

## TECHNOLOGICAL AND ENVIRONMENTAL CONDITIONS AT MATERIAL FORMING

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### ABSTRACT

*Environmental requirements, new environmental regulations, protection, reduction and management of waste, reducing the use of chemicals in manufacturing, reducing of product weight, control are forcing manufacturers to solve this problems joined with continuous improvement of product quality and competition on the world market. 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. The contribution solves the problem of manufacturing of drawn parts, their pressability, surface protection and minimalisation of waste during the production.*

### KEY WORDS

*Environment, metal forming, production*

### Introduction

The environmental relevance and importance of sheet metal forming processes is mainly based on their application in the production. The total environmental impact covers the whole area of production not only the impact of a single part or technological operation. The environmental aspects define process and product aspects. The process aspects inform about the using of materials, energy consumption and occurring of material waste during the manufacturing. The product aspects involve the environmental impacts, which are caused by the manufactured products.

### Analysis of deep drawn process for decreasing of production waste

Production of drawn parts requires interior and exterior quality parameters of products, waste. They can be divided as:

- design parameters as shape of tools and products,
- technological parameters, which are characterized by drawn conditions, lubrication conditions, roughness of materials and tools,
- material parameters, which are characterized by the material properties, chemical and mechanical properties and formability of steel sheet itself,
- human influence during the production as a control, service function,
- life and workplace environment influence as humidity, temperature, dust.

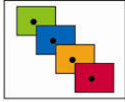
The most often occurred errors of drawn tools are following:

- 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, for example the wearing places appears at the front and back parts of margin of bath tube.
- 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 can be wrong set up of blankholder.

Also the technological parameters have great influence on drawing process:

- blankholder force and pressure (it depends from wearing of hydraulic parts of press and influence of temperature).
- drawn speed of drawn tool,
- manner of lubrication applying and friction conditions.

The lubrication uses 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. 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 to reaching the higher degrees of deformation and also



allows to decreasing 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, wrong manner of lubricant applying on material surface, non-stabilized properties during drawing can influence on the creating of waste during drawing operation.

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

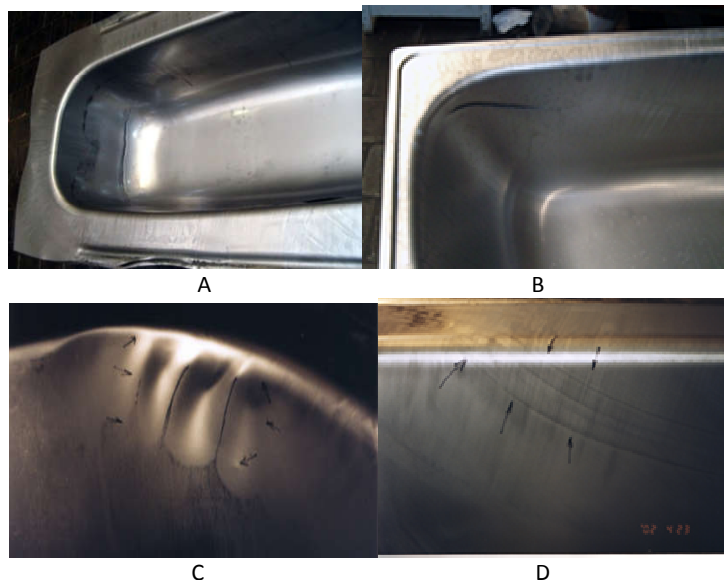
- production and material properties – as formability, weld-ability, surface finishing,
- design of products- as freedom of shapes,
- function of product and its quality,
- costs- production, running, service
- environment- consumption of energy, recycling of materials.

Except the mentioned requirements the most important material parameters for deep- drawn process are chemical compound 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, we can divide them 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 and margin deformation , waviness, ripples, interruption of continuity-rifts or failures, creation of earings, wrong margins, small punch and die radii, which caused the failure of pressings,
- surface errors (unstable surface roughness, scratches, grooves, stucked- up material parts- iron scales, mill chips, marks, impressions of cylinders, corrosion, next so called orange peel, which appear after stamping as unstable oval steps of rough surface, 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 errors during the pressings operations**

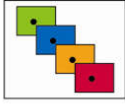
According to the knowledge about technological and environmental processes during the manufacturing, in the Department of Process and Environmental Engineering, Technical University of Kosice, where it was confirmed and shown, how the precision in the manufacturing of drawn and surface finished pieces influence as a factor on decreasing of production waste. In the Fig.1 are shown the examples of damaged drawn pieces from manufacturing, which create the production waste.



*Fig. 1. Examples of waste drawn pieces during the drawing operation*

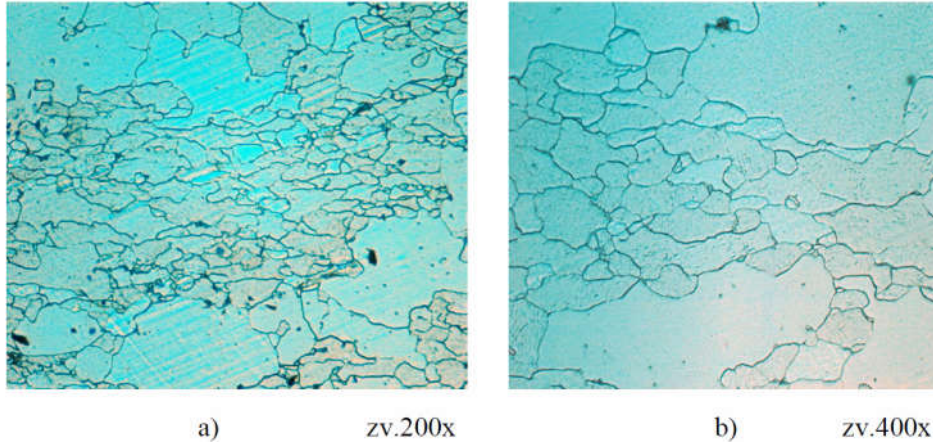
In the mentioned lot of factors influenced on the waste, mainly the type of used material Fig.1 a,b,d, force of blanking holder Fig, 1c.

The material properties depends of production history, thermal processing and clearness of material. In the Fig.2 is shown the microstructure of material KOSMALT180, used for bath production. Non- homogeneity of material is caused by



secondary recrystallization as a result of incorrect annealing. There could occur slow cooling rate from the annealing temperature or there was exceeded annealing time of steel strip/belt, which was the reason of the disproportionate growth of some grains at the expense of other grains.

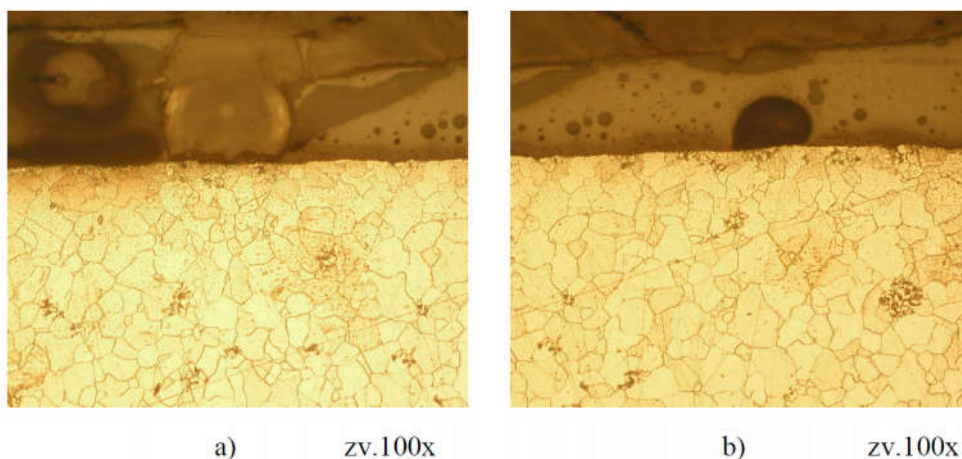
After deep-drawing operation follows the surface pre-treatment operation, mainly chemical pre-treatment. The chemical pre-treatment consists of characteristic basic operations as degreasing in acids as sulphuric acid, rinse in inhibitor, finishing degreasing pickling, bath in passivation agent and detergent 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.



*Fig. 2. Non-homogeneous ferrite structure*

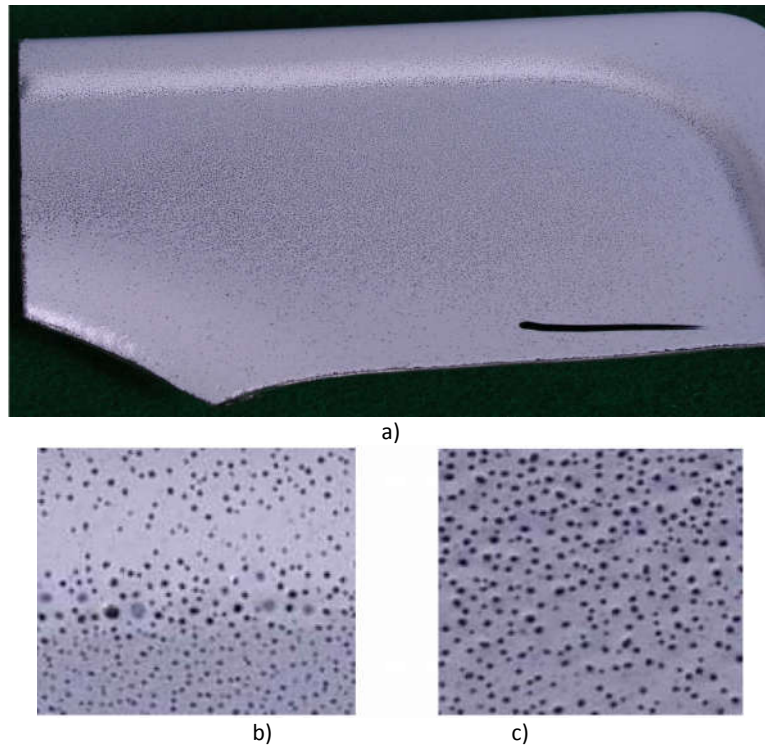
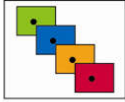
After drying and powder coating in the electrostatic field, burned in the stove, follows the control of bath tubes. When becomes failure of technological conditions from various reasons, waster are occurred as a flakes, small holes, bubbles, non-enameled places and fall off the enamel from the basic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

The reason of occurrence of black points is the excessive formation of bubbles arisen by large size CO respectively CO<sub>2</sub> bubbles in the enameling process. This error is identified as high temperature error during the enameling. In the Fig.3 are shown the phase boundary of metal and enamel on the tested sample with bubbles in the enamel layer. Also the perlite nests can be seen in the phase boundary of metal - enamel, and their incidence can be attributed to enrichment of the enameled surface area of sheet by carbon.



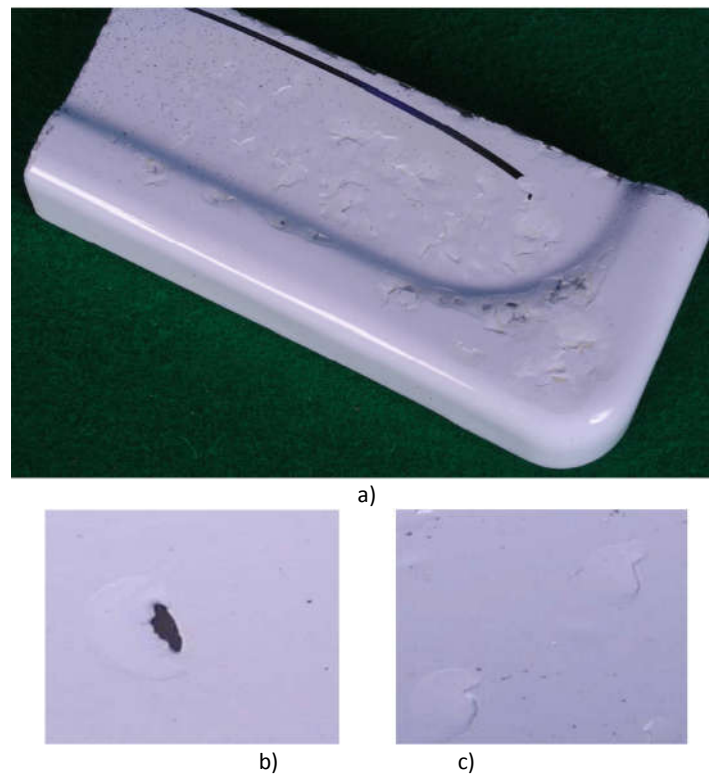
*Fig. 3 The phase boundary of metal and enamel, on the tested sample*

In the Fig.4 are shown the errors of surface on the bath- tubes as black points/holes.



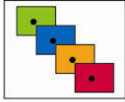
*Fig. 4. Errors in the coating of bath-tube: a) view of the bath-tube corner, b) detail of black and grey points on the bath radius, c) detail of black and grey points on the flat place*

In the Fig. 5 are shown the large scales/flakes after first and second sputtering operation of enamel frit after heating in the calciner.



*Fig. 6. Errors in the coating of bath-tube: a) view of the bath-tube corner with irregularly distributed scales, b) detail of enamel scale to the basic sheet, c) detail of scales with applying of second coat*





## CONCLUSION

After analyzing of waste from deep-drawn operations, we can make a claim that the biggest influences have:

- tool design - punch and die radius, drawn gap, using and type of blankholder, draw beads,
- tool production - as production accuracy, clearance, surface roughness,
- set up of tool and its clamping to machine,
- rigidity and stability of tool,
- condition and quality of surface of active tool parts,
- tool maintenance and its wearing,
- production and technological parameters of drawing process,
- material of drawing part,
- human factors participated in control and maintenance of process.
- energy.

The utilization of new materials puts essentially higher requirements in deep drawing to strict observance of instructions and technological conditions at drawing. By changing of friction relations on the drawn edges of die and draw beads, caused by inadequate lubrication or by changing of micro-geometry (arising of scratches) gives out to quicker arising of failures on pressings. With the introducing of new progressive technologies, continuing in study of deep-drawn processes, increasing of qualification and control, make possible to reach the required results, reducing of waste and also make the competitive ability in the world market.

One of the reasons of waste at the drawn parts production is also the human factor. The waste appears by wrong setting up of drawn tools and their periodical maintenance. The wrong setting up of blankholder pressures was also very often error. These negative effects can be limited or essentially decreased only by non-stop increasing of qualification, professional and practical knowledge of workers, who shear in the working process of bath tubes.

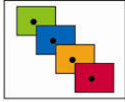
The future environmental research requires a further co-operation with many disciplines and will contribute and optimize to a better evaluation of the environmental impacts and environmental performance of manufacturing.

## ACKNOWLEDGEMENT

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