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Designing Of Multi-Cavity Extrusion Die To Increase Productivity

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ABSTRACT

Extrusion is described as the act of compressing a material so that it is pushed to flow through a die opening and take the shape of the profile (2). Extrusion, on the other hand, is usually done through a single cavity. As a result, we're working on a multi-section extrusion project to increase our production speed. Extruding items through a die with multiple sections is known as multi-section extrusion. Multi-section extrusion improves production efficiency while lowering costs. We will create four sections at a time in this project. We chose H 13 steel as a suitable die material for our project because we would be using aluminum as a billet material.

In this project we are going to produce four section at a time. We are selected die material as H 13 steel which are suitable for our project because we are going to use aluminum as billet material so our working temperature range will 400 to 500 C

Key Words: Productivity, Cost of Production, Die Design, Manufacturing, Multi-Cavity

I. INTRODUCTION

Now day's extrusion manufacturing become a major production process in mechanical industries but due to increase in population, the customers' demands and requirements also increased. So to fulfill the customer demands we need to improve production rate within short period so our project is on improve production rate of extrusion process. Extrusion dies can be made to form a virtually limitless array of shapes and sizes. The die itself is a steel disk (normally H13) with an opening, the size and shape of the intended cross-section of the final extruded product, cut through it. Dies are broadly grouped as solid (or flat) dies, which produce solid shapes, and hollow dies, which produce hollow or semi hollow shapes. Combinations of solid, semi hollow, and/or hollow shapes may be incorporated into a single die. Solid die may have one or more orifices or apertures through which the softened alloy is forced (extruded). Multiple apertures in a single die produce multiple extrusions with each stroke of the press. (1) A semi hollow die extrudes a shape that is nearly hollow, partially enclosing a void; the area of which (the area of the die tongues) is large in comparison with the gap where the tongue is connected to the main body of the die. Hollow dies take a variety of forms. Bridge, porthole, and spider dies, for example, include a fixed stub mandrel as an integral part of the die. Each type of hollow extrusion die serves certain functions and carries its own advantages and disadvantages.

The manufacturing methods and costs vary widely (1). The ram force in a single-hole extrusion process is more than in a multi-hole extrusion process (3). Multi-cavity name itself shows that more than one number of holes is there in a die. When a multi-hole die will be used in extrusion process then this is known as multi-cavity extrusion process. As the number of cavity on the die, the same number of products will extrude at a time during extrusion. The process has great importance for producing micron-size parts. In order to increase the productivity, the multi-hole extrusion process is also considered by the practicing engineers to design an efficient extrusion tooling (2). The choice of design, and even manufacturing methods, will depend on the profile, press and container size, and production requirements. And we are manufacturing the solid die for aluminum extrusion process.

II. PROBLEM DEFINITION

How to increase the production rate?

The main motive of our project is to increase the production rate by using the multi section die. In extrusion industries now days they are using only one cavity section die. So it require more machine to achieve the target, then making the multi section die we can increase the production rate and minimize the time of production. It reduces the human effort.

How to reduce production cost?

If one machine achieves three machines target so comparatively it reduces the cost of production. Machine Installation cost to machine maintenance cost will reduces because machines are less used.

How to satisfy the customer?

By using multi section die it achieve the target of production and fulfill the requirement of customer within less period of time

III. DIE DESIGN

In extrusion process, geometry of the die constitutes an important aspect of die design. The die geometry determines the extent of redundant work done during the deformation demanding aspects of the entire extrusion process. Die design is influenced by many factors including press procedure and maintenance, understanding of the section or profile and its tolerances, and alloy characteristics (1). Three basic goals apply to all extruding operations. They are providing for relative ease of metal flow, dimensional stability, and desirable surface finish (1). Deformation of the die under pressure and its expansion under high temperatures also must be considered in the die design (1). Following six factors are considered in the design and construction of a die (4).

1. The flow pattern. 2. Maximum specific pressure. 3. Geometrical shape of the section.

4. Wall thickness and tongue sizes. 5. Shape of the bearing surfaces (die lands). 6. The tolerances of the section.

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To start with the design of a die, the designer needs fundamental information regarding the geometry of the shape, alloy to be extruded, size of the press, billet size, runout required by the customer, support tooling like backer or bolster to be used, the weight of extrusion per unit length, and so on. After looking through the customer profile drawing, the die designer decides the type of die needed, that is, solid, hollow, or semi hollow.

a. Dimensions of Extrusion Section:

The size of extrusion section depends upon customer requirement so designer design extrusion section according to customer's demands. So we are going to manufacture below size section (cavity).

Size= 25mm.*25mm.*1 mm.

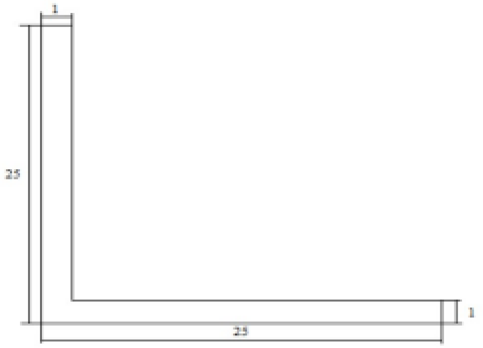

Fig 1: Line sketch for die L-section

1. Area - 49mm^2 2.Perimeter =100mm 3.Weight/M -0.130 Kg. 4. Billet Material – Aluminium

3.2 Die Dimensions:

We are going to design die for hydraulic press having capacity of 600 ton. So according to standard size of die stack of 600 metric ton hydraulic extrusion press, dimension of die will be **dimension of die will be-**

1. Diameter= 169 mm. 2. CCD= 94 mm. 3. Thickness= 35 mm.

Note- CCD depend upon diameter of billet

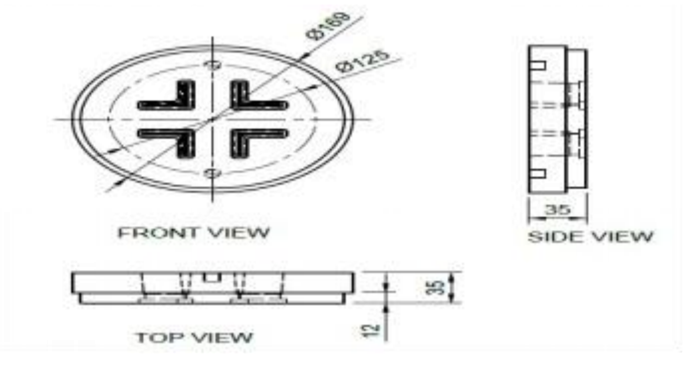

Fig 2: different view of die

Fig 3: 3d model

3.3 Design Calculation:

1. PRESS SPECIFICATION-

a) Press Capacity= 600t b) Die Ring Size= Dia.169x80mm c) Bolster Size= Dia.182x55mm

d) Container Bore= Dia.110x400mm

A) MAIN CYLINDER DETAILS-

a) Cylinder Bore = 585mm b) Ram Diameter= 580mm c) Stroke= 1150mm d) Working Pressure=210kg.F/Cm^2 e) Main Cylinder Area=2.65x10^6

B) SIDE CYLINDER-

a) Cylinder Bore = 115mm, b) Ram Diameter= 70mm, c) Stroke= 1200mm, d) Working Pressure=210kg.F/Cm^2 , e) Side Cylinder Area=0.454x10^6mm^2

2. SECTION DETAILS-

a) L- Section 4 Cavity, b) Section Area= 49 Mm^2 , c) Section Perimeter= 100 Mm, d) Alloy=6063

3. FORCE APPLIED BY THE PRESS

Fp=P*A1+2*P*A2

Where,

a) A1=Area of Main Cylinder

b) A2=Area of Side Cylinder

c) P=Hydraulic Pressure

Fp = 210x2.65x10^6+210*2*0.454x10^6 = 747.18x10^6 N

2. **EXTRUSION FORCE**

F=Ac*K*Ln (Ac/Ae)

Where,

a) Ac= Area of Container

b) K= Strength Coefficient

c) Ae= Extruded Profile Area Mm^2

=7850 X 400 X Ln (7850/2*145.3)

=10.35x10^6 mm^2

3. **EXTRUSION RATIO**

R=Ab/N*Ae

Where,

a) Ab = Billet Area Mm^2

b) Ae =Area of Extruded Rod

c) N =No Of Cavities

R=7850/4*145.31 R= 13.50

4. STRAIN RATE

€ E=4*Ln*√R

E=4*Ln*√13.50

E=6.89

5. FLOW STRESS

Δ= K*E^M

Where,

a) K=Strength Coefficient

b) E=Strain Rate

c) M=Friction Factor

=200x (6.89) ^0.11

=247.30N/mm^2

6. EXTRUSION PRESSURE

Pext. =K (A+B*Ln*(R))

=200*(0.5+1.2*Ln (13.50))

=724.64N/mm^2

7. Extrusion Force (F)

F (N) = P X Ac

=891.00*157000

=139.88x10^6 N

Where,

a) P=Extrusion Pressure N/mm^2

b) Ac=Area of Container Mm^2

9. Extrusion Speed

= Ram Speed x Extrusion Ratio

=3x13.50

=40.5mm/Sec.

4. MATERIAL SELECTION

The properties to be considered for the selection of the die material are the ability to harden uniformly, high wear resistance, resistance to plastic deformation, toughness, resistance to thermal fatigue and resistance to mechanical fatigue. Based on these properties Hot Die Steel (H13) has been selected.

In the process of manufacturing an aluminum extrusion, the selection of a die material and its specific properties are critical factors. Since the aluminum extrusion process is a hot working process in the average range of 1050 °F, the most frequently used die material worldwide is the well established hot die steel AISI H13 (5). The performance of the extrusion die is normally limited by typical material related failure mechanisms. In aluminum extrusion, the most common die failure mechanisms are hot wear, plastic deformation, and cracking.

In order to offer good resistance against these failure mechanisms, the die material should have the following properties (1):

- High hot hardness (hot yield strength)
- High tempering resistance
- Good wear resistance (response to nitrating and thin hard coatings)
- Good toughness

4.1Chemical Composition-

Table 1 Chemical Composition

C	MN	SI	CR	MO	V
0.40	0.40	1.00	5.25	1.35	1.00

4.2Physical Properties-

Density- 7750kg/M^3

a) Machinability- 70% Of 1% Carbon Steel

4.3Mechanical Properties-

a) Modulus of Elasticity- 215 GPA

b) Ultimate Tensile Strenght-1590 MPA

c) Yield Strenght-1380 MPA

d) Hardness- 55 HRC

4.4Thermal Properties-

a) Melting Point – 1427c

5. METHODOLOGY

Starting with the customer's profile drawing and ending with the transportation of a die, die manufacture entails various phases and processes. The flow diagram depicts the steps and processes (Fig.4).

In die making, two distinct regions must be considered. The die must be created in the first location depending on cost and extrusion productivity. Die manufacturing, the second factor to examine, must ensure the highest level of quality and reliability. The die manufacturer can gradually minimise the number of stages using modern technology (1).

Depending on the key aspects of the extrusion, the die is sent to the press for testing and production, or for testing only.Despite the introduction of CAD/CAM and CNC in the design and manufacture of aluminum extrusion dies, the shape and finish of the product may not be accurately predictable. If the produced shape is successful in he first trial, production continues with proper checks and measures. If the extrusion does not succeed, the die needs to be corrected based on the report of the test run along with the front piece of the extrusion (1).

Fig 4: multi cavity extrusion die

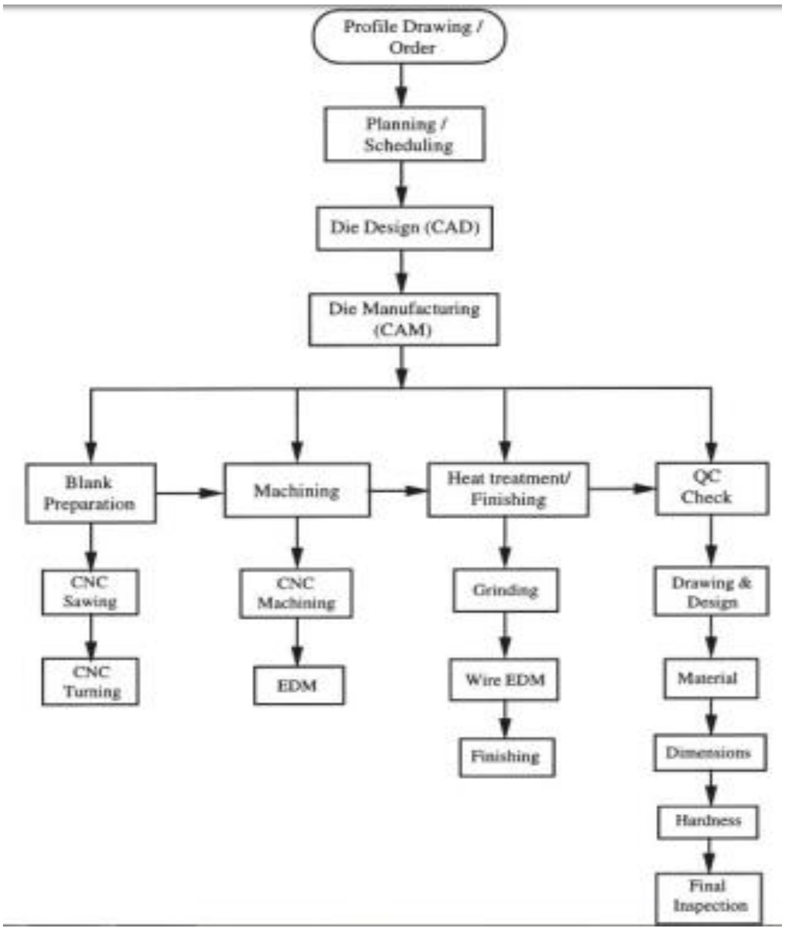

Fig. 5 Methodology

6. CONCLUSIONS

1. When compared to single section extrusion systems, multi section extrusion systems require less extrusion force.
2. When compared to single section extrusion systems, the production rate of multi section extrusion systems rose.
3. A multi-section extrusion method reduces manufacturing costs and saves time during installation and die inspection.
4. All extrusion sections had to be the same shape and size to avoid flow imbalance.

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