

A REVIEW ON MECHANICS OF DEEPPDRAWING

K.Praveen Kumar

Department of Mechanical Engineering,
VEMU INSTITUTE OF TECHNOLOGY,AP,INDIA

Abstract

Deep Drawing (DD) practice is the one in which a punch forces a flat sheet metal blank into a die cavity. DD can besides be described as the procedure which involves adaptation of flat thin sheet metal blanks into parts of beloved contour. Modest work is offered in the applications of DD processes at prominent temperatures which is departure to be a very vital manufacturing appliance in the approaching decades. Deep Drawing (DD) is one of the sheet metal forming processes broadly used in automobile, aerospace, electronics and similar industries to manufacture the void parts. The upgrading in the deep drawing manufacturing process with most recent methodologies leads to developments in the automobile and other sheet metal industries. In the current study, the method of Deep Drawing **mechanics** initiation and growth in the cylindrical cup deep drawing process is investigated in detail.

Keywords: Sheet metal, forming, mechanics, Deep-Drawing.

1.Introduction

The drawing of metal or “deep drawing” is the method by which a punch is used to force sheet metal to flow connecting the surfaces of a punch a die [1]. A flat sheet is produced into a cylindrical, conic, or box- shaped part. With this process, it is potential to produce a final work piece-using minimal operations and generating minimal scrap-that can survive assembled without supplementary operations. The advance of explicit methods for the deep drawing process has paralleled general

technological development, especially in the automotive and aircraft industries. However, this progression has a wide appliance for the invention of parts of unlike shapes and dissimilar magnitude for other goods, ranging from very tiny pieces in the electrical and electronic industries to dimensions of several meters in other branches of production [4]

2.BACKGROUND OF STUDY

Deep draw stamping is a practice that's been broadly uses in the manufacturing field particularly in the oil and gas industry, the automotive industry, and also Worn to produces a variety of household objects such as soup cans, battery casings, fire extinguishers, and Even a kitchen sink. A part is called deep drawn if the deepness of the part is at least half of its diameter [7]. Otherwise, it is simply called general stamping.

A deep drawn part may have one or more illustration operations depending on the convolution of the piece. In a deep drawing process, a punch pushes a sheet metal blank in to a die cavity, consequential the preferred contoured part [9]. Multi stage drawing process of a blank material experiences additional complex deformation in each stage compared to a conventional drawing process. The procedure generally involves extra bending, stretching, compression and shearing by unusual drawing ratios through the following drawing stage [5]. The deformation logically precedes with the irregular shapes of the cross section and situation that cause break down such as tearing and wrinkling. Since the buckle mechanism is very

dense and the final involuntary properties are difficult to expect, the procedure design is not an effortless mission for the manufacture of a result of desired shape and material properties [8]. The achievement or failure of the forming procedure is partial by many process parameters such as the drawing ratio in each period, the disparity of the drawing ratio within the cross-section, the shape of the die, the strain-hardening coefficient, material formability, the lubrication conditions and the degree of ironing. One of the type parameters affecting the forming process is the blank holder force (BHF)[2]. The advantage of unstable the blank holder force during the forming course is the two primary model of failure which are wrinkling and tearing are avoided. This gives rise to enhanced formability, higher accuracy and better part consistency.

3.MECHANICS OF DEEP DRAWING

3.1 Die Concept

Deep drawing die is a metal working tool that is considered and built to translate raw material into parts that kowtow to blue print condition. Before happening with the production, the primary of deep drawing process must be known first. In deep drawing, dies are located into a stamping press and when the stamping press moves up, the die opens. As the stamping press moves down, the die closes. The raw material or blank moves through the die while the die is open, being fed into the die in a accurate amount with each blow of the press [10]. As the die closes, the die performs its effort on the metal. The superior the die cavity depth, the supplementary blank material has to be pulled behind in to the die cavity and the larger the threat of wrinkling in the walls and flange of the part. In stamping, mainly of the concluding part is created by stretching over the punch though a few materials about the sides may have been strained inwards from the flange. As there is a limit to the stretching that is potential by tearing, stamped parts are classically shallow. To appearance deeper parts, much extra material must be pinched here to form it. One of the most frequent examples of deep drawing is the cup drawing procedure. It is used to produce products

such as cartridge bases, zinc dry cells, metal cans and steel pressure vessels [6]. It is also used as a method for formability test of sheet metals such as the Swift cupping test. Forming a simple cylindrical cup is shown in Figure 1.

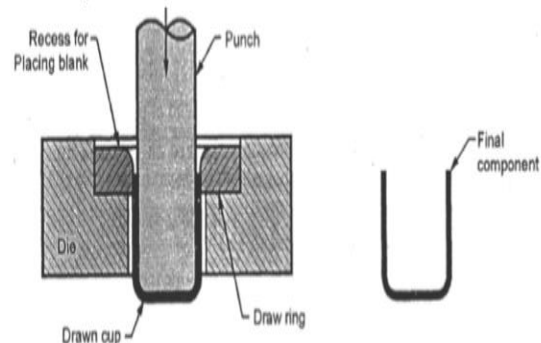


Figure 1. Cylindrical cup

3.2 Draw Stages

The numeral of consecutive draws compulsory is a role of the proportion of the part height, h to the part diameter,

$$(d)n = \frac{h}{d} \text{ Where: } n = \text{number of draws, } h = \text{part height, } d = \text{part diameter}$$

h/d	0.6	0.6-1.4	1.4-2.5	2.5-4.0	4.0-7.0	7.0-12.0
n	1	2	3	4	5	6

height, d = part diameter

Table 1.Number of draws (n) for a cylindrical cup [3]

3.3 Die Clearance and Radius

One of the factors that must be measured in formative a die extent is the sum of approval (Fig.2) between the punch and die members. A proper clearance of the die will give the chosen force through the stamping method. The radius degree of the punch and die cavity limits control the flow of vacant material into the die cavity. Wrinkling in the cup wall can occur if the radius

of the punch and die cavity limits are too vast. If the radius is too tiny the blank is flat to tearing

material thickness	low carbon steel, copper and brass	medium steel 0.20%-0.25% carbon	hard steel 0.40-0.60 carbon	aluminium
0.25	0.01	0.015	0.02	0.01
0.50	0.02	0.03	0.03	0.05
1.00	0.05	0.06	0.07	0.10
1.50	0.07	0.09	0.10	0.15
2.00	0.10	0.12	0.14	0.20
2.50	0.13	0.15	0.18	0.25
3.00	0.15	0.18	0.21	0.28
3.50	0.15	0.18	0.21	0.28
4.00	0.20	0.24	0.28	0.40
4.50	0.23	0.27	0.32	0.45
4.80	0.24	0.29	0.34	0.48
5.00	0.25	0.30	0.36	0.50

since of the high stresses. Appropriate clearance use also depends on the material degree of stiffness and thickness [3]. Table 2. Illustrates the absolute value for clearance depending on the type and thickness of the material.

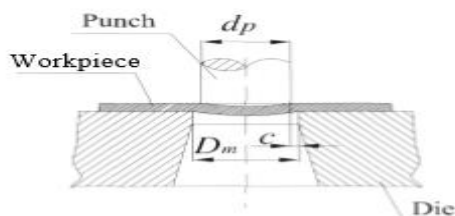


Figure 2. Punch & die clearance

Table 2. Absolute value for clearance [3]

3.4. Limit Draw Ratio

In deep drawing, the limits for the allowable buckle are set by the draw ratio. The draw ratio is used to:

- Determine how numerous drawing operations are required to make a drawn part;
- Evaluate the draw ability of deep drawing steels;

- Determine the improvement value $n = f$ (draw ratio) to determine the drawing force.

The drawing forming parameter for cylindrical cup drawing is the limit drawing ratio (LDR), which is the ratio of the ceiling blank diameter to punch diameter that can be drawn in one draw operation.

$$\text{LDR} = \frac{\text{maximum blank diameter}}{\text{punch diameter}} [3]$$

4. Common Defects in Deep Drawing

The three main frequent defects which arise during DD are fracture, wrinkling and earing. Fracture occurs when the sheet metal is subjected to strains above the secure strain limits of the material. For ductile sheets this fracture often occurs near the punch corner. It is because utmost forming load appears in the material in this area and also stress absorption lines are converging in this section. Once this necking exceeds past a convinced value, break appears in the drawn cup. A formed cup with a fracture at the cup bottom is shown in Fig 3.[8]



Fig. 3 Fracture in deep drawing [4]

Wrinkling occurs in the flange while compressive stresses in the circumferential track reach a serious point of volatility. It can occur in regions where the work piece is unproven or when the blank holding force is deficient. Wrinkling defect is shown in Fig. 4. The wrinkling can be

prevented by growing blank holder force and by using a draw bead [5]. The draw bead bends and unbends the work piece material as it passes during the blank holder. This bending over the bead increases the radial tensile stresses and thus reduces the possibility of wrinkling.



Fig. 4 wrinkling in deep drawing [4]

Deep drawing of anisotropic sheets consequences in a drawn cup with rough top edge i.e. some range of ears are formed at the top as shown in Fig. 5. This fault is called earing and it is because of planar anisotropy of the blank material. [4]



Fig. 5.Earing in deep drawing

5. Problems encountered in conventional deep drawing

Some of the troubles encountered through the conventional deep drawing operation are:

- (i) Complexity in pronouncement the metal flow exactly.
- (ii) Complexity in location the criteria for the constancy of the metal forming process.
- (iii) Complexity occupied in the collection of accurate process parameters and proper press tool design parameters.
- (iv) Great deformation during deep drawing at room temperature causes problems in

forming high strength, low formability materials similar to magnesium, aluminum alloys etc

- (v) Deformation induced change of microstructure as in the case of austenitic stainless steels.
- (vi) Amount of tools necessary to produce the preferred deficiency free module.[8]

5.1 Limitations of conventional deep drawing

The main limitations of conventional deep drawing are:

1. Extremely high warning draw ratio cannot be obtained due to unnecessary reduction and fracture in the cup wall, allied with large draw ratios. [8].
2. Very jagged corners of the punch and the die lead to fracture.
3. High friction among the die and the sheet puts a border on the LDR and increases the punch force required for drawing
4. The surface finish of the factor obtained frequently is of low value due to the friction between the sheet and the punch and between the die and the sheet.
5. Further than a confident degree development in formability is not promising since of inherent limitations of conventional sheet forming processes. But it was shown that higher forming limits than in conventional forming processes would be possible with the modification of the process itself [9].

6. Nonconventional deep drawing

Non-conventional deep drawing is one in which additional than the natural mechanical punch similar to hydraulic, pneumatic, gas etc., is used to supply the compulsory force or some supplementary resources are used beside with the conventional method to recover the forming uniqueness of a material. Some of the nonconventional deep drawing operations are hydro-forming (HF), hydro-mechanical forming

(HMDD), warm deep drawing (WDD), super plastic forming (SPF), electromagnetic forming (EMF), incremental forming (IF) etc.[8]

6.1 ADVANTAGES OF NONCONVENTIONAL DEEP DRAWING

- (i) Metals preserve be deep drawn which, or else, cannot be made at room temperature due to their deprived forming distinctiveness.
- (ii) Opportunity of deep drawing elevated strength low formability metals and alloys.
- (iii) Components of extremely thin sheet (less than 0.5 mm) can be drawn effectively.
- (iv) Lesser forming forces to form the component. Decline in number of tools required for producing the desired part and hence the diminution in manufacture cost.
- (v) Decrease in the probability of imperfection arrangement on the produce surface. [4]

conclusion

Many researchers place their hard work to study the deep drawing or warm deep drawing of high strength, low formability materials like Al and Mg alloys. Very modest amount of research work has been accepted out on Mechanics of deep drawing or warm deep drawing of materials like stainless steel, copper, high strength low alloy steels etc, even though these materials are very widely used in numerous industries like automobile, aeronautics, electronics industries and so on. The in sequence concerning the metallurgical aspects of warm deep drawing is exceptionally a great deal restricted.

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