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Extrusion process and parameters involved in the experimental and numerical investigation-review

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Abstract:- With the conventional extrusion process it is very difficult to produce a hollow section tubes, for various types of Aluminium Alloys, such as Al6061, Al6063 & Al7075. Because of complicated structure of die Assembly it is became mandatory to investigate experimentally. For 6061 Al alloy Taguchi Method is applied to optimize the parameters involved in it. For other materials Numerical Analysis is carried out for investigation of various parameters. In this review paper the discussion is carried out for Al6061,Al6063& Al7075 materials in the extrusion process for investigating the different process parameters by Taguchi & Numerical Analysis Method.

I. INTRODUCTION

Extrusion appears to be a means of breaking down as cast structure of billet being subjected to only compressive forces in the extrusion process. In the cold extrusion, punches and dies are made up of wear resistant tool steels such as high alloy chromium steels which are subjected to severe working conditions in order to report dimensional stability and good surface finish.

Cold extrusion models to verify parameters that influence the process have been investigated. Qamar [3], through a Finite Element Method (FEM) studied extrusion complexities and dead metal zone using numerical simulations extrusion to validate experimental observations. Dies of three different profiles made of H13 steel were used on lead and Al- 6063 alloy. Fluctuations in metal distortion during plastic flow and dead metal zone size were observed. This shows the variation in die profile symmetry and extrusion ratio. Tiernan used two different lubricants namely zinc stearate and oil based lubricant containing lead and copper additives. The experiment was configured to analyze effects on the reduction ratio die angle and die length on the extrusion force. Data obtained from experimental result and by computations using FEM predictive simulations were compared. The highest extrusion force obtained by experiment. The force was measured when extruding the aluminum billet using a die with exit diameter, die angle, and land height. In comparison of results, reasonable correlations were observed to exist between FEM and experimental values of extrusion forces[1].

Aluminum extrusion is a single pass process to produce a long part with high accuracy and complex cross sectional geometry. The only way to vary the cross section is by the use of extrusion die. A solid cylindrical billet is heated and placed inside a container which is pushed by hydraulic punch is forced to flow through die set. Therefore, products with varied cross sections such as rods, wires, sheets, tubes, hollow or non-hollow parts can be fabricated [1]. In recent years, there are many researches analyzing plastic deformations as well as die wear by finite element analysis[2].The basic process of extrusion is well described as a thermo-mechanical event in a quite recent text which indicates that the mathematical description of the process is still largely semi-empirical. The extrusion process is complex and involving interaction between the process variables and the material's high temp properties. Theoretically the variables that can be controlled are the extrusion ratio, the ram speed, and the initial extrusion temperature. However, events on the micromechanical scale are still not sufficiently described. The most important of all these is possibly the mechanics at the interface between tooling and material. This influences the analyses of the temperature changes occurring during the process, the temperature and the temperature history determining the structure of the extruded and hence, to a large extent, its properties.[3]

II. LITERATRE REVIEW

S. O. Adeosun et al [1] Have made an investigation of die entry angles 15^o, 30^o, 45^o,60^o,75^o& 90^o were simulated. Improvement is observed with 45^o, 90^o& 75^o die entry angles. It is been observed that at 45^o die entry angle the index of 2.1 for plain carbon steel die & 1.8 for steel die.

Quang-Cherng Hsu et al [2] Have investigated for Al7075 square tube with both simulation & experiment. In this there are several factors which are taken for simulation & experiment are billet temperature, billet dimensions, flow stresses, die cavity & product geometry. The material Al7075 behaves high forming resistant when compared to Al6063 & Al6061.

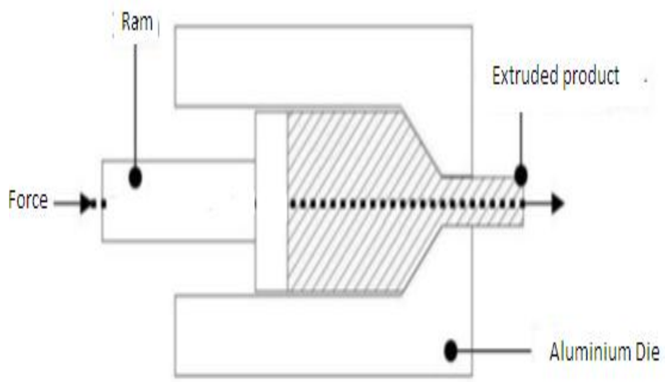
Flitta et al[3] This investigation is mainly focuses on simulation of the extrusion process & in particular the effect of the initial billet temperature on friction & its consequences on material. The simulation is validated with experimental results. The effect of billet temperature both in simulation & experimentally are presented.

Rajamamundi Prabhu et al [4] Have gone through the forming of hollow section tubes that are very difficult to produce by conventional extrusion with a mandrel on the stem. During the hot extrusion for Al6061 Alloy the change of process parameters will effect to the mechanical properties. In this extrusion are tested for tensile test, flattening test, expanding test using a conical punch, surface finish & micro-structure.

III. EXTRUSION PROCESS FOR ALUMINUMALLOY

A. Extrusion Process

This study uses direct extrusion or forward extrusion. The process is that when the billet is pushed in the container, the ram keeps pushing forward, and then the material is extruded and flows out of the die outlet. As the material flows out in the same direction as the ram moves, when the billet is about 20mm thick, the extrusion stops, while the ram moves backward, another billet is put into the container, and then the ram presses in the new billet. The process is then repeated, as shown in Figure. [2]



IV. FRICTION

The coefficient of friction at the metal billet interface contributes significantly to the difficulty of extruding, and it is a point where the friction resistance approaches the shear resistance of the hot material during the deformation. Furthermore it is a point where a fraction or all of the displacement of billet at the interface occur by shear in its surface layers leaving a fragment of the billet deposited on the wall of the container. In practice aluminium alloys are extruded without any lubricant or with only a small amount of graphite applied to the die face. Finding a suitable lubricant would be adifficult task and in any case of un-lubricated aluminium extrusion is desirable in order to prevent impurity pick up from the tools and to ensure that all the material making up the extruded surfaces originates from material within the billet. Therefore the interfacial conditions at the billet container interface during extrusion has a direct effect on metal the stresses acting upon both the tools and within the material and hence load and energy requirements and extruded temperature.

V. SELECTION OF CONTROL FACTORS

The objective of the present work is to identify the effect of convex die angle which would optimize the load and tensile strength of hot extruded tubes. The process parameters generally considered for hot extrusion process of Al 6061 alloy tubes using port hole die method include extrusion speed, die shape, billet temperature, mandrel length, convex angle, tooling temperature, extrusion ratio, port hole number and mandrel shape etc. In Taguchi method, the selection of influential parameters for analysis is a critical issue. For the present case, the most influential process parameters for the analysis are selected based on studies reported in literature with main focus on tensile strength and load characteristics and they are listed. These four input parameters are taken as control factors and each factor has been considered with three levels. Since the number of degrees of freedom is 8, an orthogonal array (inner array) L_9 has been found suitable for the present design.[4]

VI. CONCLUSIONS

1) In this extrusion process the thickness of the product is varied and other parameters are kept remain same.
2) If we consider billet dimension for fixed condition, we get smaller extrusion ratio for thicker product & also smaller stress in the die.
3) With the numerical analysis the maximum stress is on corners of the square tube which is same for the experimental method.

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