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Experimental Study for Improvement of Press Tool Life and Component Accuracy

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Abstract— the press tool life is major criteria in high volume production of sheet metal components. For a Progressive die, proper tool life and component accuracy are necessity for achieving higher productivity and low cost per component. This paper describes and forms a basis by accumulating factors for tool life selection. The data is based on old tool which was analyzed and its characteristics were studied closely and improvements were made which are a part of this paper. In this work, we use the software UNIGRAPHICS for modelling a progressive tool for Arc Chute plate. Here, a multiple station die with initial operation as trimming and later as parting off is performed. In each stroke, one operation is performed with four punches, thus in one stroke we get four final plates. Thus, factor selection is made easy by specific data made available and the usefulness of the system is demonstrated by sample run of Arc Chute plate analysis. It caters for obtaining the final components conforming to required dimensions and standards.

Keywords- Press tool, Tool life, Arc chute plate, Progressive die, Unigraphics.

I. INTRODUCTION

The sheet metal industry plays important role in switchgear industry. Sheet metal processes are important and quick means of producing durable, intricate and accurate components on a large scale. Metal cutting includes separating a piece of predetermined strip material. It contains various processes as blanking, trimming, parting off, notching etc. The tool life and accuracy depend on variety of factors as tolerances, selection of material for tools, amount of cutting force, replaceable die inserts etc.

II. SELECTION OF MATERIAL FOR DIE AND PUNCH

The material cost accounts for 20% of total cost. Sheet metal industries are given due considerations to reduce the manufacturing costs and hence to reduce the cost of production. Thus selection of proper material for manufacturing of tool components essentially increases the tool life and hence reduces the cost of production. Tool steels find much wide applications in stamping of large volumes of small and medium sized parts are inserts in larger dies. These steels are designed especially to develop high hardness level and abrasion resistance. Both through heat treatment and through existence of hard, stable and complex chromium, tungsten, molybdenum and vanadium carbides, we selected D2 from the AISI table for the modified tool. The old tool had ONHS for punches and dies.

For our tool, the material OHNS vs. D2 is plotted and thus the tool life variation is shown between the modified tool and the old tool. The tool life increased considerably as shown below:

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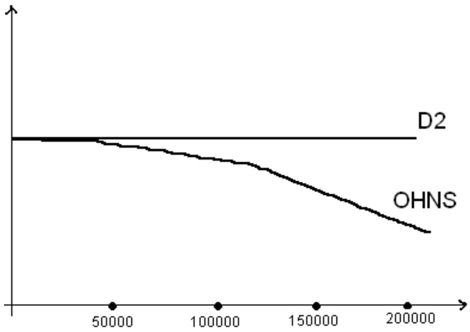

Fig 1: Tool Life Vs Number of Strokes

OHNS

Oil Hardened Non-shrinking Steel / Oil Hardened Nickel Steel has chemical composition of carbon content 0.95%, Manganese 1.15%, Chromium 0.5% and Vanadium 0.2%.

D2 (1.2374)

Also known as High Carbon High Chromium Steel. HCHCR Steel is widely utilized in punch and dies in metal stamping industry, injection mold tools, and barrel liners in plastic molding industry.

III. DESIGN OF TOOL COMPONENTS

A) Land

Although long life of all tool components is desirable, special attention is given to dies and punches inserts. The term "die life" specifically refers to dimension length of land in a cutting edge. Generally, the press tools are built to manufacture millions of components and expected to be replaced after being ground and shimmed over a period of time. However, sections should be provided for maximum possible use and generally, 3 to 4 mm land is kept with 1/3 to ¼ degree draft angle depending on shape of die, punch and material of sheet. In our previous tool, there was no provision for land. Hence, once punches and dies wore out, we scraped the whole tool. While in modified tool, the land provided was 3 mm which allowed us to grind the height 0.1mm each time and thus using the tool even after wear.

B) Excessive Wear

Abnormal wear can be caused by any of the following conditions:

i) Cutting clearance: insufficient or excessive. Cutting clearance in old tool was 0.3 mm while in modified tool was 0.108 mm. It produced accurate components for all its tool life.

ii) Punch height: Vertical height is too great in relation to cross-sectional area of the punch

iii) Hardness: Hardness of OHNS was 25-30 HRc. While, after heat treatment hardness of D2, its value is above 50 HRc. This makes new tool tougher to resist the shocks.

C) Radial Mounting of Punches

The cutting force is considered when more components per stroke are expected and more tonnage of capacity press is available. This is a new concept in which slight (about) curve is given to the punches. The mechanism works with principle that the curving portion make the side punches hit slightly before the punches in center. Thus, the cutting force is distributed. Data below show the difference in cutting force of initial tool and modified tool:

Cutting force of tool 1: Cf = 163.72 kN in one stroke.

Cutting force of tool 2: 1^{st} stage = 96.26 kN

2^{nd} stage = 130.19 kN

Thus, the force is distributed and the tool life increases.

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D) Replaceable Die Inserts

Die and punch have maximum forces acting on them. Their wear out can cause replacing of the tool. Also their edges must be sharpened from time to time so as to have proper shearing action. The die and punch are made replaceable to have easy maintenance. Thus, they are screwed to the die set for easy replacing.

IV. DESIGN OF PRESS TOOL

Design procedure actually starts with the component details given by the customer. Then after analyzing the required component details, various operations to be performed on the component and various concepts that are related to actual design are considered. After going through the above phases, the tool design gets started after detailed discussion with the manufacturing department.

A. Component Drawing and Location of Arc Chute

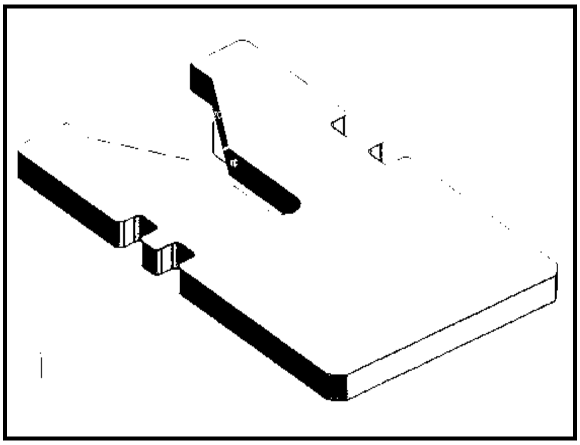

Fig 2: Arc Chute Plate (3D view)

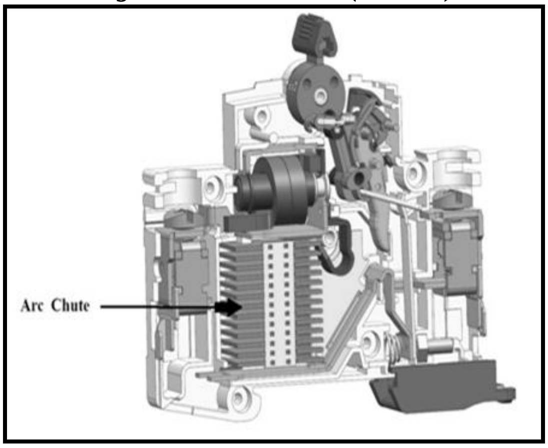

Fig 3: Location of Arc Chute

Arc chute is the critical component of MCB which is used to cool and extinguish the arc that occurs during short circuit overload condition. The location of Arc Chute in MCB is as shown.

Thickness of plate is 0.8 mm and main objective was to design and manufacture of press tool for medium batch long run press tool for Arc-Chute component.

In the design of die set, the 1st step is to prepare various configurations of strip layout possible. Strip layout is the position of the component in the metal strip & their orientation with respect to each other. After strip layouts are prepared, we select the most feasible layout for the given application.

The factors which influence the strip layout are:

Economy of material direction of material grain or fiber, strip or coiled stock, direction of burr, press used, production required and die cost. The most appropriate strip layout is also based on the scrap produced.

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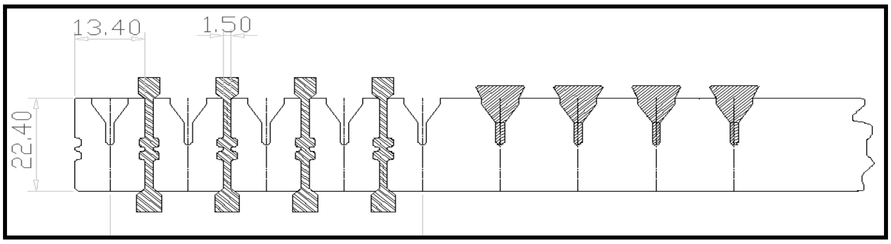

Fig 4: Strip Layout

B. Types of Scraps

1) Design scrap: This scrap is produced due to the functional requirement of the component. This scrap cannot be eliminated.

2) Tool scrap: This scrap is produced due to the arrangement of components in strip layout. This must be kept minimum as possible. In the old tool we had tool percentage scrap 29.77% and in new tool 24.5%.

V. MANUFACTURING

Manufacturing of blanking dies with utmost precision and properly sharpened with correct amount of clearance between punch and die is the most important, as improper clearance can throw off entire press operation. Manufacturing procedure actually starts with ordering of raw material according to the tool drawing and pre-machining it to approximate sizes of various plates. Then precision machining is done so that the machined plates are within tolerances. After going through the above phases, the tool gets assembled after detailed inspection of each plate. Various manufacturing operations involved in the Press tool are Lathe work, Conventional Milling- drilling, Grinding, Jig boring, Wire-EDM.

VI. RESULT AND DISCUSSION

A. Result

Using progressive die of 2-stage operations, we have manufactured the Arc chute plate by efficient strip layout and by considering various parameters as optimum cutting clearance, land for shim, tool steels for various components, stripper plate, crop punch, radial punch and floating stripper. Results obtained from this tool trial and component inspection process are listed as below:

Table 1. Results of Tool Trial and Component Inspection

Sr.No.	Parameters	Single stage die (Old tool)	Progressive die (New tool)
1	Component dimensions	Accurate during initial tool trials but inconsistent after as early wear and tear of tool takes	Accurate, consistent and conforming to the customer drawing.
2	Component cutting edge finish at the shear plane side	No uniform cutting layer patterns are obseved as the cutting force acting is large and not concentrated due to normal clearance.	Uniform cutting layer pattern as cutting force is divided into 2 stages and concentrated force at cutting edge due to the close clearance.
3	Tool life	Tool life is 1 lacs components	Tool life is 10 lac components
4	Component scrap	Is higher as it has front and back scrap	Is lower as it containes only scrap bridge and no front and

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5	Productivity	Uniform during initial trial and then of decreasing order	Uniform throughout

B. Discussion

1. **Component dimensions**
   The component dimensions in a single stage die are conforming to original dimensions but the variation in dimension starts with wear of tool. While, in progressive die, regrindable land is accommodated so as to have same clearance and component accuracy. Thus the progressive die accounts for wear of sharp edges increasing the tool life considerably.
2. **Component finish at the shear plane side**
   The definite pattern for shearing showing varying intensities of cutting force as punch hits the work piece is not observed in single stage tool as the cutting force is too large. While in this case, we have multiple stations which reduces the direct effect of cutting force by dividing it to various punch operation.
3. **Tool life**
   Tool life of conventional tool is less as it has to be replaced whole if a single defect is present in the tool. While in progressive die, we provide for shim by extra land allocation and replaceable inserts provide for easy maintenance and which ultimately result in higher tool life.
4. **Scrap reduction**
   The front and back scrap are component scrap which adds to the waste cut off parts. This was too much high in old tool so as to replace it for better & in long run.
5. **Productivity**
   It is constant during initial phase and decreases ultimately. While in progressive die, there i high production rate and hence high product effectiveness.

CONCLUSION

- By introducing progressive die for Arc Chute Plate, it is concluded that the tool is very feasible for the medium batch capacity and efficient in operation.
- By using two stage tool die, the tool life is 3 -12 lac components.
- Also, the accuracy of the component is high due to use of precision machine for production of the punch and die.
- The provision for replaceable inserts has made the maintenance simple.

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