Indian Journal of Science and Technology, *Vol 9(35), DOI: 10.17485/ijst/2016/v9i35/97089, September 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Effect of Coating in Chilled Cast Iron Tappet with Different Chill Material

V. M. Gobinath * and K. Annamalai

Vellore Institute of Technology, Chennai - 632014, Tamil Nadu, India; vmgobinath@gmail.com, kannamalai@vit.ac.in

Abstract

Objectives: To study the effect of coating (with or without) in the chill plate material on the chilled cast iron engine tappet. **Methods/Statistical Analysis:** The impact of Coating material and chill plate over chilled depth has been examined. Experimental work was contacted with coating and without coating material. The Design Of Experiment (DOE) will be performed and taking into DOE account; the trail will be reached. The casting of tappet with differing the measure of coating material influences the chilled depth that has been checked taking into microstructure study account. **Finding**: Coating thickness affects the chilled and mottled depth growth. Our aim is to increase the chill depth and decrease or to avoid the molted zone. As per excremental trials, we observed that Coating thickness increases the chill depth and as well as molted depth also. We have to use the coating thickness very carefully to manage the chill and mottled depth. Combination of with coating thickness (0.3 mm) and Gray cast iron is giving good results for the chilled depth. **Application/Improvement**: This mushroom type tappet is used in automobile industry as especially Heavy vehicles like trucks, tractors and etc. Coating on shell mold will give us the more chill depth on the tappet head which will improve the engine tappet life and diminishing tappet casting outer surface roughness by 2-4 times.

Keywords: Chilled Cast Iron, Coating, Chilled Plate, Mottled Cast Iron

1. Introduction

In more recent times, numerical simulations and PC based assessment of casting solidification are accepting more consideration because of its awesome potential for expanding the profitability of the metal casting industry by lessening the time[1,2]. The change from dark to white cast iron begins from nucleation and development rivalry between the steady gray and white eutectic[3]. The marvel of move from gray to white eutectic solidification with quick cooling rate is known as the chill of cast iron[4].

Figure 1 expresses the impact of cooling rates and cooling range on the structure of standard wedge-shaped castings. Most impacting variables that influence heat exchange from the hardening casting to chills are resistance offered by the casting/chill interface[5]. The chilling propensity for various cast irons is controlled by contrasting showed part of cementite eutectic in castings set under same cooling rate[6]. Figure 2 demonstrates the examination of the chilling inclination in cast iron (I and II).

There are a couple of frameworks to upgrade surface quality when casting into metal molds. These are throwing into influentially cooled molds[7], and casting into preheated molds[8]. In any case, these frameworks are genuinely entangled in regards to their execution and much of the time disregard to administer totally with the casting blemishes which are shaped at first glance. The most widely recognized technique for accomplishing a top notch casting surface is a coating of the chill plate in the foundry. It helps us to wipe out the blaze on because of the additional medium that makes an allotment between the melt from the mold. These coatings are having the properties of low warm conductivity, which broaden the period when the melt is in a fluid state and permits more exactness expulsion of gas from the melt. These sorts of foundry coatings contain natural folios, which discharges gasses subsequent to copying which lead to the development of pinholes at first glance[9,10]. Foundry coatings containing super scattered metal oxide powders grants us in the decrease of castings surface harshness by 2-4

**Author for correspondence*

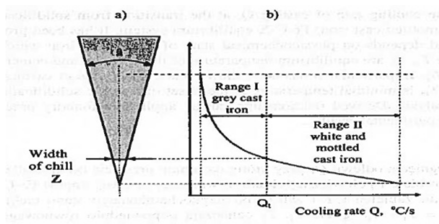

Figure 1. (**a**) Standard wedge-shaped specimen (**b**) Cooling rate ranges near the tip and along the axial direction of the wedge[2].

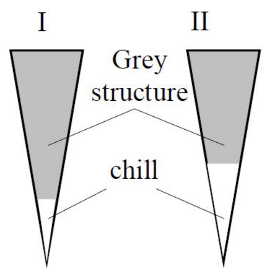

Figure 2. Casting for chill and chilling tendency estimation[4].

times[11]. For checking the impact of covering and different parameters speculations accept that a solitary variable is determinant in setting up the hardening structure while the remaining components are disregarded[12].

The target of this examination work to dissect the impact of covering material and chill plate material over chilled depth of chill cast iron.

2. Methodology

2.1 Model Designing

CATIA V6 has done the model making of tappet. The sort of Tappet considered for trial is "Mushroom Tappet" which is displayed in Figure 3. Mold utilized for throwing of Tappet is "Shell Mold".

Chill plate size for the trial is 125 mm x 125 mm x 75 mm. Three distinctive material chill plates have been utilized for examination. The plans of chill plates with filled mold are appeared in Figure 4. In this 'C' signifies copper chill plate, "I" indicates gray cast iron chill plate, "S" means chill steel plate, and after that the number "2" means a trial number.

2.2 Factors Selection for Casting Trial

Variables that influence the chill depth and mottled depth are distinguished taking into account the information

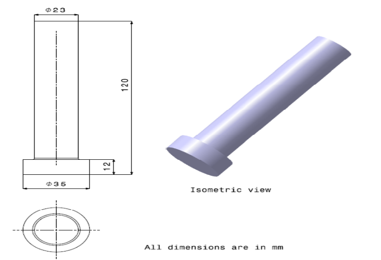

Figure 3. Detailed drawing of Cast iron Tappet.

Figure 4. Chill plates with mould.

accessible in the writing. For this trail the accompanying components are considered:

- Chill Plate Material
- Coating thickness

By the above elements, six exploratory trials have been performed, and results are dissected.

The coating material selected for the experimental trial was "Min-coat 3341," with specific gravity ranging from 1.30 to 1.450. This material is obtained by the dispersion of complex alumino silicate, modified with iron oxide and graphite in water. It is used as a refractory coating in foundry applications.

Coating range was 1400 to 1450°C. and coating time was less than 5 minus from the ladle.

The chill plate is utilized to advance hardening in a particular segment of the casting mold. The adequacy of chill relies on upon size, thermal conductivity, thermal limit and the thermal warmth exchange rate. For this examination work Steel, copper and Gray cast chill iron plate is utilized that is recorded underneath with thermal control points of interest in Table 1.

The configuration of Experiments (DOE): Two parameters are recognized and two levels altered for three variables because of the constraints of experimental facilities. The three levels are altered for one element (Chill plate material). The quantity of components and their levels for the experimental trials is given in Table 2. In this manner six exploratory trials are arranged and directed.

Table 1. Chill Plate Material Properties

S.No	Chill Plate Material	Thermal Conductivity W/m.K	Ratio
1	Steel	30	0.09
2	Gray Cast Iron	44	0.13
3	Copper	342	1.00

Table 2. Factors and levels

S. No	Factors	Levels		
1	Coating thickness mm	0	3	
2	Chill plate material	Gray cast iron	Steel	Copper

Two-phase of coating has been chosen in light of foundry condition as "0" (Without Coating), and with 3mmcoating thickness. Three sorts of a chill plate made up of steel, dim cast iron and copper are utilized for the trials.

2.3 Casting Trial

Subsequent to selecting every one of the elements, levels and its sorts, casting has been performed. Synthetic synthesis was built up before casting the liquid metal. The arrangements of the liquid metal for trials are given in Table 3.

Trials are performed in light of changing the four variables. Trails are coded as 1S, 1C, and 1I. 1S implies the primary trail over a steel plate, 1C-first trail over the copper plate and 1I-first trail over gray cast iron plate.

3. Result and Discussion

The outcomes are watched and examined to ponder the impact of every element on chilled depth, mottled depth, and variety in microstructures.

3.1 Effect of Factors Over Chilled Depth

The impacts of every component examined over chilled depth and are appeared in Figure 5.

3.1.1 Effect of Coating Thickness

At "0" mm coating thickness, the chilled depth acquired was 4.5 mm (approx). At 3mm coating thickness, it is watched that the chill depth has expanded to 9.25 mm

Table 3. Chemical Composition

C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Sn
3.28	2.4	0.59	0.04	0.04	0.23	0.21	0.14	0.5	0.13

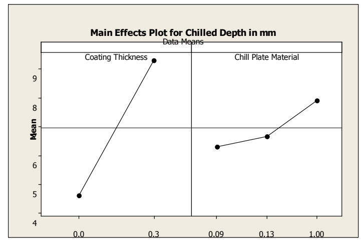

Figure 5. Effect plot for chilled depth in mm.

(approx). It implies chilled profundity is expanding as expanding the coating thickness.

3.1.2 Effect of Chill Plate Material

Three sorts of chill plate material have been chosen for the trail. Chilled depth is more with a copper plate (1.00) i.e. 8 mm approx, normal with dark cast iron (0.13) i.e. 6.75 mm approx, and less as contrast with all in steel (0.09) i.e. 6.25 mm approx. Here 1.00 indicates Copper, 0.13 means Gray Cast Iron and 0.09 signifies Steel. Thus copper chill plate is useful to get the around chilled depth.

From collaboration plot for chilled depth shown in Figure 6 unmistakably at "0", chilled depth is less of steel, and more in copper plate and at 3 mm coating thickness, chilled depth is more with the copper chill plate. So copper cast iron is useful for chilled depth development at both coating thickness.

3.2 Effect of Factors Over Mottled Depth

The impacts of every variable explored over mottled depth and are appeared in Figure 7.

3.2.1 Effect of Coating Thickness

At "0" mm coating thickness, mottled profundity is 3.25 mm (approx). At 3 mm, coating thickness, it comes to up to 5.25 mm. Consequently to avoid mottled zone coating thickness ought to be more.

3.2.2 Effect of Chill Plate Material

Mottled depth is normal with a copper plate, less of gray give iron and progressively a role as contrast with all in steel. Copper has 4.5 mm; Gray cast iron 3.5 mm and Steel

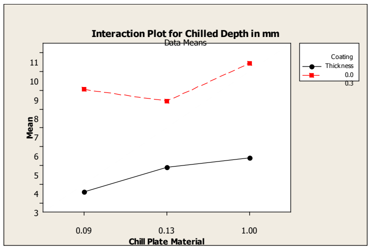

Figure 6. Interaction plot for chilled depth in mm.

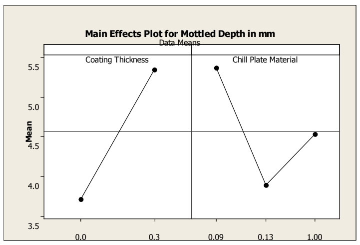

Figure 7. Effect plot for mottled depth in mm.

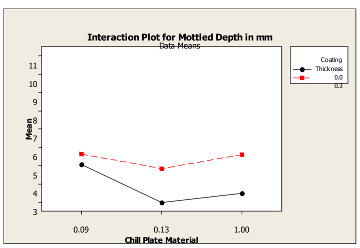

Figure 8. Interaction plot for mottled depth in mm.

5.25 mm. It is watched that Gray cast iron chill plate is useful in diminishing the mottled depth.

From association plot for mottled profundity shown in Figure 8, unmistakably at "0" mm coating thickness, mottled profundity is less of gray cast iron and at 3mm coating thickness mottled depth is more with chill steel plate. Yet, for Gray cast iron there is a substantial distinction. With the goal that Gray cast iron is useful for keeping away from mottled zone development at both coating thickness.

4. Microstructure Details

In every one of the cases a slope microstructure of white cast iron (chilled profundity), a blend of Carbides, Pearlite and fine Graphite (mottled structure) and gray give iron are found a role as appeared in Figure 9 from base to the highest point of the tappet.

- Chilled Zone Micro shows Cementite and alloy carbides observed (100 X).

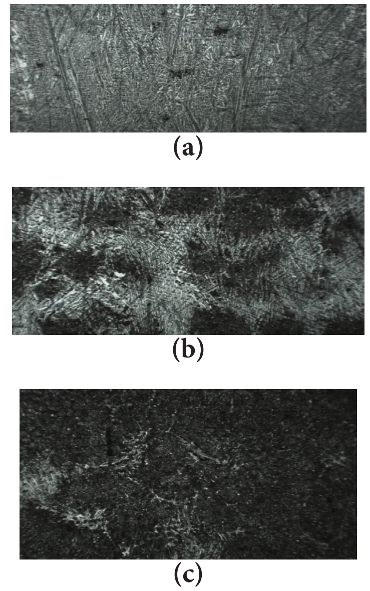

Figure 9. Gradient microstructure **(a)** Chilled Zone Micro shows Cementite and alloy carbides observed (100 X) **(b)** Mottled Zone Micro shows Cementite and Pearlite Few Type B&D type graphite observed (100 X) **(c)** Grey Zone Micro shows Pearlite and some ferrite with Type D Graphite.

- Mottled Zone Micro shows Cementite and Pearlite Few Type B&D type graphite observed (100 X).
- Grey Zone Micro shows Pearlite and some ferrite with Type D Graphite.

5. Conclusion

Use of foundry coatings containing super scattered metal oxide powders permits us to diminishing castings' surface roughness by 2-4 times, take out gas porosity at first glance and evade chilly close when casting leaded tin bronzes. This makes it convenient to diminish the machine remittance essentially. This impact is accomplished because of the little size of powder particles (< 1 mm): gasses oozed from the mold surface and amid the fastener ignition go between the powder particles as though through a wipe and are discharged along these lines from the metal casting zone. The subsequent layer between the mold dividers and the poured metal comprising of the super scattered powder coating and getting away gasses will empower the melt to be in the fluid state for a more drawn out period. Subsequently, liquid metal involves the whole shape depression staying away from the development of frosty close and misruns.

Coating thickness affects the chilled and mottled depth growth. Our aim is to increase the chill depth and decrease or to avoid the molted zone. As per above excremental trials, we observed that Coating thickness increases the chill depth and as well as molted depth also. We have to use the coating thickness very carefully to manage the chill and mottled depth. Combination of with coating thickness (0.3 mm) and Gray cast iron is giving good results for the chilled depth.

6. References

1. Monfared V, Hassan M, Daneshmand S, Taheran F, Ghaffarivardavagh R. Effects of geometric factors and material properties on stress behavior in rotating disk. Indian Journal of Science and Technology. 2014 Jan; 7(1):1–6.
2. Kumruoglu LC. Mechanical and microstructure properties of chilled cast iron camshaft, Experimental and computer aided evaluation. The Journal of Materials and Design. 2009; 30(4):927–38.
3. Seyedmohammadi N, Nemati M, Samariha A, Tabei A, Ravanbakhsh F, Kiaei M. Studying the effect of the age of a tree on chemical composition and degree of polymerization cellulose. Indian Journal of Science and Technology. 2011 Dec; 4(12):1–2.
4. Fras E, Gorny MH, Lopez L. The transition from grey to white cast iron during solidification. Archives of Metallurgy and Materials. 2006; 51(1):127–36.
5. Gafur MA, Haque MN, Prabhu Kn. Effect of chill thickness and superheat on casting/chill interfacial heat transfer during solidification of commercially pure aluminum. J Mater Process Technology. 2003; 133(3):257–65.
6. Fras E, Gorny M. Mechanism of silicon influence on the chill of cast iron. Archives of Foundry Engineering. 2007; 7(4):57–62.
7. Martyushev NV, Pashkov EN. Tribotechnical properties lead bronzes. Applied Mechanics and Materials. 2013; 379(87):87–90.
8. Martyushev NV, Pashkov EN. Bronze sealing rings errors and ways of its elimination. F7Applied Mechanics and Materials. 2013; 379:82–6.
9. Pashkov EN, Zijakaev GR, Tsigankova MV. Differential equations of processes for the hydro pulse power mechanism of drill machines. Applied Mechanics and Materials. 2013; 379:91–4.
10. Sorokova SN, Knyazeva AG. Numerical study of the impact of the technological parameters on the composition and stressed-deformed state of a coating synthesized under electron-beam heating. Theoretical Foundations of Chemical Engineering. 2010; 44(2):172–85.
11. Nikita V, Nikolay R. Effect of protective release coatings by super dispersers ed zirconium oxide powder on the generation of gas defects in bronze casting. IOP Conference Series: Materials Science and Engineering. 2013; 66(1):1–5.
12. Nastac L, Stefanescu DM. The foresight of grey-to-white transition in cast iron by solidification modeling. AFS Transaction.1995; 103(1):329–37.