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Analysis of Rejection in Manufacture of Bosch Dimension Nozzle for Indirect Injector and its Remedy

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Abstract: *Using the Quality tools, we expose the area of problem and give an appropriate solution and suggestions to reduce the rejection. In a manufacturing process defects arise due to single or multiple causes. The defects are analysed systematically based on the received data to find the source of error and to derive a suitable contingency plan to eliminate the error. Here in the manufacturing of injector nozzles for diesel engines there is a loss in the tool used. Electro Chemical machining process is equipped for nozzle tip machining. This rejection analysis and quality study has been carried out and successfully implemented at "Delphi-TVS Technologies Ltd." The previous tool material was Nylon material. Later after identifying the loss alternate Delrin material has been installed for the tool which resulted in decreased loss rate. Moreover, the concept of quality is managerial philosophy that mainly aims at satisfaction of the customer and improving the organizational performance. The defect analysis is based entirely on the totality of the quality in all facets of an organization with the objective of reducing the waste and rework thereby reducing cost as well as increasing the efficiency in production. The main aim is to improve the product quality and its process in the industry.*

Key Words: *Quality, Quality Control, Pareto Analysis, Defect Rejection, Injector Nozzle.*

1. INTRODUCTION:

The project is aimed to ensure the successful Implementation of quality control tools and Techniques in manufacturing industry. In today's world, business has become more and more competitive. All industries and organizations have to perform well in order to survive and be profitable. Quality is the standard of products that meet customer expectations and ensures customer satisfaction. The repeated damage in tool the existing tool used is identified. The tool life, material used, properties and purpose is studied and a noted. After knowing the complete process about ECM (electro chemical machining) the Nylon tool is observed for its quality. Later with suggestions and idea from the quality team, we came with the idea to change the type of material used in the tool. Instead of Nylon, a material called 'Delrin' which has a balanced properties of both metals and plastics. This polymer designed to replace metal that has low friction and advanced properties. This material is widely used in automotive and electronics for its high mechanical strength and rigidity.

2. OBJECTIVE OF THE PROJECT

- To determine a cost effective method for machining nozzle by using seven quality tools.
- To study about Electro chemical machining and suggest a effective tool.
- To reduce the rejection rate in tools due to machining.
- To control the scrap of BDN (Bosch Dimension Nozzle) outer diameter unwash.

3. SPECIFICATION OF PRODUCT :

Finishing	-	Polish
Use	-	For TATA vehicles
Product Type	-	Fuel injector
Material	-	Steel
Part Type	-	Rotary pump part
Weight	-	50-150 Grams(g)

BDN for Diesel rotary fuel pump

BDN in Delrin bush with electrode

Fig 3.1 BDN after Assembly

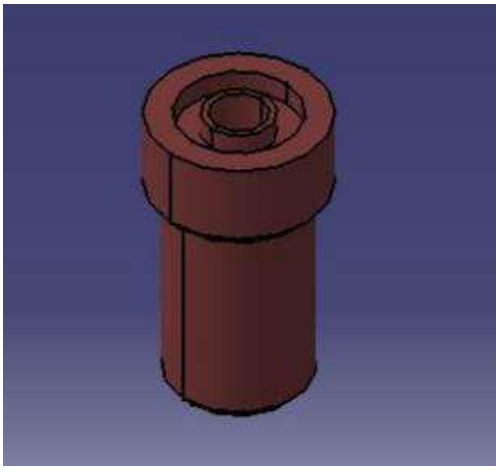

Fig 3.2 BDN Hard

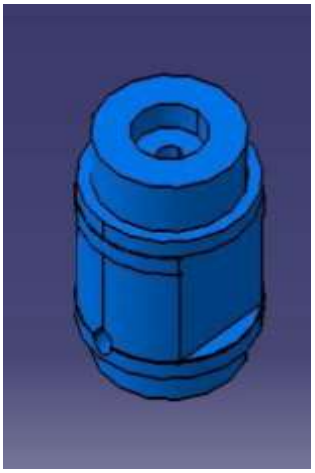

Fig 3.3 Delrin holder

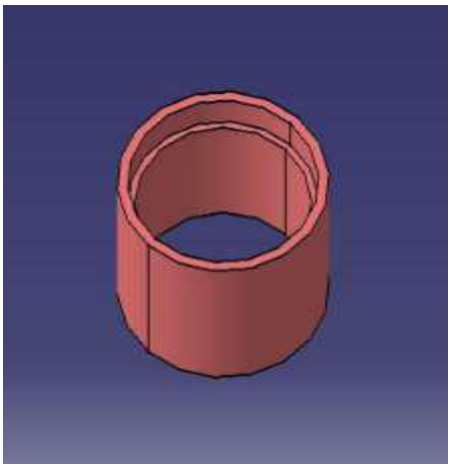

Fig 3.4 Delrin bush

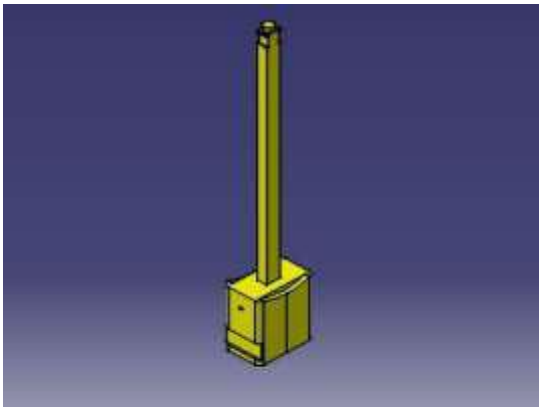

Fig 3.5 Electrode

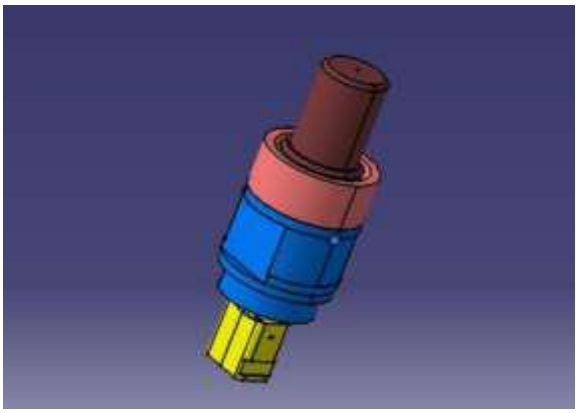

Fig 3.6 BDN after assembly

4. ELECTRO CHEMICAL MACHINING :

Electrical energy is utilized with chemical reactions to remove material. Relies on the principle of electrolysis for material removal. Michael Faraday discovered that if two electrodes are placed in a bath containing a conducting liquid and a DC potential is applied across them, then metal can be depleted from the anode and plated on the cathode – process universally used in electroplating by making the workpiece the cathode. In ECM, the material is removed and hence electroplating is reversed, i.e. workpiece is made the anode. Work material must be a conductor. Machines requiring current capacities as high as 40,000 A and as low as 5A are available in the industry. Net result of electrolysis: Iron gets dissolved from the anode and forming the residue consuming electricity and water, and nothing else. Reaction products are ferric hydroxide and hydrogen gas. Metal from the anode is dissolved electrochemically in the electrolyte. The cathode evolves hydrogen gas and no other reaction takes place. Here the shape of the cathode remains unaffected.

Fig 4.1 Ember Electro Chemical Machining

4.1 Tool Design and Considerations :

The major aspects of tool design are:

- For achieving the desired shape of the tool the shape of the tool is determined.
- Apart from this electrolyte flow, insulation, strength and fixing arrangements are to be considered.
- The tool profile is modified to get the final surface that is relatively complex. To get this final tool design FEM can be used.
- Designer must determine the nature and the extent of the required deviation or gap allowances from the mirror image configuration, while providing for a uniform and sufficiently high flow rate of electrolyte.
- Tool dimensions must vary from the nominal mirror dimensions of the finished part to allow for ECM overcut. Part and the cathode must have adequate current-carrying capacity. ECM cell must have rigidity and strength to avoid flutter and arcing.

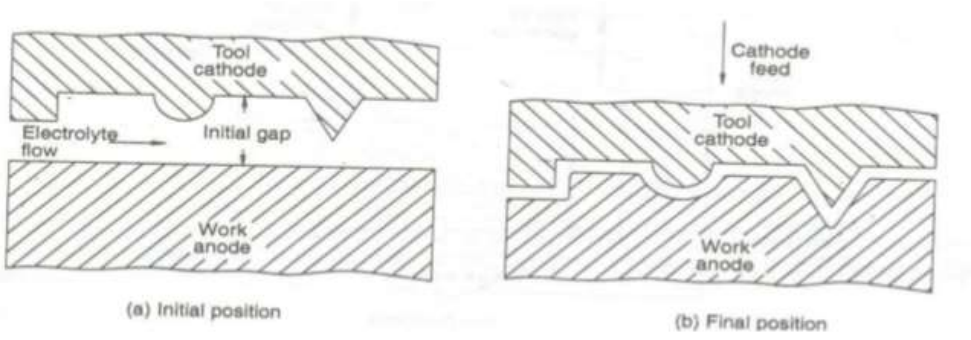

Fig 4.2 Tool shape by ECM

5. TYPES OF REJECTIONS :

Various types of rejections and defects are tabulated below

Type of Rejections	Number of defects
Head od unwash	808
Feed hole not open	260
Bore puncher	135
Seat u/w due to ECM	127
Seat chattering	52
Pressure face unwash	13
Bore under/over size	4

Table 5.1 Types of Rejection

5.1 Rejection Pareto

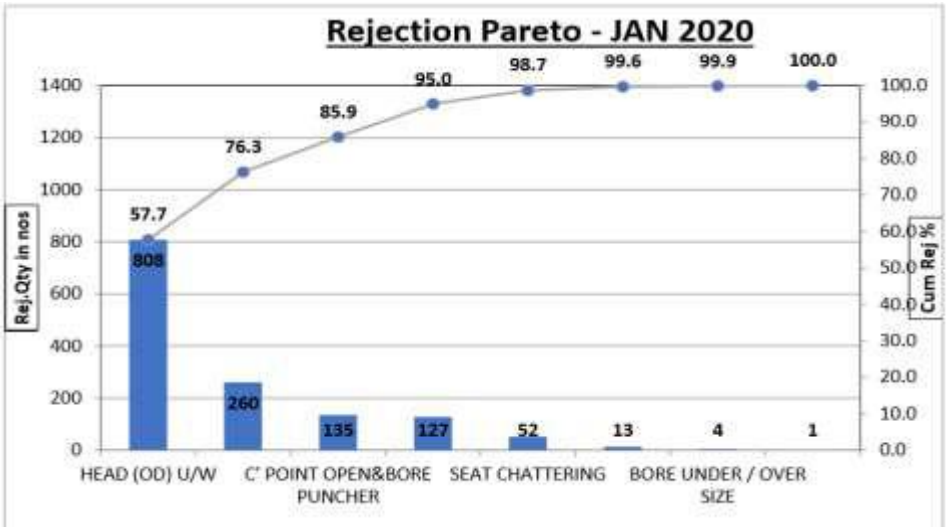

Chart 5.2 Pareto on Various Components

Upon The various components that have been manufactured the manufacturing of the BDN is made with the greater number of rejections hence we select that particular component to reduce its rejection by analysing the various causes of Rejection and to come up with a solution to reduce the rejection rate thereby providing Zero Defect as well as reducing the cost that has been used in production of the defective part.

6. COUNTER MEASURE :

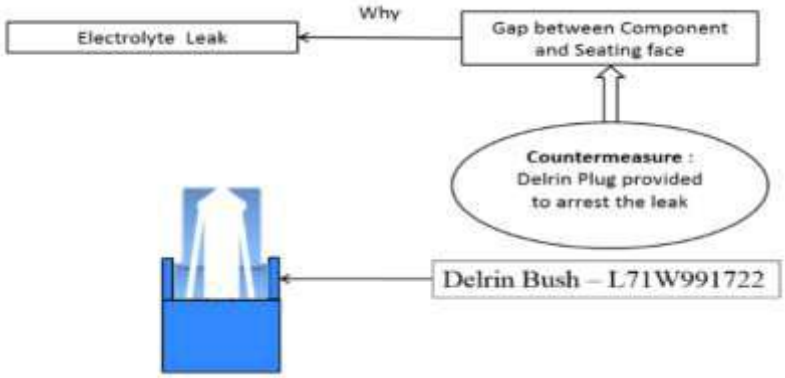

Fig 6.1 Counter measure

After the identification of repeated leak in electrolyte and considering the loss of tool, the nylon bush was replaced with a Delrin bush. Here the Delrin bush was plugged in between the seating of components and arrested the leak caused. Since it has a balanced properties of both metal and plastics it was rigid and tool life was higher than nylon material.

Probable Cause Validation

Part:	BDN Nozzle			Failure Mode:		Head OD Unwash
FTQ(Month):		6.6%		Project Start Date:		27/01/2020
Sl.No	**Probable Cause**	**SOP**	**Trail Parameters**	**Trial Results**		**Cause Validation**
				OK Qty	Rej. Qty	
1	Electrolyte Pressure	6-8 Bar	4 Bar	100	2	Invalid
2			6 Bar	100	1	Invalid
3			10 Bar	100	2	Invalid
4	Electrolyte Temperature	40° ± 5°	35°	100	2	Invalid
5			40°	100	2	Invalid
6			45°	100	2	Invalid
7	Electrolyte leak	Free from leak	With Leak	100	15	Valid
8			With out Leak	100	3	Invalid

Table 6.2 Probable Cause Validation

7. RESULTS :

CAUSE TYPE	CAUSES	MEASURES
Leak at face	Gap between electrode and seat facing	DERLIN BUSH introduced
Operator skill (man)	Due to absence of skill chances of accidents at operation station is more	Operator should provide with sufficient training
Operator awareness (man)	Operator is not locating the part properly on gauge. Specified tolerance limit may vary due to Negligence	Operator should be trained regarding slight changes in part specification may affect quality
Material properties (material)	Poor material properties leads to Crack and damages	Material should be ductile enough to absorb pressure at peaks and not shatters
Grinding outer diameter minus (method)	High infeed of the cutting tool	Infeed rate should be mitigated and should be paralel to the coolant supply
Milling width minus (method)	Incorrect cutting tool parameters fed in to the cnc machine	Tool parameters and its tool life must be monitored periodically by tool monitoring system or manual inspection
Centre drill offset defect (man)	Improper clamping of work piece	Training the operator on the job as well as testing the components
Milling taper defect(man)	Work piece elevated inclination with respect to tool	Positioning and fixing of the fixture And removing the burs using air gun
Tool grinding (method)	leads to deep cut or improper surface finishing	Tool has to be grind or changed whenever its necessary
Blow holes	Due to excessive gas content in the metal bar and rejection of dissolved gases during solidification, it includes hydrogen and nitrogen	Detect before machining, requiring harmonic, ultrasonic, magnetic or x-ray analysis.

Table 7.1 Results on every Aspect and Measures Taken

8. CONCLUSION:

In the earlier days traditional Quality Control techniques such as hit and trial or thumb rule are not guided by scientific principle or rules but follow an unsystematic approach leading to wastage of time, improper utilization of resources and ineffective solutions. These techniques do not provide optimum solutions but only provide a shortcut whose effectiveness is not guaranteed. Quality Problem Solving Analysis using various quality tools such as why analysis, Frequency Sheets, control chart, Pareto Chart and Cause and Effect Diagram, it can be concluded that these scientific problem solving techniques are far better and efficient as well as provide systematic approach towards problem solving as compared to traditional quality control techniques used in Indian Industries leading to overall improvement in productivity.

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