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Review on Optimization of process parameter in square shaped components in deep drawing process.

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Abstract: *Deep drawing is one of the most importing processes for forming a sheet metal parts. It is widely used for mass production of good strength and light weight part in automobile and aerospace industries. Optimization of process parameters in sheet metal forming is the important task to reduced manufacturing cost per year. In this review paper importance is given to gather the recent research work and the effect of process parameter on the sheet metal component .There are many process parameters like that blank holding force, die radius, friction, punch speed, and other factors that affect on product quality produced by deep drawing process. In square shape of component major failures are occurs due to stress concentration at the square shape sharp edges of die and punch. Therefore is important to optimize the process parameters to avoid stress concentration. For the ooptimization several tools have been used by researcher like ANOVA, FEA, Taguchi etc. In this review paper major focus is to review for square shape deep drawing component.*

Keywords: *Deep Drawing, process parameters, bank shape, blank holding force.*

I. Introduction

Most body suit parts are produced form sheet metal in automobile and aerospace components as well as consumer like home appliances, cans, sinks, boxes, etc. A thin blank sheet is subjected to plastic deformation using forming tools to conform a designed shape. During in deep drawing process the many defects are developed because process parameters are selected improper [1].

For minimize production cost and avoid defects in the parts, the solution proposed in two categories:

1. Improvement in the material properties of sheet metal.
2. Optimization of process parameters.

Optimization of the process parameters such as die corner radius, blank holder force and also friction coefficient etc[2].

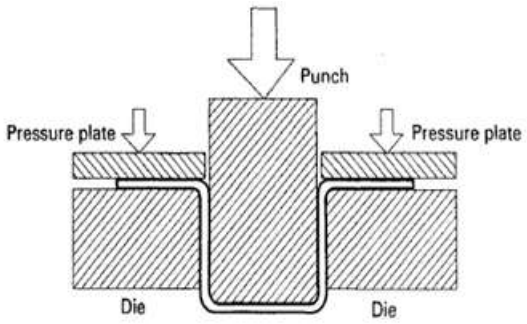


Figure1:- Deep Drawing Process [3]

In deep drawing operation, the sheet metal is hold firmly by application as per predetermined force called blank holding force and pressed against the die by the punch/upper die, blank holding force control the flow rate of material into the die.In traditional method of determining the optimum level of the process parameter is time consuming and costly. It relies heavily on trial-error and the expertise and based on the skill of the workers. The incorrect setting of the parameter and tool can lead to manufacturing of defective products. The main objective of designer is to design and manufacture forming tools and set process parameter in such a way that, the process can be used dependably for the production of defect-free products within the desired dimensional tolerances and with the required surface quality [4].In present review paper, Cracking, Thinning,

Wrinkling, Earring, Fracture, Tearing, Surface scratch are revived and analyzes the effect of process parameter. Following is table describes the major defects in square deep drawing and there causes.

Table 1-Major defects in square deep-drawing and its causes.

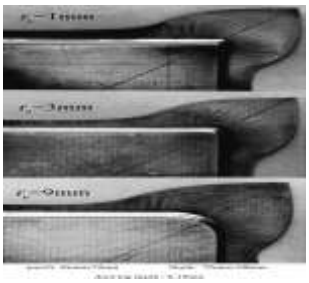
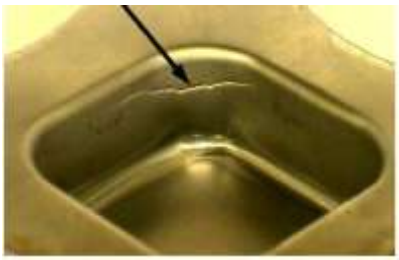
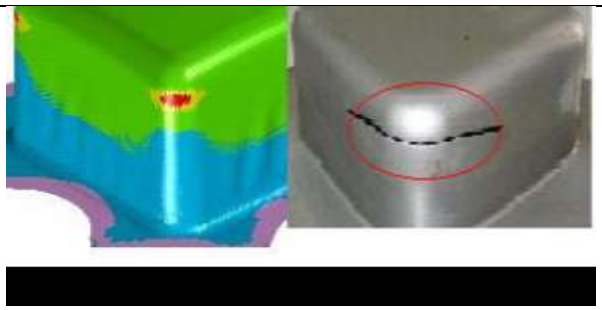
Sr. No.	Name of Defects	Pictures of Defects	Causes
1	**Wrinkling**	 **Fig 2- Wrinkling Defect** [5]	Occurs in the areas where is excessive material flow [5].
2	**Earring**	 **Fig 3- Earring**	Occurs when the material is anisotropic and has varying properties in different directions.
3	**Fracture**	 **Fig 4- Fracture [6]**	Occurs in the areas subjected to high tensile stresses [6].
4	**Tearing**	 **Fig 5- Tearing [6]**	In numerical Damage prediction and Experime-nts in Deep Drawing of Irregular Square Cup they are explained how to effect of blank holding force on tearing [6].

Table no-1 sheet metal defects and its causes

II. Literature review:

In this review paper twenty one technical paper are reviewed critically and they are classified based on research. Pawan.S.Nagda (2017) concluded that reduction in the earings defect of deep drawing is possible by modification of initial blank shape. Simulated results showed the initial blank as circular blank produced more % earing height because of planar anisotropy and modified blank showed reduction in the % earing height. The

use of modified blank i.e. non circular blank produced considerable reduction in % earing height [7]. Rashmi Dwivedia, Geeta Agnihotri (2017) critically reviewed the process parameters and their effect such as blank holding forces, effects of friction etc. Blank holder pressure is important process parameter that needed to be selected very carefully [8]**.** Ajay Kumar Choubey (2017) was show that the stresses are minimum on 5mm punch fillet radius, with 3.5 mm/sec punch speed. Also the simulation results state that the optimized punch pressure for stainless steel cup is 16 MPa on 35 mm punch stroke [9].Tushar Y. Badgujar, Vijay P. Wani (2016) concluded in paper the object and selected punch radius, die radius blank holder force, draw tonnage, binder stroke, draw bead height, contact friction with a thinning as an required criteria. To study the effect on thinning two-step methodology, FEA and orthogonal experiment method used. Thinning rate reduced from the from strong to weak are punch radius using experiments and that impact of the several process parameters on, draw tonnage, blank holder force, die radius, contact friction, draw bead height, binder stroke. The thinning rate effectively planned through FEA simulation optimization and orthogonal experiment, and the quality forming parts can be produced without obvious defects [4]. Lucian Lăzărescu (2015) results imply that the wall thinning in the punch shoulder part cannot be influenced by the constant or variable BHF considered in this study. On the other hand, the thickening at the side wall of deep-drawn cups can be influenced both by constant and variable BHF. In all the cases, it was shown that the increasing in BHF leads to a decrease of thickening of the side wall of drawn cups. Contrarily, by adopting a time variable BHF, decreased throughout the punch stroke, may lead to an increase of thickening of the side wall [10]. Ajay Kumar Choubey, Geeta Agnihotri (2015) present research appears to be superior and convenient for drawing sheets of thicknesses 3 mm. A Mild Steel impeller part with a LDR of 2.0 is successfully achieved. It is also possible to use low grade sheets and produce irregular shapes with deeper drawing depth [11]. Chandra Pal Singh (2015) result shows the limit thinning ratio will be decreases gradually and the deformation area tends to be scattered with the increase of blank holder load value and the coefficient of normal anisotropy. Also the occurring of wrinkles in the local deformation area reduces and the maximum height increases, which is favorable to formation of sheet metal [3]. Yasunori Harada and Minoru Ueyama (2014) concluded that square cups of pure titanium were formed at ambient temperatures by multistage deep drawing processes. The drawn cup by multistage deep drawing could be carried out to the 3rd stage. Various cups were drawn by exchanging the punch and the ringed die [12]. Mohsen Hassana, Labib Hezamb (2014) concluded that the deformation characterizes of square cups through conical dies have been studied by FE analysis and verified by experimental investigations. [2]. Halil . Ibrahim Demirci, Cemal Esner (2008) seen from his study that FEM analysis can give acceptable results of forming conditions, BHF and forming limits diagrams for every sort of materials. Therefore the need for the costly experimental work will be eliminated. In this way, a great saving in time and cost can be derived during the design and manufacturing phase in industry [13]. R. Padmanabhana, M.C. Oliveiraa (2007) concluded that the effective tools influence of process like FEM and Taguchi technique forms an. The analysis of variance (ANOVA) was carried out to examine the influence of process parameters on the quality characteristics (thickness variation) of the circular cup and their percentage contribution were calculated. The die radius (89.2%) has major influence on the deep-drawing process, followed by friction coefficient (6.3%) and blank holder force (4.5%) [1].C. Boher, D. Attaf, L. Penazzi, C. Levaillant (2005) concluded that the die radius surface observations confirm that wear industrial phenomena can be reproduced on the process simulator: strip particle transfer is the main wear damage and it is located on two specific areas of the die radius. Ploughing or abrasion is essentially observed at the entry of the die radius. There is a good agreement between high-pressure contact areas calculated by a finite element model and localised wear zones. The tribological behaviour of the die radius is quite different in function of the strip exit angle. For low strip exit angles, particle transfer on the die radius is important and for high strip exit angle, the main damage is abrasion. The friction coefficient may also give information about the contact evolution [14].

Some of the technical papers are classified according to the process parameter optimization as follows.

2.1 Punch Force and Punch Speed

Zhao et. Al. (2007) has investigated a linear relation was between the initial maximum Punch force are required. Hydro- mechanical machine is axial pushing force is exerted one the brim of the blank by has pushing boxing ring, this reduces radial nerve tensile stress at the sidewall and the risk of occurring break can be reduced considerably.

2.2 Blank Holder Force (BHF) and Optimization BHF

Failure is occurs due to Insufficient material flow results in the part by tearing defect will produced and also wrinkling form due to excessive material flow. Therefore, optimum the setting of blank holder force can avoid tearing as well as wrinkling.Blank Holder Force is applied to control the flow rate of material in the die and have a significant impact on the final product quality. Higher BHF can be reduces wrinkling in deep drawing process.[4].

For different applications of the different blank holder force have been required explained in the paper Numerical Damage prediction and Experiments in Deep Drawing of Irregular Square Cup such as 350KN,450KN, 550KN, 600KN,700KN,750KN,800KN. A low-blank holder force of 350kN was applied all through the punch displacement at the starting. At the last of deep-drawing process, higher blank holder force is necessary due to smaller flange area. [6]. At the 350KN blank hold force when wrinkle area is large the risk of crack produced in little area, when the Wrinkle area is smaller at 800KN BHF the crack area is visible, An approach to the tear area is visible when the extensive BHF of 800KN and above will be increasing [6].

2.3 Blank Shape

The solutions for improvement in draw ability of square cups can be improvement in the material properties of sheet metal. Knowledge of the process and material variable are required to minimize the defects and optimize the process Blank shape is one of the important to parameter in deep drawing process have the quality of deep drawn product, thickness distribution (casting), forming limits, minimizing the defects can be improved by having blank shape optimum, also material cost of product reduced when proper selection blank shape [2].

Molotnikovet .Al. (2012) has investigated the size effect one maximum load and limit drawing ratio for deep drawing of copper. Numerical analysis and experimental analysis have been done to study the effective ratio of blank thickness to grain size on blank thickness. He has been suggested Through mathematical modelling and experimental work it that size effect play an important role in square deep drawing when grain size kept constant and dimensions of work-piece get reduced.

2.4 Friction

Friction is another important process parameter between tools and blank that also influences deep drawing process. Its effect on surface quality of finished product also tool life and drawability of the blank sheet. The presence of good lubricating film between contact surfaces is essential for efficient for deep drawing process as strain distribution in blank is affected by contact of friction. Friction also contributes to the tool wear and blank wear. For more uniform strain distribution require the large value of full film lubrication region. The higher value of contact area ratio occurred when the surface asperity of die and blank comes into contact, and it will result produced in the larger value of frictional stresses. The value of Lower friction results in a more uniform radial strain distribution. [4].

2.5 Thickness

The distribution of thickness of square cups drawn process gets thinner towards the edges, wall thickness differences occur at sections corresponding to the punch edges and thickenings occur towards to the mouth section of square cup. The depth of the square cup increases in direct proportion to force applied by the blank holder plate on the sheet during a process. It has been observed in Effect of the blank holder force on drawing of aluminium alloy square cup. [13] .Theoretical and experimental investigation that thinning is more when compared to horizontal edges as thinning at straight edges of the square cup remains between the punch radius and the matrix radius in deep drawn [13].

III. Conclusion

This paper has reviewed the process parameters and their effect such as blank holding forces, die pressure, punch force and punch speed, effects of friction etc. In this review about twenty one research papers have been reviewed for the study of all affecting process parameters. Square shaped component has major problem in wrinkling and tearing which can be control by the selecting proper process parameter as given below.

Blank holder force controls metal flow during deep drawn process, it affects on thickness variation, strain path, stress path and blank holding forces also affect on wrinkling behaviour.

Friction effect on surface quality of finished product and tool life also draw ability of the blank sheet. The good lubricating film require between contact surfaces for efficient for deep drawing process.

Punch Force and Punch Speed affect product quality and production rate and tearing.

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