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Analysis of Technological Schemes for Producing Bars by Forging on Radial Crimping Machines

Tilavov Yunus[1], Danilenko Anjela[2], Urokov Komol[1], Elmurodov Nuriddin[1]

[1]Karshi State University, Karshi, Uzbekistan
[2]Belgorod State National Research University, Belgorod, Russia

ABSTRACT
This article examines the analysis of technological schemes for the production of rods by forging on radial swaging machines that allows you to select the structural material and geometric dimensions of the workpiece and tool and technological parameters, the feed rate of the workpiece, the parameters of the reduction cycle of the forging process of refractory metals on radial swaging machines that ensure the production of bars good quality, sufficiently high plasticity.

KEYWORDS: *bar, billet, technological schemes, recrystallization, annealing, drawing*

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1. INTRODUCTION

In order to determine the optimal design parameters of the technological tool of the radial crimping machine (ROMe) and the choice of its material, which ensures reliable performance during deformation of bars made of refractory metals, the authors have developed a mathematical model of the thermal and thermally stressed state of the workpiece-tool system.

2. Methods

It is known that during the deformation of refractory metals and alloys based on them (for example, molybdenum and its alloys are deformed at 1000-1100 ^{0}C) on radial crimping machines, the technological tool is exposed to large thermal, mechanical and dynamic loads, which often cause the destruction of the tool [1 , 2]. In this regard, the use of computational methods [3, 4] for determining the stress state, choosing the material of the tool and assessing its performance is of great scientific importance.

3. Results and Discussion

Hot-pressed rods of molybdenum grades MChVP and MCh with a diameter of 52-65 mm and a length of 350-400 mm, pre-annealed at a recrystallization temperature (Tm = 1000-1100 ^{0}C for 1 hour), are used as initial blanks for obtaining rods with a diameter of 12-16 mm. It is recommended to forge the initial blanks at a heating temperature of 900 ± 50^{0}C, and with a diameter of 25-30 mm at 600 ± 50^{0}C. Before forging at Tn = 600 ± 50^{0}C, the rods should be subjected to recrystallization annealing in a hydrogen atmosphere for 40-60 minutes. The basic technological scheme for forging molybdenum rods with a diameter of 52-65 mm to rods with a diameter of 12-16 mm on a radial crimping machine (POMe) is shown in table 1.

The authors proposed a methodology and performed calculations of energy-force and deformation parameters for forging molybdenum blanks on a VV4032Ts radial crimping machine, the equipment of which is currently installed at the Moscow Refractory Metals and Hard Alloys Plant [1, 2].

The total force P at radial compression is recommended to be determined by the formula:

$$P = q \cdot F \qquad (1)$$

where, q – specific effort, F – contact area of the striker with the workpiece, and the specific effort q according to the following formula:

$$q = \sigma_s \left(1 + \frac{2}{3}\mu \frac{l_0}{d_n}\right) \qquad (2)$$

where, σ_s – tensile strength at compression temperature, μ – coefficient of friction, l_o – length of the deforming part of the striker, d_n – forging diameter.

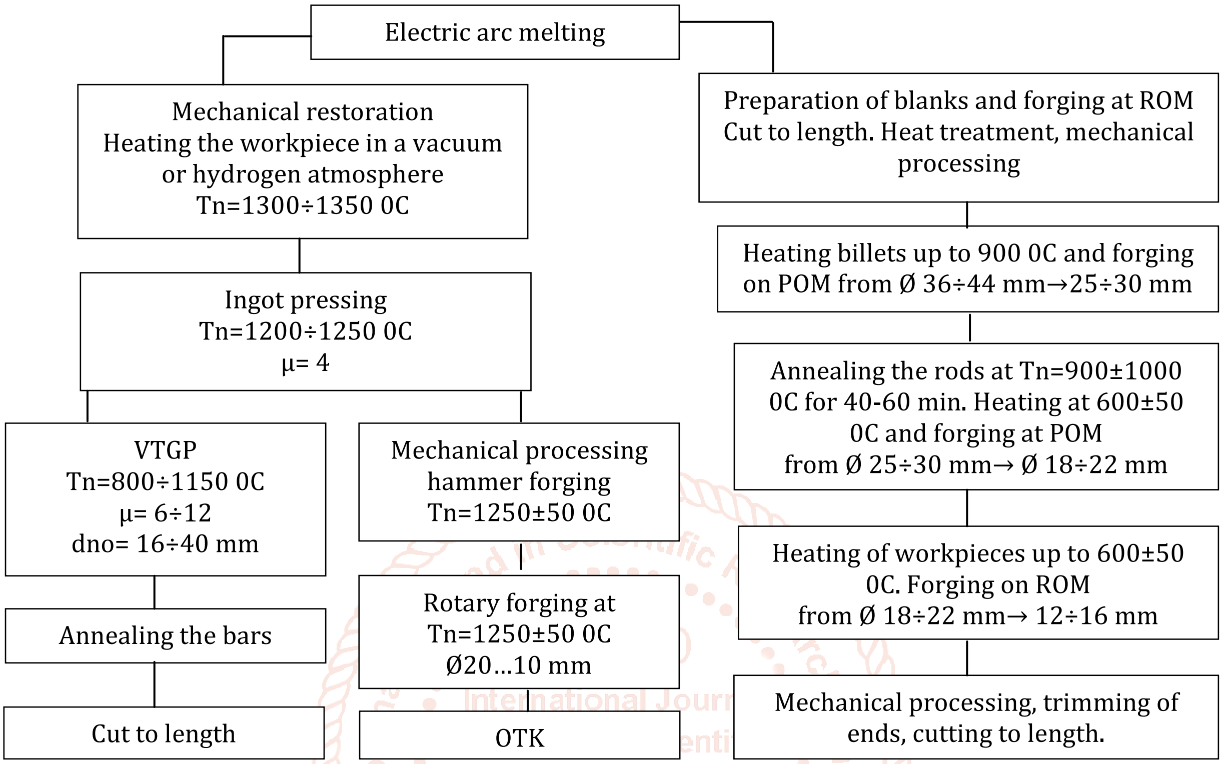
When forging with cut radius strikers, there are two zones of contact areas of the forging with four strikers:

a) for the conical deforming zone of the striker

$$F_{\partial} = \frac{1}{4}\left(D_3^2 - d_n^2\right)\frac{\sin\frac{\theta}{2}}{tg\beta} \quad (3)$$

where, θ – angle / coverage / working radius surface of the striker from the workpiece being processed;

Table 1. Flow chart for the production of cast molybdenum rods using the forging process at POM.



b) for the calibrating cylindrical area of the striker

$$F_{\kappa} = d_n l_k \sin\frac{\theta}{2} \quad (4)$$

Specific effort q is determined:

- for the conical deforming zone of the striker

$$q = \sigma_s\left(1 - \frac{2}{3}\mu\frac{D_3 - d_n}{2tg\beta}\cdot\frac{\sqrt{2}}{\sqrt{D_3^2 - d_n^2}}\right) \quad (5)$$

- for the calibrating cylindrical area of the striker

$$q_k = \sigma_s\left(1 + \frac{2}{3}\mu\frac{l_k}{d_k}\right) \quad (6)$$

The total force at radial compression of molybdenum by four strikers is determined from the expression:

$$P = q_Д \cdot F_Д + q_K \cdot F_K \quad (7)$$

At the indicated heating temperatures of workpieces (molybdenum at T_n = 900 ^{0}C and T_p = 600 ^{0}C equal to 90-110 kN and single reductions from 30% to 75%, the total force is 1000-1600 kN) [3, 4].

To ensure that the specific loads on the strikers do not exceed the limiting values (80-85 kN), it is advisable to forge molybdenum rods at 300 ^{0}C in two passes with hoods $\mu = 2{,}0 - 2{,}5$, and at a heating temperature of 600 ± 50 ^{0}C - with hoods $\mu = 1{,}37 - 2{,}0$.

The maximum permissible feed rate of the workpiece into the strikers is calculated by the formula:

$$V_n = \frac{\pi \cdot n \cdot H \cdot (1 - \cos\varphi_0)}{60 \cdot (2\pi - \varphi_0) tg\beta} \quad (8)$$

where, n-striker strokes frequency per minute, n = 800 rpm, H-full stroke of the striker, mm; H=6 mm, φ_0 – loading angle of the crank shaft, the limiting value of which is 30-40⁰, $\varphi_0 = 40^0$, β – the angle of the lead-in cone of the striker, which is equal to 12⁰.

For forging molybdenum rods, the feed rate of the workpiece into the strikers should not exceed the values:

$$V_n = \frac{\pi \cdot n \cdot H \cdot (1-\cos\varphi_0)}{60 \cdot (2\pi - \varphi_0) tg\beta} = \frac{3,14 \cdot 800 \cdot 6(1-\cos 40^0)}{60 \cdot (2 \cdot 3,14 - 40^0) tg12^0} = \frac{15072(1 \cdot 0,8)}{60 \cdot 6,2 \cdot tg12^0} = \frac{3014,4}{74,4} = 40,52\, {}^{mm}/_{s};$$

The working speed of rapprochement of the strikers is determined by the formula:

$$V_c = \frac{\pi \cdot n \cdot H(1-\cos\varphi_0)}{60(2\pi - \varphi_0)} \qquad (9)$$

When forging molybdenum, the working speed of drawing the strikers together is 8.1 mm/s, and the maximum permissible speeds for POM VV4032Ts at and will be equal;

$$V_n = \frac{n \cdot H \cdot (1-\cos\varphi_0)}{60 \cdot \left(2 - \frac{\varphi_0}{\pi}\right) tg\beta} = \frac{800 \cdot 6(1-\cos 40^0)}{60\left(2 - \frac{40}{\pi}\right) tg12^0} = \frac{4800 \cdot 0,2}{60\left(2 \cdot \frac{0,8}{3,14}\right) \cdot 02} = 49,52\, {}^{mm}/_{s};$$

and $V_c = \dfrac{n \cdot H \cdot (1-\cos\varphi_0)}{60 \cdot \left(2 - \frac{\varphi_0}{\pi}\right)} = \dfrac{800 \cdot 6(1-\cos 40^0)}{60\left(2 - \frac{40^0}{3,14}\right)} = 10,53\, {}^{mm}/_{s};$

the average speed of the strikers convergence should always be less than the average speed of the striker $V_\delta = \dfrac{n \cdot H}{60}$ because forging of the workpiece is carried out by the flywheel drive-stroke of the striker, and not by bringing it together.

$$V_\delta = \frac{n \cdot H}{60} = \frac{800 \cdot 6}{60} = 80\, {}^{мм}/_{c} \qquad V_\delta \rangle V_c$$

Selecting the angular velocity of the workpiece.

In the general case, the angular velocity of the workpiece during its processing is determined by the dependence

$$W = \frac{\theta}{t_ц} = \frac{\pi \cdot n_3}{30} \qquad (10)$$

where, $n_3 = \dfrac{n \cdot \theta}{2\pi}$ and $n_3 = C \cdot \Pi \dfrac{n \cdot \theta}{2\pi}$

θ – the angle of coverage by the striker of the workpiece at the end of the stroke, n_3 – workpiece revolutions. C – the coefficient of overlap of the deformed surface, which is taken equal to 0.1-0.6.

$\theta \le \dfrac{360}{Z} = \dfrac{360}{4} = 90$ C-takes =0,2.

where, Z – number of strikers in the car $Z = 4$.

$$n_3 = \frac{800 \cdot 90}{2 \cdot 3,14} = \frac{72000}{6,28} = 11465\, rpm$$

$$W = \frac{\pi \cdot n_3}{30} \cdot C = \frac{3,14 \cdot 11465 \cdot 0,2}{30} = \frac{7200}{30} = 240\, s^{-1}.$$

The number of revolutions of the workpiece during processing in the hot state is taken in the range $n_{з.г}$=(0.125…0.05) rpm, $n_{з.г}$ = 0.1x11465 = 1146.5 rpm.

This technology for the production of rods from molybdenum and the method for calculating the forging forces, as well as the thermo mechanical parameters of forging of molybdenum blanks, adopted for implementation at the Moscow Refractory Metals and Hard Alloys Plant and will be implemented with the commissioning of a radial swaging machine model VV4032Ts.

4. Conclusions

1. A new highly efficient process and thermomechanical modes of forging on a radial swaging machine have been developed to produce small-diameter bars from refractory metals, which provides an increase in product quality, an increase in equipment productivity and an improvement in working conditions.
2. A highly efficient technology for the production of rods from molybdenum ingots has been created, which includes hot pressing, high-temperature hydro-pressing and forging on a radial crimping machine, provides the production of small-diameter rods with a well-developed structure, improved quality and with an increased (by 15-20%) level of mechanical properties.

References

[1] Tilavov Y. S. Development and implementation of low-waste technology for the production of rods from molybdenum and niobium. - Diss. for the degree of candidate of technical sciences. - M .: 1994. 285 p.

[2] A. P. Kolikov, Yu. S. Tilovovidr. Matematicheskaya model termonapryajennogosostyaniyatexnologicheskogoinstrumentaprikovketrudnodeformiruyemixmaterialov. Dep. VINITI. № 5. 1994.

[3] A. P. Kolikov, I. A. Levitskiy, Yu. S. Tilovovidr. Matematicheskaya model teploobmenaitermonapryajennogosostyaniya v sistemezagotovka – rabochiyinstrumentapriobrabotketugoplavkixmetallov. Izv. Vuzov. Chernayametallurgiya. – 1994. № 9.

[4] A. A. Vardiyashvili, Yu. S. Tilovov, K. X. Urokov. Analizrezultatovraschetaparametrovtemperaturnogoitermonapryajennogosostoyaniyavsistemezagotovka-instrumentpriradialnoykovke. Nauchno–texnicheskiyjurnalFerPI. 2020., Tom 24. №5. s. 213-216.