RESEARCH ON HOT FORMING AT HIGH SPEEDS

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1. INTRODUCTION

It is known that during the hot plastic forming the complex phenomena accompanying the metal flow entail a nonuniform penetration of the deformation on the volume of the processed machine part, characterized by the so called nonuniformity of the deformation – nonuniformity which, in turn, causes internal stresses in the deformed machine part, capable, in some cases, to determine microfissures, fissures or even visible cracks.

Using the S. I. Gubkin's theory [1], this paper approaches the study of deformation nonuniformity of the first order, which implicitly implies the existence of the nonuniformities of the second and the third order. Taking into account the studies performed in statical conditions [6], this paper highlights the macro-nonuniformity for two quality steels (OLC15 and OLC45), hot upset with high deformation speeds (> 1000 s^{-1}).

2. EXPERIMENTAL STUDIES

The cylindrical specimens Φ 12x18 mm, with eccentric screw M4 (figure 1), have been upset on a hydraulic press of 50 tf, with a low deforming speed (0.3 s^{-1}), and on an explosion installation with butane-oxygen, at speeds of over 1000 s^{-1}. Complying to the working conditions from [6], the testing temperatures have been of 900, 1000, and 1100 ºC, at a constant deforming degree of 50%, with a deformation between plane tools, without lubrication.

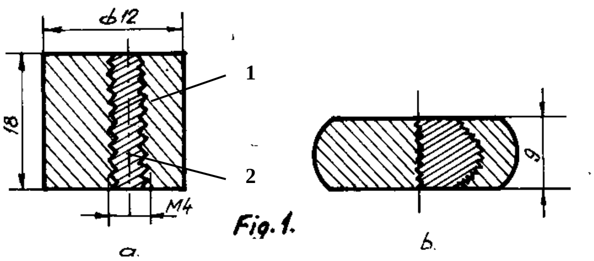

Figura 1. 1 – Cylindrical specimen Φ 12x18 mm; 2 – screw M4; a) prior to upsetting; b) after the upsetting.

fective deformation degree (ε_e) has the

The experimental results are given in Table 1 and are represented graphically in figures 2 and 3.

Table 1.

Oţelul	T°C %	ε_g %	ε_{emin} %	ε_{emax} %	$\Delta\varepsilon$ %	Viteza de deformaţie s^{-1}
OLC 15	900	50	8	64,3	56,3	0,3
		50	29	71,5	42,5	$3,5 \cdot 10^3$
	1000	50	10	64,3	54,3	0,3
		50	28	71,5	43,5	$3,5 \cdot 10^3$
	1100	50	9	68,6	59,6	0,3
		50	30	78,6	48,6	$3,5 \cdot 10^3$
OLC 45	900	50	5	68,6	63,6	0,3
		50	27	78,6	51,6	$3,5 \cdot 10^3$
	1000	50	7	71,5	64,5	0,3
		50	34	78,6	44,6	$3,5 \cdot 10^3$
	1100	50	10	71,5	61,5	0,3
		50	37	78,6	41,6	$3,5 \cdot 10^3$

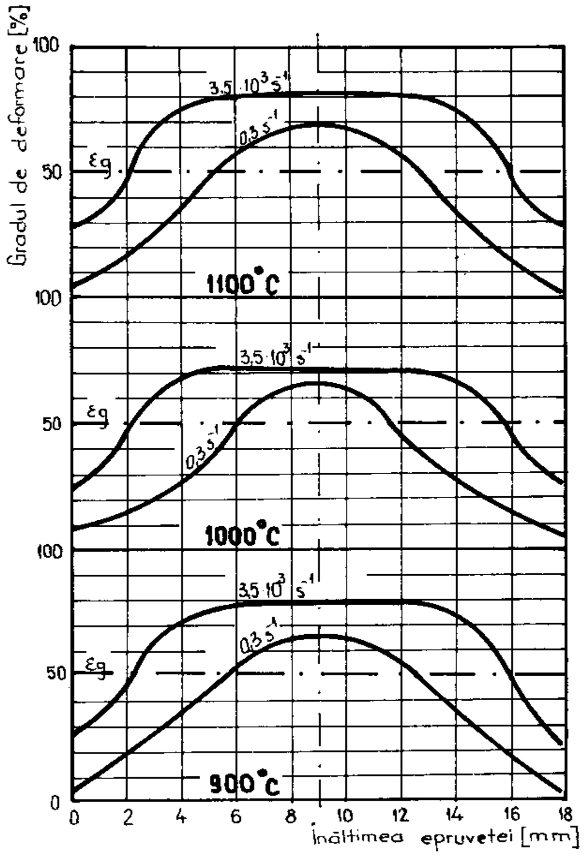

Figure 2. The dependency of deformation degree ε_g on the height of the specimen (h) for the OLC15 steel.

$$\varepsilon_e = (p_0 - p_e) / p_0 \cdot 100\ [\%] \quad (1)$$

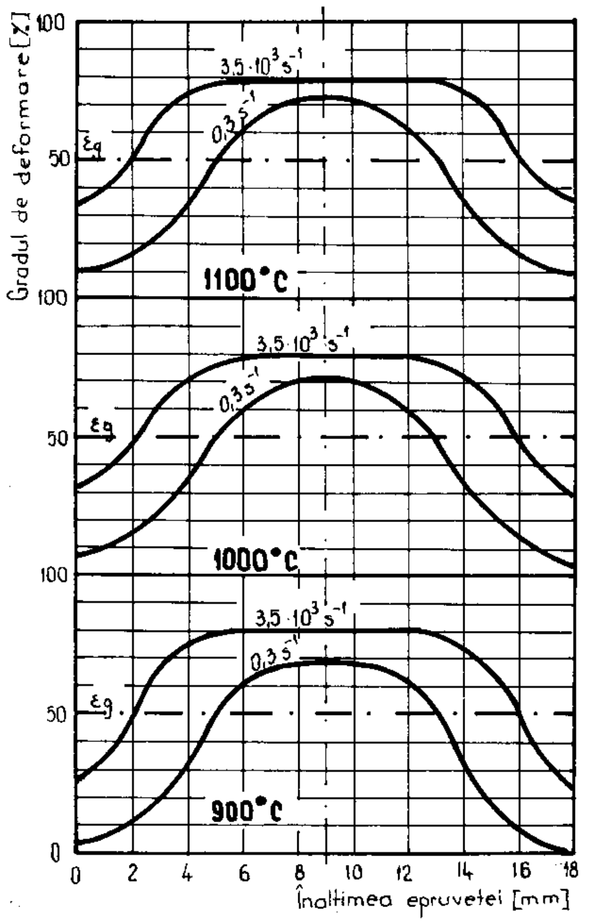

Figure 3. The dependency of deformation degree ε_g on the hight of the specimen (h) for the OLC45 steel.

where p_0 – the initial pace (mm); p_e – the effective pace in the deformed area.

In these conditions, the absolute deforming nonuniformity was determined using formula (2):

$$\Delta\varepsilon = \varepsilon_{e\,max} - \varepsilon_{e\,min}\,[\%]\,. \qquad (2)$$

Analyzing Table 1 and the aspect of the curves presented in figures 2 and 3, one can observe that the deformation penetration exhibits essential differences according to the deformation speed. First, the deformation was distributed in a much more uniform manner in the case of hot upsetting with high deformation speed; on the other hand, the deformation between the maximum and the minimum deformations is much lower than in case of high deformation speed upsetting. A very important feat is the fact that the decrease of deformation nonuniformity is carried out on the basis of the approaching of the effective deformation degree to the imposed general deformation degree.

It must be also noted that the barreling effect of the specimens is much lower in case of high speed deformation upsetting, the front surfaces being much closer to the average diameter of the specimen, compared to the static deformation. This effect is due especially to the transformation of the side surface into a front surface; this bring us to the conclusion that, in case of hot plastic forming with lubrication, the barreling phenomenon is even more diminished.

3. CONCLUSIONS

On the basis of this research, we can draw the following conclusions:

- the study of the deformation nonuniformity using the hot upsetting method can highlight the behavior of the steel during the forming process, the values of absolute nonuniformity of the first order marking considerable variations between the two processing types using hot plastic forming (both statically and dynamically).
- the tests made on the two types of quality steels highlight the superiority of hot processing with high deformation speeds, compared to static processing, both in what concerns the deformation penetration and the diminishing of the barreling effect.
- the association of the forming nonuniformity value with the recrystallization structure after the forming leads to the choosing of lower optimal starting forming temperatures, entailing a time and energy economy, ensuring, in the same time, a higher quality heated and deformed steel.

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