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An Overview of Forging Process and Defects in Hot and Cold Forging

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Abstract - *Forging is the manufacturing technology of shaping the essence piece into the asked shape. The forging operation are performed with the help of forged hammer or die. This technology is extensively used in the industry for making the well-defined shape of the material. The different types of operation are performed in forging are fullering, bending, jumping, and edging by performing forging operation various defects occur in both hot and cold forging process due to indecorous design of forging die, excessive chilling in forging product, residual stresses, cold shut, flakes, and sharp corner. The ideal of this review paper to understand the forging process and colorful blights means defects of both hot and cold forging operation in detail.*

Key Words: - Forging, Types of forging, Forging defects and Advantages and disadvantages of hot and cold forging.

1. INTRODUCTION:

Forging is a metal forming manufacturing process involving the shape of the metal using compressive forces (i.e., Hammer or die). According to temperature forging are classified into two types. Cold forging and Hot forging. In hot forging operation are carried out at above the recrystallisation temperature of the metal. In cold forging are carried at or near room temperature. Forging processes are widely used in manufacturing industries for producing large numbers of product like automotive, aerospace, hardware, machine, hand tools, jewelry etc. Today forging is a major worldwide industry because forging process can create parts that are stronger than other manufactured parts like casting. Therefore, forging is always used where reliability and human safety are critical such as airplanes, poor heating, less raw material used, excessive chilling of the forged product, sharp automobiles, tractors, ships, engines oil drilling equipment etc. There are different types of forging operations like Open die forging or Smith forging, Impression die forging, Flash less forging, roll forging and Machine forging or Upset forging. But there are different types of defects occur in forging due to poor design of a die, corners of the object. Some other defects occur due to rapid cooling of forged parts, using light hammer blows and one more type of defects occur when dies are not aligned with each other. Advantages of forging process are it is stronger than casting products, it improves the strength of the material, it can be easily welded etc.

2.Literature Summary:

Forging is a manufacturing process in which material is shaped by the operation of localized compressive forces applied manually or with power hammers, special forging machines or press. It may be carried out on accoutrements in either hot or cold state. When forging is done cold process are given special names. Therefore, the term forging generally implies hot forging carried out at temperatures which are above the recrystallization temperature of the material.

Forging is an effective system of producing multitudinous useful shapes. Forging process is applied to produce separate corridor. Typical forged corridor includes rivets, bolts, coil hooks, connecting rods, gears, turbine shafts, hand tools, roads and a variety of structural factor used to manufacture ministry. The forged corridor has good strength and continuity; they can be used reliably for largely stressed-out and critical operations.

Table -1: Literature survey

Serial Number	Title Of Paper	Author Name and year
1)	Smart Diagnostic Expert system for defects in forging process by using Machine Learning Process	S Mewada, A Saoliya, N Chandramouli in 2022
2)	Analysis of forging defects for selected industrial die forging process	Marek Hawryluk, Joanna Jakubik in 2016
3)	An overview of forging processes with their defects	MG Rathi, NA Jakhade in 2014
4)	Investigation of defects in forging tools by Non-destructive detection method	D Stancekova, A Czan, M Derbas in 2013

3.Forging Operation:

1) Drawing Down: It is the process of outstretch the length and reduce the sampling area of the workpiece. Simply in this operation the length of workpiece increases, and cross

section area diminishments. In forging process, a compressive force is applied at vertical direction of its length axis. If, a tensile force is applied to change its length at resemblant to its length axis this process is known as wire or line delineation.

2) Upsetting: Capsizing is just contrary operation to drawing down operation. In this operation the length of workpiece diminishments, and its cross-section area increases. In this process, a compressive force is applied at resemblant direction to its length axis.

3) Edging: It is a type of open die forging in which forging operation are carried out at the edges of the workpiece. In this operation the workpiece is forged to a desired shape by using dies to compress the materials.

4) Bending: In bending operation the force is applied to a piece of distance metal which causes it to bend at an asked shape**.**

5) Punching: Punching operation is carried out using a die and punch to produce holes in a distance substance or metal.

6) Forged welding: It is a metal joining process in which two pieces of metal are joined with each other to elongate its length. For illustration, to forge the steel sword it is first heated at a temperature of 1050 Degree Celsius to 1150 Degrees Celsius and it is brought together and hammered or pounded.

7) Swaging: In this operation the workpiece is reduced to a desired shape generally round shape or hexagonal shape. For small workpieces the top and the nethermost swage pair is used to shape the metal while, for large workpieces the swage block is used**.**

4. Types of forging:

1) According to the temperature:

a) Hot Forging: If the work piece is hotter above its recrystallization temperature is known as hot forging. The recrystallization temperature is defined as the temperature at which the new grains are formed in the essence. This kind of extreme heat is necessary in avoiding strain hardening of the essence during distortion.

Advantages High strain rates and hence easy inflow of the essence, Recrystallization and recovery are possible, Forces needed are less.

Disadvantages Lubrication is delicate at high temperatures, Oxidation and scaling do on the work piece, Poor surface finish due to overheat, less precise forbearance, Possible screwing of the material during the cooling process.

Table- 2 Temperature range of different metals or alloy

Metal or alloy	Approximate range of forging temperature, °C (°F)
Aluminum alloys (least difficult)	400–500 (750–930)
Magnesium alloys	250–350 (480–660)
Copper alloys	600–900 (1110–1650)
Carbon and low-alloy steels	850–1150 (1560–2100)
Martensitic stainless steels	1100–1250 (2010–2280)
Maraging steels	1100–1250 (2010–2280)
Austenitic stainless steels	1100–1250 (2010–2280)
Nickel alloys	1000–1150 (1830–2100)
Semiaustenitic PH stainless steels	1100–1250 (2010–2280)
Titanium alloys	700–950 (1290–1740)
Iron-base superalloys	1050–1180 (1920–2160)
Cobalt-base superalloys	1180–1250 (2160–2280)
Niobium alloys	950–1150 (1740–2100)
Tantalum alloys	1050–1350 (1920–2460)
Molybdenum alloys	1150–1350 (2100–2460)
Nickel-base superalloys	1050–1200 (1920–2190)
Tungsten alloys (most difficult)	1200–1300 (2190–2370)

PH, precipitation-hardenable. Source: Ref 2

b) Cold Forging: If the work piece is heated at room temperature is known as cold forging. To get more accurate dimension and face finish we use warm forging.

c)Warm Forging: In warm forging work piece is heated above the room temperature but below the recrystallization temperatures.

Advantages: Product rates are veritably high with exceptional bones life, improves mechanical parcels, lower disunion between bones face and work piece, Lubrication is easy, no oxidation or spanning on the work.

Disadvantages: Residual stress may do, Heavier and further important outfit is demanded, Stronger tooling is needed, Tool design and manufacturing are critical.

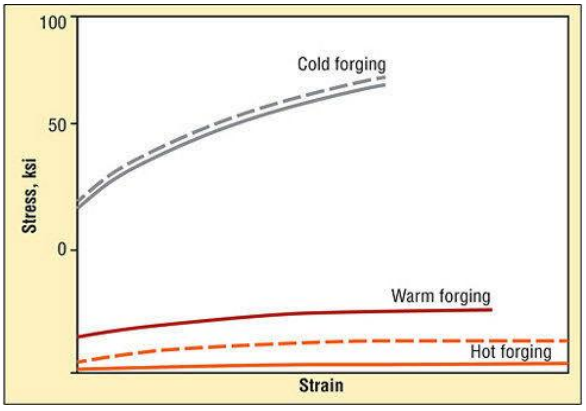

Fig.1- Graph of Hot Warm and Cold forging

2) According to the arrangement of die:

a) Open die forging: This forging process uses flat dies or no die. This is hot forging process in which workpiece heated

and pounded to gain desired shape. This process produces rough product.

b) Close die forging: In close die forging set up impression dies used to produce desired shape on workpiece substantially these products do not need any finishing process. This process needed advanced force.

3) According to the forging equipment:

a) Smith forging:

b) Drop forging:

c) Press forging:

d) Machine forging.

5. Defects in Hot and Cold forging:

1)Unfilled section: In unfilled section defects some of the forging section remain unfilled because off the indecorous design or improper heat treatment of metals. Minimum use of raw material or due to poor heating cause major defects.

Remedies: This disfigurement can be removed by proper die design, proper use of raw equipment and proper heating.

2) Cold shut: In cold shut forging defects at the corner of the object. This type of defect arises due to improper design of the forging die, sharp corner of the object, excessive chilling of the forge product creates small cracks at the corner.

Remedies: The fillet radius of the die is to be increased and working temperature should be maintain in case of cold shut defects.

3) Scale pits: It is usual in forging carried in open environment and it causes irregular deputations on the forging surfaces. This type of forging defects produces due to unethical cleaning of the outer forged surface.

Remedies: This defect can be avoided by adequate cleaning of forged surface.

4) Die shift: When the upper and lower dies are mismatch and not aligned which produce defects and don't provide accurate dimensions. This will lead to improper dimensions of the product.

Remedies: Both the upper and lower are properly aligned with each other. It can be removed by keeping half portion of the workpiece on the upper die and half on lower die. So that the portion can match.

5) Flakes: It is internal cracks caused when both forged products cool quickly, or improper cooling and it reduces the strength of that product.

Remedies: proper cooling and flakes can be avoided when cooling is performed.

6) Surface cracking: This type of defects arises when the forging operation is done at low temperature or below recrystallization temperature in which cracks occur on the workpieces.

Solution: It can be controlled by working on proper temperature, so strength of the material gets increases.

7) Incomplete forging penetration: This forging defect occurs when forging takes place only at the surface. At the interior of the forging material dendritic ingot structure is not broken. This is caused using light rapid hammer blow.

Remedies: Use forging press for full penetration, use heavy hammer.

8) Residual stresses: In residual stress forging defects takes place when the forged parts of the material are not properly cooled. It can be caused by rapid cooling.

Remedies: It can be prevented by slow cooling of the forged parts.

Fig.2 Forging Defects.

6. CONCLUSIONS

Forging is an experience acquainted process. Throughout the times, a great deal of know style and experience has been accumulated in this field, largely by trial- and- error styles. Forging processes produces final products in veritably short time with little or noscrap. therefore, there's saving in energy and material.

Forgings occasionally bring further than corridor produced by other processes or like casting machining, but it gives further dependable corridor with better mechanical and metallurgical parcels.

Since blights causes high rejection rates, it's important to move any process inthe direction of barring all defects as part of an effective nonstop enhancementprogram.

A good quality program begins with a station ofmaking it right the first time. Forging processes are no exception to this. Economically, as well as from a quality perspective, it's better to understand and control the process to avoid blights rather than scrapping the imperfect corridor during final examination.

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