TECHNOLOGICAL AND ECONOMICAL ASPECTS REGARDING HOT ROLLING ON THE ASSEL LINE AT S.C. TMK SLATINA

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This article describes theoretical and practical aspects concerning the hot rolling process on the Assel line at S.C. TMK Slatina. We will present both technological elements in this field and specific economic elements. The start point for our article is the description of the flow sheet for the hot rolling process on the Assel line at S.C. TMK Slatina. Out of all of the technological elements analyzed in this article, the most important one is rolling mill calibration. All economic elements specific to the analyzed technological process constitute the analysis of the cost-volume-profit interrelation, and they mainly relate to: critical production volume (QCR), critical turnover (CACR), critical production capacity usage level (GCR), critical time period (TCR), sold production volume in order to obtain a profit estimated as an overall sum (Qp) etc.

Keywords: rolling, Assel processing line, technological elements, economic elements

1. Introduction

Rolling is defined as a continuous technological process of plastic deformation performed by two cylindrical devices (rolling mill working rolls) that rotate in opposite directions (longitudinal rolling), or tapered and bitronconical rolls rotating in the same direction (transverse rolling) [1-3].

The most important physical and/or chemical processes that occur in the deformation zone are the following:

- Dogging conditions

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- Micro-slipping between the rolled product and rolling cylinders
- Pressure and rolling moment

The stages of the hot rolling process on the Assel line at S.C. TMK Slatina are given in Fig. 1.

Fig. 2 shows a view of the technical quality control process.

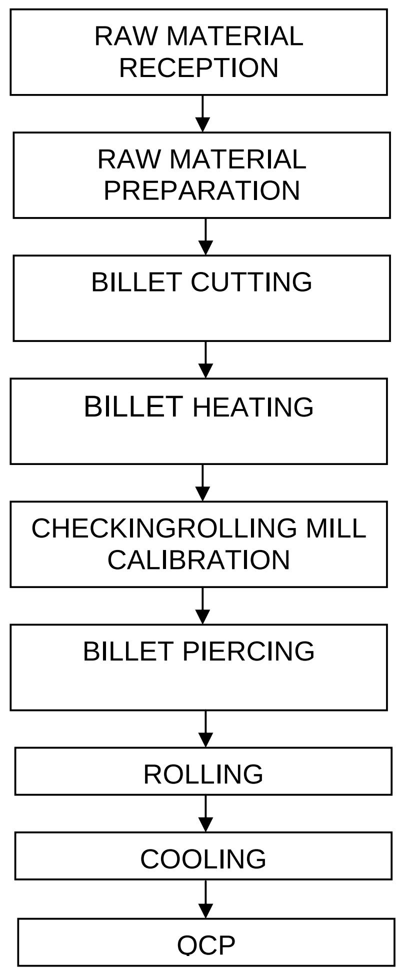

Fig.1. Hot rolling flow sheet diagram for the Assel line

Fig. 2 Rolled pipes being prepared for the technical quality control process (QCP)

2. Technological elements regarding hot rolling on the assel line

Pipe rolling begins after checking that the rolling mills have been correctly calibrated based on the first 2-3 pipe blanks, and after performing the proper corrective adjustments [4].

The pipe blanks must move along the process line without jamming, in accordance with the specified metal temperatures downstream of the piercing rolling mill, walking beam furnace, reducing mill and if the temperature of the billet, blank or pipe is too low, rolling is not allowed until the material is reheated to the proper temperature [5].

The fundamental equation used to adjust the rolling mill takes into account the advance value for the boring bar after the end of the roll cylinder, as shown in equation (1):

$$y = 325 + K - L_{dop} \quad (1)$$

where:

y - advance value for the boring bar after the end of the rolling mill roll cylinder [mm]

K – advance of the tip of the plug relative to the centre of the rolling mill (according to the rolling tables), [mm]

L_{dop} – total length of the plug [mm]

The thickness of the plate positioned underneath the inferior lineal is chosen according to the calculation done to determine how much the rolling axis has to be lowered relative to the axis of the rolling mill (by 5-7 mm), and can be determined with the following equation:

$$H = 323 - h - 0.5 \times L \quad (2)$$

where:

H – thickness of the plate positioned underneath the inferior ruler [mm].

h – height of the inferior scraper support (for billets Ø105÷170 mm – 215 mm; for billets Ø170÷250 mm – 185 mm)

L – distance between the ruler [mm]

The rolling mill is correctly calibrated if [6,7]:

- there are no disruptions or delays while grabbing the billets, during the piercing process or departure of the blank from the plug and boring bar;
- the blanks have adequate dimensions that comply with the data in the tables and have dimensional discrepancies of less than + 2.0 mm for the exterior diameter, + 1.0 mm to -1.5 mm for the wall thickness;
- there is no spalling on the inside surface of the pipes;
- there are no cuts, dents or other defects on the inside or outside surfaces of he pipes;
- the ends of the pipes with different walls (at a distance of 50-350 mm from the previous end) do not have *dimensional deviations* greater than *the accepted dimensional tolerances*.

Table 1

Typical dimensions for the plugs and boring bars

Plug dimensions			**Boring bar dimensions**	
Diameter (plug) [mm]	**Active length (l_0) [mm]**	**Total length (L) [mm]**	**Body diameter (Dst) [mm]**	**Cone diameter (Dcon) [mm]**
58÷60	140	175	57	45
62÷66	145	180	60	45
68÷70	150	185	63	45
72	155	190	70	50
74÷78	165	200	70	50
80÷84	170	205	76	50
86÷90	175	210	83	50
92÷98	180	215	89	60
100	187	222	89	60
102÷104	197	232	95	60
106÷110	202	237	102	70
112÷116	212	247	108	70
118÷122	222	257	114	80

124÷128	235	270	121	80
130÷134	240	275	121	80
136÷140	245	280	121	80
142÷146	250	285	127	90
148÷152	260	295	127	90
154÷158	270	305	133	90
160÷164	275	310	133	90
166÷172	280	315	133	90
174÷184	290	325	133	90

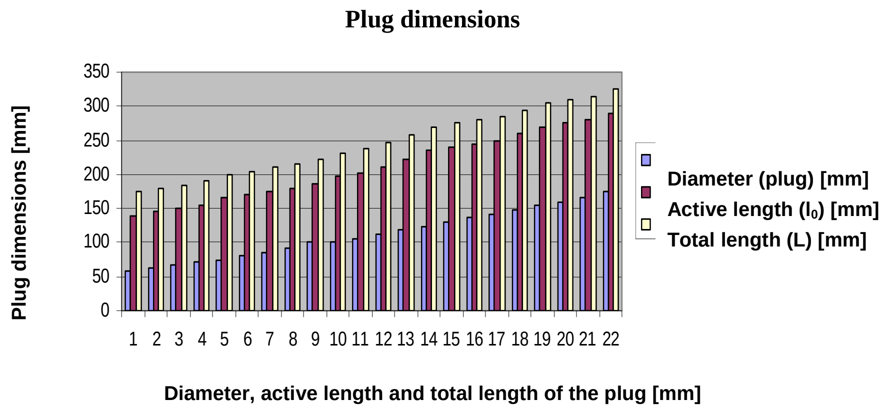

Fig. 3. Typical dimensions for the plugs and boring bars

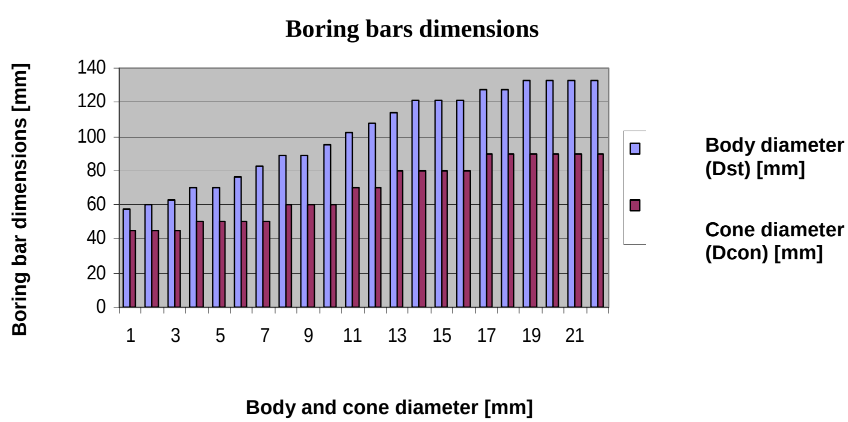

Fig. 4. Typical dimensions for the plugs and boring bars

3. Economical elements regarding hot rolling on the assel line

We will study elements concerning the analysis of the cost-volume-profit interrelation.

The cost-volume-profit interrelation is analyzed using the following major indices:

- Critical production volume (QCR)

$$QCR = \frac{FC}{p - VC} = \frac{4080934}{550 - 321} = 17820 \text{ t/year} \quad (3)$$

where:

CF – is Fixed Costs

P – is selling price of the product

VC – is Variable Costs

Critical turnover (CACR)

CACR = QCR x p = 17820 x 550 = 9801000 Euro/year (4)

- Critical production capacity usage level (GCR)

$$GCR = \frac{QCR}{Q_{max}} \cdot 100 = \frac{17820}{97630} \cdot 100 = 18{,}25\% \quad (5)$$

Where Q_{max}– is Maximum production

We considered a value of Q_{max} = 97630 tone – milled billet production

- Critical time period (T_{CR})

$$T_{CR} = \frac{CA_{CR}}{\frac{CA}{T}} = \frac{9801000}{\frac{53696500}{360}} = 65{,}7 \text{ days} \quad (6)$$

Where:

CAcr – turnover corresponding to the critical point (breakeven)

CA – turnover (annual)

T – annual work time [360 days]

- Turnover per time unit:

$$\frac{CA}{T} = \frac{53696500}{360} = 149156{,}9 \text{ Euro} \quad (7)$$

With the turnover (CA) equal to:

CA = Q x p = 97630 x 550 = 53696500 Euro/year

T = 360 days

- sold production volume used to obtain a profit estimated as an overall sum(Q_p)

$$Q_p = \frac{FC + P_n}{p - VC} = \frac{4080934 + 13707368}{550 - 321} = 77678{,}17 \text{ tons/year} \quad (8)$$

Where:

P_n – net profit

Estimated net profit P_n = 13707368 Euro/year

- Maximum profit (P_{max})

$$P_{max} = Q_{max}(p - CV) - CF \quad (9)$$

$$P_{max} = 97630(550 - 321) - 4080934 = 18276336 \text{ Euro/year}$$

Evaluation of the minimum selling price for a breakeven point of 94115 tons of rolled billets

Considering a production capacity usage level of 96,4%, production will be 97630 x 96,4% = 94115 tons/year.

Under these circumstances the minimum selling price per ton of rolled billets will be:

$$Q_{CR} = \frac{FC}{p - VC} \Rightarrow p = \frac{FC + (Q_{CR} x VC)}{Q} = \frac{4080934 + (17820 x 321)}{94115} = 104 \text{ Euro/t}$$

4. Conclusions

The correct and efficient operation of the hot rolling technological process on the Assel line atS.C. TMK Slatina requires the knowledge and practice of several technological and economic field specific aspects.

Among the numerous technological elements, calibration of the rolling mill has a significant importance, influencing production quality.

The following economic elements relating to the hot rolling process on the Assel line at S.C. TMK Slatina have been analyzed in the article:critical production volume (QCR), critical turnover (CACR), critical production capacity usage level (GCR), critical time period (TCR), sold production volume in order to obtain a profit estimated as an overall sum (Qp), evaluation of the minimum selling price for a previously calculated breakeven point.

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