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REJECTION ANALYSIS IN FUEL EQUIPMENT

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Abstract - *In today's modern day world there is an increase in the demand for the quality of any manufactured product. Customers nowadays hope to get full quality products so as to meet the desired characteristics and thus in this regard customer satisfaction becomes the major target for any company. So it becomes necessarily important to identify the number of rejections which takes place within the company and also provide the suggestions to reduce these if needed. In general rejection analysis refers to the identification of the quality of any part or component and to ensure that the part accepts to the notified dimensions and tolerances provided. The part which does not fall within the specifications must be rejected if it cannot be reworked. This study deals with the quality issues faced in the manufacture of an advance housing also known as AA housing. After studying the various machining processes involved in the advance housing the defects and their reasons were noted and also the rejection rates due to each defect were studied. Using Pareto analysis, the defects with highest percentage of rejections were found. The Ishikawa diagram also known as the Fishbone diagram for the highest defect was plotted and the root causes were identified as a result. The control charts are plotted so as to figure out whether the component dimensions are within the upper control limits and lower control limits. Why-why analysis is also done for the above mentioned advance housing which helps to figure out the root causes of any problem. It finds the often hidden causes of the problems. Finally our suggestions are provided for minimizing the defects and rework which can help to reduce the rejection rate by a fair margin.*

Key words: Rejection Analysis, Advance Housing, Pareto Analysis, Ishikawa Diagram, Root Cause, Why-Why Analysis, Control Charts.

1. INTRODUCTION

Any manufacturing industry will always look to please their customers so that they retain their value in the global market. To achieve this, the companies start manufacturing thousands of parts every day so as to meet the required number of quantities, but in this process the quality of the product goes unnoticed at times. The decline in quality is due to the different type of defects that are associated with an advance housing. The different defects observed are rust, blow holes, improper drills, tool markings etc. The frequencies of the defects are noted down and the Pareto diagram is drawn based on the obtained data of rejection.

In the Pareto diagram the defects are arranged in decreasing order of the occurrences. The Pareto diagram is based on the Pareto principle which states that a few of the defects accounts for most of the effects. It is also called as 80/20 rule which means that 20% of the problems account for 80% of the effects. The fishbone diagram is a tool which finds out the reasons for variation, failures or defects. It is called as a cause and effect diagram where the effects are usually mentioned in the right hand side of the figure while the causes leading to it are written on the left side of the figure. The six main causes for any problem are classified as method, measurement, people, environment, machine and materials. These are called the primary causes.

To carry out this project, we took the help of M/s Jay Engineering Works located in Ambattur, Chennai. Using Pareto analysis, the defects with highest percentage of rejections were found. The advance housing is an integral part of the fuel injectors used in the diesel engines. The main function of the AA Housing is to pressurize the fuel before it enters the combustion chamber for the burning of fuel to take place. The raw materials for the manufacture of an AA housing are provided by Delphi TVS. The manufacturing of an AA housing has 20 processes which is done machines like CNC (computer numerical control) and VMC (vertical milling center). The operations like facing, turning, boring and drilling are done in CNC machines and slotting, tapping are done in VMC machines.

The why-why analysis is done to figure out the root causes to any problem. In this, initially the problem is laid out at the top and the subsequent causes to the problem are mentioned vertically downwards, which means the causes are noted down for the preceding problem. The control chart is the most widely used tool in statistical process control(SPC). It displays data taken over time and the variations of this data. Control chart can be used to check whether the process is being controlled statistically.

2. LITERATURE REVIEW

Rohit Ravasaheb Shinde et al [1] stated that this paper makes use Of Failure Mode Effect Analysis (FMEA) to adopt the innovative technologies integrated with the operational aspects in order to enhance the process capability. The main objective of the study is to improve machinery system reliability and its performance. The Pareto analyses were done to select the type of bush and its machine as it contributing more percentage of the total scrap quantity.

Raghuwanshi Rohit et al [2] concluded that this paper deals with the usage of two major tools like control chart and sampling for the quality control. The emphasis is weighed more on the zero defections. It analyses the type of defects and the quantity of defects which occurs in the gear manufacturing processes.

Milind Raut [3] concluded that this paper represents analysis and investigation of cutting defects and identification of remedial measures. Cutting products revealed that the contributions of the five prominent defects in cutting rejections were found and they are taper cutting, over size, under size, rough surface and burr. Systematic analysis were carried out to understand the reasons for defects occurrence.

Ashwini et al [4] Conducted the study to observe the process going on in the production line, to reduce the rejection rate by identifying the root causes by the management tools. The tools and techniques used to achieve the objectives were check sheet, Pareto chart, cause and effect diagram and control charts.

R S Magdum [5] revealed that the project is carried out on ATC chain link where repeated ovality problem is identified and analyzed. The reason for the ovality has been analyzed and inspected by the method of Fish bone diagram and why-why analysis.

3. PROCESSES IN AA HOUSING

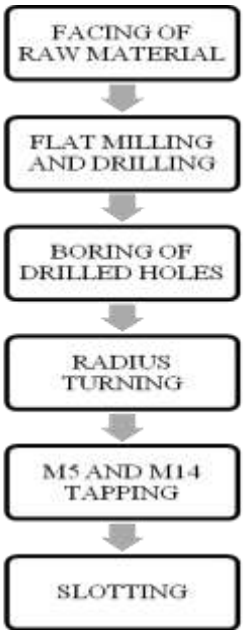

Fig-1: Processes involved in AA housing

The above flow chart shows the sequential processes that take place in the manufacture of an advance housing. It begins from the facing of raw material followed by few more machining operations like flat milling and drilling, boring of drilled holes, radius turning with a radius of 46.90mm, M5 and M14 tapping and the last step is the slotting process.

Fig-2: Raw material

The raw materials of an AA housing are provided by Delphi TVS. The material of this housing are made of cast iron. The weight of the raw material usually decreases as the number of operations performed on it increases thus the weight of the advance housing will be inversely proportional to the total number of operations being performed in it. The length of the raw material is 79mm and it must be faced to a length of 76.6±0.2mm which is the usual ideal length of the housing. The extra 2.4mm on the raw material is provided so as to compensate for any type of mishandling of the material or to overcome the material loss which may take place during a sudden fall or a breaking of the edges.

Fig-3: Finished product(front view)

The completely finished appearance of the Advance housing with all the operations is shown above. There are two tapping processes which takes place, one is the M5 tapping and the other is the M14 tapping. The M5 tapping uses the normal carbide tools whereas the M14 tapping uses the carbon tool whose appearance is similar to a gold flake. There are a total of two diameters which are considered main, one hole has a diameter of 10.8mm and the other hole has a diameter of 7.5mm. The centre distance between the two holes is 42.8mm.

Fig-4: Finished product(rear view)

4. NATURE OF DEFECTS OBSERVED

The following were some of the defects noted in the AA housing:

- Blow holes
- Rust
- Improper drills
- Tool Markings
- ID groove miss
- Chamfer unwash
- Wall thickness undersize
- Thread damage

5. MANAGEMENT TOOLS USED

PARETO DIAGRAM

The different data's related to the advance housing are collected and various pareto's are sketched to understand the percentage and the number of rejections of any particular defect.

Fig-5: Reasons of rejection

Table-1: Number of rejections occurred(as per the above figure)

REASONS FOR REJECTION	NUMBER OF REJECTIONS
Blow holes	45
Rust	40
Chamfer unwash	24
Improper drills	18
Damages	15
2mm drill missing	15
Bore line mark	8
M5 thread missing	7
OD miss	6
Tool mark	3
ID groove miss	2
Thread damage	10

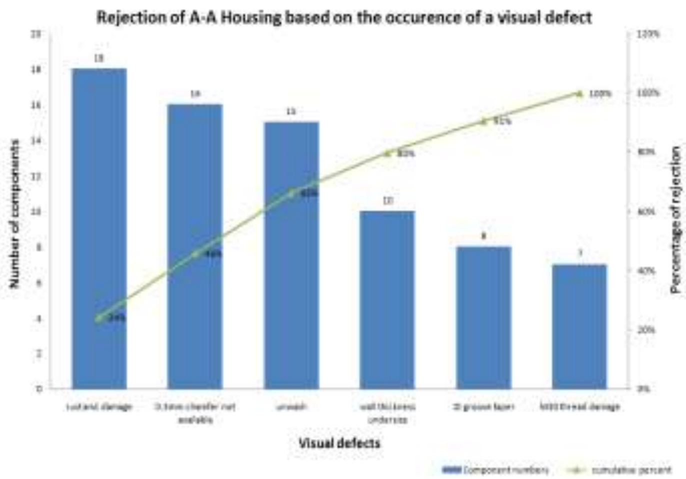

Fig-6: Occurrence of visual defects

Table-2: Rejections due to visual defects(as per above figure)

REASONS FOR REJECTION	NUMBER OF REJECTIONS
Rust and damage	18
Chamfer not available	16
Unwash	15
Wall thickness undersize	10
ID groove taper	8
Thread damage	7

CONTROL CHART

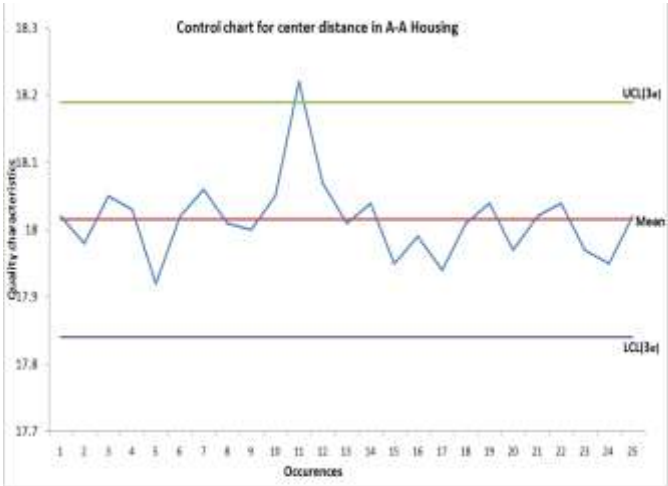

Fig-7: Control chart for center distance in AA housing

The readings were taken on a daily basis for a month and were recorded in the form of a control chart. The average of the samples is 18.015mm which is taken as the centre line for plotting the chart. The UCL is 18.19mm and the LCL is obtained as 17.841mm. Out of 25 readings recorded, one of the measurements for the center distance was found to be lying beyond the UCL of 18.19mm which was observed on the 11th day. This is the pattern that signifies an out of control point special cause of variation.

ISHIKAWA DIAGRAM

The following listed causes are the governing factors that define the state of the clamping. To control this, either the entire sub causes must be kept under control or the main causes must be eliminated so that it also removes the sub causes which lie within these major causes. Once these major causes are controlled or eliminated the sub causes are under control automatically.

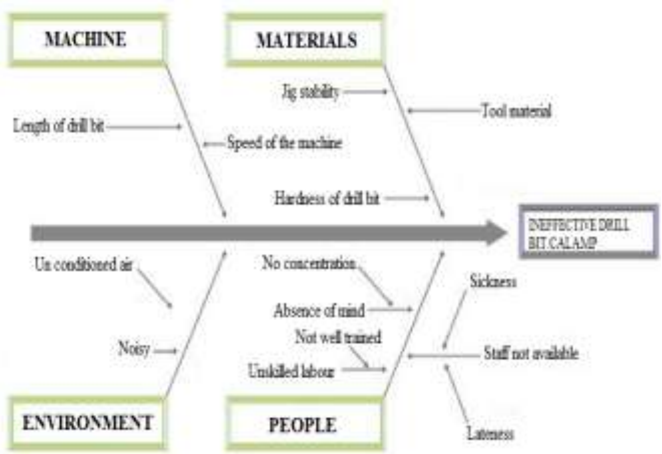

Fig-8: Fishbone diagram for ineffective drill bit clamp

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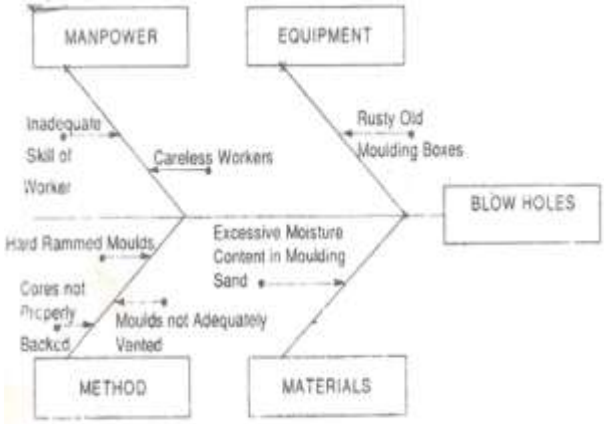

Fig-9: Fishbone diagram for blow holes

Since the number of rejections due to the blow holes were observed as the maximum in number, the cause and effect diagram for the same is listed as below. There are four possible causes derived for the formation of blow holes. The possible causes arrived from brainstorming process were fitted on each category of cause & effect diagram. After analyzing the above results two sessions of brainstorming were organized to get different key points.

SCATTER DIAGRAM

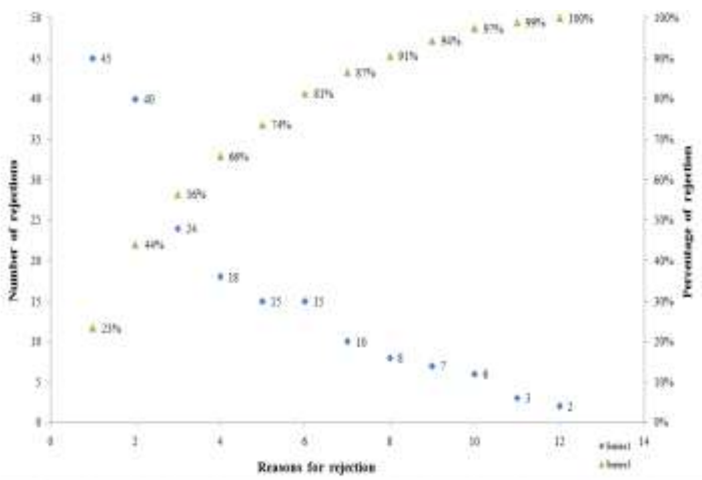

Fig-10: Scatter diagram

The scatter diagram graphs pairs of numerical data, with one variable on each axis, to look for a relationship between them. If the variables are correlated, the points will fall along a line or curve. This cause analysis tool is considered one of the seven basic quality tools. In this above shown figure, the scatter for the different types of reasons for rejection is provided.

WHY-WHY ANALYSIS

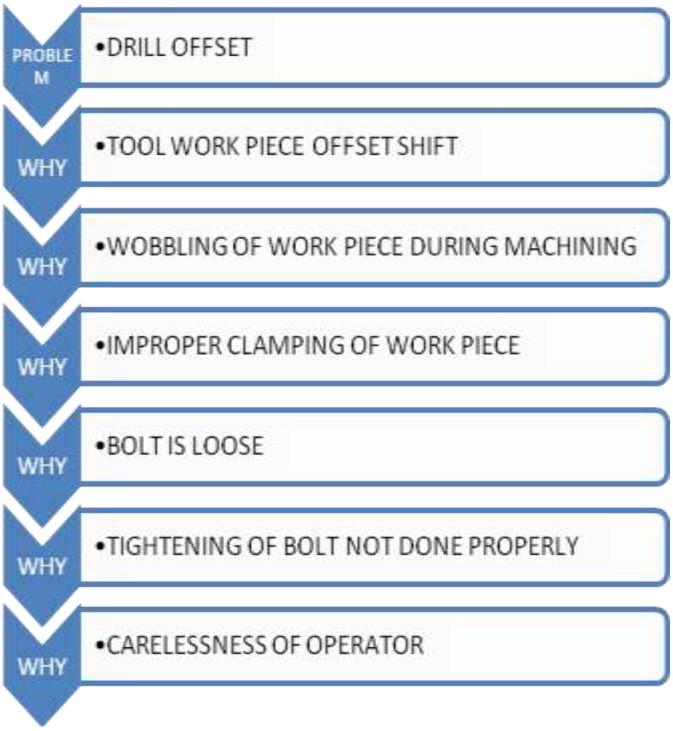

Fig-12: Why-why analysis

The above shown why-why analysis describes the causes which lead to the drill offset. From the diagram it can be noted that the main cause or reason due to the offset in drill is due to the tool work piece offset. This is further caused due to the wobbling of work piece during machining. And on identifying the reason for this it was found out to be due to improper clamping of work piece and all these were caused due to a primary reason i.e. the carelessness of the operator.

Table-3: Data collection for monthly production and rejection over the past three month (from Nov 2019 to Jan 2020)

Month	Monthly Production	Total Accepted Quantity	Total Rejected Quantity	Rej. %
Nov 2019	5212	5021	191	3.66%
Dec 2019	5196	5018	178	3.42%
Jan 2020	5184	5010	174	3.35%

Fig-13: Graphical representation

Since the blow holes and rusting together contribute to the major proportion of rejection in an advance housing, so it is necessary to study the quantity of these rejections.

6. SUGGESTIONS

Type of causes	Causes	Solution or Measures
Blow holes	Due to excessive gas content in the metal bath and rejection of dissolved gases during solidification. It includes hydrogen and nitrogen.	Vents are provided in the areas where the blow hole occurs so that the trapped air can escape.
Rusting	corrode and deteriorate	The components are dipped in a solution of Castrol ferrocate 5856 after the machining processes
ID groove miss	Improper machining or due to the lack of operators	Operators must carefully observe the process as it is an important part in the component.
Tool markings	It is caused due to the cutting and sliding of the tool with the surface of the work piece.	More amount of coolant must be used in order to eradicate the markings. It should be operated at high speeds.
Improper drill	It may be caused due to the wear and tear of the tool or the tool life would have descended.	Changing of drill bit and proper usage or supply of coolant.

	Also Due to insufficient feed	
Tool indexing	Wrong positioning of tool will damage the housing.	Tool has to be set accurately.
Operator skill	Due to absence of skill chances of accidents at operation station is more.	Operator should provide with sufficient training.
Mass rejection at final inspection	Due to ignorance of slight changes occurred. Due to not reworking the part or component which was showing a minute deviation at the earlier stages.	In process checking should be frequently done by the workers to ensure there are no high rejections at the final inspection.

7. RESULT

From the above data and studies done, it can be seen that the total number of rejections of an advance housing can be drastically reduced by controlling the occurrence of blow holes and rusting. Based on the above mentioned suggestions the number of defects and the different types of defects produced can be kept in control.

8. CONCLUSION

In this, we studied all the processes related to the manufacture of an AA housing or advance housing, noted the cycle time for each operation and also figured out the possible problems which are associated with the same. The data's were collected and several management tools were used so as to depict the rate of rejection and rejection as a whole by using pareto diagram, control chart, cause and effect diagram or Ishikawa diagram, scatter diagram and the why-why analysis. Finally the possible suggestions from our side were provided so that the numbers of rejections are controlled.

9. ACKNOWLEDGMENT

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