ALUMINIUM GDC TECH
GREAT DIE CASTING

# GREAT DIECASTING TECHNOLOGY FORUM

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ALUMINIUM GDC TECH
GREAT DIE CASTING



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# Training Programme Calendar 2021-2022

## April

**Die Design**
21 - 22 PDC
(Thu-Fri)
6 hrs two consecutive days

**Core Technology**
28 - 29 GDC
(Wed - Thu)
1/2 Day each

April 2021

## May

**Die Coatings**
13 GDC
(Thu) - Half Day

**Quality & Process Control**
27 - 28 Common
(Thu-Fri)
4 hrs. Two Consecutive Day

May 2021

## June

**Methoding of Aluminium Gravity Die Casting**
17 - 18 GDC
(Thu-Fri)

**IMPORTANCE OF RELEASE AGENTS IN ALUMINIUM HPDC PROCESS**
28 PDC
(Mon) - 1.5 Hour

June 2021

## July

**Defect Analysis & Remedial Measures**
15 - 16 PDC
(Thu-Fri)

**Three days programmes for begineers/buyers (at two centres)**
Common

July 2021

## August

**Three days programmes for begineers/buyers**

**(at 3 different centres)**

Common

August 2021

## September

**Melting & Metal Treatment & Defect Analysis & Remedial Measures**

16 - 17 GDC
(Thu-Fri)

September 2021

## October

**GDCTECH 2021**

**Virtual Conf & Exhibition**
21 - 22
(Thu-Fri)

October 2021

## November


November 2021

## December

**GDCTECH Special**

**Thermal Management**

16 - 17
(Thu-Fri)

December 2021

## January

**Two Weeks Proficiency Development Programme**
17 - 29
(Mon-Sat)
Common

January 2022

## February

**Machine Maintenance**

17 - 18
(Thu-Fri)
PDC

February 2022

## March


# Reserve Your Dates

**Programmes are Virtual or Physical**
**Will be conmmunicated well in advance as the situation may be**
*** Programmes subject to change**

GDC TECH Great Die Casting

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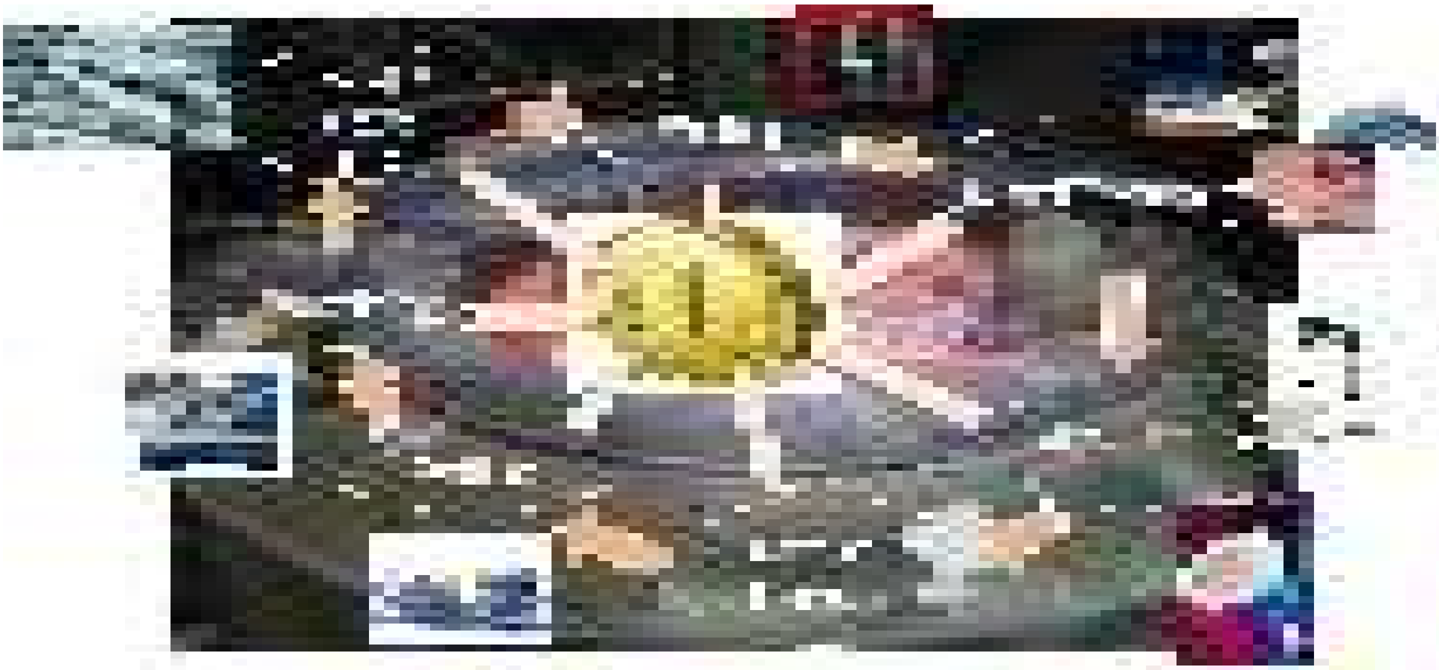
# CONSUMABLES FOR HPDC PROCESS

From the earlier years where the High Pressure Die Casting process was typically used to manufacture small, low performance, relatively easy to make castings like brackets and covers with high productivity, the process is now emerging as a more demanding one that can deliver more complex, high performance, heavier components at reduced thicknesses but with the same productivity levels as before. Even the smaller and easier components demand to be produced lighter and in more eco and economy friendly way. Selection and application of consumables, therefore has acquired a greater importance in producing sound High Pressure Die Castings. To make the best use of the consumables to achieve these objectives, a foundry man needs to have a preliminary understanding of their basic role and application best practices in the making of castings.



**Melting---- Molten metal transfer----Degassing, Fluxing, Metal Treatment------Casting------Finishing------Melting**

# CONSUMABLES FOR HPDC PROCESS

**Crucibles:**

Thermal conductivity of crucible decides the efficiency of melting or for that matter holding application also. Shape and geometry of the crucible contributes to the capacity and efficiency of the furnace. An advice from an expert about appropriate selection may be helpful in getting the maximum output, efficiency and life from a crucible.

Energy Efficient and Long Life Crucibles

Ideally the selection of a crucible should be an integral part of furnace design. The increasing heat consumption of a crucible is often an indicator that the life of the crucible may be close to an end and needs to be changed. The life and energy efficiency are always a trade-off and call for a judicious choice between the two.

Liquid dross would get built up on the walls or bottom of a crucible or refractory lined furnace and reduce its capacity and thermal efficiency. For the crucible furnaces the Oxide build up has a dual effect. On one hand, it reduces the capacity and heating efficiency (since Alumina is an insulating material in itself), whereas on the other hand, because of the difference in the expansion rates between the two, the crucible is liable to expansion cracking.

Appropriate use of a melting flux and a furnace wall cleaning flux helps in reducing the build-up and maintain the life and efficiency of furnace/ crucible walls.

Simultaneously, innovative geometries of Crucibles like Corrugated Crucibles improve the life and heat transfer efficiency of the crucible substantially.

# CONSUMABLES FOR HPDC PROCESS

**Fluxes:**

Castings, small as well as large have to face the challenge of inclusions; newly formed or old. They lead to rejections during testing or machining.

It is well known that molten aluminum alloys have two inherent characteristics:

1. The tendency to absorb hydrogen gas from the atmosphere, and
2. The ability to readily react with Oxygen and get oxidized.

On melting, an alumina film is instantaneously formed and this will act as a protective layer so long as it is left undisturbed. However metal movement and breaking of the alumina film during melting (due to charging), metal treatment, transfer and pouring cause oxide films and inclusions to be formed and simultaneously Hydrogen to be picked up and included within the melt. For the HPDC process, the molten metal is constantly disturbed due to the ladling action. Therefore, one needs to look carefully at two fundamental and critical treatments, viz: Degassing and Fluxing.

To help avoid excessive hydrogen pick up and oxide formation protective chemical fluxes have long been used. These fluxes can be categorized depending upon their purpose.

- Covering fluxes which form a molten layer to protect the melt from oxidation and hydrogen pick-up. These are added during melting and should be left in place as far as possible. If the melt stands for long periods, then further additions of flux should be made to ensure that an active cover is maintained.
- Drossing-off fluxes which agglomerate the oxides allowing easy removal from the surface of the melt. These are typically used immediately prior to transfer or pouring.
- Cleaning fluxes which remove non-metallics from the melt by encouraging the inclusions to float and then trapping them within the dross layer. These fluxes should be encouraged to move to the bottom of the melt so that they can float back to the surface, bringing oxide and inclusions up with them.
- Fluxes which "modify" the alloy structure, by introducing sodium, thereby improving the microstructure. These are used just prior to degassing and casting. They are normally high in fluoride and can also be very effective cleaning agents.
- Fluxes for the removal of oxide build-up from furnace walls. These can be used regularly to prevent such a build-up or can be used occasionally as part of a cleaning program. These fluxes can be sprayed by a flux gun onto the walls in very large furnaces.

# CONSUMABLES FOR HPDC PROCESS

For many years, these fluxes were added in powder form but the environmental pressures encouraged the developments of fluxes which give:

- ✓ Reduced flux addition rates
- ✓ Freedom from dust
- ✓ Lower emissions
- ✓ More efficient performance
- ✓ Easy automation

Finally, a new system of flux addition was developed to aid the high production automotive foundry, particularly the High-Pressure Diecasting foundry.

**Oxide Build Up in Crucible furnace**

**Granular fluxes:**

Over the past ten year there has been a growing pressure to reduce the addition of chemical products into the melt, reduce process costs and to improve the working environment. In order to move towards these goals fluxes have been manufactured in granular form. One problem with powder fluxes is that the individual grains tend to segregate during transport. It is therefore likely that the chemistry of the flux will change due to the flux make up changing within a bag of product. Each grain within a granular flux contains the exact chemistry from the original mix; they are also compressed closely together and so will react in exactly the required way when introduced into the melt. When using a granular flux the foundry can be certain that they are using the precise recipe of flux which was intended. Granular fluxes also generate much less dust when being handled and introduced into the melt and it has been found that there is close to 30% loss when adding a powder flux into most furnaces and ladles. Every granule would find its way onto the melt surface and maximum efficiency is achieved and addition rates are lower. A granular flux may or may not have the same formulation as a powder flux, however, because of the different grain morphology, granular fluxes offer operational and product advantages over their powder counterparts. For these reasons the use of granular fluxes offers the foundry a reduction in spend as well as better working conditions and reduced metal loss.

**Typical Powder and Granulated flux**

Flux reaction efficiency, whether granular or powder, depends on three factors that are interrelated to each other:

- Molten metal temperature
- Stirring power applied
- Reaction time.

Fluxes added at an inappropriate temperature for that product will **not** perform well. Fluxes added to the melt surface without vigorous stirring will fail to fully react and fluxes added and removed too quickly will again not fully react. It is not uncommon to see flux reacting in the dross bin because it was not given sufficient time to react on the melt.

The fluxing can be done in the melting furnace, the transfer ladle or the holding furnace depending on the convenience of application, but the best practice would be to do it at the last point from where metal would go to the mold, i.e the holding furnace.

# CONSUMABLES FOR HPDC PROCESS

**Dross with entrapped Aluminium** **Dry Powdery Dross**

**Molten Metal Transfer:**

Conventionally, worn out or new crucibles or refractory lined ladles are used for transfer of Aluminium. Crucibles, in reality, are produced to have good conductivity so that they can melt Aluminium efficiently. The use for transfer is thus contradictory to the fundamental need from the pot to be insulating. Also, used crucibles would generally contain a lot of oxides which can be troublesome to the castings as hard spot inclusions.

Use of castables for making of ladles is also a newer trend that addresses the life and wetting concerns to some extent.

However, lack of sufficient insulation leads to excessive temperature drop during transfer time from melting furnace to holding furnace or the casting area. A drop of eight to ten Degree Celsius per minute is commonly seen. To compensate this loss in temperature, obviously, during melting, the molten metal needs to be superheated. e.g. for a transfer ladle having a temperature drop of 8 Deg per minute, a transfer time of 7 minutes would mean that the metal needs to be superheated by 56 Deg C.

Old Crucible for Transfer

Properly Designed Ladle with Proprietary Lining Material

# CONSUMABLES FOR HPDC PROCESS

**Degassing:**

Degassing may not be as critical for High Pressure Die Cast components as other casting processes, but the simultaneous effect of floatation of the suspended inclusions is helpful for the HPDC process working at relatively lower temperatures.

Various types of Degassing processes are available: Tablets, lancing/ purging and rotary Degassing are the basic types used more widely. Choice is done depending on the suitability of application and the requirement of quality of the casting.

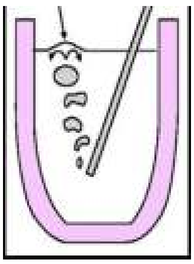
Conventionally used tablets provide unarguably the easiest way of Degassing, but with challengeable results due to the turbulence created, the bubble size limitation and the possibility of moisture pick up in the tablets themselves.

Lancing/ purging of an inert gas or Chlorine can be the next simple option for Degassing, but also faces the limitations of efficiency due to reasons of Bubble size and coverage. Chlorine thus used or from the tablets poses severe Health and Safety issues to the worker and the infrastructure.

Patented rotor shapes and designs with pumping activity yield faster reduction of Hydrogen from the liquid Aluminium. Conditions of Rotary degassing can be simulated using proprietary simulation software to derive the optimum parameters resulting in minimum time for maximum degassing. This is possible because of the understanding of the collective effects of rotor geometry, alloying elements, ambient conditions, Degassing parameters, metal condition on the Hydrogen levels before and after the process. With optimised cycles of degassing, costs of consumables can be saved and one can expect improved metal turn around with reduced temperature drop due to shorter times.

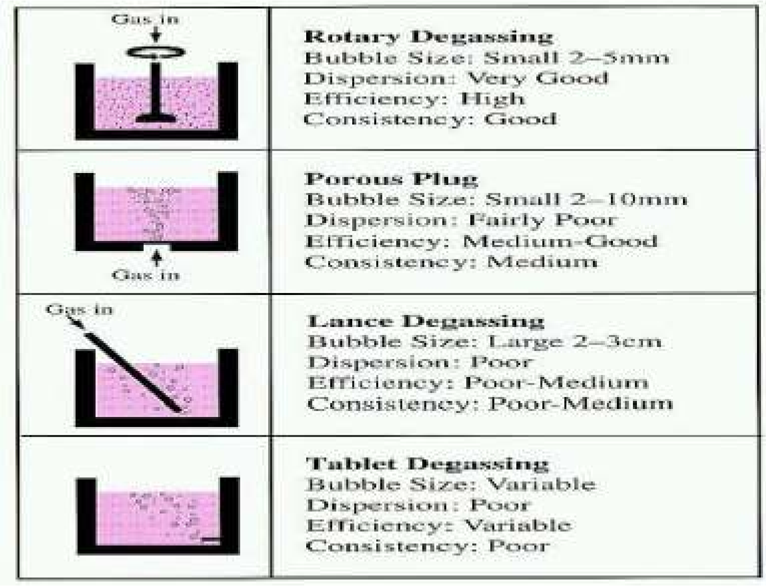
Choice of Degassing consumables such as rotors, shafts and baffles should be done in advice with the manufacturer to understand the best fit for the desired results.

Tablets



Lancing

Rotors




**Comparison of Various Degassing Processes**

**Metal Treatment: Grain refinement and Modification:**

In view of the thicker sectioned and larger castings demanding field performance and ability to withstand tests such as leakage tests, metal treatments for property enhancement such as Grain refinement and Modification are becoming more important, so much so that many HPDC foundries think of these processes as an essential part of their process.

**Grain refinement:** Addition of Master alloys containing Titanium and Boron is the most commonly used way of providing the nuclei for refining of grains in Aluminium. Although difficult to ensure, effort should be made to use the products that deliver Ti and B in the proportion of 5:1 for best results. Chemical Tablets based on Titanium containing compounds is another option for grain refinement. This chemical tablet process, however, needs to be seen in the light of the harmful gases that it may evolve and its turbulent nature leading to increased oxidation losses.

Alternatively, newly developed Proprietary Granular Fluxes give a combined action of cleaning, Drossing and grain refinement (TiB). Since this is an addition through a chemical route, one can be sure of the adding right proportion of Ti and B and getting maximum results. The combined Drossing effect ensures that the loss of Aluminium in the dross is minimized.

# CONSUMABLES FOR HPDC PROCESS

**Modification**: Here, again, Master Alloys that introduce Strontium to the metal are the most commonly used modification agents. Another school of thoughts is to use Sodium as a modifying element. This addition of Sodium can be done as pure Sodium or through powder fluxes containing Sodium compounds. Addition of Granular flux gives a better pick up of Sodium at lower additions and a less loss of Aluminium in the dross.

**Piglets, Waffles, Ingots** **Tablets**

**Integrated Metal Treatment: MTS 1500:**

Although hand applied granular flux has several advantages over manually applied powder flux the continuous search for further performance improvements and mechanization for getting consistent output has resulted in the development of a novel treatment process based around granular flux and a specialist treatment station. In order to further improve the performance of a granular flux it is essential to put more energy into the treatment process and this is done by the use of a controlled vortex treatment, MTS 1500.

The controlled vortex treatment ensures effective degassing and complete reaction of the flux added. The process is completely PLC controlled and therefore any operator dependence is avoided, thus giving the foundry consistent and repeatable results at their best.

The development of single/ combination treatment fluxes and their application through MTS 1500 means that the foundry can carry out the complete metal treatment process, to protect, clean, sodium modify and grain refine and even the removal of harmful trace elements in one single integrated process.

The MTS Process:

- Increases productivity
- Improves metal turn around
- Reduces temperature drop
- Reduces costs of consumables
- Consistently Improved quality
- Reduces oxidation loss

Extremely intensive flux stirring during MTS 1500 treatment significantly increases the metal cleanliness and reduces the required quantity of flux.
This treatment method avoids human error by the pre-programmed addition of metal treatment products and thereby guarantees a high level of reproducibility.

Use of inferior quality scrap can lead to increased generation of Oxides. The consistent cleaning of suspended oxides means that a foundry can use inferior scrap and still make castings of high integrity.

**Dross produced by conventional treatment**

**Dross produced by MTS 1500**

**Savings from Loss of Metal in Dross**: The strong vortex action of MTS 1500 ensures complete reaction of the flux with the suspended oxides. This flushes them out to the surface and also helps the Drossing action of the flux so that the dross is dry and free of entrapped metal.

One of themain advantages with MTS 1500 treatment is that the amount of dross created is significantly reduced. The saving in metal loss often offers a break even time of less than 18 months for a fairly busy foundry.

.....To be continued.....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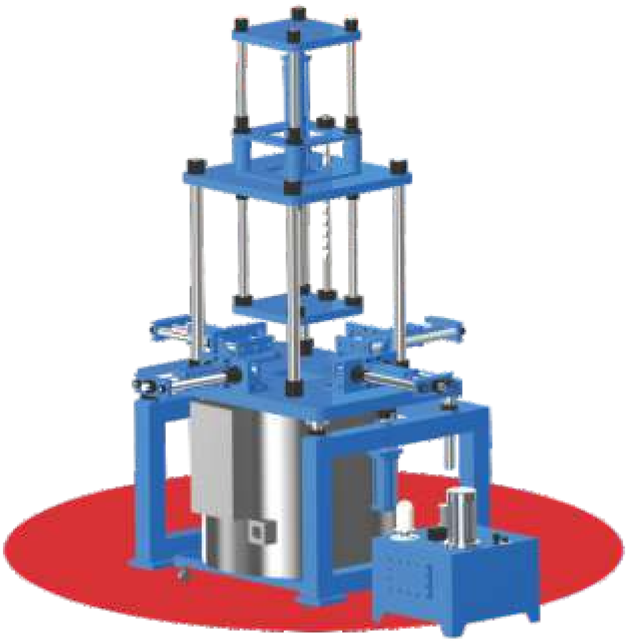



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Inner View


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# Design and Process-Specific Optimization of Complex 3d Temperature Control Systems in Order to Increase the Effectiveness of a Combination with a High-Speed Casting Cell

W. Sokolowski, R. Aspacher, N. Clauss & G. Hartmann, H. Rockmann, H. Bramann
MAGMA GmbH, Germany

Every optimization measure in die casting has the goal of positively influencing availability, process speed and component quality. The subject of temperature control of die casting molds is as old as die casting itself. The cycle time, tool durability, microstructure and distortion of the parts as well as other technical and economic aspects are strongly dependent on the temperatures in the tool. The layout and process-specific optimization of die temperature control should therefore be a focus for the entire die and process design.

In fact, complex three-dimensional, contour-adapted temperature control systems, such as those that can be produced using generic AM processes, represent the state of the art in polymer injection molding. They are also attracting attention in die-casting: the approach of temperature control systems to the component drastically increases the controllability of the casting processes and makes them more robust, sustainable and cost-effective. To achieve a robust, reliable casting process, the design of close contour temperature control systems must be considered in the context of the overall system consisting of die casting cell, tool and production parameters.

This article deals with the virtual layout of complex three-dimensional, contour-adapted temperature control systems and the determination of optimally adapted process settings. The methodology and examples of a frontloading approach, where the design of the die temperature control system is developed and verified in parallel to the part design, are demonstrated. This approach is based on virtual molding supported by automated virtual DOEs and optimization algorithms - all applicable in the die casting component development environment. The evaluation of the virtual process variants is based on the real production key figure OEE.

**3D temperature control systems in casting tools**

The design of casting tools or die-casting dies is usually carried out according to the following aspects (in the order of their weighting): adaptation to the machine including determination of the number of die cavities, part removal, die layout with minimum slide effort and,-ejector. Casting or process-technical interests such as the flow-favorable course of the casting runs or the entire thermal design are only taken into account afterwards. The definition of the thermal process control includes the determination of the cooling and heating temperatures, the corresponding heating/cooling devices with the required capacities, the cycle time, etc. This is done during the patterning and running-in of the mold, i.e. completely decoupled from the definition of the heating/cooling channels and other temperature control devices and measures in the die.

On the other hand, the thermal design of a die-casting tool must ultimately support an optimum result from the casting process, i.e. variables such as casting quality, process stability, and cycle time or tool service life. However, if these parameters are to be influenced, all equipment and measures for the temperature control of tools must be relevant to the casting result and must also be easily reproducible, adjustable and controllable.

From this, two essential boundary conditions for the design of a mold temperature control system can be derived:

1. **Design of die segments**: In the thermally relevant die segments, the temperature control must be individually and efficiently controllable and, if possible, variable in time. For this purpose, the corresponding mold segment must be thermally agile. This is made possible by powerful heating/cooling units with the option of variothermal control and by temperature control ranges that are close to the contour and adapted to the contour, which can also be represented by generic (AM) processes.

**2. Development methodology**: The effect of temperature control measures and parameters on casting quality, process stability, cycle time or tool life must be known and documented at the time of tool design. This is possible by early virtual assessment and optimization of the casting process with full consideration of the temperature control measures to be tested.

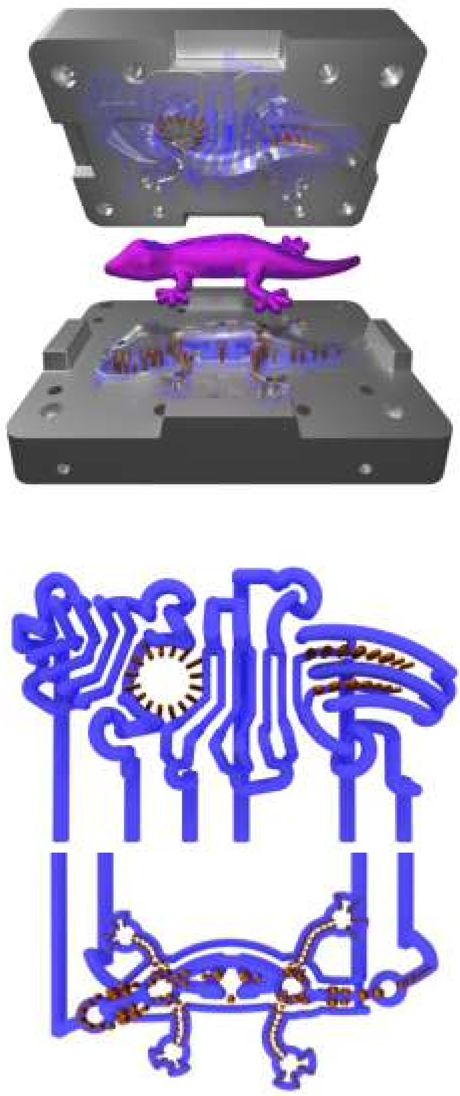

Figure 1: "Thermally nimble" die with close contour and contour-following temperature control, consisting of temperature control channel meanders and copper pins for the connection between temperature control medium and cavity (Contura MTC: Plastics + Processing 40/2019 Kuhn Fachverlag, page 65 Citation of Contour article)

Thermally agile die segments with variothermal temperature control (Figure 1) have been under discussion in the field of plastic injection molding for about 20 years, but even today they still tend to mark the "high end" of die technology.

Reiner Westhoff, Contura MTC: "Tools with near-contour temperature control are able to reduce the unit costs of molded or cast parts significantly, in some cases well over 15%, like hardly any other technological development in mold making.

The reported advantages in plastic injection molding are almost always in the area of shorter cycle times and improved component quality. This also results in a well calculable ROI of the additional costs in tool making and operation.

In the field of die casting tools, near-contour temperature control, at least as core cooling, has also been used for a long time. There may be several reasons why this narrow field of application has hardly been exceeded:

First of all, in conventional die-casting tool making it is still true that cooling holes should not be closer than approx. 10-15 mm to the engraving. This is certainly understandable and correct if you consider the likewise classic casting process with two violent thermal shocks during shooting (high compressive stresses) and during spraying of the release agents (high tensile stresses).

Furthermore, the significantly higher costs of die segments with three-dimensional temperature control ranges that follow the contours and are close to the contours play a role. In general, no detailed information is available on the actual heating and cooling requirements during operation at the time of the decision on mold temperature control. But this is the exact information needed to identify and qualify the risks and potentials hidden in the heat balance of the casting tool and thus justify additional costs in tool making.

This is where the virtual design of the casting process comes into play. Parallel to the design of the casting, it is already necessary - and possible - to qualify the temperature control expenditure for a safe and economical production process. As soon as 3D CAD data of a casting is available, the first simulation calculations for the casting process provide a clear picture of the locally necessary temperature control measures around the cavity of the tool.

Later, when casting runs and venting areas are designed in the die, further, more detailed simulation calculations for the casting process provide the flow-optimized design of the casting run and the gates as well as the optimum thermal design of the temperature control in the casting chamber and anvil area and in the area of the casting run.

The methodology described here is not new, exotic or difficult to implement. It is based on approaches of collaborative engineering, whose positive effect on the economic efficiency of development processes prior to SOP has been extensively documented for 40 or more years. From a technical point of view, this methodology is supported by "state-of-the-art" CAE tools from 3D CAD to FE simulations to virtual assessment and automatic process optimization.

Collaborative engineering across this entire development process chain is even supported today by interdisciplinary media, which represent a common information platform between departments and companies with their interlinked tasks (Giesserei 106, 11/2019, p. 81).

**Virtual assessment and optimization of temperature control systems in die casting**

Using the example of the new product range presented at GIFA 2019 by Oskar Frech GmbH & Co. KG presented at GIFA 2019, the technical possibilities in combination with a methodology of virtual process planning according to the principle of Collaborative Engineering are explained.

The motivation for this project was a significant increase in productivity of an aluminum die cast component by reducing the total cycle time by at least 35%.The real challenge, however, was to determine an "optimal process" - i.e. the best compromise between product quality, economy and robustness of production. Starting from the existing series process, a benchmark was to be created using state-of-the-art plant technology combined with innovative tool design and supported by a methodical virtual process analysis.

The starting point for the "High Speed Casting Cell" project was a series production concept for an aluminum heat sink. The die casting cell consisted of a DGM of the type Frech DAK580 with a conventional dosing device as well as spraying and handling technology. The tooling used in 4-fold design is based on a classic casting run design with vertical arrangement of the nests (fir tree) as well as a tempering system with conventional cooling holes at a distance of 10-15 mm from the die engraving (Figure 2).

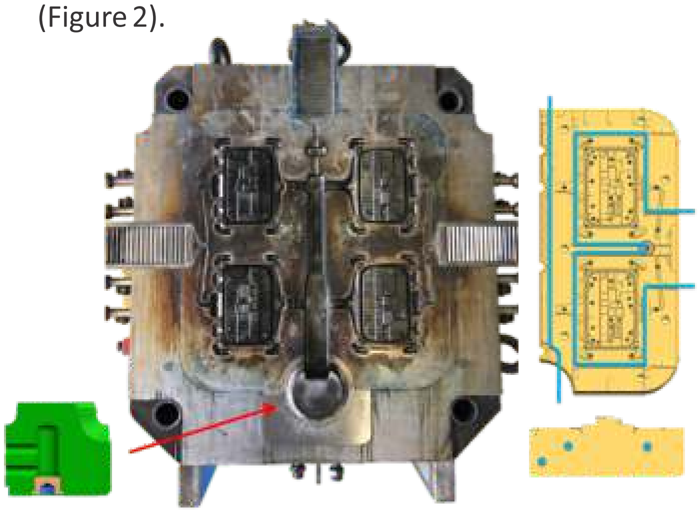

Figure 2: 4-fold series tool for the die-cast aluminum heat sink; the tool inserts and anvil have conventional cooling channels and stab cooling

**Figure 3**: Schematic thin-walled die-cast component "heat sink" made of the aluminum alloy EN AC-Al Si12 (Fe)

The essential requirements for the component are a high surface quality and dimensional accuracy as well as optimum heat dissipation from the heating banks via the cooling fins. The corresponding technical casting objectives are:

- Avoidance of flow errors (flow lines, cold running, oxides)
- Avoidance of surface defects due to shape erosion and adhesives

- Avoidance of large filling time differences between the 4 cavities of the mold
- Avoidance of internal defects due to trapped air or shrinkage porosity

In order to increase productivity by reducing the total cycle time, the first step was to investigate the optimization potential by using state-of-the-art networked plant technologies. For this purpose, a "High Speed Casting Cell" consisting of the following components was set up at MONEVA GmbH + Co KG Leichtmetallguss:

- Frech die casting machine K640
- Meltec vacuum dosing furnace with integrated system for fast weighing of the dosing quantity (dosing accuracy and repeatability) as well as a fast servo-controlled transport device
- Robamat high-performance multi-zone temperature control units for mold inserts, in particular with close contour temperature control
- Spesima handling and removal system

By consistently linking modern plant technologies, valuable seconds can be saved during dosing, die -opening and removal (see Table 1 for a comparison of the proportional cycle times). With the high-speed casting cell, the total cycle time can be reduced from 38 (series process) to 33.4 seconds. This corresponds to an increase in productivity of approx. 12%.

| **Production Status DAK580** | | | **High Speed Casting Cell K640** | |
|---|---|---|---|---|
| | | [sec.] | [sec.] | |
| Closing | | 2,8 | 2,7 | |
| Metering | | 5,5 | **2,1** | Start dosage with "mold protection end" for K640.<br>Use of special dosing containers from Meltec |
| Casting | | | | |
| 1. Phase | | 1 | **1,2** | |
| 2. Phase | | 0,1 | 0,1 | |
| Cooling Period | | 6 | 6 | |
| Opening | | 2,5 | 2 | |
| Ejector before | | 0,5 | **0,4** | |
| Withdrawal | | 5,6 | **4,9** | Optimized process |
| Spraying | | 11,5 | 11,5 | |
| Ejector back | 0,5 sec | | | During spraying |
| Casting plunger | 1,5 sec | | | During spraying |
| Waiting time for removal until spraying starts | | 2,5 | 2,5 | Optimized process |
| Total cycle time | | 38 | **33,4** | **Reduction of the cycle time by 12 %** |

**Table 1: Comparison of process times for series production and for the innovative high-speed casting cell; cycle time reduction from 38 to 33.4 seconds**

Based on the newly installed high-speed casting cell, the potential of tool optimization in combination with further process improvements in temperature control and spray technology was investigated in a second step.

The aim was to find the best compromise between maximum reduction of the cycle time while maintaining the same component quality, minimum use of resources (aluminum/return component) and maximum tool service life. The focus of the tool optimization was on a targeted design of the casting run with regard to minimum energy input and rapid solidification, as well as an innovative design of an effective, local temperature control through near-contour cooling in the die casting mold.

The specified surface quality of the components requires a fast and homogeneous mold filling of all 4 cavities of the tool. In view of the thin-walled component geometry of the heat sink and the relatively uniform wall thickness distribution, the risk of significant shrinkage-related porosity in the component is low. The runner system does not have to ensure effective replenishment of the component and can be optimized for resource efficiency and short solidification time. A corresponding runner system with reduced mass and increased specific surface area was developed by the tool development department of Oskar Frech GmbH & Co. KG and designed in CAD.

The near-net-shape design of the heat sink with minimal draft angles requires a robust release agent application for the shake out process. The conventional application of water-based release agents by spraying is characterized by two second-intensive process phases:

- Local cooling of the die surface into the effectively usable temperature range.
- Blowing out residual moisture before the next casting cycle

A significant reduction of the cycle time for the spraying process (conventionally 11.5 seconds) can be achieved by modern water-free micro-spraying processes. In the second optimization step, the WOLLIN Micro Spraying Technology was therefore integrated into the high-speed casting cell with a mask spray tool that is individually adapted to the mold. In contrast to a conventional spraying process, the WOLLIN Micro Spraying Technology withdraws almost no energy from the tool surface. The energy balance has to be maintained by an adapted internal die temperature control. Innovative, near-contour temperature control offers a targeted and efficient way of influencing the local temperature balance of the mold.

Starting from the conventional temperature control of the die casting tool, the relevant areas (partial inserts of the cavity and anvil) were reconstructed to highly efficient near-contour cooling using Frech Laser Melting (FLM®) technology (Figure 4).

Figure 4: 4-cavity mold with schematic view of the near-contour temperature control in the area of the anvil and the cavity inserts

In parallel to the design and implementation, a comprehensive virtual process analysis of all relevant geometry and process parameters was performed with MAGMASOFT® according to the principle of collaborative engineering. Methodical, virtual experimentation with MAGMASOFT® is a forward-looking way of working in order to design component geometry, tool and manufacturing processes in an optimal and robust way through transparent and quantitative process understanding.

The goal of the virtual process analysis was to identify a concrete manufacturing solution, the best compromise between quality and efficiency.

............To be continued..........

# AI FOR ENTERPRISE


**Vaishali Jumde**

**BEEHIVE COMPUTER SYSTEMS**

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## PART II

We have seen that **the true business value is not in storing data, no matter how cleverly. The value is unlocked when you do something with the data. That's where the AI comes in.**

**Exploratory Data Analysis (EDA)**

Users normally say that they have a large amount of data but don't know how to use it. Can we have some interesting patterns derived from the data? Can we have some interesting insights which can be useful for my business? This is called EDA. This helps us in solving various business use cases. The most important steps in performing EDA are

1. Sourcing: Gather the data in one form
2. Cleaning: There can be 999, blank, null numbers in numeric data
3. Univariate Analysis: This considers only one variable at a time at the time of analysis. E.g.
   Max or min Temperature required for Heat
4. Bivariate Analysis: Here we consider 2 columns.
   There is always some correlation between two parameters like Price and quantity of any material, Measurements of any product.
5. Derived Metrics: Actually, This is an art to derive a new column. We derive a new column from which we can get some interesting facts. They can be like
   a. Type Driven Matrix, b. Business Driven Matrix, c. Data-Driven Matrix.

There can be different types of data,

1. Private: Pricing, Costing, Any formulae related like chemical composition, etc.
2. Public: Ex. www.data.gov.in

Before applying any Mathematical Algorithms, We need to clean the Data as there are different issues with the data. Like Alignment Issue, Long Names, Spelling Mistakes, etc. There are some processes which we need to consider are

1. Fix Rows and Columns,
2. Fix Missing Values,
3. Standardize values,
4. Fix Invalid Values,
5. Filter Data,
6. Study Meta Data

There are again two types of Data.

1. Categorical
2. Quantitative Data.

We can perform numerical operations on Univariate Categorical data by performing operations like Sorting, Filtering, Taking Logs, and then plot graphs. Similarly, for numeric data, we can have Mean Median, Mode, Standard Deviation and Variance Etc.

We can also perform Segmented Analysis. E.g. Production is first shift, 2nd Shift or Weekdays, Weekends. Inventory by ABC Type, Performance of the employees. For this, we need to

1. Check the Raw Data,
2. Grouping,
3. Summarising,
4. Then comparing,
5. Box Plot: this gives you median, Quartile 1, Quartile 2...., Outliers

In AI, Data processing is the first and very important phase that leads correctness of our AI model and Results. To get the fullest, most accurate picture possible, that data should be gathered from as many sources as possible. This can include everything from Process Data, Quality Data, Raw Materials, and even external factors like weather, Temperature.

Next, and just as importantly, we need to decide what question we want the machine learning model to answer – and whether it is possible to answer this question using the available data.

**Modeling Phase**
Modeling uses Machine Learning algorithms in which machine learns from existing data just like human learn from their experiences. There are many methods and techniques used for this process.

**Supervised Machine Learning**
In manufacturing use cases, supervised machine learning is the most commonly used technique since it leads to a predefined target: we have the input data, we have the output data, and we are looking to map the function that connects the two variables.

It demands a high level of involvement – Data Input, Data Training and choosing Algorithm, Data Visualizations and to construct a mapping function with a level of accuracy that allows us to predict outputs when new input data is entered into the system.

Initially, the algorithm is fed from a training dataset, and by working through iterations, continues to improve its performance as it aims to reach the defined output. The learning process is completed when the algorithm reaches an acceptable level of accuracy.

In Manufacturing, there are two common Learning approaches:

1. Regression
2. Classification

The two approaches share the same goal: to map a relationship between the input data (from the manufacturing process) and the output data (known possible results such as quality or waste losses, part failure, overheating, etc.

**Regression**
Regression is used when data exists within a range (ex. Temperature, Weight), which is often the case when dealing with data collected from sensors.

In Manufacturing, a regression can be used to calculate an estimate for the Remaining Useful Life of an asset. This is a prediction of how many days or cycles we have before the next component/ Machine/ System failure.

For regression, the most commonly used machine learning algorithm is Linear Regression, being fairly quick and simple to implement, with output that is easy to interpret. An example of linear regression would be a system that predicts temperature since the temperature is a continuous value with an estimate that would be simple to train.

There can be Simple Linear Regression, Multiple Linear Regression.

When data exists in well-defined categories, Classification can be used. In Machine Learning, common classification algorithms include Naïve Bayes (Bayesian Networks), K-nearest Neighbour Algorithm, Logistic Regression, Support Vector Machines, and Artificial Neural Networks.

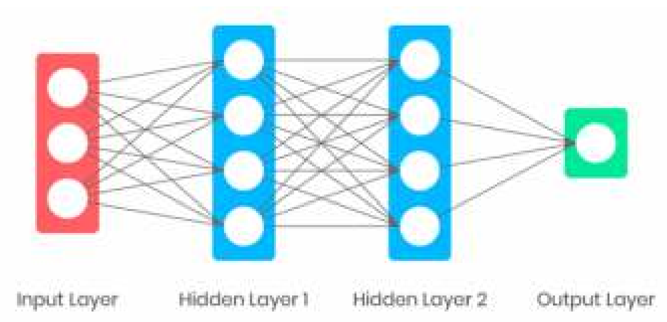
With supervised machine learning, we start by working from an expected outcome and train the algorithm accordingly. Unsupervised learning is suitable for cases where the outcome is not yet known.

**Clustering**
In some cases, not only will be outcome be unknown to us, but information describing the data will also be lacking (data labels). By creating clusters of input data points that share certain attributes, a machine learning algorithm can discover underlying patterns. Clustering can also be used to reduce noise (irrelevant parameters within the data) when dealing with extremely large numbers of variables.

**Artificial Neuron Networks**
In the manufacturing sector, Artificial Neuron Networks are proving to be extremely effective in unsupervised learning tool for a variety of applications including production process simulation, Predictive Quality Analytics, Metal Analytics of Heat to reduce Rejections, Optimising Casting Parameters, detection of causes of casting defects, micro-shrinkage occurring in cooling processes, Mechanical Properties of casting, etc.

The basic structure of the Artificial Neural Network is loosely based upon how the human brain processes information using its network of around 100 billion neurons, allowing for extremely complex and versatile problem-solving.

Every node in one layer is connected to every node in the next. Hidden layers can be added as required, depending on the complexity of the problem. The ability to process a large number of parameters through multiple layers makes Artificial Neural Networks very suitable for the variable-rich and constantly changing processes common to manufacturing. Moreover, once properly trained, an Artificial Neural Network can demonstrate a high level of accuracy when creating predictions regarding the mechanical properties of processed products, enabling cuts in the cost of raw material.




**Benefits of Machine Learning and AI for Manufacturing**

The introduction of AI and Machine Learning to the industry represents a sea change with many benefits that can result in advantages well beyond efficiency improvements, opening doors to new business opportunities. Some of the direct benefits of Machine Learning in manufacturing include

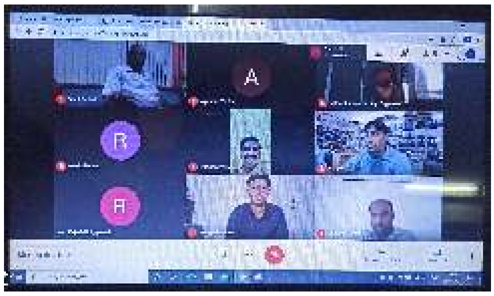
- Reducing common, painful process-driven losses e.g. yield, Waste, Quality, and throughput
- Increased capacity by optimizing the production process
- Enabling growth and expansion of product lines at scale due to a more optimized process
- Cost reduction through Predictive Maintenance, which leads to less maintenance activity, which means lower labour costs and reduced inventory and material wastage.
- Improved Supply chain management through efficient inventory management and a well monitored and synchronized production flow.
- Improving Employee safety conditions and boosting overall efficiency
- Consumer-focused manufacturing – being able to respond quickly to changes in the market demand.

# Member's Achievement

# REPORT ON TRAINING PROGRAMMES

**1. Die Design - HPDC – 21-22 April 2021**
**Faculty : Mr. Rajesh Aggarwal**
**Number of Participants: 15 nos. from following companies**

- ABILITIES INDIA PISTONS & RINGS LTD.
- AL METALS & METHODS (P) LTD.
- ALPHATEK TOOLING
- CAPARO ENGINEERING INDIA LTD.
- G-PLAST (P) LTD.
- JET-AGE ENGINEERS
- KNORR BREMSE SYSTEMS FOR COMMERCIAL VEHICLES INDIA PVT. LTD.
- MAHINDRA CDMM
- MATRIX COMSEC PVT. LTD
- ROOTS CAST PRIVATE LTD.



**2. Core Technology – 28 – 29 April 2021**
**Faculty : Mr. B. B. Lohiya and Mr. R. D. Dhumal**
**Number of Participants: 16 nos. from following companies**

- AAKAR FOUNDRY PVT. LTD.
- ABI SHOWATECH (INDIA) LTD.
- ALPHACRAFT PVT. LTD.
- AURANGABAD ELECTRICALS LTD. (AEL)
- HI-TECH ARAI PVT. LTD.
- INDO SHELL MOULD LTD.
- NIF MECHANICAL WORKS PVT. LTD.
- MAHINDRA CDMM
- NOBLE CAST COMP. PVT.LTD.
- ROOTS CAST PVT. LTD.

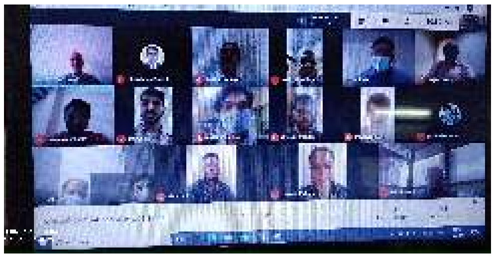
**3. Die Coating – 14th May 2021**
**Faculty : Mr. Shrikant Bhat**
**Number of Participants: 24 nos. from following companies**

- ALTECH ALLOYS INDIA PVT. LTD.
- CAPARO ENGINEERING INDIA LTD.
- CERAFLUX INDIA PVT LTD.,
- COOPER CORPORATION PVT. LTD.
- EMMEL VHEELERS (FIE GROUP)
- FEB TECH INDUSTRIES
- FOSECO India Ltd. Pune
- GABRIEL INDIA LIMITED
- G-PLAST (P) LTD.

- MINDA INDUSTRIES LTD.
- SAMKRG PISTONS & RINGS LIMITED
- SIGMA ELECTRIC MANUFACTURING CORPORATION PVT. LTD.
- UNITED METALLURGICALS PVT. LTD.
- UNIVERSAL METALLURGICALS

**4. Quality & Process Control - 28-29 May 2021**
**Faculty : Mr. Pramod Gajare,**
**Number of Participants: 19 nos. from following companies**

- CAPARO ENGINEERING INDIA LTD.
- DEEKSHA EXPORTS PVT. LTD.
- INSPIRON ENGINEERING PRIVATE LIMITED
- MAP ALLOYS
- MINDA INDUSTRIES LTD. (Alloy Wheel 2W Division)
- PEPPERL & FUCHS MANUFACTURING (INDIA) PVT. LTD.
- PRAVIN ENGINEERING PVT LT.D
- SAHAYOG FOUNDERS & ENGINEERS
- SAMKRG PISTONS & RINGS LIMITED
- SUNDARAM CLAYTON LIMITED
- SWISS STEEL INTERNATIONAL
- UNIVERSAL METALLURGICALS




# Mr. Abbasbhai Lokhandwala
# Arko Engineers

**His Dedication & Love Towards Foundry Industry will always have Footprints on our hearts.**

ALUMINIUM GDC TECH GREAT DIE CASTING

**From**

**GREAT DIECASTING TECHNOLOGY FORUM**

UPCOMING EVENT

Conference on

**"Recycling of Aluminium for Alloy Manufacturing & Extrusion Billet Casting"**

**on 8th & 9th July 2021 on Virtual Platform.**

## Technical Papers

- Furnaces
- Billets Casting Metal Preparation
- Effect of Alloying Elements Homogenising
- Metallurgical aspects of Billets
- Scrap Identification, Segregation and Processing
- Alloy Ingot Manufacturing & Metallurgy
- Mechanical Stirring
- Digitisation of Melting
- Overview of the Aluminium Recycling and Alloy Manufacturing
- Overview of the Scrap Market Recycling and Environmental Aspects
- Use of XRF for Sorting of Aluminium Scrap
- Melt Treatment
- Furnace Design
- Recuperation
- Refractories
- Chips & UBC Treatment technology
- Billet Casting Technology for Forging Industry / Special Alloys Applications (Defence/Railway)

ALUMINIUM GDC TECH GREAT DIE CASTING

NEW CONSTITUTION

# GREAT DIECASTING TECHNOLOGY FORUM (GDCTECH FORUM)

## ENLARGED SCOPE OF FORUM (GDC/LPDC/PDC)

### ACTIVITIES

- ❖Bi-Monthly Journal
- ❖Technical Services (Training, Solution Centre and Library)
- ❖Annual Conference/Bi Annual Mega event with Exhibition
- ❖Competitions (Quiz, Project and Casting)
- ❖Industry Delegations
- ❖Coffee Talk
- ❖Interaction with Buyers
- ❖Panel Discussions