



Rolling Process Formulas

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List of 18 Rolling Process Formulas

Rolling Process @

Analysis at Entry Region 🗗

1) Mean Yield Shear Stress given Pressure on Entry Side

$$\label{eq:Se} \boxed{ \begin{split} \mathbf{F}_{e} &= \frac{P_{e} \cdot \frac{h_{in}}{h_{e}}}{\exp \left(\mu_{rp} \cdot \left(H_{in} - H_{x} \right) \right)} \end{split} }$$

2) Pressure Acting on Rolls from Entry Side

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$$ext{P}_{ ext{e}} = ext{S}_{ ext{e}} \cdot rac{ ext{h}_{ ext{e}}}{ ext{h}_{ ext{in}}} \cdot ext{exp} \left(\mu_{ ext{rp}} \cdot \left(2 \cdot \sqrt{rac{ ext{R}_{ ext{roller}}}{ ext{h}_{ ext{f}}}} \cdot a an \left(\Theta_{ ext{r}} \cdot \sqrt{rac{ ext{R}_{ ext{roller}}}{ ext{h}_{ ext{f}}}}
ight) - 2 \cdot \sqrt{rac{ ext{R}_{ ext{roller}}}{ ext{h}_{ ext{f}}}} \cdot a an \left(lpha_{ ext{bi}}
ight)$$

ex

$$5.3 \text{E}^{-6} \text{N/mm}^{2} = 5896.83 \cdot \frac{0.011 \text{mm}}{3.5 \text{mm}} \cdot \exp \left(0.5 \cdot \left(2 \cdot \sqrt{\frac{104 \text{mm}}{7.5 \text{mm}}} \cdot a \tan \left(19.5^{\circ} \cdot \sqrt{\frac{104 \text{mm}}{7.5 \text{mm}}}\right) - 2 \cdot \sqrt{\frac{104 \text{mm}}{7.5 \text{mm}}}\right) - 2 \cdot \sqrt{\frac{104 \text{mm}}{7.5 \text{mm}}}\right) - 2 \cdot \sqrt{\frac{104 \text{mm}}{7.5 \text{mm}}} \cdot a \cdot \frac{104 \text{mm}}{7.5 \text{mm}}} = \frac{10.011 \text{mm}}{10.011 \text{mm}} \cdot \frac{10.011 \text{mm}}{10.011$$

3) Pressure on Rolls given H (Entry Side)

$$P_{e} = S_{e} \cdot rac{h_{e}}{h_{in}} \cdot exp ig(\mu_{rp} \cdot (H_{in} - H_{x}) ig)$$

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4) Thickness of Stock at given Point on Entry Side

$$h_{e} = rac{P_{e} \cdot h_{in}}{S_{e} \cdot expig(\mu_{rp} \cdot (H_{in} - H_{x})ig)}$$

Open Calculator





Analysis at Exit Region 🗗

5) Mean Yield Shear Stress using Pressure on Exit Side

$$\text{fx} \left[S_y = \frac{P_{rolls} \cdot h_{ft}}{h_x \cdot exp(\mu_r \cdot H)} \right]$$

Open Calculator 🛂

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

6) Pressure Acting on Rolls in Exit Region

$$\mathbf{R} \mathbf{P}_{\mathrm{ex}} = \mathbf{S}_{\mathrm{y}} \cdot rac{\mathbf{h}_{\mathrm{x}}}{\mathbf{h}_{\mathrm{ft}}} \cdot \exp \left(\mathbf{\mu}_{\mathrm{r}} \cdot 2 \cdot \sqrt{rac{\mathbf{R}_{\mathrm{roll}}}{\mathbf{h}_{\mathrm{ft}}}} \cdot a an \left(\mathbf{\Theta}_{\mathrm{cn}} \cdot \sqrt{rac{\mathbf{R}_{\mathrm{roll}}}{\mathbf{h}_{\mathrm{ft}}}}
ight)
ight)$$

$$\underbrace{ 0.001083 \text{N}/\text{mm}^2 = 58735 \cdot \frac{0.003135 \text{mm}}{7.3 \text{mm}} \cdot \exp \left(0.6 \cdot 2 \cdot \sqrt{\frac{100 \text{mm}}{7.3 \text{mm}}} \cdot a \tan \left(17.5^{\circ} \cdot \sqrt{\frac{100 \text{mm}}{7.3 \text{mm}}} \right) \right) }$$

7) Pressure on Rolls given H (Exit Side)

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

Open Calculator 🗗

8) Thickness of Stock at given Point on Exit Side

$$\boxed{\mathbf{fx}} \left[h_x = \frac{P_{rolls} \cdot h_{ft}}{S_y \cdot exp(\mu_r \cdot H)} \right]$$

$\boxed{ \text{ex} \ 0.001176 mm = \frac{0.000190 N / mm^2 \cdot 7.3 mm}{58735 \cdot exp(0.6 \cdot 5)} }$

Rolling Analysis 🗗

9) Angle Subtended by Neutral Point

$$\phi_{
m N} = \sqrt{rac{h_{
m fi}}{R}} \cdot an \Biggl(rac{H_{
m n}}{2} \cdot \sqrt{rac{h_{
m fi}}{R}}\Biggr)$$





10) Bite Angle 🚰

$$lpha_{
m b} = a \cos igg(1 - rac{
m h}{2 \cdot
m R} igg)$$

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$$\boxed{ 20.03884^{\circ} = a \cos \bigg(1 - \frac{27.4 \mathrm{mm}}{2 \cdot 102 \mathrm{mm}} \bigg) }$$

11) Factor H at Neutral Point 🗗

fx
$$H_{n}=rac{H_{i}-rac{\ln\left(rac{h_{i}}{h_{fi}}
ight)}}{2}$$

ex
$$2.617882 = rac{3.36 - rac{\ln\left(rac{3.4 mm}{7.2 mm}
ight)}{0.4}}{2}$$

12) Factor H used in Rolling Calculations

$$extstyle H_{
m r} = 2 \cdot \sqrt{rac{
m R}{
m h_{
m fi}}} \cdot a an \Biggl(\sqrt{rac{
m R}{
m h_{
m fi}}}\Biggr) \cdot \Theta$$

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

13) Initial Stock Thickness given Pressure on Rolls 🗗

$$\mathbf{h}_{\mathrm{t}} = rac{\mathrm{S} \cdot \mathrm{h}_{\mathrm{s}} \cdot \exp(\mu_{\mathrm{friction}} \cdot (\mathrm{H_{i}} - \mathrm{H_{r}}))}{\mathrm{P}}$$

14) Maximum Reduction in Thickness Possible 🗗

fx
$$\Delta t = \mu_{friction}^2 \cdot R$$

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

Open Calculator

Open Calculator



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

$$\boxed{\mathbf{R}} P_r = b \cdot \frac{2 \cdot \sigma}{\sqrt{3}} \cdot \left(1 + \frac{\mu_{shear \, factor} \cdot R \cdot \frac{\pi}{180} \cdot \alpha_b}{2 \cdot (h_i + h_{fi})}\right) \cdot R \cdot \frac{\pi}{180} \cdot \alpha_b}$$

Open Calculator

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

16) Projected Area

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

Open Calculator

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

17) Projected Length

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

Open Calculator

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

18) Total Elongation of Stock

$$\mathbf{E} = rac{A_i}{A_f}$$

$$= \frac{60 \text{cm}^2}{9 \text{cm}^2}$$

Variables Used

- A Projected Area (Square Centimeter)
- Af Final Cross Sectional Area (Square Centimeter)
- Ai 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** Thickness at Entry (Millimeter)
- **h**f Final Thickness after Rolling (Millimeter)
- hfi Thickness after Rolling (Millimeter)
- hft Final Thickness (Millimeter)
- **h**_i Thickness before Rolling (Millimeter)
- Hi Factor H at Entry Point on Workpiece
- hin Initial Thickness (Millimeter)
- H_{in} Factor H at the Entry Point on Workpiece
- Hn Factor H at Neutral Point
- H_r Factor H in Rolling Calculation
- h_s Thickness at given Point (Millimeter)
- ht Initial Stock Thickness (Millimeter)
- **h**_x Thickness at the given Point (Millimeter)
- H_x Factor H at a given Point on Workpiece
- L Projected Length (Millimeter)
- P Pressure Acting on Rolls (Newton per Square Millimeter)
- Pe Pressure Acting at Entry (Newton per Square Millimeter)
- Pex Pressure Acting on Exit (Newton per Square Millimeter)
- Pressure Acting while Rolling (Newton per Square Millimeter)
- Prolls Pressure on Rolls (Newton per Square Millimeter)
- R Roller Radius (Millimeter)
- Rroll Roll Radius (Millimeter)
- Rroller The Roller Radius (Millimeter)
- S Mean Yield Shear Stress of Work Material
- Se Mean Yield Shear Stress at Entry
- S_v Mean Yield Shear Stress in RP





- w Width (Millimeter)
- α_b Bite Angle (Degree)
- α_{bite} Angle of Bite (Degree)
- Δt Change in Thickness (Millimeter)
- O Angle made by given Point Roll Center and Normal (Degree)
- Θ_{cn} Angle made by Roll Center and Normal (Degree)
- $\Theta_{\mathbf{r}}$ Angle made by Point Roll Center and Normal (Degree)
- **µ**friction Friction Coefficient
- µr Coefficient of Friction in RP
- μ_{rp} Coefficient of Friction
- **µ**shear factor 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: In, In(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 (cm²)

Area Unit Conversion

• Measurement: Pressure in Newton per Square Millimeter (N/mm²)

Pressure Unit Conversion

• Measurement: Angle in Degree (°)

Angle Unit Conversion 🗹





Check other formula lists

Composite Materials Formulas

Rolling Process Formulas

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