Root Cause Analysis Using Ishikawa Diagram For Reducing Radiator Rejection

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ABSTRACT
Manufacturing problems are very crucial, needs vigilant and immediate attention otherwise it damages to company's not only profit margins but also reputation. Quality Management includes quality assurance and control, is very necessary technique to maintain and continuously improve quality of product. Out of many techniques used to improve quality, reduce rejection, Ishikawa diagram is very well known and widely used. Ishikawa diagram is very useful to identify the probable causes of error or problem from different prospective. Our research is in radiator manufacturing, the Ishikawa diagram is used to identify various root causes for radiator rejection due to fin opening problem. After detailed study of radiator manufacturing process and data gathering for many problems which causes rejections, first problem chosen to embark upon was Fin opening because it contributed heavily around 7% to 8% of total production. The root causes identified as out come of Ishikawa diagrams implies that many causes behind rejections. To reduce the rejection related to fin opening, identified causes have to priorities and attended.

Key words: Ishikawa diagram, Fin opening Problem, Radiator manufacturing

1.INTRODUCTION

1.1 IMPORTANCE OF FISHBONE IN PRODUCT IMPROVEMENT:

Ishikawa diagrams also known as fishbone or cause & effect diagram, was invented by Kaoru Ishikawa in the 1960s, he is pioneered quality management processes. The design of the diagram is similar to the skeleton of a fish. The representation can be simple, through bevel line segments which lean on a horizontal axis. The root causes and sub-causes which produce the problem or defect are represented in that respective heads. The causes of problem or imperfection can be grouped into categories like Man (People), Machine, Material, Method and environment, represented in diagram as shown in fig.1. Sometimes these can be grouped into other two categories as well such as management and measurements but that depends on the purpose of use.

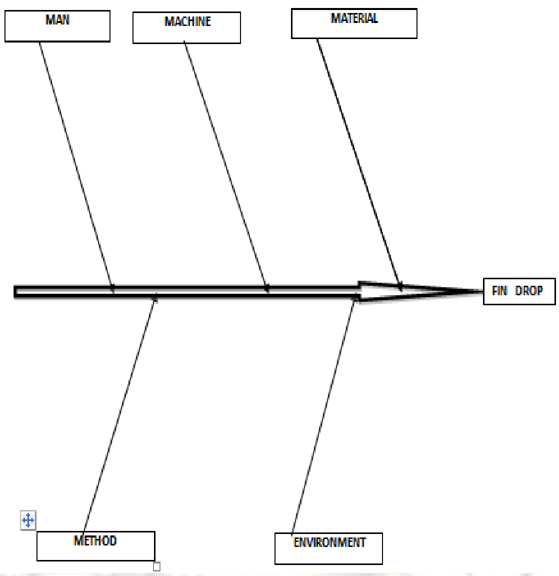

Fig.1 Layout of Fishbone Diagram

The Ishikawa diagram method becomes more powerful tool when it's used with brainstorming and cross functional team, which helps to identify causes of problem with different point of view. All root causes identified, then to be listed and consensus will finalize. Some times other tool like FMEA or Pareto may be used to priorities the various causes identified. The ultimate aim of the tool is to improvement. The Ishikawa diagram is such global tool and used in various industry segments like manufacturing, marketing, research, service, etc.

1.2 IMPORTANCE OF RADIATOR & DIFFERENT TYPES OF PROBLEMS:

The automobile radiator is exceptionally important as it not only cools the engine, but also other systems within the vehicle such as the automatic transmission system and the air conditioning system. If your radiator malfunctions, you risk having all the above-mentioned systems (as well as several other systems under your car's hood) failing at the same time due to overheating issues as the heat trapped within the systems are not transferred out effectively. Vehicle cooling system is one of most important system for internal-combustion engine proper functioning and safety. It provides that engine's working temperature is in permit limits and without breakdown components of car cooling system - radiator, it needs to reduce temperature in very short time and to prevent internal-combustion engine damage.

Fig. 2 – Radiator used in automobile - car

After studying different assembly and manufacturing processes in radiator manufacturing unit, it has been observed that many manufacturing issues contribute to the rejection online or final. Radiator are having problems related to fin opening like forming of fins are not proper, fins are not compressed properly and opened from both ends and others such as leakages from fin, rhombus problem, head plate leakage, improper brazing, etc.

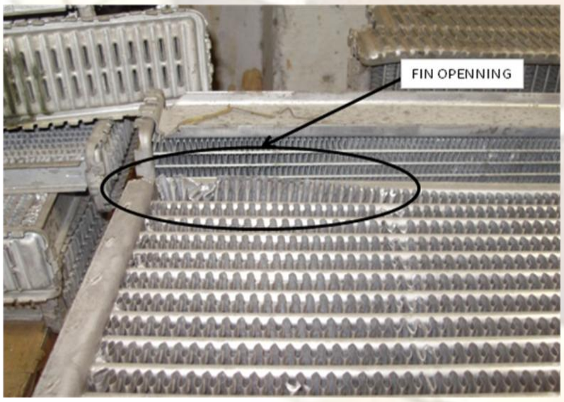

Fig. 3 - Fin Opening Problem

2. RADIATOR MANUFACTURING STUDY & ANALYSIS:

Radiator manufacturing, where three simultaneous processes are taking place namely fin making, core channel making, header plate making, assembly and brazing process follows the earlier processes. The process of manufacturing radiator comprise of 34 steps, starting from fin making to dispatch, as represented in below fig.4. Various symbols were used for graphical representation like operation, transport, storage, delay, etc to make process flow easy to understand. The fin making and brazing are the two very important process of radiator manufacturing. The process parameters for each processes has to be defined and validated mainly for brazing. Also different process checks are defined. Fin making process followed in plant is machine based but more dependent on skill set, especially core building process.

3. DATA ANALYSIS OF RADIATOR MANUFACTURING – REJECTION:

During the study and analysis of radiator manufacturing on floor, the various data had been collected related to rejection. The process had been monitored for six month and data for six month are collected in check sheet, namely Daily rejection report. The daily rejection report is outcome of the in process quality inspection, where daily inspection data are consolidated to monitor the different rejections. Common problems observed during six months along with percentage rejection are shown in table: 1. it is quite clear that problem of fin opening is in good amount and needs immediate attention. Other problems are also important but its contribution less to overall rejection. Also graphical comparison of various problems for six months is presented in Fig: 5 Rejection Analysis Graph.

The fig: 6 show the rejection analysis, comparison of fin opening rejection on monthly basis. The rejection pattern is directly proportional to the number of parts produced in month, in fact no trends is followed. Rejection remains between 7% & 8%, not increases or decreases with time. It means problem mostly remains with method followed, machine used or material used not related to environment.

Legend: ● Operation ⇨ Transportation ■ Inspection D Delay ▲ Storage

STEP	Operation	Transportation	Inspection	Delay	Storage	Description of Operation or Event	Evaluation and Analysis Methods
010	●					Receiving Material	Material Handling Instruction
020			■			Incoming Inspection	Process Instructions
030					▲	Material Storage in store	Material Handling Instruction
040		⇨				Fin Machine	Material Handling Instruction
050	●					Fin Forming	Process Instructions
060			■			Hourly inspection	Process Instructions
070		⇨				Transport in Core Assembly	Material Handling Instruction
080	●					Core Channel	Process Instructions
090	●					Cut Blank size for Core channel	Process Instructions
100			■			inspection	Inspection Instructions
110	●					Core Channel End cutting	Process Instructions
120		⇨				inspection	Inspection Instructions
130	●					Washing & Drying	Process Instructions
140		⇨				Transport parts to Core Assembly	Material Handling Instruction
150	●					Tube Cutting	Process Instructions
160			■			inspection	Inspection Instructions
170		⇨				Transport parts to Core Assembly	Material Handling Instruction
180	●					Core Assembly	Process Instructions
190		⇨				Transport parts to Barzing	Material Handling Instruction
200	●					Brazing	Material Handling Instruction
210	●					Degreesing at 270°c	Process Instructions
220	●					Wet Fluxing	Process Instructions
230	●					Drying 250°c	Process Instructions
240	●					Brazing Zone 1,2,3.	Process Instructions
250	●					Cooling	Process Instructions
260	●					visual inspection	Inspection Instructions
270		⇨				Transport parts to final assembly	Material Handling Instruction
280	●					Barzing welding at I / O Pipe	Process Instructions
290		⇨				Transport parts to Testing	Material Handling Instruction
300			■			inspection	Inspection Instructions
310	●					Packing Assembly	Process Instructions
320		⇨				Transport parts to Store	Material Handling Instruction
330					▲	Storage	Material Handling Instruction
340	●					Dipatch Product	Process Instructions

Fig: 4 Radiator Manufacturing Process flow

Month	FIN OPENING	RHOMBUS PROBLEM	FIN LEVEL PROBLEM	IMPROPER BRAZING	SCRAP
Jan-12	7.18%	3.27%	2.91%	0.70%	0.82%
Feb-12	7.76%	3.74%	2.97%	1.01%	0.81%
Mar-12	7.45%	2.96%	2.90%	0.88%	1.10%
Apr-12	8.11%	3.89%	2.89%	0.67%	0.97%
May-12	7.10%	3.04%	2.79%	0.34%	0.81%
Jun-12	7.62%	3.66%	2.91%	0.94%	0.82%

Table: 1 – Overall Rejection Data

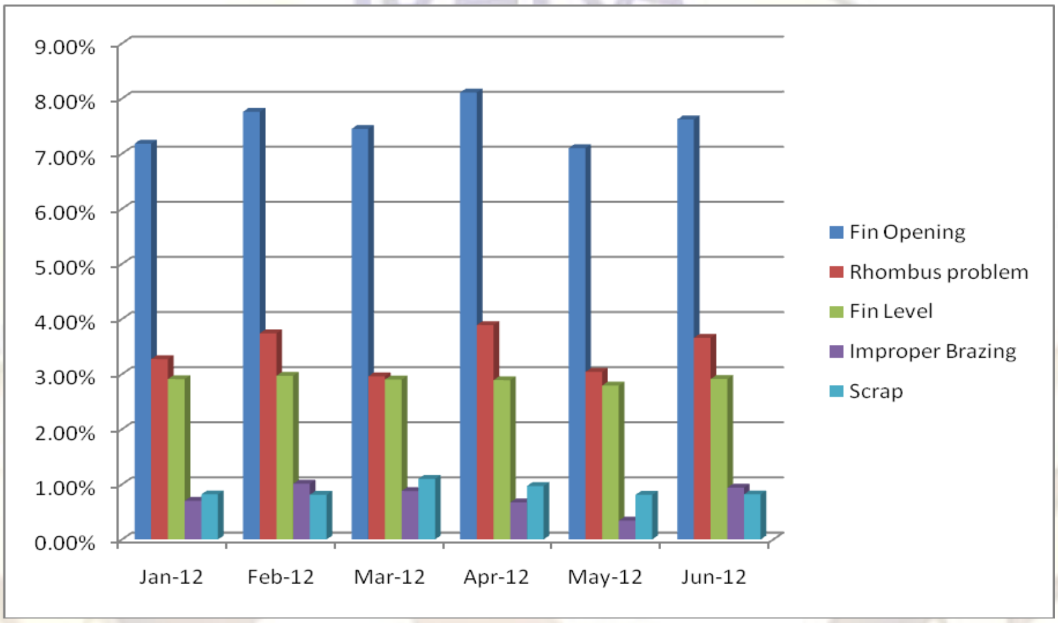

Fig: 5 Rejection Analysis Graph

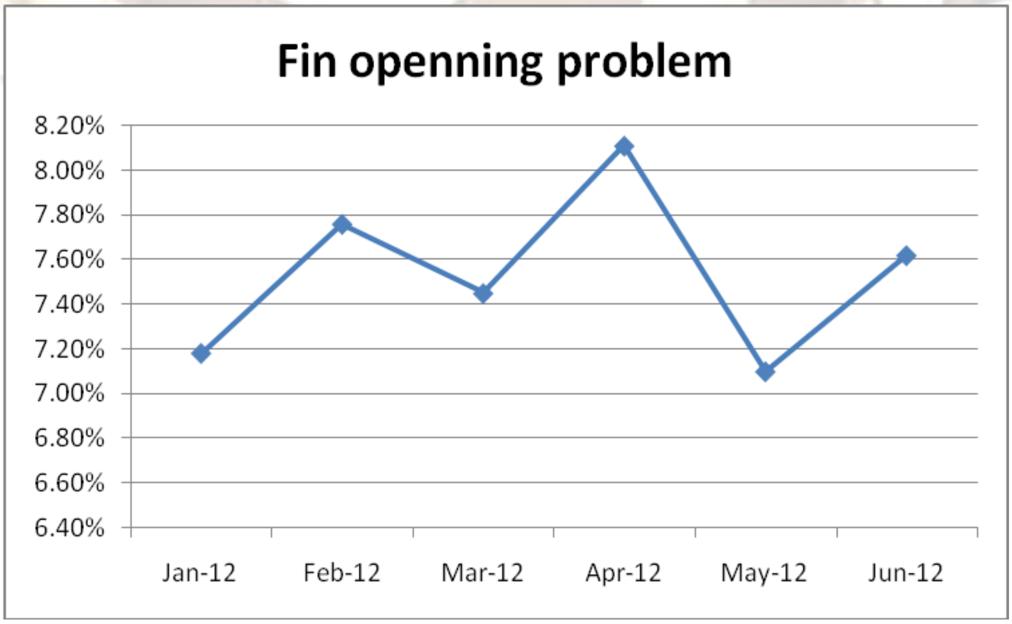

Fig: 6 – Fin Opening Rejection Analysis Graph

4. PROBLEM ANALYSIS THROUGH ISHIKAWA DIAGRAM

The fin opening problem had been area of concern along with others mentioned above. To identify the root causes of fin opening problem and to come to the accurate conclusion, systematic approach of Ishikawa diagram technique has been implemented. The different root causes are described in fig: 7 by Ishikawa diagram for fin opening problem. The causes are identified in relations to People, Machine, Material, Methods (Procedures) and Environment factors. The various reasons which can be contribute to the problem of fin opening are unskilled labor, lack of training ,attitude towards working can effect over all quality of work from manpower resource, there are also significant impact on machine power by improper clamping, wear due to non lubrication, reduction in efficiency due to depreciation etc.

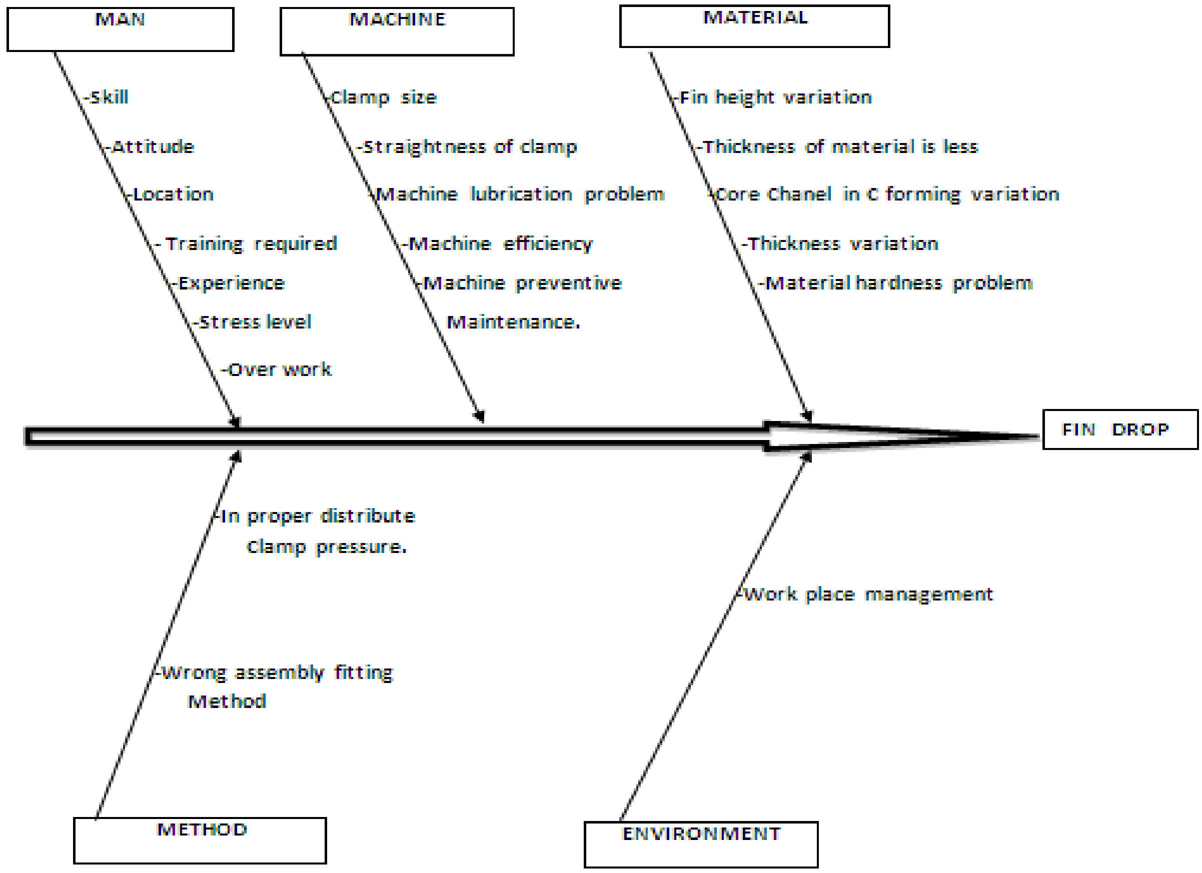

Fig: 7 – Ishikawa Diagram

Each causes itself must be a desirable or undesirable impact characterized by its effect produced so a special attention also given to material related causes like height variation in fin, uneven fin thickness, material hardening problem etc. Most of the times improper operating methods of assembly line also lead fin separation. Following root causes have been identified by Ishikawa diagram. The causes and their contribution to the problem are also calculated based on the experience and product knowledge.

SR	CAUSES	SUB CAUSES	CONTRIBUTION
1	**MAN**		
1.1		Skill	Medium
1.2		Attitude	Low
1.3		Location	Low
1.4		Training	Medium
1.5		Experience	Medium
1.6		Stress level	Medium
2	**MACHINE**		
2.1		Clamping size	High
2.2		Flatness of Clamping	High
2.3		Lubrication issue	Medium
2.4		Working Efficiency	High
2.5		Preventive maintenance	Medium
3	**MATERIAL**		
3.1		Thickness of material	High
3.2		Properties of material (i.e. Hardness)	High
3.3		Specification of material	High
3.4		Supplier of material	High
3.5		Defects in material	High
4	**METHOD**		
4.1		Uneven Pressure Distribution over clamping process	High
4.2		Wrong Assembly sequence	High
5	**ENVIRONMENT**		
5.1		Workplace Management	Low

Table: 02 – Prioritization of Root causes of Fin Opening Problem

5. CONCLUSION:

From the above application of Ishikawa diagram in the company with the help of available resources, many causes are contributing to the Fin problem. Ishikawa tool is very useful to the management for taking proper decision to solve the problem. Even focus on the causes related to machine needs to be strengthened, as it contribution to the problem is very critical. From the current analysis of fin opening problem, it seems major issues with the clamping device used in fin assembly area. However further technical methods may be applied to priorities the each cause which helps to solve the problem properly. The tools and techniques like Failure Mode Effect Analysis or Pareto Analysis, etc may be used to priorities. Prioritization must be followed by identification of solution and implementation of the same to reduce or omit problem from manufacturing.

REFERENCE

[1] The application of cause and effect diagram in the oil industry in Iran: The case of four liter oil canning process of Sepahan Oil Company. Masoud Hekmatpanah, International Journal on Industrial Engineering 2012

[2] Production part approval process - AIAG manual, fourth edition, effective June 1st 2006 copyright DaimlerChrysler Corporation, Ford Motor Company, General Motors Corporation.

[3] American Society for Quality, Fishbone diagram, http://www.asq.org/learn-about-quality/cause-analysistools/overview/fishbone.html

[4] Ishikawa, Kaoru (1986). Guide to Quality Control. Tokyo, Japan: Asian Productivity Organization