calculator

fx $$b = 4 \cdot h$$

ex $$188\text{mm} = 4 \cdot 47\text{mm}$$

V Ring Packing

Multiple spring installations

32) Bolt Load given Flange pressure

Open Calculator

fx $$F_b = p_f \cdot a \cdot \frac{C_u}{n}$$

ex $$15.4\text{N} = 5.5\text{MPa} \cdot 100\text{mm}^2 \cdot \frac{0.14}{5}$$

33) Bolt Load given Modulus of Elasticity and Increment Length

Open Calculator

fx $$F_b = E \cdot \frac{dl}{\left(\frac{l_1}{A_i}\right) + \left(\frac{l_2}{A_t}\right)}$$

ex $$99.53362\text{N} = 10.01\text{MPa} \cdot \frac{1.5\text{mm}}{\left(\frac{3.2\text{mm}}{53\text{mm}^2}\right) + \left(\frac{3.8\text{mm}}{42\text{mm}^2}\right)}$$

34) Bolt load in gasket joint

Open Calculator

fx $$F_b = 11 \cdot \frac{m_{ti}}{dn}$$

ex $$9821.429\text{N} = 11 \cdot \frac{2.5\text{N}}{2.8\text{mm}}$$

35) Flange pressure developed due to tightening of bolt

Open Calculator

fx $$p_f = n \cdot \frac{F_b}{a \cdot C_u}$$

ex $$6482.143\text{MPa} = 5 \cdot \frac{18150\text{N}}{100\text{mm}^2 \cdot 0.14}$$

36) Flange pressure given Twisting moment

Open Calculator

fx $$p_f = 2 \cdot n \cdot \frac{T}{a \cdot C_u \cdot d_{bolt}}$$

ex $$1031.746\text{MPa} = 2 \cdot 5 \cdot \frac{13\text{N*m}}{100\text{mm}^2 \cdot 0.14 \cdot 9\text{mm}}$$

37) Gasket Area given Flange pressure

Open Calculator

fx $$a = n \cdot \frac{F_b}{p_f \cdot C_u}$$

ex $$117857.1\text{mm}^2 = 5 \cdot \frac{18150\text{N}}{5.5\text{MPa} \cdot 0.14}$$

38) Initial Bolt Torque given Bolt Load

Open Calculator

fx $$m_{ti} = dn \cdot \frac{F_b}{11}$$

ex $$4.62\text{N} = 2.8\text{mm} \cdot \frac{18150\text{N}}{11}$$

39) Minimum percentage compression

Open Calculator

fx $$P_s = 100 \cdot \left(1 - \left(\frac{b}{h_i}\right)\right)$$

ex $$30 = 100 \cdot \left(1 - \left(\frac{4.2\text{mm}}{6\text{mm}}\right)\right)$$

40) Nominal Bolt Diameter given Bolt Load

Open Calculator

fx $$dn = 11 \cdot \frac{m_{ti}}{F_b}$$

ex $$1.515152\text{mm} = 11 \cdot \frac{2.5\text{N}}{18150\text{N}}$$

41) Number of Bolts given Flange pressure

Open Calculator

fx $$n = p_f \cdot a \cdot \frac{C_u}{F_b}$$

ex $$0.004242 = 5.5\text{MPa} \cdot 100\text{mm}^2 \cdot \frac{0.14}{18150\text{N}}$$

42) Twisting Moment given Flange Pressure

Open Calculator

fx $$T = \frac{p_f \cdot a \cdot C_u \cdot d_{bolt}}{2 \cdot n}$$

ex $$0.0693\text{N*m} = \frac{5.5\text{MPa} \cdot 100\text{mm}^2 \cdot 0.14 \cdot 9\text{mm}}{2 \cdot 5}$$

43) Uncompressed gasket thickness

Open Calculator

fx $$h_i = \frac{100 \cdot b}{100 - P_s}$$

ex $$5\text{mm} = \frac{100 \cdot 4.2\text{mm}}{100 - 16}$$

44) Width of u collar given uncompressed Gasket Thickness

Open Calculator

fx $$b = \frac{(h_i) \cdot (100 - P_s)}{100}$$

ex $$5.04\text{mm} = \frac{(6\text{mm}) \cdot (100 - 16)}{100}$$

Single spring installations

45) Actual Diameter of Spring Wire given Actual mean diameter of Conical spring

Open Calculator

fx $$d_{sw} = 2 \cdot \left(D_{\text{driver a}} + D_o - \left(\frac{w}{2}\right)\right)$$

ex $$21.5\text{mm} = 2 \cdot \left(8\text{mm} + 7\text{mm} - \left(\frac{8.5\text{mm}}{2}\right)\right)$$

46) Actual Diameter of Spring Wire given Deflection of Spring

Open Calculator

fx $$d_{sw} = .0123 \cdot \frac{(D_{driver\ a})^2}{y}$$

ex $$0.302769\text{mm} = .0123 \cdot \frac{(8\text{mm})^2}{2.6\text{mm}}$$

47) Actual mean diameter of conical spring

Open Calculator

fx $$D_{driver\ a} = D_o - \left(\frac{1}{2}\right) \cdot (w + d_{sw})$$

ex $$0.75\text{mm} = 7\text{mm} - \left(\frac{1}{2}\right) \cdot (8.5\text{mm} + 4\text{mm})$$

48) Actual Mean Diameter of Conical Spring given Deflection of Spring

Open Calculator

fx $$D_{driver\ a} = \frac{\left(\frac{y \cdot d_{sw}}{0.0123}\right)^1}{2}$$

ex $$0.422764\text{mm} = \frac{\left(\frac{2.6\text{mm} \cdot 4\text{mm}}{0.0123}\right)^1}{2}$$

49) Deflection of conical spring

Open Calculator

fx $$y = .0123 \cdot \frac{(D_{driver\ a})^2}{d_{sw}}$$

ex $$0.1968\text{mm} = .0123 \cdot \frac{(8\text{mm})^2}{4\text{mm}}$$

50) Diameter of wire for spring given Mean diameter of Conical spring

Open Calculator

fx $$d_{sw} = \frac{\left(\frac{\pi \cdot (D_m)^2}{139300}\right)^1}{3}$$

ex $$3.3E\hat{}\text{-}6mm = \frac{\left(\frac{\pi \cdot (21mm)^2}{139300}\right)^1}{3}$$

51) Inside diameter of member given Mean diameter of Conical spring

Open Calculator

fx $$D_i = D_m - \left(\left(\frac{3}{2}\right) \cdot w\right)$$

ex $$8.25mm = 21mm - \left(\left(\frac{3}{2}\right) \cdot 8.5mm\right)$$

52) Mean diameter of conical spring

Open Calculator

fx $$D_m = D_i + \left(\left(\frac{3}{2}\right) \cdot w\right)$$

ex $$18.15mm = 5.4mm + \left(\left(\frac{3}{2}\right) \cdot 8.5mm\right)$$

53) Mean diameter of conical spring given Diameter of spring wire

Open Calculator

fx $$D_m = \frac{\left(\frac{(d_{sw})^3 \cdot 139300}{\pi}\right)^1}{2}$$

ex $$1.418898mm = \frac{\left(\frac{(4mm)^3 \cdot 139300}{\pi}\right)^1}{2}$$

54) Nominal packing cross section given Actual mean diameter of Conical spring

Open Calculator

fx $$w = 2 \cdot \left(D_{\text{driver a}} + D_o - \left(\frac{d_{sw}}{2}\right)\right)$$

ex $$26\text{mm} = 2 \cdot \left(8\text{mm} + 7\text{mm} - \left(\frac{4\text{mm}}{2}\right)\right)$$

55) Nominal packing cross section given Mean diameter of Conical spring

Open Calculator

fx $$w = (D_m - D_i) \cdot \frac{2}{3}$$

ex $$10.4\text{mm} = (21\text{mm} - 5.4\text{mm}) \cdot \frac{2}{3}$$

56) Outer Diameter of spring wire given Actual mean diameter of Conical spring

Open Calculator

fx $$D_o = D_{\text{driver a}} - \left(\frac{1}{2}\right) \cdot (w + d_{sw})$$

ex $$1.75\text{mm} = 8\text{mm} - \left(\frac{1}{2}\right) \cdot (8.5\text{mm} + 4\text{mm})$$

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Variables Used

- **a** Gasket Area *(Square Millimeter)*
- **A** Area of seal contacting sliding member *(Square Millimeter)*
- A_b Actual Bolt Area *(Square Millimeter)*
- A_i Area of cross section at the inlet *(Square Millimeter)*
- A_m Greater Cross-section Area of Bolts *(Square Millimeter)*
- A_{m1} Bolt Cross-sectional Area at Root of Thread *(Square Millimeter)*
- A_t Area of cross section at the throat *(Square Millimeter)*
- **b** Width of u-collar *(Millimeter)*
- C_u Torque Friction Coefficient
- **d** Diameter of elastic packing bolt *(Millimeter)*
- d_1 Outside Diameter of Seal Ring *(Millimeter)*
- d_2 Minor Diameter of Metallic Gasket Bolt *(Millimeter)*
- d_{bolt} Diameter of Bolt *(Millimeter)*
- $D_{driver\ a}$ Actual mean diameter of spring *(Millimeter)*
- d_{gb} Nominal diameter of metallic gasket bolt *(Millimeter)*
- D_i Inside Diameter *(Millimeter)*
- D_m Mean Diameter of Conical Spring *(Millimeter)*
- D_o Outer diameter of spring wire *(Millimeter)*
- d_{sw} Diameter of spring wire *(Millimeter)*
- **dl** Incremental Length in Direction of Velocity *(Millimeter)*
- **dn** Nominal Bolt Diameter *(Millimeter)*
- **E** Modulus of Elasticity *(Megapascal)*
- F_0 Seal Resistance *(Newton)*
- F_b Bolt Load in Gasket Joint *(Newton)*
- F_c Design Stress for metallic gasket *(Newton per Square Millimeter)*

- $F_{friction}$ Friction Force in elastic packing *(Newton)*
- f_s Factor of Safety for Bolt Packing
- F_μ Friction force in metallic gasket *(Newton)*
- **G** Gasket Diameter *(Millimeter)*
- **h** Radial Ring Wall Thickness *(Millimeter)*
- **H** Hydrostatic End Force in Gasket Seal *(Newton)*
- h_i Uncompressed gasket thickness *(Millimeter)*
- H_p Total Joint Surface Compression Load *(Newton)*
- **i** Number of bolts in metallic gasket seal
- l_1 Length of joint 1 *(Millimeter)*
- l_2 Length of joint 2 *(Millimeter)*
- **m** Gasket Factor
- M_t Torsional Resistance in Elastic Packing *(Newton)*
- m_{ti} Initial bolt torque *(Newton)*
- **n** Number of Bolts
- **N** Gasket Width *(Millimeter)*
- **p** Fluid Pressure in elastic packing *(Megapascal)*
- **P** Pressure at Outer Diameter of Gasket *(Megapascal)*
- p_f Flange pressure *(Megapascal)*
- P_s Minimum Percentage Compression
- p_{seal} Fluid Pressure on Metallic Gasket Seal *(Megapascal)*
- P_t Test Pressure in Bolted Gasket Joint *(Megapascal)*
- **T** Twisting Moment *(Newton Meter)*
- **w** Nominal Packing Cross-section of Bush Seal *(Millimeter)*
- W_{m1} Bolt Load Under Operating Condition for Gasket *(Newton)*
- W_{m2} Initial bolt load to seat the gasket joint *(Newton)*
- **y** Deflection of Conical Spring *(Millimeter)*
- y_{sl} Gasket Unit Seating Load *(Newton per Square Millimeter)*

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- **μ** Coefficient of Friction in elastic packing
- **σ_{sbat}** Stress Required for Gasket Seating *(Newton per Square Millimeter)*
- **σ_{sbd}** Stress Required for Operating Condition for Gasket *(Newton per Square Millimeter)*

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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: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Moment of Force** in Newton Meter (N*m)
  Moment of Force Unit Conversion
- Measurement: **Stress** in Newton per Square Millimeter (N/mm²)
  Stress Unit Conversion

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