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A Study On The Casting Defectsof Printing Machine Cylinder Using Failure Mode Effective Analysis

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Abstract: *Printing press is one of the main products of HMT Ltd, Kalmassery. A printing press is a mechanical device for applying pressure to an inked surface resting upon a medium (such as paper or cloth), thereby transferring an image. The main component of this machine is the press cylinders. These cylinders are manufactured in the casting section in HMT. Nowadays they are producing according to the order received. The production is less in number compared to earlier period.*
Nowadays the defects during the casting of press cylinder are high in such a way that if 10 cylinders are casted 5 of them are rejected. Because of this, rework of the cylinders required and thereby the production cost is increased. This study deals with the casting defects in offset printing press cylinder by failure mode effective analysis and suggesting the remedies for these issues.
Key words: *FMEA, Cause and Effect diagram, Check list.*

I. Introduction

Casting can negatively impact the productivity of a foundry. At the simplest level, they manifest as rework costs or casting scrap costs. However in many cases, the casting defects may bediscovered at the machining stage, at the assembly stage or during the functioning of the component. Foundry personnel may not have the time to conduct a detailed casting analysis to prevent reoccurrence of these defects. The purpose of this case study is to outline a systematic approach, which when combined with various teams and headed by an appropriate trained quality engineer can produce excellent result in reduction of casting defects.

II. Literature Review

Aniruddha Joshi, L.M.Jugulkarhave used the quality control tools to investigate and analyse the casting defects like Mold shifting, Crushing, Lower Surface finish, Shrinkage, Porosity, Cold shut during manual operation. They formulated the cause and effect diagram for each defect. They show the data regarding operations of manual metal casting and also the defects which cause the rejection of products. They analyse these defects with the help of pareto chart and cuase and effect diagram to find the actual cause and to take the remedial actions to improve the quality of the organization.

PrasanKinagi and Dr. R.G Mench have optimized the process parameters of the casting defects like cold shut and blow holes. They used combined design of experiment and FMEA analysis to analyse the casting defect. The defect analysis is done by FMEA tool and pareto analysis is done to find out the potential cause of the defects. And they use the DOE method by Taguchi method to optimize the process parameters of the sand casting. For this purpose they use

L9 orthogonal was used for the analysis. After the analysis they found out the remedial actions to reduce the defect and improve quality.

Piyush Kumar Pareek, Trupti V Nandikolmath and Praveen Gowda have done identification of failures which causes the rejection of bushes in the foundry. They use FMEA tool to improve product quality and operational performance process. They identified the various stages of core making in the foundry and analysed using RPN (Risk Priority Number) to rank the causes of failure. They considered the monetary loss of core rejection as a risk. After implementing the FMEA tool in the foundry, the reduced the loss as they required.

Vaibhav. S. Kamble and T.Z Quazi used the FMAE tool for process development and improvement and it is implemented in a foundry to find out the major failure modes. And they used the AHP tool to prioritize the critical operations for the action. They took some suggestions and implemented it for two months. After that they revised the effect of implementation of actions and it revealed that the actions improved the process.

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III. Methodology

The method presented in this study is Failure Mode Effective Analysis(FMEA). Failure mode and effect analysis is a methodology for analysing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effect on the operation of the product and Identify actions to mitigate the failure.A crucial step is anticipating what might go wrong with a product. Anticipating every failure mode is not possible, so one should formulate an extensive list of potential failure modes as possible. FMEA is also a proactive process used to look more carefully and systematically at vulnerable area of process and provide special control to those critical areas.

Basically there are two types of FMEA

a. Process type:- Deals with failure mode occurring due to process.
b. Design type:- Deals with failure mode due to design.

Here using the process type FMEA. The major benefit of a FMEA study is from the standpoint of quality and reliability of the process and provides a logical, structural method to identify process areas of control. FMEA considerably reduces the time spent considering potential problem with process and design concept and keep crucial elements of the process under check. Documentation and tracking risk reduction activities is another added advantage of FMEA. It also provides historical failure and service records to maintenance department which aids their activities such as planning and scheduling.

Steps involved in FMEA areIdentification of major defects, Cause and effect diagram of each defect, Process type FMEA worksheet, Document the analysis and summarize the major causes, Identification of critical process parameters, Evaluation of critical process parameter and Follow up plan.

IV. Analysis

Initially the defects which are occurring during the different casting stages printing machine cylinders are identified. The defects include blowhole, porosity, sand inclusion and crack. After the identification of these defects that cause and effect diagram of each defects are formulated.

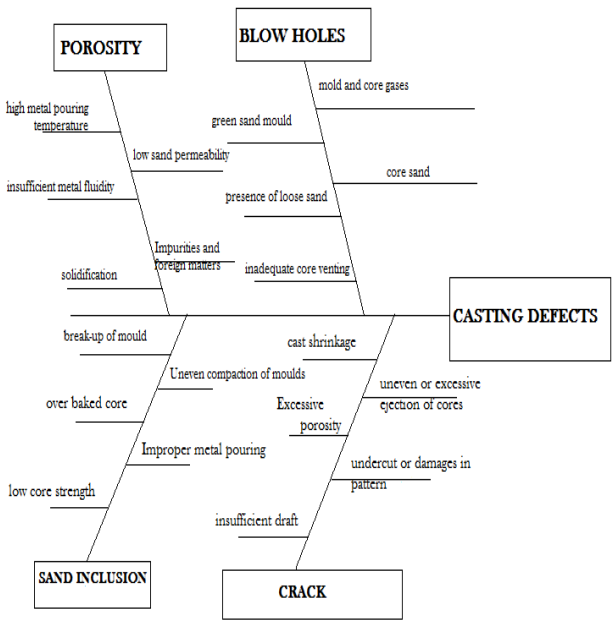

Fig 1. Cause and effect diagram of casting defects.

4.1 Process Fmea Worksheet

From the cause and effect diagram, it can be seen that the causes of the defects from the different stages of the casting. As per the cause and effect identified from the cause and effect diagram as mentioned above and as a part of the FMEA the defects are ranked according to the severity, occurrence and detection.

Table 1. Ranking Characteristics Of Detection Of Defects In Process Fmea

SCALE	DETECTION
10	Absolutely impossible to be detected
9	Very remote likelihood
8	Remote likelihood
7	Very low likelihood
6	Low likelihood to be detected
5	Moderate likelihood
4	Moderately high likelihood
3	High likelihood to be detected
2	Very high likelihood
1	Current inspection certain to detect

Table 2: Ranking Characteristics Of Severity Of Defects In Process Fmea

SCALE	SEVERITY
10	HAZARDOUS: without warning
9	HAZARDOUS: with warning
8	VERY HIGH: product to be scrapped
7	HIGH: product likely to be scrapped
6	MODERATE: Product may be scrapped or salvaged
5	LOW: Product likely to be salvaged
4	VERY LOW: product can be salvaged
3	MINOR: Product can reworked in process stage
2	VERY MINOR: No effect on primary function
1	NO EFFECT AT ALL

Table 3: Ranking Characteristics Of Occurrence Of Defects In Process Fmea

SCALE	OCCURENCE
10	MAXIMUM LIKELIHOOD
9	EXTREME LIKELIHOOD
8	VERY HIGH LIKELIHOOD
7	MODERATELY HIGH LIKELIHOOD
6	MEDIUM LIKELIHOOD
5	MODERATELY LOW LIKELIHOOD
4	LOW LIKELIHOOD
3	VERY LOW LIKELIHOOD
2	REMOTE LIKELIHOOD
1	EXTREMETLY LIKELIHOOD

Table 4.Process Fmea Worksheet Of Blowholes

POTENTIAL FAILURE MODE	POTENTIAL FAILURE EFFECT	POTENTIAL FAILURE CAUSES	O	S	D	RPN	ACTIONS
Blowholes	1.Surface imperfections 2.causes damage to bush 3.clotting of ink causing poor printing	1. insufficient permeability of moulding and core sand 2. Mould and core gases 3. high moisture content 4. insufficient venting 5. too high pouring temperature	7	5	7	245	1. Check pouring temperature 2. Check permeability and strength of moulding 3. Check moisture content 4. Reduce impurities in sand 5. Increase number of vents

Table 5.Process Fmea Worksheet Porosity

POTENTIAL FAILURE MODE	POTENTIAL FAILURE EFFECT	CAUSES	O	S	D	RPN	ACTIONS
Porosity	1.show a series of fine holes during machining 2.lacks pressure tightness	1.wrong metal composition 2.High metal pouring temperature 3. Low sand permeability 4.Improper cooling rate 5. Impurities and foreign matters	4	6	4	96	1. Scavenge the molten metal before pouring 2. Check silicon and phosphorous content 3. Use proper risers 4. Improve venting of mould

Table 6.Process Fmea Worksheet Of Sand Inclusion

POTENTIAL FAILURE MODE	POTENTIAL FAILURE EFFECT	POTENTIAL FAILURE CAUSES	O	S	D	RPN	ACTIONS
sand	1.surface imperfection 2.rusting due to deposition of ink 3.poor printing	1.low sand strength 2.loose ramming 3.improper cleaning 4.Over baked cores 5.high slag content 6.Low core strength	8	4	5	160	1. Careful pouring of molten metal 2. Removal of slag 3. Check sulphur content 4. Cleaning of mould 5. Proper ramming

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Table 7.Process Fmea Worksheet Of Crack

POTENTIAL FAILURE MODE	POTENTIAL FAILURE EFFECT	POTENTIAL FAILURE CAUSES	O	S	D	RPN	ACTIONS
crack	1.poor fatigue strength 2.poor printing due to clotting of ink	1. Cast shrinkage 2. Uneven or excessive force of ejection 3.Excessive porosity 4. Insufficient draft 5. Undercut or damages in the pattern	4	4	5	80	1. Check the strength of cores 2. Check the contraction allowance provided in the pattern 3. Provide correctly designed necks to the risers 4. Allow casting to cool sufficiently prior to knockout

Table 8. Casting Defect Ranking

Rank	Defect	RPN
1	BLOWHOLES	240
2	SAND	168
3	POROSITY	96
4	CRACK	90

V. Result And Discussion

As per the RPN (Risk Priority Number) the table shows the major risk is from the blowhole defect and then sand and porosity defects comes just below that. And crack ranks at last. ie., the risk of crack is very minor. The risk of the blowholes, sand and porosity should be minimized. To reduce the risk of these defects, the detection and occurrence should be reduced. Detection can be reduced by periodic or regular inspections.
The main causes of defects are attributed to three reasons.

a. Defects due to properties of sand- the low permeability and high moisture content results in blowholes, porosity and pinholes. The expansion properties of sand cause shift. The low green strength of the sand results in sand drops. The mould created using porous sand cause chance to the cast part having rough surface.
b. Defects due to moulding practice- during the moulding process the excessive moisture content, low permeability, hard ramming and improper venting results in blowholes. The sand ramming should be hard and uniform. Soft ramming and causes the defect like sand inclusion. The turbulent molten metal flow through the gating system causes the sand inclusions.
c. Defects due to poor melting practice- during the melting process the gases like hydrogen, oxygen and nitrogen will dissolved in the molten metal and it decreases below a particular temperature. These gases will cause the defects like blowholes and porosity. Hydrogen causes high trouble and sulphur makes the material too hard to machine.

VI. Conclusion

This paper covered a detailed study of casting defects occurring during the casting of printing machine cylinder. The FMEA analysis is used for the detailed study of the casting defects and its causes. And several remedies for reducing or avoiding the defects are suggested. This study thus provides the basis of action plans that can be taken to keep the rate of rejections under allowable limits.

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