THE INSTITUTE OF INDIAN FOUNDRYMEN

WESTERN REGION

FOUNDRY TALKS

Foundry E-Magazine

For The Foundrymen By The Foundrymen

Edition : January 2023
By : IIF - Western Region

INNOVATE TO ELEVATE
IIF-WESTERN REGION 2022-23

Innovation Article By

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MESSAGE FROM CHAIRPERSON

Lost Wax Castings

Anuja Sharma
Chairperson, IIF-Western Region
Dir.-Mrkt.-Shamlax MetaChem Pvt. Ltd.

Investment Castings also known as lost wax casting is a metal casting technique that has been used for almost 5000 years. When it comes to intricate designs with accuracy Investment casting is a preferred method. This process make efficient use of material and energy.

Investment Castings generally used in
Aerospace
Agriculture
Automotive
Electric Vehicles
Defense
Mining...etc...etc

This year during Republic day Parade, only made in India weapon systems were showcased including British 21 - gun salute which were replaced by 105mm Indian field guns. This is really matter of pride and foundry industries specially those into investment casting are contributing significantly in defence and aerospace and we witnessed the prowess of the armored with hitech indigenously made equipment during this Republic day.

So this edition of "Foundry Talks" dedicated to investment casting process, please go through it and share your valuable comments. Happy Reading.

LETTER TO EDITOR

Dear Editor,

Thanks for sharing the article. The reference parameters for the green sand system with respect to the molding line was really helpful, we thank the author for that and as well as the fish-bone chart for various defects.

Thanks & Regards,

From
Mr. Charanjeet Singh
Foundry - Owner

MESSAGE FROM THE EDITOR

Anant Bam
Editor Foundry Talk
Foundry Consultant
& Energy Auditor

Dear Readers,

This issue of Foundry Talks is dedicated to investment castings.

Although there are quite many senior foundrymen and consultants in this field, we found it very difficult to get good articles for this issue.

There were many hurdles we faced in compiling articles, however with strong support of team members, our young and dynamic Hon. Secretary came to our rescue. I owe big thanks to him.

Sometimes it is disheartening that many knowledgeable personalities hesitate to share their knowledge, but then looking at people like Prayut, one gets back their energy. Expecting your feedback and anticipating your contribution to this e-magazine.

Wishing you all a happy Utyarayan.

Happy Casting.

We truly welcome your feedback or suggestions for WR E-magazine. Please feel free to write to us at **wr@indianfoundry.org** with subject “Letter to Editor”.

FOUNDRY TIPS

UNDERSTANDING INVESTMENT CASTING WAX & BASIC TIPS TO MINIMISE WAX RELATED DEFECTS

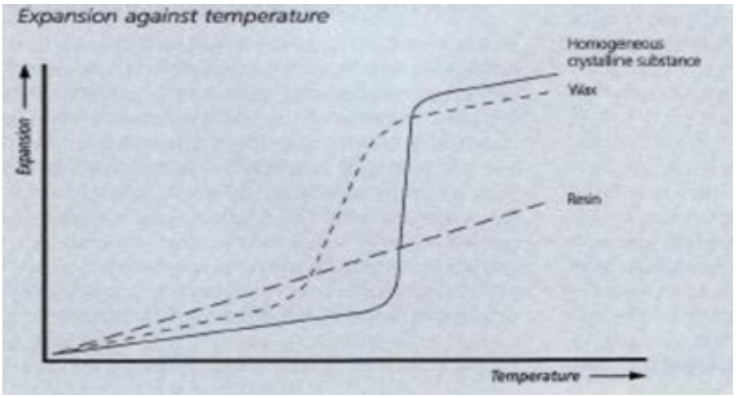
By Mr. Keith Batchelor
keithbatchelor@blayson.com

Structure of Investment Casting Wax

Many variations are formulated to suit differing requirements of wax. Key properties such as melting point, hardness, viscosity, expansion and contraction, setting rate are all influenced by the structure and composition of the wax compound. The complex composition manifests itself in a physical behaviour different to that of other substances. Knowledge of the properties of the individual components and how they interact is essential in understanding the behaviour of wax during the investment casting process. Wax properties influence pattern behaviour in the foundry and ultimately the quality of castings produced hence the understanding of wax characteristics and their control is critical to the investment casting foundry

Expansion & Contraction

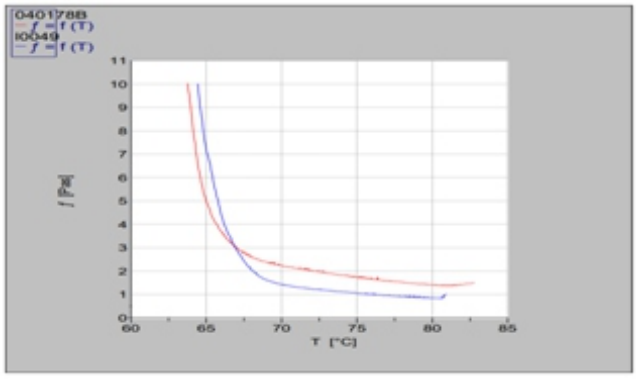
The structure and components used in an investment casting wax will influence the expansion and contraction. Like other materials wax expands on heating and contracts on cooling& in comparison with a metal the expansion is relatively high. Wax expansion and contraction rates are not uniform but vary with phase and structure changes during heating and cooling as shown in graph.



Wax Fluidity

Fluidity is the ability of a material to flow, in particular through thin sections. The effects of wax fluidity should not be underestimated as too low a fluidity may cause non-fill or flow lines &Too high a fluidity will lead to turbulence during injection causing flow lines and air entrapment.

There is a clear relationship between the viscosity of a wax and its fluidity, the more viscous, generally the less fluid, e.g. water and treacle and also between temperature and fluidity, the cooler the wax and die temperatures the lower the fluidity. Experiments show a linear relationship occurs in the liquid and paste regions, but not around the congealing point.

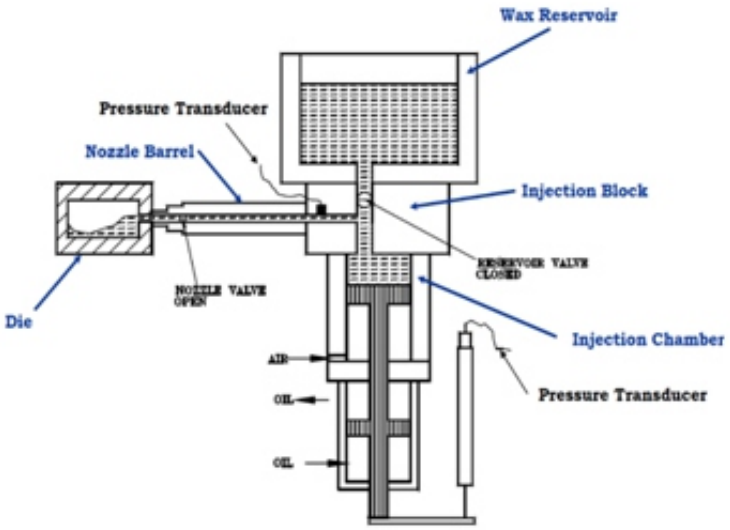


Wax Testing

Wax testing has traditionally been based around the Petrochemical industry with tests that can be performed with basic infrastructure such as

- Congealing point
- Melting point
- Viscosity
- Penetration
- Percentage ash

There are some advanced wax testing as well which are specifically developed to model how the wax is used in the foundry such as Rheometry, Infrared Analysis, Differential Scanning calorimetry, wax strength analysis, thermomechanical analysis, injection profiling and fluidity analysis.



Wax Injection System and its control

Basic schematic of the simple wax injection machine is given in the figure herewith. Mainly below parameters are important for injection machine controls

- Clamp Pressure
- Wax tank temperature
- Wax injection cylinder temperature
- Wax hose temperature
- Injection nozzle temperature
- Injection speed
- Injection pressure
- Platen temperature

It is known that wax has a very poor thermal conductivity hence any temperature changes take hours to achieve. As a rule 15 minutes per degree Celsius is suggested. When using automatic wax filling it is important that the liquid level in the holding tank does not fall too low. It is worth to know that temperature gauges give an indicative reading only and often do not reflect the wax temperature in the centre of the tank. Also, die temperature will change with use, this may give rise to changes in wax injection characteristics like fluidity. Fluidity of wax is also affected by the finish of the die & release agent, ability of the die to evacuate the air and injection pressure and flow.rates are not uniform but vary with phase and structure changes during heating and cooling as shown in graph.

Tips on Wax Storage

Whether its inside or outside wax materials will age prematurely with sunlight – If stored outside ensure they are covered, if inside ensure they are not located directly below a sky light.

Wax pellets stored in cold conditions, for example just above freezing should not be affected unduly if in sealed bags& pellets stored at elevated temperatures for example above 30°C may soften and stick together. Ideal storage temperatures 20 - 22°C.

Care should be taken to ensure that wax products are not in direct contact with solvents for long periods as this will “soften” or even dissolve them. With materials such as water soluble wax it is important to ensure they are sealed from moisture in the atmosphere.

Wax materials have a shelf life, typically 2 years if storage conditions are ideal.

Tips to Minimise Wax Related Defects

Flow Lines: It is defined as a negative surface indication seen as a line from above. It is caused due to lack of energy within the wax either as a result of cold wax or turbulence and it can become a source of ceramic inclusions on shelling, weakening of the wax structure.

Possible solutions:
- Increase the injection pressure
- Increase the temperature
- Reduce the turbulence by reducing pressure and or flow
- Use a filled wax
- Use more viscous wax

Surface Pitting: It is a rough surface finish which visually has a "Sandpaper" effect caused by the lack of wax fluidity and causes ceramic inclusions on the shelling.

Possible solutionsis to increase the wax fluidity by either increasing the temperature or changing the wax.

Cavitation: It is a surface depression, normally in the form of a bowl like shape caused by the lack of feed to the area. Possible solutions are:
- Reduce the injection temperature
- Increase the size of the injection sprue
- Use a filled wax
- Use a wax "chill"
- Reduce die temperature

Incorrect Wax Dimensions: It is caused if the wax contraction is incorrect giving the finished parts to be of wrong size. Possible solutions are to change the wax temperature, change wax or change the die dimensions (expensive).

Air Defects: It is either surface or just below surface depressions caused by air and mainly caused due to inability of the air to escape from the wax quickly enough during injection. Possible Solutions:

- Reduce wax turbulence
- Increase wax viscosity
- Allow air to escape from the die more easily

Non-Fill or Cold Shut: The cavity either does not fill completely or the pattern has rounded edges. It is caused due to insufficient wax energy to fill the die cavity. Possible Solutions are:

- Increase injection pressure
- Increase wax temperature
- Make wax more fluid
- Improve wax venting
- Reduce turbulence

Good Assembly Practices: Most of the defects can be taken care during the assembly stage. Below are some tips which can be a good assembly practice:

- Ensure any negative depressions such as flow lines and surface depressions are filled in or polished out.
- Parts should be allowed to complete contraction before assembly as failure to do this may put pressure on the joints.
- Remember wax has a 'memory', and particularly twisted sections will attempt to straighten themselves over time once taken off setters.
- Any liquid runs from glue or welding should be trimmed off, as they can be a source of shell inclusions.
- Air Defects near to or breaking the surface must be exposed and filled. Ensure all surfaces are clean and free from release agent, consider use of pattern wash.

Innovation Article

By M/s. SoftCAST

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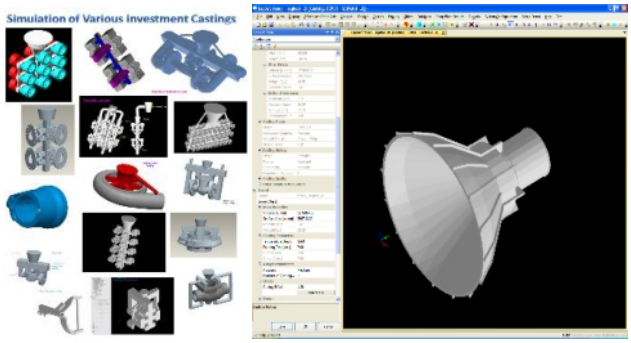
SoftCAST IC v4.4->v5.x: Advanced Simulation & Methoding System for IC Foundries

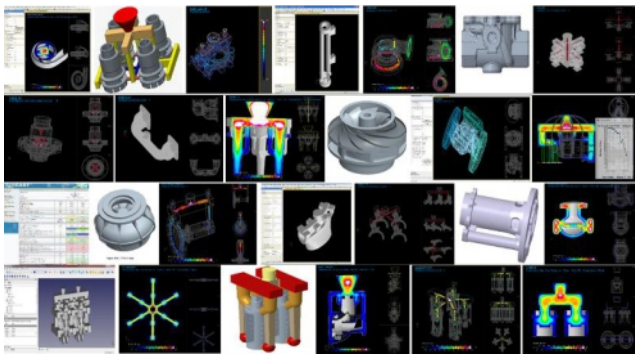
SoftCAST™ IC System: SIMULATION + SOLUTION

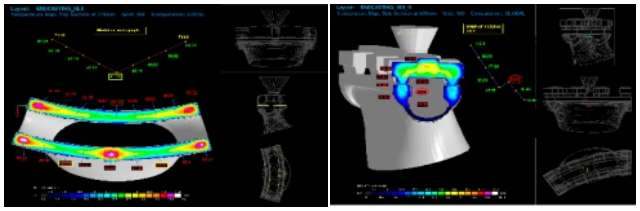
SoftCAST IC is an advanced Simulation and Methoding System specifically designed and tuned for the IC Industry. The **latest version is SoftCAST IC v4.4, with enhanced versions v5.x on the horizon.**



A multi-award winning software, SoftCAST™ IC simulates casting behavior during manufacture. A complete simulation system for IC castings and their method designs (i.e. Trees), for all cast alloys, with variants for both lost wax and lost foam processes, it contains all the Simulation and Method Design Modules required by an IC foundry to perform casting and Tree simulations, to design and develop methods, and to improve Quality and Yield. Both, Single-User Stand- Alone System, and Multi-User Client-Server System, are available. The System incorporates all alloy, mold and process parameters, and cooling and heating appliques, with no limitation on size, weight, or thickness.

From the various simulation outputs, one can easily understand the solidification zones, the castability, defect potential and quality issues, and methoding requirements. It shows the precise required locations of the feeding-gating entities, i.e. the gates, vents and cooling entities. The design modules in SoftCAST™ facilitate easy development of new methods and optimization of existing methods. You can quickly get inputs on a methoding strategy for your casting, and easily check the efficacy of a method, *i.e.* whether a given Tree design will result in acceptable quality castings. If the resultant quality is Not OK, as seen from the simulation outputs, you can easily understand what and how to modify in the method design so as to secure good quality castings.



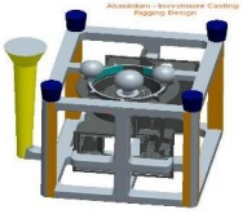


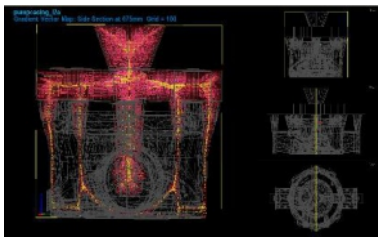
The System is specifically designed for the IC segment: the thermodynamic nuances of this casting process, especially with multi-cavity and stack-structured Tree designs, make for a degree of complexity that goes beyond the normal obtained in other cast processes. This is true in the case of both lost wax and lost foam investment processes. The SoftCAST IC System incorporates all the features and factors necessary for simulating this process with these nuances. Apart from being experimentally tuned at a leading IC Foundry, it has been field-tested and proven across hundreds of castings and their Tree designs, and across a large number of users.

Key Modules/Features of SoftCAST IC v4.4:

SoftCAST IC v4.4 incorporates the following main modules/sub-systems:

Complete Simulation System for IC Castings and their Methods (Trees). A variety of graphical and numeric displays of the simulation results assist the IC designer in easy inferencing of the casting and Tree behavior: Hotspots, Sectional & 3D TempMaps, Gradient Vectors, Thermal Traces, Feed Metal Flow Paths, Heat Intensity, Significant Modulus:

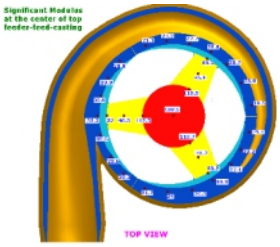


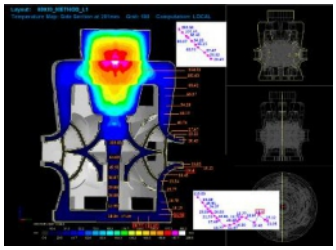


a) From the results of the casting simulation, the User can understand its behavior, and get inputs on: locations and intensities of hot spots, whether the thermal profiles set up are conducive or not, the extent of feeding, extent and intensity of isolations, casting quality and defect potential, castability, and methoding guidelines: Solidification Zones, and required locations of the Gates and Cooling appliques.

b) From the results of the method (Tree) simulation, the User can understand its behavior, and infer the following:

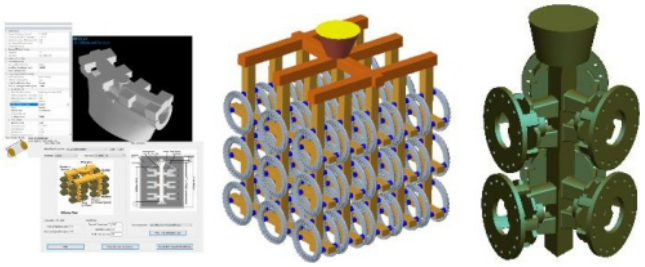
1) Whether the casting would be OK or not,
2) Quality level that would be achieved, and
3) Design modifications needed to eliminate / minimize the likely defects.

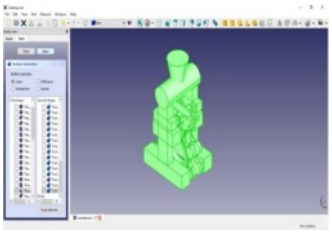


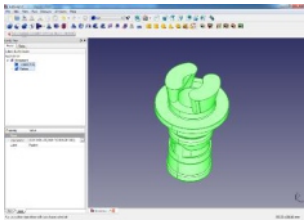


Method Design System: this unique module computes all the feeding-gating entities, from Gate (Feed) to Pour Cup, through the intervening Feeder & Runner bars, catering to all types and shapes: for single-cavity & multi- cavity designs, for single & multi-stack designs, and for any Tree configuration. With all scientific principles taken into account, the System eliminates human error, and enables robust and safe designs, as also optimization of the Tree designs.

AutoLayout: This CAD system, integrated inside SoftCAST IC, enables semi-automated creation of the solid model of the Tree, automatically taking inputs from the Tree Design system, and then generating STP and STL files of the Tree. Equally important, AutoLayout has facilities for correcting the casting model that is input. This is apart from the CAD Healing module which minimizes model errors and normalizes the mesh. At times, especially with CAD models created in surface modelers, errors creep into the 3D model, that are not seen in the surface modeler but get trapped and shown up in solid modelers. Given that all CAE systems need true solid models of the entity for accurate simulation and analysis, this is a great aid to IC Units that create 3D models in surface modelers and then use them in the SoftCAST System.





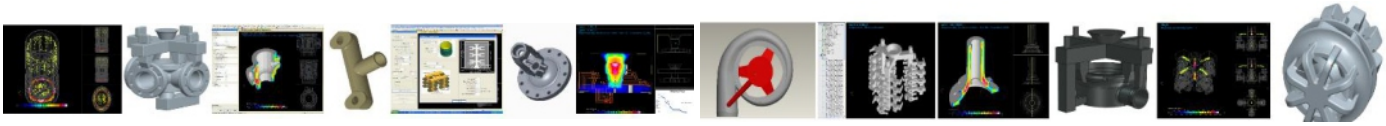


Assessment & Report Modules: Assessment of a casting and its method designs is done on a number of quality parameters as also on yield. More important, comparative assessment of two or more Tree designs enables Quality Improvement and Yield Improvement without shop trials. This module also generates HTML and indexed PDF Reports on the entire casting project.

Moving on ... to versions 5.x: A number of add-on modules are WIP; these upgrades cover: 3D thermal visualizations and animations, Thermal traces, Sectional Thermal animations, Solidification Times and Movement of the Solidification Front, Niyama Criterion and Hot Tearing. A new Tree Assessment module is being included to strengthen the AR module. Examples of some other enhancements include: a wax module, computation of weights of the Tree Pattern and Tree Shell, estimation of the approx. number of castings that can be loaded onto a Tree, Fin design and Fin display, Filling Time checks, and Flow characteristics.

And finally, one of the add-on modules, a KB Module, is worth mentioning. The Knowledge Base module contains advanced technical information on a variety of relevant topics, such as:

a) Cast alloys, liquid metal flow and freezing behavior, casting quality and customer requirements
b) Casting simulation result inferences
c) Method (Tree) simulation result inferences
d) Methoding
e) Quality and Defects; Prevention vs Cure; Causes and Remedies
f) Castability, DFM, and optimizing casting design for manufacturability



Mahesh Date

Raw Material Price Index

Movement In Foundry Raw Material Prices

As per IIF data, there are nearly 7,000 foundries across India. The Indian foundry industry is ranked second globally with a production of 10 million tons per annum. It is catering to the automotive, tractor, power train, railways, energy and engineering sectors in domestic as well as overseas markets - Directly and indirectly.

There was sudden spike observed in April. 2022 and continued due to various reasons. Prices got declined-stabilized thereafter but these fluctuations led us to establish the common reference point where we can study the actual raw material prices variations.

Now prices ruling in Kolhapur during second week of Jan. 2023 are given in column 14 in the Table below. Also, given in table are the prices since Oct. 2022. These prices are collected from Kolhapur market. These are approximate, ruling during the month and week as indicated in the table.

In the prices indicated below, transportation cost is included in most items. Only applicable GST is to be added. Prices of many materials are on the basis of "Immediate Payment"

Movement Of Prices of Raw Materials over a Period of 4 Months

(A) Major Ferrous Metallic Raw Materials, Low Ash Metallurgical Coke, and Electro-Graphite Fines {Rs / Tonne}														
	Oct'22	Oct'22	Oct'22	Oct'22	Nov'22	Nov'22	Nov'22	Nov'22	Dec'22	Dec'22	Dec-22	Dec-22	Jan-23	Jan-23
	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week
Foundry Grade Piglron	56850	55850	54666	54666	54666	53666	52314	52314	52314	51766	51766	51766	51766	52366
MS Scrap (good quality)	50500	50500	50000	49000	47500	45500	47000	47500	45500	45500	44000	44500	44500	46000
Low Mn Steel Scrap	53000	53000	52500	52000	51500	50000	50000	49500	49000	48500	48000	48500	48500	49000
Si Steel Stamping Scrap	52000	52000	51500	51000	51000	49500	49500	48500	48500	48000	47750	47000	48000	48000
Low Ash Met. Coke	57000	56500	55000	53500	52500	51000	50000	52600	52600	52600	51600	52000	52000	53500
Electro-Graphite Fines	102000	102000	101000	101000	101000	100000	100000	100000	100000	100000	99500	99500	99500	100000
(B)Major Ferro-Alloys {Rs./Kg}														
Fe-Si (70-75% Si)	150	150	145	145	142	142	141	139	135	132	132	138	138	135
Fe-Si-Mg (5-7% < Mg)	230	230	210	205	205	205	200	195	195	190	190	195	195	195
Fe-Si-Mg (5-7% < Mg) (TOL)	±5	±5	±5	±5	±5	±5	±5	±5	±5	±5	±5	±5	±5	±5
High C Fe-Cr (60% Cr)	240±5	240±5	230±5	220±5	210±5	210±5	200±5	200±5	195±5	195±5	195±5	200±5	195±5	200±5
High C Fe-Mn (60% Mn)	126	120	115	115	110	100	100	100	100	98	98	98	97	100
Ferro-Moly (60% Mo)	95	95	92	92	90	90	89	90	88	88	86	84	84	86
Ferro-Moly (60% Mo)	2400	2400	2400	2200	2200	2350	2550	2700	2750	3000	2900	2800	2800	2700

1. Above Prices are Excluding Taxes, GST Extra as Applicable
2. Phenol Price: Rs. 130/Kg during 2nd week of January 2023

(Info collected during Jan.2023, Reader are requested to check the market prices)

Disclaimer: Rates represented here are as per the data collected from the reliable sources based in Kolhapur and it may vary based on the supplier, location, payment terms & other conditions.

Innovation Article

By M/s BDA Industrial Resources Pvt Ltd.

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HIGH PERFORMANCE BACKUP BINDER FOR THE INVESTMENT CASTING COATING PROCESS

BDA INDUSTRIAL RESOURCES PVT. LTD. Is a Supplier of Raw Material Utilized in Lost Wax Precision, Investment Casting, Sand Casting, Cast Irons & S.G. Our Products are supplied to dominant foundries, steel plants, ceramic, refractories, and textile industries across the globe.

With a Legacy of more than a Century, BDA has continued to flourish and has a Latest addition to the business I.E., manufacturing of sands and powders for investment casting coating application. Our endeavor is to succeed as a chief manufacturer and supplier of raw materials in various fields such as textile, chemical & auxiliaries.

DOMESTIC AND GLOBAL PRESENCE

With the support of our Domestic and Global trade partners, BDA has accomplished a trust and achieved a distinguished Position in the Industry. We feel proud to mention about our distribution ship & association with prominent companies consistently for years, across the globe. BDA has successfully catered 250+ companies. BDA are partners with many MNC's and more in past and current.

OUR PRODUCTS

Over the years BDA has derived numerous products for various industries, one of the products being exclusively supplied by BDA is Matrixcote System from Ransom & Randolph which is a very high performance back-up binder system used for secondary coating slurry for the investment casting process. It has numerous advantages which has been highlighted below in the form of case study for the benefit of IIF members.

MATRIXCOTE® SYSTEM

Background

In an effort to improve casting results for a commercial casting foundry, whose existing shell was under performing. R&R tailored the Matrixcode System to improve their casting results. This particular foundry was experiencing significant dewax cracking. positive metal and permeability defects. as well as losing money in scrap and rework. R&R was pleased to provide the foundry with the Matrixcode System customized specifically to meet their needs.

The Foundry's existing shell was composed of colloidal silica binder. a fused silica refectory containing carbon and fiber and an alumina silicate stucco. The typical shell sequence required an intermediate coat, 2-3 backup coats (depending on the part) and a seal coat.

The Challenge

Given the casting issues that the foundry was facing. the following goals were identified:

1. Reduce or elimate dewax cracking. with the existing system, over 50% of the trees going through dewax showed signs of cracking. As a result a post - dewax seal dip was being applied to all trees. This not only increased cost in material usage. but also interrupted the process flow. which created logistical issues as well. figure 1 shows one of the parts chosen for this measurement.
2. Reduce for elimate positive metal defects. With the existing system, there were certain part configurations that required nearly 100% rework due to positive metal. Figure 2 shows one of the most challenging parts chosen for this measurement.
3. Increase permeability to reduce or elimate defects. Fifure 3 shows one of the parts chosen for this measurement.
4. Accomplish these goals without adding backup coats to the process. The existing system allowed the foundry to decrease the number of backup dips that they needed previously, by one coat.

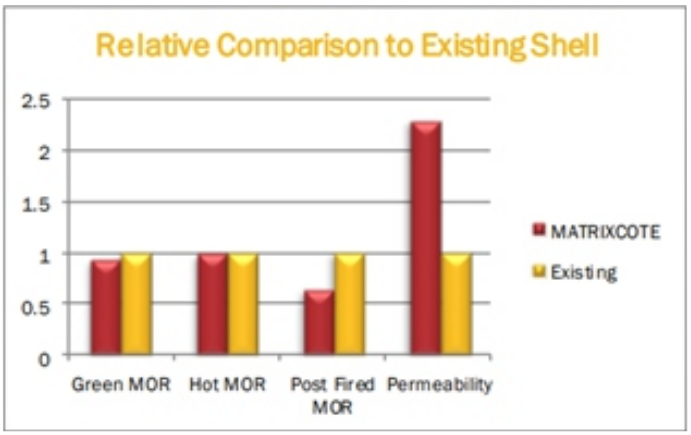
The sequence of shell coats was maintained: 2 primary coats (Keycote binder), 1 intermediate coat. 2-3 backup coats and a seal coat.


Figure 1


Figure 2


Figure 3

Photos from left to right show parts experiencing cracking. Possitive mental and permeablity defects.



The Trial

The matrixcote system tailored to meet the challenge was a combination of Matrixsol® 30 colloidal silica, Matrixcote® concentrate with fiber, and Matrixblend® blue refractory with alumina silicate stuccos. MOR data generated in the laboratory indicated that the Matrixcote system had similar green and hot strength to the existing material. Laboratory data comparing the two shells also indicated that post fired strength was reduces by 35% and permeability was increased by 128%.

In the foundry, the Matrixcote system showed promise as indicated with the 2¾ inch round ring part shown in figre 1. The Shell from supervisor noted that the shell made with the Matrixcote system was thinner than their existing shell. but showed cracking on only one ring where the existing shell showed cracking on multiple rings.

Scrap and rework associated with positive metal on parts shown in fig. 2 were decreased significantly after a simple wetting agent adjustment in the intermediate slurry made with the Matrixcote system. Similarity, gas defects pr4eviously seen on the parts shown in Fig. 3 were elimated. The foundry moved the Matrixcote system onto one robot system. After consuming all the existing material on the second robot, it also was converted to the Matrixcote system.

Conversion

Conversion to the robots required two minor modifications to slurry viscocity. Both were very easily implemented and the foundry supervisor noted that the slurries have been easy to maintain ever since. The foundry no longer struggles to keep slurries in control and continues to see positive casting results on their parts. including the more difficult to cast parts shared in this case study.

The foundry supervisor noted unanticipated operational benefits after conversion as well. These were not identified as original goals for the trial, but are attractive additional advantages.

1. Slurry make up is much faster than the old system. It takes approximately 20 min. in a high shear mixer set to low speed to make the slurry. Once made, it is ready to use. The slurry required a more rigid. high shear protocol and took 60min. or more to make.
2. Slurry maintenance is very easy. The slurry made with the Matrixcote system is very consistent and hitting the appropriate viscosity target takes little effort. The old slurry seemed to be more temperamental and the foundry never quite got the viscosity target right.

The foundry has been extremely pleased with the results that they continue to achieve with the Matrixcote system and look forward to the lasting success of the system.

Other products which BDA Industrial Resources Pvt Ltd, deals in are as mentioned below:

Our Products

Minerals

- Alu Silicate
- Kaynite
- Pyrophyllite
- Calcined Clay
- Fused Silica
- Pure Alumina
- Silimanite
- Quartz / Silica
- Zircon
- Size Available*

Insulation Material

- Mica Sheet
- Coil Sheet

Technology Ceramics

- Ceramic Bar (To use as a Ceramic Core)
- Ceramic Metal Pouring cup
- Ceramic Crucible

Chemicals

- Polymer Binders for Prime and Backup Coat
- Colloidal Silica 30%
- Wetting Agent (O.T.)
- Anti foaming Agent (N. Octanol)
- Pattern Wash & Pattern Shield
- Ethyl Silicate 40%

Refractories

- Basic Ramming Mass
- Netural Ramming Mass
- Patching Material
- Gas Diffuser

Waxes

- Filled Pattern Wax
- Un filled Pattern Wax
- Water Soluble Wax
- Stick Wax
- Patching Wax
- Recycled Wax

Our Brands

Calusil®

Calusil products range includes processed minerals for stucco and secondary slurry.

- Calcined raw materials with additives for shell permeability.
- Fast dry of shells
- Smooth knock out
- Better sticking ability due to maintained grain size.

Duracast®

Duracast product range includes filled and non filled pattern waxes, patching waxes, stick waxes and soluble waxes for lost wax precision casting.

- Durability with performance
- Excellent surface finish
- Dimensional stability
- Complex and intricate shapes can be produced.

Zicroprime®

Zicroprime are high quality zircon sands and zircon flour from world best zircon mines.

Zircon is used in the foundry industry mainly for casting and refectory applications. Zircon's properties make it ideal for use in sand casting. investment casting and as a mould coating in die casting processes. It is also used in refractory paints and washes to reduce wettability of other foundry sands.

Precibond®

Precibond product range includes various high performance chemicals for ceramic shell casting.

- Polymer enhanced material to give superior performance and stronger bonding.
- Consistent coating is obtained in slurry and slurry draining will improve.
- Shell cracking is elimited on the primary coat.
- Boosts to help the gelling process of colloidal silica
- Decreases drying time of shells
- Improves adhesion of prime coat with wax.
- More tolerant of unfavourable environmental conditions. (humidity, temperature, air movement)
- Increases shell permaability when its polymer is burnt out in shell backing furnace.
- Better stucco adhesion performance.

BDA®
Active Since 1959

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SPECIAL INSIGHTS

Estimation of Complexity Involved in Investment Casting Using Complexity Computation System (CCS)

By: Mr. Nikunj Maheta, Bharat Davda & Dr. Amit Sata

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CEO, Foundry Business Centre, Rajkot
Professor, Department of Mechanical Engineering, Marwadi University, Rajkot

India has created a benchmark in the domain of metal casting since last few years, and maintain the position of second largest metal casting producers of world. India has more than 4500 foundrieswith market size of more than 19 billion USD, and contributes nearly 0.7% in Gross Domestic Products (GDP) of India. India also significantly contributes nearly 4% (worth of 425 million USD) by producing investment castings from more than 600 investment casting foundries. Investment casting market is expected to grow at a rate of 2.8% in next five years as investment casting is an effective manufacturing process to produce extremely thin and multifarious components with closed dimensional tolerances and excellent surface finish.

Various stages in manufacturing of investment castings usually involves, creating expendables wax patterns by injecting molten wax into the metallic die with the help of wax injection machine; making of pattern-tree by assembly of wax patterns with riser, sprue, runner as well as gate (also made of wax); building ceramic shell around to assembled tree by dipping it into slurry (made of sand, binder and some additives) till sufficient hot and cold strength of shell is achieved; dewaxing to remove wax from built ceramic shell; backing of dewaxed ceramic shell followed by pouring of the liquid molten metal (parallelly melted using melting furnace) inside the ceramic shell followed by solidification and knockout operation. Investment castings manufactured passed through these stages usually take lots of efforts, rigors follow-up and energy, and can be employed in different sectors including aerospace, automobile, bio-medical, chemical, defense and many more.

Rajkot is geographically located in western India, and considered to be one of the largest clusters of investment casting foundries in India with more than 200 functional investment casting foundries. An industry survey of nearly 25% of these foundries has been conducted for getting an insight about regional foundries' capacity, capabilities, competency, challenges as well as concerns. It was revealed that one of major challenges faced by regional investment casting foundries is related to lead time required to develop new investment casting, and it consumed on an average duration of four weeks. It is known that lead time is mainly driven by complexity of industrial component, and in turn it usually based on information about several parameters related to geometry (e.g., length, breadth, height, volume, thickness of casting) as well as features (e.g., presence of a hole, slot, groove, fillet, rib, or boss in the casting) required in investment casting and manufacture ability (e.g., types of alloys, desired hardness, need of any supplementary processes, range of pouring temperature, batch size) of the relevant foundry. It is also revealed from an industrial survey that development of newly required product is mostly initiated immediately without any systematic approach that might assists in estimating the possibility of manufacturing it using investment casting process considering respective foundry's capacity as well as capabilities.

This is due to the fact that decision to manufacture any industrial component using investment casting process is usually taken by past experience or by using trial and error approach. Other key concern about required relatively longer lead time is lack in adopting systematic approach as well as implementation of advanced technologies to estimate complexity of investment castings. Also, specific methodology to connect complexity with cost of manufacturing is relatively unexplored. The lacking in adopting systematic approach as well as advanced technology in estimating complexity of investment casting and its connection with estimating cost of manufacturing mostly leads in incorrect decision about manufacturing any industrial component using investment casting. It is further results in increasing overall lead time as well as more rejection, and in turn results in loss of productivity, energy, etc.

A very user-friendly tool, Complexity Computation System (CCS), to address the challenges faced by regional foundries has been developed by team of researchersat Marwadi University located in Rajkot (India). This tool usually mimics the intelligence of domain experts that estimates overall complexity involved in an industrial part, and provides guidelines about possibilities to manufacture it using investment casting process. Furthermore, it can also be integrated with any design tool for computing manufacturing cost of an industrial component.

The CCS estimates the complexity based on details related to geometry characteristics, desired features and manufacturability of an industrial component provided by OEMs. The CCS is essentially an expert system that is comprised of four layered architecture, and need inputs related to 19 different elements(dimensional and surface characteristics, hole, slot, groove, hollow region, rib, boss, fillet, chamfer, alloying elements, desired properties, need of any melting aids, need of any solidification aids, need of any supplementary aids, melting temperature and application); 52 attributes(e.g., length/width/height of industrial component, shape and size of features, low/medium/high alloy, batch size); 212 meta-attributes(presence/absence of features, and quantification of these attributes) for computing complexity of investment castings. These architecture and relevant elements, attributes as well as meta-attributes were selected as a result of interaction with more than 75 investment casting foundries located in Rajkot cluster. The relative weightage of each element, attribute and meta-attribute were also computed using one of most effective multi-criteria decision-making method. This tool was also tested on more than 75 industrial components for estimating complexity of investment casting. One of such industrial components (table 1), and its complexity estimated using CCS is demonstrated herewith (figure 1-5).

Table 1: Industrial component used in demonstration for estimating complexity index

Sector	Automobile
Specific alloy	EN9
Volume (mm3)	29260
Weight (kg)	3.8
Wall thickness - Minimum (mm)	2.5
Wall thickness - Maximum (mm)	9.8
Batch size (quantity)	750
Need of heat-treatment	Yes
Need of NDT	Yes
Need of machining	No
Lead Time(Weeks)	04

Figure 1: User interface of CCS

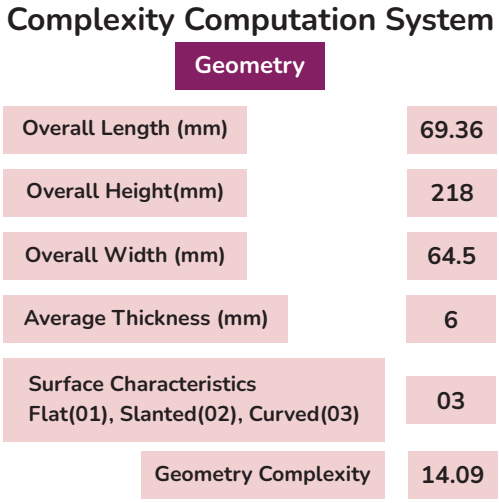

Figure 2: User interface for providing information about desired geometry of casting

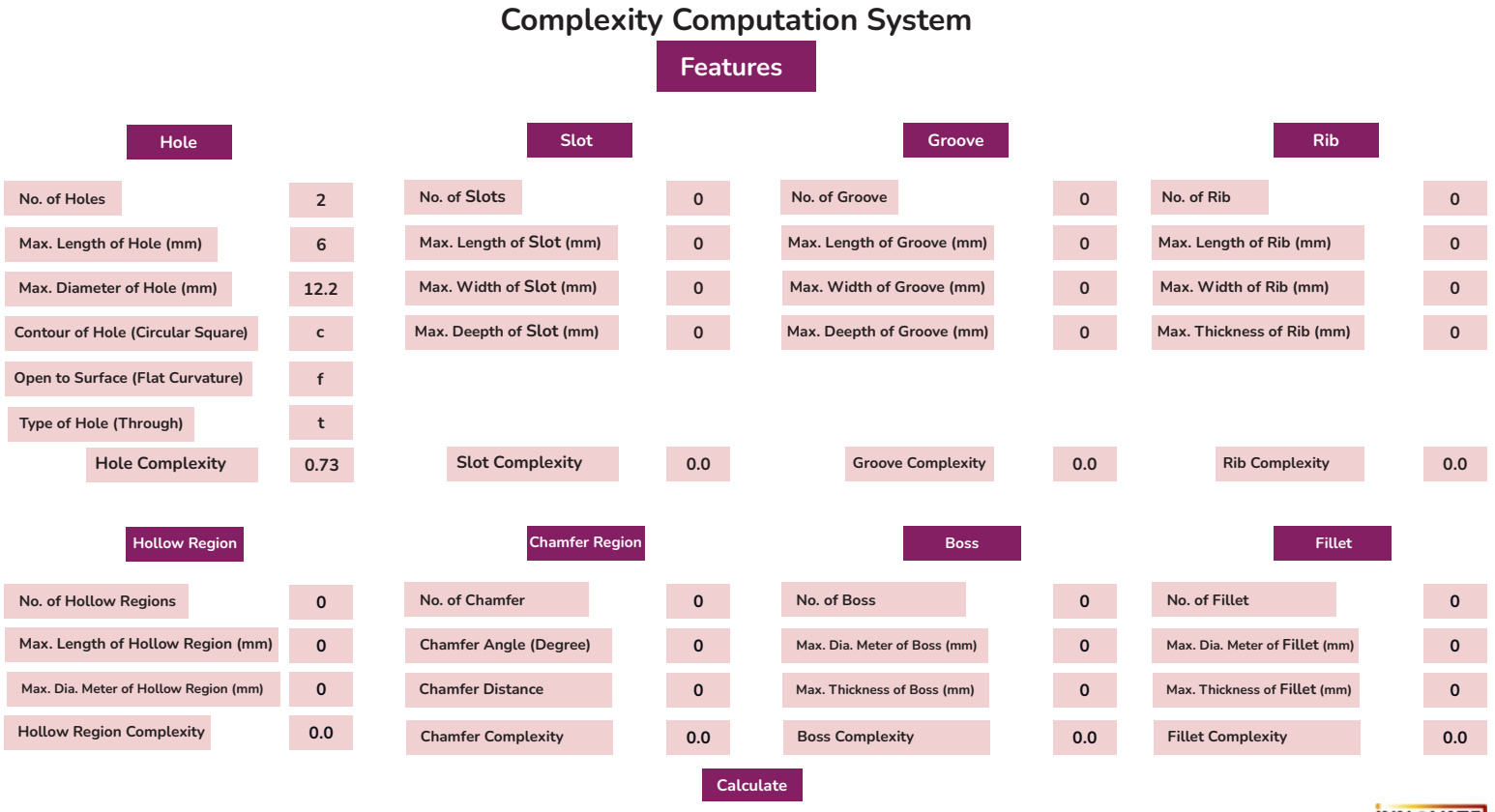

Figure 3: User interface for providing information about desired features of casting

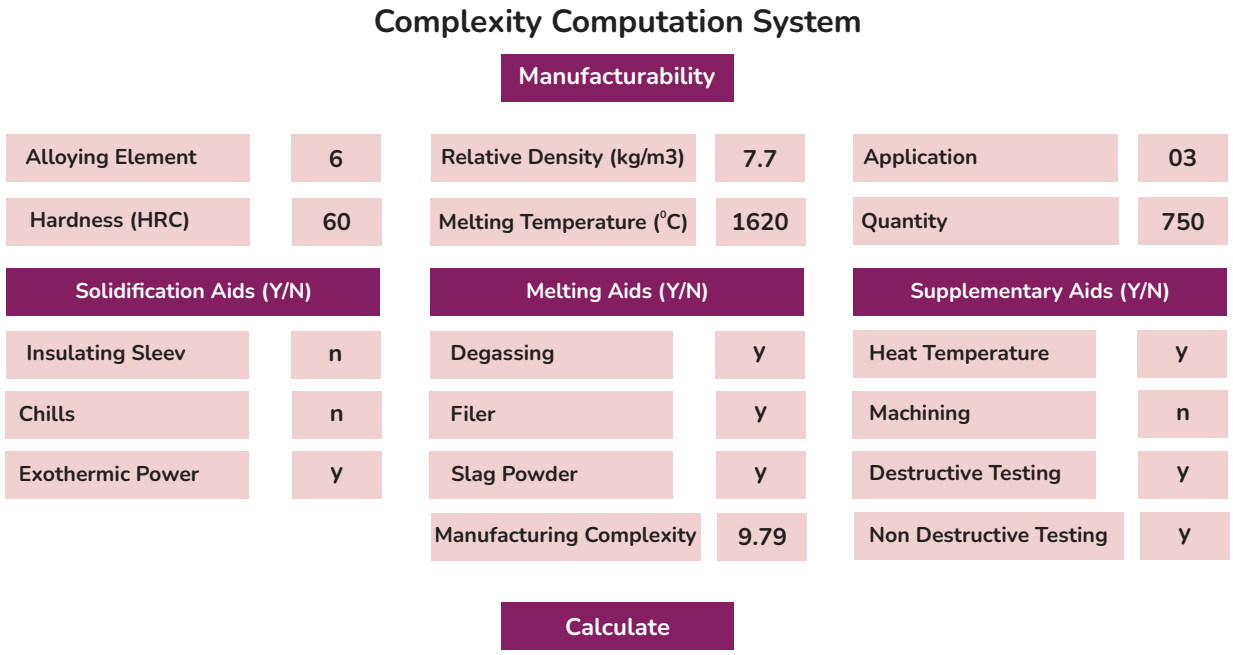

Figure 4: User interface for providing information about manufacturability of foundry

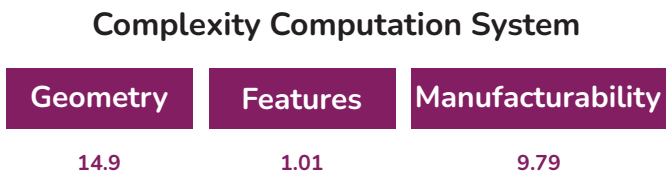

Figure 5: Estimation of complexity using user-friendly CCS

Estimation of complexity of investment casting using CCS is represented in the scale of 100, and can be interpreted as higher complexity if estimation of complexity using CCS is nearer to 100. The results values are further categorized in four categories: Low (if complexity is between 0-40); Medium (for 41-65); High (for 66-90); Very High (91-100).It can be seen that complexity of selected industrial component is estimated as 30.80 (~31) in the scale of 100 using CCS, and considered to be as part with low complexity. It is also observed that geometry related characteristics in the selected industrial component plays critical role followed by manufacturability in complexity index in comparison with features.

The CCS is found to be very useful in making appropriate decision to select investment casting process for its suitability in manufacturing any given industrial component, and can be easily embedded with any existing tool on design for casting.The application of CCS can also be extended in benchmarking process, and can be included in accreditation norms set by various OEMs.

Authors are still open for accepting inputs from reader of this article that will further improve the overall system for estimating complexity involved in investment castings. **If any IIF company member wishes to get the complexity of their investment casting evaluated, they can mail the details of the castings to wr@indianfoundry.org with subject "Evaluation of Complexity for Investment Castings" with their IIF Company membership number.**

Innovation Article

By M/s SHREE MAYUR ENGINEERING COMPANY – RAJKOT - GUJARAT

Innovation Articale is sponsored article to promote the innovation done by the company. To Showcase your company product / Innovation, Please write to **wr@indianfoundry.org**

THE LOST WAX INVESTMENT CASTING PROCESS

Lost wax casting, or investment casting is used to produce arts that require tight tolerances that can have thinner walls with surface finishes that require little after process finishing. A unique feature of lost wax casting is how it recreates a CAD design using wax to create the pattern of the piece to be manufactured.

INTRODUCTION

We introduce Shree Mayur Engineering Company as a leading in engineering industries with strong foundation in the Manufacturer of All Types of Investment Casting Machinery, our all product list can see at our website:https://www.shreemayurgroup.com

Our plant is located at Rajkot, Gujarat. The plant has modern facility for manufacturing quality products. Shree Mayur Engineering Co. has technically strong management team having rich and diverse experience of 27years in Investment Casting Machinery Industry. We already Full Plant Successfully installation in 200 Industries and Machinery Supply more than150 industries in India & Abroad Countries. casting process. It has numerous advantages which has been highlighted below in the form of case study for the benefit of IIF members.

We build machines with tried and tested designs, quality workman-ship and with excellent value for cost. Our experienced team is not only familiar with the investment casting machines, but is also well versed with the investment casting process itself. This ensures that our machines contribute to good casting quality and low running costs. We have qualified professional and experience personnel in all our department, efficient management, skill team, state-of-art infrastructure and standard process are the real strength of Shree Mayur Engineering Co. for meeting complete customer satisfaction.

OUR PRODUCTS:

Below are some of our innovative product which was developed by our own R&D team based on the feedback from the customer. It helps our users to get consistent, reliable and quality investment castings.

C-FRAME WAX INJECTOR

VERTICAL WAX INJECTOR

AUTOMODE WAX INJECTOR

SHREE MAYUR ENGINEERING COMPANY
Plot No. 14, Survey No.1, Nr. Tip Top Forging, Shapar Main Road, Shapar - 360024, Rajkot, Gujarat (India).
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Sales and Marketing: +91- 99252 24227 (Mr. Vallabh Ambasana)
Web: www.shreemayurgroup.com

Ask The Expert

Q 1: How can we expedite the ceramic shell drying process? What are the important parameters to control the drying environment?

Ans: The drying stage of the ceramic shell casting process is crucial to producing quality shells. While you can't rush the drying stage, there are ways you can speed it along by adjusting humidity, airflow, and temperature.

Humidity

The lower the humidity of the room, the faster the drying time of the shell. One way to achieve lower humidity is to install an air conditioner or dehumidifier in the drying room as both of these options take moisture out of the air. If possible, cover tanks or dehumidify a separate drying room so water is removed from the shells but not from the slurry.

Airflow

The airflow of the room has the greatest impact on shell drying times. Too little airflow can drag out the drying time, slowing production. Too much airflow is not an issue unless it causes breakage of your parts. To achieve optimum airflow, be sure to provide airflow from all directions. If necessary, turn the parts to provide even airflow. Oscillating fans and blowers are great tools to increase airflow.

Temperature

Any temperature fluctuation in the drying room can have an adverse effect on the wax patterns. For best results, maintain the temperature of the drying room at 19-23°C (66.2-73.4°F). Always allow waxes

to stabilize at the recommended temperature prior to dipping. When needed, use a window or room air conditioner. Be sure to clean the filter frequently.

Answer by Mr. Sohil G Ghiya

Q 2: What is the benefit of having a two-slurry system instead of using one type of slurry through the entire process?

Ans: The benefit of a two-slurry system is that you can formulate each slurry to optimize the process of shell building. The goal of the primary slurry is to capture the detail of the pattern and provide a protective layer that the metal can be cast against with minimal reaction. Backup slurries are formulated to provide bulk and strength to the shell, typically consist of larger refractory particles and are formulated to have a lower viscosity.

Answer by M/s Ransom & Randolph Team

To ask your question or get the suggestions, please write your problem with detailed description to **wr@indianfoundry.org** with subject "Ask the Experts". Identity of the Questioner will be kept confidential.

Invitation to IFEX 2023

8-10 Feb. 2023, India Expo Centre & Mart, Greater Noida

By: Mr. Pradeep Mittal, Chairman, Organizing Committee- 71stIFC

We are delighted to invite you to invite you to its 71st Indian Foundry Congress (IFC), the 19th International Foundry and Equipment Exhibition (IFEX)-2023, and the Cast India Expo, which is being organized by the Institute of Indian Foundrymen during February 8-10, 2023at theworld-class venue India Expo Mart, Greater Noida, India. New Delhi is fast emerging, and this event will act as a fulcrum of industrialization, trade & commerce in the northern region of India.

The theme of IFC and IFEX 2023 is “Arise, Automate & Aatmanirbhar” and has been chosen keeping in line the Government of India’s initiatives “Make in India” and “Ease of Doing Business”, where it aims to promote investments in manufacturing sector and support new initiatives for skill development. This is going to be the largest exhibition spread over 10,000 sq. meters with around 300 exhibitors participating from across the globe. We have already received an enormous count of responses from India and overseas and more than 1500 delegates has already registered for this three-day gala event. With the growth in the manufacturing sector in the post pandemic era,this casts an eye on the future and aim to cater to the burgeoning demand of the fast-growing foundry industry. IFEX aims to become largest global business summit of foundries after 3 years of the pandemic world. This is for the first time, in the Northern region of the country, that an event of such a big magnitude is going to be held for the foundry industry bringing together foundry sectors from across the world to explore technologies as well as business alliances in this sector.

The main highlights of the exhibition and conferenceis great response received from pan-India forCast source meet, B2B meetings with casting buyers, post congress tours, work visits and cultural programmes. Eminent dignitaries,Ministers, Senior Government Officials and leading CEOs in the foundry will grace the event with their presence and support. A pool of top-class experts from across the globe has been invited for conducting the technical sessions on various important arenas. Special sessions on areas such as cost saving by sustainable energy sources, opportunities for foundries in defense production and railways and opportunities for electric vehicles have also been planned for the Exhibition.Unique casting camp will be a great value addition for foundries.

There will be entertainment night planned, to provide our participants with a fine blend of business leisure, whereBollywood singers like Benny Dayal and Akhtar brothers will burn the floors with their ecstatic live performances, along with other international acts and performances,andgala dinners.

We, the IIF family, are looking forward to receiving a grand applaud, and success of this three-day event

Message from IIF Rajkot Chapter Chairman

Mr. Dhirubhai Patel
Chairman, IIF - Rajkot Chapter

Dear Foundrymen & Members,

Thanks to giving a chance to express me on this digital platform.

Glad to mention about IIF WR **"Project Prayaas"**- Technical workshop and Inter Regional Work Visit. During work visit at IIF SR Coimbatore, All WR members had a wonderful interaction with the Foundries visited and was a great learning and knowledge sharing experience.

The challenges for foundries is Shortage of skilled work force we may always pay attention and out come through Conduct training & skill up-gradation program from IIF WR Platform.

Foundry industry is the mother of all industries and so despite the challenges and roadblocks we will continue to be a force to reckon with and play a pivotal role in nation building.

My best wishes to all IIF members & our foundry industry to become a United India, United Foundrymen. Also I willing to wish western region Chairperson **Mrs. Anuja Sharma & her team** for success of exciting projects ahead in there tenures.

Western Region & Rajkot Chapter welcomes members of SR on 4th & 5th March to Rajkot.

Western Region Activities

IIF WR Initiative of “Project Prayaas” - Inter Regional Work Visit to Coimbatore