

WASTE REDUCING OF LARGE ENAMELED PRESSINGS

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Environmental protection, management of waste, reducing the use of chemicals in manufacturing, reducing of product weight, control and keep the technological methods are forcing manufacturers to solve problems joined with continuous improvement of product quality and competition on the world market. The paper deals with the problem of complex evaluation of drawn parts, their pressability and surface protection as well as with the influence of waste on environment. The tests were realised on cold-rolled sheets suitable for enamelling of quality KOSMALT 190 (thickness 1.5 mm) and KOSMALT 180 IF (thickness 1.35 mm). With keeping of strong production requirements, it is possible to reach the required results and it is the possibility how to save financial resources for the firms and ecological requirements.

Key words: waste, material, drawing technology.

Redukcija otpada velikih emajliranih otpresaka. Zaštita okoliša, gospodarenje otpadom, smanjenje upotrebe kemikalija u proizvodnji, smanjenje mase proizvoda, kontrola i zadržavanje tehnoloških metoda prisiljavaju proizvođače na rješavanje problema povezanih s kontinuiranim poboljšanjem kvalitete proizvoda i zadržavanjem konkurentnosti na svjetskom tržištu. Rad se bavi problemom kompleksne evaluacije vučenih dijelova, njihove sposobnosti za prešanje i zaštite površine, te utjecajem otpada na okoliš. Ispitivanja su provedena na hladno-valjanim limovima kvalitete KOSMALT 190 (debljine 1.5 mm) i KOSMALT 180) IF (debljine 1.35 mm), pogodnim za emajliranje. Uz zadržavanje strogih zahtjeva proizvodnje, moguće je postići željene rezultate i na taj način ostvariti financijske uštede firmama i zadovoljiti ekološke zahtjeve.

Ključne riječi: otpad, material, tehnologija vučenja.

INTRODUCTION

There are put high requirements on metal materials and their surface finishing from the reason of continual progress in machinery production. The requirement for reducing of weight of drawn products urges the producers to reduce thickness of used materials. It means the reducing of thickness of products from sheet. The thickness and the roughness of material surface influences on the required properties of steel sheets and also on the changes of technological conditions of deep drawing. The second requirement for product is its adequate stiffness, it means, sheets with higher

strength properties and formability with defined surface.

Various new lubricants are explored and evaluated in order to improve the formability of draw quality of galvanic annealed steels. This could be a result in lower scrap rate of steels. The properties of sheet and lubricant must guarantee deep - drawing of stampings without problems, but with required qualitative and dimensional parameters. Also the surface finishing after deep-drawing operations plays the main role in surface protection during the life-service of material or working piece [1-2].

ANALYSIS OF DEEP DRAWN PROCESS FOR DECREASING OF PRODUCTION WASTE

During the manufacturing of drawn parts many interior and exterior parameters have influence on the quality of products, waste and production processes. They can be divided as:

- design parameters, which are characterized as shape, material quality of drawn tools and products,
- technological parameters, which are characterized by influence of drawn conditions, lubrication conditions,
- material parameters, which are characterized by the material properties, physical, chemical and mechanical properties [3-4],
- human influence during the production as a control and service function [5-6],
- life and workplace environment influence as humidity, temperature, dustiness.

When the waste is analyzed from deep-drawn operations, the biggest influences have following parameters [7-8]:

- tool design - as punch and die, their radius, blank holder, shape of draw beads,
- tool production - as production accuracy, clearance, surface roughness,
- set up of tool, drawn gap and its clamping to machine,
- rigidity and stability of tool,
- condition and quality of surface of active tool parts,
- tool maintenance and its wearing.

The most often occurred errors of drawn tools are following [7,9]:

- oversized wearing of drawn tools caused by deficiency of material running in critical places. The oversized wearing appears and changes the geometrical

dimensions, shape and surface quality of functional parts or can tear the drawn piece.

- the life-service of drawn tool,
- scratch arises as a result of default of lubrication or as a result of abrasive mechanical parts.
- sticking or welding of small metal parts on drawn tool.
- wrong set up of drawn tool causes the non-constant drawn gap and can arise waves during drawing, respectively tear the drawn piece.

Also the technological parameters have great influence on drawing process [10]:

- blank holder force and pressure drawn speed of drawn tool,
- manner of lubrication application and friction conditions.

The lubricants are used as the medium for decreasing of friction between forming material and working parts of drawn tool. Lubrication is one of the process variables that affect the quality of stamping sheet materials and production of waste. Using a good lubricant can significantly reduce scrap rate and/or improve quality during stamping. It protects the processed material against arising of surface errors and tool against wearing. The lubricant allows reaching the higher degrees of deformation and also allows to decrease of the drawn force under the same technological condition of drawing with higher degrees of deformation and the wall thickness is more stabilized. Wrong type of lubrication creates non-stabilized environment during drawing and can create the waste as scraps.

Material of pressings is one of the most important parameter influenced on the waste. For deep - drawing, there are used the steel sheets with higher degree of plastic properties, which must fulfill the complex requirements for:

- production and material properties – as formability, weld-ability, surface finishing,
- design of products- as freedom of shapes,
- function of product and its quality,
- costs- production, running, service
- environment-consumption of energy, recycling of materials.

Except the mentioned requirements the most important material parameters for deep- drawn process are chemical composition of material, structure of material, texture of material, mechanical properties of material, protection against material ageing, quality of material surface, shape and dimension of material or semi-product.

The errors, which are occurred at deep drawing operations and were identified, can be divided as following groups:

- internal errors, they are hidden and depends on chemical compound of material ,
- dimensional errors of semi-product and pressings,
- shape errors (spring back, wall deformation, waviness, ripples, interruption of continuity-rifts or failures, creation of earrings,
- surface errors (unstable surface roughness, scratches, grooves, sticked- up material parts- iron scales, mill chips, marks, impressions of cylinders, corrosion, black points- elements created by pure graphite, started- up coloration, various dirties,
- semi - product errors – as shape, flatness, wedge shaped parts, convexity, concaveness
- errors appear during manipulation of semi-product, wrong packing, transport, storage.

EXPERIMENTAL VERIFICATION OF PRESSING ERRORS

According to the knowledge about technological and environmental processes during the manufacturing, in the Department of Process and Environmental Engineering, Technical University of Kosice were prepared the experiment with the examples of waste drawn products.

In the mentioned causes lot of factors influenced on the waste, mainly the type of used material, force of blank holder and lubrication.

The material properties depend of production history, thermal processing and clearness of material.

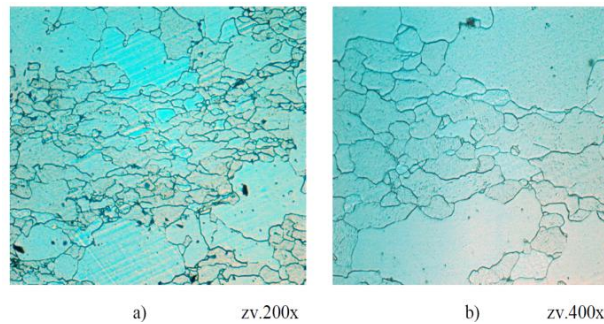


Figure 1. Non-homogeneous ferrite structure
Slika 1. Nehomogena feritna struktura

In the Figure 1 is shown the microstructure of material KOSMALT180 IF, used for bath

production and chemical and mechanical properties, Table 1 and Table 2.

Table 1. Chemical compound of steel sheets suitable for enamelling [11]
Tablica 1. Kemijski sastav čeličnih limova prikladnih za emajliranje [11]

Quality	Chemical compound [%]						
	C	Mn	Si	P	S	Al	Cu
	max	max	max	max	max		max
KOSMALT 180 IF	0,005	0,35	0,01	-	0,015	min. 0,02	0,06
KOSMALT 190	0,04	0,19	0,01	0,01	0,012	0,02- 0,06	0,06

Table 2. Mechanical properties of steel sheets suitable for enamelling [11]
Tablica 2. Mehanička svojstva čeličnih limova prikladnih za emajliranje [11]

Quality according to EN 10209/96 U. S. Steel Košice, s.r.o.	Mechanical properties					Thickness [mm]
	R _{p0.2} [MPa]	R _m [MPa]	A _{min} [%]	ε _{90min}	η _{90min}	
KOSMALT 180 IF	180	270 - 350	42	1,80	0,22	0,40 - 2,00
KOSMALT 190	190	280 - 350	40	1,40	0,22	0,40 - 2,00

In the Fig.2 to Fig. 5 are shown the examples of damaged drawn pieces from

manufacturing, which create the production waste.



Figure 2. Damaged bath tube at high blank force

Slika 2. Oštećena kada kod visoke sile tlačnog prstena



Figure 3. Damaged bath tube with wrong lubrication and high blank holder force

Slika 3. Oštećenje kade kod lošeg podmazivanja i visoke sile tlačnog prstena



Figure 4. Damaged bath tube without using of bead

Slika 4. Oštećenje kade bez korištenja zateznog rebra

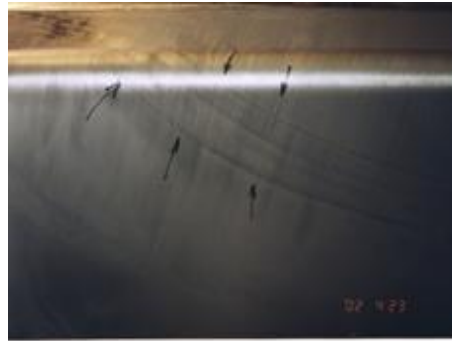


Figure 5. Inner material error of bath tube
Slika 5. Unutarnje greške materijala kade

Non-homogeneity of material is caused by secondary recrystallization as a result of incorrect annealing. The slow cooling rate from the annealing temperature or exceeded annealing time of steel strip/belt can be a reason of the disproportionate growth of some grains at the expense of other grains. The chemical pre-treatment, after drawing operations, consists of characteristic basic operations as degreasing in acids as sulphuric acid, rinse in inhibitor, finishing degreasing pickling, bath in passivation agent and detergent agent. These operations are carried out in practice under

various conditions of temperature, of concentration, of the quality of the active ingredients of the spa, with respect to the movement of the product, and also according to inter-service logistics of products.

After drying and powder coating in the electrostatic field, burned in the stove, follows the control of bath tubes surface. When becomes failure of technological conditions from various reasons, waster are occurred as a flakes, small holes, bubbles, non-enameled places and fall off the enamel from the basic material.

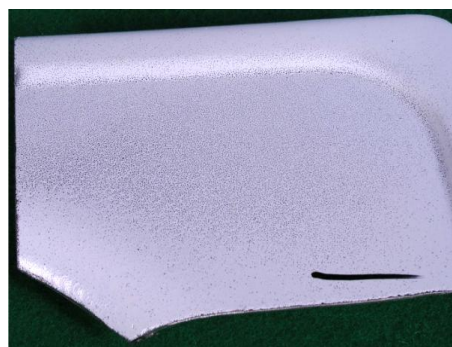


Figure 6. Errors in the coating of bath tube
Slika 6. Greške u premazu kade

From the Fig.6 to the Fig.8 are shown the errors of surface on the bath - tubes as black points/holes, failures.

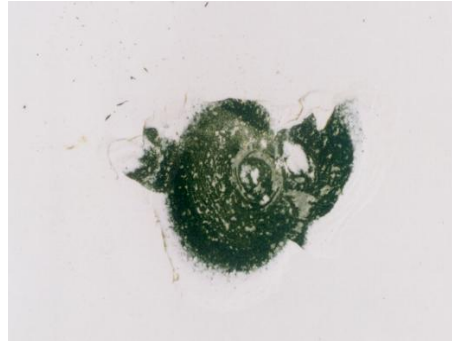


Figure 7. Failure of enamel surface of bath tube

Slika 7. Neispravnost emajlirane površine kade



Figure 8. Peel off parts from enamel

Slika 8. Ljuštenje dijela emajla

CONCLUSION

From the analysis of deep drawing operation of pressings follows that the product quality and waste mainly depends from parameters:

- production and technological parameters of drawing process,
- material of drawing part,
- human factors participated in control and maintenance of presses and drawn tools.

The using of new materials puts essentially higher requirements in deep drawing to strict observance of instructions and technological conditions at drawing. By

changing of lubrication relations on the die and draw beads, arising of scratches, which causes quicker arising of failures on pressings. The waste appears by wrong setting up of drawn tools and blank holders, wrong maintenance and control. These negative effects can be limited or essentially decreased only by non-stop increasing professional and practical knowledge of drawn process, specialists, who shear in the working process of pressings.

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