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DETERMINATION OF THE GRINDING ROLLER GRINDING ARROW IN A LBC FINISHER

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ABSTRACT

The required profile of the cylinders is achieved by their proper correction after the change due to wear.

In this paper I studied how the profile of the working cylinders can influence the profile of hot rolled steel strip.

KEYWORDS: manufacturing, lean manufacturing, cost, optimization, Romanian automotive industry

1. Introduction

The profile of the cylinders can be used as an effective factor for ensuring the optimal width variation of the strip if the following conditions are met:

- ensuring a uniform distribution of temperature along the length of the cylinder bar;
- supply to maintain a constant cylinder temperature;
- cooling water is adjusted to take up the entire amount of heat that tends to increase the cylinder temperature.

Cylinders change immediately when their wear causes the tolerances admitted to the tape to no longer be guaranteed.

2. Experiments performed

To illustrate how to determine the quartz coulter grinding arrow in an LBC finisher, we will consider the roll forming profile for rolling the 1500 mm bands.

We take, for example, laminating a strip of 5 mm final thickness and 1500 mm wide, grade steel OL 37.

The rolling forces and reductions are given in Table 1.

Calculate the bending of the support cylinders with relation 1 and obtain the results in Table 2.

$$f_{sb} = f_s \cdot \frac{b}{a} \qquad (1)$$

Calculate the bending stroke of the work cylinder due to the contact between the working cylinder and the bearing with the relationship 2, the results being given in Table 3.

$$f_l = F\,(b\text{-}KB/L)\cdot 10^{-5} \qquad (2)$$

where: F is the rolling force in N;

b, K - coefficients that can be taken from nomograms according to reports and

B / L - the ratio of the width and length of the cylinder bar.

We will calculate the average wear of the supporting cylinders when changing the work cylinders by nomograms, the results being given in Table 4.

The thermal dilatation of the working cylinders with relations 3, 4 is calculated, its values are shown in Table 4 and the temperature difference between the middle and the edge of the work cylinder slab in Fig. 1.

$$\Delta t_1 = \frac{\alpha \cdot D(t - t_i)}{2} \qquad (3)$$

$$\Delta t_l = \alpha \cdot R(t\text{-}t_i); \quad \text{or} \quad \frac{\alpha \cdot D(t - t_i)}{2} \qquad (4)$$

Since the temperature difference of the support cylinders between the middle and the edges is small (maximum 2 °C), according to the relationship 2, Figure 1, this can be neglected.

Table 1. *Rolling forces and reductions in rolling a 5x1500mm strip*

	F1	F2	F3	F4	F5	F6
Force, MN	1.6	1.8	1.6	1.5	1.4	0.7
Thickness, mm	18	12.4	8.9	6.5	5.5	5

Table 2. *Bending of Supporting Cylinders*

	F1	F2	F3	F4	F5	F6
f_{st}	0.066	0.075	0.066	0.062	0.057	0.029

Table 3. *Bending of working cylinders*

	F1	F2	F3	F4	F5	F6
f_l	0.016	0.019	0.016	0.015	0.014	0.006

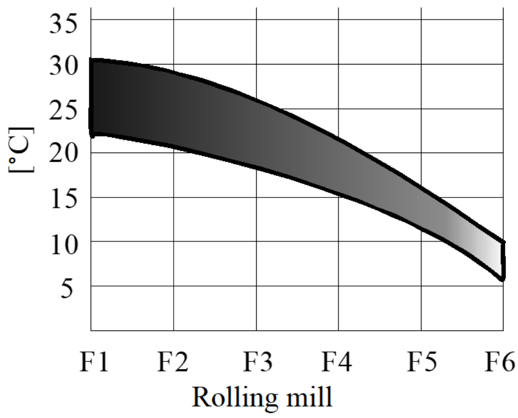
Table 4. *Average wear of supporting cylinders*

	F1	F2	F3	F4	F5	F6
u_m	0.140	0.130	0.110	0.110	0.100	0.100

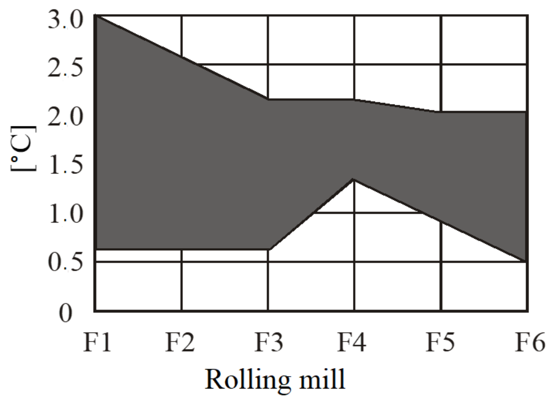
Table 5. *Thermal expansion of working cylinders*

	F1	F2	F3	F4	F5	F6
$t-t_i$	30	28	25	20	15	10
Φ cil.	715	770	730	740	745	750
Δt	0.212	0.197	0.180	0.146	0.110	0.075

Since the temperature difference of the support cylinders between the middle and the edges is small (maximum 2 °C), according to the relationship 2, Figure 1, this can be neglected.



a



b

Fig. 1. *Temperature difference between the middle and the edge of the slab: a. Working cylinders; b. Supporting cylinders*

We calculate with the relationship 5 the required arrow at each cage to assure the shape condition (according to Figure 1), the data obtained being given in Table 6.

$$\delta_n = \delta_{6-7} \frac{h_{in}}{h_{6-7}} \tag{5}$$

in which:

δ_n is the difference in thickness between the middle and the edge of the band at passage n, in mm;

δ_{6-7} - the difference in thickness between the middle and the edge of the strip at the last finish, in mm;

h_n - the thickness of the band at passage n, in mm;

$h_{6\text{-}7}$ - the thickness of the band at the last pass, in mm.

According to the relationship 6 the correction arrow will be given by the calculations in table 6.

$$f = 2f_l + 2f_{st} + u_m - (2\Delta t_l + \Delta t_s + \delta) \qquad (6)$$

in which:

δ is the difference in thickness between the middle and the edge of the strip;

f_l - the bending arrow of the working cylinder due to the elastic compression of the working cylinders in contact with the supporting cylinders in mm;

f_{st} - the bending arrow of the supporting cylinders in mm;

u_m - the average wear value of the support rollers when mounting the working cylinders in the cage, in mm;

Δt_l - thermal expansion of working cylinders in mm;

Δt_s - thermal expansion of supporting cylinders in mm.

The calculated values are rounded to values of 0.005 mm, as shown in Table 7.

Tabel 6. *Cylinder rectification arrow (calculated values)*

	Cylinder rectification arrow, **f**	
	Calculus	**Value**
F1	0.132+0.032+0.140-(0.424+0.180)	0.290
F2	0.150+0.038+0.130-(0.394+0.124)	0.200
F3	0.132+0.032+0.110-(0.360+0.089)	0.175
F4	0.124+0.030+0.110-(0.292+0.065)	0.093
F5	0.114+0.028+0.100-(0.220+0.055)	0.031
F6	0.058+0.012+0.100-(0.150+0.050)	0.030

Table 7. *Cylinder rectification arrow*

	Cylinder rectification arrow, f	
	Calculate value	**Adopted value**
F1	0.290	-0.300
F2	0.200	-0.200
F3	0.175	-0.150
F4	0.093	-0.100
F5	0.031	-0.050
F6	0.030	0

The calculated values represent the maximum arrow at the centre of the cylinder bar. The value of the arrow should decrease parabolically, from the middle to the edge, on one side and the other, the calculation at any point of the tile can be done with the relationship:

$$f_x = f \cdot \left[1 - \left(\frac{z}{z_0}\right)^2\right] \qquad (7)$$

in which: f_x is the roll grinding arrow at point x in mm;

f - the trimming arrow at the centre of the slab in mm;

L - drum length in mm;

z - the distance from the middle of the tile to the edge thereof, in mm.

Graphically, the arrow will appear according to the diagram in Figure 2.

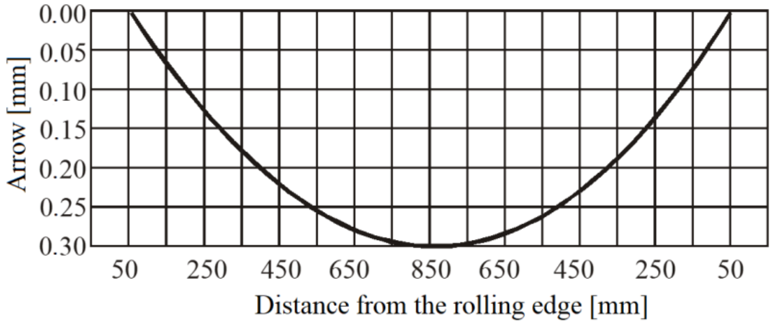


Fig. 2. *The resulting arrow for F3*

3. Conclusions

In the hot rolling of the strip, there is a thickness limit (reduction) until the band profile can be effectively influenced; the cross-flow of the material below this limit being strongly impeded, the relative profile remaining almost constant. This limit moves to higher thicknesses for tougher steels because, with increasing resistance to deformation, the cross-flow of the material is difficult.

An effective influence of the strip profile for the laminated strip at thicknesses below 5 mm can be affected in the thickness range of 8-16 mm.

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