International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 4, Issue 5, May-2018

INFLUENCE OF PUNCH ON BLANK HOLDER PRESSURE IN HYDROFORMING

Dr. R. Uday Kumar

Associate Professor
Dept.of Mechanical Engineering
Mahatma Gandhi Institute of Technology
Gandipet, Hyderabad. 500075.
E-mail: u_kumar2003@yahoo.co.in

Abstract

The hydro formed components are used in the aerospace, automotive, marine and other industries. In hydro forming deep drawing process, applying the hydraulic pressure in radial direction on the periphery of the blank is obtained through the punch movement with in the fluid chamber. The fluid is taking place in the die cavity and punch chamber and these are connected with the bypass path provided in the die. The gap is provided between die surface and blank holder bottom surface for movement of pressurized fluid and blank in the process. The pressure is generated in fluid due to punch movement within the fluid chamber and directed through the bypass path to the blank periphery and is to reduce tensile stresses acting on the wall of the semi drawn blank. The fluid pressure is obtained through ANSYS Flotran CFD analysis software for castor oil. The evaluation of fluid pressure with changing the punch speed at constant punch radius. The pressure of fluid is acting radially on surface of blank during the process. The radial pressure of fluid is controlled by the blank holder pressure. This pressure of fluid is used to evaluate the blank holding pressure. In this process of hydro forming deep drawing the fluid pressure is equal to blank holder pressure is to be obtained. The deformation of blank is uniform to get a required shape and also it prevents the blank failure during deformation due to these two pressures are being equal. The pressure of fluid and blank holder pressure depends on punch speed. The fluid pressure and blank holder pressure increases with increasing in the punch speed. The fluid pressure and blank holder pressures are the dominant parameter for failure and success of forming of cups from the cylindrical blanks.

***Key words:** Deep drawing, Hydro forming process, Fluid pressure, Blank holder pressure, Cfd model Analysis*

1. Introduction

In the hydro forming deep drawing process the pressurized fluid serves several purposes are supports the sheet metal from the start to the end of the forming process, thus yielding a better formed part, delays the on set of material failure and reduces the wrinkles formation. The hydro forming deep drawing process is a one of the sheet metal forming process. In this process the medium is pressurized fluid. This pressurized fluid is used to form different component shapes. The process allows manufacturing lighter complex shapes more with increased strength at lower cost compared to more traditional techniques such as stamping, forging, casting or welding.

The performance of deep drawing process can be enhanced for producing components through using the liquids in the process. The process performance like draw ratio, thickness ratio, ratio of volume to surface area of product, volume to thickness of product, good surface finish, high quality surface, high accuracy in dimensional, no scratches developed on outer side of cup, limiting drawing ratio, deep drawability and formability index are improved and these are obtained in higher levels. The fluid pressure effects on radial, hoop and drawing stresses of blanks in during the process. The various types of fluid forming are Hydroforming process [1-5], hydromechanical deep drawing process[6-8], Aquadraw process [9], hydraulic counter pressure process [10-12].These processes have some differences and some features are common. These principles are utilized for improvement in production of drawing cups with help of hydraulic pressure through conventional methods.

In this process the blank is subjected to fluid pressure on its periphery to get high forming limits and also preventing the failure. So there is improvement of deep drawing process for making the cups with utilization of fluid pressure. The contribution of hydraulic pressure to the deep drawing process is positively in several ways. The frictional resistance reduces in the flange due to lubrication of flange and dies radius. The Deep drawing process is a simple non-steady state metal forming process, it is widely used in industry for making seamless shells, cups and boxes of various shapes.

Deep drawing is an important process used for producing cups from sheet metal in large quantities. In deep drawing a sheet metal blank is drawn over a die by a radiuses punch [13-14]. Amongst the advantages of hydraulic pressure assisted deep drawing techniques, increased depth to diameter ratio's and reduces thickness variations of the cups formed are notable. In addition, the hydraulic pressure is applied on the periphery of the flange of the cup, the drawing being performed in a simultaneous push-pull manner making it possible to achieve higher drawing ratio's then those possible in the conventional deep drawing process. The pressure on the flange is more uniform which makes it easiest to choose the parameters in simulation. The pressure in the die cavity can be controlled very freely and accurately, with the approximate liquid pressure as a function of punch position. In the hydro forming deep drawing process the pressurized fluid also serves to delays the on set of material failure and reduces the wrinkles formation.

The process is an automatic co-ordination of the punch force and blank holding force, low friction between the blank and tooling as the high pressure liquid lubricates these interfaces and elimination of the need for a complicated control system. Hydraulic pressure can enhance the capabilities of the basic deep drawing process for making cups. Amongst the advantages of hydraulic pressure assisted deep drawing techniques, increased depth to diameter ratio's and reduces thickness variations of the cups formed are notable. In addition, the hydraulic pressure is applied on the periphery of the flange of the cup, the drawing being performed in a simultaneous push-pull manner making it possible to achieve higher drawing ratio's then those possible in the conventional deep drawing process. The pressure on the flange is more uniform which makes it easiest to choose the parameters in simulation. The pressure in the die cavity can be controlled very freely and accurately, with the approximate liquid pressure as a function of punch position, the parts can drawn without any scratches on the outside of the part and also obtained in good surface finish, surface quality, high dimensional accuracy and complicated parts.

In this process, the pressurized fluid is utilized for many purposes as the sheet metal blank is supported in entire forming process, elimination of fracture in deformation of cup and formation of wrinkles on the wall and edges of the cup are minimized.

2. Methodology

The process of hydro forming deep drawing as shown in fig.1. The hydraulic pressure is to be applied on the periphery of the blank in radial direction for successful formation of cup. The fluid is placed in the die cavity and punch chamber, which are connected through bypass path in the die. The gap is provided between the blank holder and die surface for the fluid and blank movement.The punch movement in the fluid chamber produces pressure in the fluid. This pressurized fluid is directed through the bypass path and acts radially on the blank periphery. The blank is supported by pressurized viscous fluid in between blank holder and die surface within the fluid region in the gap and a fluid film is formed on the upper and lower surfaces of blank which reduces frictional resistance. The wrinkling is reduced in the blank due to the support of high pressurized viscous fluid. The radial pressure of fluid P, which is produced in hydro forming deep drawing process is due to punch movement within the fluid chamber is equal to blank holder pressure P_h . So mathematically expressed $P = P_h$

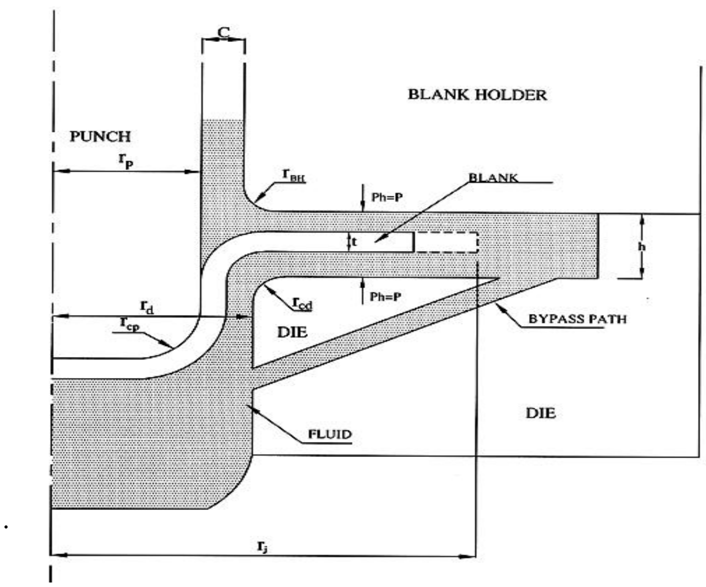

Fig.1 Hydro forming Deep drawing process

This fluid pressure and blank holder pressure depends on the punch speed and various process parameters of process. Evaluation of fluids pressure by using ANSYS Flotran CFD analysis software.

2.1 Evaluation of blank holder pressure and fluid pressure

Ansys - Flotran CFD analysis is used to study the variation of pressure of fluid and blank holder pressure with different punch speeds at constant punch radius using castor oil medium. This pressure of fluid is used to evaluate the blank holding pressure and analization of stresses in this process.

The element type is fluid 141 element from flotran CFD library is selected for meshing.The FLUID 141 element shown in fig.2. This figure shows FLUID 141 geometry, locations of node and coordinate system for this element. The element is defined by three four nodes [quadrilateral] and by isotropic properties of material.

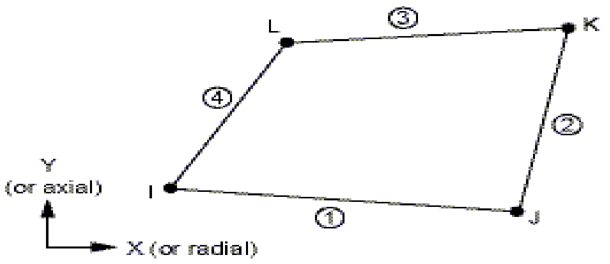

Fig.2 Geometry of FLUID 141 Element

The fluid model is developed in Ansys preprocessing using geometric modeling approach. The finite element model - Flotran CFD model (using adaptive mesh, a converged mesh) with boundary conditions as shown in fig.3

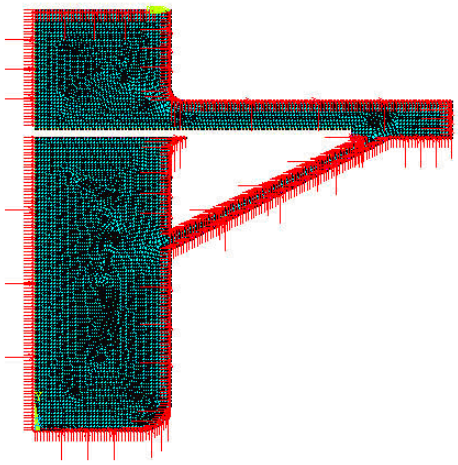

Fig.3 Flotran CFD model with boundary and loading conditions

The total number of elements and nodes in the model are 9926 and 11054.

Boundary and loading conditions: $V_x = V_y = 0$ on the boundary and punch velocity,

V_y = 35 - 50mm/sec.

In this hydro forming deep drawing process the pressure of the fluid is equal to the blank holder pressure is obtained.

3. Results And Discussion

The variation of fluid pressure and blank holder pressure is evaluated with different punch speed at constant punch radius for castor oil as medium in hydro forming deep drawing process. The parameters considered as punch speed u = 35,40,45 and 50 mm/sec , radius of punch r_p = 40mm and radius of die opening r_d = 45mm. The viscosity of castor oil μ = 0.985N–sec/ m^2, Castor oil density ρ = 960 kg/m^3.The ANSYS Flotran CFD analysis results are presented in fig.4. In this process the pressure of the fluid is equal to the blank holder pressure.

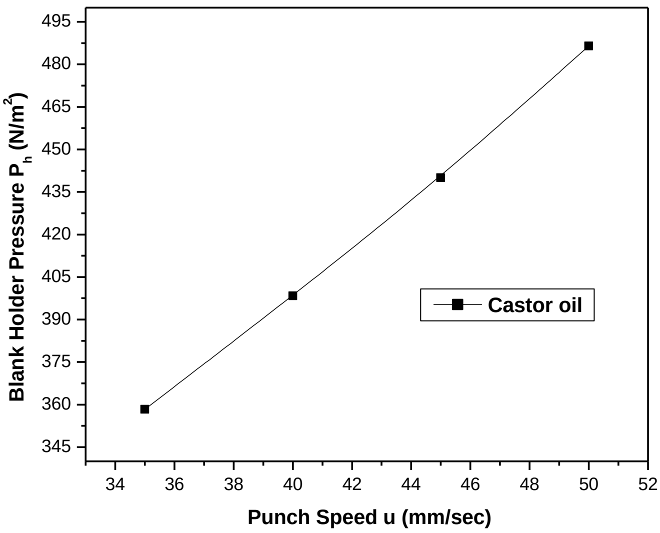

Fig.4 Blank holder pressure with punch speed for castor oil medium

From fig.4 the blank holder pressure increases with increase in the punch speed for castor oil medium. The range of blank holder pressure for castor oil 358.3 N/m^2 – 486.5 N/m^2. The blank holder pressure is maximum at u = 50mm/sec for castor oil is 486.5 N/m^2 and the blank holder pressure is least variation observed for castor oil is 358.3 N/m^2 at u = 35mm/sec.

In hydro forming deep drawing process, the fluid pressure as well as blank holder pressure is the dominant parameter for failure and success of forming of cups from the cylindrical blanks. The undesirable wrinkles are formed in the flange due to an insufficient pressure of fluid as well as blank holder pressure and premature tearing produced in flange due to excess fluid pressure as well as blank holder pressure. So appropriate pressure of fluid as well as blank holder pressure is used for success in forming of cups in this process.

4.Conclusions

In this present work the conclusions are drawn as follows

- The blank holder pressure is evaluated by varying of punch speed at constant punch radius.
- Castor oil pressure evaluated by varying of punch speed at constant punch radius.
- Blank holder pressure has been increased with increase in the punch speed.
- Fluid pressure has been increased with increase in the punch speed.
- Blank holder pressure is equal to castor oil pressure is obtained.
- The wrinkling is reduced in the blank due to the support of high pressurized viscous fluid with supporting of equal blank holding pressure
- Fluid pressure in the process depends on the geometry of process and process parameters.
- The variation of blank holder pressure studied based on the order of fluid pressure at given its speed and punch radius
- In this process the uniform deformation of blank is obtained to get a required shape and also blank failure is prevented during deformation due to fluid pressure and blank holding pressure being equal.

Acknowledgement

One of the authors (Dr.R.Uday Kumar Associate Professor Dept.of Mechanical Engineering Mahatma Gandhi Institute of Technology Hyderabad) thanks to the Management and Principal of Mahatma Gandhi Institute of Technology, Hyderabad for encouraging and granting permission to carry out this research work.

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