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EFFECT OF REDUCTION IN THREE-DRAWN AND TWO-DRAWN SINGLE-RUN TECHNOLOGY ON ROUGHNESS OF INNER SURFACE OF TUBES

Martin RIDZOŇ, Ľubica ELEKOVÁ, Jana LIŠKOVÁ, Jozef BÍLIK

Abstract

The paper deals with the production of could drawn precision seamless steel tubes with three-drawn and two-drawn single-run technology.. The aim of experiment is to verify the possibility of drawing rolled tubes of size ∅ 70 x 6.3 mm (material E355) with three-draw single-run technology without intermediate recrystallising annealing on the final size ∅ 44 x 3 mm in the fixed reduction and two-draw single-run technology∅ 70 x 6.3 mm without intermediate recrystallising annealing on the final size ∅ 50 x 3.75 mm in the fixed reduction and with size ∅ 70 x 6.3 mm without intermediate recrystallising annealing on the final size ∅45 x 3.75 mm in the fixed reduction. Advise the impact choice of the reduction on roughness of inner surface of tubes.

Key words

reduction, three-draw and two-draw single-run technology, roughness of surface

Introduction

Under the name of drawing tubes, cold-forming means, during which the original material (tube) forms in beams, its cross-section shrinks, thins up or the thickness of wall of pipe enlarge and length increases. The process of forming moves in several draws, depending on the original and final size of the tube. The important task is the choice of proportional reduction for the particular cross-sections because the unbalanced decomposition of reduction results into tension and deformation or cracks during the pulling, that will consequently influence the roughness of tubes' surface.

Martin Ridzoň, MSc. Eng., Ľubica Eleková, MSc. Eng., Jana Lišková, MSc. Eng., Jozef Bílik, Assoc. Professor, PhD. - Department of Forming, Institute of Production Technologies, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology Bratislava, J. Bottu 25, 917 24 Trnava, e-mail: martin.ridzon@stuba.sk, lubica.elekova@stuba.sk, jana.liskova@stuba.sk, jozef.bilik@stuba.sk

Experiment

The experimental material is non-alloy structural steel grade E355 (see tab.1) which was used to produce hot rolled tubes' size ∅ 70 x 6.3 mm.

CHEMICAL COMPOSITION OF EXPERIMENTAL MATERIAL E355 Table 1

C	0,1800	Mn	1,1800	Si	0,2300	P	0,0150	S	0,0140	Cr	0,0500
Ni	0,0800	Mo	0,0200	Ti	0,0020	V	0,0030	Nb	0,0010	N	0,0090
Al	0,0230	Zr	0,0020	Ca	0,0022	As	0,0060	W	0,0100	Zn	0,0040
Cu	0,2000	Sn	0,0160	Pb	0,0010	O	0,0032	Sb	0,0040	Ce	0,0010

The experiment was contucted to the following technological process:
Deburring → chemical treatment → drawing tube at a fixed mandrel roller → other operations. Detailed view of the internal tube surface is shown in Fig.1., Fig. 2., and Fig. 3.

Fig. 1 *Detail of the inner tubes' surface material E355 a) Ø57x5, first- draw, b) Ø50x3.75, second- draw c) Ø44x3, third- draw*

Fig. 2 *Detail of the inner tubes' surface grade OR-3) Ø55x4.75, first- draw, b) Ø50x3.75, second- draw*

Fig. 3 *Detail of the inner tubes' surface grade and OR-3) Ø55x4.35, first- draw,*
b) Ø45x3.75, second- draw

Determining of the final reduction:

- Specified final reduction with three-drawn single-run technology of drawing tubes from ∅70 x 6.3 mm to final diameter ∅44x 3mm is 69.35 % which was consequently divided into three draws.
- Specified final reduction with two-drawn single-run technology of drawing tubes from ∅ 70 x 6.3 mm to final diameter ∅50x 3.75 mm is 56.78 % which was consequently divided into three draws.
- Specified final reduction with two-drawn single-run technology of drawing tubes from ∅ 70 x 6.3 mm to final diameter ∅45x 3.75mm is 61.45 % which was consequently divided into three draws.

Experiment evaluation

After various draws in the samples was measured roughness of the inner surface of tubes and was considered whether the sample properties are according to EN 10305-1. Surface roughness was measured by Taylor Hobson touch profilometer Surtronic 3 + (Fig.4), in according to STN EN ISO 4287. Principle of measurement: the sensing tip of the arm moves at a constant speed across the surface and picks up his inequality. The device provides output numerical values for the standard characteristics of surface roughness on the display or graphical output (measured profile and curve of the material profile share) in the monitor.

Fig. 4 *Touch profilometer Surtronic 3 +*

For the experiment were monitored and measured values of the arithmetic mean deviation Ra considered profile. The measured values were constructed in following charts:

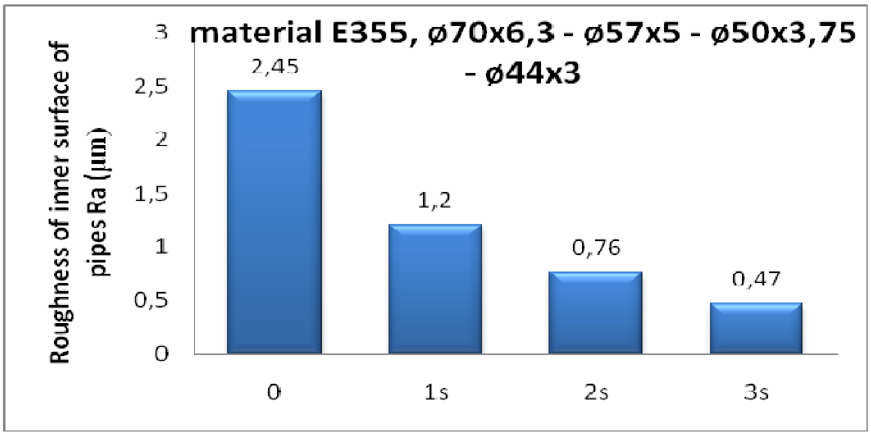

Fig. 5 *The resulting roughness values of tubes Ra [μm]*
0 – rolled tube (intermediate input), 1s – first drawn, 2s –second dawn, 3s – third drawn

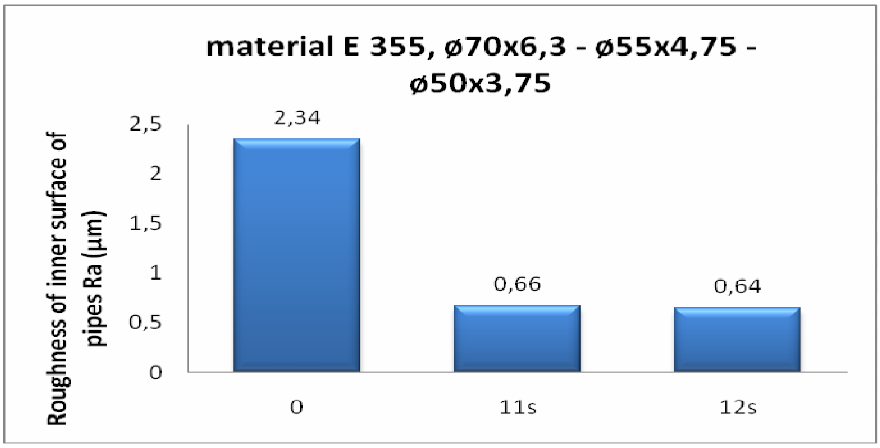

Fig. 6 *The resulting roughness values of tubes Ra [μm]*
0 – rolled tube (intermediate input), 11s – first drawn, 12s –second drawn

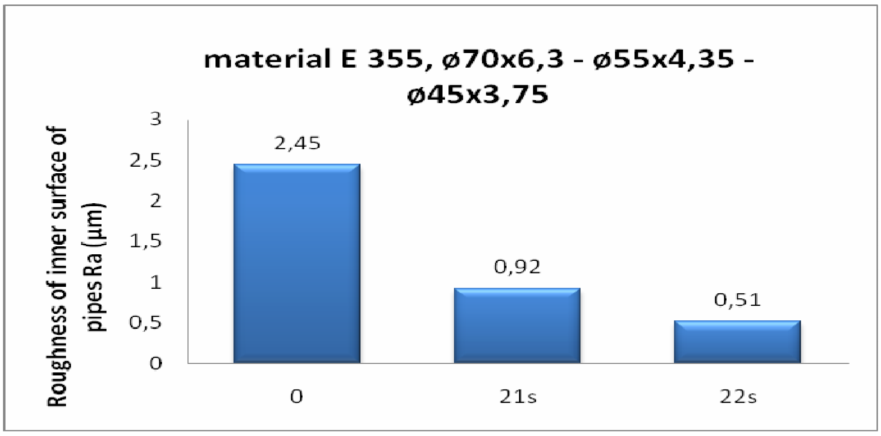

Fig. 7 *The resulting roughness values of tubes Ra [μm]*
0 – rolled tube (intermediate input), 21s – first drawn, 22s –second drawn

The required roughness Ra value according to EN 10305-1 and formed by heat-treated steel E355 + C (symbol + C means - no heat treatment after the last cold forming) Ra is 4 μm.

Conclusion

The consequential roughness of inner tubes' surface has large influence on the choice of a proportional reduction in the individual sections. By mistaken determining of reduction would be express to roughness of surface and the Ra value would be greater than according to EN 10305-1. According to this standard is given by max. arithmetic mean value of deviation Ra = 4 μm, while the charts show that these samples by three-drawn single-run technology was roughness after third drawn Ra 0.47μm and by two-drawn single-run technology was roughness with reduction 56.78 % after second drawn Ra 0.64 μm and with reduction 61.45 % was after second drawn Ra 0.51 μm. It follows that the material in terms of roughness verifies the requirements in standard to EN 10305 is suitable for forming other operations related to roughness of surface.

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Reviewers:

Emil Evin, Professor, PhD. – Faculty of Mechanical Engineering, Technical University of Košice

Zdenko Lipa, Professor, PhD. - Institute of Production Technologies, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology Bratislava