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Rolling Process Formulas

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List of 18 Rolling Process Formulas

Rolling Process

1) Angle Subtended by Neutral Point

Open Calculator

fx $$\varphi_N = \sqrt{\frac{h_{fi}}{R}} \cdot \tan\left(\frac{H_N}{2} \cdot \sqrt{\frac{h_{fi}}{R}}\right)$$

ex $$7.428548^\circ = \sqrt{\frac{4.7\text{mm}}{30.01\text{mm}}} \cdot \tan\left(\frac{1.6}{2} \cdot \sqrt{\frac{4.7\text{mm}}{30.01\text{mm}}}\right)$$

2) Bite Angle

Open Calculator

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

ex $$36.86353^\circ = a\cos\left(1 - \frac{12\text{mm}}{2 \cdot 30.01\text{mm}}\right)$$

3) Factor H at Neutral Point

Open Calculator

fx $$H_N = \frac{H_i - \frac{\ln\left(\frac{h_i}{h_{fi}}\right)}{\mu_{friction}}}{2}$$

ex $$1.197656 = \frac{2.55 - \frac{\ln\left(\frac{5\text{mm}}{4.7\text{mm}}\right)}{0.4}}{2}$$

4) Factor H used in Rolling Calculations

Open Calculator

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

ex $$0.683405 = 2 \cdot \sqrt{\frac{30.01\text{mm}}{4.7\text{mm}}} \cdot a\tan\left(45^\circ \cdot \sqrt{30.01\text{mm}}\right)$$

5) Initial Stock Thickness given Pressure on Rolls

Open Calculator

$$h_i = \frac{S \cdot h_s \cdot \exp(\mu_{friction} \cdot (H_i - H))}{P}$$

$$8.560138\text{mm} = \frac{4 \cdot 2.5\text{mm} \cdot \exp(0.4 \cdot (2.55 - 0.75))}{2.4\text{E}\hat{}\text{-6N/mm}^2}$$

6) Maximum Reduction in Thickness Possible

Open Calculator

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

$$4.8016\text{mm} = (0.4)^2 \cdot 30.01\text{mm}$$

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

Open Calculator

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

$$9.5\text{E}\hat{}\text{-6N/mm}^2 = 11.52\text{mm} \cdot \frac{2 \cdot 2.6\text{N/mm}^2}{\sqrt{3}} \cdot \left(1 + \frac{0.41 \cdot 30.01\text{mm} \cdot \frac{\pi}{180} \cdot 30^\circ}{2 \cdot (5\text{mm} + 4.7\text{mm})}\right) \cdot 30.01\text{mm} \cdot \frac{\pi}{180} \cdot 30^\circ$$

8) Projected Area

Open Calculator

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

$$0.434814\text{cm}^2 = 3\text{mm} \cdot (30.01\text{mm} \cdot 7\text{mm})^{0.5}$$

9) Projected Length

Open Calculator

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

$$14.49379\text{mm} = (30.01\text{mm} \cdot 7\text{mm})^{0.5}$$

10) Total Elongation of Stock

Open Calculator

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

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

Entry

11) Mean Yield Shear Stress given Pressure on Entry Side

Open Calculator

$$S = \frac{P \cdot \frac{h_i}{h_s}}{\exp(\mu_{friction} \cdot (H_i - H))}$$

$$2.336411 = \frac{2.4E^{\wedge}\text{-}6N/mm^2 \cdot \frac{5mm}{2.5mm}}{\exp(0.4 \cdot (2.55 - 0.75))}$$

12) Pressure Acting on Rolls from Entry Side

Open Calculator

$$P = S \cdot \frac{h_s}{h_i} \cdot \exp\left(\mu_{friction} \cdot \left(2 \cdot \sqrt{\frac{R}{h_{fi}}} \cdot a\tan\left(\Theta \cdot \sqrt{\frac{R}{h_{fi}}}\right) - 2 \cdot \sqrt{\frac{R}{h_{fi}}} \cdot a\tan\left(\alpha_b \cdot \sqrt{\frac{R}{h_{fi}}}\right)\right.\right.$$

$$2.9E^{\wedge}\text{-}6N/mm^2 = 4 \cdot \frac{2.5mm}{5mm} \cdot \exp\left(0.4 \cdot \left(2 \cdot \sqrt{\frac{30.01mm}{4.7mm}} \cdot a\tan\left(45° \cdot \sqrt{\frac{30.01mm}{4.7mm}}\right) - 2 \cdot \sqrt{\frac{30.01mm}{4.7mm}} \cdot a\right.\right.$$

13) Pressure on Rolls given H (Entry Side)

Open Calculator

$$P = S \cdot \frac{h_s}{h_i} \cdot \exp(\mu_{friction} \cdot (H_i - H))$$

$$4.1E^{\wedge}\text{-}6N/mm^2 = 4 \cdot \frac{2.5mm}{5mm} \cdot \exp(0.4 \cdot (2.55 - 0.75))$$

14) Thickness of Stock at given Point on Entry Side

Open Calculator

$$h_s = \frac{P \cdot h_i}{S \cdot \exp(\mu_{friction} \cdot (H_i - H))}$$

$$1.460257mm = \frac{2.4E^{\wedge}\text{-}6N/mm^2 \cdot 5mm}{4 \cdot \exp(0.4 \cdot (2.55 - 0.75))}$$

Exit

15) Mean Yield Shear Stress using Pressure on Exit Side

Open Calculator

$$S = \frac{P \cdot h_{fi}}{h_s \cdot \exp(\mu_{friction} \cdot H)}$$

$$3.342572 = \frac{2.4E^{\wedge}\text{-}6N/mm^2 \cdot 4.7mm}{2.5mm \cdot \exp(0.4 \cdot 0.75)}$$

16) Pressure Acting on Rolls in Exit Region

Open Calculator

$$P = S \cdot \frac{h_s}{h_{fi}} \cdot \exp\left(\mu_{friction} \cdot 2 \cdot \sqrt{\frac{R}{h_{fi}}} \cdot a\tan\left(\Theta \cdot \sqrt{\frac{R}{h_{fi}}}\right)\right)$$

$$2E^{\wedge}\text{-}5N/mm^2 = 4 \cdot \frac{2.5mm}{4.7mm} \cdot \exp\left(0.4 \cdot 2 \cdot \sqrt{\frac{30.01mm}{4.7mm}} \cdot a\tan\left(45^{\circ} \cdot \sqrt{\frac{30.01mm}{4.7mm}}\right)\right)$$

17) Pressure on Rolls given H (Exit Side)

Open Calculator

$$P = S \cdot \frac{h_s}{h_{fi}} \cdot \exp(\mu_{friction} \cdot H)$$

$$2.9E^{\wedge}\text{-}6N/mm^2 = 4 \cdot \frac{2.5mm}{4.7mm} \cdot \exp(0.4 \cdot 0.75)$$

18) Thickness of Stock at given Point on Exit Side

Open Calculator

$$h_s = \frac{P \cdot h_{fi}}{S \cdot \exp(\mu_{friction} \cdot H)}$$

$$2.089107mm = \frac{2.4E^{\wedge}\text{-}6N/mm^2 \cdot 4.7mm}{4 \cdot \exp(0.4 \cdot 0.75)}$$

Variables Used

- **▲t** Change in Thickness *(Millimeter)*
- **A** Projected Area *(Square Centimeter)*
- A_f Final Cross-Sectional Area *(Square Centimeter)*
- A_i Initial Cross-Sectional Area *(Square Centimeter)*
- **b** Width of Strip of Spiral Spring *(Millimeter)*
- **E** Total Elongation of the Stock or Workpiece
- **h** Height *(Millimeter)*
- **H** Factor H at given Point on Workpiece
- h_{fi} Thickness after Rolling *(Millimeter)*
- h_i Thickness before Rolling *(Millimeter)*
- H_i Factor H at Entry Point on Workpiece
- H_N Factor H at Neutral Point
- h_s Thickness at given Point *(Millimeter)*
- **L** Projected Length *(Millimeter)*
- **m** Frictional Shear Factor
- **P** Pressure Acting on Rolls *(Newton per Square Millimeter)*
- **R** Radius of Roller *(Millimeter)*
- **S** Mean Yield Shear Stress of Work Material
- **w** Width *(Millimeter)*
- α_b Bite Angle *(Degree)*
- **Θ** Angle made by given Point, Roll Center and Normal *(Degree)*
- $\mu_{friction}$ Coefficient of Friction
- **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)
  Inverse trigonometric cosine function
- Function: **atan**, atan(Number)
  Inverse trigonometric tangent function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **exp**, exp(Number)
  Exponential function
- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- Function: **sqrt**, sqrt(Number)
  Square root function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- 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

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