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Rolling Process Formulas

Calculators! Examples! Conversions!

List of 18 Rolling Process Formulas

Rolling Process

Analysis at Entry Region

1) Mean Yield Shear Stress given Pressure on Entry Side

Open Calculator

fx $$S_e = \frac{P_{en} \cdot \frac{h_{in}}{h_e}}{\exp\left(\mu_{rp} \cdot (H_{in} - H_x)\right)}$$

ex $$4359.697\text{Pa} = \frac{0.0000099\text{N/mm}^2 \cdot \frac{3.5\text{mm}}{0.011\text{mm}}}{\exp(0.5 \cdot (3.35 - 4))}$$

2) Pressure Acting on Rolls from Entry Side

Open Calculator

fx $$P_{en} = S_e \cdot \frac{h_e}{h_{in}} \cdot \exp\left(\mu_{rp} \cdot \left(2 \cdot \sqrt{\frac{R_{roller}}{h_f}} \cdot a\tan\left(\Theta_r \cdot \sqrt{\frac{R_{roller}}{h_f}}\right) - 2 \cdot \sqrt{\frac{R_{roller}}{h_f}} \cdot a\tan\left(\alpha_{b}\right.\right.\right.$$

ex $$3.5\text{E\^{}-6N/mm}^2 = 4359.69\text{Pa} \cdot \frac{0.011\text{mm}}{3.5\text{mm}} \cdot \exp\left(0.5 \cdot \left(2 \cdot \sqrt{\frac{104\text{mm}}{7.5\text{mm}}} \cdot a\tan\left(18.5^\circ \cdot \sqrt{\frac{104\text{mm}}{7.5\text{mm}}}\right) - 2 \cdot \sqrt{\frac{104}{7.5}}\right.\right.$$

3) Pressure on Rolls given H (Entry Side)

Open Calculator

fx $$P_{en} = S_e \cdot \frac{h_e}{h_{in}} \cdot \exp\left(\mu_{rp} \cdot (H_{in} - H_x)\right)$$

ex $$9.9\text{E\^{}-6N/mm}^2 = 4359.69\text{Pa} \cdot \frac{0.011\text{mm}}{3.5\text{mm}} \cdot \exp(0.5 \cdot (3.35 - 4))$$

4) Thickness of Stock at given Point on Entry Side

Open Calculator

fx $$h_e = \frac{P_{en} \cdot h_{in}}{S_e \cdot \exp\left(\mu_{rp} \cdot (H_{in} - H_x)\right)}$$

ex $$0.011\text{mm} = \frac{0.0000099\text{N/mm}^2 \cdot 3.5\text{mm}}{4359.69\text{Pa} \cdot \exp(0.5 \cdot (3.35 - 4))}$$

Analysis at Exit Region

5) Mean Yield Shear Stress using Pressure on Exit Side

Open Calculator

$$S_y = \frac{P_{rolls} \cdot h_{ft}}{h_x \cdot \exp(\mu_r \cdot H)}$$

$$22027.01\text{Pa} = \frac{0.000190\text{N/mm}^2 \cdot 7.3\text{mm}}{0.003135\text{mm} \cdot \exp(0.6 \cdot 5)}$$

6) Pressure Acting on Rolls in Exit Region

Open Calculator

$$P_{ex} = S_y \cdot \frac{h_x}{h_{ft}} \cdot \exp\left(\mu_r \cdot 2 \cdot \sqrt{\frac{R_{roll}}{h_{ft}}} \cdot a\tan\left(\Theta_r \cdot \sqrt{\frac{R_{roll}}{h_{ft}}}\right)\right)$$

$$0.000459\text{N/mm}^2 = 22027.01\text{Pa} \cdot \frac{0.003135\text{mm}}{7.3\text{mm}} \cdot \exp\left(0.6 \cdot 2 \cdot \sqrt{\frac{100\text{mm}}{7.3\text{mm}}} \cdot a\tan\left(18.5^\circ \cdot \sqrt{\frac{100\text{mm}}{7.3\text{mm}}}\right)\right)$$

7) Pressure on Rolls given H (Exit Side)

Open Calculator

$$P_{rolls} = S_y \cdot \frac{h_x}{h_{ft}} \cdot \exp(\mu_r \cdot H)$$

$$0.00019\text{N/mm}^2 = 22027.01\text{Pa} \cdot \frac{0.003135\text{mm}}{7.3\text{mm}} \cdot \exp(0.6 \cdot 5)$$

8) Thickness of Stock at given Point on Exit Side

Open Calculator

$$h_x = \frac{P_{rolls} \cdot h_{ft}}{S_y \cdot \exp(\mu_r \cdot H)}$$

$$0.003135\text{mm} = \frac{0.000190\text{N/mm}^2 \cdot 7.3\text{mm}}{22027.01\text{Pa} \cdot \exp(0.6 \cdot 5)}$$

Rolling Analysis

9) Angle Subtended by Neutral Point

Open Calculator

$$\varphi_n = \sqrt{\frac{h_{fi}}{R}} \cdot \tan\left(\frac{H_n}{2} \cdot \sqrt{\frac{h_{fi}}{R}}\right)$$

$$5.518163^\circ = \sqrt{\frac{7.2\text{mm}}{102\text{mm}}} \cdot \tan\left(\frac{2.617882}{2} \cdot \sqrt{\frac{7.2\text{mm}}{102\text{mm}}}\right)$$

10) Bite Angle

Open Calculator

fx $$\alpha_b = a\cos\left(1 - \frac{h}{2 \cdot R}\right)$$

ex $$30.03884° = a\cos\left(1 - \frac{27.4\text{mm}}{2 \cdot 102\text{mm}}\right)$$

11) Factor H at Neutral Point

Open Calculator

fx $$H_n = \frac{H_i - \frac{\ln\left(\frac{h_i}{h_{fi}}\right)}{\mu_f}}{2}$$

ex $$2.617882 = \frac{3.36 - \frac{\ln\left(\frac{3.4\text{mm}}{7.2\text{mm}}\right)}{0.4}}{2}$$

12) Factor H used in Rolling Calculations

Open Calculator

fx $$H_r = 2 \cdot \sqrt{\frac{R}{h_{fi}}} \cdot a\tan\left(\sqrt{\frac{R}{h_{fi}}}\right) \cdot \Theta_r$$

ex $$3.186783 = 2 \cdot \sqrt{\frac{102\text{mm}}{7.2\text{mm}}} \cdot a\tan\left(\sqrt{\frac{102\text{mm}}{7.2\text{mm}}}\right) \cdot 18.5°$$

13) Initial Stock Thickness given Pressure on Rolls

Open Calculator

fx $$h_t = \frac{S \cdot h_s \cdot \exp(\mu_f \cdot (H_i - H_r))}{P}$$

ex $$1.047159\text{mm} = \frac{58730\text{Pa} \cdot 0.00313577819561353\text{mm} \cdot \exp(0.4 \cdot (3.36 - 3.18))}{0.000189\text{N}/\text{mm}^2}$$

14) Maximum Reduction in Thickness Possible

Open Calculator

fx $$\Delta t = \mu_f^2 \cdot R$$

ex $$16.32\text{mm} = (0.4)^2 \cdot 102\text{mm}$$

15) Pressure Considering Rolling Similar to Plane-Strain-Upsetting Process

Open Calculator

fx $$P_r = b \cdot \frac{2 \cdot \sigma}{\sqrt{3}} \cdot \left(1 + \frac{\mu_{sf} \cdot R \cdot \frac{\pi}{180} \cdot \alpha_b}{2 \cdot (h_i + h_{fi})}\right) \cdot R \cdot \frac{\pi}{180} \cdot \alpha_b$$

ex $$3.3E\hat{}\text{-}5N/mm^2 = 14.5mm \cdot \frac{2 \cdot 2.1N/mm^2}{\sqrt{3}} \cdot \left(1 + \frac{0.41 \cdot 102mm \cdot \frac{\pi}{180} \cdot 30.00^\circ}{2 \cdot (3.4mm + 7.2mm)}\right) \cdot 102mm \cdot \frac{\pi}{180} \cdot 30.00^\circ$$

16) Projected Area

Open Calculator

fx $$A = w \cdot (R \cdot \Delta t)^{0.5}$$

ex $$1.224cm^2 = 3mm \cdot (102mm \cdot 16.32mm)^{0.5}$$

17) Projected Length

Open Calculator

fx $$L = (R \cdot \Delta t)^{0.5}$$

ex $$40.8mm = (102mm \cdot 16.32mm)^{0.5}$$

18) Total Elongation of Stock

Open Calculator

fx $$E = \frac{A_i}{A_f}$$

ex $$6.666667 = \frac{60cm^2}{9cm^2}$$

Variables Used

- **A** Projected Area *(Square Centimeter)*
- **A_f** Final Cross Sectional Area *(Square Centimeter)*
- **A_i** Initial Cross Sectional Area *(Square Centimeter)*
- **b** Strip Width of Spiral Spring *(Millimeter)*
- **E** Total Stock or Workpiece Elongation
- **h** Height *(Millimeter)*
- **H** Factor H at given Point on Workpiece
- **h_e** Thickness at Entry *(Millimeter)*
- **h_f** Final Thickness after Rolling *(Millimeter)*
- **h_{fi}** Thickness after Rolling *(Millimeter)*
- **h_{ft}** Final Thickness *(Millimeter)*
- **h_i** Thickness before Rolling *(Millimeter)*
- **H_i** Factor H at Entry Point on Workpiece
- **h_{in}** Initial Thickness *(Millimeter)*
- **H_{in}** H Factor at Entry Point on Workpiece
- **H_n** Factor H at Neutral Point
- **H_r** Factor H in Rolling Calculation
- **h_s** Thickness at given Point *(Millimeter)*
- **h_t** Initial Stock Thickness *(Millimeter)*
- **h_x** Thickness at the given Point *(Millimeter)*
- **H_x** Factor H at a Point on Workpiece
- **L** Projected Length *(Millimeter)*
- **P** Pressure Acting on Rolls *(Newton per Square Millimeter)*
- **P_{en}** Pressure Acting at Entry *(Newton per Square Millimeter)*
- **P_{ex}** Pressure Acting on Exit *(Newton per Square Millimeter)*
- **P_r** Pressure Acting while Rolling *(Newton per Square Millimeter)*
- **P_{rolls}** Pressure on Roller *(Newton per Square Millimeter)*
- **R** Roller Radius *(Millimeter)*
- **R_{roll}** Roll Radius *(Millimeter)*
- **R_{roller}** Radius of Roller *(Millimeter)*
- **S** Mean Yield Shear Stress of Work Material *(Pascal)*
- **S_e** Mean Yield Shear Stress *(Pascal)*
- **S_y** Mean Yield Shear Stress at Exit *(Pascal)*

- **w** Width *(Millimeter)*
- **α_b** Bite Angle *(Degree)*
- **α_{bite}** Angle of Bite *(Degree)*
- **Δt** Change in Thickness *(Millimeter)*
- **Θ_r** Angle made by Point Roll Center and Normal *(Degree)*
- **μ_f** Friction Coefficient in Rolling Analysis
- **μ_r** Friction Coefficient
- **μ_{rp}** Coefficient of Friction
- **μ_{sf}** Frictional Shear Factor
- **σ** Flow Stress of Work Material *(Newton per Square Millimeter)*
- **φ_n** Angle subtended at Neutral Point *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **acos**, acos(Number)
  The inverse cosine function, is the inverse function of the cosine function. It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.
- Function: **atan**, atan(Number)
  Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- 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.
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Centimeter (cm^2)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Millimeter (N/mm^2)
  Pressure Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Stress** in Pascal (Pa)
  Stress Unit Conversion

Check other formula lists

- Composite Materials Formulas
- Rolling Process Formulas

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