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QUANTIFICATION OF THE INFLUENCE OF RELEVANT TECHNOLOGICAL PARAMETERS ON SURFACE ROUGHNESS BY AWJ CUTTING TECHNOLOGY

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ABSTRACT:
The article deals with the quantification of the influence of three selected technological parameters of the production system with abrasive water jet on the cut surface quality of steel Hardox 500 with a thickness of 6, 10, 15 and 40 mm. It presents partial results of the solution of the thesis, solved on KPVK FVT TU in Košice, located in Prešov (Department of Manufacturing Processes Operation, Faculty of Manufacturing Technologies, Technical University of Košice with a seat in Prešov).
KEYWORDS:
AWJ technology, technological parameters, surface roughness

1. INTRODUCTION

AWJ technology is one of the progressive technologies increasingly applicated in material cutting. Quality of the cut surface belongs to the important attributes which significantly affect the competitiveness of the AWJ technology. Surface quality is influenced by the set of factors, quantifiable by parameters [1].

The article deals with the quantification of the influence of technological parameters of the AWJ technology production system on the cut surface quality of the wear resistant steel and presents partial results of the solutions of the thesis [2] solved on KPVP FVT TU in Košice, with a seat in Prešov.

2. EXPERIMENTS

Condition of experiments:

Samples for experiments were cut from the Swedish steel HARDOX 500 with a thickness of 6, 10, 15 and 40 mm. The influence of three technological parameters (p-pump pressure, v-cutting head speed, m_A - abrasive mass flow) on qualitative parameters of the cut surface roughness *Ra* is examined. Samples are prepared on the production system in the Laboratoř kapalinového paprsku IF TU VŠB Ostrava (Laboratory of water jet, Institute of physics, Technical University in Ostrava). Setting range of technological parameters during the experiments is specified in tab. 1. The samples have the shape of a triangle (3 cutting surfaces on

FIGURE 1. Detail of a triangular footprint shape of the samples (from the left: 40, 15, 10, 6 mm; 2 of 3 cut surfaces displayed)

each sample), each surface of the sample is cut by different combination and values of the technological parameters. Fig.1 shows the samples of each examined thickness of the material.

Ranges of values coding in tab.1:

- „-1“ indicates minimal value of the range of technological parameter
- „0“ indicates middle value of the range of technological parameter
- „1“ indicates maximal value of the range of technological parameter.

Tab. 1. Identification, range of values and level determination of the examined technological parameters

Factor	Parameter	Technol. parameter identifier	Unit	Range of value			Note
				-1	0	1	
x_1	Abrasive mass flow	m_A	g/min	170	220	270	-
x_2	Pump pressure	p	MPa	300	340	380	-
x_3	Cutting head speed	v	mm/min	40	60	80	Sheetmetal thickness 6, 10, 15 mm
x_3	Cutting head speed	v^-	mm/min	10	15	20	Sheetmetal thickness 40 mm
x_3	Cutting head speed	v^+	mm/min	60	90	120	Speed increased by 50% toward „v“ for thickness 6 mm

Surface roughness R_a is measured with device MITUTOYO Surftest SJ-301.

Based on design of experiment theory (DoE), the result number of combinations of values of technological parameters was set on 27 (3^3 – three levels of the technological parameters, three factors).

3. EVALUATION OF EXPERIMENTS

Heading of records with the measured values shows tab. 2. One parametric and two parametric graphic functional characteristics are evaluated from the measured values. Fig. 2 shows a sample of a one-parametric characteristic and Fig. 3 shows two-parametric characteristic. Equations of numerical functional dependencies and coefficient of regression (R2), which indicates the degree of convergence between experimental and theoretical curve, are inscribed in the top part of the graph (Fig. 2).

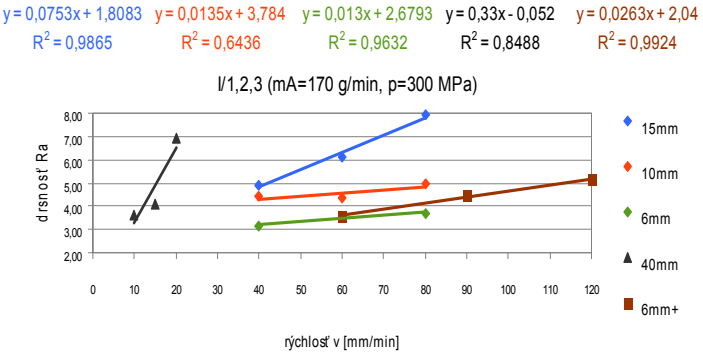

FIGURE 2. Example of a set of oneparametric dependencies R_a (surface roughness) on v (cutting head speed) for all examinated thicknesses

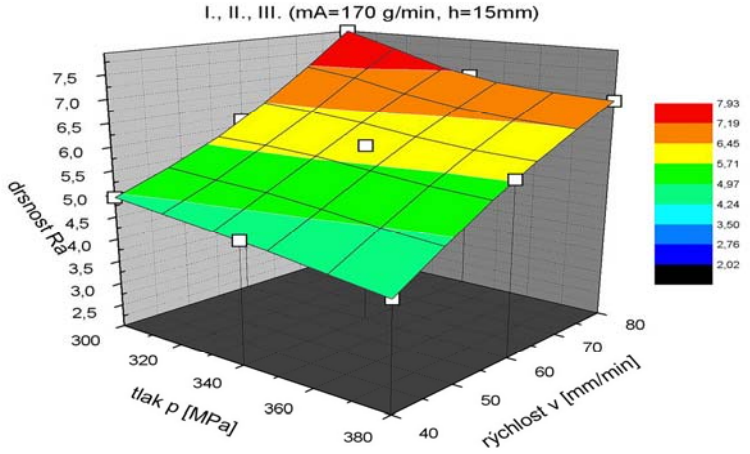

FIGURE 3. Graphic representation of 2-parametric dependency Ra-p-v (m_A = 170 g/min, h = 15 mm)
Note to the Fig. 2: **Ra** (surface roughness), **p** (pump pressure), **v** (cutting head speed)

Tab. 2. Sample of the heading of records with the measured values for the thickness of 6mm

Namerané hodnoty drsností rezaných povrchov Ra, Rz, Ra4, Rz4 pri vzorkách s hrúbkou 6 mm vrátane kontrolných meraní a celkovej chyby merania D_R																																	
Hrúbka vzorky h						6 mm																											
IDENTIFI-KACIA VZORKY		TECHNOLOGICKE PARAMETRE				KVALITATIVNE PARAMETRE																													
č. vz.	č. rez. pl. vz.	m_A [g/min]	p [MPa]	v [mm/ min]	t [s]	Ra_1						D_R [%]	Ra	Rz_5					D_R [%]	Rz	Náh. č.	Ra_{4K}						D_R [%]	Ra_4	Rz_{4K}						D_R [%]	Rz_4
						k.m.1	k.m.2	k.m.3	k.m.4	k.m.5				k.m.1	k.m.2	k.m.3	k.m.4	k.m.5				k.m.1	k.m.2	k.m.3	k.m.4	k.m. 5			k.m.1	k.m.2	k.m.3	k.m.4	k.m.5		
I	1	170	300	40	60							3,17							21,88	82								3,37							22,84
	2	170	300	60	40	3,61	3,61	3,44	3,48	3,45	4,83	3,52	22,49	22,72	21,62	21,63	21,63	5,00	22,02	83								4,02							23,91
	3	170	300	80	30							3,69							22,11	84								4,25							25,88
II	4	170	340	40	60							3,06							21,73	85								3,29							22,64
	5	170	340	60	40	3,38	3,36	3,43	3,41	3,50	4,10	3,42	21,44	21,68	22,15	22,02	22,23	3,74	21,90	86								3,73							23,72

4. NEW KNOWLEDGE AND RECOMMENDATIONS

The sample of the new knowledge of the results from the analysis of graphical dependencies on the Fig. 2 and 3 is described below.

- The surface roughness **R_a** of steel HARDOX 500 is ascending dependently on increase of the cutting speed and the quality of the surface descends with increasing thickness
- The surface roughness **R_a** of steel HARDOX 500 is ascending dependently on increase of the cutting speed and increase of the pump pressure, where the influence on the surface quality of the ascending cutting speed is bigger than the influence of the descending pump pressure.

Formulated recommendations are based on evaluation of the experiments and new knowledge.

Presented is the sample of the recommendations following new knowledge.

- design of the products produced from steel HARDOX 500 by AWJ technology, where requirement on the cut surface quality is higher, should use material with a minimal thickness.
- in single production (where cutting time is not so important) from steel HARDOX 500, cutting with lower speed and higher pressure is recommended (e.g. v = 5 mm/min and p = 390 MPa).

5. CONCLUSION

Article deals with the actual and acute issue of the companies running production systems using AWJ technology of the influence of technological parameters on the quality parameter R_a of the cut surface.

The evaluation of the experiments is presented by one-parametric and two-parametric graphical dependency. In the article an example of the formulation of new knowledge and recommendations based on the evaluated experiments is presented.

6. UTILLIZATION OF THE PRESENTED KNOWLEDGE

The application of the knowledge presented in the article, is in the science and research (new graphical dependencies based on the evaluation of the experimental measurement complements actual knowledge in this field vor example [1], [3]), but first and foremost in the companies running production systems using AWJ technology, that can shorter the programming time by setting suitable and optimal values of the technological parameters in the production system for achieving required quality of the cut surface of the products [4].

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