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Change in the Mechanical and Electrical Properties of Aluminium 6063 Alloy under Cold Forging Process

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Abstract - *Aluminum alloys have gained considerable attention in the last fifteen years for application in electronic and automotive application due to their high strength to weight ratio. High pressure die casting is currently the predominant production technique with over 90% of aluminum products produced by casting. Forging provides many performance advantages over cast parts due to increased strength but the metal is difficult to form due to a limited number of slip systems active at room temperature; alloys have been developed to improve forging characteristics. In the present investigation aluminium alloy 6063 have been forged using a multi step forging process. Difficulty was encountered in forming deep embossments due to the inadequate flow characteristics of the material. Microstructure analysis has been performed to determine the development of texture through the forging process. Mechanical testing has shown a significant improvement in mechanical properties after forging compared to the blank material.*

1. Introduction

Plastic forming by cold forging is a production process where high strength aluminium alloys can be produced with close tolerances. It might have several additional advantages including simplified tooling and improved concentricity. The process is therefore particularly suitable for parts with narrow geometrical tolerances, smooth surface finish, and for near net shape products. Often combination of forward and backward forging make the process route in order to create products of complex geometry. When parts for advanced technological use are produced, the need of several consecutive forming operations becomes of importance. Due to strain hardening in the material, the need of soft annealing between thee forming operation is required. Also lubrication is very important in cold forging. Sticking between the tool and the work piece must be avoided. As for the soft annealing, the lubrication process must be performed several times to secure no friction at every production stages. This might lead to a time consuming and expensive production route of the part. In cold work production, the work piece is inserted into the container at room temperature. However, during the deformation process, the temperature can increase to above 100° C as a result of local geometrical and frictional conditions. This means that what is called cold forging, actual is forging with an increase in temperature during the forming process. Anyway, this increase in temperature is not considered to have influence on the mechanical properties on the final product.

2. Forging process

Forging is one of the oldest known metal working process. Traditionally, forging was performed by a smith using hammer and anvil, and though the use of water power in the production and working of iron dates to the 12th century, the hammer and anvil are not obsolete. The smithy or forge has evolved over centuries to become a facility with engineered processes, production equipment, tooling, raw materials and products to meet the demands of modern industry. In modern times, industrial forging is done either with presses or with hammers powered by compressed air, electricity, hydraulics or steam. These hammers may have reciprocating weights in the thousands of pounds. Smaller power hammers, 500lb (230kg) or less reciprocating weight, and hydraulic presses are common in art smithies as well. Some steam hammers remain in use, but they became obsolete with the availability of the other, more convenient, power sources. Forging refines the grain structure and improves the physical properties of the metal with proper design, the grain flow can be oriented in the direction of principal stresses encountered in actual use . Grain flow is the direction of the pattern that the crystals take during plastic deformation. Physical properties (such as strength, ductility and toughness) are much better in a forging than in the base metal, which has crystals randomly oriented.

Common forging processes

There are some basic hot or cold forging processes.

1. Hand forging
2. Roll forging
3. Upsetting
4. Press forging

Experimental work

Material

Aluminium is a chemical element in the boron group with symbol Al and atomic number is 13. It is silvery white, and it is not soluble in water. After oxygen and silicon, aluminium is the third most abundant element in the Earth's crust. Aluminium has a unique combination of attractive properties. High strength, Low weight, great malleability ,easy machining ,excellent corrosion resistance and good thermal and electrical conductivity are amongst aluminium's most significant properties. Aluminium is also very easy to recycle. The chief ore of aluminium is bauxite.

It is nonmagnetic and does not easily ignite. Commercial purity of aluminium is 99.5 to 99.79%, but pure aluminium is too soft to be of structural value. The primary reason for alloying aluminium is to increase strength without increasing weight and reason are to improve weldability, machinability, surface appearance silicon and zinc. To help identify aluminium and aluminium alloys, the Aluminium Association created a system of four digit numbers. The first number in the four digit number indicates the alloy group.

Procedure

1. **Cutting the material of desired dimensions**

Initially we have a material of dimension 400 X 100 X 11.5 mm of aluminium alloy 6063. We had cut it into six pieces of dimensions 100X35X11.5mm with the help of hacksaw. After cutting we finished cutting surfaces with the help of filer.

2. **Setting up of specimen hydraulic press**

Now we have placed the specimen on the press bed of hydraulic press of capacity 500 tonne. Move the ram until the upper edge touches the specimen.

3. **Applying the load**

Further the various loads are applied on specimen. Different loads can be control with the help of load regulator. We have applied the load of 15, 50, 100, 150, 200 tonne on the specimen to get desired percent reduction.

Conclusion

Aluminium when subjected to deformation shows an increase in hardness and electrical resistance and decrease in conductivity as the amount of deformation increased. Aluminium 6063 alloy processed by press forging at ambient temperature has shown that the hardness increase as the range of thickness reduction suffered increases from 0 to 30 percent.

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