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A Review on Influence of the Effect of Process Parameters in Deep Drawing

KEYWORDS

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ABSTRACT Deep drawing is the manufacturing process of forming sheet metal stock, called blanks, into geometrical or irregular shapes that are more than half their diameters in depth. During deep drawing process, the process parameters such as punch/die radii blank holder force, punch velocity, draw depth, type and position of lubricant used have a significant effect on the quality of the drawn part. Regardless of the factors mentioned that affect draw quality in one way or the other, the most important element for a deep drawing operation is smoothness of sheet metal flow. To determine the optimum values of the process parameters, it is essential to find their influence on the deformation behavior of the sheet metal. Experimental as well as statistical means will be used to identify the influence of process parameters. Taguchi method will be employed. As we know that properly controlled metal flow leads to good quality parts.

I. INTRODUCTION

Forming is a process in which force is applied to metal to modify its geometry instead of removing of material. The applied force stresses the metal beyond its yield strength, causing the material to plastically deform, but not to fail. The stresses induced during the process are greater than yield strength, but less than fracture strength, of the material. The type of loading may be tensile, compressive, bending or combination of these. This is very economical process as the desired shape, size and surface finish can be obtained without any significant loss of material.The forming operation includes:

1. Bending
2. Drawing
3. Roll forming
4. Deep drawing

Deep drawing:

Deep drawing is process to produce cups, shells, boxes and similar parts from metal blank. It is a sheet metal forming process in which a sheet metal blank is radially drawn into forming die by the mechanical movement of the punch. It is thus a shape transformation process with material retention.

A simple drawing operation is shown in fig 1.1. A round blank is first cut from flat stock. The blank is then placed in the draw die, where the punch pushes the blank through the die. On the return stock the cup is stick with punch, to avoid this blank holder is used. Generally, a drawing operation is referred to as shallow drawing when the depth of cup is less than the diameter of cup and drawing of cup is deeper than half its diameter then it is called deep drawing.

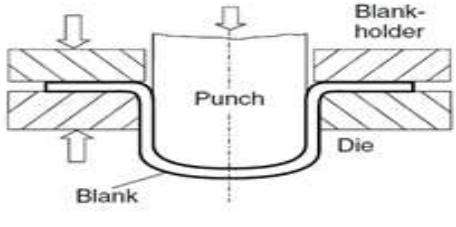

Fig1.1 A typical Deep drawing operation

Steps followed during deep drawing process:

To understand what happened to the metal during operation, the process should be broken into progressive stapes of formation as shown in fig 1.2. Here the flat circular blank is drawn into a flat-bottomed cup by forcing a punch against the blank, which is rest on a die. During first stage the punch contacts the blank. As the punch penetrates, the metal is bent from die radius and also from the punch radius, half cup will be formed. After further penetration, the metal that was previously bent over the die and punch radius becomes straight. As the punch progress downward final cup will form.

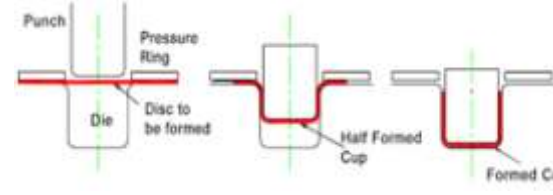

Fig 1.2 Steps during deep drawing process

II. LITERATURE REVIEW

Mark Colgan, John Monaghan [1], reports on the initial stages of a combined experimental and finite element analysis (FEA) of a deep drawing process. The objective of this research was to determine the most important factors influencing a drawing process, using the help of a design of experiments and statistical analysis. The parameters varied include the punch and die radius, the punch velocity, clamping force, friction and draw depth. After observing the anisotropic effects of the rolling process on the sheet material through drawing it and seeing the extent of earing in the flange, some blanks were annealed for stress relief, then the draw depth was compared to that of the original mild steel blanks. The main aspect that the ANOVA highlighted is that the geometry of the tooling is generally most important, especially the die radius. The smaller is the die radius, the greater is the drawing force induced and the greater is the overall thinning of the cup sidewall.

G. Venkateswarlu, M. J. Davidson and G. R. N. Tagore [2], carried study on AA7075.It is one of the most important

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structural materials extensively used in automobile and aerospace industries. In this study, the significance of three important deep drawing process parameters namely blank temperature, die arc radius and punch velocity on the deep drawing characteristics of Aluminium 7075 sheet was determined. The combination of finite element method and Taguchi analysis was used to determine the influence of process parameters. Simulations were carried out as per orthogonal array using DEFORM 2D software. Based on the predicted deformation of deep drawn cup and analysis of variance test (ANOVA), it was observed that blank temperature has greatest influence on the formability of Aluminium material followed by punch velocity and die arc radius. ANOVA methods can provide optimal parameters, however, these parameters have to be validated by conducting experiments.

S. Raju, G. Ganesan, R. Karthikeyan [3], reported that Deep drawing is one of the most important processes for forming sheet metal parts. It is widely used for mass production of cup shapes in automobile, aerospace, Railways and packaging industries. Cup drawing, also its importance as forming process, also serves as a basic test for the sheet metal formability. The effect of equipment and tooling parameters results in complex deformation mechanism. continuation of thickness variation in the formed part may cause stress concentration and may lead to hastening of damage.Using TAGUCHI's signal-to-noise ratio, it is found that the die shoulder radius has major influence followed by blank holder force and punch nose radius on the thickness distribution of the deep drawn cup of AA 6061 sheet. Deep drawing experiments were carried out according to the central composite design. The best parameter setting for most even wall thickness was found out using TAGUCHI's signal-to-noise ratio. The degrees of influence of the selected parameters on the deep drawing behavior of circular cup in order to improve the quality of the formed part were determined. The die shoulder radius has major influence followed by blank holder force and punch nose radius.

R. Padmanabhan, M.C. Oliveira, J.L. Alves, L.F. Menezes [4], in his studies revealed that to determine the optimum values of the process parameters, it is important to find their manipulate on the deformation behavior of the sheet metal. The importance of three significant process parameters namely, the die radius, blank holder force and friction coefficient on the deep-drawing characteristics of a stainless steel axi-symmetric cup was resoluted Finite element method combined with Taguchi technique form a refined predictive tool to determine the influence of forming process parameters. The Taguchi method was employed to identify the relative influence of each process parameter considered in this study. It reduced set of finite element simulations were carried out as per the Taguchi orthogonal array. Based on the expected thickness distribution of the deep drawn circular cup and analysis of variance test, it is evident that the die radius has the greatest influence on the deep drawing of stainless steel blank sheet followed by the blank holder force and the friction coefficient. This paper illustrates the use of FEM with Taguchi technique to determine the proportion of contribution of three important process parameters in the deep-drawing process namely die radius, blank holder force and friction coefficient. FEM and Taguchi technique forms an effective tools combination to predict the influence of process parameters. 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 has major influence on the deep-drawing process, followed by friction coefficient and blank holder force.

Young Hoon Moon, Yong Kee Kang, Jin Wook Park, Sung Rak Gong [5], studied the effects of internal air-pressing on deep draw ability to increase the deep drawability of aluminum sheet. The predictable deep drawing process is limited to a certain limit drawing ratio(LDR) beyond which failure will occur The intention of this work was to examine the possibilities of relaxing the above limitation through the deep drawing with internal air-pressing, aiming towards a process with an increased drawing ratio. The equipment and tooling parameters that affect the success or failure of a deep drawing operation are the punch and die radii, the punch and die clearance, the press speed and the lubrication. On the basis of the experimental investigation made herein, higher air pressing guarantees higher LDR. The increased LDR is mainly caused by the relaxation effect of local strain concentration at punch nose radius area.

Y. Marumo, H. Saiki, L Ruan [6],The objective of the work was to study the influence of sheet thickness on blank holding force and limiting drawing ratio. The paper shows variation in the blank holding force required for the elimination of wrinkling and the limiting drawing ratio with sheet thickness. The blank holding force required for the elimination of wrinkling increased rapidly as the sheet thickness decreased. The blank holding force was strongly influenced by sheet thickness and the coefficient of friction. The limiting drawing ratio decreased as sheet thickness decreased.

A.FallahiArezodar and A. Eghbali [7], stated that deep drawing process has some noticeable defects such as wrinkling, tearing, spring back, and thickness variation in different locations of produced cups. In the research the parameters of interest were punch/die shoulder radius, blank holder force, friction between sheet and die/punch/holder. Simulations were carried out using ABAQUS finite element software, and to study the effects of these parameters, Taguchi method was used. To verify the study's simulation results, experimental tests was carried out. Also By applying Analysis of Variance (ANOVA) method the significance and magnitude of each parameter in determining the thickness was used. Finally, to get the initial blank thickness in different locations the optimum level of parameters was calculated. He concluded that Die radius and Punch radius had the major influence in variation in thickness.

Kopanathigowtham, K.V.N.S. Srikanth&k.L.N. Murty [8], reports on the initial stages of finite element analysis(FEA) of a Deep drawing process. The objective of this study was to determine the factors influencing a drawing process and analyzing the process by varying the Die radius and keeping the Friction, Punch radius and Blank Thickness as constant. In this paper Punches, blank thickness of same geometry and dies of various geometries were drawn by using CATIA software. And an effort is made to study the simulation effect of main process variant namely die radius using finite element analysis. As the FEM code, the commercially available software DEFORM-3D is used here. Aluminium alloy 6061 is used for deep drawing with initial diameter as 56mm. It has been found that as the die radius is reduced, the amount of fore required to draw the material is increased. A decreased die radius created stretching marks and earring type problems.

R. Venkat Reddy, Dr T.A. Janardhan Reddy, Dr. G.C.M. Reddy [9], studied that the appearance of dimensional

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deviations of shape and position, of the defects in the metal sheets that have been subjected to a cold plastic deformation process (deep drawing), represents a critical problem for the mass production, like the machine manufacturing industry. The aim of this publication was to present the principal aspects that effect of various factors like BHF, punch radius, die edge radius, and coefficient of friction on the wrinkling of cylindrical parts in deep drawing process. The initiation and growth of wrinkles are influenced by many factors such as stress ratios, the mechanical properties of the sheet material, the geometry of the work piece, and contact condition. He concluded that the height of the wrinkles is reduced by increasing the BHF, decreasing friction, increasing the tools edge radius all together in one operation. It was also noticed that when Friction forces are low, the wrinkling is more pronounced, but if the friction forces are too high the material can break.

After studying of above literatures we have concluded that following process parameters are taken place in deep drawing process.

1. Radius on Punch
2. Radius on Die
3. Friction
4. Material to be drawn
5. Blank holding force
6. Percent reduction and depth of draw
7. Die clearance

In our project we are going to use SS316. The composition of SS316 is given in below.

Chemical Composition of Material

Component	Wt%
C	Max 0.03
Cr	16-18
Mn	Max 2
Ni	10-14
P	Max0.045
S	Max 0.03
Si	Max1

Physical Properties of Material

Hardness, Rockwell B	79	
Tensile Strength, Ultimate	558 MPa	
Tensile Strength, Yield	290 MPa	0.2% YS
Elongation at Break	50 %	in 2 inches
Modulus of Elasticity	200 GPa	Tension

III. Conclusion

From the literature survey it has been concluded that for deep drawing process blank holding force, die radius and punch radius are affective process parameters.Design of Experiments will be used to carry out different experiments.Percentage reduction in thickness will be calculated. It is a part of formability analysis. It will be checked for failure. ANOVA will also be carried out after the completion of calculations of percentage reduction in thickness.

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