Important Seals Formulas PDF

Formulas
Examples
with Units

List of 36
Important Seals Formulas

1) Leakage through Bush Seals Formulas

1.1) Amount of Leakage of Fluid through Face Seal Formula

Evaluate Formula

Formula

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

Example with Units

$$259501.2447\,\text{mm}^3/\text{s} = \frac{3.1416 \cdot 1.92\,\text{mm}^3}{6 \cdot 7.25\,\text{St} \cdot \ln\left(\frac{20\,\text{mm}}{14\,\text{mm}}\right)} \cdot \left(\frac{3 \cdot 1100\,\text{kg/m}^3 \cdot 75\,\text{rad/s}^2}{20 \cdot 9.8066\,\text{m/s}^2} \cdot \left(20\,\text{mm}^2 - 14\,\text{mm}^2\right) - 1\text{E-}6\,\text{MPa} - .0000002\,\text{MPa}\right)$$

1.2) Inside Diameter of Gasket given Shape Factor Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$0.1893\,\text{MPa} = .0000002\,\text{MPa} + \frac{3 \cdot 1100\,\text{kg/m}^3 \cdot 75\,\text{rad/s}^2}{20} \cdot \left(20\,\text{mm}^2 - 14\,\text{mm}^2\right) \cdot 1000$$

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

Evaluate Formula

Formula

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

Example with Units

$$7.255\,\text{St} = \frac{13200 \cdot 7.9\text{E-}16\,\text{W} \cdot 1.92\,\text{mm}}{3.1416 \cdot 8.5\,\text{mm}^2 \cdot \left(20\,\text{mm}^4 - 14\,\text{mm}^4\right)}$$

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

Evaluate Formula

Formula

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

Example with Units

$$266669.4441\,\text{mm}^3/\text{s} = \frac{2 \cdot 3.1416 \cdot 15\,\text{mm} \cdot \left(16 - \frac{2.1\,\text{MPa}}{10^6} \right)}{0.038262\,\text{mm}} \cdot 7.788521\,\text{mm}^3/\text{s}$$

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

Evaluate Formula

Formula

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

Example with Units

$$944.7506\,\text{mm}^3/\text{s} = \frac{2 \cdot 3.1416 \cdot 15\,\text{mm} \cdot \left(16 - \frac{2.1\,\text{MPa}}{10^6} \right)}{15\,\text{mm} - 4.2\,\text{mm}} \cdot 7.788521\,\text{mm}^3/\text{s}$$

1.7) Outside Diameter of Gasket given Shape Factor Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$20.0026\,\text{mm} = \left(\frac{7.9\text{E-}16\,\text{w}}{\frac{3.1416 \cdot 7.25\,\text{St} \cdot 8.5\,\text{mm}^2}{13200 \cdot 1.92\,\text{mm}}} + 14\,\text{mm}^4 \right)^{\frac{1}{4}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$7.9\text{E-}16\,\text{w} = \frac{3.1416 \cdot 7.25\,\text{St} \cdot 8.5\,\text{mm}^2}{13200 \cdot 1.92\,\text{mm}} \cdot \left(20\,\text{mm}^4 - 14\,\text{mm}^4 \right)$$

1.10) Radial Pressure Distribution for Laminar Flow Formula

Evaluate Formula

Formula

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

Example with Units

$$0.092\,\text{MPa} = .0000002\,\text{MPa} + \frac{3 \cdot 1100\,\text{kg/m}^3 \cdot 75\,\text{rad/s}^2}{20 \cdot 9.8066\,\text{m/s}^2} \cdot \left(25\,\text{mm}^2 - 14\,\text{mm}^2 \right) - \frac{6 \cdot 7.25\,\text{St}}{3.1416 \cdot 1.92\,\text{mm}^3} \cdot \ln\left(\frac{25\,\text{mm}}{40\,\text{mm}} \right)$$

1.11) Shape Factor for Circular or Annular Gasket Formula

Evaluate Formula

Formula

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

Example with Units

$$0.7812 = \frac{60\,\text{mm} - 54\,\text{mm}}{4 \cdot 1.92\,\text{mm}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$1.9187\,\text{mm} = \frac{3.1416 \cdot 7.25\,\text{St} \cdot 8.5\,\text{mm}^2}{13200 \cdot 7.9\text{E-}16\,\text{W}} \cdot \left(20\,\text{mm}^4 - 14\,\text{mm}^4 \right)$$

1.13) Thickness of Fluid between Members given Shape Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$1.9231\,\text{mm} = \frac{60\,\text{mm} - 54\,\text{mm}}{4 \cdot 0.78}$$

1.14) Volumetric Efficiency of Reciprocating Compressor Formula

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$7.7885\,\text{mm}^3/\text{s} = \frac{0.9\,\text{mm}^3}{12 \cdot 7.8\,\text{cP}} \cdot \frac{16 + 2.1\,\text{MPa}}{2.1\,\text{MPa}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$2.8039\,\text{mm}^3/\text{s} = \frac{0.9\,\text{mm}^3}{24 \cdot 7.8\,\text{cP}} \cdot \frac{15\,\text{mm} - 4.2\,\text{mm}}{15\,\text{mm}} \cdot \frac{16 + 2.1\,\text{MPa}}{2.1\,\text{MPa}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$4.4052\,\text{mm}^3/\text{s} = \frac{0.9\,\text{mm}^3}{12 \cdot 7.8\,\text{cP}} \cdot \frac{15\,\text{mm} - 4.2\,\text{mm}}{15\,\text{mm} \cdot \ln\left(\frac{15\,\text{mm}}{4.2\,\text{mm}}\right)}$$

2) Packingless Seals Formulas

2.1) Depth of U Collar given Leakage Formula

Evaluate Formula

Formula

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

Example with Units

$$55493.8456\,\text{mm} = \frac{3.1416 \cdot 0.9\,\text{mm}^3}{12} \cdot \left(200.8501\,\text{MPa} - 2.85\,\text{MPa}\right) \cdot \frac{12.6\,\text{mm}}{7.8\,\text{cP} \cdot 1.1\text{E}6\,\text{mm}^3/\text{s}}$$

2.2) Diameter of Bolt given Leakage of Fluid Formula

Evaluate Formula

Formula

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

Example with Units

$$8.7\text{E}{-6}\,\text{mm} = \frac{12 \cdot 0.038262\,\text{mm} \cdot 7.8\,\text{cP} \cdot 1.1\text{E}6\,\text{mm}^3/\text{s}}{3.1416 \cdot 0.9\,\text{mm}^3 \cdot \left(200.8501\,\text{MPa} - 2.85\,\text{MPa}\right)}$$

2.3) Leakage of Fluid past Rod Formula

Evaluate Formula

Formula

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

Example with Units

$$1.6\text{E}{+12}\,\text{mm}^3/\text{s} = \frac{3.1416 \cdot 0.9\,\text{mm}^3}{12} \cdot \left(200.8501\,\text{MPa} - 2.85\,\text{MPa}\right) \cdot \frac{12.6\,\text{mm}}{0.038262\,\text{mm} \cdot 7.8\,\text{cP}}$$

2.4) Radial Clearance given Leakage Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0092\,\text{mm} = \left(\frac{12 \cdot 0.038262\,\text{mm} \cdot 7.8\,\text{cP} \cdot 1.1\text{E}6\,\text{mm}^3/\text{s}}{3.1416 \cdot 12.6\,\text{mm} \cdot 200.8501\,\text{MPa} - 2.85\,\text{MPa}}\right)^{\frac{1}{3}}$$

3) Straight Cut Sealings Formulas

3.1) Absolute Viscosity given Leakage Velocity Formula

Evaluate Formula

Formula

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

Example with Units

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

3.2) Absolute Viscosity given Loss of Liquid Head Formula

Evaluate Formula

Formula

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

Example with Units

$$7.8\,\text{cP} = \frac{2 \cdot 9.8066\,\text{m/s}^2 \cdot 997\,\text{kg/m}^3 \cdot 2642.488\,\text{mm} \cdot 34\,\text{mm}^2}{64 \cdot 119.6581\,\text{m/s}}$$

3.3) Area of Seal in contact with Sliding member given Leakage Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0002\,\text{m}^2 = \frac{2.5\text{E}7\,\text{mm}^3/\text{s}}{119.6581\,\text{m/s}}$$

3.4) Change in Pressure given Leakage Velocity Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0001\,\text{MPa} = \frac{8 \cdot 1.5\,\text{mm} \cdot 7.8\,\text{cP} \cdot 119.6581\,\text{m/s}}{10\,\text{mm}^2}$$

3.5) Density of Liquid given Loss of Liquid Head Formula

Evaluate Formula

Formula

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

Example with Units

$$997\,\text{kg/m}^3 = \frac{64 \cdot 7.8\,\text{cP} \cdot 119.6581\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2 \cdot 2642.488\,\text{mm} \cdot 34\,\text{mm}^2}$$

3.6) Incremental Length in Direction of Velocity given Leakage Velocity Formula

Evaluate Formula

Formula

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

Example with Units

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

3.7) Leakage Velocity Formula

Evaluate Formula

Formula

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

Example with Units

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

3.8) Loss of Liquid Head Formula

Evaluate Formula

Formula

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

Example with Units

$$2642.488\,\text{mm} = \frac{64 \cdot 7.8\,\text{cP} \cdot 119.6581\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2 \cdot 997\,\text{kg/m}^3 \cdot 34\,\text{mm}^{\,2}}$$

3.9) Modulus of Elasticity given Stress in Seal Ring Formula

Evaluate Formula

Formula

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

Example with Units

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

3.10) Outer Diameter of Seal Ring given Loss of Liquid Head Formula

Evaluate Formula

Formula

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

Example with Units

$$34\,\text{mm} = \sqrt{\frac{64 \cdot 7.8\,\text{cP} \cdot 119.6581\,\text{m/s}}{2 \cdot 9.8066\,\text{m/s}^2 \cdot 997\,\text{kg/m}^3 \cdot 2642.488\,\text{mm}}}$$

3.11) Quantity of Leakage Formula

Evaluate Formula

Formula

$$Q_o = v \cdot A$$

Example with Units

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

3.12) Radial Clearance given Stress in Seal Ring Formula

Evaluate Formula

Formula

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

Example with Units

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

3.13) Radius given Leakage Velocity Formula

Evaluate Formula

Formula

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

Example with Units

$$10\,\text{mm} = \sqrt{\frac{8 \cdot 1.5\,\text{mm} \cdot 7.8\,\text{cP} \cdot 119.6581\,\text{m/s}}{0.000112\,\text{MPa}}}$$

3.14) Stress in Seal Ring Formula

Evaluate Formula

Formula

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

Example with Units

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

3.15) Velocity given Leakage Formula

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Seals Formulas above

- **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)*

Constants, Functions, Measurements used in list of Seals Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[g]**, 9.80665 *Gravitational acceleration on Earth*
- Functions: **ln**, ln(Number) *The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.*
- 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: **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*

- 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)*

Download other Important Design of Coupling PDFs

- Important Design of Cotter Joint Formulas
- Important Design of Knuckle Joint Formulas
- Important Design of Rigid Flange Coupling Formulas
- Important Packing Formulas
- Important Retaining Rings and Circlips Formulas
- Important Riveted Joints Formulas
- Important Seals Formulas
- Important Threaded Bolted Joints Formulas

Try our Unique Visual Calculators

- Percentage error
- LCM of three numbers
- Subtract fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

10/29/2024 | 11:20:32 AM UTC