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Casting Defect Analysis in Printing Machine Cylinders

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Abstract **— This paper deals with casting defects in offset printing press cylinderand their remedies. 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. Sand inclusion is one of the most frequent causes of casting rejection. It is often difficult to diagonise, as these defects generally occur at widely varying positions and are therefore very difficult to attribute to a local cause. Areas of sand are often torn away by the metal stream and then float to the surface of the casting because they cannot be wetted by the molten metal. Sand inclusions frequently appear in association with CO blowholes and slag particles. Sand inclusions can also be trapped under the casting surface in combination with metal oxides and slags, and only become visible during machining. If a loose section of sand is washed away from one part of the mould, metallic protuberances will occur here and have to be removed. In this paper sand inclusions were closely studied and two methods were proposed such as a gating system and mixing of sands. By the implementation of these two techniques fifty percentage reduction in rejection rate was achieved.**

Keywords **— Castings, casting defect, sand inclusions, gating system, sprue, gating system design.**

I. INTRODUCTION

Foundry industry is considered as the mother industry for all types of industrial, agricultural and consumer products. The development in this industry is therefore found to have far reaching effects on the production in all other sectors. Though the casting processes are based on techniques that are age old and amazingly simple in principle, considering the effectiveness of result achieved the metal casting industries have become the key industry in the world today

II. LITERATURE REVIEW

Offset printing is a commonly used printing technique where the inked image is transferred (or "offset") from a plate to a rubber blanket, then to the printing surface. When used in combination with the lithographic process, which is based on the repulsion of oil and water, the offset technique employs a flat (planographic) image carrier on which the image to be printed obtains ink from ink rollers, while the non-printing area attracts a water-based film (called "fountain solution"), keeping the non-printing areas ink-free. Ira Washington Rubel invented the first offset printing press in 1903. Figure1 represents how the image gets printed in the offset printing press. It consists of three types of cylinders and two types of rollers .In plate cylinder a plate is wound on which the image is imprinted. With the water roller, water is placed in the area, where there is no image. Likewise the ink roller places ink where there is no water. Thus impression of the image on the plate cylinder is transferred to the blanket cylinder and From the blanket cylinder image is printed on paper. The impression cylinder ejects the paper outside. Printing machine cylinders are basically of three types.

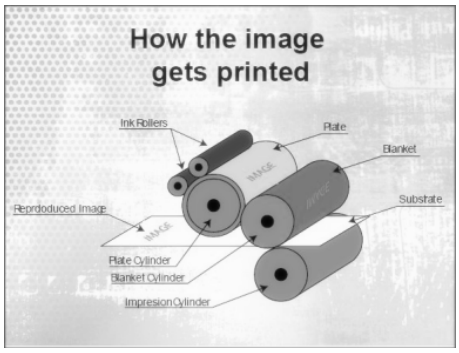

Fig1 Schematic diagram of offset printing press

1. Plate cylinder:- This cylinder occupies the topmost position where it receives the ink to be imprinted. One half of this cylinder has certain hollow sections where plates are assembled.
2. Blanket cylinder: - It is located in the middle, just after plate cylinder. Its function is to transfer (offset) the ink it receives from plate cylinder to the paper. Its shape is similar to plate cylinder except for a broad projection head.
3. Impression cylinder: - This cylinder occupies the lower most position and located below blanket cylinder. It has outer peripheral surface for holding and transferring a sheet.

Processes involved in Casting Of Printing Machine Cylinders

Following processes generally needed for manufacturing printing machine cylinders,

1. Patternmaking

2. Moulding
3. Melting and pouring
4. Fettling
5. Heat treatment

III. DEFECT ANALYSIS

After analysis of final casting five major defects are found namely sand inclusion (S.I), blow holes (B.H), shift (Sh), cracks (Cr) and porosity (Po). From the data available with the rejections of cylinder three graphs were drawn showing three types of defects. The graph below shows the rejection in percentage on the Y axis alone and defects in X axis.

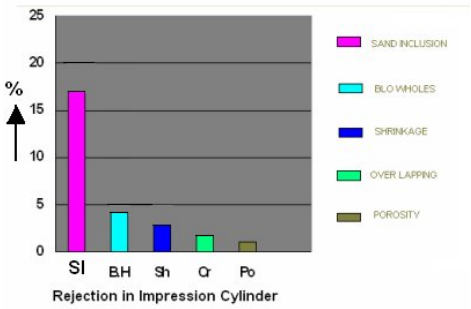

Fig.2 Percentage of rejection in impression cylinders

From the above graph (fig.2) it is evident that the majority of defects are caused due to sand inclusion. Blow holes were found to be the second major cause of rejection and the rejection due to porosity and cracks were found to be very less. These defects do not fall within the accepted limit. The graph below (Fig.3) shows the percentage of rejection in plate cylinders.

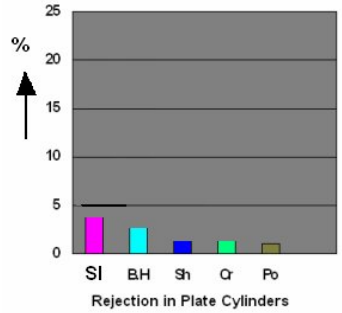

Fig.3 Percentage of rejection in plate cylinders

From the above graph it is evident that the majority of defects are caused due to sand inclusion. Blow holes were found to be the second major cause of rejection and the rejection due to porosity was found to be very less. The graph that shows the percentage of rejection in blanket cylinders is depicted in Fig.4. It is evident from the above graph that majority of defects were caused due to sand inclusion. Blow holes were found to be the second major cause of rejection and the rejection due to porosity was found to be very less, but rejection rate of plate and blanket cylinders fall within the accepted limit.

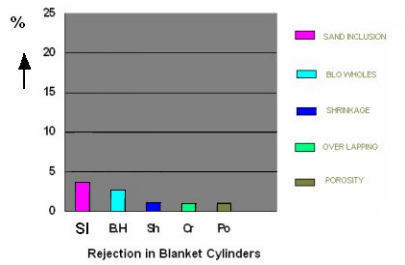

Fig.4 Percentage of rejection in blanket cylinders

IV. RESULTS AND DISCUSSION

A. *Sand inclusion*

After close scrutiny of the final casting five major defects occurring in different casts were detected. It is also observed that sand inclusion was the major defect. If examined closely before cleaning the sand we can find rough cavities of pits on casting surface. The various defects and remedies are discussed below

Fig.5 Diagram of sand inclusion

The reasons for sand inclusion are: -

1. Strength of sand low
2. Loose ramming
3. Metal stream hitting sand directly
4. Displacement of sand by cores
5. Mould breakage
6. Insufficient pattern draft
7. Sand washes from below the down sprue
8. High velocity of metal

The remedies for the above defects are:-

1. Increase sand strength.
2. Ram uniformly.
3. Improve gating.
4. Blow out loose sand after placing the core.
5. Shift and clamp the mould carefully.
6. Correct pattern draft.

7. Improve sand properties.
8. Place refractory brick below the down sprue.
9. Provide down sprue cup.
10. Increase gate area.

If these causes and remedies are considered during casting further reduction of these defects is possible.

B. Blowholes

Fig.6 Diagram of blowholes

They are rough shaped holes occurring on the outside of casting or in the thicker sections. They may be found just below the surface on machining. In severe cases, section of casting may be hollow; cavities may be dull or bright depending on conditions under which they have formed. The various defects and remedies are discussed below

Reasons for porosity are:-

1. Insufficient permeability of molding or core sand.
2. Hard ramming
3. High moisture content, above 2.5%
4. Rusty or damp chills or chaplets
5. Very hard cores
6. Core and molding gases getting trapped
7. Improper baking
8. Damp pouring ladles
9. Too low pouring temperature, below 1150° C
10. Down sprue not full
11. Very fast pouring, pouring rate is 0.80kg/sec
12. Improper gating ratio

Remedies for the above defects are:-

1. Increase permeability by use of coarser sand
2. Avoid excess ramming
3. Reduce moisture to minimum content with workability
4. Ensure the chaplets are dry and chills are free from rust. Use silicon carbide chills.
5. Avoid metal impinching chills by properly locating the gates.
6. Reduce oil in core sand.
7. Take out the core properly. Mould gasses should be allowed to go out properly by increasing mould vents.
8. Ensure proper baking of cores and moulds. Check mould dryness.
9. Dry thoroughly all pouring ladles.
10. Increase pouring temperature
11. Use large pouring basins
12. Pour correctly
13. Correct gating ratio

C. Cracks

Fig.7 Diagram of cracks

Hairline cracks shown in Fig. 7. When broken, discoloration shows that crack was produced while casting was hot. No discoloration shows cold crack. The various defects and remedies are discussed below

The reasons for cracks are :-

1. High dry strength ($45kg/mm^2$), poor collapsibility
2. High pouring temperature($1150^{\circ}C$)
3. Superheated metal
4. Uneven cooling due to section variation
5. Improper feeding
6. Early knock out
7. Wrong composition
8. Sharp corners

Remedies for the above defects are : -

1. Reduce dry strength, add saw dust/ coal dust
2. Reduce pouring temperature
3. Avoid superheating of metal
4. Use chills
5. Provide feeders
6. Avoid early knockout. Give sufficient cooling time.
7. Correct composition
8. Reduce sharp corners

D. *Mismatch shift*

Fig.8 Diagram of mismatch shift.

It is shift in the casting along the parting line. The various defects and remedies are discussed below.

The reasons for mismatch shift are :-

1. Pattern shift
2. Box shift

The remedies for the above defects are :-

1. Check pattern mounting on match plate and rectify, correct dowels.
2. Use proper molding box and closing pins.

E. *Porosity*

Fig.9 Diagram for porosity

Porosity is identified by the weeping of casting under pressure test. Machined surfaces show cavities in thick sections or a series of pin holes on machined skin. The various defects and remedies are discussed below

Reasons for porosity are:-

1. Incorrect metal composition
2. Low steel percentage in charge
3. Gassy metal
4. Coarse graphite
5. Shrinkage

Remedies for porosity are:-

1. Correct composition. Reduce carbon equivalent
2. Increase steel percentage
3. Avoid wet scrap and wet ladles
4. Improve inoculation. Correct steel charge.
5. Improve feeding. Use chills.

F. *Cause and Effect Diagram*

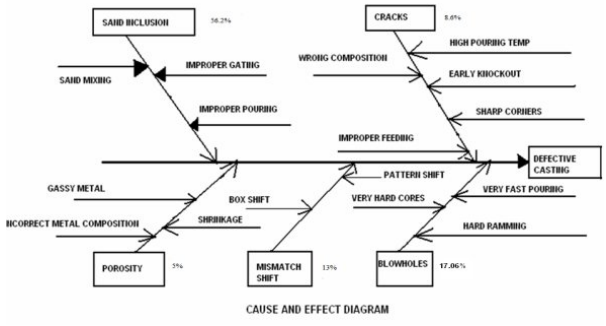

Fig.10 Cause and effect diagram of casting defects

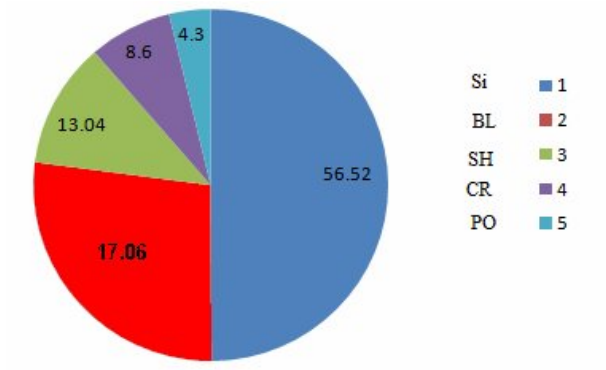

Fig.11 Diagram showing the defects of casting in pie chart

G. *Gating system*

In the previous case, (Fig. 12) possibility of sand inclusions in the final casting was more as the molten metal used to directly hit the core and there was also a chance of sand wash due to flow of molten metal.

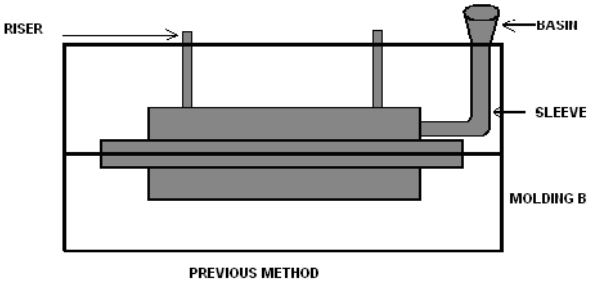

Fig.12 Diagram of previous method

Suggested method

In the suggested modification (Fig. 13) molten metal does not hit the core directly.In the present system molten metal is poured directly to the mold through gate which causes ultimate damage to the sand and at the same time it may be broken.

In order to avoid this new sprue is provided which will act as a storage tank for molten metal and smooth flow to the mould is assured.

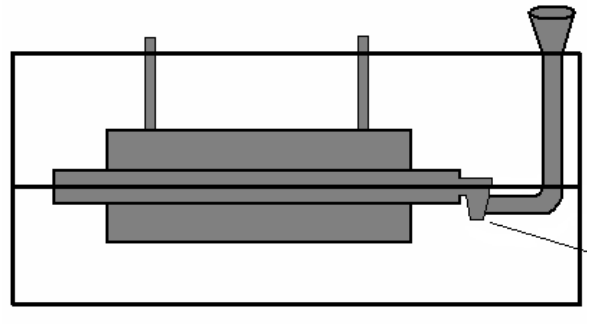

Fig.13 Diagram of suggested method

H. *Sand Mixing*

New sand and reused sand are mixed in the same proportions in the existing system. The suggestion recommended is to use new sand in the adjacent pattern and the reused sand surrounding it inside the core box. This will increase the surface finish and strength of the casting. In addition to this the cost of sand will also be reduced.

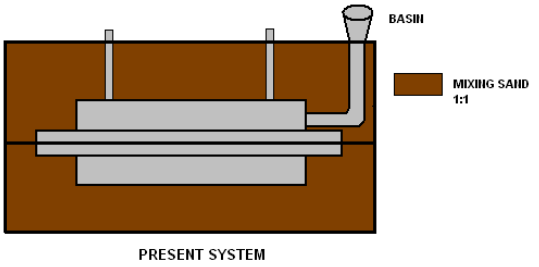

Fig.14 Diagram of present system

Suggested system

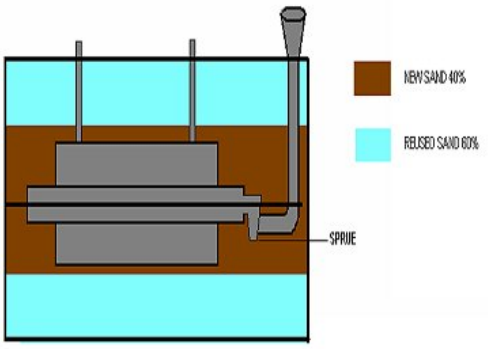

Fig. 15 Diagram of suggested system

After incorporating the suggestions it was observed that the rejection rate was reduced. It was noticed that the rejection rate falls with in the accepted limit. It is shown in the bar chart (Fig. 16)

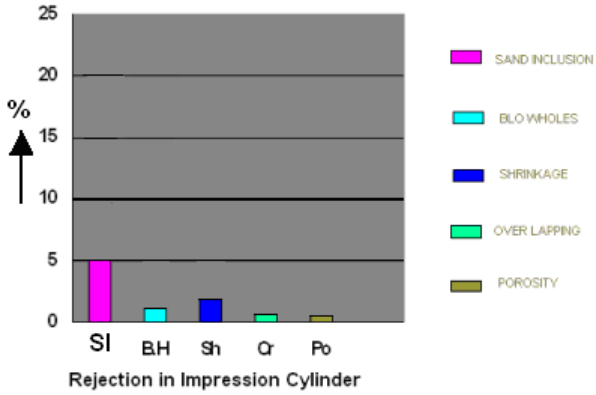

Fig.16 Represents percentage of rejection after the suggested method

The percentage of rejection in the existing system is 20%. After the suggestion the percentage of rejection has come down to 10%. Thus there is a savings of 10%.

Table 1 Comparison of existing and suggested gating system

Particulars	*Existing system*	*Suggested system*
Strength	45kg/mm^2	55kg/mm^2
Permeability	120	150
Binding property	Less	More
Cost	More	Less

CONCLUSION

A study was conducted in the foundry department of H.M.T, Kochi producing offset printing press cylinders. The prominent defects occurring in casting of offset printing machine cylinder were identified in the course of the analysis. After considering the various aspects, two suggestions were put forward for reducing the defect density. From the two suggestions, gating system and sand mixing system were implemented. By implementing the suggestions, fifty percentage reduction in rejection rate was achieved.

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