Dedicated to Diecasting Industry

ALUCAST®

PARTNER IN PROGRESS FOR ALUMINIUM AND DIE CASTING INDUSTRY

Official Journal of Aluminium Casters' Association

Issue 156 - October 2025

RECENT DEVELOPMENTS IN CASTING TECHNIQUES AND EQUIPMENTS

Inside

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IMPRINT

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Pune	21	75	28	**124**
TOTAL	**70**	**201**	**61**	**332**

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N. Ganeshan
Editor

Dear Readers,

It is highly recommended for all die casting foundries to keep up with the new developments in production process, consumables and equipment. Regularly updating processes, tools and skills helps directly improve product quality, lower cost, reduce risk and keep your customers happy and your margins healthy. There are multiple ways to do this, like participating in seminars, webinars and conferences related to your field, by reading and discussing relevant articles published in technical journals from time to time and by visiting national and international foundry exhibitions to get a glimpse of the new equipment and products that have come up in the market.

We list below some of the factors that are necessary to take into consideration for maintaining modest advantage in aluminium component manufacturing industry. Customers expect better tolerances, lighter parts, and faster lead times. New technology lets you meet those demands and win more business. Further these new techniques also protect your operating margins. Moreover, improved yield, shorter cycle times, and reduced rework cut unit costs, which often results in more savings than the cost of the new equipment over time. Therefore, it is necessary to gain access to new markets and products. We need to adopt advanced techniques like low-pressure, counter pressure, application vacuum techniques, implementation of squeeze process wherever necessary and go in for HPDC variants. Introducing high-integrity alloys to enable production of components for EVs, aerospace, and medical applications is yet another way. To gain customer confidence & achieve compliance, one has to constantly promote up-to-date processes to meet current regulatory, safety and quality standards, which is important for OEMs and Tier-1 suppliers.

Acquiring and practising new technology, consumables and process equipment can lead to better technical & operational benefits like higher first-pass yield and fewer defects. Better gating, shot control, simulation-led die design and process control reduce porosity, cold shuts, and dimensional failure. Further this newer technology can shorten the cycle times to gain higher throughput. Modern die casting machines with faster automation and optimized cooling can increase output without proportionally increasing requirement of additional labour. Additionally, to lower energy and material usage, one has to go in for more efficient furnaces, implement thermal management and optimized gating to reduce energy per part.

To gain improved repeatability and traceability, one has to make use of modern PLCs, Industry-4.0 integration, sensors and MES that let you control variables and trace every part to process data. New guards, robotics, better ventilation and remote diagnostics reduce operator exposure and incidents & lead to safer working environment. Easier maintenance & uptime can be improved by condition-based monitoring and modular equipment that reduce unplanned downtime. Dependence on scarce skilled labour can be reduced through automation and operator-assist tools.

To survive and grow, one needs to focus on future-proofing against material & regulatory changes. For example, newer and better performing alloys are coming into practice. We need to study, learn and start using these new compositions. Likewise, from time to time, governments tend to change and bring out stricter norms for environment protection and waste material disposal. There are also number of restrictions in surface-treatment processes. One has to constantly monitor fresh guidelines imposed and make necessary corrections. Periodically we need to conduct technology audit to review die casting machines, furnaces, die-cooling, automation, simulation software, quality systems and data capture. Invest in simulation & process control like casting, flow, fill simulation and SPC coverage to pay off quickly on complex dies. Similarly, appropriate investments are needed in operator training program or continuous upskilling in the areas like die handling, basic metallurgy, SPC and troubleshooting. Maintenance strategy needs to be revised and shifted to predictive maintenance (vibration, thermal imaging, cycle counters) to avoid surprise downtime. Simple MES/traceability for critical parts can be implemented and a small percentage of revenue (common is 1–3%) must be reserved for continuous improvement & pilot projects.

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Intensive Cooling and Vacuum Technologies in Die Casting

- Rahat A Bhatia, Founder & Director, Raga Group

ABSTRACT

Mold cooling and vacuuming are critical in die casting to ensure casting integrity and quality. The die casting process demands precise temperature control to prevent cold defects such as shrinkage, porosity, and warping. At the same time, vacuuming helps minimize hot defects like gas porosity, blisters, and short shots. This article explores the importance of intensive mold cooling and vacuuming, their impact on casting defects, practical solutions, and advance solution.

INTRODUCTION

Die casting is the process in which molten metal is poured into the desired shape cavity with high pressure to get the desired shape or product.

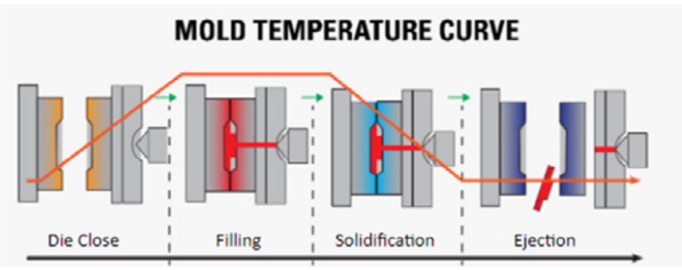


Fig1: Die casting process Source: DME

Die casting is one of the most widely used processes in modern manufacturing, enabling high-volume production of complex metal components with superior dimensional accuracy and surface finish. To meet the increasing demands for lightweight, durable, and defect-free parts—particularly in the automotive, aerospace, and electronics industries—manufacturers have turned to advanced process enhancements.

Mold cooling & Vacuuming in die casting is a critical factor that significantly influences casting quality and die life.

Mold cooling is designed to make the mold thermally balanced.

And vacuuming is designed to remove all air from the cavity before filling.

WHAT IS THE THERMAL BALANCE?

Die thermal balance refers to the control and regulation of the temperature within the die-casting dies during the casting process. It involves maintaining an optimal temperature range to ensure proper filling, solidification, and ejection of the casting. Effective thermal balance is crucial for achieving high-quality castings with minimal defects.

As shown in Fig. 2, the thermal unbalanced die image of the die indicates that some regions are at approximately 590°F, represented in white, while other regions are at about 150°F, represented in blue.

Fig2: Thermally unbalanced Die Thermal Image.

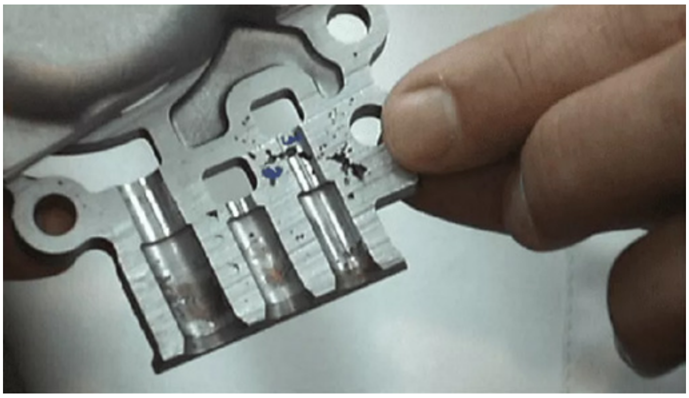
A thermally unbalanced die is not only characterized by hot and cold temperatures but also by temperature variations between different regions and within the thickness of the cavity.

Impact of Thermally Unbalanced Die

A thermally unbalanced die can lead to several defects in casting. If the die temperature is too high or too low, it can cause issues such as incomplete filling, cold shuts, shrinkage porosity, and warping. High temperatures can lead to excessive thermal expansion, resulting in dimensional inaccuracies, while low temperatures can cause premature solidification, leading to incomplete filling and cold shuts.

Shrinkage Porosity Defects:

Shrinkage porosity is one of the most common defects associated with inadequate thermal management in die casting. It refers to small voids or air pockets within the casting.



Source: Think 3D Fig3: Cut-section of casting to show Shrinkage Porosity defect.

Soldering: Hot aluminum alloys tend to react with die steel. Insufficient cooling leads to a continuous increase in die temperature with each cycle, causing molten aluminum to weld to the die surface. When the casting is ejected, layers of the casting parts or the die surface may peel off.

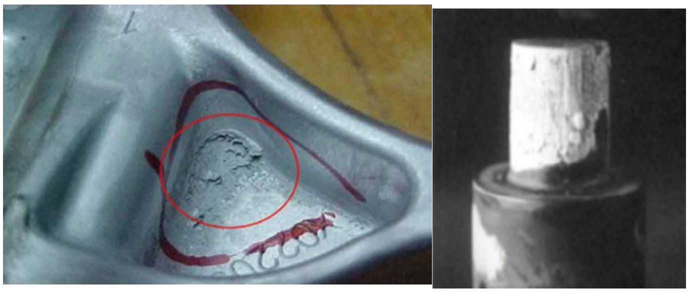
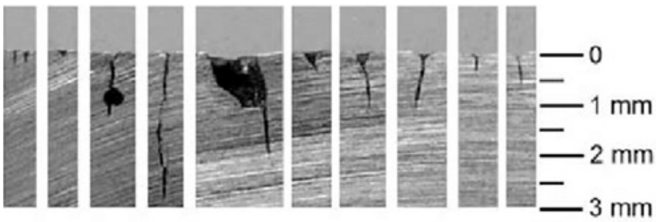


Fig4: Die casted parts with soldering defect (left side) and Core pin with soldering (right side).

Die Cracks & Heat Checks: The die temperature is a critical aspect of process control, influencing Die life. Excessive cooling lowers the die temperature too much. When hot metal is poured into a significantly cooler die, thermal shock can occur, leading to cracks and heat checks in the die.



Source: Thermal fatigue cracking of die-casting dies, J. Tušek, Kosel F, Pleterski M
Fig5: Die crack of different depth

Solution for Thermally unbalanced Die
To prevent defects, make the die thermally balanced

Thermal balancing of dies involves maintaining a minimal temperature difference across all regions of the die and preventing temperature fluctuations with each cycle.

As shown in Fig. 6, after thermal balancing, the temperature variation in the thermal image is from 273°F to 122°F, compared to Fig. 2, where the variation is from 590°F to 122°F.

Fig6: Thermally balanced Die Thermal Image.

To achieve thermal balance in the die, intensive cooling needs to be incorporated.

Intensive cooling:

Die Design stage:

- Simulation: Simulate tool design and optimize the cooling design. Simulation can help achieve thermal balance before manufacturing. However practical conditions may differ from simulated scenarios.

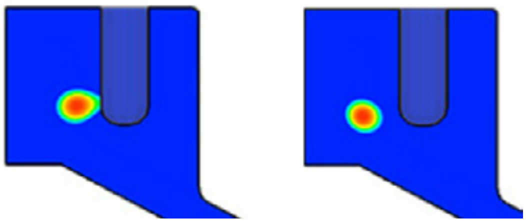


Fig7: A solidification simulation image indicating the location of hot zones or porosity (Left side) After Optimizing cooling porosity shifting (Right side).

Production stage Techniques:

- Jet Cooling: If a hot zone is difficult to cool using conventional methods, use jet cooling. This technique involves flowing water at high pressure and a high flow rate, removing more heat from the die. Jet cooling is primarily used for thin sections such as core pins and small punches, but it can also be applied to any die-casting region where conventional cooling is inadequate. In jet cooling designs, thinner walls are used for core pins or inserts. If cooling holes are not properly drilled, core pins or inserts can break, leading to major accidents. Also, improper utilization of jet cooling can result in Mould overcooling and can cause heat cracks.

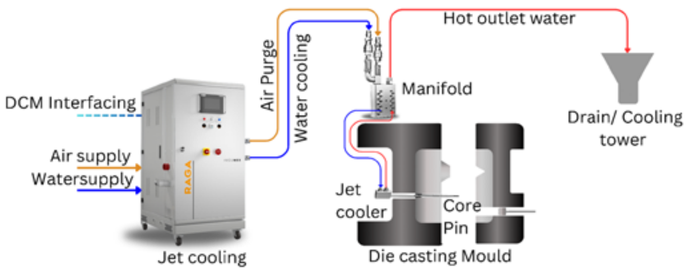


Fig8: Jet cooling machine and its connection layout.

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File Format	Print ready PDF in CMYK color space. No spot colors. All fonts embedded & images @ 300dpi resolution

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- **Closed-loop Cooling:** Seasonal changes affect cooling tower water temperature, with hotter temperatures in summer and colder temperatures in winter. This variability impacts Mould heat transfer, resulting in lower heat transfer in summer and higher in winter, affecting casting quality. In-mould cooling also consumes significant amounts of water. Utilize a water temperature and TDS control unit to maintain consistent thermal balance despite external temperature variations. This practice can save significant costs annually. In Fig8, closed-loop cooling is depicted, employing RAGA AquaControl to regulate water temperature and quality

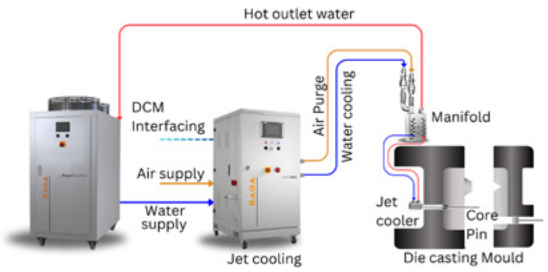


Fig9: Closed-loop jet cooling machine & its connection layout

Measuring/Monitoring system

- **Infrared Thermal Vision:** Use an infrared thermal vision camera to capture thermal images and monitor the temperature of the die This helps identify hot and cold zones. However, it only monitors temperature changes and does not provide the cause of these changes

Fig10: Infrared thermal vision

- **Mould Cooling Water Outlet Monitoring:** Mould cooling monitoring system tracks individual Mould cooling lines. It detects any blockages or leaks and monitors the temperature of the cooling line outlets. If scaling deposits occur, it reduces the water cooling temperature, as scaling reduces heat removal rate.

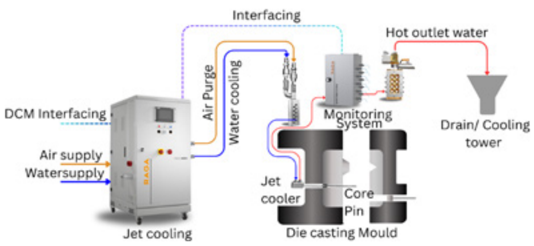
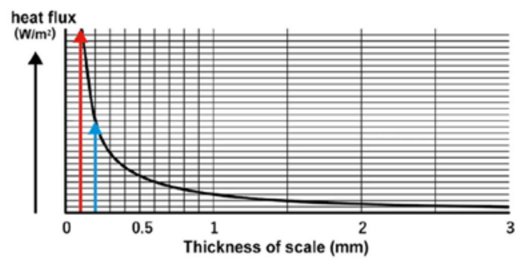


Fig11: Mould cooling monitoring system

CHALLENGES WITH THE CURRENT COOLING & HEATING SYSTEM

- **Cracks or Leakage in Cooling Lines:** Cracks in punches or core pins, or leakage in cooling lines, pose significant challenges for mould cooling and heating. If cooling water or oil leaks and mixes into molten metal due to cracks in punches or core pins, it can lead to serious accidents. In low-pressure die casting, die casters are particularly cautious about using water cooling because if it mixes with molten aluminum in the furnace, it can result in dangerous incidents. Leakage in the cooling line causes insufficient cooling, which increases the rejection rate. Addressing issues like cracks or leakage in cooling lines is crucial to prevent production losses. If spare parts are not available, these issues can lead to even greater losses.

- **Blockage and scaling in Cooling Lines:** Blockage in cooling lines leads to inefficient cooling. Such blockages may be caused by bends, dents, or scaling and rusting in the lines. Scaling not only reduces the flow rate of the cooling water but also acts as an insulator between the cooling water and the die steel, preventing effective heat extraction from the cavity. In Fig. 12, the curve illustrates a significant trend: an increase of 0.2 mm in scaling results in a 50% decrease in heat flux.



Source: matsui.net

Fig12: Curve between Heat flux & Thickness of scaling

ADVANCED SOLUTION FOR MOULD COOLING :

- **CoolSense Technology:** This advanced solution enhances mold cooling monitoring by tracking the heat removal rate. Since it does not involve water, if the flow rate remains the same while the heat removal rate changes, it indicates an issue with thermal balancing. It also provides guidance on regulating the flow rate to achieve the desired heat removal rate. This system offers real-time monitoring, collecting, and transferring data from each cycle to a server, allowing for the extensive collection and analysis of cooling data.

Fig14: Coolsense Technology

Intensive Vacuuming:

Die Design stage:

- **Gate and overflow design:** The gate should be designed in accordance with NADCA standards to ensure proper metal flow and filling efficiency. Overflow locations must be strategically placed at points where trapped air and gases can escape easily from the cavity, thereby enhancing vacuum effectiveness and reducing porosity.

Production stage:

- **Vacuuming:** Vacuum die casting is a process used in the manufacturing industry to produce high-quality, complex metal parts. Vacuum die casting helps improve casting quality, reduce porosity, and improve the mechanical properties of the finished casting. Additionally, the vacuum system allows for the casting of complex shapes with thin walls and intricate details, which would otherwise be difficult to achieve using conventional casting methods.

Vacuum System: A vacuum system/ Machine or vacuum technology in die casting refers to the equipment and technology used to create a vacuum in the cavity during the casting process. The vacuum system removes air and gases from the mold cavity during filling, reducing the risk of defects in the final casting. The mold is sealed within the chamber.

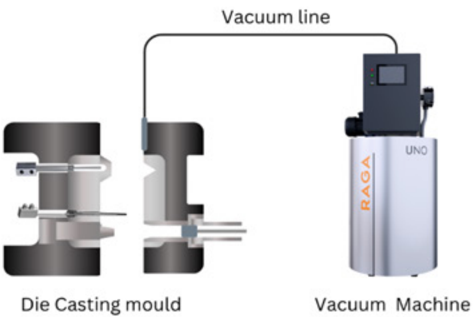


Fig15: Vacuum machine connection layout

Advancements in vacuum technology are as follows:

1. Twin-stage vacuuming: This involves vacuuming from both the mold and the shot sleeve. It shows a considerable reduction of gas porosity, especially in the gate area. It also improves shot velocity consistency by reducing resistance.

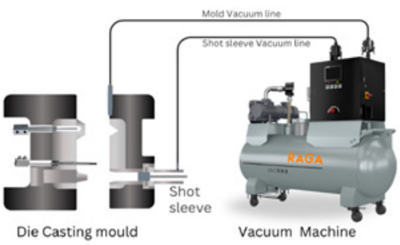


Fig16: Twin-stage Vacuum machine connection layout

2. High vacuuming: This is for critical and safety-sensitive castings that have very stringent porosity requirements. You need to maintain a vacuum of sub-50 millibar levels within the cavity. All points in the mold and leakage points must be sealed thoroughly for it to be effective. In High vacuum with mold and shot sleeve also need to be vacuumed in the Ejector box.

3. Modular vacuuming: Actuation of the vacuum is required nearest to the mold for large die-casting machines. This reduces actuation time and losses in creating a vacuum.

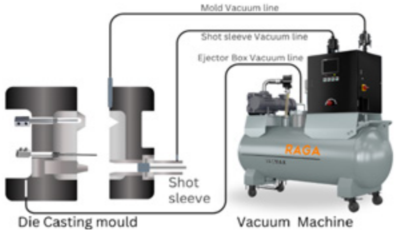


Fig17: High-Vacuuming machine connection layout

Some makers like Fondarex and Raga Group have come up with solutions for modular vacuuming. The modular or extension units are mounted on the platen. The units actuate a vacuum and also take inputs through the measurement of the gas sucked. Gases can escape easily from the cavity, thereby enhancing vacuum effectiveness and reducing porosity.

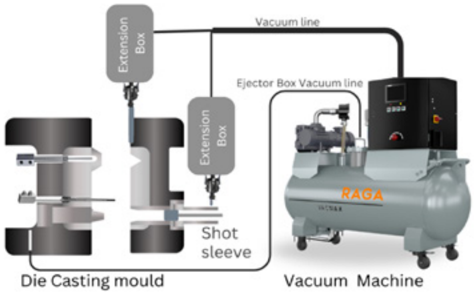


Fig18: Modular Vacuuming machine connection layout

CONCLUSION

Effective mold cooling and advanced vacuum technologies are essential for producing high-quality, defect-free die castings. By achieving thermal balance and eliminating trapped gases, manufacturers can significantly enhance casting strength, dimensional accuracy, and die life. With innovations like jet cooling, closed-loop systems, and modular vacuuming, the die casting process continues to evolve—meeting the growing demand for lightweight, reliable, and complex components in modern industries.

Share your feedback at: **rahat@ragagroup.com**

Rahat A Bhatia
Founder & Director
Raga Group

ALUCAST® 2025

TECHNICAL CONFERENCE & TABLE TOP EXHIBITION
HOTEL DOUBLE TREE BY HILTON, PUNE | 25th & 26th NOVEMBER 2025

PREMIER 2-DAY CONFERENCE AND TABLE TOP EXHIBITION

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With the theme “Effective Application of Modern Technology in Casting Processes,” the event will bring together industry leaders, experts, and innovators to share insights, discuss advancements, and explore practical solutions to enhance efficiency, quality, and sustainability in aluminium casting.

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Technical Presentations on the following topics

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- CFD-Driven AI Optimization of Critical Die Design Parameters in High-Pressure Die Casting
- Leveraging Automated Optimisation for Die Design and Casting Process Through Simulation.
- Heat Treatment Process Simulation for Casting Applications
- Sustainable Die Casting: Buhler’s Integrated Approach
- Lightweighting of Aluminium Alloy Wheels Using Flow Forming Process
- Minimizing Casting Scrap by the Collaborative Methodology of Engineering Expertise with Artificial Intelligence
- Probabilistic Property Modeling for Reliable Casting Design and Production

- Advancing Sustainability in High Pressure Die Casting Through Minimum Quantity Lubrication Release Agent Technology
- Shrinkage Elimination in Thick Sections of HPDC Castings through - FLOW-3D
- Effect of the size of TiB2 and TiAl2 of ATB 5:1 Master Alloy on grain-refinement
- An Innovative Approach in Aluminium Cast Components Manufacturing to Enhance Sustainability
- Smart Monitoring for Die Casting: Predictive Maintenance & Quality Improvement through Industry 4.0
- TOYO INNOVEX Die Casting Machine Technology
- X-ray & CT Technologies for Aluminium Die Casting Industries
- Casting Compactness Evaluation
- Enhancing Performance and Productivity - through Green Alternatives to Conventional System
- Buhler Ecoline DS-Efficient Solutions for High-quality Products. Diecasting with Confidence
- Energy-Saving Servo Solutions for Hydraulic Press Machines & Aluminium Pressure Die-Casting Machines
- Enabling Smart Foundries: Modern Control for High-Performance Die Casting

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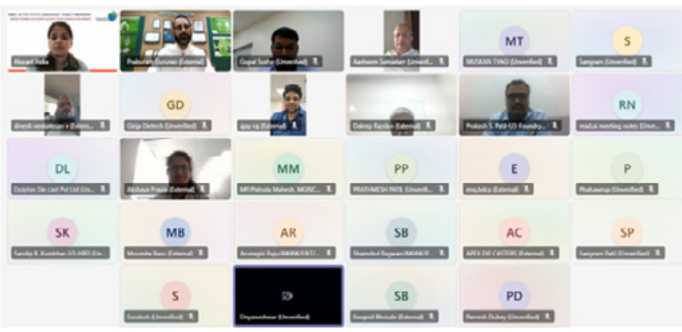
ALUCAST® Activities held in August - September 2025

Workshop Title	Decoding Human Behaviour at Work
Trainer	Mr. G. Praburam Managing Director - Alubee Die Casters Honorary Secretary - ALUCAST , Bangalore Zonal Centre
Date	05th August 2025
Time	03:00 pm to 04:15 pm
Location	Microsoft Teams

Topics Insight:

- Why people actually quit—and why it's rarely just about money
- How people treat you based on what you tolerate and communicate
- The quiet power of recognition in shaping behaviour
- Real motivators behind commitment and performance
- Why people resist systems—and how to build trust
- Transitioning from managing work to leading people



Workshop Title	Finance Discipline for Businesses
Trainer	Mr. Shirish Joglekar, CA with over 35 years of experience
Date	08th August 2025
Time	04:30 pm to 05:15 pm
Location	Hybrid mode (MS Teams & ALUCAST H.O.)

Key Takeaways:

- Gain practical insights to manage finances effectively and make informed business decisions.

Workshop Title	From LEARNING to IMPACT – Workforce Transformation
Trainer	Ms. Sarika Joshi — Certified Auditor, Consultant, Facilitator & Trainer
Date	20th August 2025
Time	06:00 pm to 07:00 pm
Location	Hybrid mode (MS Teams & ALUCAST H.O.)

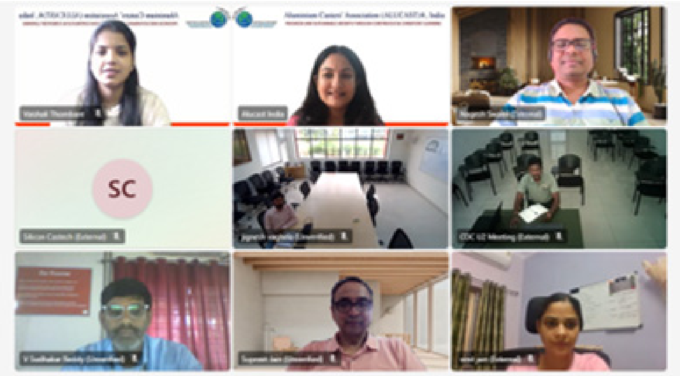
Topics Insight:

- The role of training in driving business impact
- Identifying the right learning needs and topics
- Effective processes to plan and execute training
- Real-world best practices that deliver results

Workshop Title	Certification Course in MS-Excel & Data Analysis
Trainer	Mr. Nagesh Swami - 15+ years of training experience in Advanced Excel & Power BI
Date	23^{rd} & 24^{th} August 2025
Time	09:30 am to 01:30 pm
Location	Microsoft Teams

Topics Insight:

- Mastery in handling complex datasets
- Ability to create automated reports & dashboards
- Proficiency in cleaning, analysing, and visualizing data
- Understanding Excel's integration with ERP & business systems
- Tools to reduce manual effort and enhance accuracy
- Improved career prospects through Excel expertise



Workshop Title	Exclusive Industry Study Visit for Members
Date	29^{th} September 2025
Location	Jaya Hind Industries Pvt. Ltd, Urse Aakar Foundry Pvt Ltd, Pune

The Industry Study Visit was designed to:

- Facilitate knowledge sharing among member companies.
- Enable participants to observe real-time operations and benchmark against best practices.
- Provide insights into safety, productivity, and sustainability initiatives.
- Strengthen professional networking and collaboration within the industry.

Studies of the Aluminum Rotary Degassing Process resulting in an Intelligent Process Control Software

- R. Simon, VESUVIUS plc., FOSECO Foundry Division, Cleveland, OH

ABSTRACT

The production of Aluminum castings globally is dominated by the automotive industry and the growing importance of emissions and fuel economy has resulted in a rapid increase in the use of Aluminum castings. Melt treatment by rotary degassing must be capable of achieving consistent levels of cleanliness and hydrogen control. Many quality management systems also require a 100 % record of production data and a sophisticated melt treatment system with data storage becomes more even attractive to the automotive industry.

This paper summarizes various studies on the influence of ambient conditions, alloy composition, and melt temperature on hydrogen solubility in Aluminum melts.

Findings from extensive lab and field trials result in a new SMARTT software which analyses all starting parameters and calculates the treatment parameters for the rotary degassing process just before each treatment. It guarantees a constant melt quality after each treatment. In a case study, results of degassing treatments under different environmental conditions are shown. Upgassing is a common technology in melt treatment for wheel casting.

Overall, SMARTT software with all possible features can become an integrated part of process control in foundries and is a major step on the way to “Foundry 4.0”.

INTRODUCTION

The production of Aluminium castings globally is dominated by the automotive industry. To ensure that the correct casting quality is achieved, a more effective and technically sound melt treatment is essential, followed by a well-designed and controlled pouring practice. Automotive industry requests process reproducibility and so any melt treatment adopted must be capable of achieving consistent levels of cleanliness and hydrogen control. Many quality management systems also require a 100 % record of production data, so again a sophisticated melt treatment with data storage capabilities becomes more attractive.

Process control in general refers to the way in which foundries maintain a tight control over the various components and steps involved in making castings. The importance of process control is derived from the way in which a strict adherence to process control helps a foundry avert potentially costly mistakes. Considering the fact, that process control requires a complete monitoring of the various parameters, any potential problem will be spotted early, before it becomes a significant problem later.

The intelligent use of process control technologies within the manufacturing process has beneficial effects far beyond the traditional aspects of quality assurance:

- Increase throughput from existing assets
- Increase automation and reduce human intervention
- Reduce rework, concessions and scrap
- Enhance production capability and take on more work.

DEGASSING SIMULATION

Degassing simulation for batch treatments of aluminum melts builds the basis for process optimization. The Batch Degasser Simulation has been designed as a tool to analyze quickly foundries' operations and make suggestions for their improvement.[1] The mathematical model behind this software is based on the best available published information concerning the kinetics of hydrogen degassing (e.g. hydrogen solubility, diffusivity, mass transfer rates and stable bubble sizes). An extensive trial program was undertaken to provide specific information about individual degassing rotors under different conditions.

To characterize different rotors the following trials were carried out:

- Power analysis of degasser rotors
- Mixing capabilities of degasser rotors
- Gas solubility tests in water
- Foundry trials in aluminium melts

PARAMETERS INFLUENCING ROTARY TREATMENTS

In rotary degassing we differentiate between factors that are almost constant over longer periods of time and variable factors. Alloy composition, vessel geometry and target melt quality are often well known and do not change remarkably. Usually, several treatment programs are set in the PLC, defining treatment time, rotor speed and gas flow rate. The operator selects a program following given instructions. The number of programs is limited, the programs need to be changed manually in case of process variations, and the operator might choose the wrong program. Other factors such as ambient conditions and melt temperatures often vary in much wider ranges. The influence on degassing is usually underestimated or operators change parameters based on their experiences. Variations in these starting conditions may cause inconsistencies in degassing results. The hydrogen concentration in the melt during degassing for various ambient conditions and melt temperatures has been calculated using the Degassing Simulation for the following widely common set of parameters. Variations of the parameters illustrate the influence on the degassing result and the final hydrogen content in the melt after every single treatment.

Table 1- Model simulation parameters

Transfer ladle with 850 kg (1,875 lb) melt	XSR 220 rotor
AlSi7Mg	420 rpm
750 °C (1,380 °F) melt temperature	20 l/min (42 sqfh) inert gas
50 % relative humidity	20 l/min (42 sqfh) forming gas with 20 % hydrogen
25 °C (77 °F) outside temperature	0,30 ml H2 / 100 g Al starting level

AMBIENT CONDITIONS

The melt forms an equilibrium with the water in the surrounding atmosphere; a warm and humid climate results in a much higher hydrogen content in the melt than a dry and cold climate (Figure 1).

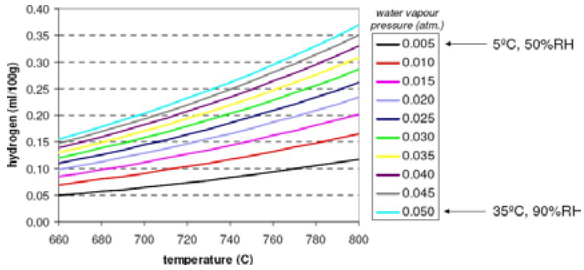


Figure 1- Influence of ambient conditions on hydrogen equilibrium2 (0,005 atm = 5 °C / 50 % rH; 0,050 atm = 35 °C / 90 % rH)

During rotary degassing the melt is in interaction with the atmosphere. The degassing simulation shows the effect of different ambient conditions (Figure 2):

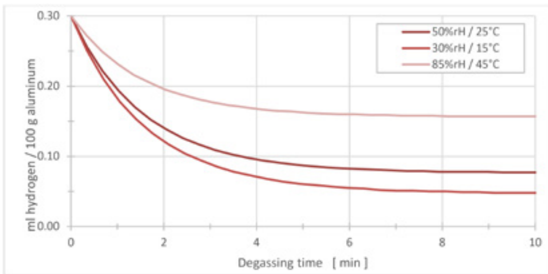


Figure 2- Degassing curves for different ambient conditions

Likewise, the use of forming gas – a N2 -H2 mixed gas - for upgassing procedures ends up with different hydrogen levels (Figure 3). 50% rH / 25 °C and 30% rH / 15 °C degas down to 0.08 hydrogen before upgassing, 85% rH / 45 °C degas down to 0.13 hydrogen only because this is the lowest achievable degassing level at these conditions.

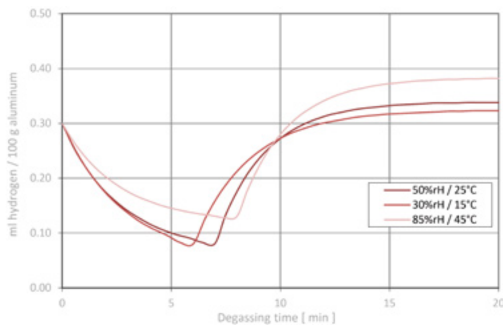


Figure 3- Upgassing curves for different ambient conditions

MELT TEMPERATURE

The melt temperature influences the equilibrium with the atmosphere as well; melt at higher temperatures dissolves more hydrogen (Figure 4).

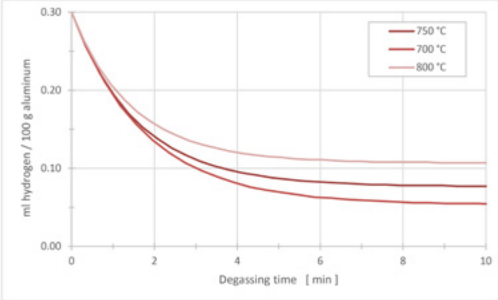


Figure 4- Degassing curves for different melt temperatures

The variations in results for use of forming gas are even higher at different melt temperatures (Figure 5). Melt temperatures of 700 °C and 750 °C degas down to 0.08 hydrogen before upgassing, 800 °C degas down to 0.10 hydrogen only because this is the lowest achievable degassing level at these conditions.[3]

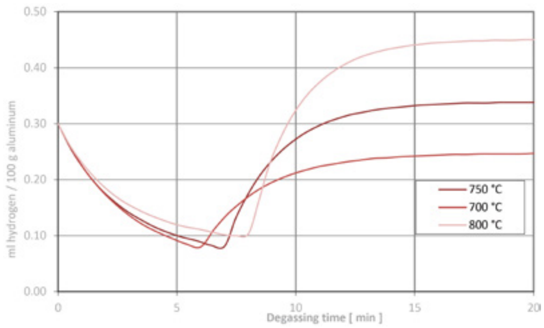


Figure 5- Upgassing curves for different melt temperatures

SMARTT – AN INNOVATIVE PROCESS CONTROL

SMARTT is an acronym for self-monitoring adaptive recalculation treatment and an innovative process control that analyzes all incoming parameters and calculates the treatment parameters for the rotary degassing process just before each treatment. The target for the optimization is a constant melt quality after each treatment. The SMARTT software is installed on a Windows PC, input and output of data is conducted on a comfortable touch screen panel with a LAN connection to the SIEMENS PLC that finally controls the degassing unit.

Relative humidity and outside temperature are measured by a standard humidity meter, mounted next to the control cabinet in the area where the treatment takes place. The actual readings are on-time transferred to SMARTT and recorded over time.

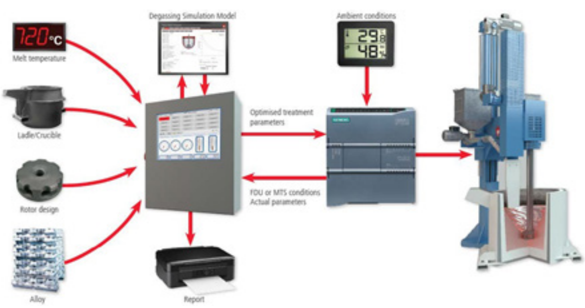


Figure 6– Schematic interaction of process control using SMARTT software

SMARTT comes with several pre-defined alloys and crucible or transfer ladle geometries. The user can easily modify, add, or delete these. Alloy and treatment vessel become part of each program together with a recommended rotor type and diameter (Figure 6). SMARTT offers four different treatment schemes to choose from. The calculation is based on a minimum and maximum gas flow rate and rotor speed depending on rotor type and diameter as well as on vessel size.

The minimum degassing time is a parameter to ensure proper oxide removal. The software is suitable for degassing machines with the optional MTS 1500 automated granulate addition as well. The MTS parameter setting is carried out on the touch screen in the conventional way, those parameters are not part of the optimization. Nevertheless the different MTS programs are part of the treatment programs and combined with optimization schemes and hydrogen targets (picture 5).

All previously described screens are accessible for the administrator only. The operator sees a specially designed interface to make an easy choice from 20 different administrator defined products. Additionally, the ambient conditions, remaining treatment time and actual parameters are displayed (Figure 7).

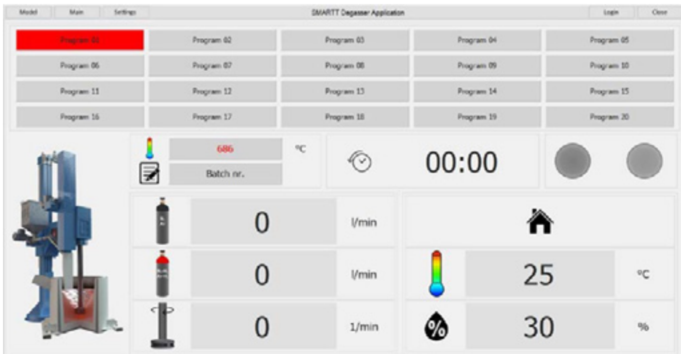


Figure 7- Operator screen

A report system is part of the SMARTT software package. All treatment data are stored and available in Excel file format. Figure 8 shows a part of an auto-generated report.

Figure 8- Example of a treatment report in SMARTT

PRACTICE OF DEGASSING USING SMARTT SOFTWARE

For different ambient conditions SMARTT calculates treatment parameters to reach a target hydrogen content after each treatment. With increasing air temperature and relative humidity, the rotor speed and inert gas flow rate increases to compensate the higher moisture content in atmosphere. The optimization always starts at minimum time, a time that allows sufficient oxide and inclusion removal as well (Table 2, Figure 9). As humidity and temperature increase, hydrogen removal becomes more difficult, so SMARTT increases the amount of inert gas and rotor speed. When the specific rotor speed and inert gas limits are reached, the software automatically extends the treatment time. A maximum treatment time limits temperature loss or melt shortage in the following casting step.

Variations in melt temperature before degassing are compensated by SMARTT in a similar way. Finally, every treatment cycle is started with different rotor speed, inert gas flow rate and treatment time to achieve the same hydrogen content in the melt at the end of each treatment. Foundry trials have shown that the target was always reached regardless of starting conditions.

Table 2- Process parameters for SMARTT degassing

BU 600 with 530 kg (1,170 lb) melt	0,06 ml H_2 / 100 g Al target
AlSi8Cu3	Standard optimization
750 °C (1,380 °C) melt temperature	240 s minimum time
XSR 190 rotor	500 s maximum time

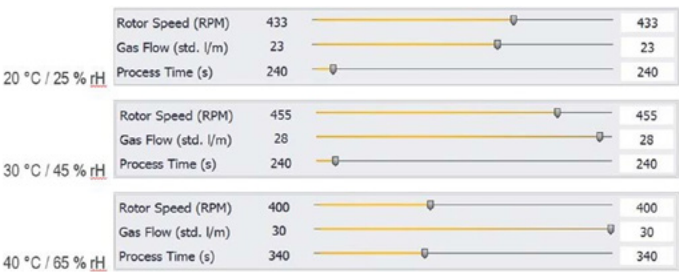


Figure 9- Treatment parameters for different ambient conditions

Aluminium dissolves more hydrogen at higher temperatures and takes even more hydrogen back at the melt surface from atmosphere. The treatment is carried out at faster rotor speed and higher inert gas flow rates with increasing temperature and conversely. The SMARTT found a logical solution for up to 780 °C, no parameter setting could be predicted for 800 °C due to too high moisture pick-up on the surface during the cycle (Figure 10).

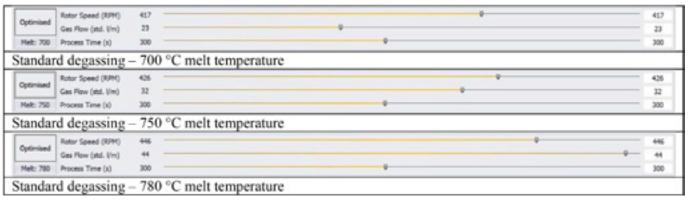


Figure 10- Results for different melt temperatures

PRACTICE OF UPGASSING WITH FORMING GAS USING SMARTT SOFTWARE

Some applications in foundries require a defined hydrogen content such as in the casting of wheels. It is common practice to run very short treatment times to avoid too much hydrogen removal; often oxide removal is not sufficient. The use of a N_2 - H_2 mixed gas improves oxide removal due to longer treatment times but the variations in hydrogen at end of treatment are still high. N_2 - H_2 blend are available with different hydrogen contents between 5 and 50%; higher hydrogen percentage in mixes allow higher hydrogen in the melt after upgassing. SMARTT now runs an inert gas treatment followed by a two stage upgassing. The 1st stage runs with N_2 -H_2 mixed gas only reaching about 90 % of the target hydrogen; during stage 2 a mix between N_2 -H_2 and inert gas provides a defined hydrogen content in treatment gas and ends in an equilibrium between treatment gas, aluminum melt and atmosphere (Figure 11).

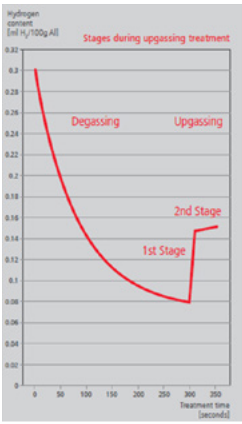


Figure 11- Stages of an upgassing procedure

Table 3- Process parameters for SMARTT upgassing

Transfer ladle with 850 kg (1,875 lb) melt	0,08 ml H2 / 100 g Al target for degassing
AlSi7Mg	0,15 ml H2 / 100 g Al final target
750 °C (1,380 °F) melt temperature	360 s minimum time
50 % relative humidity	600 s maximum time
FDR 220 rotor	45 s dwell time (2nd stage)
Standard optimization	20 % hydrogen in N2 -H2 mixed gas

Table 4- Treatment parameters for different temperatures for upgassing

		Rotor [rpm]	Inert gas [l/min]	N2 -H2 [l/min]	Time [s]	Effective H2 [%]
720 °C	Degassing	315	16	0	360	0
	1st Stage	400	0	35	28	20
	2nd Stage	400	26	9	45	5,3
740 °C	Degassing	303	25	0	360	0
	1st Stage	400	0	35	22	20
	2nd Stage	400	28	7	45	3,8
760 °C	Degassing	309	30	0	360	0
	1st Stage	400	0	35	17	20
	2nd Stage	400	30	5	45	2,8

Hydrogen transfer into melt becomes easier at higher temperatures which reduces 1st stage time. In this way 2nd stage is influenced as well; the effective hydrogen level in purge gas gets lower.

This value is exactly the equilibrium between degassing the melt, hydrogen pickup at melt surface and upgassing by N2 -H2 mixed gas. Under given conditions those parameters keep the final hydrogen content in the melt at constant level; a dwell time of 30 to 45 s is sufficient to get into that equilibrium.

The mass flow controller for inert gas and N2 -H2 mixed gas blends the correct effective hydrogen content without operator involvement. The differences in effective hydrogen in purge gas and resulted treatment times illustrate the complexity of upgassing; it is obvious that a computer-based simulation only can handle all variations in starting conditions.

SUMMARY

SMARTT - innovative degassing control - offers a comfortable interface to program all necessary treatment steps, to read or measure the starting conditions before every rotary degassing and predicts the best treatment parameters for different schemes. An integrated report system stores all data per treatment in Excel format and enables the melt shop manager to run further analysis on the process.

The use of SMARTT for degassing processes provides a melt on a constant hydrogen level independent from inconsistent starting conditions in a foundry. SMARTT enables the foundry to always reach this in a cost-effective way, there is no need for compensating these variations in overrunning the treatment which wastes time, inert gas and graphite consumables.

In upgassing – often used in wheel foundries – even small changes in environmental conditions or melt temperature have an enormous impact on the hydrogen content after the treatment.

These complex relationships can only be managed by a mathematical model. SMARTT, based on the batch degasser software, is an intelligent solution to handle data for rotary degassing.

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2. Evans, P., Rick, R., "Equilibrium Levels of Hydrogen in Aluminium", presentation (2009)
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Digital Radiography in the Age of Industry 4.0 & AI

Redefining Industrial Quality with Smart Imaging Systems

- Karthikeyan Jawahar, Director and Malaravan Palanisamy, Director
Karma Innovations & Solutions Pvt. Ltd.

INTRODUCTION - THE NEW AGE OF INSPECTION

In an era where speed, precision, and intelligence define industrial success, inspection technologies are undergoing a revolution. Traditional methods, once considered reliable, are now too slow, too manual, and too limited for the pace of modern manufacturing. Welcome to the age of Industry 4.0 — where automation, connectivity, data analytics, and AI converge to create intelligent factories.

Here, Digital Radiography (DR) has emerged as one of the most transformative tools in industrial quality control, enabling faster decision-making, higher accuracy, and full digital traceability.

FROM FILM TO DIGITAL: A PARADIGM SHIFT

For decades, film-based radiography was the standard. It involved physical films, chemical processing, darkrooms, and long waiting periods. While effective in its time, film inspection had multiple challenges:

- Long processing times (15–30 minutes per exposure and development cycle)
- Chemical waste and high recurring costs
- Limited accuracy and traceability
- No real-time feedback
- Manual interpretation prone to fatigue and error

As industries began adopting Industry 4.0 principles — demanding faster feedback loops, digital traceability, and smart data systems — film radiography became a bottleneck.

That's where Digital Radiography (DR) changed everything.

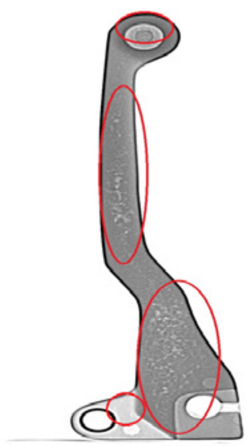
With flat-panel detector systems, manufacturers can now capture, analyze, and share high-resolution X-ray images instantly — resulting in faster decisions, lower costs, and stronger quality assurance.

WHAT MAKES DIGITAL RADIOGRAPHY REVOLUTIONARY?

Digital Radiography replaces film with digital flat-panel detectors that convert X-rays into electronic images. These can be viewed, processed, and stored on computers — forming the backbone of a fully digital, AI-ready inspection ecosystem.

Key benefits include:

1. Instant Imaging: Defects become visible within seconds — no waiting, no darkrooms. Engineers can analyze and act immediately.
2. High Accuracy and Detail: Even micron-level



discontinuities such as porosity, shrinkage, or foreign particles are detected with precision.
3. Zero Consumables: No films, no chemicals, no recurring costs — enabling sustainable and cost-efficient inspection.
4. Smart Data and Traceability: Each scan is stored digitally, traceable, and easily retrievable — ensuring full compliance and audit readiness.
5. AI Integration: Intelligent algorithms identify patterns, highlight potential defects, and minimize human error — particularly in high-volume inspections.

6. 24/7 Operations: With robust design, DR systems can function continuously, adapting to challenging conditions such as heat, voltage fluctuations, and demanding workloads.
7. Automation Ready: DR systems can integrate with conveyors, robotics, and automated workflows, enabling round-the-clock inspection with minimal manpower.
8. Peace of Mind for Business Leaders: Digital inspection ensures that every image is time-stamped, traceable, and verifiable, offering manufacturers legal and brand protection. In case of disputes or quality concerns, companies can confidently demonstrate that their components met every specification before shipment.

DIGITAL RADIOGRAPHY MEETS INDUSTRY 4.0

Industry 4.0 is not just about automation — it's about intelligence, connectivity, and data-driven decision-making. Modern DR systems align perfectly with this vision through:

- IoT Connectivity – Real-time data sharing across factory networks
- Analytics-Ready Platforms – Turning every image into a data point for process optimization
- Cloud Integration – Remote accessibility and collaboration
- Predictive Insights – AI-driven trend analysis and proactive maintenance

This synergy transforms Digital Radiography from a quality assurance tool into a strategic enabler for smart manufacturing.

AI: THE GAME-CHANGER IN DEFECT DETECTION

Even the best inspectors experience fatigue in repetitive, high-volume environments — such as foundries inspecting thousands of castings daily. This often leads to:

- False negatives (missed defects)
- False positives (rejection of good parts)

By integrating AI-powered interpretation, manufacturers can drastically reduce these errors.

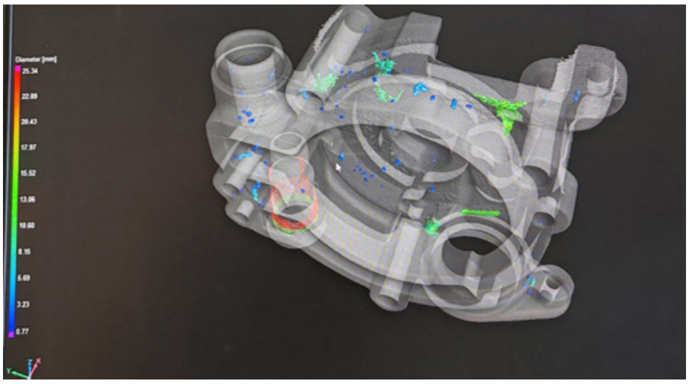
AI models trained on thousands of images can detect patterns, anomalies, and trends with human-like intelligence — but without fatigue.

This doesn't replace human expertise; it enhances it, allowing engineers to focus on analysis and improvement while AI handles repetitive evaluation.

THE LEAP BEYOND 2D: INDUSTRIAL CT (COMPUTED TOMOGRAPHY)

While DR provides a 2D projection, Industrial CT reconstructs multiple radiographs into a 3D volumetric model — revealing internal structures in unparalleled detail.

CT enables non-destructive evaluation of both geometry and material integrity, capturing micron-level discontinuities across all dimensions.



Key applications include:

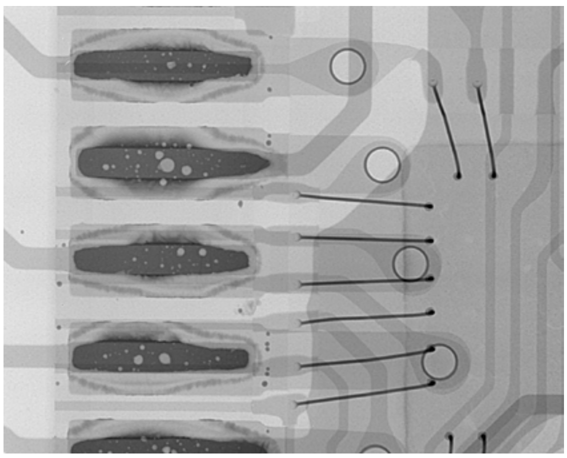
- Aerospace – Turbine blades, critical castings
- EV & Batteries – Electrode alignment, internal voids
- Precision Engineering – Internal geometry verification
- R&D – Prototype validation and material behavior studies

CT aligns with Industry 4.0 concepts like digital twins and virtual prototyping, helping organizations move toward zero-defect manufacturing.

WHY DIGITAL RADIOGRAPHY IS THE FUTURE OF QUALITY

- Speed – Instant results accelerate feedback loops and production cycles
- Accuracy – Detects internal defects invisible to surface inspection
- Sustainability – No chemicals or consumables, reducing environmental impact
- Traceability – Every scan is stored, traceable, and audit-ready
- AI Readiness – Built for automation, analytics, and continuous improvement

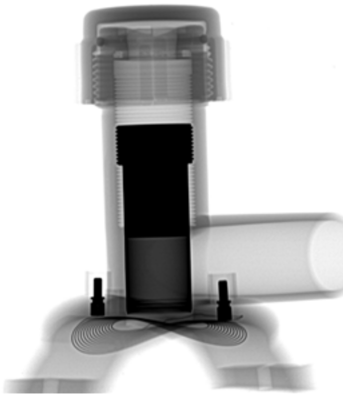
By embedding Digital Radiography within Industry 4.0 ecosystems, manufacturers can transition from reactive quality control to proactive, data-driven excellence.



CASE EXAMPLE: FOUNDRIES AND DR — A PERFECT MATCH

In foundries, casting integrity is everything. Even tiny voids or inclusions can cause catastrophic failures.
By adopting DR technology, foundries can:

- Inspect thousands of castings daily
- Detect porosity, shrinkage, and inclusions instantly
- Store and share results digitally with OEMs
- Identify recurring defect trends through AI analytics
- Accelerate new product development via faster validation
- Reduce inventory holding by shortening inspection feedback loops



The result? Flawless castings, reduced scrap, and greater customer confidence.

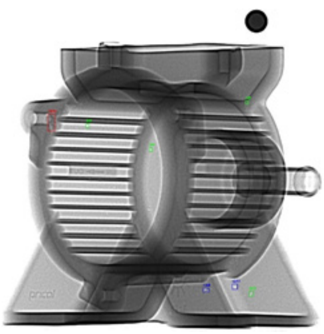
SUSTAINABILITY AND COMPLIANCE

Unlike film-based systems requiring chemical developers and lead shielding, DR is fully digital and eco-friendly, aligning with ESG commitments and regulatory standards. This shift not only supports the environment but also enhances workplace safety and global compliance.

THE ROAD AHEAD: AI, AUTOMATION, AND DIGITAL TWINS

As AI and data analytics advance, DR will evolve into a self-learning, autonomous inspection system. Future-ready DR and CT solutions will integrate with MES, ERP, and cloud platforms to deliver:

- Automated defect classification



- Predictive process analytics
- Digital twin integration
- Real-time dashboards for decision-making
- The vision is a fully connected ecosystem where every component is inspected, analyzed, and certified digitally — instantly, accurately, and sustainably.

CONCLUSION: SEEING BEYOND THE SURFACE

In today's manufacturing world, quality is not optional — it's the foundation of trust, safety, and competitiveness.

Digital Radiography, powered by AI and Industry 4.0, gives manufacturers the eyes to see the unseen — detecting internal flaws before they become failures.

And the best part?

All the features, benefits, and capabilities discussed above are already available in India, designed and delivered by Karma Innovations — a homegrown pioneer bringing world-class DR and CT systems to Indian and global industries.
With Karma Innovations, manufacturers gain exceptional inspection technology along with local expertise, customization, and support—ensuring that Made in India represents excellence, precision, and trust. Because in the age of Industry 4.0, it's not just about what we make —
It's about how clearly we see what we make.

Karthikeyan Jawahar
Director
Karma Innovations & Solutions Pvt. Ltd

Malaravan Palanisamy
Director
Karma Innovations & Solutions Pvt. Ltd

Segment wise Comparative Production, Domestic Sales & Exports data for the month of April-July 2025									
Report I - Number of Vehicles									
Category	**Production**			**Domestic Sales**			**Exports**		
Segment/Subsegment	**April-July**			**April-July**			**April-July**		
	2024-25	**2025-26**	**% Change**	**2024-25**	**2025-26**	**% Change**	**2024-25**	**2025-26**	**% Change**
Passenger Vehicles (PVs)*									
Passenger Cars	5,85,138	5,53,900	-5.3%	4,37,945	3,99,138	-8.9%	1,34,079	1,39,952	4.4%
Utility Vehicles(UVs)	9,62,031	10,33,568	7.4%	8,34,011	8,63,019	3.5%	1,05,769	1,28,355	21.4%
Vans	54,209	54,977	1.4%	50,835	50,976	0.3%	2,564	3,315	29.3%
Total Passenger Vehicles (PVs)	**16,01,378**	**16,42,445**	**2.6%**	**13,22,791**	**13,13,133**	**-0.7%**	**2,42,412**	**2,71,622**	**12.0%**
Three Wheelers									
Passenger Carrier	2,79,646	3,26,396	16.7%	1,81,939	1,94,564	6.9%	97,315	1,33,997	37.7%
Goods Carrier	38,007	37,974	-0.1%	35,159	35,190	0.1%	1,040	1,586	52.5%
E-Rickshaw	5,554	3,491	-37.1%	5,972	3,646	-38.9%	-	-	-
E-Cart	1,029	1,114	8.3%	1,084	1,214	12.0%	-	-	-
Total Three Wheelers	**3,24,236**	**3,68,975**	**13.8%**	**2,24,154**	**2,34,614**	**4.7%**	**98,355**	**1,35,583**	**37.9%**
Two Wheelers									
Scooter/ Scooterettee	24,47,009	26,06,966	6.5%	22,18,636	23,04,921	3.9%	2,06,006	2,03,733	-1.1%
Motorcycle/Step-Throughs	51,94,451	53,23,304	2.5%	40,48,411	37,93,556	-6.3%	10,40,226	13,58,796	30.6%
Mopeds	1,65,949	1,58,583	-4.4%	1,60,278	1,43,352	-10.6%	1,824	8,286	354.3%
Total Two Wheelers	**78,07,409**	**80,88,853**	**3.6%**	**64,27,325**	**62,41,829**	**-2.9%**	**12,48,056**	**15,70,815**	**25.9%**
Quadricycle									
Quadricycle	2,699	1,279	-52.6%	98	4	-95.9%	2,634	1,296	-50.8%
Grand Total of All Categories	**97,35,722**	**1,01,01,552**	**3.8%**	**79,74,368**	**77,89,580**	**-2.3%**	**15,91,457**	**19,79,316**	**24.4%**

*** BMW, Mercedes, JLR, Volvo Auto data is not available and Tata Motors data is available for Apr-June only. Society of Indian Automobile Manufacturers (14/08/2025).**

Segment wise Comparative Production, Domestic Sales & Exports data for the month of April-August 2025									
Report I - Number of Vehicles									
Category	**Production**			**Domestic Sales**			**Exports**		
Segment/Subsegment	**April-August**			**April-August**			**April-August**		
	2024-25	**2025-26**	**% Change**	**2024-25**	**2025-26**	**% Change**	**2024-25**	**2025-26**	**% Change**
Passenger Vehicles (PVs)*									
Passenger Cars	7,20,723	6,78,782	-5.8%	5,35,143	4,89,604	-8.5%	1,69,292	1,83,602	8.5%
Utility Vehicles(UVs)	11,91,380	12,58,763	5.7%	10,34,607	10,42,607	0.8%	1,35,676	1,65,877	22.3%
Vans	66,001	66,241	0.4%	61,820	61,761	-0.1%	3,452	4,389	27.1%
Total Passenger Vehicles (PVs)	**19,78,104**	**20,03,786**	**1.3%**	**16,31,570**	**15,93,972**	**-2.3%**	**3,08,420**	**3,53,868**	**14.7%**
Three Wheelers									
Passenger Carrier	3,69,396	4,33,183	17.3%	2,40,637	2,58,418	7.4%	1,25,587	1,75,887	40.1%
Goods Carrier	48,610	49,370	1.6%	43,593	44,941	3.1%	1,641	2,438	48.6%
E-Rickshaw	8,576	4,402	-48.7%	8,627	4,990	-42.2%	-	23	-
E-Cart	1,180	1,875	58.9%	1,259	2,024	60.8%	-	-	-
Total Three Wheelers	**4,27,762**	**4,88,830**	**14.3%**	**2,94,116**	**3,10,373**	**5.5%**	**1,27,228**	**1,78,348**	**40.2%**
Two Wheelers									
Scooter/ Scooterettee	30,70,286	33,38,165	8.7%	28,24,886	29,88,318	5.8%	2,60,324	2,68,543	3.2%
Motorcycle/Step-Throughs	65,33,664	67,62,655	3.5%	51,09,277	49,00,194	-4.1%	13,24,336	17,23,283	30.1%
Mopeds	2,14,015	1,99,457	-6.8%	2,04,824	1,87,238	-8.6%	2,004	11,022	450.0%
Total Two Wheelers	**98,17,965**	**1,03,00,277**	**4.9%**	**81,38,987**	**80,75,750**	**-0.8%**	**15,86,664**	**20,02,848**	**26.2%**
Quadricycle									
Quadricycle	3,154	1,708	-45.8%	104	4	-96.2%	2,916	1,698	-41.8%
Grand Total of All Categories	**1,22,26,985**	**1,27,94,601**	**4.6%**	**1,00,64,777**	**99,80,099**	**-0.8%**	**20,25,228**	**25,36,762**	**25.3%**

*** BMW, Mercedes, JLR, Volvo Auto data is not available and Tata Motors data is available for Apr-June only. Society of Indian Automobile Manufacturers (15/09/2025).**

ALUCAST SNIPPETS

GLOBAL ALUMINUM SCRAP TRADE LANDSCAPE SHIFTS: INDIA TOPS AS LARGEST IMPORTER IN H1 2025

Global aluminum scrap trade is undergoing significant adjustments, with shifting demand patterns, tariff pressures, and regional recycling dynamics driving dramatic changes in import rankings. According to the latest UN Comtrade data, India has surged to become the world's largest aluminum scrap importer in H1 2025, while China's import share has substantially contracted. Driven by tariff-induced demand surges, the US has climbed to the second position among importers.

H1 GERMANY MAINTAINED ITS POSITION AS THE WORLD'S THIRD LARGEST ALUMINUM SCRAP IMPORTER.

Germany's aluminum scrap import value reached $919 million in H1 2024 and $851 million in H1 2025 (January-May only), with its share among the top five globally declining slightly from 17.8% to 16.2%. Imports decreased from 526,873 mt to 446,476 mt (January-May data), remaining largely stable after time-dimension adjustment. However, Germany's aluminum scrap industry faces structural challenges: attracted by US tariff advantages, substantial European aluminum scrap flows to the US, causing a local supply deficit; Turkey, with lower energy costs and access to Russian resources, competes with Germany in aluminum processing, weakening its industry competitiveness; weak demand from the construction and EV sectors, coupled with high energy costs and inflationary pressures, further suppresses aluminum scrap imports.

ZF INDIA TO QUADRUPLE SOURCING TO ₹25,000 CRORE, EYES 2,000+ SUPPLIERS

ZF India President Akash Passey said the company plans to expand its supplier network from 700 to over 2,000 to drive localisation and support its export-led growth strategy. ZF India is set to sharply ramp up its sourcing footprint in the country, quadrupling the value of components procured from local suppliers to ₹25,000 crore in the coming years, up from the current ₹6,500 crore. The move underscores the German auto component giant's increasing reliance on India as a global hub for both internal combustion engine (ICE) and electric vehicle (EV) technologies. Akash Passey, President of ZF India, said the company is preparing to expand its supplier network from 700 firms at present to more than 2,000, as part of a wider localisation and export-led growth strategy. "Today we do about 6,500 crores out of India and we're aiming to do 25,000 crores of sourcing… which means we have today 700 suppliers and probably go to 2,000 plus suppliers," he said during the Automotive Component Manufacturers Association's (ACMA) 65th Annual Session in New Delhi.

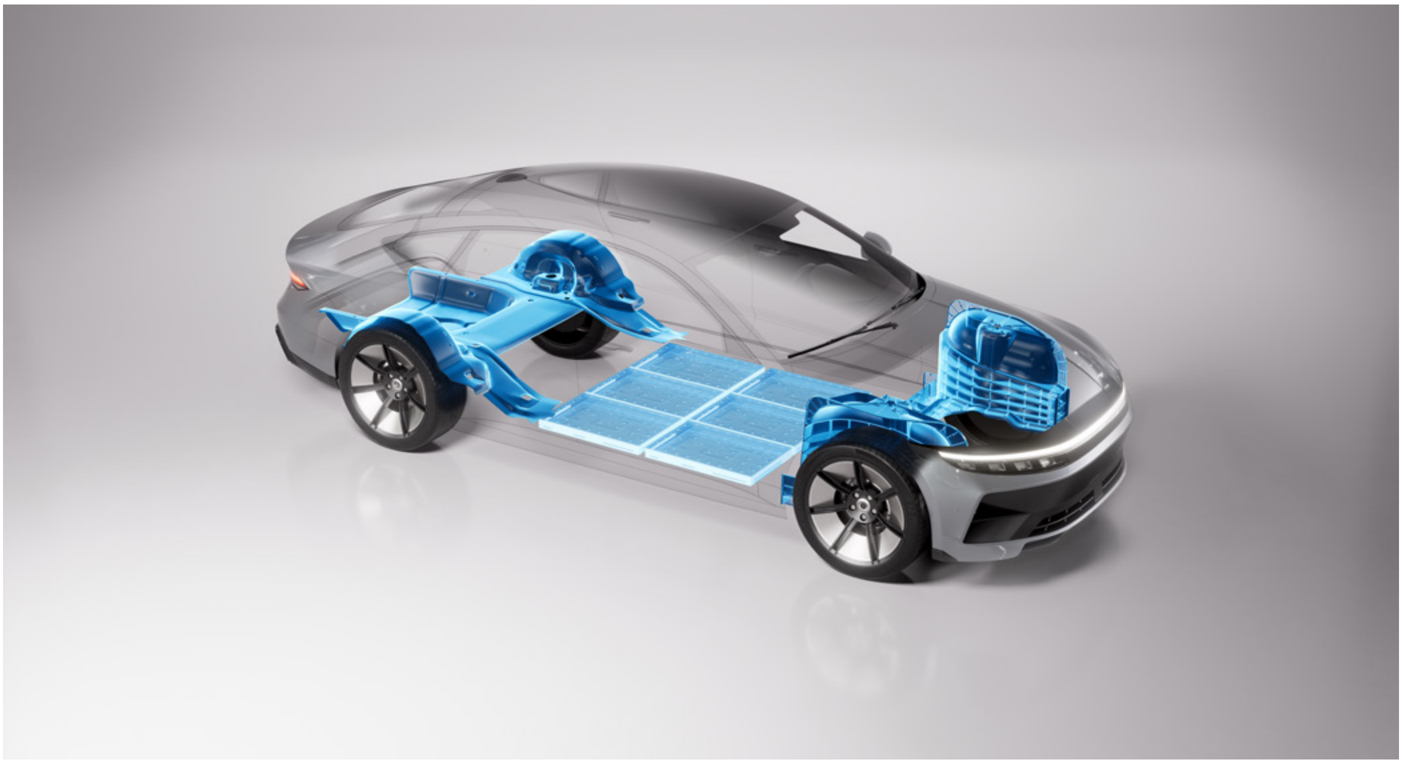
Passey argued that India is emerging as a rare growth market at a time when global automotive volumes are under pressure. While many developed economies are winding down ICE-related investments, India and several other regions continue to offer significant opportunities. "ICE is the biggest opportunity for us… things like ADAS coming in, bigger transmissions, not just in passenger cars but also in trucks, buses, and construction. Each of these areas, at least in our country, is going to have 50 to 100% growth in the next five years," he noted. ZF is considering moving some of its 162 global plants to India, allowing it to build scale and then supply to international markets such as the Middle East and Africa.

Passey said ICE will not fully disappear worldwide, even if many regions are targeting phaseouts by 2035, making India a critical hub for both legacy and emerging technologies. Highlighting the company's priorities, he said ZF's India strategy rests on four pillars: sourcing, local manufacturing for both domestic and export needs, engineering and prototype validation, and talent development. He also underlined the importance of preparing the supplier base for future technologies. On whether the future belongs only to large, vertically integrated suppliers, Passey stressed that size alone is not decisive. "It's not about big or small, it's about keeping your eyes open, be resilient, be agile, be ready for change… It is the age of collaboration. This is the age to work with startups. This is the age to work with other partners," he said. "In today's world, size doesn't matter as much as category, product, and leadership. Many car brands that once didn't even exist are now global giants. And we've all seen the Kodak story — a reminder of what happens when you fail to adapt," he said. Passey acknowledged that global markets are under stress, with 2025 shaping up worse than an already difficult 2024. But he contrasted that with the outlook in India, where volumes and government-led initiatives under Viksit Bharat are creating opportunities. Passey said the company is also investing in sustainability, with all 19 of ZF's plants in India expected to transition to 100% renewable energy by the end of this year, as part of its global carbon neutrality goal for 2040. "We all are sitting on an opportunity to grow the market. So we must make the best use of it, whether as ACMA we are Indian or international players," he said.

BÜHLER Page

Driving the Future of Aluminum Castings: Integrated optimization of component structure and casting process

Bühler Group



As the automotive industry shifts toward electric vehicles, the demand for large, thin-walled structural components produced via high-pressure die casting (HPDC) is surging. This transformation is not only reshaping vehicle architecture but also redefining the boundaries of casting technology. At the forefront of this evolution is Bühler, whose holistic approach to optimize component design and casting process is enabling die casters to meet stringent performance, cost, and sustainability targets. This article explores the technical challenges and innovative solutions that are driving the next generation of aluminum body parts.

Tackling Wall Thickness vs. Flow Length

One of the most critical challenges in casting large structural components is managing the relationship between wall thickness and flow length. Thin walls combined with long flow paths (up to 2 meters) can lead to premature solidification, cold laps, and incomplete filling. This requires an optimization of the filling concept, for example by increasing the gate cross-section to achieve short filling times and ensuring a flow from thick to thin cross-sections. Finding an optimal runner concept homogenizes the flow velocity and reduces kinetic energy, minimizes erosion and soldering while ensuring complete and uniform filling.

Enhancing Die Life and Reducing Porosity

Die and shot sleeve longevity are major cost drivers in HPDC. Besides the reduction of erosion and soldering, optimizing the thermobalance is crucial to avoid hotspots in the die and shrinkage porosities within the part. This not only improves part quality but also extends die life significantly.

Structural Integrity and Crash Performance

The design of rib structures has a pronounced impact on the stiffness and strength of a structural part. To choose an optimal design it is crucial to know the expected static and dynamic loads, e.g. by performing crash simulations. Bühler supports its customers to integrate rib structures tailored to handle prescribed load cases, improving bending and torsional stiffness, and to distribute forces effectively. These ribs also aid melt flow during casting, reducing porosity and contamination, and thus improving mechanical properties. With the use of simulation tools and through iterative design processes together with OEMs, structural integrity can be maximized while ensuring manufacturability.

Managing Gas Porosities and Entrained Air

Gas porosities caused by entrained air and contaminations such as slags and cold laps are another challenge in large castings. Optimized filling strategies minimize air entrapment by reducing flow separations in both runner and part, e.g. by improving the design, controlling melt acceleration and using flow aids. Redistribution of entrained air into non-critical sections and an optimal placement of overflows ensures that contaminants do not compromise structural performance. This is especially important in crash-relevant zones where a high elongation and strength of the material is vital.

Conclusion

The evolution of HPDC for structural automotive components is not merely a technological advancement, it is a strategic enabler for sustainable, scalable, and cost-effective vehicle production. Bühler's integrated approach, combining simulation-driven part and die design, process optimization, and collaborative development with OEMs, demonstrates how engineering excellence can overcome the complex interplay of part requirements, material behavior, crash performance, and manufacturing constraints. As the industry moves toward larger castings and increasingly integrated part architectures, these innovations will be essential in meeting the demands of OEMs.

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