

Design and Fabrication of Bonnet Insulator Hole Punching Machine

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Abstract - The project is based on fabrication of punching machine for bonnet insulator. Basic aim of project is to replace manual work by automation. Project includes design of pneumatic circuit, DC valves, FRL unit which are important components to achieve automation for any process. Project also includes design of fixture which comprises of locking nut, stoppers and rubber pads so that job can be properly mounted on machine without any error. Design of fixture is important because the job should be properly mounted or fixed to machine otherwise error can be produced during manufacturing. Stoppers are mounted so job is placed properly. Locking nut is provided to hold the job properly. Rubber pads are provided so that job can sustain hammering effect and does not get crack or damage. To achieve automation electric, hydraulic or pneumatic circuit are used. As process required rapid operation for this purpose pneumatic circuit is used. Various important components of pneumatic circuit are DC valve, FRL unit. After successful completion of project most of manual work will be completely eliminated only operator will need to load and unload the machine. Process efficiency will be improved, quality of product increased, reduction in cycle time can be observed through various observations.

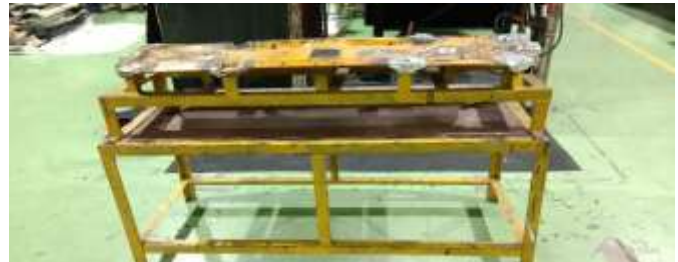


Fig -1: Bonnet Insulator Punching Machine

2. MANUFACTURING PROCESS

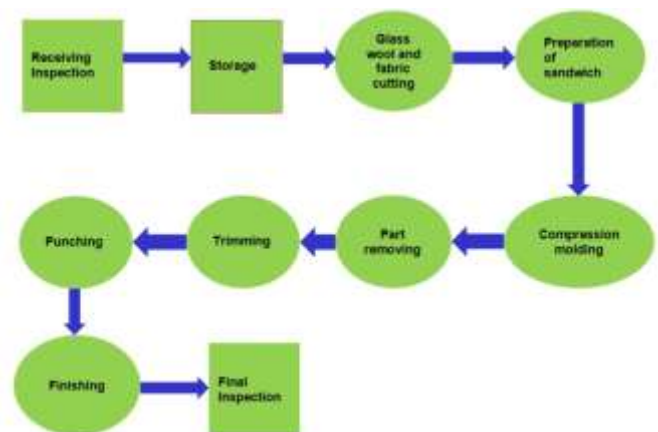


Fig -2: Flow process diagram

Key Words: Punch, Stopper, Rubber Pads, Locking nut, Bonnet Insulator Machine, Pneumatic Circuit, DC Valve, FRL unit.

1. INTRODUCTION

Bonnet insulation acts as a thermal insulation especially during hot condition. It is also used to reduce noise from engine and resonance that occurs when engine is running. Bonnet Insulator punching machine is a punching machine which is fabricated by Ukay Metals. Design of die is provided by Mahindra Company. Hole to punch is hammered manually by hand. Generally one worker is required to perform operation. Cycle time for process is 2min 17 sec. Total numbers of hole to be punched are 14. Material used for manufacturing of machine is FRP. FRP is preferred because it is cost effective. The material used for bonnet insulator is made from sandwich of three materials. First layer is of fabric (200 GSM). Second layer is of glasswool (1400 GSM). Third and final layer is of Fabric (100 GSM). LPD powder is sprayed between each layer of fabric. The LPD powder acts as adhesive material which helps to carry out proper forming process.

Raw material i.e. glasswool and fabric are stored. Then with the help of cutting machine glasswool and fabric are cut to required dimension (600 mm x 1480 mm). Sandwich is made. First layer is of fabric (200 GSM). Second layer is of glasswool (1400 GSM). Third and final layer is of Fabric (100 GSM). LPD powder is sprayed between each layer of fabric. The LPD powder acts as adhesive material which helps to carry out proper forming process. LPD powder is sprayed manually and it should be sprayed evenly throughout the surface. Then compression moulding process is carried out. Top mould or male mould is kept at temperature about 180 C and bottom mould or female mould is kept at temperature of about 190 C. Require pressure to carry out process is 70 bar. Cycle time of process is 2min 30sec. Then after compression moulding process is done sandwich material is allowed to cool. The step is trimming of unwanted parts. The bonnet insulator is placed on die and worker with help of cutter cuts the unwanted side parts. Cycle time for trimming is 3 min. Next step is punching of hole. Holes are punched with help of hammer also called as punching tool. Total 14 holes are to be punched. After this finishing process is carried out. Soldering is done as finishing process. The temperature of soldering gun is provided by DC current.

3. PROBLEM STATEMENT

The major problem during manual punching was that some holes were missing due to which quality was compromised. Safety of worker was also compromised as during punching injury can happen. Sometimes operator may punch hole too hard or too soft so quality of product was compromised.



Fig -3: Hole missing

4. PROJECT OBJECTIVE

- To improve quality as some holes are missing during manual operation.
- To reduce the breaking of tools and insure proper hole is punched.
- To reduce cycle time of product.
- To reduce fatigue to operator.
- To reduce COPQ (Cost of Poor Quality). COPQ is cost which can be reduced if process parameters are improved.
- To reduce PPN (Part Per Notation). PPN means checking of part every time machining operation is carried out.
- To achieve customer satisfaction by improving product quality.

5. SOLUTION

Manual work can be replaced by using automation. As process requires fast operation the most effective will be use of pneumatic circuit to achieve automation and also it is cost effective. Hydraulic circuit gives accuracy but its speed is limited which is not desirable for our process.

6. METHODOLOGY

The most important parameter to carry out operation was to find required pressure to punch the hole. If pressure was too high it will damage the tear or crack the material and if pressure is too low it will hole will be not punched. Due to this the quality of bonnet insulator will be compromised. So pressure for cylinder to punch the hole is the most crucial

parameter. So to find required pressure trial and error method was applied also known as process validation sheet in industrial language. The table below shows the process validation sheet.

Table -1: Process validation sheet

No	Critical parameter to be controlled	Pressure value (bar)	Observation	Remark
1	Pneumatic pressure in (bar)	1	No punching	Not ok
		2	No punching	Not ok
		3	No punching	Not ok
		4	Proper punching	Ok
		4.5	Proper punching	Ok
		5	Proper punching	Ok
		6	Part stick on punch	Not ok
		7	Hole surface damage	Not ok
		8	Hole surface damage	Not ok

From the process validation sheet we observed that pressure between 1 to 3 bars were too low and holes were not punched. Pressure between 6 to 8 bars were too high which resulted in some damage to punch or material surface. So pressure between 4 to 5 bars were selected to be operating pressure.

To achieve automation pneumatic circuit is preferred because it operates fast and economical. FRL unit performs the function of filter, regulator and lubricator. To control the movement of air in cylinder 5/2 DC valve is used. It has two cylinders ports which causes punch to move upward or downward. One pressure port and one exhaust port to remove exhaust gases to air. One port is blocked. Total 19 DC valve are used. Low pressure cylinder having maximum pressure upto 10 bar are used. There are total 14 cylinders whose operating pressure is 4 to 5 bar as calculated by process validation sheet.

To properly mount the workpiece stopper and locking nut are used. Due to use of stopper and locking nut workpiece is mounted properly as per given position of required holes and while punching the workpiece will not move and error will be reduced. Rubber pads are used so that hole will be properly punched and workpiece will not get lifted.

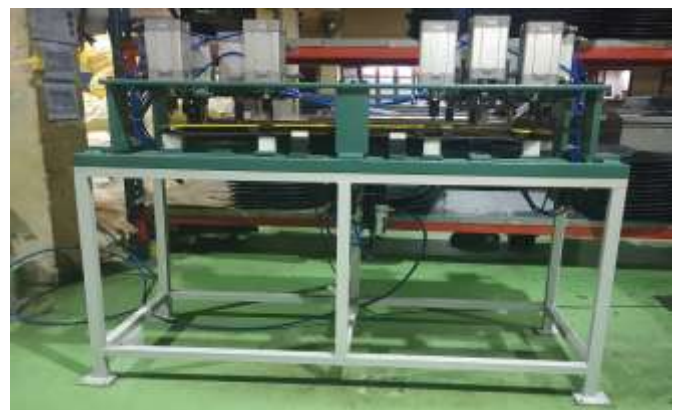


Fig -4: Automated punching machine for bonnet insulator

7. CONCLUSIONS

- Quality is improved as there are no missing holes.
- As pressure is properly applied so no damage to punch and insulator material.
- Cycle time of product is reduced.
- Reduction in fatigue to operator.
- Saving in COPQ (cost of poor quality) as quality is improved due no missing holes and proper punching.
- As process is automated part per notation is reduced.
- Customer satisfaction as product quality is improved.



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