Review A Sheet Metal Deep Drawing Process

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Abstract— Sheet metal forming is one of the most basic and versatile process which is having highest applicability in Modern world applications , Considering wide applicability of deep drawing process in sheet metal forming product industries, this basic process has been selected for study. Formability of sheet metal is affected by various material and process parameters, where temperature at which process is carried out plays a major role in determining the success rate and time required for manufacturing product of sheet metal. From the literature survey I found that during the Sheet metal drawing process the required steps required to manufacture a product is higher and the process timing can be reduced. For this there needs to be undertake FEA simulation for predicting the effect of temperature on the process variable and number of stages required to draw the component successfully thus minimizing experimental trial and error which can save time and cost of experiments. In this study there needs to work on specimen whose manufacturing processes can be compared in the room temperature and in the specified temperature. After the FEA simulation from the obtained data for the typical component of four stage part, the results shows that at higher temperature the production time can be minimized.

Key words: Deep Drawing, Warm Deep Drawing, Forming, FEA, ANSYS

I. INTRODUCTION

The term deep drawing implies that some drawing - in of the flange metal occurs and that the formed parts are deeper then could be obtained by simply stretching the metal over die.

Flat sheet metal is formed into cylindrical or box type parts by means of punch that presses blank into die cavity, thus the component formed is the result of combined controlled moment of punch and of material in the die, and here important value is the L/D ratio of the component.

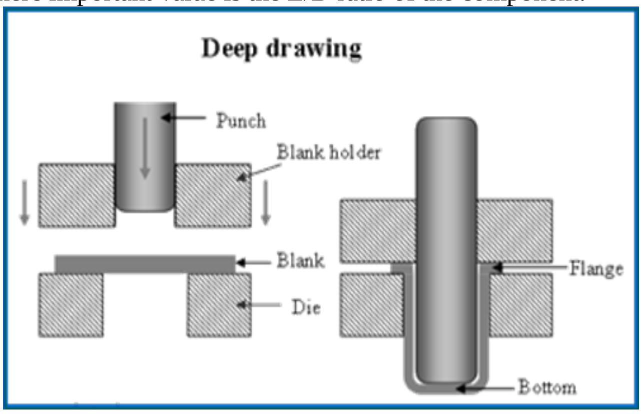

Fig. 1: Deep Drawing Process [1]

As per the temperature criteria Depp drawing process is classified into Cold Deep drawing process, Warm Deep Drawing process & Hot Deep Drawing process. Cold Deep Drawing process has the working temperature of room temperature, Warm Deep drawing process has working temperature above the room temperature but below the recrystallization temperature and the Hot deep drawing process is on recrystallization temperature.

A. Application Of Deep Drawing Process

It is one of the most important manufacturing processes especially with those components which cannot have desired physical and mechanical properties if produced by casting process, practically all metals, which are not used in cast form, can be easily produced by deep drawing process.
For Instance: Kitchen Wares, Boxes of various shapes etc.

II. LITERATURE STUDY

A. Effect Of Temperature On Anisotropy In Forming Simulation Of Aluminum Alloys [2]

S. Kurukuri, A. Miroux, M. Ghosh.
A combined experimental and numerical study of the effect of temperature on anisotropy in warm forming of AA 6016-T4 aluminum was performed. From the presented warm forming simulations of the cylindrical cup deep drawing, it is seen that the effect of temperature on shape change of yield locus has an effect notably on the predicted thickness distribution, indeed the predicted thickness with the model including temperature effects is almost overlaps the experimentally measured thickness at the bot-tom. In the die radius area also, the model with temperature effects performs slightly better than the one obtained without temperature effects. However the model cannot represent the experimental earing profile at elevated temperatures.

B. Warm Forming Of Stainless Steel Sheet [3]

F. Stachowicz, T. Trzepiecinski
The aim of warm sheet metal forming processes is to improve plastic ow of material, as well as to decrease the spring back effect. with the effect of temperature in the range from 20 °C to 700°C on basic material parameters of stainless steel sheet metal such as yield stress, ultimate strength, total and uniform elongation, strain hardening parameters and plastic anisotropy factor. It was determined that the most suitable temperature of warm forming of the AMS 5604 stainless steel sheet is 500C. The MSC Marc Mentat commercial computer code was used for numerical simulation of analyzed forming processes.

C. Metallurgical Studies Of Austenitic Stainless Steel 304 Under Warm Deep Drawing [4]

Jayahari Lade, Balu Naik Banoth, Amit Kumar Gupta, Swadesh Kumar Singh
Austenitic Stainless Steel 304 was deep drawn with different blank diameters under warm conditions using 20T hydraulic press. A number of deep drawing experiments both at room temperature and at 150° C were conducted to study the metallography. Also, tensile test experiments were conducted on a universal testing machine up to 700° C and

the broken specimens were used to study the fractography of the material using scanning electron microscopy in various regions. The microstructure changes were observed at Limiting Draw Ratio (LDR) when the cup is drawn at different temperatures. In austenitic stainless steel, martensitic formation takes place that is not only affected by temperature, but also influenced by the rate at which the material is deformed. In austenitic stainless steel 304, dynamic strain regime appears above 300 °C and it decreases the formability of material due to brittle fracture as studied in its fractorgraphy. From the metallographic studies, the maximum LDR of the material is observed at 150 °C before dynamic strain regime. It is also observed that at 150 °C, grains are coarse in the drawn cups at LDR.

D. Finite Element Based Simulation On Warm Deep Drawing Of AISI 304 Steel Circular Cups [1]

N. Ethiraj, V.S. Senthil Kumar

According to this Literature the warm deep drawing process is one of the unconventional deep drawing processes which has attracted a lot of researcher to study in the said stream. In this Study Finite Element method based simulation was used by commercial available software package to carry out on deep drawing of Circular cups of austenitic stainless steel at a temperature of operation from room temperature to 300 C. At the same temperature experiments were also carried out. The results showed the comparison between the experimental values and the Finite Element simulation results. This results shows a very good agreement between the two. So it can be understandable that the FEM simulation can be used effectively for deep drawing operation at any temperature within this range by modifying any input parameters without conducting the experiment and which can effectively saves cost.

E. Development Of An Analytical Model For Warm Deep Drawing Of Aluminium Alloys [5]

Hong Seok Kim, Muammer Koc, Jun Ni

In this study, an analytical model was developed to investigate the effects of material, process, and geometric parameters in the warm forming of aluminum alloys under simple cylindrical deep drawing conditions. The model was validated with both existing experimental findings in the literature and FEA results. The effects of the main process parameters (i.e. temperature, forming rate, blank holder pressure (BHP), and friction between a blank and a tooling element) on formability were studied under a variety of warm forming conditions. The developed model offers rapid, useful, and reasonably accurate results for the design of warm forming process by predicting the deformation mechanism of the material and the relationships between limiting drawing ratio (LDR) and process parameters in isothermal and non-isothermal heating conditions. It was demonstrated that significant formability improvement could be achieved when a large temperature gradient was realized between die and punch, while a slight decrease of LDR was observed when tooling elements and a blank were heated up to same temperature levels.

F. Finite Element Analysis Of The Formability Of An Austenitic Stainless Steel Sheet In Warm Deep Drawing [6]

H. Takuda , K. Mori, T. Masachika ,E. Yamazaki , Y. Watanabe.

The LDR increases as the temperature increases. The numerical blank model was divided into a cooling zone and a heating zone. The temperature of the heating zone was gradually increased and, during the computation, temperature-dependent material properties were used. The numbers of elements and nodes are 4225 and 4429, respectively.

The limiting drawing ratio and the maximum drawing depth increase and the maximum drawing force decreases as the die temperature increases. The distribution of through-thickness, strain is more uniform at elevated temperatures than that at room temperature, and the difference between the maximum and minimum through -thickness strains decreases. Numerical simulation using an FEM code, the distribution of through-thickness strain generally agreed with the experimental results. But, a big discrepancy at the head of the punch was observed, the effect of heat transfer between the punch and blank should be considered to obtain more accurate results.

G. Numerical And Experimental Analysis Of The Warm Deep Drawing Process For Magnesium Alloys [7]

G. Palumbo, D. Sorgente, L. Tricarico, S.H. Zhang, W.T. Zheng

The experimental procedure in the WDD tests is followed: (1) to heat the female die and the blank holder up to the test temperature, being the punch and the blank at room temperature; (2) to assemble the blank; (3) waiting few minutes for heating the blank up to the temperature of the female die; (4) to move down the punch to deform the blank.

H. An Analysis Method For Deep Drawing Process Design [8]

J H Vogel, D Lee

In this report an analysis method has been developed that predicts the strain distribution in deep drawn sheet parts. The method is based on plane stress characteristic theory, which neglects both normal and shear stresses acting across the thickness of the material, as well as variations through the thickness of in-plane stresses. Isotropic hardening and normal anisotropy have been introduced, and the von Mises yield condition and associated flow rule are employed. The theory is valid for regions in the sheet which are characterized by drawing as opposed to stretching deformation. The process model has been implemented as a computer program capable of modeling circular, square, and rectangular cups.

I. Delayed Cracking In 301LN Austenitic Steel After Deep Drawing: Martensitic Transformation And Residual Stress Analysis [9]

M.R. Berrahmoune, S. Berveiller, K. Inal, E. Patoor

Objective of this literature was to study the delayed cracking phenomenon of the 301LN unstable austenitic steel, by determining the distribution of residual stresses after deep drawing, taking into account the phase transformation. Deep drawing for different ratios is done for two different temperatures. Cracks appear for the highest drawing ratio (DR = 2.00) in the top of the cup. The breaking patterns observed using a scanning electron microscope show ductile fracture in the middle region, and both inter-granular and trans-granular rupture in the edges. Martensitic contents throughout the cup wall and through the thickness are determined. Increasing the martensitic content was found to have a great effect on the cracking sensitivity. X-ray diffraction allows us to determine the residual stresses in the martensitic phase. These last are positive, increase with increasing drawing ratios. The maximum value is located at the middle height of the cup, it exceeds 500 MPa for the 2.00 drawing ratio, and is less than 350 MPa for the 1.89 drawing ratio.

III. CONCLUSION

Hence for the Deep drawing processes most industries works on cold deep drawing process but the production time is high and defects scenario is seen in the production at higher rate. So considering the same for minimizing the phenomena the literature study was carried out. [5]

From the literature published it was seen clearly that temperature affects the process of deep drawing up to a great extent for both ferrous as well as non-ferrous metals. As well as the formation of martensitic phenomena can be seen in deep drawing process of the Austenitic steel, which tends to various deformations in the component. [4] SS 304/316 grade austenitic steels change their state to martensitic grade due to strain hardening during cold working process which requires annealing at definite values of strain produced in order to increase its formability, In order to eliminate this need of annealing, temperature can be combined with process by means of induction heating and control.

This can lead to reduce or eliminate the number of stages required to produce the component in order to increase the production and optimize the process parameters using FEA in order to save the time required and cost of experimenting.

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