A REVIEW ON FORMING PROCESSES

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Abstract:- *Forming technology is one of the important technologies in order to improve manufacturing efficiency and productivity. This technology helps to achieve high standard quality products in almost no time with great economy. This paper provides the review on forming technologies used to form the different components, advantages and limitations of techniques, parameter affecting on forming process, equipment used, different materials used for dies and punches.*

Key Words: *Forming, productivity, manufacturing efficiency, dies, punches.*

1. INTRODUCTION:

Forming- Forming processes are particular manufacturing processes which make use of suitable stresses (like compression, tension, shear or combined stresses) which cause plastic deformation of the materials to produce required shapes. No material is removed during forming process [4]

This is a process for mass production of various products, ranging from home appliances to automotive components. Generally it is a press tool that is capable of cutting a metal, bending, piercing and altering the shape [3]. Stamping is a very complicated mechanical process [7]. It is a complex category because it contains many different parameters. These parameters such as friction between the tools and blank sheet, material properties, punch speed and many others influence the quality of formed components [4] The main material used in forming is metal due to the massive need for various products demanded by the public, but other compounds like plastic can also be formed due to a big market for plastic based products. Forming die design is a complex task as forming involves interaction between the sheet metal blank, the press, the blank holder and the die. Typical defects that occur due to incorrect flow of material into the die during the stamping process are wrinkling caused by excessive compression, tearing caused by excessive tension and spring-back caused by elastic recovery of material.

Forming process nomenclature

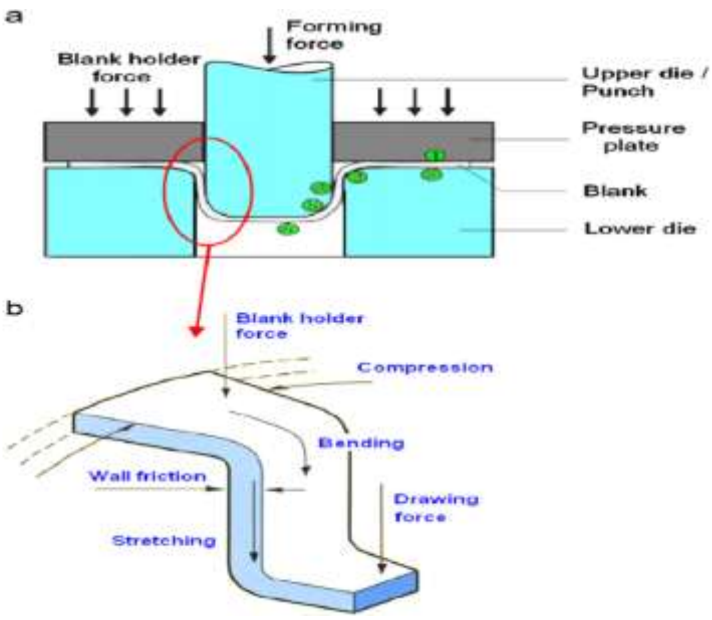

Fig-1 Forming process nomenclature

Upper die (Punch): Apply forces on blank and made up of Hardened Steel or Tungsten Carbide

Lower die (Cavity): It is of similar shape of die but somewhat larger in dimension.

Blank Holder: Holds the blank while punch travels and avoid wrinkling by maintaining tensile force on blank.

Blank: Sheet of metal which takes the shape according to punch and cavity.

Ejector pins: Used to eject the formed part from cavity.

2. CLASIFICATION OF FORMING PROCESS:

2.1 On the basis size, shape and form of material used

- **Bulk forming-** This refers to the use of raw materials for forming which have low surface area to volume ratio. Rolling, forging, extrusion and drawing are bulk forming processes.

- **Sheet forming-** This refers to the use of sheet/blank for getting final shape product.
- **Powder forming-** Here the press is used to form a final shaped product from powder[9].

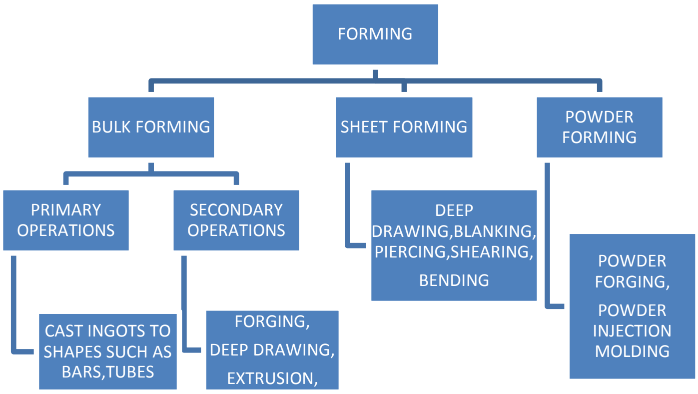

Fig-2 Classification of forming process on the basis of size, shape and form

2.2 On the basis of Nature of forces applied

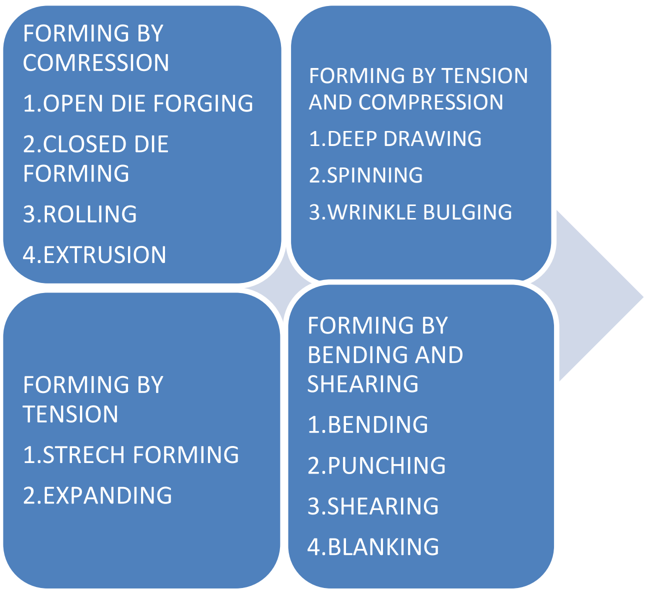

Fig-3

2.3 On the basis of temperature

- **Hot forming-** Involves deformation above recrystallization temperature, between 0.5*Tm* to 0.75*Tm*.

- **Cold Forming-** Generally done at room temperature or slightly (10-20 degree) above room temperature.

- **Warm Forming-** Forming is performed at temperatures just above room temperature but below the recrystallization temperature. The working temperature is taken to be 0.3 *Tm*.

  Tm=Melting temperature.

3. BASIC PROCESSES OF FORMING:

"Forming technology" is a term which covers the extremely wide range of chip less forming production processes which are possible when presses are used. The following forming processes are used in the production of body parts.

3.1 Separating

Separating refers to the complete separation of the sheet metal section from the semi-finished product. Example: Blank production.

Field of application:

- coil strip
- sheet metal strip
- sheet metal plate

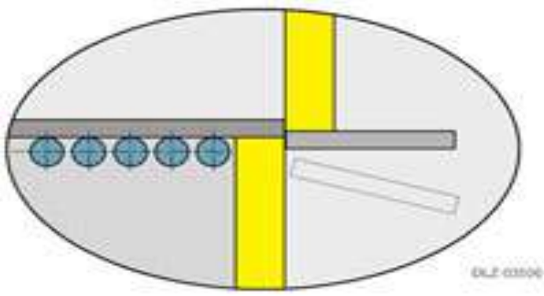

Fig.4-Separating

3.2 Blank cutting

Blank cutting involves the complete separation of any shapes along a closed line.

Field of application (examples):

- blanks with cut-out sections
- reworking of drawn parts
- production of form sheets

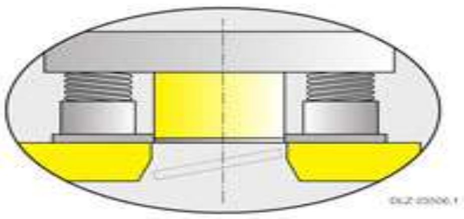

Fig.5-Blank cutting

3.3 Trimming

Trimming is the removal of excess material to produce a final form.

Field of application (example):

- trimming of the inner and outer contours of drawn parts

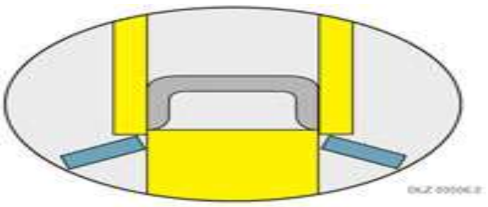

Fig.6-Trimming

3.4 Piercing

Piercing is the production of recesses of any shape using piercing or punching tools.

Field of application (examples):

- fastening holes
- recesses
- slots
- ventilation openings on body parts

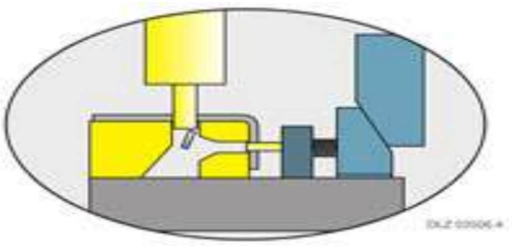

Fig.7-Piercing

4. FACTORS AFFECTING ON FORMING PROCESS

1. Material Elasticity

When planning a design and evaluating material choices, it is essential to remember spring back: a material will always tend to bend back to its original shape. Fabricators and formers can often take this into account and compensate by over bending the material beyond its desired final radius, allowing the metal to "spring back" into the proper final position.

2. Minimum inside Bend Radius:

To avoid material fractures or weakness in a bent component, careful material evaluation needs to be considered from the start. Each material type has a unique recommended minimum inside bend radius which is critical to evaluate because as the thickness of a material increases, so does the minimum inside bend radius.

3. Bending Direction: Optimizing Natural Ductility

When sheet metal is milled, it is stretched in particular directions. The resulting grains impact the nature and strength of the material in a given direction, so be sure to whether a sheet is being formed longitudinally or across the grain.

4. The drawing ratio: The drawing ratio is the ratio of the blank diameter relative to the formed cup diameter (D/d). When this ratio is too large, the blank is

Stretched across the punch face rather than drawn into the die cavity.

5. The die entry radius: A small die entry radius induces very high bending strains, which in turn restricts material flow. A minimum die entry radius of four to six times metal thickness is generally required for plain carbon steel and stainless steel while six to ten times material thickness may be required for aluminium alloys.

6. The punch nose radius: When the punch radius is too small, the punch face acts like a cutting punch. Punch nose radii should be at least four to eight times metal thickness for steel, eight to ten times for aluminium.

7. Punch position over die. Position of die and punch should be such that projections on punch should match the cavity on die. Wrong position causes die and punch breakage.

8. The punch to die clearance: Provide 1.08 to 1.10 times metal thickness clearance (8% to 10% per side additional clearance) is required for plain carbon steel. Some stainless steels can require as much as 1.40 times (40% per side clearance)

9. Punch velocity (forming speed): High punch velocity causes sheet fracture. Keep the forming speed of 80 feet per minute for steel and 9000 to 12000 mm per minute for stainless steel and strong aluminium alloys.

10. Blank holder pressure: A generally accepted rule of thumb is 105 newton per mm for plain carbon steel, 70 newton per mm for aluminium and 315 newton per mm for stainless steel and HSLA steel.

11. Material is stretching across punch face. Roughen the punch face to retard metal flow. Also limit the amount of lubricant between the punch face and the blank. If stretching problems persist, roughen the punch nose radius as well.

12. Large die radius: An overly large die entry radius will allow material to wrinkle as the edge of the blank it is drawn off the die surface. These wrinkles enter the die cavity and “lock out” material flow

13. Restraining forces: Excessive restraining forces applied to the end of punch stroke which causes damage to sheet. Add gap blocks i.e. place blocks in between die and punch such that it will create clearance between them, to accommodate material thickening. As a general rule, gap blocks should be set at 1.10 times material thickness for carbon steels.

14. Blank holder pressure: Low blank holder forces allow wrinkles form in the flange area, thus restricting metal flow into the die cavity.

5. DIFFERENT PROBLEMS AND THEIR PROBABLE SOLUTIONS

1. Wrinkling and loose metal problems in drawn parts

Wrinkles are the results of insufficient stretch or uncontrolled compression (see fig-8). If the blank is wrinkling on the blank holder surface, this happens due to four factors: insufficient blank holder force; a poor fit between the die face and blank holder surface; an insufficient height of an equalizer block that is holding the die face apart from the blank holder surface; or severe blank holder deflection.

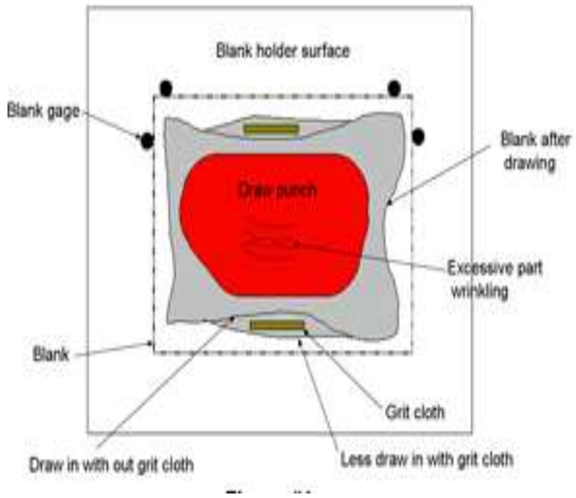

Fig.8-Wrinkling

With the exception of severe blank holder deflection, these factors can be corrected by using following concepts, such as increasing the blank holder force, re-adjusting the equalizer height, and refitting or spotting the blank holder or the die face. However, in the case of deep-drawn contoured parts, wrinkling in the product area can occur from insufficient sheet material stretching. To simulate the effects of a draw bead, a process that restricts metal from flowing into the cavity, grit cloth or sandpaper can be placed on one or both sides of the blank in a specific area. The abrasiveness of the grit cloth and the increased pressure exerted on the blank simulate the draw bead effect and help to reduce the wrinkling in the product area. It should be noted that excessive use of the simulated draw bead process will result in die erosion.

2. Tearing problems

Using equalizers can solve tearing problems. Increasing the shim thickness increases the gap between the die face and blank holder and allows more metal to flow inward.

3. Nonconforming part surfaces

If there is problem of nonconforming surface then it can be solved by placing Aluminized tape in certain areas of a re-strike die. This process simulates the effects of welding the tool and changing the die's geometry. It can be used to bump or tweak part surfaces temporarily. Adding aluminized tape to a punch or cavity requires grinding the mating half respectively. Also, the tape can fall off during production and cause die damage. The permanent fix is to change the die or cavity shape by re-machining or welding, if necessary.

Fig.9-Nonconforming surface

CONCLUSION:

This paper contains critical review on forming processes, which contains definition of forming, general tools and its nomenclature, types of forming processes based on different parameters which can be used to sort out or identify particular forming process. Paper contains particular factors affecting on forming processes and this can be used as an effective data while designing forming tools such as punch and die. Different types of forming defects listed in paper will readily aware the die designers, about numbers of defects which he may face. Ready solutions of some of the defects are listed above to eliminate particular defect.

So this paper can be used in initial learning stages by the students and can also be useful for die designers in intermediate stage, after basic learning and can be useful for industrial persons to solve particular defects.

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