

# NUMERICAL ANALYSIS OF BLANK HOLDER PRESSURE IN DEEP DRAWING

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**ABSTRACT:** Deep drawing process with fluid medium is the one of the unconventional processes of the sheet metal forming, used for forming the sheet metal. The technological forming processes by fluids are deep drawing, stretching, bending, tube forming. Deep drawing with fluid medium and other actions of plastic forming are based on the laws of plastic theory, balance of forces that are opposite to deformation. The success of deep drawing with fluid medium action depends on the processing parameters are forming force, the force of sheet metal holder, the frame, dimensions of work piece and friction. Deep drawing analysis at the plasticity area is possible because of actual knowledge application on deformation processing for conventional or unconventional processing as the values of individual parameters can be compared. The fluid pressure intensification pressure system consists of a low-pressure, high flow rate filling system, along with a high pressure intensifier to raise the fluid pressure to forming levels. Deep drawing process with fluid medium is also known as hydro mechanical 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. It 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. 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 pressure is generated in fluid due to punch movement with in 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 pressures obtained from numerical analysis software for using the fluids such as olive oil, heavy machine oil. The Evaluation of fluids pressure and blank holder 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. As these two pressures are equal, the deformation of blank is uniform to get a required shape and also it prevents the blank failure during deformation. In this paper blank holder pressure is evaluated through numerical analysis and studied.

**KEY WORDS:** Deep drawing, fluid pressure, blank holder pressure

## 1. INTRODUCTION

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(1-5). In hydro mechanical forming process the pressurized fluid is used as a medium. 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 hydro formed components are used in the aerospace, automotive and other industries(6-7). 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 within 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 portion. Fluid pressure is the dominant parameter for failure and success of forming of cups from the cylindrical blanks(8-9). This pressure of fluid is used to evaluate the blank holding pressure. 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. The fluid pressure effects on radial, hoop and drawing stresses of blanks in during the process(10). Hydro forming deep drawing process the pressurized fluid also serves to delays the on set of material failure and reduces the wrinkle formation.

## 2. BLANK HOLDER PRESSURE

The deep drawing process with fluid medium is the one of sheet metal forming process, 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. In this deep drawing process 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 radial pressure of fluid, which is produced in hydro forming deep drawing process is due to punch movement within the fluid chamber is equal to blank holder pressure. The deep drawing process with fluid medium as shown in fig.1.

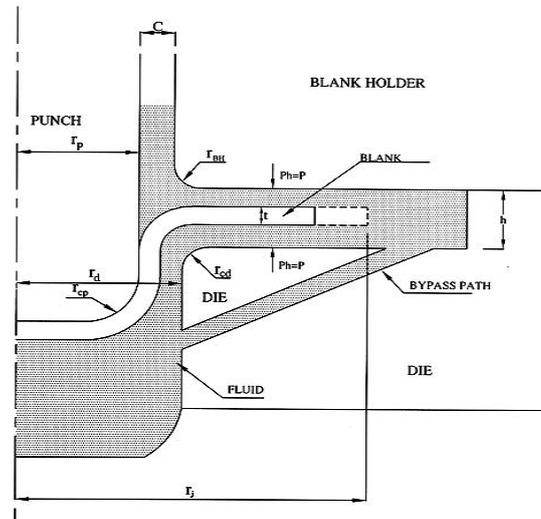


Fig.1 Deep Drawing process with fluid medium

This fluid pressure depends on the punch speed and various process parameters of process. Evaluation of fluids pressure by using numerical analysis such as Finite element simulation software. Ansys - Flotran CFD analysis is used to study the variation of pressure of fluid with different punch speeds at constant punch radius using fluids such as olive oil and heavy machine oil. This pressure of fluid is used to evaluate the blank holding pressure. The element type is fluid 141 element from the Flotran CFD library is selected for meshing. The element is defined by three nodes [triangle] or four nodes [quadrilateral] and by isotropic properties of material. The fluid model is developed in Ansys preprocessing using geometric modeling approach. Using adaptive mesh, a converged mesh is obtained. The total number of elements and nodes in the model are 8235 and 11996. Boundary and loading conditions are  $V_x = V_y = 0$  on the boundary and punch velocity,  $V_y = 30-45\text{mm/sec}$ . In this deep drawing process the pressure of the fluid is equal to the blank holder pressure is obtained.

### 3. RESULTS AND DISCUSSION

The fluid pressure and blank holder pressure is evaluated with different punch speed at constant punch radius for two different oils such as olive oil and heavy machine oil as medium in deep drawing process through numerical analysis. The parameters considered as punch speed  $u = 30,35,40,45$  mm/sec, radius of punch  $r_p = 30\text{mm}$  and radius of die opening  $r_d = 35\text{mm}$ . Viscosity of olive oil  $\mu = 0.081\text{N-sec/m}^2$ , viscosity of heavy machine oil  $\mu = 0.453\text{N-sec/m}^2$ . The numerical analysis results of the process are presented in Table.1. In this process the pressure of the fluid is equal to the blank holder pressure for successfully formation of cups. This blank holder pressure is divided by contacting area of blank holder with blank or fluid contact area is gives the blank holding force.

Table.1. Blank holder pressure for two oils

S.No.	Punch Speed (u) mm/s	Blank holder pressure (N/m <sup>2</sup> )	
		Olive oil pressure (N/m <sup>2</sup> )	Heavy machine oil pressure(N/m <sup>2</sup> )
1	30	35.4	78.3
2	35	48.3	96.4

3	40	60.5	115.8
4	45	72.3	140.6

From Table.1.the blank holder pressure increases with increase in the punch speed for two fluids. The high pressures are obtained in heavy machine oil medium and low pressures are obtained in olive oil medium. Also the pressure of oil depends on its viscosity. The range of blank holder pressure heavy machine oil and olive oils are  $78.3\text{N/m}^2 - 140.6\text{N/m}^2$  and  $35.4\text{N/m}^2 - 72.3\text{N/m}^2$  respectively. The blank holder pressure is maximum at  $u = 45\text{mm/sec}$  for heavy machine oil is  $140.6\text{N/m}^2$  and in olive oil which is  $72.3\text{N/m}^2$ . At  $u = 30\text{mm/sec}$ , the blank holder pressure is least variation is observed for heavy machine oil is  $78.3\text{N/m}^2$  and olive oil is  $35.4\text{N/m}^2$ . High fluid pressures as well as blank holder pressure are found for heavy machine oil and least in olive oil medium is observed.

The induced pressure in the oil is higher with high viscosity oil and the generated pressure in the oil is lower with low viscosity oil. So blank holder force, pressure is required high for high viscosity oil and low for low viscosity oil.

#### 4. CONCLUSIONS

The conclusions are drawn from present research work analysis as follows

- Blank holder pressure is analyzed with fluids pressure through Numerical analysis
- Fluid pressures are equal to blank holder pressure is obtained
- Blank holder pressure has been increased with increase in the viscosity of fluid.
- Fluid pressure has been increased with increase in the viscosity of fluid.
- Blank holder pressures are obtained higher with heavy machine oil.
- Blank holder pressure are obtained lesser with olive oil.
- 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.
- The failure such as wrinkling, fracture is reduced in the blank due to the support of high pressurized viscous fluid, that fluid pressure is equal to blank holder pressure.

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