IMPROVEMENT IN PRODUCTIVITY AND QUALITY OF BUMPER PUNCHING MACHINE

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ABSTRACT

In the current industrial scenario with emerging global competition and rising customer expectation, providing low cost and high quality products is a winning rule. These high expectations can be met through low cost automation and by keeping low operational cost with better accuracy. Reducing the operation value can be achieved by improving operational measures like parts delivery, desired quality, performance etc. The development of this design started with evaluating the current process we used for cutting the plastic bumpers. Noticeable problems include extremely low production, poor cutouts geometry, sharp burr and the use of cutters without protection. Cut circles on bumper failed the quality checks, which is used for insertion of the fog lamp cutout into a cap to ensure a snug fit. Comparing the new punching machine driven by hydraulic systems with its traditional form, new machine has many advantages such as, simply constructed, optimum size and weight, low production cost, least production time, easy to control, low noise and expected energy saving. This paper introduces basic idea of automatic punching machine which results into valuable production rate improvement with good quality of cut out to meet flush and gap conditions.

Index Terms—Productivity improvement, Special Purpose Machine, Cost and Time control.

I. INTRODUCTION

Now a days, in the automobile area, research are involved in using the plastic parts to reduce the weight of the vehicle. Bumpers are the most extreme parts in any of the vehicle. It is the part for which biggest injection tool required. Concentrating to fog lamp area, it requires special arrangement to cut the cutout for the perfect fitment of fog lamp module. This hole punching machine creates clean holes using a replaceable punch block and pin which is specially machined and hardened for the task. For this case mechanical press are best player [3][7]. Presently existence of Special purpose machines is widely distributed amongst the automotive components. But, the cost of machine plays an important role while development. Herein we will have a target of cost optimization and expected production count with better accuracy [4][11]. In traditional ways, cutting process result in scruffy holes and drills breaking. Fog lamp hole punching machine, which combines a steel hole punching facility with a guillotine [1][4][5].
Ideal for production areas, where traditional drilling methods through the steel frequently result in scruffy holes and drills breaking.

Considering all above problems faced by manual punching machine, it become necessary to adopt some new technology to cut these cutout very accurately. The product developers are also looking for solution which will give expected production rate as well with the best quality output [7].

In automobile bumper, it needs to punch the fog lamp holes which are almost asymmetric in all directions. Bumpers are made from injection molding process. In Injection tool, such cavity cannot demolded in main tool direction and Integration of slider or lifter for this particular cutout will cost so much. Also the complexity becomes more in tool wherein the solidification of mold is of major concern. After injecting the parts in the mold. It is necessary to cool the part within the prescribed time. Within such a short period. Some cavities cannot drawn through the injection. The stiffness and flexibility of plastic causes problem during punching operation. This holes needs to be accurate so as to meet the craftsmanship prescribed by the OEM.

When a product is manufactured, it always provided with some tolerances from the ideal CAD-geometry. These tolerances are assigned by the product developer, so that the product development teams knows how much the parts are allowed to process. The product developer wants to assure that tolerances are rather tight, so that all functions are met, and the parts can be easily assembled. Otherwise, to optimize production costs, it is necessary that the parts have wide tolerances, so that cheap manufacturing way can be adopted. In the case of automotive design this process is even more difficult, because additionally the designer wants that the aesthetic quality of the product is high, just not to sell the product sells badly. The specimen which we received is required to do slitting operation. Front bumpers are produced by injection process. As it is the biggest part of the vehicle. The molding tool also very huge compared to rest of the parts.

The molding direction as well as the assembly direction of the component is in X direction. (As per the std car position). If we analyses the cutout of the bumper, it is very irrespective of the tooling direction. In the plastic injection process, the molding tool includes core, cavity, Sliders and lifters arrangement, cooling circuit etc. Due to such complicated structure some features like fog lamp cutouts in the components are cannot clear in the injection tool. On the contrary, if we add the additional slider arrangement. It becomes almost infeasible to implement. Also cost of such tilted slider arrangement is becomes so high. To overcome this problem, we are making one Special Purpose Machine which will pierce such feature, without disturbing the geometry.

Cockpit components of a vehicle, such as the instrument panel and trim, are inspected for fit by the manufacturer and inspected for
the fitment after they assembly in vehicles. Measuring gap and flush on these parts is difficult because of the unusual shape and small gaps. Mechanical tools are almost impossible to use because of the flowing contours and the small to non-existent gaps.

II. METHODOLOGY

As the problem statement clearly stated that the problems during punching hole into bumper. The technology portfolio extends from simple Special Purpose punching machine. The systems are ideal for mass production and also characterized by low maintenance expenses and low operating costs.

The main cut is made by the ram, which is simultaneously positioned for subsequent slide cuts. The result is a high-quality cut and very fast cycles. The punching machine is used mainly in production of instrument panels, center consoles and door trims. The hydraulic stroke is synchronized with the punch slides.

High-precision cutouts are placed with the precision punch tools from Vimal Industrial Systems. They are optimized for plastics and adapted with specific materials and part geometry. The precision cutting gap means no post processing is required, and you get superior part quality. The tools are equipped with hydraulic splitters as knife drive for the kind of cuts. Faster cycles give you high production rate. Low operating costs are a further benefit.

The methodology includes the Basic design. Analytical Design:

Cylinder 1:

Force developed = 6all *Area of cutout

Now, Force = Pressure/Area

Now Area of piston (Ap) rod,

\[ Ap = \frac{3.14}{4} \times d^2 \]  \text{ (1)}

We get the diameter from these formulae.

With the calculated diameter, we approached to cylinder manufacturers and select the possible combination for the cylinder. As the systems needs two hydraulic cylinder, we have selected two hydraulic cylinders.

In addition to that we need some standard components viz; Hydraulic hose, springs, Bolts. We have verified also the standard components for its feasibility in terms of strength. Below are the some catalogues from which we have selected to perform this machine.

Table 1. Standard Radius of Hydraulic Hoses
III. EXPERIMENTAL SET-UP

Below is the assembly view of front bumper punching machine. It involves these carries many components such as cylinders, bearing, support plates, bushes, guide rods, springs, wheels, safety grills, hoses, control panel.

![Assembly View](image)

Fig. 3 Assembly View

Its aims to operate complete process by fully automated way. We have implemented PLC program, which takescare complete operation in smoother way. The working can be understood by the hydraulic circuit diagram. The Relative hydraulic circuit drawing is also shown. The working of the system is carried out in three stages i.e. mounting, Clamping and forming. The machine can be operated by Auto as well as in Manual mode.

Initially, as the motor is started, the piston pump starts to develop the pressure in the system. The pressure inside the suction line is falls down to that of atmosphere, so the oil started to rise in the system. Before the oil reaches to the pump, the oil contaminant like dust, dirt is avoided by providing the pump is shown. Further the pump started to discharge the fluid at the required pressure about 100 Bar into the system. The pump is provided with the pressure control valve which governs the discharge pressure of the system as required. The excessive pressured fluid is returned to the reservoir through the return line as shown in fig. 4

![Circuit Diagram](image)

Fig. 4 Circuit Diagram

The mechanical level indicator is provided at front side of the tank and also the level switch is provided for the tank to avoid the dry
running of the pump. This pressurized fluid is then passes to the hydraulic valve bank. To avoid the return flow, the non-return valve is provided. The line pressure is indicated by pressure gauge. To maintain the pressure at different stations, the five station pressure regulator is provided by selecting the appropriate station we can alter the pressure. For the safety purpose, the High pressure Switch is also provided in the line. The Valve bank is provided with three no. of 4/3 Solenoid operated valve. This solenoid valves are connected with the cylinder with the help of hydraulic hoses. As solenoid valves operate, the cylinder get actuated toward splitting zone. The bumper is get pierced with the expected cutout for fog lamp.

IV. RESULT

Coming to the quality perspective, we have taken dimension of the output parts during the trial phase. The customer is providing tolerance over the cutout for two cases. The tolerance band for the gap and flush condition is very tight in the visible area. We have results which explain itself the advantages of this machine. Let’s discuss with the GAP condition, below are the readings,

Table 2 Reading for the gap condition

<table>
<thead>
<tr>
<th>Reading Numbers</th>
<th>Customer Request</th>
<th>Old Machine</th>
<th>New Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5 ± 0.3</td>
<td>1.6</td>
<td>0.3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1.9</td>
<td>0.4</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>1.4</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Note: All dimension are in mm

Achievement of gap tolerance is comparatively easy than the flush condition. Because in most of the cases for flush area, parts going across its parting line. Due to such movements, it’s difficult to achieve close tolerances. We have taken reading for flush condition also as below,

Table 3 Reading for the flush condition

<table>
<thead>
<tr>
<th>Reading Numbers</th>
<th>Customer Request</th>
<th>Old Machine</th>
<th>New Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00 ± 1.0</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2.7</td>
<td>1.3</td>
</tr>
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<td>3</td>
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<td>2.9</td>
<td>1.1</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>3.1</td>
<td>1.9</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>2.3</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Note: All dimension are in mm

Coming to the point of production rate, we noted the time requirement for the manual as well as the current special purpose machine. This survey has been for different OEM.
Table 4 Reading for production rates of different OEM

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Company</th>
<th>Old Machine\Hr</th>
<th>Automated Machine\Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Company 1</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Company 2</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Company 3</td>
<td>12</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>Company 4</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Company 5</td>
<td>15</td>
<td>50</td>
</tr>
</tbody>
</table>

From the above table, it’s clearly indicated that, Part can be produced with expected output rate. In addition to these targeted milestones, the Profile Tolerance was also achieved with the expected output.

V. CONCLUSION

From this paper we are conclude that, all the slitting operation can be done with a single stroke. The parts are not getting warp after the cutting operation. We are getting the parts with highly expected quality output with the minimum possible cost of time. In addition to that, the part is able to satisfy the craftsmanship section i.e. it must satisfy the Gap and Flush condition with respect to RPS (Reference Point System)

REFERENCES

[2] Hydraulic cylinders catalogue, Data hydraulic controls
[5] Hydraulic cylinders catalogue, Rexroth Bosch group, Component series 1X.