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Seals Formulas

Calculators! Examples! Conversions!

List of 36 Seals Formulas

Seals

Leakage through Bush Seals

1) Amount of Leakage of Fluid through Face Seal

Open Calculator

fx $$Q = \frac{\pi \cdot t^3}{6 \cdot \nu \cdot \ln\left(\frac{r_2}{r_1}\right)} \cdot \left(\frac{3 \cdot \rho \cdot \omega^2}{20 \cdot [g]} \cdot \left(r_2^2 - r_1^2\right) - P_2 - P_i\right)$$

ex $$259501.2\text{mm}^3/\text{s} = \frac{\pi \cdot (1.92\text{mm})^3}{6 \cdot 7.25\text{St} \cdot \ln\left(\frac{20\text{mm}}{14\text{mm}}\right)} \cdot \left(\frac{3 \cdot 1100\text{kg/m}^3 \cdot (75\text{rad/s})^2}{20 \cdot [g]} \cdot \left((20\text{mm})^2 - (14\text{mm})^2\right) - 1\text{E\^{}-6MI}\right.$$

2) Inside Diameter of Gasket given Shape Factor

Open Calculator

fx $$D_i = D_o - 4 \cdot t \cdot S_{pf}$$

ex $$54.0096\text{mm} = 60\text{mm} - 4 \cdot 1.92\text{mm} \cdot 0.78$$

3) Internal Hydraulic Pressure given Zero Leakage of Fluid through Face Seal

Open Calculator

fx $$P_2 = P_i + \frac{3 \cdot \rho \cdot \omega^2}{20} \cdot \left(r_2^2 - r_1^2\right) \cdot 1000$$

ex $$0.189338\text{MPa} = .0000002\text{MPa} + \frac{3 \cdot 1100\text{kg/m}^3 \cdot (75\text{rad/s})^2}{20} \cdot \left((20\text{mm})^2 - (14\text{mm})^2\right) \cdot 1000$$

4) Kinematic Viscosity given Power Loss due to Leakage of Fluid through Face Seal

Open Calculator

fx $$\nu = \frac{13200 \cdot P_l \cdot t}{\pi \cdot w^2 \cdot \left(r_2^4 - r_1^4\right)}$$

ex $$7.255011\text{St} = \frac{13200 \cdot 7.9\text{E\^{}-16W} \cdot 1.92\text{mm}}{\pi \cdot (8.5\text{mm})^2 \cdot \left((20\text{mm})^4 - (14\text{mm})^4\right)}$$

5) Oil Flow through Plain Axial Bush Seal due to Leakage under Laminar Flow Condition

Open Calculator

fx $$Q = \frac{2 \cdot \pi \cdot a \cdot \left(P_s - \frac{P_e}{10^6}\right)}{l} \cdot q$$

ex $$266669.4\text{mm}^3/\text{s} = \frac{2 \cdot \pi \cdot 15\text{mm} \cdot \left(16 - \frac{2.1\text{MPa}}{10^6}\right)}{0.038262\text{mm}} \cdot 7.788521\text{mm}^3/\text{s}$$

6) Oil Flow through Plain Radial Bush Seal due to Leakage under Laminar Flow Condition

Open Calculator

fx $$Q = \frac{2 \cdot \pi \cdot a \cdot \left(P_s - \frac{P_e}{10^6}\right)}{a - b} \cdot q$$

ex $$944.7506\text{mm}^3/\text{s} = \frac{2 \cdot \pi \cdot 15\text{mm} \cdot \left(16 - \frac{2.1\text{MPa}}{10^6}\right)}{15\text{mm} - 4.2\text{mm}} \cdot 7.788521\text{mm}^3/\text{s}$$

7) Outside Diameter of Gasket given Shape Factor

Open Calculator

fx $$D_o = D_i + 4 \cdot t \cdot S_{pf}$$

ex $$59.9904\text{mm} = 54\text{mm} + 4 \cdot 1.92\text{mm} \cdot 0.78$$

8) Outside Radius of Rotating Member given Power Loss due to Leakage of Fluid through Face Seal

Open Calculator

fx $$r_2 = \left(\frac{P_l}{\frac{\pi \cdot v \cdot w^2}{13200 \cdot t}} + r_1^4\right)^{\frac{1}{4}}$$

ex $$20.00263\text{mm} = \left(\frac{7.9\text{E\^{}-16W}}{\frac{\pi \cdot 7.25\text{St} \cdot (8.5\text{mm})^2}{13200 \cdot 1.92\text{mm}}} + (14\text{mm})^4\right)^{\frac{1}{4}}$$

9) Power Loss or Consumption due to Leakage of Fluid through Face Seal

Open Calculator

fx $$P_l = \frac{\pi \cdot v \cdot w^2}{13200 \cdot t} \cdot \left(r_2^4 - r_1^4\right)$$

ex $$7.9\text{E\^{}-16W} = \frac{\pi \cdot 7.25\text{St} \cdot (8.5\text{mm})^2}{13200 \cdot 1.92\text{mm}} \cdot \left((20\text{mm})^4 - (14\text{mm})^4\right)$$

10) Radial Pressure Distribution for Laminar Flow

Open Calculator

fx $$p = P_i + \frac{3 \cdot \rho \cdot \omega^2}{20 \cdot [g]} \cdot (r^2 - r_1^2) - \frac{6 \cdot \nu}{\pi \cdot t^3} \cdot \ln\left(\frac{r}{R}\right)$$

ex $$0.091988\text{MPa} = .0000002\text{MPa} + \frac{3 \cdot 1100\text{kg/m}^3 \cdot (75\text{rad/s})^2}{20 \cdot [g]} \cdot \left((25\text{mm})^2 - (14\text{mm})^2\right) - \frac{6 \cdot 7.25\text{St}}{\pi \cdot (1.92\text{mm})^3} \cdot \ln$$

11) Shape Factor for Circular or Annular Gasket

Open Calculator

fx $$S_{pf} = \frac{D_o - D_i}{4 \cdot t}$$

ex $$0.78125 = \frac{60\text{mm} - 54\text{mm}}{4 \cdot 1.92\text{mm}}$$

12) Thickness of Fluid between Members given Power Loss due to Leakage of Fluid through Face Seal

Open Calculator

fx $$t = \frac{\pi \cdot \nu \cdot w^2}{13200 \cdot P_l} \cdot (r_2^4 - r_1^4)$$

ex $$1.918674\text{mm} = \frac{\pi \cdot 7.25\text{St} \cdot (8.5\text{mm})^2}{13200 \cdot 7.9\text{E\^{}-16W}} \cdot \left((20\text{mm})^4 - (14\text{mm})^4\right)$$

13) Thickness of Fluid between Members given Shape Factor

Open Calculator

fx $$t = \frac{D_o - D_i}{4 \cdot S_{pf}}$$

ex $$1.923077\text{mm} = \frac{60\text{mm} - 54\text{mm}}{4 \cdot 0.78}$$

14) Volumetric Efficiency of Reciprocating Compressor

Open Calculator

fx $$\eta_v = \frac{V_a}{V_p}$$

ex $$0.8 = \frac{164\text{m}^3}{205\text{m}^3}$$

15) Volumetric Flow Rate under Laminar Flow Condition for Axial Bush Seal for Compressible Fluid

Open Calculator

fx $$q = \frac{c^3}{12 \cdot \mu} \cdot \frac{P_s + P_e}{P_e}$$

ex $$7.788521\text{mm}^3/\text{s} = \frac{(0.9\text{mm})^3}{12 \cdot 7.8\text{cP}} \cdot \frac{16 + 2.1\text{MPa}}{2.1\text{MPa}}$$

16) Volumetric Flow Rate under Laminar Flow Condition for Radial Bush Seal for Compressible Fluid

Open Calculator

fx $$q = \frac{c^3}{24 \cdot \mu} \cdot \frac{a - b}{a} \cdot \frac{P_s + P_e}{P_e}$$

ex $$2.803868\text{mm}^3/\text{s} = \frac{(0.9\text{mm})^3}{24 \cdot 7.8\text{cP}} \cdot \frac{15\text{mm} - 4.2\text{mm}}{15\text{mm}} \cdot \frac{16 + 2.1\text{MPa}}{2.1\text{MPa}}$$

17) Volumetric Flow Rate under Laminar Flow Condition for Radial Bush Seal for Incompressible Fluid

Open Calculator

fx $$q = \frac{c^3}{12 \cdot \mu} \cdot \frac{a - b}{a \cdot \ln\left(\frac{a}{b}\right)}$$

ex $$4.405219\text{mm}^3/\text{s} = \frac{(0.9\text{mm})^3}{12 \cdot 7.8\text{cP}} \cdot \frac{15\text{mm} - 4.2\text{mm}}{15\text{mm} \cdot \ln\left(\frac{15\text{mm}}{4.2\text{mm}}\right)}$$

Packingless Seals

18) Depth of U Collar given Leakage

Open Calculator

fx $$l = \frac{\pi \cdot c^3}{12} \cdot (p_1 - p_2) \cdot \frac{d}{\mu \cdot Q_l}$$

ex $$55493.85\text{mm} = \frac{\pi \cdot (0.9\text{mm})^3}{12} \cdot (200.8501\text{MPa} - 2.85\text{MPa}) \cdot \frac{12.6\text{mm}}{7.8\text{cP} \cdot 1.1\text{E6mm}^3/\text{s}}$$

19) Diameter of Bolt given Leakage of Fluid

Open Calculator

fx $$d = \frac{12 \cdot l \cdot \mu \cdot Q_l}{\pi \cdot c^3 \cdot (p_1 - p_2)}$$

ex $$8.7\text{E\^{}-6mm} = \frac{12 \cdot 0.038262\text{mm} \cdot 7.8\text{cP} \cdot 1.1\text{E6mm}^3/\text{s}}{\pi \cdot (0.9\text{mm})^3 \cdot (200.8501\text{MPa} - 2.85\text{MPa})}$$

20) Leakage of Fluid past Rod

Open Calculator

$$Q_l = \frac{\pi \cdot c^3}{12} \cdot (p_1 - p_2) \cdot \frac{d}{l \cdot \mu}$$

$$1.6E^12mm^3/s = \frac{\pi \cdot (0.9mm)^3}{12} \cdot (200.8501MPa - 2.85MPa) \cdot \frac{12.6mm}{0.038262mm \cdot 7.8cP}$$

21) Radial Clearance given Leakage

Open Calculator

$$c = \left(\frac{12 \cdot l \cdot \mu \cdot Q_l}{\pi \cdot d \cdot p_1 - p_2} \right)^{\frac{1}{3}}$$

$$0.009175mm = \left(\frac{12 \cdot 0.038262mm \cdot 7.8cP \cdot 1.1E6mm^3/s}{\pi \cdot 12.6mm \cdot 200.8501MPa - 2.85MPa} \right)^{\frac{1}{3}}$$

Straight Cut Sealings

22) Absolute Viscosity given Leakage Velocity

Open Calculator

$$\mu = \frac{\Delta p \cdot r_s^2}{8 \cdot d_l \cdot v}$$

$$7.800001cP = \frac{0.000112MPa \cdot (10mm)^2}{8 \cdot 1.5mm \cdot 119.6581m/s}$$

23) Absolute Viscosity given Loss of Liquid Head

Open Calculator

$$\mu = \frac{2 \cdot [g] \cdot \rho_l \cdot h_\mu \cdot d_1^2}{64 \cdot v}$$

$$7.8cP = \frac{2 \cdot [g] \cdot 997kg/m^3 \cdot 2642.488mm \cdot (34mm)^2}{64 \cdot 119.6581m/s}$$

24) Area of Seal in contact with Sliding member given Leakage

Open Calculator

$$A = \frac{Q_o}{v}$$

$$0.000209m^2 = \frac{2.5E7mm^3/s}{119.6581m/s}$$

25) Change in Pressure given Leakage Velocity

Open Calculator

$$\Delta p = \frac{8 \cdot d_l \cdot \mu \cdot v}{r_s^2}$$

$$0.000112\text{MPa} = \frac{8 \cdot 1.5\text{mm} \cdot 7.8\text{cP} \cdot 119.6581\text{m/s}}{(10\text{mm})^2}$$

26) Density of Liquid given Loss of Liquid Head

Open Calculator

$$\rho_l = \frac{64 \cdot \mu \cdot v}{2 \cdot [g] \cdot h_\mu \cdot d_1^2}$$

$$997\text{kg/m}^3 = \frac{64 \cdot 7.8\text{cP} \cdot 119.6581\text{m/s}}{2 \cdot [g] \cdot 2642.488\text{mm} \cdot (34\text{mm})^2}$$

27) Incremental Length in Direction of Velocity given Leakage Velocity

Open Calculator

$$d_l = \frac{\Delta p \cdot r_s^2}{8 \cdot v \cdot \mu}$$

$$1.5\text{mm} = \frac{0.000112\text{MPa} \cdot (10\text{mm})^2}{8 \cdot 119.6581\text{m/s} \cdot 7.8\text{cP}}$$

28) Leakage Velocity

Open Calculator

$$v = \frac{\Delta p \cdot r_s^2}{8 \cdot d_l \cdot \mu}$$

$$119.6581\text{m/s} = \frac{0.000112\text{MPa} \cdot (10\text{mm})^2}{8 \cdot 1.5\text{mm} \cdot 7.8\text{cP}}$$

29) Loss of Liquid Head

Open Calculator

$$h_\mu = \frac{64 \cdot \mu \cdot v}{2 \cdot [g] \cdot \rho_l \cdot d_1^2}$$

$$2642.488\text{mm} = \frac{64 \cdot 7.8\text{cP} \cdot 119.6581\text{m/s}}{2 \cdot [g] \cdot 997\text{kg/m}^3 \cdot (34\text{mm})^2}$$

30) Modulus of Elasticity given Stress in Seal Ring

Open Calculator

fx $$E = \frac{\sigma_s \cdot h \cdot \left(\frac{d_1}{h} - 1\right)^2}{0.4815 \cdot c}$$

ex $$10.01\text{MPa} = \frac{151.8242\text{MPa} \cdot 35\text{mm} \cdot \left(\frac{34\text{mm}}{35\text{mm}} - 1\right)^2}{0.4815 \cdot 0.9\text{mm}}$$

31) Outer Diameter of Seal Ring given Loss of Liquid Head

Open Calculator

fx $$d_1 = \sqrt{\frac{64 \cdot \mu \cdot v}{2 \cdot [g] \cdot \rho_l \cdot h_\mu}}$$

ex $$34\text{mm} = \sqrt{\frac{64 \cdot 7.8\text{cP} \cdot 119.6581\text{m/s}}{2 \cdot [g] \cdot 997\text{kg/m}^3 \cdot 2642.488\text{mm}}}$$

32) Quantity of Leakage

Open Calculator

fx $$Q_o = v \cdot A$$

ex $$2.5\text{E}^\wedge 7\text{mm}^3\text{/s} = 119.6581\text{m/s} \cdot 0.000208\text{m}^2$$

33) Radial Clearance given Stress in Seal Ring

Open Calculator

fx $$c = \frac{\sigma_s \cdot h \cdot \left(\frac{d_1}{h} - 1\right)^2}{0.4815 \cdot E}$$

ex $$0.9\text{mm} = \frac{151.8242\text{MPa} \cdot 35\text{mm} \cdot \left(\frac{34\text{mm}}{35\text{mm}} - 1\right)^2}{0.4815 \cdot 10.01\text{MPa}}$$

34) Radius given Leakage Velocity

Open Calculator

fx $$r_s = \sqrt{\frac{8 \cdot d_l \cdot \mu \cdot v}{\Delta p}}$$

ex $$9.999999\text{mm} = \sqrt{\frac{8 \cdot 1.5\text{mm} \cdot 7.8\text{cP} \cdot 119.6581\text{m/s}}{0.000112\text{MPa}}}$$

35) Stress in Seal Ring

Open Calculator

$$\sigma_s = \frac{0.4815 \cdot c \cdot E}{h \cdot \left(\frac{d_1}{h} - 1\right)^2}$$

$$151.8242\text{MPa} = \frac{0.4815 \cdot 0.9\text{mm} \cdot 10.01\text{MPa}}{35\text{mm} \cdot \left(\frac{34\text{mm}}{35\text{mm}} - 1\right)^2}$$

36) Velocity given Leakage

Open Calculator

$$v = \frac{Q_o}{A}$$

$$120.1923\text{m/s} = \frac{2.5\text{E}7\text{mm}^3/\text{s}}{0.000208\text{m}^2}$$

Variables Used

- **a** Outer Radius of Plain Bush Seal *(Millimeter)*
- **A** Area *(Square Meter)*
- **b** Inner Radius of Plain Bush Seal *(Millimeter)*
- **c** Radial Clearance For Seals *(Millimeter)*
- **d** Diameter of Seal Bolt *(Millimeter)*
- d_1 Outside Diameter of Seal Ring *(Millimeter)*
- D_i Inside Diameter of Packing Gasket *(Millimeter)*
- d_l Incremental Length in Direction of Velocity *(Millimeter)*
- D_o Outside Diameter of Packing Gasket *(Millimeter)*
- **E** Modulus of Elasticity *(Megapascal)*
- **h** Radial Ring Wall Thickness *(Millimeter)*
- h_μ Loss of Liquid Head *(Millimeter)*
- **l** Depth of U Collar *(Millimeter)*
- **p** Pressure At Radial Position For Bush Seal *(Megapascal)*
- p_1 Fluid Pressure 1 For Seal *(Megapascal)*
- p_2 Fluid Pressure 2 For Seal *(Megapascal)*
- P_2 Internal Hydraulic Pressure *(Megapascal)*
- P_e Exit Pressure *(Megapascal)*
- P_i Pressure at Seal Inside Radius *(Megapascal)*
- P_l Power Loss For Seal *(Watt)*
- P_s Minimum Percentage Compression
- **q** Volumetric Flow Rate Per Unit Pressure *(Cubic Millimeter per Second)*
- **Q** Oil Flow From Bush Seal *(Cubic Millimeter per Second)*
- Q_l Fluid Leakage From Packingless Seals *(Cubic Millimeter per Second)*
- Q_o Discharge Through Orifice *(Cubic Millimeter per Second)*
- **r** Radial Position in Bush Seal *(Millimeter)*
- **R** Radius of Rotating Member Inside Bush Seal *(Millimeter)*
- r_1 Inner Radius of Rotating Member Inside Bush Seal *(Millimeter)*
- r_2 Outer Radius of Rotating Member Inside Bush Seal *(Millimeter)*
- r_s Radius of Seal *(Millimeter)*
- S_{pf} Shape Factor For Circular Gasket
- **t** Thickness of Fluid Between Members *(Millimeter)*
- **v** Velocity *(Meter per Second)*
- V_a Actual Volume *(Cubic Meter)*

- **V_p** Piston Swept Volume *(Cubic Meter)*
- **w** Nominal Packing Cross Section of Bush Seal *(Millimeter)*
- **Δp** Pressure Change *(Megapascal)*
- **η_v** Volumetric Efficiency
- **μ** Absolute Viscosity of Oil in Seals *(Centipoise)*
- **ν** Kinematic Viscosity of Bush Seal Fluid *(Stokes)*
- **ρ** Seal Fluid Density *(Kilogram per Cubic Meter)*
- **ρ_l** Density Of Liquid *(Kilogram per Cubic Meter)*
- **σ_s** Stress in Seal Ring *(Megapascal)*
- **ω** Rotational Speed of Shaft Inside Seal *(Radian per Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Function: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Function: **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: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Millimeter per Second (mm^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Dynamic Viscosity** in Centipoise (cP)
  Dynamic Viscosity Unit Conversion
- Measurement: **Kinematic Viscosity** in Stokes (St)
  Kinematic Viscosity Unit Conversion
- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion

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