iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IX **Month of publication:** September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31498

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Innovative Method for Production of High Chrome Iron Castings using Ceramic Foam Filters

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***Abstract:** The biggest challenge for an export foundry is to produce quality castings meeting international standards and competing with global casting manufacturers in terms of quality consistency, on time delivery and price. In case these are not met then there is a loss of business which means financial loss for the foundry. To combat these difficulties foundries look for producing castings first time right in accordance with international standard. For doing this foundries use many improvised techniques and application of ceramic foam filters is one of such initiative to arrest inclusions in high chrome abrasion resistant castings. This paper gives an overview of high chrome iron production using ceramic foam filters mentioning the mechanism of metal filtration, application of filters and benefits using filtration system for high chrome iron.*

***Keywords:** Endogenous and Exogenous inclusions Priming, Cake Mold Filtration, Deep Bed Filtration, Choke, ASTM A 532 Class III Type A.*

I. INTRODUCTION

Ceramic foam filters first appeared in the 1970s and have primarily been used for the filtration of cast iron and non-ferrous alloys. Initially used outside Russia, the filters were first introduced to Russia at the beginning of the year 2000. Many companies have introduced filters, but many production facilities have discontinued using filters due to bad results. The main problem encountered was filter breakage. However, this breakage issue was understood and fixed in due course of time.

As regards making inclusion free castings, the first step is to identify the source of any incoming non-metallic inclusions. These can be divided into two main groups – endogenous inclusions and exogenous inclusions. Exogenous inclusions are foreign bodies, typically sand particles, mould and ladle /furnace lining materials and furnace and ladle slag. Indigenous inclusions are the products of chemical oxidation reactions, which take place during the production and pouring of the metal. Indigenous inclusions are represented by silicates, oxides, nitrides, sulphides and their compounds. Metal that contains impurities will have reduced strength, and this usually requires a heavier section thickness to compensate for the lower strength. Impurities also present serious stress points if they are located on the surface of the castings that are subjected mechanical working. (Ref # 1 Foundry management & Technology Jan 1996)

II. CONCEPT OF METAL FILTRATION

Ceramic foam filter is an new industrial ceramic product with low bulk density (0.25 ~ 0.65) gm/cc , high porosity (60% ~ 90%), and three-dimensional reticulated structure. These filters are normally available in 10 and 20 ppi mostly with 15 mm thickness.

These filters have excellent properties like high temperature resistance, strong chemical corrosion resistance, and large surface area as a result of high porosity it is widely used in molten metal filtration to remove undesirable nonmetallic inclusions in the melt.

These filters are pre-fabricated shapes designed for use in iron foundries to provide a smooth laminar flow of molten metal and especially in ductile iron prevent the ingress of slag, magnesium reaction products, inoculant residues or sand grains into the mould cavity.

The maximum application temperature for filters in use at iron foundries is about 1450 degree C. The high filtration effectiveness combined with a reduction in turbulence often allows gating systems to be greatly simplified. These filters can be positioned vertically or horizontally in a suitably designed runner system. Filters can be also used in high pressure molding line. In some cases filters can be placed inside a pouring cup also and pouring can be done through filter fitted pouring cup. It is important to maintain a maximum height of fall of around 75 mm from pouring point. (Ref #2 Casting Technology and Cast Alloys, Prof. A K Chakravorty)

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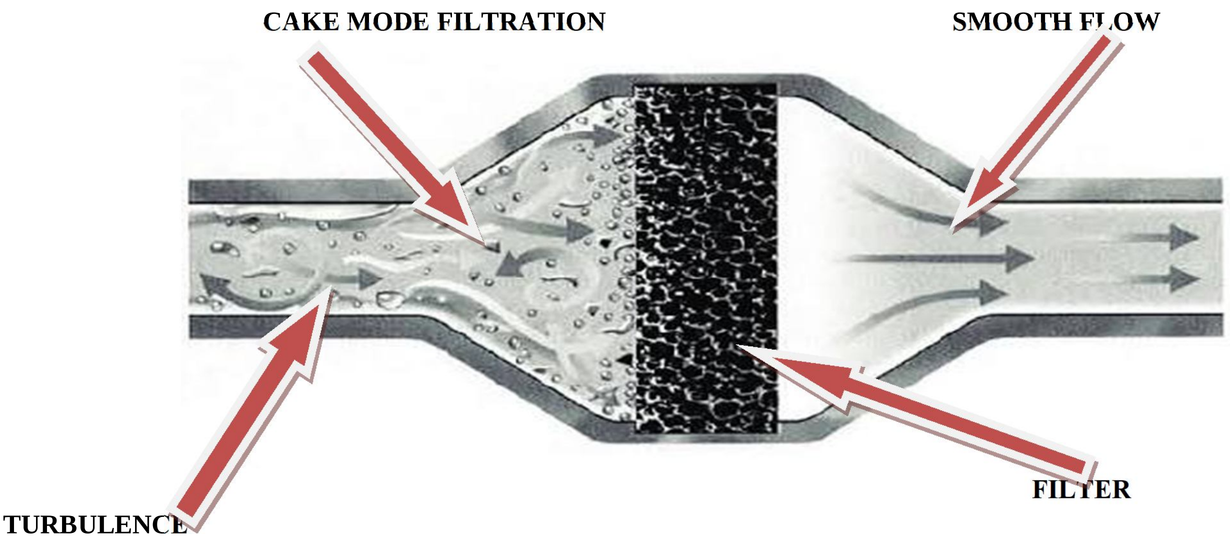
III. MECHANISM OF FILTRATION

As soon as liquid metal enters into a suitably positioned Ceramic Foam Filter an initial Priming occurs followed by Cake Mode Filtration. Big inclusions are arrested at the interface of the cake and still small finer inclusions which passes through this cake gets arrested deep inside these shapes. This is referred to as Deep Bed Filtration. An unpressurised gating system is the most suitable for effective filtration otherwise a filter can act as a Choke.

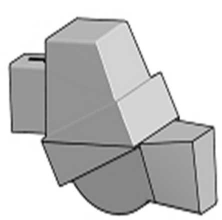


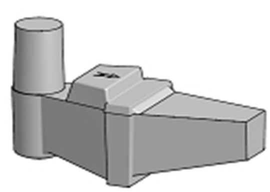
A favorable unpressurised gating system can be Downsprue Area : Runner Area : Total In gate Area is 1: 1.1:1.2.
Considering adequate clean metal a general guideline on flow rate of liquid metal through a 10 ppi filter is mentioned below:

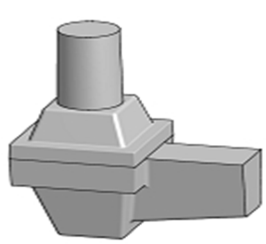
- Grey Iron : 2-3 kg/cm2
- Ductile Iron : 1-2 kg/cm2
- In-mold Ductile Iron : 0.5-1 kg/cm2

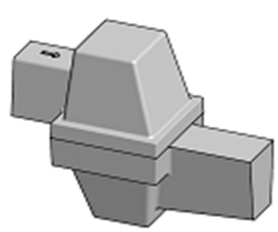
Turbulence is minimized using Ceramic Foam Filter as shown above.
(Ref # 3 Filtration & Gating systems- www.vesuvius.com)/ LANIK FOAM FILTERS)

A. Typical Filter Print Positions are Shown Below


Filter In Distribution Runner


Filter Under Sprue


Filter Under SPRUE


Filter In Runner

(Ref #4 Publication on LANIK filters)

B. Production Parameters Of High Chrome Iron Castings ASTM A 532 Class Iii Type A (*Ref#5: Inhouse Restricted Data Of CMF)*

Charge Mix for 1650 kg liquid metal.
Clean Metallic Charge including Foundry Return = 1400 kg.
Ferro Chrome = 230 kg
Special Alloying Element = 3.8 kg
Make up alloy addition = 18 kg
Composition of a typical alloy poured is mentioned below:

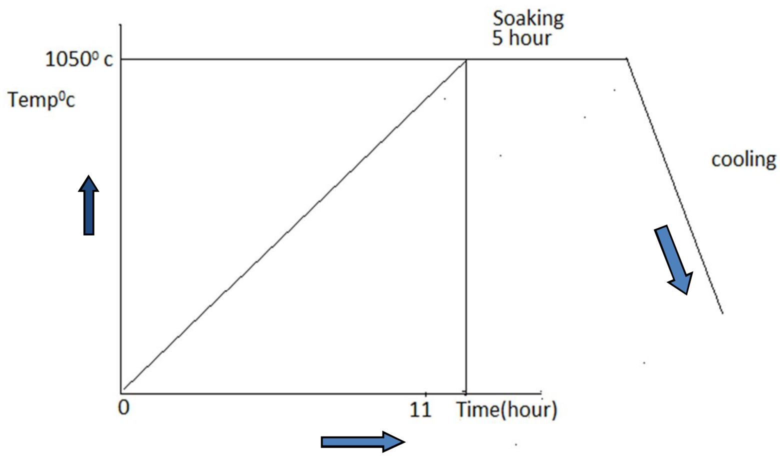
Carbon%	Silicon%	Manganese%	Chromium%	Copper%	Sulphur%	Phos%
2.60	0.593	0.718	26.19	0.409	0.0245	0.033

C. Pouring Temperature

Typical Pouring temperature for high chrome iron castings can be between 1380 to 1430 degree centigrade depending on the section thickness and geometry of castings.

D. Demolding & Heat Treatment

After pouring and sufficient cooling of poured molds de-molding is done followed by carefully removal of runners. Sand particles are removed from castings in a shot blasting machine. Castings are then heat treated in a batch type gas fired furnace and total hardening, air quenching and furnace cooling cycle including soaking time applicable is approximately 16 hours**.**
After heat treatment of castings final finishing and riser cutting as well as grinding operations are done followed by visual inspection using LPT.
A typical heat treatment cycle is shown below:



Typical Hardness after heat treatment can be approximately 630/650 BHN. This hardness can be increased to about 730 BHN by adopting special technique.

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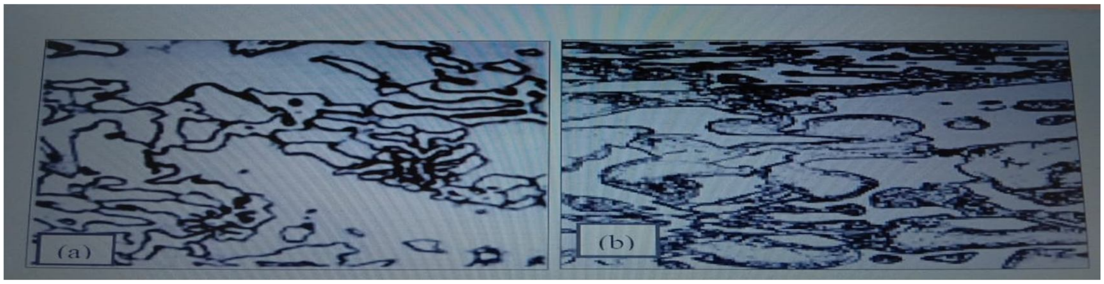
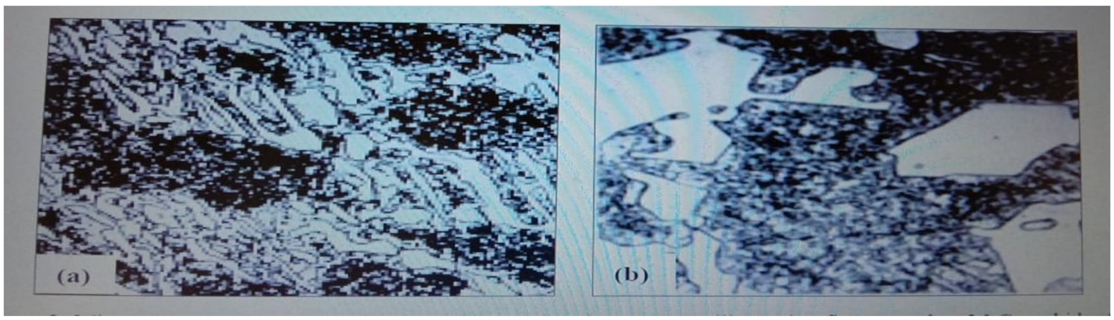
E. Microstructure



As cast microstructure (a) with austenitic matrix, (b) with austenitic- martensitic matrix (100X)

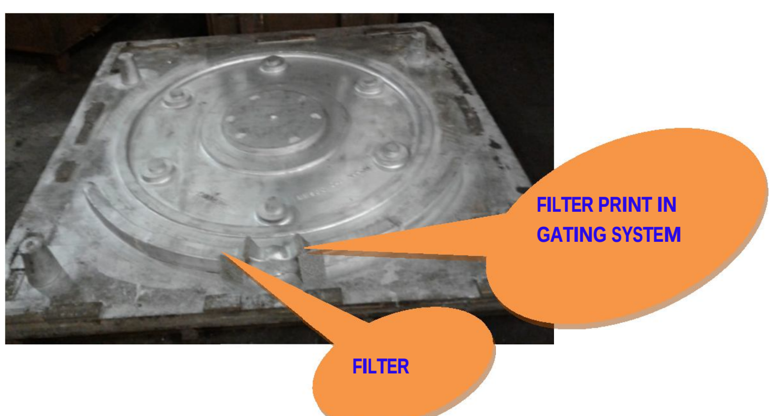


Heat treated microstructure of martensitic matrix with fine M7C3 carbides. (100X)

(Ref#6 : Microstructural characteristics and mechanical properties of heat treated HCCI, Kh Abdel Aziz, MEL Shennawy & Adel A Oman)

F. A Few Applications Of Filters For Making High Chrome Iron Castings

Pattern of Ring Casting



Pattern Of Liner Casting

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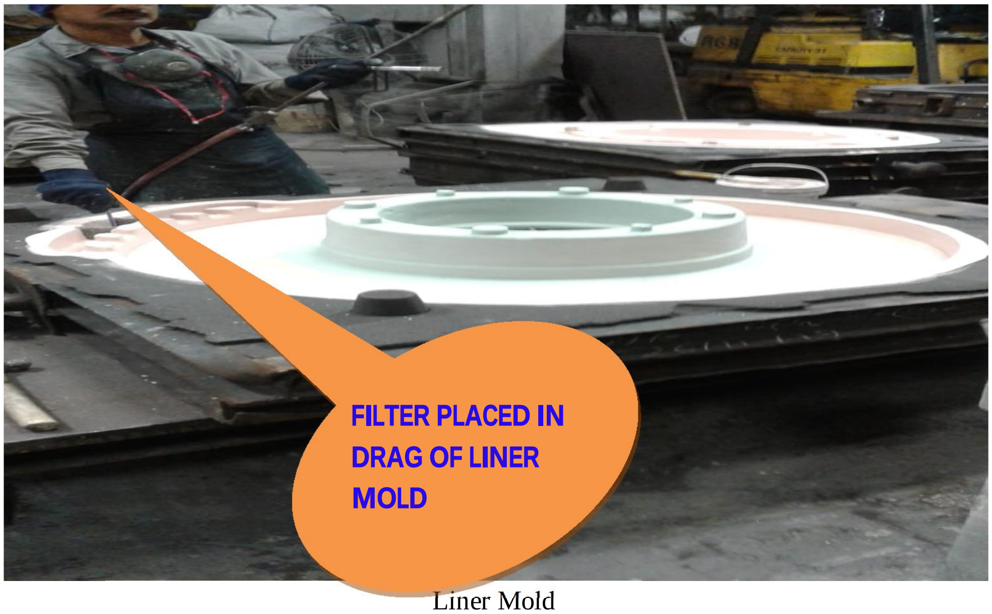
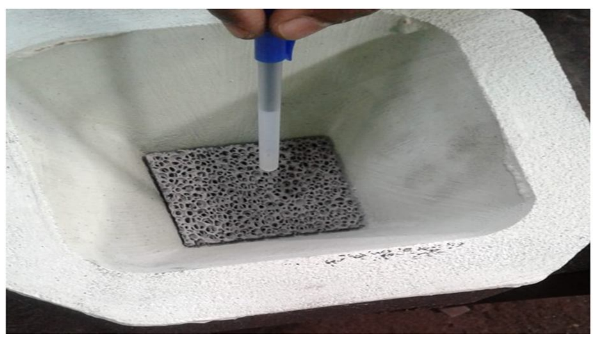


Liner Mold

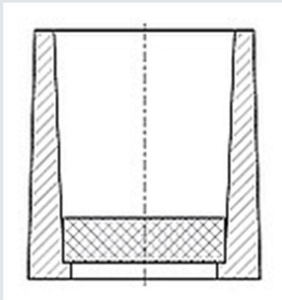

Filter Fitted Inside Pouring Cup

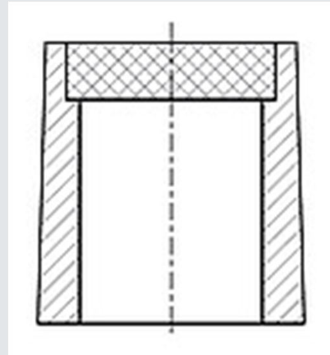

Liner Casting


Ring Casting

G. Benefits using Ceramic Foam Filters (Ref#7: AFS publication)

1) *Pouring a Casting using a Filter in the Riser:* Direct casting through the riser is a relatively new method which can be utilized with success in all materials, where the riser is necessary. The main advantage is the elimination of Gating System which means higher yield.





Filter in exothermic riser for Pouring an IRON CASTING

Direct Position — Reverse Bevel

2) Filters arrest Inclusions and help to make sound castings.
3) Filter helps to reduce turbulence in gating system.

IV. CONCLUSION

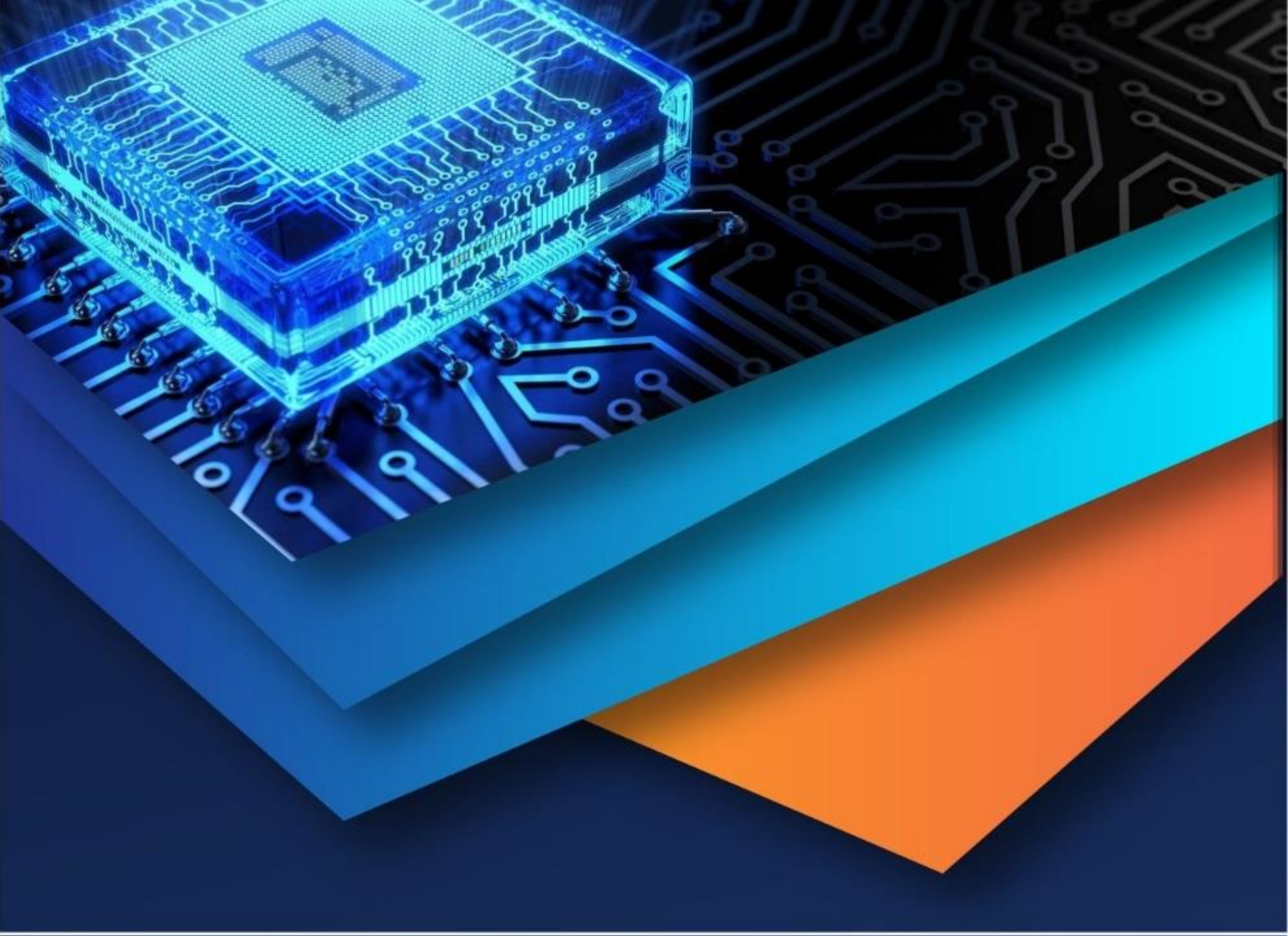
Foundries using Ceramic Foam Filters are immensely benefited as mentioned above. Simplification of gating system helps to reduce fettling time and improves yield. However, selection anSd application of filters requires experience especially in methoding of castings.

V. ACKNOWLEDGEMENT

The author is thankful to Cresmac Management for permitting to publish this paper.

REFERENCE

[1] Ref#1 Foundry management & Tecnology Jan 1996
[2] Ref#2 Casting Technology & Cast Alloys- Prof. AK Chakravorty
[3] Ref#3 Filtration and Gating System
[4] Ref#4 Publication on Lanik filters
[5] Ref#5 In-house restricted data of CMF
[6] Ref#6 : Microstructural characteristics and mechanical properties of heat treated HCCI, Kh Abdel Aziz, MEL Shennawy & Adel A Oman.
[7] Ref#7 AFS publication



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