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Optimization Of Process Parameters In Extrusion Of Aluminium Alloy

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Abstract- Recently extrusion processes have been used to make a wide range of metal products, including bars and tubes and strips and solid and hollow profiles, that are usually long, straight, semi-finished metal products.Analysis of temperature and extrusion load during in the extrusion of aluminium 2024 alloy was conducted in this study. This was determined that the best set of extrusion variables again for selected answers was discovered. Based on Taguchi's L9 design matrix, the experiments were conducted out. ANOVA is used to determine which variables have a significant influence on the responses. Additionally, the percentage of each variable's contribution to each response was graphically depicted. The Taguchi optimization method was used to find the best set of process variables based on the lowest S/N ratio. All of these ideal process variables aid in efficiently extruding the selected aluminium alloy at a low temperature and using the least amount of extrusion force possible. As a result, the extruded product's quality was enhanced while using minimal energy.

Keywords-Optimization, process parameters, extrusion, aluminium alloy

I. INTRODUCTION

Forming is the procedures wherein the intended shape and size are attained by the plastic deformation of a material. The stresses created during forming process are higher than that of the yield strength, which is less than the fracture strength of the material [1-2]. Metal Forming processes such as forging, Rolling, Drawing etc. are capable of delivering great productivity comparison to other metal working techniques. Metal forming is among the most significant procedure in manufacture of a vast variety of items. Metal forming or metal working process are separated into two components; Bulk forming and sheet metal forming.

The Bulk shaping refers to operations like Forging, Rolling, Extrusion etc. and there is a controlled plastic flow of material into appropriate forms. Materials can be deformed in both cold and hot working, depending on how far below or above the Re-crystallization point the material being deformed. Wound-working, on the other hand, is the deformation of a material at such a recrystallization temperature. Due to work hardening, cold-worked items will be much more durable than hot-worked products. Because there is no shrinking in the cold working process, more accurate items with superior dimensional precision may be created. Cold working is uneconomical for hard and brittle Materials because of the increased load they would experience during the process. Material losses can be reduced or minimised by metal forming activities. Analysis of stresses there in metal forming process is critical to understanding plasticity. Generally, the forces and deformation were fairly complicated. Simpler Assumptions are often helpful in finding a solution. Because of the enormous strains involved in plastic deformation, elastic strains need not be taken into account and only plastic strains need to be considered (rigid-plastic region). Also overlooked is strain hardening.

“Metal working process analysis is used mostly to determine the forces necessary for the a specific deformation and indeed the ability to accurately measure strain, stress, and velocity at every point in the deformation area of the billet or work piece." In the selection or design of equipment for a certain task, the calculations are helpful. If the deformation zone was homogenous, this approach assumes so. In the deformation zone, a square lattice could distort into four-sided parts. When it comes to building strength, this is the simplest and most generally utilised strategy. There is an inhomogeneity owing to friction that is calculated, but it does not take into account the inhomogeneity at the die-work piece interface and transverse stress. Through the use of plastic deformation work, it determines the mean forming stress.

II. RESEARCH METHODOLOGY

A defect-free, high-quality end product may be produced with increased extrusion process efficacy by optimising ram speed, friction coefficient, and die angle during aluminium alloy extrusion. "In just this swork, Taguchi's signal-to-noise ratio analysis is used to determine the optimal level of each process parameter using the response variables collected from experimental runs." In order to arrive at the optimal value for the response variable, the process factors ram speed, coefficient of friction, and die angle have all been taken into account.Based on Taguchi's L9 Orthogonal Array (OA), the ranges of the selected parameters for experiment design will be examined.

Table 1: Process variables and their limits

Parameters/Factors		level		
		1	2	3
A	Punch velocity (mm/s)	2.5	3	3.5
B	Coefficient of friction (μ)	0.15	0.25	0.35
C	Die angle	30°	45°	60°

The chosen parameters were viewed as process variables in this study. Table 3.1 provides the method parameters (as well as their units and notations) listed below.A three-factor and three-level L9 full factorial array is employed in this study. Taguchi's approach of experiment design is seen in the Table 3.2. Minitab 17 statistical software is used to conduct a signal-to-noise ratio study in order to establish the optimal parameter levels for the answers. The link between the process parameters and the response variable is depicted using main effect graphs for the s/n ratio. Process parameter optimal levels also were established using the s/n ratio plot.

Table 2:Design of experiment using L9 orthogonal array

Experiment no.	Punch velocity	Coefficient of friction	Die angle
1	2.5	0.15	30°
2	2.5	0.25	45°
3	2.5	0.35	60°
4	3	0.15	45°
5	3	0.25	60°
6	3	0.35	30°
7	3.5	0.15	60°
8	3.5	0.25	30°
9	3.5	0.35	45°

Billet diameter=80mm
Billet length=60mm
Extruded rod diameter = 40mm
Half die angle = 30°, 45° and 60°

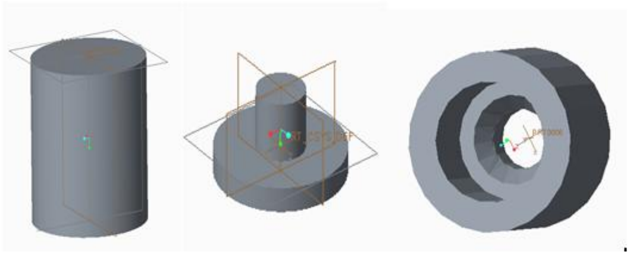

Fig. 1: Billet, punch and die.

We modelled our billet, punch and die creo 3.0 for simulation work in deform 3d.

III.RESULTS AND ANALYSIS

Simulated mixed extrusion process results are described and summarised. Different punches are simulated using a computer programme. This is what we got for the extrusion-forging process in terms of effective strain and stress as well as total velocity and load-stroke curves.

1.Effective Stress Distribution

Figure 2 depicts the stress variation as a function of friction, punch velocity, and die angle. When the friction and punch velocity are both increased, the stress fluctuation is shown to follow a similar pattern. After the first drop in tension, it rises again. Stress rises as the die angle increases.

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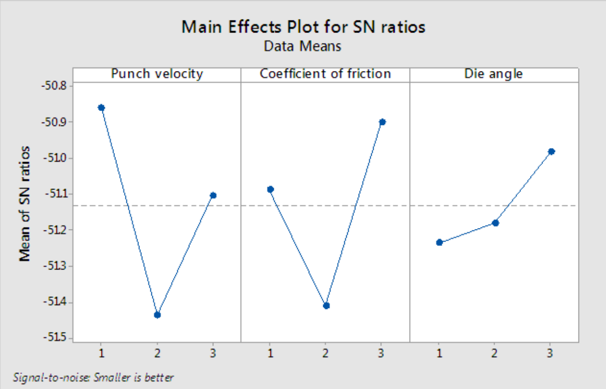

Fig. 2: Variation of effective stress

Fig. 2 shows the stress distribution obtained for the first set of experimental run corresponding parameters as punch velocity 3.5 mm/sec, coefficient of friction 0.35 µ and die angle 45°. At these levels of input parameters the predicted stress is 333 MPa. It can be observed that high stress region is occurred at middle circular portion of the blank.Above figures clearly shows that the effective stress is more in the middle circular portion and extruded part of the product.

2.Effective Temperature Distribution

Figure 3 depicts the temperature change as a function of friction, punch velocity, and die angle. When the die angle is increased, the temperature rises, but when the punch velocity or friction coefficient are increased, the temperature drops.

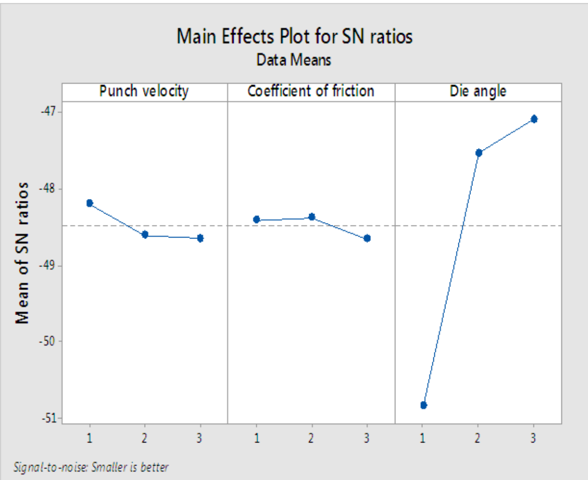

Fig. 3: Variation of temperature.

3.Variation Of Load With Punch

Figure 4 shows the variation in load wrt friction, punch velocity, and die angle. Load rises as die angle increases, while load falls as punch velocity and coefficient of friction increase.

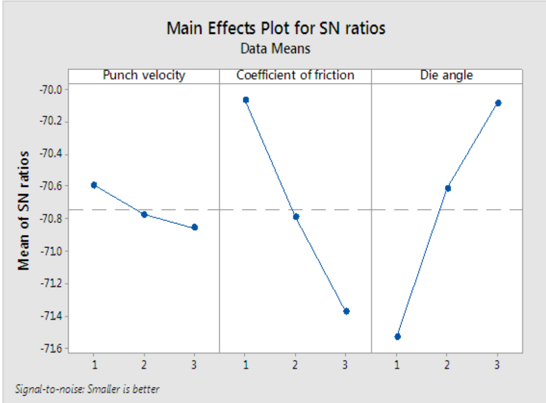

Fig. 4.Variation of load.

IV. CONCLUSIONS

Analysis of temperature and extrusion load during in the extrusion of aluminium 2024 alloy was conducted in this study. This was determined that the best set of extrusion variables again for selected answers was discovered. Based on Taguchi's L9 design matrix, the experiments were conducted out. ANOVA is used to determine which variables have a significant influence on the responses. Additionally, the percentage of each variable's contribution to each response was graphically depicted.

The Taguchi optimization method was used to find the best set of process variables based on the lowest S/N ratio. All of these ideal process variables aid in efficiently extruding the selected aluminium alloy at a low temperature and using the least amount of extrusion force possible. As a result, the extruded product's quality was enhanced while using minimal energy. Therefore, based on the S/N ratio the set of optimal parameters for stress is Pv = 3 mm/sec, COF = 0.25 and die angle = 30°, the set of optimal parameters for triaxiality stress, extrusion load, temperature is Pv = 3.5 mm/sec, COF = 0.35 and die angle = 30°, the set of optimal parameters for extrusion load is Pv = 2.5 mm/sec, COF = 0.15µ and die angle = 60°. These findings will assist the design engineers in efficient design of extrusion process.

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