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EXPERIMENTAL VERIFICATION OF SHEAR SPINNING OF SHEETS WITH TEFLON COATING

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ABSTRACT

The article deals with the experimental verification of the optimization of selected parameters of shear spinning. This forming technology was applied to cylindrical piece with teflon coating. The possibilities of shear spinning process were verified on cylindrical form made from stainless steel 17 241.1. Shear spinning is superior to classical drawing especially in the case of small production series. The experimental results presented here can be applied in engineering practice.

1. INTRODUCTION

Research of progressive technology of shear spinning is carried out on TU of Brno as a part of the Research plan "Development of the progressive high precise machine technologies." (Reg.No. MSM 26210000). It was applied to the forming of stainless steel (W.- No. for DIN :1.4300, Czech stainless steel 17241.1) coated with teflon; intermediate product being roundel ø115 mm.
It was necessary to verify in laboratory the possibility of manufacturing functional cylindrical part with variable wall and bottom thickness using shear spinning without damaging teflon layer and with least number of operations. Problems concerning pushing of cylindrical vessels without thinning the vessels' wall with diagram of limiting deformation is discussed, e.g., in [1]. Some possibilities of shear spinning are presented in [2], [3], etc.

2. EXPERIMENTS AND THEIR RESULTS

Experiments were performed in two stages. During the first stage, shear spinning was applied on a set of ø140 mm circular intermediate products, without teflon coating, with 5 mm steps to the final diameter of ø110 mm. The results btained on stainless steel 17 241.1 without surface treatment were than used for shear spinning of material with surface layer of teflon.

Both stages started with the manufacturing of cylindrical intermediate product by classical pushing on modified lathe SUI-40A. Application of shear spinning then followed. Experiments were performed in cooperation of TU and VTUO Brno.

With the aim to verify mechanical properties of stainless steel 17 241.1 tensile tests according to CSN EN 10002-1 in laboratory at TU.

The results were: R_e = 231 MPa, R_m = 560 MPa, A_{80} = 45%. The toughness (notched specimens) measured according CSN 41 7241 was K_{CU2} = 215 Jcm^{-2}.

3. MATERIAL

Corrosion resistant Cr-Ni stainless steel, Czech standard 17 241.1, with composition

Tab. 1 Nominal composition of Cr-Ni stainless steel used in experiments

C	Mn	Si	Cr	Ni	P	S
max 0,12	max 2,00	max 1,00	17,00 – 20,00	8,00 – 11,00	max 0,045	max 0, 030

Roundels were coated with two layers of teflon at 430 °C. Steel surface was sand blasted.

First layer, "primer", was 7 to 8 micrometers thick; the thickness of second layer, "top" was 17 ± 3 μm. Teflon coating was burnt out at 430 °C. In practice three layers are often used, third layer being varnish, but this type of coating was not evaluated here. Coating thickness was measured by instrument POSTECTOR 6000-3. Each roundel was measured at ten spots, each measurement was repeated three times. Average teflon layer thickness for our experiments was 21 μm.

R_a parameters of selected cylindrical intermediate product with one-side teflon coating after optimization of revolutions of forming block and feed of pulley.

Original thickness of sheet metal with teflon coating was t_0 = 1.50 mm. After shear spinning, the thickness with teflon coating was t_1 = 1.25 mm on operational cylidrical product (Fir. 2, point 3). During the shear spinning process, the revolutions of forming block and linear movements were optimized.

Following values of linear feed were chosen: 0.12 - 0.25 - 0.90 - 1.23 mm/rev and values of revolution of forming block 630 1/min, 1030 1/min, and 1620 1/min. Lubricant had trade mark Presspate SEM 95/800. Optimal values of linear feed were found to be between s = 0.90 and s = 1.23 mm/rev and revolution of forming block between 1030 and 1620 rev/min. Selected specimen No. 32 with unbroken teflon coating underwent processing at forming block revolution n = 1030 1/min and linear feed s = 0.90 mm/rev. Arithmetic mean of profile R_a deviations measured at spots (1) - (5) are in Fig. 1.

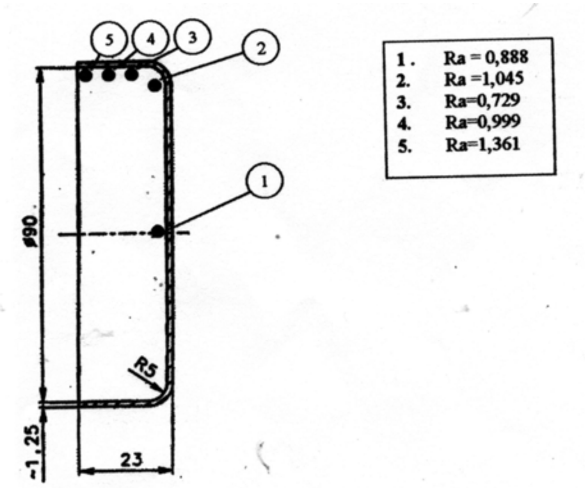

Fig. 1 Values of R_a [μm] measured on cylindrical piece with thinning of the wall

Technological process of manufacturing of cylindrical piece using shear spinning from roundel ø115, thickness of stainless steel sheet 1.5 mm, is shown in Fig. 2.

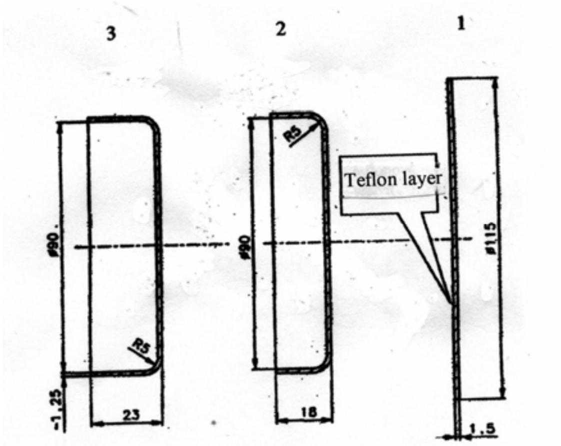

Fig.2 Technological process of manufacturing of cylindrical piece

Figure 3 represents the arrangement of tool and piece in experimental pressing with wall thinning. Teflon coating prohibits the inter-operational annealing and this fact affects formability of the material during second operation of above mentioned technological process.

Austenitic steel hardens considerably after first operation, from original tensile strength R_m = 560 MPa up to R_m = 950 MPa.

Functional cylindrical pieces with teflon coating on interior surface after optimization of parameters of shear spinning are shown in Fig. 4.

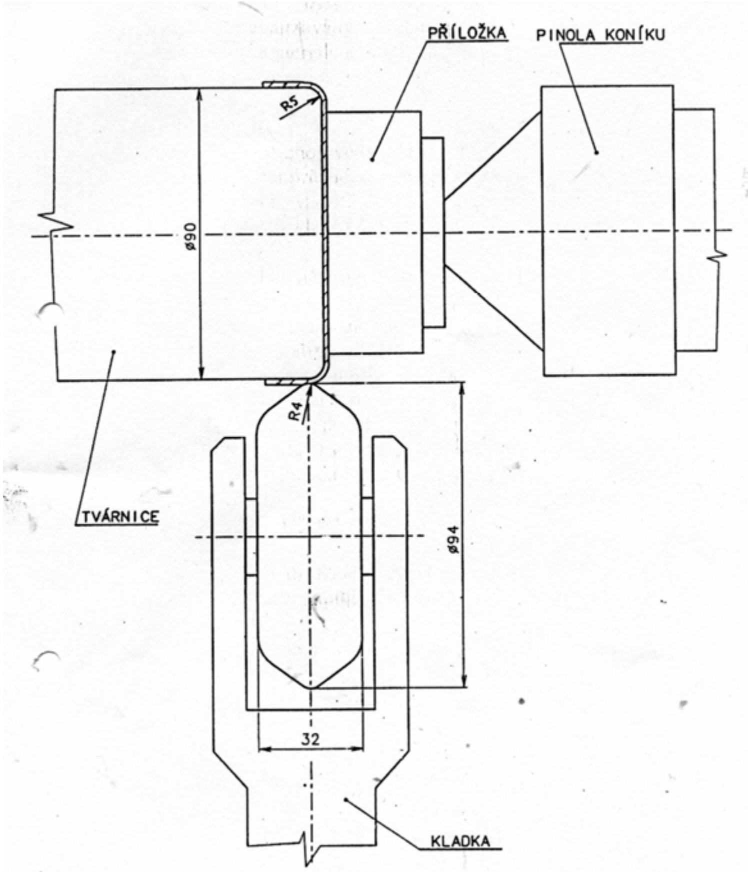

Fig. 3 Shear spinning of cylindrical intermediate piece.

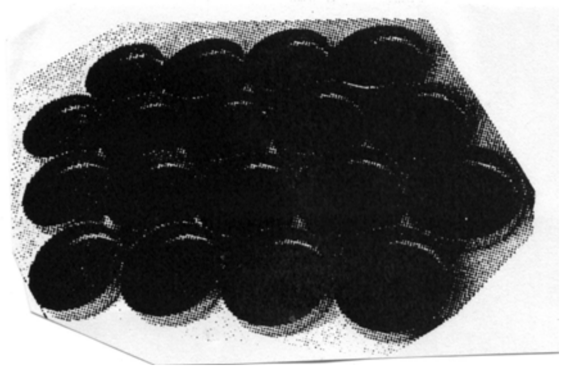

Fig. 4 Set of functional pieces with thinned wall and teflon coating

4. CONCLUSIONS

To produce successfully functional cylindrical piece with thinned wall from Cr-Ni stainless steel roundel coated one-sided with 21 μm teflon it is necessary to optimize starting dimensions of the round sheet cut.
The outcome of optimization was roundel with diameter 115 mm. Optimization of pulley linear shift and forming piece revolutions followed. For given material satisfactory values of linear feed were in the interval s = 0.90 - 1.23 mm/rev and two step process must be used for production of functional cylindrical piece, ø90 mm and height 23 mm, with final wall thickness 1.25 mm with teflon coating on internal surface of piece. It was necessary to apply lubricant PRESSPATE SEM 95/800 on contact surfaces of tool and material. Its amount was not optimized during the experiment. It was found that feed speed of the pulley is more important factor of technological process than increase of number revolutions when shear spinning of stainless steel with teflon layer is performed. Accomplished experiments allow partial conclusion that the production of functional piece with teflon layer requires optimization of intermediate piece dimensions, pulley feed speed and revolutions of forming piece. It is also necessary to apply suitable lubricant and minimize contact time between teflon layer and forming piece.
Materials with worse properties from the point of view of forming, here belongs also stainless steel, require high rigidity of whole system: machine-tool-material. Maximal value R_a = 1.361 μm on top edge of piece wall (point 5, Fig. 1) corresponds to the maximum of logarithmic strain φ.

5. REFERENCES

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EKSPERIMENTALNA VERIFIKACIJA ROTACIONOG TISKANJA KORIŠĆENJEM TEFLONSKIH PREVLAKA

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REZIME

Istraživanja procesa rotacionog tiskanja izvršena su na projektu "Razvoj progresivnih visoko preciznih tehnologija" delimično su prikazana u ovom radu.
Materijal koji je istraživan: čelik, češka oznaka 17241.1 presvučen teflonom. Segment istraživanja koji je prezentovan u ovom radu imao je za cilj da verifikuje mogućnost izrade funkcionalnog cilindričnog komada sa debljinom zida koja je manja od debljine dna. Pri tome prevlaka teflona treba da ostane neoštećena a deo treba da se dobije u što manjem broju operacija.
Eksperimenti su izvedeni u dve faze. U prvoj fazi tiskani su limeni polufabrikati (rondele ϕ140mm) na krajnji prečnik ϕ110mm. U drugoj fazi vršeno je dalje tiskanje. Mehaničke osobine čelika 17241,1 (hrom-nikl legiran) dobijene su testom zatezanja:
Re=231 Mpa, Rm=560 Mpa, A_{80}=45%.
Pomak za vreme tiskanja je variran:0,12-0,25-0,9-1,23 mm/obrtaju.
Podmazivanje je vršeno Pressopate SEM 95/800.
Ustanovljeno je da je optimalni pomak s=0,9 i 1,23 mm/obrtaju a broj obrtaja 1030-1620 ob/min. Nakon procesa merene su vrednosti hrapavosti Ra na 5 različitih pozicija obratka. Takođe je ustanovljeno da je došlo do ojačanja materijala sa Rm=560 Mpa.