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Failure Mode Analysis for Reducing Breakdowns in Manufacturing Industry for Life Care Product

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ABSTRACT: This paper gives the possible usage of FMEA which means failure mode and effect analysis for increasing production in a manufacturing industry. Failure mode and effect analysis is the tools which is used to find the failure or faults in the machines of production industries. The possible failure mode occurrence and their prevention are discussed in this paper. Occurrence number, severity values, risk priority number and detection are some of the parameters listed in this paper which needs to be calculated. These parameters are considered at the time of manufacturing of the machine, so that it can be repaired and the life span can be calculated. With this method continuous improvement can be made in the machine or equipment. The failure mode and effect analysis technique is applied to automatic plastic welding machine which is used in production of plastic blood bag. The machine is located in life care manufacturing company. The suggestions given in this paper can increase the production and decrease the breakdown time.

KEYWORDS: failure Analysis, manufacturing, FMEA, Risk priority

I. INTRODUCTION

An important method and documentary for manufacturing industries, more over should be treated as live document to elaborate the problems in manufacturing machines. The procedure for FMEA is very simple and straightforward. This is calculated in the three main stages and action is taken according to the problem. Before going ahead with FMEA it is necessary to analysis the problem which had occurred in past history.

Failure mode analysis was developed in 1960s by the aviation industries for their security necessities. Failure mode analysis is a methodology to prevent the system from any major or minor problem before their occurrence. This analysis is conducted either in product design stage or in process stage depending on their circumstances. Upgrading security and expanding client fulfilment. Ideally, FMEA's would lead to the item plan or methodology in improvement stages, in spite of the fact that leading an FMEA for existing results or procedures might additionally yield reductions FMEA is a procedure that permits us to keep the system in working condition, Furthermore it can reduce the issues which had occurred in recent past years. It prioritizes activities that decline that danger from claiming to be failure.

FMEA analyses include.

- Possibility failure modes of item or machine.
- Possibility impacts about failure.
- Potential cause of failure (like material defects, plan deficiencies, transforming and manufacturing deficiencies)
- Assesses current methodology controls, and Determines risk priority factor.

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II. LITERATURE REVIEW

From past many years it has been observed that scientists had carried out many research and implemented in the industries. But still many changes and advancements has to done with present scenario. So that to overcome the present trend challenges in design and manufacturing. U.S based Grumman co. developed FMCA in the year 1950s for jet plains. Ford motors introduced FMCA in their research and development department to increase their production. FMCA is sub divided into two different parts i.e. design FMCA and process FMCA. In design FMCA foreseeable failure modes are identified and they are ranked according to their impact. Process FMCA is used to identify the potential process failure and ranking is given to each impact according to their internal and external (Customer) effect impact. FMCA implementation will be help full in identifying assembly cause or potential manufacturing in order to reduce the machine failure and to detect the problem. It detects the potential defects in product which is related to failure mode. This method is used to reduce the cause of failure. FMCA is considered as an important method and documentary for manufacturing industries, more over should be treated as live document to details the problems in manufacturing machines. The procedure for FMCA is very simple and straightforward. This is calculated in the three main stage and action us taken according to the problem. Before going ahead with FCMA it is necessary to analysis the problem which had occurred in past history. The procedure to conduct FMCA is given below.

A. Severity

It is defined as the severe failure in the product. The end user is either the next process engineer or the customer. Engineers must focus on each and every failure modes dependent upon the practical prerequisites and Furthermore their impacts. A sample table for severity is given below.

Classification	Example	Code
Dangerous very high	Death or Injury	10
Extremely high	Noncompliance regulatory	9
Very high	In effective treatment	8
High	High customer dissatisfaction	7
Moderate	Potential ineffectiveness	6
Low	Complaints by costumer	5
Very low	Less effectiveness	4
Minor	A nonsense to the customer	3
Very minor	minor effect not apparent	2
None	No effect not apparent	1

B. Occurrence

Occurrence is the chance in which a particular failure will occur. The occurrence cause of failure is identified and its occurrence rate, by observing identical processes and products .The failure mode can be recorded. By looking upon the design weakness failure caused is recorded. The following table gives a clear idea about the occurrence rating.

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Classification	Example	Code
Unavoidable failure	Very high	10 9
Repeated failure	High	8 7
Periodically failure	Moderate	6 5
Less failure	Low	3 2
Unlikely failure	Remote	1

C. Detection

Detection is a methodology of identifying the potential weakness or failure mode before the failure of the equipment in the manufacturing industry. This will reduce the breakdown or shutdown time of manufacturing industries. Ranking in detection is depends on the prevention failure mode. The tables explains the ranking system in the detection

Detection	Criteria	Rank
Extremely likely	This can be modified and corrected before the prototype	1
Very high likelihood	This can be corrected before the design release	2
High likelihood	This has very high possibility of detection	3
Moderate high likelihood	This effects the design at moderate level	4
Medium likelihood	This affect can change the working	5
Moderately low likelihood	This can miss the design control problem	6
Low likelihood	In this design controls are very common to miss the problem.	7
Very low likelihood	Design control has very less chance of correction	8
Very low likelihood	Very poor chance of detection	9
Extremely unlikely	No control will be effected by this	10

D. Risk Priority Numbers (RPN)

Risk priority number is given according to severity of the problem. It is calculated by multiplying severity*occurrence*detection which is scaled from 1 to 1000.

RPN is the pointer for those deciding best possible restorative activity on the failure modes. After choosing the severity, event and identification numbers, those RPN might make effectively computed toward multiplying these 3 numbers:

$$RPN = \text{severity} \times \text{event} \times \text{identification}$$

Smaller number is RPN is better than the larger number. RPN is calculated while is the design stage or in process stage. Once the RPN is calculated the high priority failure zone is known and the FMCA analysis is performed.

Below figure shows the flow chart of FMEA process

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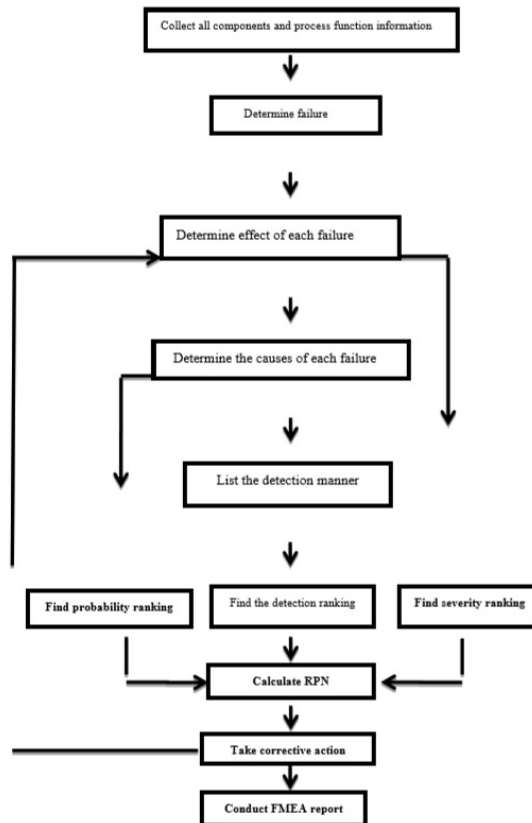


Figure 1 Flow chart FMEA procedure

III. CASE STUDY AND FMEA IMPLEMENTATION

FMCA application is conducted on automated plastic machine. It manufactures blood bags plastic covers. 12000 bags are manufactured per shift by the robotic arms of machine. For calculation past three years parameters are considered. Previous three years maintenance history is considered to calculate the FMEA.

Sample calculations of automated plastic machine is

Potential failure of the stripping the process is identified.

Failure effect is identified. Because of the stripping units industries had appointed extra agencies workers which led extra capital to the industry.

Through the table, the values of occurrence, severity and detection values are calculated. The values are 8, 4 and 5 respectively.

$$RPN = S * O * D$$

Where severity(S) is 4, occurrence(O) is 8 and detection(D) is 5

Therefore RPN number is 16

Ranking of Severity of Effect

Ranking for severity of effect is shown in a table. Table 4Severity of Effect Criteria: Severity of effect Ranking

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a. Hazardous without warning

Criteria severity effects	Rank	Effects
May endanger the machine operator or machine.	10	Dangerous and hazardous without warning
May endanger the machine operator or machine. This has very high severity chances or warnings	9	Dangerous and hazardous without warning
Major problem in production sector or line. This will effect production and damage product is manufactured. Might result in rejection of final project	8	Very High
Minor problem in the production line, defects can be sorted by external sources.	7	High
Minor defects and only small portion of product is scrapped. This doesn't include sorting	6	Medium
Defects can be corrected by reworking. This has small production line defects	5	Low
Minor defects and are noticed by the customer. It can be sorted out and rework	4	Very low
Very less defects in production line. Some rework has to be made in production line.	3	Minor
Very minor defects in production line. Rework should be done out of station in line. Defects are noted by discriminating customer	2	Very minor
No effect	1	None

b. Possible failure rate ranking

Possible failure rate	Ranking	Possibility of failure
Less than one in four and two in five	10	Very high
	9	
One in seven and one in eight	8	Moderate
	7	
One in ten and one in twelve	6	Low
	5	
One in twenty and one in thirty four	4	Very low
	3	
One in fifty and greater than one in fifty	2	Remote
	1	

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c. Ranking of detection

Criteria	Ranking	Detection
Nothing is available	10	Not possible at all
Very less likelihood, current control can detect the problems	9	Very remote
Remote likelihood. The defects are detected by the current control	8	Remote
Very less likelihood and current can detect the problem	7	Very low
Low likelihood and current can detect the failure	6	Low
Medium defects and current can identify the failure	5	Moderate
Medium defects and current can identify the failure mode	4	Moderately high
High chances of defects and current can identify the failure	3	High
Very high defects and current can detect the failure mode	2	Very high
Current controls are enough to detect the failure mode	1	Almost certain

d. Risk Priority Numbers The risk priority numbers of different processes are found out. The RPN of different process are shown in the following bar chart

S no	Process function necessity	Potential failure mode	Recommended action	Potential effect of failure mode	Action taken	Occurrence	Severity	Detection	RPN
1	Electrical power/ electrical supply for all components and substations which is required for smooth and regular functioning	It fails to meet the expectations and requirements of the system	Strengthen and repairing the electrical section	External and internal	Problem is identified and solved by supplying electricity by internal source	4	8	1	32
2	Stripping of blood bag	It fails to reach the subsequent operation	Vacuum cables are replaced	Internal	Failed or damaged cables are replaced	8	4	5	160
3	Delivering connection to bags-port delivery	It fails to reach the subsequent operation	Suction pressure of port delivery units are corrected	External	Correction is done in suction pressure	5	8	1	40

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4	Monitoring and regulating current-current indication	It fails to reach the complete process requirement	Ammeter is replaced or repaired	External and internal	Replacement of ammeter	4	8	1	32
5	Monitoring and regulating the cooling water to the sealing unit-cooling water indication	It fails to reach the complete process requirement	Replacement or repair	External and internal	Repaired	4	8		32
6	Software coordinates and control all functions	It fails to reach the complete process requirement	Ask for support from the supplier online	External and internal	Correction is made by correcting the errors by means of online support	6	9	1	54
7	Deliver high frequency current to the supply machine-welding RF generator	It fails to reach the complete process requirement	Replacement or repair	External and internal	Repaired	1	9	5	45
8	Transferred port is supplied to the delivering port-robotic arm which is out of sync	It fails to reach the subsequent operation	Alignments are corrected	Internal	Alignments are modified, corrected by the external sources	1	9	9	81
9	Initial or primary sealing of blood bags-side seal	It fails to reach the subsequent operation	Sealing unit is repaired	Internal	Sealing unit is repaired	4	8	1	32
10	Pic up area, and drop at welding unit-sheet pic up	It fails to reach the subsequent operation	Check the sheet quality and vacuum pic up pressure	Internal	Correction is made in sheet pic up pressure	4	8	1	32

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	section								
11	It is support to the sheets which is feed into the machine-holding pin for sheets	It fails to reach the subsequent operation	Repair	Internal	Repaired	4	8	1	32
12	Pressure indication at each station-pressure sensors	It fails to reach the complete process requirement	Replacement or repair	External and internal	Repaired	1	8	2	16
13	Cutting the sheets with respect to their dimensions- sheet cutting head	It fails to reach the subsequent operation	Replacement or repair	Internal	Repaired	1	8	2	16

e. RPN is founded out and graph is plotted according to the values

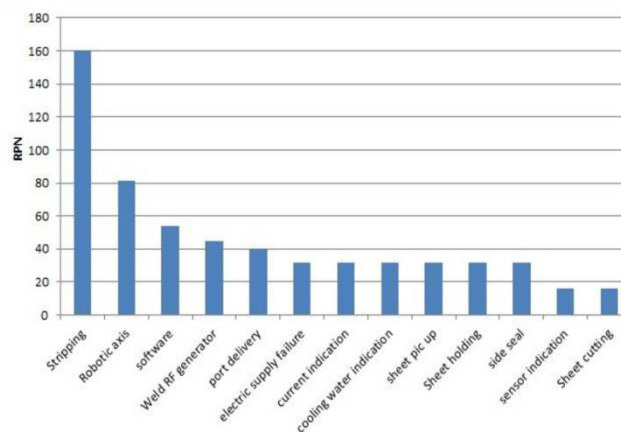


Figure 2 RPN Chart

IV. RESULTS

Stripping process has the higher value of Risk priority number. In-depth and detail analysis is done to reduce the failure mode. While preventive maintenance proper care should be done to stripping unit. To detect the problem easily, training should be arranged to the engineering professionals. Misalignment of robotic arm has a direct effect on sheet delivering process. Detection of problem is very difficult and had dangerous hazards so its RPN value is considered as severity. To reduce the RPN value proper awareness and training should be given to the employees. RPN has many

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software errors and it is due to high severity and number of occurrence. To reduce the errors online support should be used which is provide by the supplier

V. CONCLUSION

This paper deals with the conducting FMCA on automated plastic welding machine. Failure mode are identifies and basic manufacturing process is shown. Potential effects of failure mode are calculated according to their severity with the occurrence value. The value which is detected is assigned to the failure mode and further the RPN value is calculated. To reduce the failure and downtime of the machine FMCA method is used.

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