

# To Reduce the Rejection Rate for Scabbing Defect in Foundries

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**ABSTRACT:** Rejection rate is one of the major issues in Indian foundry. Foundries try to reduce rejection by experimenting with process parameters or modifying method and tooling design which reduces the quality of castings and increase cost of production. By replacing the existing trial and error method with computer simulation foundries can reduce the rejection rate from 8.5 to 1.5 %. The report titled “Reducing rate of rejection” is aimed at reducing rejection rate of castings in an Indian foundry. The overall goal of the project proposed here in is to reduce the rejection rate for scabbing defect in foundries. In this report a case study on a MF380 product, which is having high rejection rate in an Indian foundry is taken and the defects of casting are solved using the proposed trial and error method and the effective solutions for reducing rejection rate for the product is also given.

**KEYWORDS:** Rejection rate, scabbing defect, MF380 product, Indian foundry.

## I. INTRODUCTION

### 1.1 In-house rejection trend

In-house rejection trend is final quality control data by the manufacturing company itself. In-house rejection data accounts all the components which is manufactured in the company i.e manifold 380, crank shaft AK etc. In-house rejection data is cumulative rejection of all the components produced monthly.

Overall in-house rejection in terms of number of rejections and rejection in metric term by product is shown in above table. From observation, we come to know that crank shaft AK have 4757 rejections which are maximum by number. In terms of metric term, maximum rejection is shown at Manifold582.

The data is converted into pareto chart for getting clear idea about the rejection status of product,

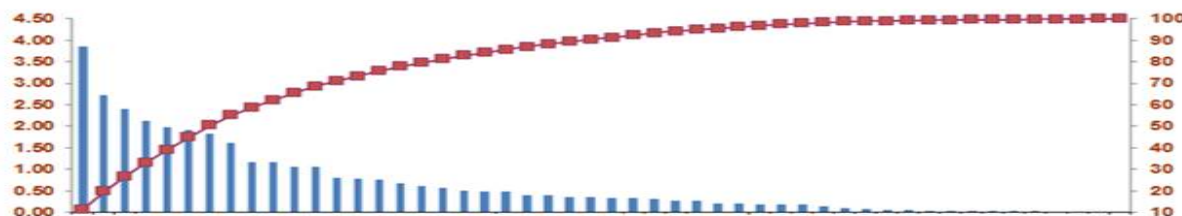


Figure 1: Customer Rejection MT Item Wise Pareto Dec 2015

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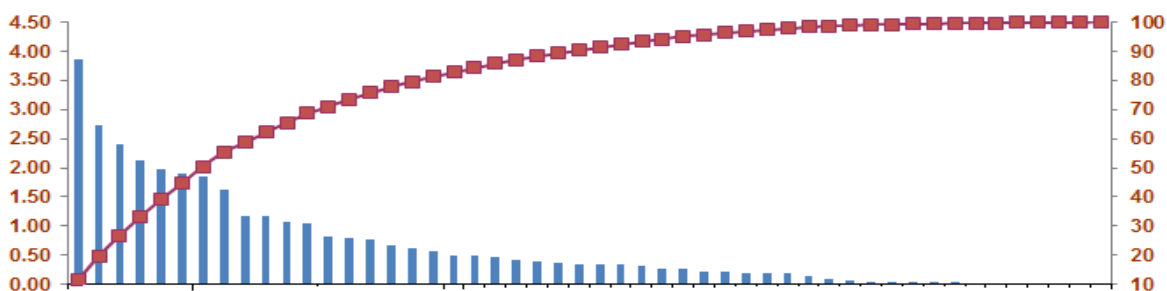
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## 1.2 Customer rejection

The customer has to inspect the order lot before he uses the purchased product, where the quality check analysis is done thoroughly and rejection sheet is formed according to the measurement and analysis. The customer rejection sheet consists of rejections in terms of number of products and rejection in metric term. The table shows that maximum rejection at Liner 52310278. Rejection rate in metric ton is for vane pump CVMM (7673801) which accounts for 3.86 metric ton.

The data is converted into pareto chart for getting clear idea about the rejection status of product,



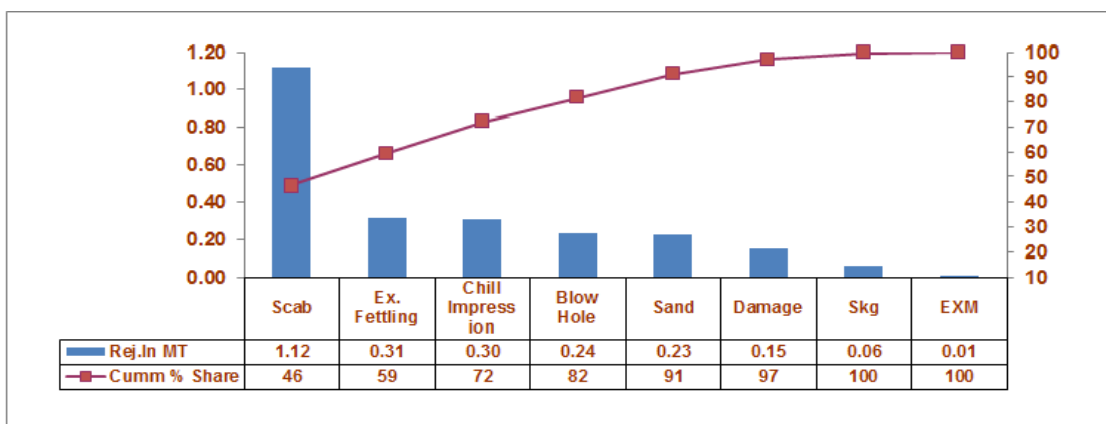
**Figure 2: Item wise customer rejection**

In overall in-house rejection, tabulated above, MF380 accounts for second highest rejection in terms of metric ton, which results into major financial losses for company. From analysis of customer rejection, MF380 has third highest which accounts for 2.41 metric ton. From above discussion, MF380 is selected.

Possible reasons of customer rejection as per inspection department:

Customer rejection:

These data is converted into pareto chart as shown below,



**Figure 3: Pareto on defect wise rejection**

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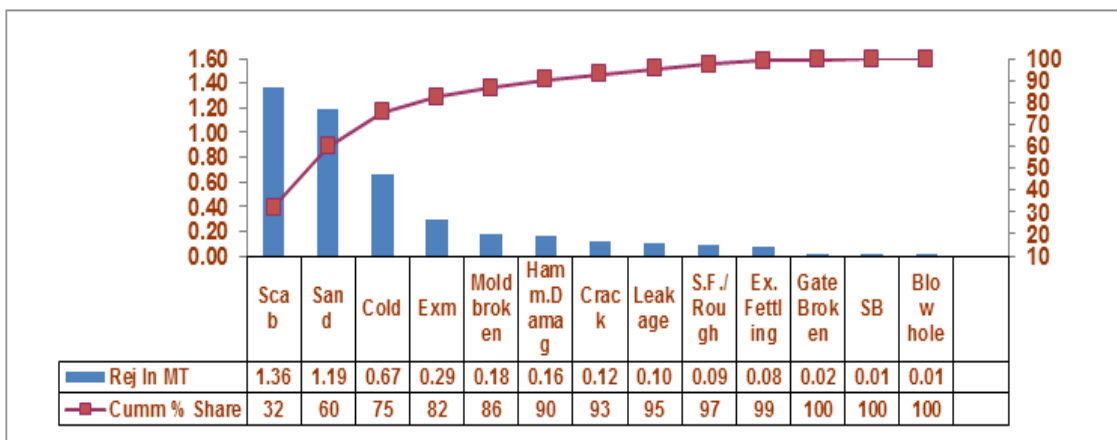
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In-house rejection:

These data is converted into pareto chart as shown below



**Figure 4: Defect wise In house pareto**

The figure shows the rejection percentage over the months from march-15 to oct-15 based on the product quantity, rejection quantity and the percentage rejection. For convenience the tabulated data is converted into graph shown below



**Figure 5: Month wise rejection**

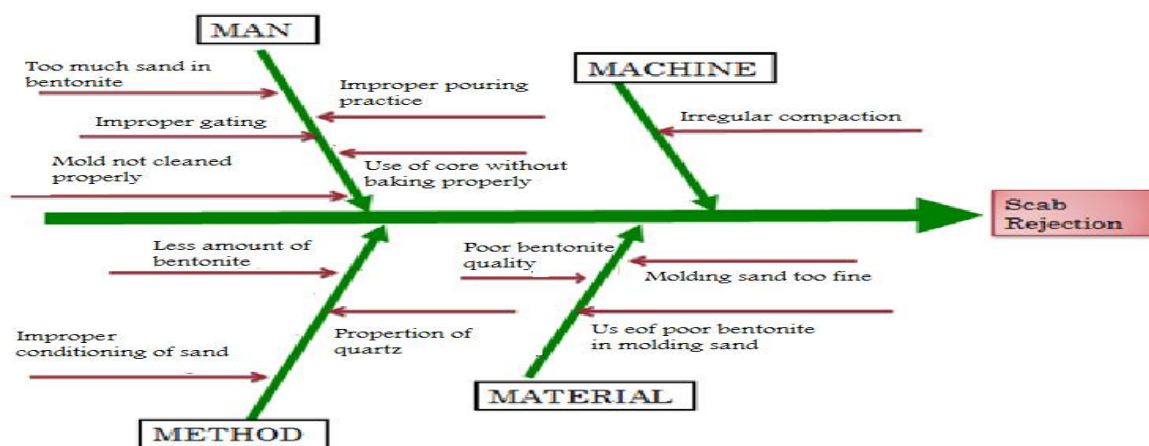
Following shows the fish bone diagram for all potential causes of defects. These causes are classified in four types: Man, machine, method, material.

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**Figure 6: Overall Fish bone diagram**

This classification is made for recognizing actual area in which the defects are likely to be occurred which helps to concentrate on the main area of defect. Fish bone diagram helps to find out causes in minimum time.

In this fish bone diagram of possible causes, (MF 380) we can observed that the maximum causes are concentrated in the areas of man and method. So it is to be concluded that the direction of problem solving should be aimed towards these two important areas.

### II. ANALYSIS

In order to find out the actual causes, we conducted the brain storming session in which all the working staff on this project and some of the experienced authorities shared their views based on their knowledge and personal experience to bring out most probable causes.

For example, the defect like improper conditioning of sand (cause no. 12) has got the rating by individuals and the summation of rating was considered for final evaluation of cause.

In the final evaluation, causes getting highest rating are highlighted and considered as important and the priority was given. In above chart, the maximum ratings are observed for the cause no. 1 i.e poor bentonite quality and cause no. 3 i.e improper gating design have equal ratings. (85/110)

Hence these two causes were given first priority.

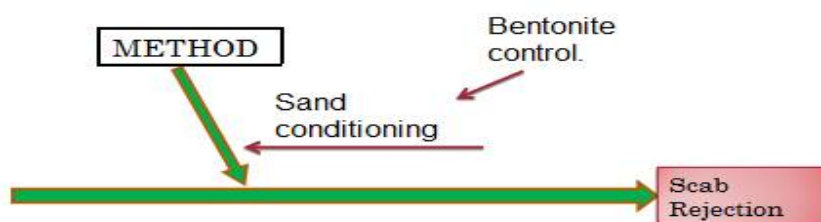
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### POSSIBLE CAUSE: 1



**Figure 7: Bentonite mixture**

Previous sand mixture was,

**Table 1: Bentonite mixture**

Sand	Weight of sand (kg)
Bentonite	2.5
Fresh sand	5
Return sand	2.5
Total	10

This molding sand gave poor quality of mold with less strength and bonding properties, compatibility and permeability which resulted into improper mold quality. i.e loosening of sand at in-gate due to friction with molten metal. So we made changes in the mixture.

Proposed sand mixture

**Table 2: Modified bentonite mixture**

Sand	Weight (kg)
Bentonite	4.5
Fresh sand	2.5
Return sand	1.5
Red-oxide	1.5
Total	10

Due to increase in amount of bentonite, the bonding properties were improved which increased the strength of mold resulted into good quality. The properties like permeability were also taken care while modifying the mixture. Also, we added Red-oxide (1.5 kg) to improve corrosion resisting properties. But addition of the bentonite requires high cost, so we focused on gating design modification.

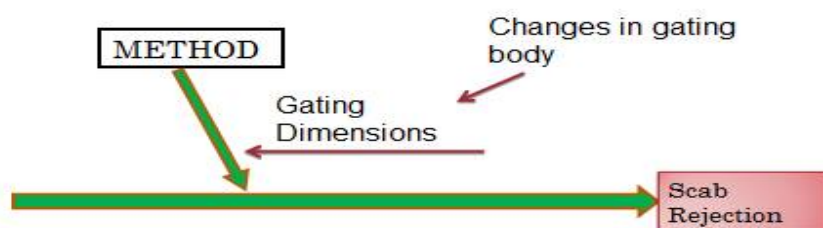
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### POSSIBLE CAUSE: 2



**Figure 8: Fish bone on Gate design**

From above analysis, we modified the gating dimensions, they are as follows:

**Table 3: Previous and proposed gate dimension**

Parameters	Previous	proposed
Weight of casting	10	
No. of castings/ molds		2
Total weight of casting		20
Liquid metal/ mold	48	
Pouring time	8.82	
Velocity factor	0.4	
Ferro static head		
Height of sprue above ingate	15.75	cm
Height of casting above in-gate	10.5	cm
Total height of casting	12.7	cm
Density of liquid metal	6.8	
HST	11.41	
Down sprue area	1338.97	cm <sup>2</sup>
Down sprue radius	426.4	cm <sup>2</sup>
Down sprue diameter	41.3	
Runner area	1606.76	
In-gate area	2008.45	
In-gate 1	32x6	28x5
In-gate 3	44x7	38x5

It is observed from the gating design, that at in-gate the cross-section area is much smaller than the runner which implies friction losses due to sudden contraction and sudden expansion. Hence we compared it with principle of venturi. i.e bernauli's theorem.

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### III. PROPOSED WORK

The shape of gate was typical rectangle having size 32x6. So for this dimension, we found turbulence in in-gate 1 and in-gate 3. So it was necessary to change the dimension with respect to size of gate. Because turbulence is created at the in-gate which results into friction between pouring metal and molding sand. Due to which, the sand loosens and the surface becomes rough, which is nothing but scabbing phenomenon. Following figure shows previous gate design.



**Figure 9: Previous gate shape**

In previous gate design, the cross-section area of runner was very less. So that the fluid was not getting steady flow and resulted into greater turbulence. Hence in-gates were modified.

From the analysis, it was observed that scab at in-gate 1 and 3 had 2.11 and 2.65% rejection respectively, which was comparatively greater than other defects. Hence gate 1 & 3 were modified.

#### **Proposed gate shape:**

Following figure shows the change in gate shape and its dimension. Previously gate dimension was 32x6, with 6 as a height of in-gate. For this dimension, turbulence occurs. So by using the concept of venturi, the turbulence inside the in-gate is lowered.



**Figure 10: Proposed gate shape**

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### IV. EXPERIMENTAL RESULTS

The defect analysis of MF380 with previous gate design is given below:

**Table 4: Defect wise rejection**

Defect	Rej Qty	Rej %
<b>MANIFOLD 380</b>		
<b>SD 1</b>	<b>32</b>	<b>1.93</b>
<b>SD 2</b>	<b>10</b>	<b>0.60</b>
<b>SD 3</b>	<b>3</b>	<b>0.18</b>
<b>SD 4</b>	<b>3</b>	<b>0.18</b>
<b>SD 5</b>	<b>17</b>	<b>1.02</b>
<b>CL 1</b>	<b>5</b>	<b>0.30</b>
<b>CL 2</b>	<b>39</b>	<b>2.35</b>
<b>CL 3</b>		
<b>Scab 1</b>	<b>35</b>	<b>2.11</b>
<b>Scab 2</b>	<b>12</b>	<b>0.72</b>
<b>Scab 3</b>	<b>44</b>	<b>2.65</b>
<b>Scab 4</b>	<b>2</b>	<b>0.12</b>
<b>Heat Rej.</b>		
<b>Skg</b>	<b>1</b>	<b>0.06</b>
<b>S.P.</b>		
<b>Crack</b>	<b>1</b>	<b>0.06</b>
<b>SB</b>		
<b>Blow hole</b>		
<b>Exm</b>	<b>8</b>	<b>0.48</b>
<b>Shift</b>		
<b>Leakage</b>	<b>2</b>	<b>0.12</b>
<b>Mold broken</b>	<b>2</b>	<b>0.12</b>
<b>K. Out DM</b>		
<b>Gate Broken</b>		
<b>FIN BROK</b>		
<b>FIN BEND</b>		
<b>Ex. Fetting</b>	<b>4</b>	<b>0.24</b>
<b>OD U SIZE</b>		
<b>CUST RETURN</b>	<b>294</b>	<b>17.71</b>
<b>Total</b>	<b>484</b>	<b>29.16</b>



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Following are results obtained from trials after modification:

Table 5: Results from trial 1 and 2

Defect	Rej Qty	Rej %
<b>MANIFOLD 380</b>		
<b>Inspection Qty</b>		<b>0</b>
<b>Production Qty</b>		<b>620</b>
<b>\$D 1</b>	<b>3</b>	<b>0.48</b>
<b>\$D 2</b>	<b>3</b>	<b>0.48</b>
<b>\$D 3</b>		
<b>\$D 4</b>	<b>3</b>	<b>0.48</b>
<b>\$D 5</b>	<b>6</b>	<b>0.97</b>
<b>CL 1</b>		
<b>CL 2</b>	<b>14</b>	<b>2.26</b>
<b>CL 3</b>		
<b>Scab 1</b>	<b>8</b>	<b>1.29</b>
<b>Scab 2</b>	<b>4</b>	<b>0.65</b>
<b>Scab 3</b>	<b>1</b>	<b>0.16</b>
<b>Scab 4</b>		
<b>Heat Rej.</b>		
<b>\$kg</b>		
<b>\$P.</b>		
<b>Crack</b>		
<b>\$B</b>		
<b>Blow hole</b>		
<b>Exm</b>	<b>1</b>	<b>0.16</b>
<b>Shift</b>		
<b>Leakage</b>		
<b>Mold broken</b>		
<b>K.Out DM</b>		
<b>Gate Broken</b>		
<b>FIN BROK</b>		
<b>FIN BEND</b>		
<b>Ex. Fettleing</b>		
<b>OD U SIZE</b>		
<b>CUST RETUR</b>		
<b>Total</b>	<b>43</b>	<b>6.94</b>



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### V. CONCLUSION

From the table 6 , it is concluded that the rejection rate of MF380 at scab 1 & scab 3 are 1.29 & 0.16 respectively. Hence, rejection rate of MF380 is reduced.

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