International Journal of Pure and Applied Mathematics
Volume 117 No. 15 2017, 489-496
ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue

A Study on Reduction of Cost in Castings by the Method of Radiographic Test

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Abstract

Foundry in developing countries suffer from poor quality and productivity due to involvement of number of process parameters due to shortage of skilled persons and automations. Casting defects result in increased unit cost and lower morale of shop floor personnel. Unfortunately, this is not an easy task, since casting process involves complex interactions among various parameters and operations. This article deals with the filling related defects, their causes, their remedies and their cost reduction in radiographic test. For our analysis we took the valve castings which are used in oil and gas refineries. There are many defects which can be identified through radiographic test and these defects are reduced or remedied by means of welding to overcome these defects. Our focus is about the cost reduction of castings by means of "Total quality management technique".

Key Words: Casting, defects, remedies, radiographic, test-analysis, welding rods, cost reduction.

1. Introduction

Capitalizing on these advantages takes an understanding of the power of casting geometry and the marriage of casting process and alloy. However Global buyers demand defect-free castings and strict delivery schedule, which foundries are finding it very difficult to meet. This is not an easy task, since casting process involves complex interactions among various parameters and operations related to metal composition, methods design, moulding, melting, pouring, shake-out, fettling and machining.

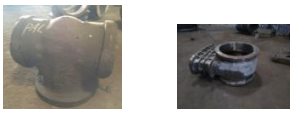


Fig. 1: 36”150 Body Literature Survey

Extensive literature survey was done on the procedure of X-Ray Computed Tomography of Castings and non-uniformity of Spatial Resolution in Computed Tomography Scanners. M. J. Dennis discussed about the industrial Computed Tomography, non-destructive Evaluation and Quality Control. Rajesh Rajkolhe1, J.G. Khan was explained about the Defects, Causes and Their Remedies in Casting Process and also casting defect reduction and productivity improvement in Automotive Component. Santosh J Jadhav studied about the investigation and Analysis of Cold Shut Casting Defect and Defect Reduction by using quality Control Tool to validate and quality improvement of the castings.

2. Casting Defects

Filling related defect, Shape related defect, Thermal defect, Defect by appearance.

Filling Related Defect

Blowhole

Blowhole is a kind of cavities defect, which is also divided into pinhole and subsurface blowhole. Pinhole is very tiny hole. Subsurface blowhole only can be seen after machining. The defects are nearly always located in the cope part of the mould in poorly vented pockets and undercuts. These defects occur when an excessive evolved gas is not able to flow through the mould. So, it collects into a bubble at the high points of a mould cavity ad prevents the liquid metal from filling that space. This will result in open blows. Closed, cavities or gas holes are formed when the evolved gases or the dissolved gases in the molten metal are not able to leave the m ass of the molten metal as it solidifies and get trapped within the casting.

Sand Inclusion

Sand inclusion and slag inclusion are also called as scab or blacking scab. They are inclusion defects. It is like there are slag inside of metal castings. Sand inclusion is one of the most frequent causes of casting rejection. It is often

difficult to diagnose, 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.

Other Defects

Pipe defects are defined as shrinkage cavities at the centre of the billet that are inherent to the end of casting. As the last steel solidifies, it shrinks and tends to leave a void at the centre of the section. It was a commonly-held belief that there are two forms of pipe - primary and secondary - the latter appearing to be discrete islands of porosity below the primary pipe.

Radiographic Test

The method used to detect internal defects in castings is radiographic inspection. It is one of the best non-destructive method for detecting internal defects, such as shrinkage and inclusions. It shows good detection ability for defects in multi-layered structures, austenitic steels and composites where other NDT methods such as ultrasonic testing cannot be used due to attenuation and scattering problems. In this method, a casting is exposed to radiation from an x-ray tube. The sources of radiation may be Iridium and Cobalt. The casting absorbs part of the radiation, and the remaining portion of the radiation exposes the radiographic film. Dense material withstands the radiation penetration, so the film is exposed to a lesser degree in those areas, giving the film a lighter appearance. Less dense materials allow more penetration and correlates to darker areas on the film. Any hole, crack or inclusion that is less dense than the casting alloy is revealed as a dark area in the film. Radiography testing provides permanent record, real time imaging, detection of internal flaws, etc.

Uses of NDT Methods

- Flaw Detection and Evaluation,
- Dimensional Measurements,
- Structure and Microstructure Characterization,
- Estimation of Mechanical and Physical Properties,
- Material Sorting and Chemical Composition.

Defect Analysis: Ro Defect

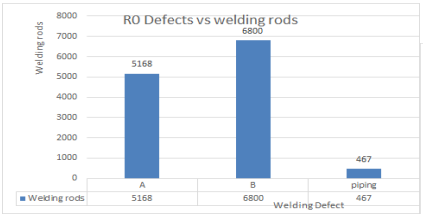
Sl no	Item	Heat No	RT No	Defects(RO)			Total	Defects (R1)		Total
				A	B	piping	Rods	A	B	Rods
1	36" 150 Body	4245	EC1130	203	253		456		219	219
2	36" 150 Body	4280	EC021	77	37		114			
3	36" 150 Body	4275	ECC020	342	136		478			
4	12"2500 Body	4296	EC5518	172	95		267	35		35
5	24"300 Body	4141	EC1118		388		388		295	295
6	12"2500 B/W Body	4295	EC5517	136	10		166			
7	30"150 Bonnet	4154-2	EC1094	100	261		361		15	15
8	20"150 GTV B/W Body	4213	EC1114	90	151		241			
9	20"600 Plug Body	4273	EC1131				179			
10	20"600 Plug Body	4268	EC1124		252		252			0
11	30"150 Bonnet	4154	EC1099	151	70		221		53	53
12	30" 150 Body	4145	EC5513	113	23		136			0
13	20"600	4237	EC1120		20		20			
14	24"300 Body	3957	EC1016		30		365			
15	24"300 Bonnet	4231	EC1116	163			163			0
16	16"900 Body	4221	EC1127		15		15			0
17	16"900 Body	4221	EC1128		15		15			0
18	36" 150 Body	3920-3	ECR127				0			0
19	30" 150 Body	3857	ECC018	154	29		183			0
20	24"300 SCV B/W Body	4252	EC1122	240	457		697		25	25
21	18"600 Body	4120	EC1108	35	85		120			0
22	10""8 300CL EW Body	4205	EC1098	180	119		299			0
23	24"300 Body	4159	EC1101				0			0
24	30" 150 Body	4145	EC5513				0		56	56
25	24"300 Bonnet	4131	EC1103				0			0
26	24"300 Body	4153-2	EC1104	53			53			0
27	30" 150 Body	3853	ECJ278	86	80		166			0
28	24"300 Body	4108	EC1086	261	111		372			0
29	30"150 Bonnet	3839	EC5491				0		20	20
30	30" 150 Body	3858	ECJ279	102	48		150			0

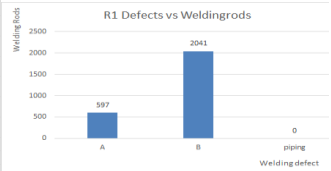
Where,
A - Gas holes
B - Sand inclusion
RO - Radiographic test -1
R1 - Radiographic test – 2

Radiographic Test

Welding defect	A	B	piping
Welding rods	5168	6800	467

Welding defect	A	B	piping
Welding rods	597	2041	0





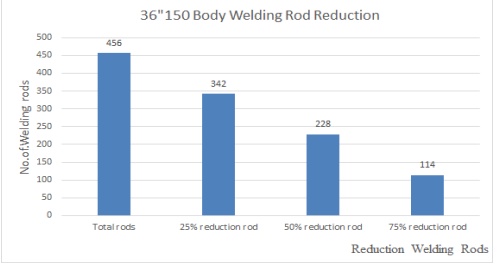
Sand Inclusion Defects

Reduction of Welding Rods

Sl no	Item	Heat No	RT No	Defects(RO)			Total Rods	25%	25% Reduction	50%	50% Reduction	75%	75% Reduction
				A	B	piping							
1	36" 150 Body	4245	EC1130	203	253		456	114	342	228	228	342	114
2	36" 150 Body	4280	EC021	77	37		114	28.5	85.5	57	57	85.5	28.5
3	36" 150 Body	4275	ECC020	342	136		478	119.5	358.5	239	239	358.5	119.5
4	12"2500 Body	4296	ECS518	172	95		267	66.75	200.25	133.5	133.5	200.25	66.75
5	24"300 Body	4141	EC1118		388		388	97	291	194	194	291	97
6	12"2500 B/W Body	4295	ECS517	136	10		166	41.5	124.5	83	83	124.5	41.5
7	30"150 Bonnet	4154-2	EC1094	100	261		361	90.25	270.75	180.5	180.5	270.75	90.25
8	20"150 GTV B/W Body	4213	EC1114	90	151		241	60.25	180.75	120.5	120.5	180.75	60.25
9	20"600 Plug Body	4273	EC1131				179	44.75	134.25	89.5	89.5	134.25	44.75
10	20"600 Plug Body	4268	EC1124		252		252	63	189	126	126	189	63
11	30"150 Bonnet	4154	EC1099	151	70		221	55.25	165.75	110.5	110.5	165.75	55.25
12	30" 150 Body	4145	ECS513	113	23		136	34	102	68	68	102	34
13	20"600	4237	EC1120		20		20	5	15	10	10	15	5
14	24"300 Body	3957	EC1016		30		365	91.25	273.75	182.5	182.5	273.75	91.25
15	24"300 Bonnet	4231	EC1116	163			163	40.75	122.25	81.5	81.5	122.25	40.75
16	16"900 Body	4221	EC1127		15		15	3.75	11.25	7.5	7.5	11.25	3.75
17	16"900 Body	4221	EC1128		15		15	3.75	11.25	7.5	7.5	11.25	3.75
18	36" 150 Body	3920-3	ECR127				0	0	0	0	0	0	0
19	30" 150 Body	3857	ECC018	154	29		183	45.75	137.25	91.5	91.5	137.25	45.75
20	24"300 SCV B/W Body	4252	EC1122	240	457		697	174.25	522.75	348.5	348.5	522.75	174.25
21	18"600 Body	4120	EC1108	35	85		120	30	90	60	60	90	30
22	10"*8 300CL EW Body	4205	EC1098	180	119		299	74.75	224.25	149.5	149.5	224.25	74.75
23	24"300 Body	4159	EC1101				0	0	0	0	0	0	0
24	30" 150 Body	4145	ECS513				0	0	0	0	0	0	0
25	24"300 Bonnet	4131	EC1103				0	0	0	0	0	0	0
26	24"300 Body	4153-2	EC1104	53			53	13.25	39.75	26.5	26.5	39.75	13.25
27	30" 150 Body	3853	ECI278	86	80		166	41.5	124.5	83	83	124.5	41.5
28	24"300 Body	4108	EC1086	261	111		372	93	279	186	186	279	93
29	30"150 Bonnet	3839	ECS491				0	0	0	0	0	0	0
30	30" 150 Body	3858	ECI279	102	48		150	37.5	112.5	75	75	112.5	37.5

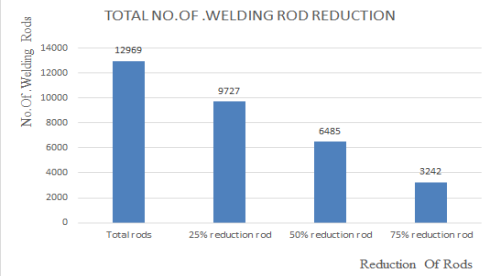
36”150 Body Welding Rod Reduction

Total rods	25% reduction rod	50% reduction rod	75% reduction rod
456	342	228	114

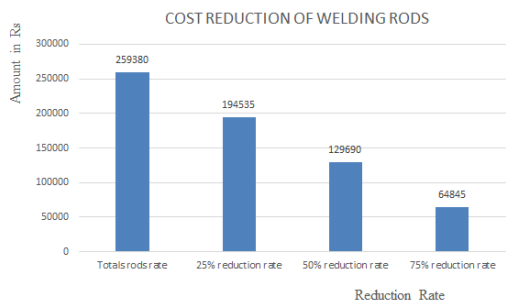


Total No.of .Welding Rod Reduction

Total rods	25% reduction rod	50% reduction rod	75% reduction rod
12969	9727	6485	3242



Cost Reduction of Welding Rods



3. Remedial Measures for Casting Defects

Remedial Measures for Blowhole

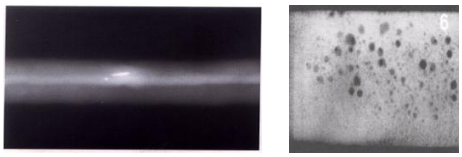
- Avoid over ramming of sand.
- Use dry chills only.
- Optimum pouring temperature for required metals.
- Proper mixing of sand and resin
- Provision of adequate venting.
- Use dried and properly dressed cores.

Remedial Measures for Sand Inclusion

- Use of high bentonite content.
- Proper ramming of sand for uniform compaction.
- Frequent cleaning of mould boxes.
- Use of properly dressed cores.
- Proper mixing ratio of reclaimed sand and binder.

4. Total Cost Reduction

Radiographic Image of High Density Inclusion



Radiographic Image of Gas Holes

	Total no.of.flim & Rods	Total Film rate	25% reduction	rate	50% reduction	rate	75% reduction	rate
RT Flim	354	85900	354	85900	354	85900	354	85900
Defect open	2593.8	38907	1945.35	38907	1296.9	25938	648.45	12969
Welding rod	12969	259380	9726.75	194535	6484.5	129690	3242.25	64845
RT Flim	354	85900	354	85900	354	85900	354	85900
TOTAL rate		470087	25% reduction	405242	50% reduction	327428	75% reduction	249614

5. Conclusion

In this paper types of filling related casting defects, their causes, their remedial measures, and their radiographic images are studied and we found that the sand inclusion is the major defect that occurs in the castings compared to blow holes, when it is tested under the radiographic test. By avoiding sharp corners, edges, early knockout and reducing the pouring rate, pouring time and by increasing metal pouring temperature we can avoid these defects. The welding rods that are used to remove the defects and their costs and the radiographic films that are used and their costs has been estimated. Our project will definitely helpful to increase the productivity and yield of the castings.

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