IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X,
PP 21-26
www.iosrjournals.org

Fmea Analysis of Grinding Defects

VISHAL K R [1] Assoc. Prof P PBinu[2]
P G scholar, Associate Professor
vkrme59@gmail.com, rajibinu.sngce@gmail.com
See Narayana Gurukulam College Of Engineering, Kadayiruppu, Kerala, India

Abstract: *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.In order to evaluate &optimize the manufacturing process rejection analysis must focus on the entire machining process. This helps designer to find identify the problems in advance and take necessary action before the failure of the component. Various problems in internal and external grinding are identified and studied using data from industrial familiarisation and their effect on the system are also studied. Various factors like Severity, Occurrence, Detection and Risk priority values are assigned to each problem and analysis is carried out.*
Keyword: *Failure mode and effect analysis, Risk priority number, Potential effect of failure, Failure analysis.*

I. Introduction

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. It is used to produce fine finished component and those with very accurate dimensions. Grinding operation can be considered as a subset of cutting operation where each wheel in grinding wheel acts as a single point cutting tool. The common types of grinding are surface grinding and cylindrical grinding. Here for analysis purpose we consider only cylindrical grinding (ie both inside and outside diameter grinding).

II. Methodology

3.1 FMEA

A failure modes and effects analysis (FMEA) is a process by which the identification and the evaluation of process is done for classification by activity which helps to identify potential failures and then prioritizing with the minimum of effort and costs. Failure modes are faults that affect the intended function or actual. An effect analysis refers to principle of FMEA is to resolve increasing customer satisfaction.

FMEA was first. Later, various groups and departments of NASA used FMEA principles under variety of names in mid 1950s and 1960s. Ford Motor Company published instruction manuals for FMEA in the 1980s and the automotive industry collectively developed standards in the 1990s. Engineers in a variety of industries have adopted and adapted the tool over the years.

3.2 Failure Analysis Techniques

Various techniques are used to identify the mode of failure of a part or component. Following are some of the major techniques

3.2.1 Field inspection

The most useful and primary approach is to inspect the failure on site as soon as the failure has occurred. This visit should be documented in detail with photographs and should also contain insights from the various personnel involved in operation and maintenance of the component. If possible the failed component should be brought back to laboratory for more detailed study,

3.2.2 Macroscopic examination

This type of examination is done at a magnified scale of 1x to 100x range. The main purpose of this is to observe the gross features of the fracture and presence or absence of cracks, defects, corrosion or oxidation. Working at such magnification it should be possible to make an initial assessment of the origin of fracture and other defects and thus narrow down the region of the fracture for further study at higher magnification.

3.2.3 Microscopic Examination

This type of examination is made at a magnification greater than 100x for microstructure analysis. To achieve such magnification we need instruments like Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), X-ray microprobe analyzer and so on. Microstructure analysis is essential because it helps to identify important features like grain size, inclusion size, crack growth, arrangement of phases and so on and give a better understanding of the microstructure and the cause of failure.

3.3 Steps to conduct a FMEA

3.3.1 Review the grinding process

Here in this step all components of grinding defects are identified and studied.

3.3.2 Brainstorm potential failure modes

The supervisors and skilled foreman in industry are interviewed and potential failure reasons for grinding operation are identified. Also all available training manuals and other documents are referred and failure reasons are noted down.

3.3.3 Listing potential failure effects

The data relating to potential effects of the failure modes identified in earlier step are collected from manuals, supervisors and foreman. Mainly four effects are chosen for analysis

Size variation
Ovality and out of roundness
Grinding marks
Cracks

3.3.4 Assign Severity ratings

Assign a severity ranking to each effect that has been identified. The severity ranking is an estimate of how serious an effect would be should it occur. To determine the severity, consider the impact the effect would have on the customer, on downstream operations, or on the employees operating the process. The severity ranking is based on a relative scale ranging from 1 to 10.

Table 1. Severity and corresponding ranks of failures

Rank	Effect	Rank	Effect
1	None	6	Severe
2	Very Slight	7	High Severity
3	Slight	8	Very High Severity
4	Minor	9	Extreme Severity
5	Moderate	10	Maximum Severity

3.3.5 Assign Occurrence ratings

Determine the failure's probability of occurrence. Assign an occurrence ranking to each of those causes or failure mechanisms. The occurrence ranking is based on the likelihood or frequency, that the cause (or mechanism of failure) will occur. The occurrence ranking scale, like the severity ranking, is on a relative scale from 1 to 10 as shown in Table.

Table2. Likely occurrences of failures and corresponding ranking

Rank		Occurrence	Rank	Occurrence
1		Extremely Unlikely	6	Medium likelihood
2		Remote Likelihood	7	Moderately high likelihood
3		Very Low Likelihood	8	Very High Likelihood
4		Low Likelihood	9	Extreme Likelihood
5		Moderately Low Likelihood	10	Maximum Likelihood

3.3.6 Assign detection rating

To assign detection rankings, identify the process or products related controls in place for each failure mode and then assign a detection ranking to each control. Detection rankings evaluate the current process controls in place. The Detection ranking scale, like the Severity and Occurrence scales, is on a relative scale from 1 to 10.

Table 3. Likely detection of failures and corresponding ranking

Rank	Occurrence	Rank	Occurrence
1	Extremely Likely	6	Moderately Low Likelihood
2	Very High Likelihood	7	Low Likelihood
3	High Likelihood	8	Very Low Likelihood
4	Moderately High Likelihood	9	Remote Likelihood
5	Medium likelihood	10	Extremely Unlikely

Data collected for assigning all above rankings

Size variation

Lot no.	Processing size (mm)	Total no of pieces	No of good pieces	No of bad pieces
1	.1	20	12	7 rejected (previous machine variation-4, grinding wheel quality-3) 1 reworked (Grinding wheel quality)
2	.3	20	11	6 rejected(previous machine variation-3, grinding wheel quality-3) 3 reworked (previous machine variation)
3	.5	20	13	5 rejected (outer diameter variation) 2 reworked (outer diameter variation)

Ovality and out of roundness

Lot no.	Processing size (mm)	Total no of pieces	No of good pieces	No of bad pieces
1	.1	20	14	4 rejected (mounting problem 2 , mismatch of wheel and workpiece 2) 2 reworked (mismatch of wheel and workpiece)
2	.3	20	15	3 rejected(wheel spindle not in center) 2 reworked (wheel spindle not in center)
3	.5	20	13	5 rejected (mismatch 3, mounting problem 2) 2 reworked (mounting problem)

Grinding marks

Lot no.	Processing size (mm)	Total no of pieces	No of good pieces	No of bad pieces
1	.1	20	16	2 rejected (coolant problem 1, grinding wheel speed 1) 2 reworked (grinding wheel speed)
2	.3	20	15	3 rejected(grinding wheel speed 3) 2 reworked (coolant problem 2)
3	.5	20	14	3 rejected (grinding wheel problem) 3 reworked (grinding wheel problem)

Cracks

Lot no.	Processing size (mm)	Total no of pieces	No of good pieces	No of bad pieces
1	.1	20	13	4 rejected (improper heat treatment2 , improper dressing 2) 3 reworked (improper heat treatment)
2	.3	20	11	6 rejected(high feed rate 3,improper dressing 3) 3 reworked (high feed rate)
3	.5	20	12	6 rejected (improper dressing) 2 reworked (improper dressing)

3.3.7 Calculate RPN

The RPN is the Risk Priority Number. The RPN gives us a relative risk ranking. The RPN is calculated by multiplying the three rankings together. Multiply the Severity ranking times the Occurrence ranking times the Detection ranking. For example,

Risk Priority Number (RPN) = (Severity) X (Occurrence) X (Detection)

Calculate the RPN for each failure mode and the corresponding effect. RPN will always be between 1 and 1000. The higher the RPN, the higher will be the relative risk. The RPN gives us an excellent way to prioritize focused improvement efforts.

Operation No	Process Description	Potential Failure Mode	Potential Effect of Failure	SEV	Potential Causes	OCC	Current Control Prevention	Current Control Detection	DET	RPN
1	Internal and external Diameter Grinding	Diameter	Size Variation	8	Previous machine variation	6	CNC inspection	In process Inspection	4	192
					Poor Grinding Wheel Quality	6	CNC inspection	In process Inspection	4	192
					Outer Diameter size variation	3	Process Drawing work instruction, First piece Instruction	100% inspection	3	72
		Concentration variation	Ovality & Out of Roundness	7	Improper mounting And clamping system	6	machine Specification details	100% inspection	3	126
					Miss match of wheel and workpiece race	6	CNC inspection	In process Inspection	4	168
					Wheel spindle not in center	3	CNC inspection	In process Inspection	4	84
		Surface Roughness	Grinding Marks	6	Coolant Problem	6	Temperature Sensor	Temperatur eSensor	5	180

					High Grinding wheel R.P.M.	9	CNC inspection	In process Inspection	4	216
		Surface Roughness	Cracks	8	Excessive Feed Rate	3	CNC inspection	In process Inspection	4	96
					Improper dressing	6	Tool and work piece material Inspection	In process Inspection	4	192
					Improper Heat treatment	3	Material hardness testing	In process Inspection	7	168

3.3.8 Develop an action plan to address high RPN's

Develop an action plan by which reduction in the RPN. The RPN can be reduced by lowering any of the three rankings (severity, occurrence, or detection) individually or in combination with one another. However this step and the following steps were not conducted due to security issues in the industry.

3.3.9 Take action

The action plan outlines what steps are needed to implement the solution, who will do them, and when they will be completed. Responsibilities and target completion dates for specific actions to be taken are identified. All recommended actions must have a person assigned responsibility for completion of the action. There must be a completion date accompanying each recommended action. Unless the failure mode has been eliminated, severity should not change. Occurrence may or may not be lowered based upon the results of actions. Detection may or may not be lowered based upon the results of actions. If severity, occurrence or detection ratings are not improved, additional recommended actions must to be defined.

3.3.9 Re-evaluate the RPN after the actions are completed

This step is to confirm the action plan had the desired results by calculating the resulting RPN. To recalculate the RPN, reassess the severity, occurrence, and detection rankings for the failure modes after the action plan has been completed.

III. Results and Discussion

The results of FMEA study where

Table 5.

EFFECT OF FAILURE	POTENTIAL CAUSE	RPN
Size variation	Previous machine variation	192
	Poor grinding wheel quality	192
Ovality and out of roundness	Miss match and clamping system	168
Grinding marks	High grinding wheel RPM	216
Cracks	Improper dressing	168

IV. Conclusion

FMEA documents potential failure modes and potential effects for future use in the industry. It has a systematic approach in failure, detection and possible impact on the process. This improves setup time and increase quality of the product. This method is a continuous improvement technique which can applied to improve the efficiency of manufacturing process.The FMEA was successfully carried out and the results obtained where studied. Suitable suggestions to avoid the critical problems where suggested

Reference

[1]. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 2000.
[2]. 2.Rakesh R[1], Jos BC [2], Mathew G[2]; FMEA analysis for reducing breakdowns of a sub system in the life care product manufacturing industry. International Journal of Engineering Science and Innovative Technology.2010.
[3]. http://www.qualitytrainingportal.com/resources/fmea/fmea_10step_pfmea.html
[4]. http://textofvideo.nptel.iitm.ac.in/
[5]. Namdari M [1], RafieeSh[2].,Jafari A [2]; Using the FMEA method to optimize fuel consumption in tillage by moldboardplow. International Journal of Applied Engineering Research, 2011
[6]. 6.Prajapati DR [1];Sidhardh G[2]:Application of FMEA in Casting Industries: A case study. UdyogPragati, 2011