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Volume 78 - October 2026





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GDCTECH Forum's

Annual General Meeting (#AGM) 2026

Does the word "AGM" sounds little boring to you? It does right ! On the contrary though, GDCTECH's AGM, conducted on 19th of August, was super enjoyable !



Many important decisions were made at the AGM.
Upcoming TECHNICAL CONFERENCE 2026's BROCHURE" was inaugurated at the AGM.
The TECHNICAL CONFERENCE 2026 is planned on October 7th and 8th, at Hotel KalaSagar in Pune. The location is very close to #Pimpri - #Chinchwad #MIDC.
15+ committees have been formed for this TECHNICAL CONFERENCE 2026.

Topic Covered:

- Automated Gating System Optimization Using Casting Simulation Improved Casting Quality and Reduced Development Time
- Synergistic Solutions for Optimized Foundry Performance: An Integrated Approach to Temperature Control, Energy-Efficient Metal Transfer and Melt Treatment
- Case Study on Rejection Control and Quality Improvement with Usage of Flow Simulation Analysis
- Thixo Molding
- Data-Driven Optimisation of Gating Design & Process Parameters Using Simulation In Aluminium Die Casting



- Application of Digital Twin Technology in Large Structural Castings in HPDC through MAGMASOFT® simulation
- Process Optimization & Simulation to reduce the casting defect
- Process Robustness Through R-FMEA
- Vision Based Spatiotemporal Detection of Air Leaks in Automotive Alloy Wheels
- Application of Artificial Intelligence in die casting
- BUHLER (INDIA) PVT LTD - Product presentation

Each committee is looking after a specific task. All the 15 "committee chairmen" were felicitated at the AGM, for graciously accepting their respective key roles.
Alongwith the "Technical Conference 2026", many more exciting announcements were made regarding the upcoming activities:

- GDCTECH's Delegation to #JAPAN
- GDCTECH's Delegation to #GIFA - #GERMANY
- #Grand #100th #CoffeeTALK !
- #CEO Meet
- Group Leader driver strong #network formation within GDCTECH's members

GDCTECH Forum promises to bring you strong networking opportunities, new business horizons; and positively looks forward to your participation.
Advait Athavale, Jitendra Lakhotia, Sagar Kaushik, Nitin Bhagwat, Kishor Dukare, Ravindra Ghogare, Anil Newale, Jalinder Katkade, MAP Alloys Rajesh Aggarwal, Kruttika Apshankar-Kher, Jitendra Parekh, tworrld tourism solutions, Chandrashekhar Kate, Anand Joshi

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GREAT DIE CASTING

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We invite Expert Articles on technical techno commercial and management aspects of Diecasting Industry, for publishing in GDCTECH Bimonthly Journal. We believe that these articles serve as good source of knowledge for foundry industry people. Please contact GDCTECH office for any further information.

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The Editor's Desk



Ms. Kruttika Apshankar Kher
Editor



Chandrashekhar N. Kate
Co Editor

Dear Readers,

The Annual Day & AGM 2026 of GDCTECH Forum was a vibrant celebration of ideas, collaboration, and vision. Held on 19th August, the event saw the inauguration of the Technical Conference 2026 brochure, with 15 committees formed to drive the upcoming conference scheduled for October 7–8 at Hotel Kalasagar, Pune. The felicitation of committee chairmen (and women) and announcements of delegations to Japan and GIFA Germany added to the spirit of growth and global networking.

This issue brings together a rich mix of technical insights and industry perspectives. We have 'Machining aluminium' by Bhagyesh Lakhotiya, 'Carbon Footprint of Magnesium Production and its Use in Transport Applications' authored by Simone Ehrenberger and submitted by Suraj Narvekar, 'Thyristor Controllers in Die Casting' by Mr. Panse, the second part of Mr. Gajare's 'Layered process audits for Aluminium foundries', an article about MSME benefits by Yogesh Kulkarni and 'Machine learning based prediction of required Titanium and Strontium additions for Grain refinement and Silicon modification in Industrial Aluminium foundries' by Olivier Dunkelmann. Alongside these, readers will find updates on innovations in fluxes, die coats, lubricants, and testing equipment—solutions that continue to shape modern aluminium casting. We have a testimony for our ex-editor, Mr. Anand Joshi from industry consultant, Mr. Surianarayanan Chandrasakeran.

Global Context: The Strait of Hormuz, a critical route for Gulf aluminium exports, has faced interruptions due to heightened military activity. Insurance premiums for vessels transiting Hormuz rose sharply in mid-2026, increasing freight costs for aluminium shipments. Gulf producers (UAE, Bahrain, Oman, Qatar) collectively account for around 8% of global aluminium output. Any disruption in Hormuz directly affects their ability to import alumina and export finished aluminium. Indian foundries have reported higher raw material costs and delays in alumina imports, as shipping lines reroute away from Hormuz, adding transit time and cost.

Be part of GDCTECH Technical Conference 2026 — 7th & 8th October - a perfect opportunity to know latest die casting Technologies and network. We also have GDCTECH's 100th Coffee-TALK coming up on 24th October. Do attend and make the milestone memorable!

As always, GDCTECH Journal remains committed to being a platform for knowledge-sharing and industry dialogue. We invite your expert articles and feedback to keep this forum dynamic and relevant.

Thanking you,
Warm Regards,

Krutika Apshankar-Kher - Editor

Chandrashekhar N Kate - Co Editor

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The articles in Magazine are solely for general informational and educational purposes for industry members. Technical figures, metallurgical parameters, CapEx estimates, and market projections are illustrative and based on broader industry data. They do not constitute formal engineering, operational, or financial advice. Process results, yield percentages, and cost economics will vary based on individual shop-floor conditions. Neither the author nor the publication accepts liability for commercial, technical, or financial decisions made based on this content. Readers are urged to conduct independent engineering evaluations and professional audits prior to implementation.



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Aluminium Is Not Easier to Machine. It Is Different.

For decades, aluminium has often been described as the "easy" material to machine.

Low cutting forces. High speeds. Good machinability.

But that description can be misleading.

Aluminium is easy to cut. It is not always easy to control.

And as aluminium moves deeper into EVs, automotive, aerospace, railways and industrial applications, that distinction is becoming increasingly important.

Aluminium offers an extraordinary combination of low density, high strength-to-weight ratio, thermal conductivity and recyclability. Its density is roughly one-third that of steel, while modern alloys can deliver impressive structural performance.

But the same material characteristics that make aluminium attractive also create machining challenges.

It expands significantly with temperature.

Thin walls can distort under clamping.

Ductile chips can create built-up edge.

High spindle speeds expose weaknesses in rigidity, balance and chip evacuation.

And different alloy families can behave very differently.

So perhaps the wrong question is:

"How fast can we machine aluminium?"

The better question is:

"How well can we control aluminium while machining it fast?"

This becomes even more important when looking at the manufacturing route.

A 2 mm wall produced through HPDC does not behave like a forged 7075 component. An extruded profile presents completely different challenges from an A356 casting.

Yet it is surprisingly common to see the same fixture philosophy, tooling logic or machining parameters carried from one application to another.

That is where productivity quietly disappears.

A few millimetres of distortion can turn into a leak-test failure.

A poor clamping strategy can become a concentricity problem.

The wrong tool geometry can become a surface-finish issue.

A machining defect discovered at final inspection can represent hours of value already added upstream.

Which leads to a simple manufacturing principle:

Hold it Right → Cut it Right

Before optimising speed and feed, make sure the component is actually being held correctly.

Before blaming the machine, understand the alloy, heat-treatment condition and manufacturing route.

Before increasing tool life, understand why the tool is failing.

And before accepting scrap as the "cost of machining", understand where the defect actually originated.

The aluminium opportunity is not simply about replacing steel with a lighter metal.

It represents a broader shift in manufacturing—**from force-driven machining to process-controlled machining.**

As components become lighter, thinner and more complex, the margin for uncontrolled variation becomes smaller.

The future may belong not to the shop that machines aluminium the fastest, but to the one that understands it the best.

Aluminium is getting lighter. Manufacturing has to get smarter.

Disclaimer:
The information mentioned, is for educational purposes and, while every effort has been made to ensure accuracy, readers are advised to independently verify critical technical details before implementation.



Role of a Thyristor Controller in Aluminum Die casting

Mahesh Panse
Proprietor, COURSE POWER & CONTROLS
coursepower@gmail.com

Aluminum die-cast parts are used in various industries, particularly for the automotive sector. The quality of casting depends upon several factors. However, the temperature at which the metal is poured in the mould plays one of the important roles. The temperature of the furnace can be controlled by either ON-OFF control, or thyristor control. Temperature fluctuations are seen if a thyristor controller is not used for a holding furnace. If the temperature is less than the set point by 10 degrees, then the required viscosity may not be achieved and the melt may have porosity or it may not reach all the parts of cavity in the mould. Even for high pressure oil and gas valves used in refineries, the pouring temperature is important.

There is another aspect of a thyristor controller. While molten aluminum is in the holding furnace, degassing is done to improve the melt quality. This decreases the temperature of molten aluminum. To reduce the time taken to increase the temperature back to its set holding value, the heater capacity must be adequate. However, once the temperature is achieved, less power is required to hold it at that temperature. Here, a thyristor controller plays a vital role.

The most important role of a thyristor controller is that it saves power. Another very important factor is that the thyristor controller increases the life of the heaters as well as crucible and hence the downtime is reduced. Despite its advantages, the control panel and thyristor controllers are the most neglected in industries. Mostly, thyristor controllers are bypassed and the panels are in very bad condition.

The reasons for failures of thyristor controllers are as follows

- Bad ventilation provided in the panel OR the environment near the panel is very poor
- Very low-cost thyristor controllers are purchased (Korean or Chinese Thyristor Controllers are not designed for Indian climatic conditions and are usually 3 pulse control which enables the manufacturer to reduce the thyristor size
- Semiconductor fuses are bypassed with short links, OR low-cost thyristor controllers are without semiconductor fuses.

This issue is worth looking into, since by reducing the initial cost with the purchase of low-cost thyristor controllers, eventually the user spends more on electricity bills and the frequent replacement of heaters.

There are broadly two types of thyristor controllers – zero-crossover and the conventional phase angle thyristor. In phase angle control, voltage and current seen reduced as we approach set temperature. This is achieved by chopping the sine wave. In zero crossover control, the sine wave is not chopped but average power is reduced by passing the full sine wave. Hence, the number of cycles passed is reduced and it is ON for less time and OFF for more time. If temperature is dropped it is ON for more time and OFF for lesser time. But it is very fast compared to contact switching. However, in contactor switching, zero-crossover of sine wave cannot be detected for switching on.

For heaters other than silicon carbide, a zero-crossover thyristor controller has more advantages than the conventional phase angle Thyristor Controller.

- Power saving is more in a zero-crossover thyristor controller
- Harmonics are much less
- The power factor is always near unity.

How power is saved by Thyristor Controller along with PID controller

When a contactor controls the temperature by switching ON/OFF, it being an electromechanical device the hysteresis is say, around 5 degrees. This means that the temperature roughly goes up by 5 Degree and down by 5 degrees. We are pumping extra energy which results in an increase of 5 degrees. When it goes below 5 degrees, we are giving full current to bring it back up to 5 Degree. This is a wastage of power. If we could keep the temperature very close to the set value, the energy required to

maintain the temperature at that value is moderate. This is only possible if we use a thyristor controller along with a PID controller. However, if a zero-crossover thyristor controller is chosen, the power saving is more than phase angle control (refer the waveform pictures attached) due to the following two reasons:

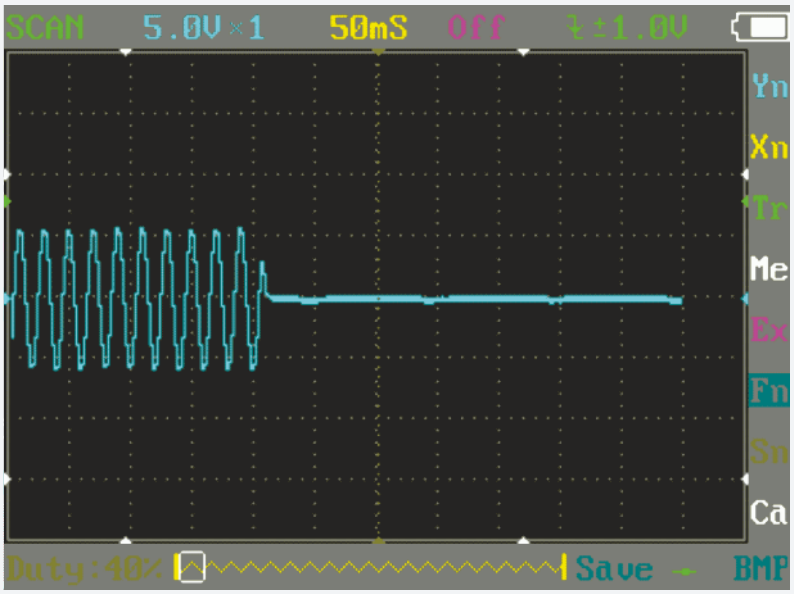
(I) In phase angle control the power factor is less than unity as set temperature is achieved. In zero crossover power factor is always near unity which is desirable.

(Ii) In phase angle control there is no OFF time. However, in zero crossover there is OFF time. More OFF time leads to more power saving.

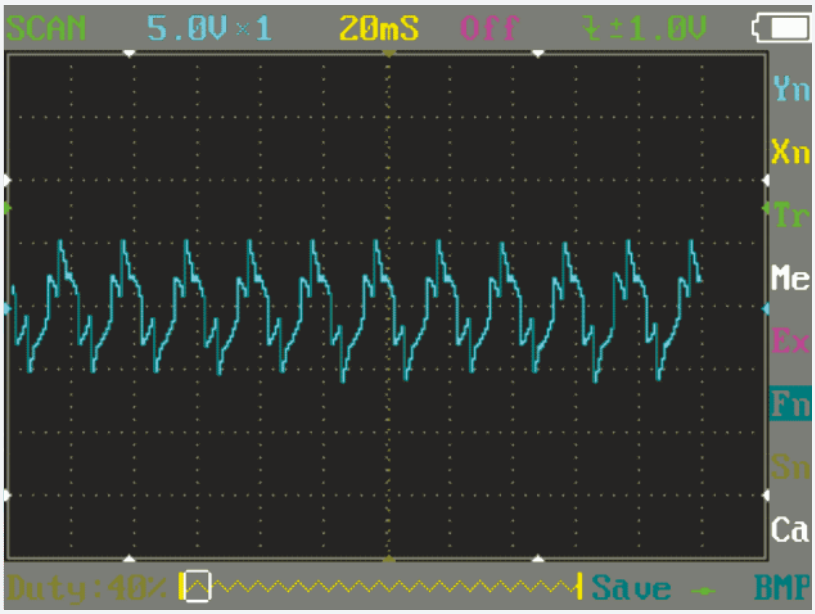
Why a transformer should be incorporated while using silicon carbide heaters

Silicon carbide heaters are generally designed on low voltage. If a thyristor controller is used to control the voltage and current is directly supplied by the main supply, the current drawn is more than the actual wattage. Instead, if a step-down transformer is used, though the secondary current is more, the primary current is much less which is flowing through main supply energy meter. This not only saves power but since a thyristor controller is operating near full sine wave, the harmonics also are very less.

1. Zero Crossover Waveform



2. Phase Angle Waveform





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This is how I call him adding affection along with the respect! Silent executioner who shares knowledge as well get his targets achieved! He can neither be taken as the boss nor a close friend because he does things with a smile?

I have been along with him from 2010 as his associate for organizing the stalls in time along with discipline. At times he will discuss about his technical journey from his Bengaluru days along with how he handled the technical crests he faced on his journey!!! Extrusion and gravity casting are his specialties. He had the magnanimous attitude to turn the people to me who has doubts or clarifications needed in pressure die casting. I cannot stop remembering him at every instant mentioned above along with making me to write articles for the magazine especially related to the technology. I thank you JOSHY SAAB your chela SURI.

C. Suraiyanarayanan
Consultant

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Machine Learning Based Prediction of Required Titanium and Strontium Additions for Grain Refinement and Silicon Modification in Industrial Aluminum Foundries

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Abstract
This study presents a supervised machine learning approach for directly estimating the titanium and strontium additions required to achieve predefined grain refinement and silicon modification criteria in industrial aluminum-silicon foundries. Unlike previous studies that predict thermal analysis parameters, the proposed methodology directly estimates treatment additions for practical industrial process control. Models were trained using data collected over a twenty-five-year period from several aluminum foundries with the QS-Master thermal and spectral analysis system, yielding approximately 1.4 million measurements. Following alloy filtering for AlSi7Mg and AlSi10Mg and automated outlier removal, a total of 464,000 and 218,000 records were retained for grain refinement and modification modeling, respectively. Five machine learning models were evaluated. For grain refinement, XGBoost achieved the highest performance (R^2 = 0.8834, MAE = 0.0090%), whereas Random Forest provided the best results for modification (R^2 = 0.9057, MAE = 0.0031%). The larger performance gap between linear and non-linear models for grain refinement (ΔR^2 = 0.177) compared with modification (ΔR^2 = 0.063) indicates that recalescence behavior is governed by more complex non-linear feature interactions. SHAP analysis confirmed that the learned feature importance patterns are consistent with established metallurgical principles. Reliable estimation of the required strontium addition was achieved without using the measured strontium concentration as an input feature. The proposed approach transforms thermal analysis from a passive quality monitoring technique into an AI-assisted decision support tool capable of recommending titanium and strontium additions under industrial production conditions, representing an important step toward intelligent process control and future Digital Twin implementation in aluminum foundries.
Keywords: Aluminum casting, Grain refinement, Modification, Machine learning, Artificial intelligence, Process optimization.

Introduction

The aluminum casting industry is undergoing a fundamental transformation. The growing demand for lightweight automotive structures driven by the transition toward electric mobility creates an increasing need for aluminum-silicon cast components exhibiting superior mechanical properties [1, 2]. At the same time, the worldwide shortage of skilled labor and the growing emphasis on sustainability create significant challenges for the casting industry, limiting its ability to maintain consistent product quality while meeting increasing production demands [3, 4]. Among the most critical metallurgical operations in aluminum foundries are grain refinement and silicon modification, as these melt treatments largely determine the final microstructure and mechanical properties of castings. Grain refinement, achieved through titanium and boron containing master alloys, improves strength, ductility, and hot cracking resistance by promoting the formation of a fine equiaxed α-aluminum grain structure [5-8]. Silicon modification, commonly performed using strontium containing master alloys or pure sodium, transforms the eutectic silicon morphology from coarse plate like particles into a fine fibrous structure, thereby improving the mechanical properties of cast products [5-8]. Despite their critical importance, these melt treatment operations are still largely controlled through empirical rules, operator experience, and manual process adjustments, while many influential process variables including raw material variability, holding time, melt temperature, and environmental conditions remain insufficiently documented and underutilized for systematic process optimization [4, 6, 8-13].

During the past decades, thermal analysis has become a standard foundry tool for evaluating both grain refinement and silicon modification. The primary recalescence (RekP) is widely used to assess

grain refinement efficiency, whereas eutectic depression (Dep) serves as the principal indicator of silicon modification efficiency. In industrial practice, however, these thermal analysis parameters are not the final objective of process control. Instead, they represent quality indicators used to determine whether additional grain refiner or modifier must be added to the melt to achieve the required metallurgical condition. Consequently, the practical objective is not only to predict RekP or Dep, but to determine the required titanium (Ti) and strontium (Sr) additions needed to reach predefined target values of these quality indicators. Altogether, thermal analysis provides a comprehensive description of alloy solidification behavior and, because of its routine implementation in aluminum foundries, represents an excellent source of production data for developing intelligent process optimization models [6, 8, 14].

Modern process optimization increasingly relies on machine learning (ML) algorithms capable of exploiting large industrial databases to identify complex relationships between process variables that are difficult to describe using conventional analytical approaches [15-17]. Applied to aluminum foundries, such methods have the potential to transform existing quality monitoring systems into intelligent decision support systems capable of recommending corrective process actions in real time. Instead of simply evaluating melt quality after sampling, ML models can estimate the amount of grain refiner or modifier required to achieve the desired thermal analysis response, thereby directly supporting foundry operators in process optimization. Such capabilities become increasingly important as experienced personnel retire and the demand for automated process support continues to grow [4].

The present study investigates the feasibility of applying supervised machine learning algorithms to predict the required titanium and strontium additions using routinely collected thermal analysis and spectral analysis data acquired during industrial aluminum casting production. The study is based on production data collected over a twenty-five-year period from several aluminum foundries using the QS-Master thermal and spectral analysis system. Various supervised ML algorithms were evaluated to identify the most accurate and computationally efficient prediction models, while SHAP (SHapley Additive exPlanations) analysis was employed to identify the metallurgically most influential input variables. Unlike most previously published studies, which focus primarily on laboratory experiments or on predicting process quality indicators, the present work addresses a practical industrial decision support problem: estimating the amount of grain refiner (Ti) and modifier (Sr) required to achieve predefined thermal analysis quality criteria. To the best of our knowledge, this is the first study combining a long term industrial thermal analysis database containing approximately 1.4 million production measurements with explainable machine learning algorithms for the prediction of required melt treatment additions. This approach represents an important step toward closed loop process optimization and future Digital Twin implementation in aluminum foundries following the principles of Industry 4.0 [4]. The main objective of this work is not only to assess the current metallurgical state of the melt but also to provide direct recommendations regarding the required titanium and strontium additions needed to achieve predefined grain refinement and silicon modification criteria. In this way, machine learning becomes an active process optimization tool rather than simply a passive quality monitoring technique. The presented methodology demonstrates how historical production data can be transformed into practical decision support systems capable of improving process stability, reducing unnecessary alloy additions, preserving expert process knowledge, and supporting the digital transformation of industrial aluminum foundries.

Grain Refinement in Aluminum Foundries

Grain refinement is one of the most common metallurgical treatments used during the production of aluminum castings [5-8]. In the context of the aluminum-silicon alloy production, the grain refinement process facilitates the formation of a fine-grained α-aluminum dendritic structure, which is beneficial from the perspective of the subsequent processing and casting performance [9]. The effects of grain refinement are directly related to the final properties of casting, as the grain size determines the mechanical properties, feeding ability, hot tearing resistance, and tendency to form casting defects, including shrinkage cavities [7-9]. The grain refinement process can be visually depicted using

Figure 1, which shows the α-aluminum grain structure of the modified and unmodified aluminum-silicon alloys. As the photos demonstrate, the refinement treatment changes the coarse grain structure of the α-aluminum into a fine equiaxed structure typical for the aluminum-silicon alloy casting.

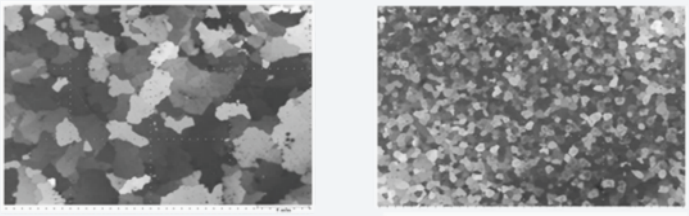


Figure 1. Comparison of coarse (on the left side) and refined (on the right side) α-aluminum grain structures in aluminum-silicon casting alloys.

From the perspective of the industrial process optimization, the grain refinement process is exceptionally complex and governed by numerous technological, metallurgical, and physicochemical interactions [6,9,11]. The refinement treatment is usually performed using the AlTiB master alloys or other grain refining fluxes with titanium and boron containing compounds as an active constituent. Due to the addition of the refining agents, the nucleation rate of the α-aluminum phase increases, while the growth rate of individual grains decreases, which leads to the formation of a fine grained structure. During the solidification of a given alloy, the grain structure formed depends on the refining agent addition rate as well as the overall alloy composition, holding temperature, holding time, and the other process specific variables [6,8,9,11, 13, 18, 19]. The process complexity puts the question of ensuring consistent process performance during production [11, 12, 18]. For instance, insufficient grain refinement leads to the formation of coarse grain structures and cast defects, while the excessive addition of titanium and boron compounds results in unnecessary material consumption and increased production costs. In modern aluminum foundries, the effectiveness of grain refinement is commonly evaluated using thermal analysis techniques [6, 8]. During this procedure, a small sample of molten metal is poured into a standardized cup equipped with a thermocouple, and the temperature evolution during solidification is recorded as a cooling curve. The shape of this curve contains valuable information about the nucleation and growth behavior of the primary α-aluminum phase. A key parameter used for assessing grain refinement efficiency is the undercooling (ΔT) during primary solidification, commonly expressed through equation (1):

$$\Delta T = TMax - TMin \quad (1)$$

where TMax and TMin correspond to characteristic temperatures observed during the recalescence phenomenon. A large undercooling indicates that the melt requires additional cooling before nucleation can begin, which is generally associated with poor grain refinement efficiency. In contrast, smaller undercooling reflects the presence of a larger number of active nucleation sites and therefore more effective grain refinement as Figure 2 illustrates.

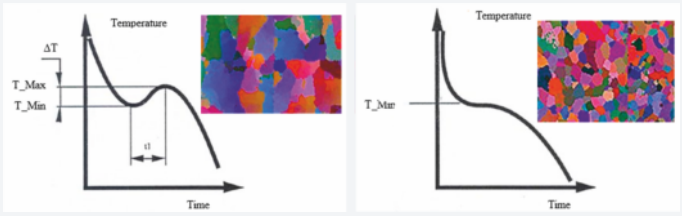


Figure 2. Evaluation of grain refinement efficiency using the thermal analysis method. Comparison of cooling curves exhibiting high and low undercooling (ΔT) during primary α-aluminum solidification.

Unlike conventional quality indicators obtained after casting, thermal analysis provides immediate, quantitative, and highly standardized process information, making it particularly suitable for data driven prediction. It should be noted that spectral analysis provides a direct quantitative measurement of the melt's chemical composition, whereas thermal analysis, despite relying on precise temperature-time measurements, yields an indirect and inherently qualitative assessment of the metallurgical state (grain refinement or modification level). Only through calibration against quantitative reference data and the application of machine learning does this qualitative thermal response acquire predictive, quantitative value. Altogether, the interaction between numerous variables affecting the change in grain structure during solidification results in the generation of vast amounts of production data in the industrial aluminum foundries. As a result, the process knowledge gained from the multiple thermal analyses can be utilized to build a model of the grain refinement process, which can serve as the basis for optimizing the process according to specific quality criteria.

Silicon Modification in Aluminum Foundries

The modification process is widely used in the aluminum foundries to alter the eutectic silicon morphology in the aluminum-silicon alloys. Unlike the refinement treatment, which primarily affects the α-aluminum grain structure, the modification process is intended to affect the eutectic silicon constituent [6, 8]. The modification treatment can be utilized to improve the mechanical properties of aluminum-silicon alloys by altering the silicon morphology from coarse platelike into a fine fibrous form [5-8]. Figure 3 below shows the visual comparison of the unmodified and modified eutectic silicon. The visual comparison of silicon morphology suggests that the modification treatment is intended to prevent the formation of the coarse platelike silicon crystals with sharp edges, which are detrimental to the mechanical performance of the casting [20].

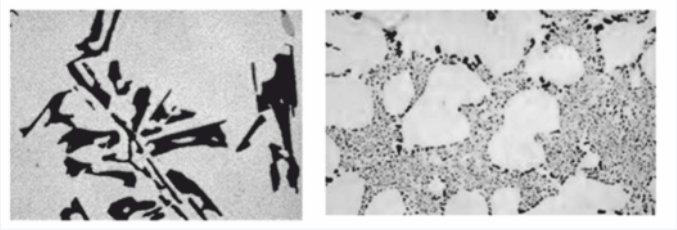


Figure 3. Comparison of unmodified (on the left side) and modified (on the right side) eutectic silicon morphology in aluminum-silicon casting alloys [21].

From the perspective of the casting process optimization, the modification process is governed by the numerous metallurgical and physicochemical interactions, which take place during the solidification of the melt. At the same time, the modification process is very difficult to control during production due to the complex sequential response of the modification agents. In particular, the continuous decrease in the concentration of the active constituents in the melt leads to the well known modifier fading phenomenon [23]. Like the grain refinement process, the modification process typically utilizes the fluxes or master alloys with strontium or pure sodium as an active constituent to alter the silicon morphology [6, 8, 20, 21]. During the modification treatment, the eutectic silicon constituent is affected in such a way that the coarse platelike morphology changes into a fine fibrous one. The modification efficiency depends on the silicon content, melt and mold temperature, time, impurity content, and other variables related to the modification treatment [6, 8, 20, 21, 22]. In turn, the modification efficiency influences the final mechanical properties of the casting, as well as the process economy, as the modification agents are typically expensive. Therefore, continuous monitoring of the modification efficiency is needed to ensure stable quality of the casting and optimize the consumption of the modification agents.

The modification process can be monitored using the thermal analysis method similarly to the grain refinement process [6, 8, 27]. In particular, the eutectic depression observed in the temperature-time curve of the thermal analysis can be utilized to estimate the modification efficiency. Figure 4 below demonstrates how the eutectic depression can be used to estimate silicon modification efficiency based on the comparison of the cooling curves of the unmodified and modified samples.

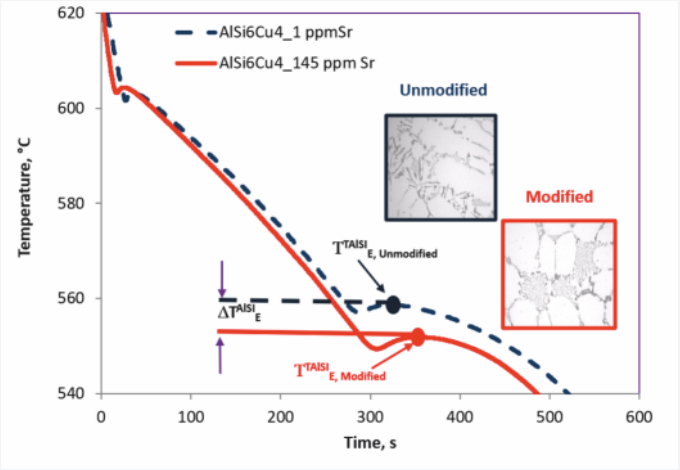


Figure 4. Evaluation of modification efficiency using thermal analysis. Comparison of cooling curves obtained from untreated and modified melts showing the characteristic eutectic depression [21].

The eutectic depression (ΔTAlSiE) is determined according to the simple equation like the one utilized for the calculation of the recalescence peak during the grain refinement process:

ΔTAlSiE = TModified – TUnmodified (2)

For the case of the hypoeutectic aluminum-silicon alloys, the value of the eutectic depression can be used to estimate the level of silicon modification according to the rule of thumb, stating that the depression values above 5 °C indicate an adequate level of modification [21]. Like the grain refinement process, the modification process is characterized by complex temporal response and governed by numerous metallurgical interactions. Thus, the continuous monitoring of the modification process

using the thermal analysis technique and the analysis of the resulting data can lead to the identification of valuable insights into the modification process. Altogether, the complex interaction between the numerous variables affecting the modification process makes it a good candidate for the application of ML algorithms to identify the hidden patterns and build a predictive process model.

Machine Learning for Process Optimization in Aluminum Foundries

The aluminum foundry industry has traditionally relied on empirical knowledge and operator expertise for controlling complex metallurgical processes. In modern aluminum foundries, large volumes of thermal analysis, spectral analysis, and process data are routinely generated but are often used only for immediate quality assessment rather than systematic knowledge extraction. For decades, critical decisions regarding grain refinement, modification, and melt treatment have been based on accumulated empirical understanding developed within individual plants. However, increasing product quality requirements, growing process complexity, and a shortage of skilled personnel have created a need for more systematic and data driven approaches. Machine learning provides a methodology for transforming historical production data into practical knowledge by identifying hidden patterns and complex relationships that remain difficult to detect using conventional statistical analysis [4]. Beyond improving process understanding, machine learning enables quantitative estimation of the corrective metallurgical actions required to achieve specified quality criteria. In the context of grain refinement and silicon modification, this includes estimating the required titanium (Ti) and strontium (Sr) additions needed to obtain the target thermal analysis response. This allows improved process understanding, more precise control of metallurgical treatments, and early detection of quality deviations, particularly in critical operations such as grain refinement and silicon modification in aluminum-silicon alloys [15–17].

A key advantage of machine learning (ML) based process analysis is its ability to simultaneously evaluate many interacting process variables. In contrast to traditional approaches, where individual parameters are often considered in isolation, data driven models can capture multivariate and non-linear dependencies within the process. As a result, decision making becomes more consistent, traceable, and reproducible, which contributes to improved process stability and reduced variability in production outcomes [15, 16, 28]. It is important to emphasize that artificial intelligence does not replace metallurgical expertise but rather extends it. Human knowledge remains essential for interpreting results, validating model outputs, and ensuring that predictions are physically meaningful within the context of metallurgical principles. In this sense, artificial intelligence serves as an intelligent decision support system that complements, rather than substitutes, experienced process engineers by recommending the corrective titanium and strontium additions required to maintain the melt within the specified grain refinement and modification process window [16, 17, 28]. Unlike laboratory studies, industrial production data are naturally heterogeneous, containing variations in alloy chemistry, raw material composition, furnace operation, and operator interventions. Consequently, machine learning models must learn robust relationships despite considerable process variability. From a methodological perspective, different classes of machine learning techniques are applied depending on the nature of the problem and the available data. Supervised learning approaches are used to develop predictive models based on historical industrial datasets [15, 17]. Artificial neural networks can represent highly non-linear relationships between process parameters and metallurgical outcomes. Composite machine learning models such as Random Forest and XGBoost provide robust predictive performance while simultaneously enabling the assessment of variable importance. Together with linear Regression models, these approaches represent complementary strategies for supervised regression on complex industrial datasets. In the present work, these concepts are applied to industrial aluminum casting data with a particular focus on thermal analysis measurements and cooling curve characteristics. The dataset consists of routinely collected production data, including thermal analysis signals and associated metallurgical and chemical information. These data form the basis for the development of predictive models that estimate the titanium and strontium additions required to achieve predefined

grain refinement and silicon modification criteria under industrial production conditions. Rather than functioning solely as quality assessment models, the proposed machine learning approach is intended to support real-time process optimization by providing practical treatment recommendations to foundry operators. The following section describes the industrial dataset, data preprocessing, feature engineering from thermal analysis, and the target variables used for model development.

Data Basis – Production Dataset

IDECO is a German company specializing in the development of thermal and melt quality systems for the aluminum casting industry, with its QS-Master system used/installed in numerous foundries worldwide since 1988. The foundation of this study is a large scale industrial dataset extracted from the QS-Master system of IDECO company. It comprises approximately 1.4 million measurements collected between 2000 and 2025 across multiple production facilities in several aluminum foundries. The database represents routine industrial production rather than data collected under controlled laboratory conditions. Consequently, it captures the natural variability of alloy chemistry, process conditions, operator interventions, and raw material quality encountered in everyday foundry practice. For each record, both thermal analysis and spectral analysis data are available, providing a comprehensive description of the melt condition and solidification behavior. Due to the significantly different metallurgical behavior of individual aluminum casting alloys, the investigation was restricted to the reference alloys AlSi7Mg and AlSi10Mg. These alloys are among the most widely used in industrial production and display comparable process characteristics in terms of grain refinement and modification behavior, as confirmed through consultation with the industrial partner. After alloy filtering in accordance with DIN EN 1706 [29] and outlier removal using the Isolation Forest algorithm [30], approximately 464,000 valid measurements remained for grain refinement model development. Based on metallurgical relevance and practical availability in routine industrial production, the following input variables (features) for grain refinement process were selected: titanium concentration (Ti), maximum melt temperature (max. T), various major (Si, Mg, Cu, Mn, …) and minor (Zr, B, Ca, Sn, …) alloying elements and some others. Feature selection combined established metallurgical knowledge with iterative model evaluation performed in collaboration with IDECO company. Additional candidate variables were systematically assessed during preliminary model development but were excluded because they did not produce measurable improvements in predictive performance. The final feature set therefore represents the smallest group of variables that captures the dominant metallurgical factors governing grain refinement under industrial production conditions. The recalescence point (RekP) serves as the intermediate training target, enabling the inverse estimation of the required titanium addition once the model is trained. Due to industrial confidentiality requirements, individual feature identities and the complete engineered feature set (correlation matrices and SHAP importance analyses) are anonymized in Figures 5, 7, 8 and 10; the underlying statistical values and qualitative metallurgical conclusions remain unchanged.

For the modification dataset, the same alloy filtering criteria (AlSi7Mg and AlSi10Mg) and outlier removal procedure were applied, yielding approximately 218,000 valid, exclusively strontium-modification measurements after preprocessing. This dataset is then used to train the supervised model to predict the required strontium (Sr) concentration directly, utilizing the desired eutectic depression (Dep) as an input feature [6, 8, 14, 21, 27]. For the modification model, the eutectic temperature of the simultaneously collected unmodified reference sample (T_eutectic_unmodified) was included as an input feature. This reference value characterizes the baseline solidification behavior of the alloy prior to strontium treatment and represents one of the two measurements required to calculate the eutectic depression (Dep = T_eutectic_unmodified − T_eutectic_modified). Its inclusion as a feature does not introduce circularity, as it reflects an independent measurement of the untreated melt rather than the target depression value itself. The input features for the modification model were selected based on metallurgical relevance and industrial data availability. The feature set comprises spectral analysis elements known to influence eutectic solidification behavior, specifically Na, Ca, Pb, Sn, P, Mg, and Cu, together with the maximum melt temperature (max. T). It should be noted that

strontium is included in the correlation matrix analysis (Figure 8) to provide a complete picture of the chemical structure of the dataset and to confirm the expected thermodynamic relationship between strontium concentration and eutectic depression. However, strontium was not used as a model input, and the predictive performance reported in Table 1 was achieved exclusively through indirect chemical indicators. The eutectic reaction temperature (RekE) was also excluded from the feature set, as it represents one of the two measured temperatures from which the eutectic depression (Dep) is calculated, and its inclusion as an independent input feature would therefore introduce redundancy and potential circularity into the model. The resulting feature set thus represents the minimum set of routinely available production parameters that can support an indirect prediction of required strontium addition.

A key limitation of the dataset is the structure of the production records. Treatment related information in the QS-Master system is stored in free text fields, resulting in inconsistent and non-standardized entries that cannot be reliably used for quantitative analysis. Furthermore, the absence of precise information on melt quantity prevents the establishment of a classical response relationship between grain refiner addition and metallurgical response. For this reason, the proposed methodology is formulated as an inverse process optimization problem rather than a conventional regression problem. The supervised learning models are trained to directly predict the required titanium or strontium additions using melt chemistry, thermal analysis parameters, and predefined quality targets as input features, thereby providing actionable treatment recommendations under real industrial production conditions. Although these limitations prevent the establishment of direct cause-and-effect relationships between treatment additions and metallurgical response, they accurately reflect routine industrial production conditions and therefore enhance the practical relevance of the developed machine learning models.

Preprocessing

Both data sets were processed through a two-stage preprocessing procedure. First, an initial preprocessing procedure was performed within the IDECO QS-Master system to remove invalid, incomplete, and inconsistent production records. Second, the data was subjected to additional processing to prepare training samples aligned with the goals of the current study. In particular, the data set was filtered to retain only the observations pertaining to the AlSi7Mg and AlSi10Mg alloys in accordance with the DIN EN 1706 standard [29]. Furthermore, several outliers were removed using the Isolation Forest algorithm [30]. Finally, additional polynomial features and interaction terms between selected input variables were generated to capture potential nonlinear relationships between the input features and the target variables.

Methodology

To identify the most suitable relationship between the process variables and the target variables, several supervised machine learning algorithms were evaluated using the datasets described above. In particular, the focus was on evaluating the performance of linear and non-linear regression models in accordance with the characteristics of the process of interest. Among the linear approaches, Ordinary Linear Regression and Ridge Regression were evaluated. Ridge regression was used to account for the possibility of multicollinearity between the features and constrain them accordingly. To model nonlinear relationships, Random Forest [31] and XGBoost [32] regression algorithms were employed. Both ensemble tree-based methods can learn complex nonlinear interactions between the process variables and the target variables. Finally, a three-layer Multilayer Perceptron (MLP) neural network was evaluated to investigate whether a feed-forward neural architecture could further improve predictive performance. The selected algorithms represent complementary modeling strategies ranging from simple linear regression to advanced ensemble learning and neural network models, thereby providing a comprehensive comparison of methods with different levels of model complexity. For all models, identical data preprocessing, train-test partitioning, and validation procedures were applied to ensure a fair comparison of predictive performance. The data sets were split into 80% training and 20% test data, with the latter used exclusively for final validation and evaluation. Hyperparameter optimization was performed using 5-fold cross-validation combined with systematic grid

search [33]. Model performance was evaluated using the coefficient of determination (R2) and the Mean Absolute Error (MAE), which are standard performance metrics for supervised regression problems. To provide actionable recommendations directly on the foundry floor, an inverse modeling approach was implemented for these machine learning algorithms. Unlike conventional forward models that predict thermal analysis parameters (such as RekP and Dep) from the chemical composition, the developed models in this study target the required active alloying elements directly. Specifically, the target variable (Y) for grain refinement was defined as the titanium (Ti) concentration, while the target variable (Y) for eutectic modification was defined as the strontium (Sr) concentration. The input features (X) comprised the initial spectrometer analysis data along with the desired metallurgical target values for RekP and Dep, respectively. In the present study, the quality thresholds used as target inputs were defined as RekP < 0.5 °C for grain refinement and Dep > 5 °C for silicon modification, in accordance with established industrial practice for AlSi7Mg and AlSi10Mg alloys [6, 8, 21]. By predicting the target concentration required to achieve optimal solidification characteristics, the system calculates the required difference between the calculated optimum and the currently active concentration measured in the melt. Consequently, the model outputs a precise corrective addition (e.g., in ppm) directly to the foundry operator, bridging the gap between predictive thermal analysis and real-time melt treatment.

Results

Model Performance on Industrial Production Data

The analysis was carried out exclusively on the industrial production data set from the QS-Master system. In Table 1, the performance of all tested models is summarized. For both prediction tasks, non-linear models consistently did better than linear ones, with combined methods providing the best results overall.

Table 1. Performance comparison of different machine learning models on the industrial production data set.

Models	Grain refinement data set		Modification data set	
	MAE	R^2	MAE	R^2
Random Forest	0.0097%	0.8601	0.0031%	0.9057
XGBoost	0.0090%	0.8834	0.0031%	0.9041
Linear Regression	0.0156%	0.6611	0.0048%	0.8254
Ridge	0.0146%	0.7068	0.0045%	0.8424
MLP	0.0138%	0.7390	0.0039%	0.8732

Overall, the results of the tested models were consistently high for the given task. From Table 1, one can see that the best performing model, XGBoost, had an R^2 of 0.8834, while the second best, Random Forest, scored 0.8601, also on the grain refinement. For the modification task, the roles were reversed: the Random Forest model achieved the best results (R^2 = 0.9057) and the XGBoost scored the second (R^2 = 0.9041). Thus, on the grain refinement data, the performance difference between linear and non-linear models was bigger (ΔR^2 = 0.177, from Ridge at 0.707 to XGBoost at 0.883) than on the modification data (ΔR^2 = 0.063, from Ridge at 0.842 to Random Forest at 0.906). This points to the relative inefficiency of Linear Regression in capturing the behavior of grain refinement in aluminum-silicon alloys. Conversely, the acceptable results achieved by linear models for the modification task indicate that the relationship between chemical composition and eutectic depression is approximately linear. This finding is interesting from an industrial point of view, as it demonstrates that the adequacy of the model is ultimately limited not by the choice of algorithm but by the characteristics of the process under study. In other words, rather than the choice of algorithm, the final accuracy depends on having enough useful metallurgical data from the chemical composition and thermal analysis. These results show exactly how accurately the system can advise the foundry operator on adding titanium and strontium in practice.

To be continued in next issue...

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MSME · GOVERNMENT BENEFIT SCHEMES · BUSINESS GROWTH

Fuel Your MSME with 2,990 Government Benefits

A practical guide to turning Government schemes into working capital, lower costs and faster growth — a scheme for every business challenge

By CA Yogesh Kulkarni · CEO & Founder Director, Global Finance Professionals (GFP)

2,990
A scheme for every struggle

Every rupee saved *flows straight to your profit*
Funding · Credit · Tax *Markets · People · Quality*
A ready answer *for every challenge you face*

Every MSME owner I meet carries a similar set of worries. **Working capital is always tight, and a bank loan feels out of reach without collateral. Buyers pay late, straining cash flow. Old machinery needs replacing, and going digital is costly. Raw-material and power bills keep climbing, skilled hands are hard to afford, and compliance is relentless. Breaking into new markets — and being paid on time once you do — feels like a mountain.** These struggles are real — and shared by millions of entrepreneurs who form the backbone of our economy.

Here is the good news: **for almost every one of these struggles, a Government scheme already exists to help.** These schemes address the evolving needs of enterprises at every stage of their lifecycle — from inception and capacity-building to expansion, technology adoption, market access and global competitiveness. India offers a remarkable portfolio of **2,990** benefit schemes — covering funding, credit, subsidy, tax relief, market access and hiring. The support is built and waiting; the real gap is **awareness, the right documentation, timely compliance and a focus on execution.**

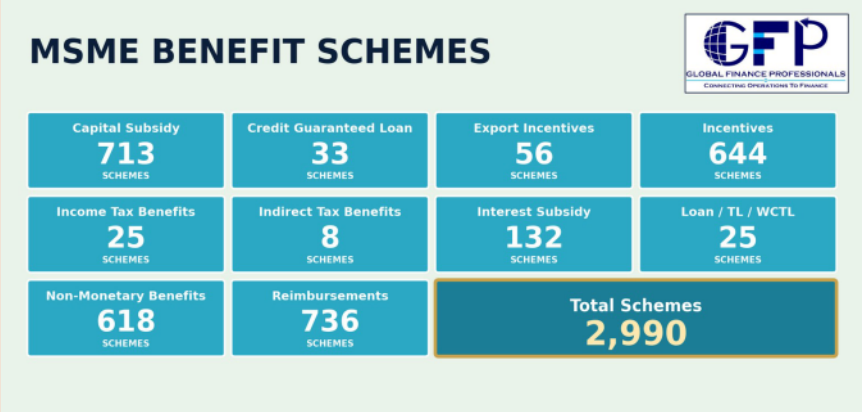
Importantly, these are not one-off giveaways. **They are woven into how the Government wants MSMEs to grow — to formalise, modernise, create jobs and export.** A business that learns to read this landscape can plan its next machine, its next hire and its next market around the support available, turning schemes from a lucky windfall into a dependable pillar of its growth strategy.

> *"For almost every problem an MSME faces, there is already a scheme designed to solve it. The opportunity is simply to connect the two."*

AT A GLANCE

The 2,990 Schemes — Ten Types of Help

All 2,990 schemes are classified into **ten types**. The snapshot below shows each type and its scheme count at a single glance:



MATCH YOUR PROBLEM TO ITS ANSWER

Your Challenge → the Scheme Type → the Schemes to Ask For

The simplest way to unlock this support is to start with ***your own problem***. Name what holds your business back, read across to the scheme type, and note the popular, high-impact active schemes to ask for (recent 2026 ones like **ECLGS 5.0** first):

YOUR CHALLENGE	SCHEME TYPE (No. of Schemes)	REPRESENTATIVE ACTIVE SCHEMES
"I can't get a loan — no collateral."	Credit Guaranteed Loan (33)	ECLGS 5.0 · CGTMSE · MCGS (₹100 Cr) · CGSSD · CGFMU
"New machinery / plant is too costly."	Capital Subsidy (713)	PMEGP · MSE-CDP · PMFME · PM Surya Ghar · EMC 2.0
"I need a big push to scale up."	Incentives (644)	Mega PLI · PM MITRA · Semiconductor Fabs · Green Hydrogen · PM E-DRIVE
"I need growth / working capital."	Loan / TL / WCTL (25)	SIDBI SPEED (₹50 Cr) · PM MUDRA · SIDBI SMILE · SIDBI ARISE · SIDBI STEP
"My interest burden is too high."	Interest Subsidy (132)	AIF (3%) · AHIDF (3%) · Niryat Protsahan · VISVAS (5%) · DAY-NRLM
"I pay too much income tax."	Income Tax Benefits (25)	22% Concessional Tax Rate · Delayed-Payment Disallowance · New-Jobs Deduction · Startup Tax Holiday · Patent Royalty Relief
"GST & compliance drain me."	Indirect Tax Benefits (8)	GST Composition · QRMP · ISD · Advance Authorisation · DFIA
"Exporting is costly and hard."	Export Incentives (56)	RoDTEP · EPCG · Duty Drawback · SEP · EOU · SEZ · MOOWR · Niryat Protsahan
"I can't reach buyers / get paid."	Non-Monetary Benefits (618)	GeM · TReDS · MSME SAMADHAAN · NSIC RMA · PMS · Udyam Assist · CHAMPIONS
"Quality / stalls / training cost too much."	Reimbursements (736)	ZED · IC Scheme (Exhibition/Stall) · MDA · TMA · LEAN · Design Clinic · Digital MSME · NATS

Notice the pattern: **every rupee you save or recover flows straight to your profit.** A subsidy cuts investment, a guarantee unlocks a loan, a reimbursement returns money already spent. This is not charity — it is smart, legitimate financial planning.

THE BIGGER PICTURE "Government schemes are a hoax or just whitewash — the money never really comes." ►

Beyond the Centre: A Whole Ecosystem Behind You

The Central schemes are the foundation — but not the whole building. The rest of the **2,990** broadly break down into four more circles of support, each with real schemes worth asking for:

State Government Schemes

Every state runs its own industrial policy that stacks on top of Central benefits — extra capital and interest subsidies, power-tariff concessions, stamp-duty and electricity-duty waivers, and special packages for priority sectors like textiles, food processing and IT.

e.g. State Investment Subsidy · Power Tariff Subsidy · Interest Subvention · Stamp-Duty & Electricity-Duty Exemption

Startup Schemes (Grants-led)

For DPIIT-recognised startups, a ladder of grants and equity takes an idea from prototype to scale — seed and deep-tech grants, defence-innovation funding, a fund-of-funds, a multi-year tax holiday and collateral-free guarantees.

e.g. iDEX (₹1.5 Cr, Defence) · MeitY GENESIS · NIDHI-PRAYAS (₹10L) · Startup India Seed Fund · Fund-of-Funds · Sec 80-IAC · CGSS

Bank & NBFC MSME Schemes

Beyond Government portals, banks and NBFCs run their own MSME products — scheme-linked lending (e.g. banks channelling PMFME and Mudra), cash-flow and equipment finance, and specialist machinery loans — often the fastest route to cash.

e.g. HDFC PMFME Loan · SBI SME Smart Score · Tata Capital MSME Unsecured Business Loan (collateral-free) · Electronica Finance (machinery)

Private & PSU Schemes

Large private platforms and public-sector units open doors too — global tech firms give free cloud and software credits to young companies, while PSUs and NSIC run vendor-development and procurement programmes that turn an MSME into a reliable supplier.

e.g. Cloud/Software Credits (AWS/Google/Microsoft) · PSU Vendor Development · NSIC Consortia & Tender Marketing

CLEARING THE DOUBTS

Common Myths — and Why They're Wrong

Many owners never apply because of beliefs that simply aren't true. Here are the most common ones, and the reality:

THE MYTH	THE REALITY
✖ "Government schemes are a hoax or just whitewash — the money never really comes."	✔ Schemes are backed by Budget allocations and paid through DBT (Direct Benefit Transfer — funds credited straight to the beneficiary's bank account) and banks. E.g. CGTMSE has guaranteed lakhs of collateral-free loans; ZED reimbursements hit registered units' accounts.
✖ "They're only for manufacturing — not for trading or services."	✔ Traders and service firms qualify widely. Beyond GeM, TReDS, MUDRA and most credit guarantees (open to all), there are vertical-specific ones: for traders/exporters — the Micro & Small Exporter's Policy (covers traders and service providers), SEP, RoDTEP and Duty Drawback; for services — Udyam Assist, PM SVANidhi (retail vendors), SFURTI and the Internship Scheme.
✖ "Only big or well-connected companies get them."	✔ Micro and first-generation units are the core target. E.g. PM SVANidhi funds street vendors; PMFME and Udyam Assist are built for the smallest enterprises.
✖ "The subsidy is too small to bother with."	✔ Benefits stack. A capital subsidy + credit guarantee + interest subvention + reimbursement together can cut project cost and EBITDA drain very materially.
✖ "Schemes need too much documentation — it's not worth the paperwork."	✔ The papers asked for are logical, scheme-specific and things a serious business keeps anyway. A CGTMSE-backed loan needs a Detailed Project Report — which any business planning growth should have. A trade-fair or exhibition claim (IC Scheme / MDA) needs the organiser's invoice, travel proof and payment receipts — the natural trail of attending. A shop-establishment registration is needed to run a shop legally in any case.
✖ "Taking a scheme invites inspections and tax trouble later."	✔ Availing a scheme is normal, encouraged compliance — not a red flag. Formalising through Udyam and GST actually improves credit scores, buyer trust and access to further benefits.

THE REAL REASON SCHEMES ARE MISSED

It's Rarely Eligibility — It's Execution

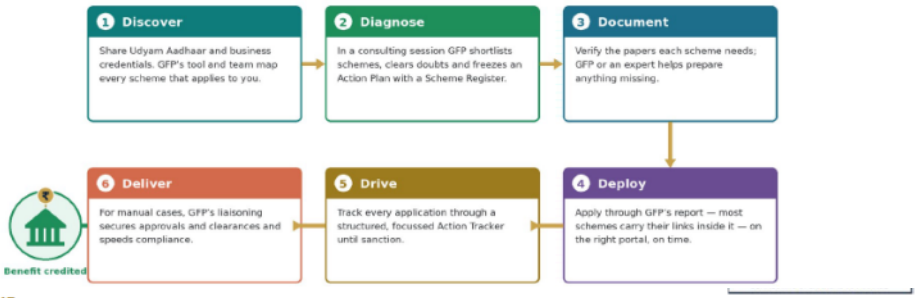
When a genuine claim is delayed or lost, the cause is usually not the scheme — it is a gap in awareness, documentation or follow-through. Each of these is fixable:

WHAT GOES WRONG	HOW IT'S PUT RIGHT
✖ Lack of awareness — the owner never learns which schemes apply.	✔ A structured Scheme Discovery / Diagnosis maps every applicable scheme to the business up front.
✖ Incomplete or wrong documentation — the single biggest cause of rejection.	✔ A document checklist per scheme, prepared in advance with expert help, clears most objections.
✖ No focussed action plan — applications stall after filing.	✔ A structured, time-bound follow-up plan tracks each application to sanction and disbursement.
✖ Weak systems & processes — deadlines and windows are missed.	✔ A simple calendar of scheme windows, renewals and claim dates prevents lapses and forfeited benefits.
✖ Basic registrations missing — no Udyam, GST or clean financials, so the unit fails eligibility screens.	✔ Getting Udyam, GST and audited numbers in order first makes the business 'scheme-ready' and unlocks most doors at once.
✖ Applying alone, then giving up after the first rejection or query.	✔ Expert follow-up answers departmental queries and re-files correctly — turning a first 'no' into an eventual sanction.

FROM CONFUSION TO CASH

How to Claim Them — and How Global Finance Professionals (GFP) Helps

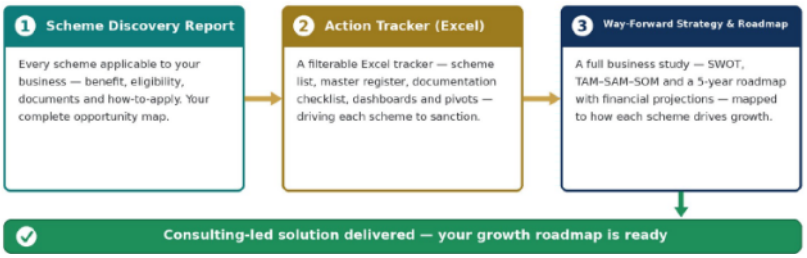
Most MSMEs already hold the basics — Udyam Aadhaar and GST registration. GFP begins by studying your full picture — **your Udyam Aadhaar plus business credentials such as your corporate profile and website** — and walks you through six clear steps, ending with the benefit credited to your account:



WHAT YOU RECEIVE

The GFP Engagement — Consulting, Clarity and Three Deliverables

This is not a form-filling service. GFP **consults with you, clears every doubt, and freezes a concrete action plan** before any application moves. You then keep **three concrete deliverables** that drive the work:



THE BOTTOM LINE

MSME बढ़ेगा तो देश बढ़ेगा

You don't need to chase all 2,990 schemes — **identify the few that fit your business, shortlist them, and claim them well.** Prioritise high-impact, active schemes — **CGTMSE for collateral-free credit, PMEGP for a capital subsidy, PM MUDRA Tarun Plus for working capital, TReDS to get invoices paid faster, GeM's 25% purchase preference for market access, and ZED for an 80% reimbursement.** Stack several together, and confirm each scheme's status on its official portal before applying. **Your next step is simple:** this week, list your top three challenges, gather your Udyam and business credentials in one folder, and book a scheme-discovery session. When the MSME grows, the nation grows.

The Road Ahead for MSMEs

The next decade of Indian enterprise will be defined less by what a business makes or sells, and more by how intelligently it plugs into the ecosystem built around it. This is not a manufacturer's story alone — **traders, exporters and service firms sit at the very heart of it,** served by GeM and TReDS for market access and faster payment, RoDTEP and the exporter's policies for global trade, and Udyam Assist for the smallest units. Government schemes have moved from being occasional subsidies to **strategic assets — levers for capital, cost, compliance and competitiveness.** The enterprises that learn to read this landscape early, and build it into their planning, will lead India's next chapter of MSME-driven growth.

FREE E-BOOK — *Master Guide to Indian MSMEs & Startups, aligned to Budget 2026–27.* **Download:** https://forms.gle/jHb5xJqCQhgRbDC96

GDCTECH COIMBATORE TRAINING PROGRAM & FOUNDRY QUIZ COMPETITION



Building a Stronger Die Casting & Foundry Industry Network in Coimbatore

Great Die Casting Technology Forum (GDCTECH) recently took an important step towards expanding its activities in Coimbatore, one of India's significant industrial centres with a strong presence of die casting and foundry industries. The programme featured a specialised technical training session designed for professionals from the die casting and foundry industry. The topic was " Artificial Intelligence for Foundry application" on 17-18 September 2026. The programme witnessed participation from 10 industry delegates representing leading organisations from Coimbatore and the surrounding industrial ecosystem.

Participating Organisations : - Pricol Ltd., - Unique Shell Mould , TK Velocity Wheels Pvt. Ltd., Craftsman Castings, Roots Cast Pvt. Ltd., Doiter Castings

The training programme was conducted by:

Mr. Karthikeyan Jawahar, Founder & Director – Karma Solutions

Mr. Karthikeyan Jawahar brought his technical knowledge and industry experience to the programme, engaging participants through practical discussions and knowledge-sharing sessions.

The programme was managed and coordinated by:

Mr. Benedict Raj, Director - The Best Marketing Company – Foundry Applications

& Mr. Advait Athavale, Founder - Sharv Consultancy

Foundry Quiz Competition

As part of the Coimbatore initiative, GDCTECH organised a Foundry Quiz Competition on the second day of the programme. The quiz was designed to create an engaging platform for testing and improving technical knowledge. The training delegates participated in the quiz as contestants. At the same time, the programme attracted foundry owners, industry professionals and students from Coimbatore, who participated enthusiastically as audience members. To encourage participation and recognise technical knowledge, the winners of the Foundry Quiz Competition were awarded free delegate passes for GDCTECH's upcoming TECHNICAL CONFERENCE 2026. GDCTECH TECHNICAL CONFERENCE 2026, 7–8 October 2026, Pune, Maharashtra. The opportunity gives the quiz winners a chance to participate in GDCTECH's larger technical platform, interact with industry experts and professionals, and gain exposure to technical presentations, panel discussions and networking opportunities.

Support from Hindusthan College of Arts and Science

A major contribution to the success of the Coimbatore programme came from Hindusthan College of Arts and Science. The college made its computer laboratory available for conducting the programme and provided extensive support through its professors and staff.

GDCTECH–Hindusthan College MOU

An important milestone during the Coimbatore visit was the signing of a Memorandum of Understanding (MOU) between GDCTECH and Hindusthan College of Arts and Science. The MOU aims to strengthen industry–academia collaboration and create opportunities for greater interaction between educational institutions and the die casting and foundry industry.

Coimbatore – A New Beginning for GDCTECH.

Coimbatore has a significant concentration of manufacturing, foundry and die casting companies, making it an important industrial ecosystem for GDCTECH. For GDCTECH, this programme is not an isolated event, but the beginning of a larger initiative. GDCTECH plans to conduct more activities in Coimbatore in the future.

Conclusion. The GDCTECH Coimbatore Training Programme and Foundry Quiz Competition was an important step towards creating a stronger network for the die casting and foundry industry in the region.

GDCTECH's 99th Coffee-TALK

I would say it was the most interactive Coffee-TALK so far !!
Though our speaker Mr. Abhijit Bongirwar's forte is "Wealth Management", he is extremely knowledgeable and successful in insurances required in manufacturing Industries.



Just like me, if you are not conversant with the types of insurances required in manufacturing, 99th Coffee-TALK was an engaging experience. Insurances rangering from simple "Group Health Coverage", to "Pandemic", "terrorism", "keyman", "line shutdown", and what not !
At the end, we had to cut short the session in respect of time. Entire audience was ready to sit for another hour at least !
Thank you Mr Abhijit, and the wonderful audience!! We are now looking forward to the 100th Coffee-TALK !!
It is planned on 24th of October 2026 !! Mark your calendars ! 100th Coffee-TALK will be a 4 hours session, with lot of knowledge and networking opportunities !!!
–
Advait Athavale
On behalf of GDCTECH's coffee-TALK team
9373171391

Training Program





Two Days Training Program On "HPDC/GDC MACHINE MAINTENANCE" held on 25-26 August 2026 at L. K. Machinery India Pvt. Ltd.,
This programme is supported by L. K. Machinery India Pvt, Ltd, and Ganesha Engisol Pvt. Ltd.,
Mr. Avinash Patil, Mr. Chandrashekhar Kate and Mr. Pramod Jagtap was the faculty for this programme.
18 delegates registered for this programme.
Special thanks to L. K. Machinery India Pvt. Ltd., for providing their conference hall for the training. And Gnaesha Engisol Pvt. Ltd., for showing their GDC Unit.

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Layered process audits for Aluminium Foundries: Part 2

Pramod Gajare – Consultant. Email: pramodgajare2013@gmail.com

While working on shop floor, people have to adhere to certain discipline, methods, and procedures so as to achieve targets of the organization related to Safety Quality, Cost, Delivery etc. While working on this millions of events occur every day in various areas right from stores to melting shop to casting to fettling and so on. Real time scrutiny of all the events for compliance and effectiveness is practically impossible. However, logical sampling can be made to understand possibility wherein the problems are likely to occur. This forms a basis for system of LPAs.

LPA and other audit methods

LPAs are sometimes confused with regular process audits or product audits. The difference can be understood by answering following questions.

- What is checked?
- Who is checking?
- When it is checked?

Table 1.0 below, explains the difference in short.

Structure of the LPA system

Layered process auditing is a scheduled, role-based verification system where multiple levels of an organization independently check critical process controls.

Many manufacturing companies use three to five layers, from bottom to top. Normally these are identified as L1, L2, L3, L4, L5 etc. A typical pyramid is shown in Figure 1.0.

LPAs check critical process controls such as standardized work, setup verification, safety-critical steps, quality checkpoints, visual management, containment, and evidence that required checks are being performed correctly.

A failed check should trigger containment when needed, ownership, due dates, root-cause follow-up, corrective action, and closure verification. A closed-loop follow-through ensures effectiveness. This avoids LPAs becoming a checklist activity instead of process improvement movement.

At the first level monitoring stage every failed check of LPA is connected to accountable corrective actions, so findings do not disappear after the checklist is submitted.

The corrective actions are monitored with due dates, containment notes, root-cause follow-up, evidence, escalation, verification, and closure review.

Tracking for effectiveness helps to see whether the same failure is recurring and whether the corrective actions are in practice.

Periodic management review --- by process, by auditor, by finding category --- to identify systemic issues and measure program health.

Define the scope

Clear definition of scope leads to successful implementation of any new system. The scope of LPA typically includes following.

Boundaries for the audit: The limits within which the audits are to be conducted. In most of the cases these are the Manufacturing plant excluding administration office.

Definition of layers: This mainly depends on size of the plant and organization structure. In most of the cases audits are conducted through three to five layers.

Areas of audit: The production shop is the main focus area. The other functions like Maintenance, Logistics, Quality, Process Engineering etc. also can be included.

Within every area all workstations are identified separately. For example; if there are nine die casting machines, each machine is treated as one workstation and separate audits are scheduled and conducted for each workstation.

While defining the scope discrimination should not be done between the company employees and the contract labour. This is because every person who is engaged in manufacturing activity contributes to the product quality.

Personnel

Leader: Top management person who drives and implements the LPA system. (Most preferred choice is CEO)

Facilitator: A person of senior management level who will provide all resources including manpower required for LPA system. (Most preferred choice is Plant Manager)

Mentor: A person responsible for:

- Providing training and guidance to the team of auditors
- Creation and revision of the check lists through cross functional approach
- Monitoring status of corrective actions
- Provide inputs for review to the top management

Coordinator: A person responsible for preparation of scheduling and tracking the audits, corrective actions requirements and countermeasures.

Auditors: Personnel form different management levels from team leader to top management.

Training the auditors:

Basic training topics includes following:

- LPA requirements
- Use of checklist
- Questioning techniques
- Nonconformity Identification
- Document findings

Depending on the type and criticality of parts, customer requirements, current burning issues in the organization training in specific area is provided.

How LPA system works?

After the initial work of scope definition, checklist creation and identification of trained auditors the next steps are dynamic. These are summarized below.

Schedule and notify.

A detailed schedule is prepared covering all workstations for every month and communicated to the concerned the people. Some organizations prefer weekly schedule for ease of monitoring.

Most of the organizations announce audits; others conduct them unannounced. Both approaches have some positive aspects. The unannounced audits reflect real process state. On the other hand, announced audits can be used as a coaching tool.

Occasion based audits are recently gaining importance since they give opportunity for fact finding which the scheduled audit can't provide. Some activities in the manufacturing shop occur less frequently which seldom get covered in scheduled audits. Die change over, Preventive maintenance or Breakdown maintenance are some examples. Naturally separate check sheets are designed for such activities.

Conduct the audit

Auditor visits the specific workstation and conducts the audit. He asks questions to the operators, observes for compliance, and records observations on the checklist. Every observation whether conforming or non-conforming is documented.

Log findings and assign corrective actions.

Some failed checks can be corrected immediately during the audit itself. Even though corrections are made, such failed checks are recorded so as to generate data about nature and frequency of occurrence. Such matrix then forms weak areas where actions are required.

In cases where immediate corrections are not possible, owners are assigned who are responsible to complete containment, root cause analysis, and corrective actions in agreed time frame.

Verify corrective action closure.

Once the corrective actions are completed and verified, it doesn't end there. The effectiveness and sustenance are regularly checked in subsequent audits. This is key difference between LPA and other types of audits.

Escalate unresolved issues.

The unresolved issues are escalated from one layer to the higher layer. If L1 hasn't closed an issue within the response window, L2 is alerted. If L2 hasn't resolved it, L3 is escalated to. The layered structure creates automatic escalation by design.

Management Review

The top management reviews trends arrived from the aggregate data. The trends can be in different ways as:

- by process,
- by auditor
- by finding category

This review enables identify systemic issues and measure program health. The improvement points at the organizational level are triggered through these reviews.

Disclaimer:

This is compilation of the information that is available as an open source on internet supported by my

analysis. I do not claim any copyright for this. The copyright of images, diagrams, pictures, and other artistic works belongs to the original creators.

Audit type	Primary focus	Type of auditor	Remarks
Layered process audit	Critical process controls and standard work	Multiple organizational layers	Recurring role-based verification at the point of work.
Process audit	Whether a process conforms to defined requirements	Quality or internal audit team	These are often broader and less frequent. All operational layers are not involved.
Product audit	Whether the output meets specifications	Inspection, quality, or production team	Checks the result only. On the other hand, LPA checks whether defect-prevention controls are being followed.

Table 1.0: Difference between LPA and other audit methods

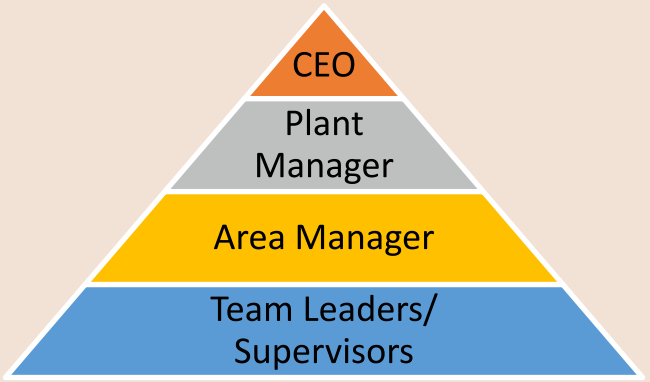


Figure 1.0: Typical Pyramid showing the layers

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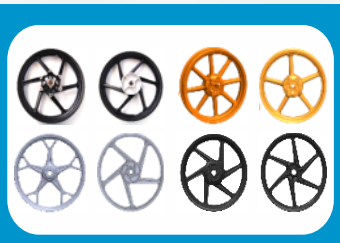
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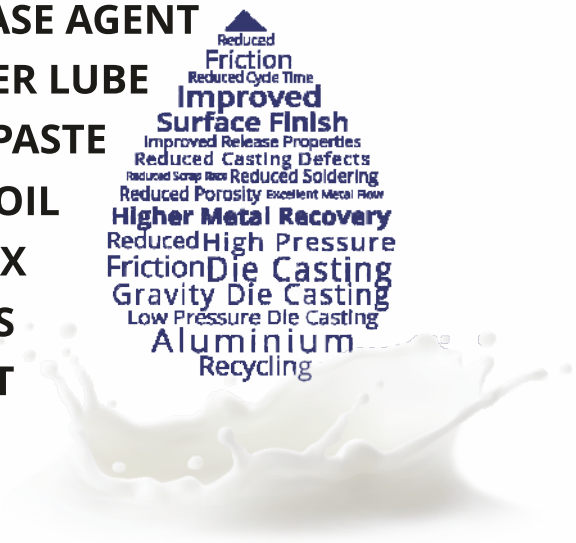
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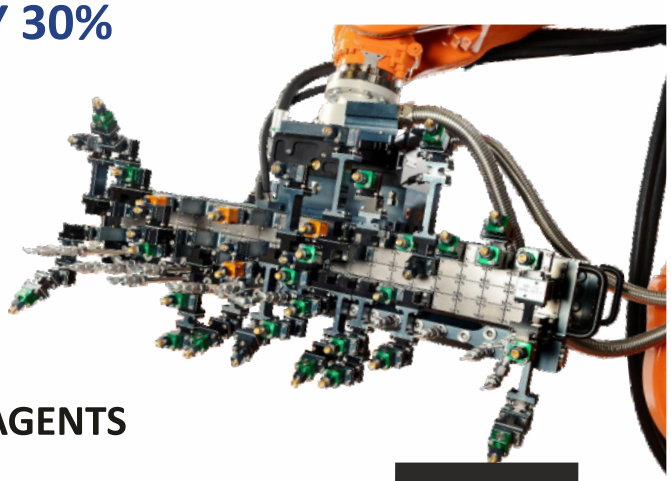
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Carbon Footprint of Magnesium Production and its Use in Transport Applications

Suraj Narvekar, Country Head - India Operations, RAUCH FURNACE TECHNOLOGY GmbH
narvekar.suraj@rauch-ft.com

IMA LCA Study

Title	Update of Life Cycle Assessment of Magnesium Components in Vehicle Construction
Date	October 30th, 2020
Author	Simone Ehrenberger

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1 MotivationMotivation Motivation and Goal and Goal and Goal

Finding new lightweight solutions is one of the major tasks that the automotive industry is addressing for various reasons. Apart from reducing the vehicle's energy consumption, the increase of electrical mileage is a further motivation in case of electric vehicles. Magnesium is one of the materials which offer advantages as a lightweight material for many transport applications. In order to assess the potential environmental benefits of magnesium, to show the status and progress of different production routes to manufacture magnesium and magnesium alloys and to compare these with each other and with competitive lightweight materials, the International Magnesium Association (IMA) initiated a study on the life cycle assessment of magnesium that was published in 2013. The study "Life Cycle Assessment (LCA) of Magnesium Components in Vehicle Construction" was written by the Institute of Vehicle Concepts of the German Aerospace Centre (DLR) and analysed the entire life cycle of magnesium components for transport applications (Ehrenberger, Dieringa, and Friedrich 2013). Environmental concerns of the production, alloying, components production and use of magnesium were addressed as well as the end-of-life of magnesium components (Figure 1). Since the magnesium production and especially the Pidgeon process in China are subject of continuous improvements, an update of the LCA study reflecting the carbon dioxide (CO2) and greenhouse gas (GHG) emissions of the current production situation is presented in this update of the 2013 study. The key changes of this update address the following aspects:

- The focus is on the update of the data on the Pidgeon process. Main changes of the Pidgeon process affect the energy sources of the plants, the amount of energy needed and the upstream processes for China specific energy supply. Additionally, the energy supply and direct emissions of the ferrosilicon (FeSi) production are updated.
- Information on the CO2 balance of alternative existing and of newly planned magnesium production processes is included in this analysis.
- For the magnesium end-of-life phase, additional information on the recycling rate of post-consumer magnesium scrap as well as data on the secondary magnesium production is included.
- A comparison of an automotive and an aircraft part with a reference part made of aluminum is presented in this study in order to show how the magnesium source influences the results on greenhouse gas emissions.

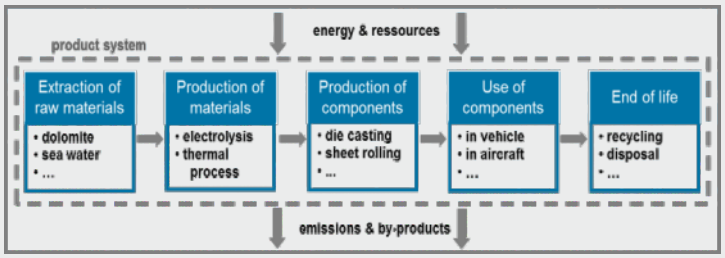


Figure 1: Overview of magnesium life cycle for transport applications analysed in the LCA study in 2013 (Ehrenberger, Dieringa, and Friedrich 2013)

Concerning the applied methodology, the study follows the standards for life cycle assessment DIN EN ISO 14040 and 14044 (ISO 14040 2006; ISO 14044 2006). The results of this study are available to all interested parties. Above all, the study intends to provide up-to-date and reliable data and results on magnesium production. The results of the magnesium production evaluation can be used for any magnesium product as it is not part specific. In general, the user of this study needs to bear in mind that the LCA methodology is an estimate of environmental impacts and the results have to be interpreted as potential impacts rather than predictions on environmental burdens or risks.

2. Analysis of Primary Magnesium Production

Pidgeon Process in China

In the past years since the 2013 LCA study has been published, the Pidgeon process has been further improved. Major efforts have been made to improve the energy efficiency of the process, e.g. by waste heat utilization. Furthermore, stricter requirements concerning the reduction of air pollutants forced the magnesium producers to install additional equipment for air purification. This leads to higher electricity demand for the peripheral equipment and partly compensates for the efforts of energy savings in the reduction process.

The fuel gases used by the various Pidgeon process plants are defined as follows (Ehrenberger, Dieringa, and Friedrich 2013): Producer gas (made in dedicated gas plants for magnesium smelters), coke oven gas (from coking plants), semi-coke oven (from semi-coke plant) and natural gas. The data on the energy consumption of the Pidgeon process has been surveyed by CMA and represents the state of Pidgeon process in 2019. Compared to the data of the 2013 LCA study, the use of semi coke oven gas has increased from 45 % to 64 %. The share of producer gas has decreased from 34 % to 22 % and from 14 % to 6 % in case of coke oven gas. Though the overall amount of magnesium produced with natural gas increased from 43 kt in 2011 to 75 kt in 2019, its relative share remains almost constant at a low level of 8 % (compared to 6 % in 2011). The average consumption of fuel gas as well as other production materials is calculated according to the number of companies without considering the individual production volume of the respective companies.

The emissions of the FeSi production are subject of uncertainty. Due to the nature of the process, certain amounts of CO2 and CO (carbon monoxide) are released during production. The data for the direct emissions of FeSi production have been updated using data provided by Kero (2017). Furthermore, current FeSi production in China largely takes place in regions with CO2 intensive electricity supply. Directing attention to a low carbon supply chain would further reduce the overall emissions of the magnesium production (Ehrenberger and Brost 2015).

Results for Greenhouse Gas Emissions

The calculation of the greenhouse gas emissions of the Pidgeon process includes all upstream processes like FeSi or fuel gas production. The production of FeSi, the calcination of dolomite and the reduction itself remain the most GHG-emission intensive life cycle steps. Emissions of FeSi production amount to 12.5 kg CO2eq per kg magnesium. Results for the calcination process vary from 6.7 to 9.1 kg CO2eq / kg Mg depending on the energy source used. Due to the reduced energy consumption, the emissions of the Pidgeon process are lower than in 2011. The overall average emissions of the current process amount to 28 kg CO2eq including all upstream processes. The calculation of the life cycle inventory is based on an allocation for the production of coke oven gas and semi coke oven gas according to the energy contribution of the fuel gases to the entire production from the (semi) coke plant. As at present, these fuel gases are provided to the magnesium producers either for free or at low prices, the gas which would be otherwise released to the atmosphere without use and can be credited to the magnesium production. In this case, the production of these fuel gases is not part of the magnesium production system. The coke production which is an upstream process for the FeSi production is burdened with the full environmental loads in this scenario. When applying this crediting method to the

emissions, the weighted average emissions of the Pidgeon process from a cradle to gate perspective amount to 21.8 kg CO2eq per kg magnesium. The direct emissions of the Pidgeon process steps amount to 12.1 kg CO2eq per kg of primary magnesium (Figure 2).

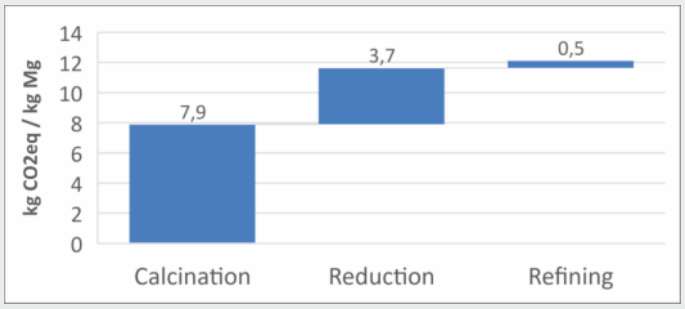


Figure 2: Weighted average greenhouse gas emissions per process and contribution to total emissions (only emissions of the Pidgeon process without upstream processes)[1]

Other Processes on Industrial Level

Apart from the Pidgeon process in China, there are some other plants which provide primary magnesium (Figure 3). Another plant using the Pidgeon process is located in Central Turkey. This plant has also a solar power unit. Its CO2eq emissions are in a similar range to those of the Chinese Pidgeon process (Ehrenberger and Brost 2015). Considerable savings potential results from the possibility an alternative source of FeSi which uses a higher share of renewable electricity. Another plant located in Brazil uses a silicothermic process which is a modified type of Bolzano Process. (Russ, Sandilands, and Hasenberg 2012) have calculated CO2eq emissions of 10.1 kg per kg magnesium. This includes a credit for the CO2 uptake by eucalyptus trees that are used as biomass in the production process.

[1] No direct CO_2 emissions result from the briquetting process step.

Alternatively to thermal production pathways, primary magnesium can be produced via electrolysis. In this case, the emissions depend mainly on the energy source used for this process. The 2013 LCA study analyzed an electrolytic process located in Israel in detail (Ehrenberger, Dieringa, and Friedrich 2013). With credits for the process by-products, the global warming potential is 14.0 kg CO2eq per kg magnesium. Another electrolysis plant is located in the province of Qinghai, China (Magontec 2017). In this process, pure magnesium is produced from magnesium chloride (MgCl2) brine which is a waste product of the adjacent potash production. The energy for the plant stems from different sources. The overall greenhouse gas emissions of the electrolysis amount 8.5 kg CO2eq per kg magnesium. Crediting the further use of chlorine as by-product of the process, the magnesium electrolysis leads to overall emissions of 5.3 kg CO2eq per kg of magnesium.

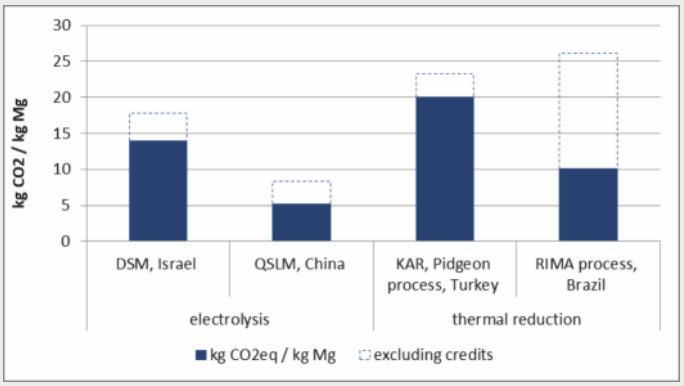


Figure 3: Greenhouse gas emissions of further industrialized magnesium production sites

Production Processes on Project Level

In the past years, there have been various projects for establishing new production processes for primary magnesium. Generating low environmental impact in magnesium production is one criterion for establishing new processes. This can either be achieved by using renewable energy, by avoiding pollutant emissions or by using waste of other industrial processes as raw material. Figure 4 shows the greenhouse gas emissions of two different processes. One is a hydrometallurgical process in Canada combined with an electrolytic process using serpentine as raw material. Combined with a low carbon energy supply, this results in greenhouse gas emissions lower than 5 kg CO2eq per kg magnesium (Fournier 2017). Another planned primary magnesium production site in Australia uses fly ash, a waste material from another industrial process, as raw material. As a thermal process, the process as such has higher CO2eq emissions compared to the electrolytic process. But the remaining ash waste generated from the process can be used as a cement substitute in the concrete industry. Credits given for the use of this by-product lower the emission balance to about 7.5 kg CO2eq per kg magnesium (Paterson 2020).

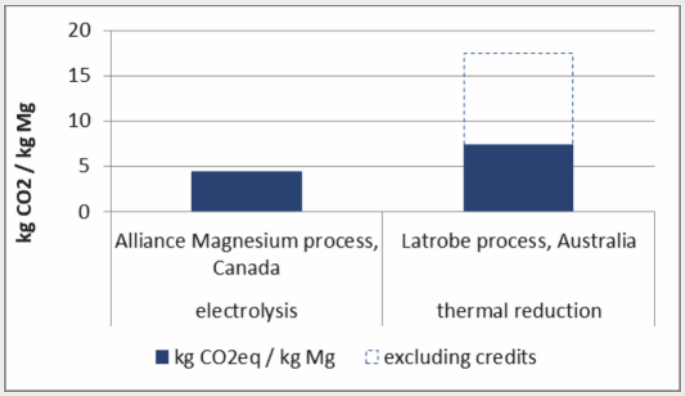


Figure 4: Greenhouse gas emissions of magnesium production on project level

3 Analysis of End of Life and Recycling

A detailed analysis of different magnesium recycling pathways can be found in the 2013 LCA report. The following information adds an analysis of secondary magnesium production in Europe to the data given in the original report. Furthermore, results of the IMA study "Magnesium Recycling in the EU" (Bell et al. 2017) are presented and included in the analysis of the magnesium overall life cycle.

Recovery of Magnesium as secondary Alloy

During the manufacturing of magnesium parts or during the further processing, magnesium scrap is generated which in some sites is treated in-house, but often is delivered to dedicated magnesium recycling plants. Two plants run by Magontec GmbH in Europe are analysed. The resulting greenhouse gas emissions are quite similar for both sites (Figure 6). The energy supply is the dominant process for the recycling plant. Apart from the emissions of the process itself, the emissions of material transport have to be added to the GHG balance of the secondary magnesium.

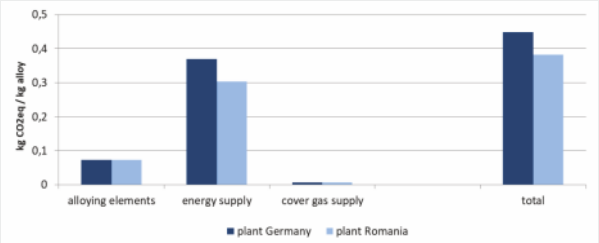


Figure 5: Greenhouse gas emissions from the recycling of new magnesium scrap

Recycling of End-of-Life Scrap

Technically, it would be possible to separate magnesium from the rest of the vehicle, but due to relatively low volumes per unit which reduce the economic benefits of recovering the magnesium less magnesium is recycled than possible. Bell et al. (2017) analyzed the fate of magnesium for automotive end-of-life parts. The figures are based on an analysis of statistical data on magnesium content in passenger cars, calculations of in-use accumulation and end-of-life vehicle statistics in Europe. Based on this analysis, we assume that functional and non-functional recycling of magnesium substitute for primary magnesium in the follow-up process for the analysis of the life cycle of the automotive part in this study. As presented in the 2013 LCA study, the contribution of vehicle's end-of-life processing is comparatively small (0.2 CO2eq / kg recovered material), while the re-use of magnesium for aluminium alloying, as assumed as standard case in the 2013 LCA study, amounts to 3.6 kg CO2eq.

4 Analysis of Magnesium use

Magnesium as a Car Component

On average, magnesium shows higher emissions during component production compared to steel or aluminium on a per kg base. These higher emissions should be compensated during the use stage. The amount of fuel and emissions that can be saved depends on the weight savings. In this study, we compare a cross car beam (CCB) made of magnesium with the same part made of aluminium. The characteristics of the exemplary CCB are taken from Fackler and Berkmortel (2016). The main structure of the magnesium is cast out of magnesium. The magnesium part weights 4 kg and is made from an AM50 alloy. The weight of the aluminium part is 5.4 kg and an AlMg3 alloy is used. The emissions of the die casting process incl. alloying elements amount to 1.5 kg CO2eq per kg material for the magnesium part and 1.4 kg CO2eq per kg material in case of the aluminium part. The functional unit of the comparison is the use of the component in a passenger car with a life time mileage of 200,000 km. In case of aluminium we refer to a 90 % recovery rate, while magnesium has a recovery rate of 66 %.

For the ecological assessment of the use of lightweight materials in transport, the use phase has considerable influence on the overall balance. The calculation of the fuel savings using a fuel reduction value of 0.35 l gasoline per 100 kg and 100 km results in CO2eq savings of 32 kg for the 200,000 km mileage. The component die-casting and the alloying elements account for 7.3 kg CO2eq per component in case of magnesium and 9 kg CO2eq in case of aluminium. The main contributor to the production

emissions is the production of primary metal. Therefore, the emissions range considerably between the different sources of magnesium. Except for the low carbon QSLM production path, the production of magnesium has a positive difference to aluminium which means that the emissions for magnesium are higher in this life stage. This includes production of primary metals and alloys as well as the manufacturing of the CCB via die casting. The magnesium world average gives a hint on average emissions. Due to the dominance of the Chinese Pidgeon process, the value is similar to the average Pidgeon process. The emissions of the CCB production based on average Pidgeon process as source of primary magnesium amount to 115 kg CO2eq while the emissions for the aluminium CCB assuming an average aluminium mix in Europe are 53 kg CO2eq. The CO2 emissions of the component using magnesium from the RIMA process result in a similar level like the aluminium reference.

For calculating the overall difference to the reference component, the emissions of the overall life cycle are summed up (Figure 6). The results show a positive net balance of greenhouse gas emission for all magnesium production scenarios that represent the current magnesium market. The results presented represent the range of current probable scenarios. They are valid for a comparison to the European aluminium use mix. If the aluminium part uses carbon intensive material produced in China, the result would look quite different. The same applies for scenarios where a share of low carbon secondary aluminium is assumed for the parts production. Equally, if other upcoming magnesium production paths are compared to the aluminium compontent, the magnesium components could gain much higher savings.

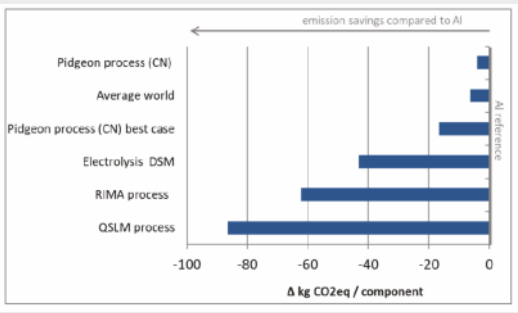


Figure 6: Overall greenhouse gas difference of different magnesium sourcing options compared to aluminium (used in Europe)

Aircraft Part

As the operation of aircrafts is energy intensive, the use of lightweight materials helps to reduce fuel consumption and emissions. To show the potential of emissions saving, parts used in an aircraft door are taken as an example. The parts are a gearbox and a seal closer for each of top and bottom of an aircraft door. The emissions of the sandcasting process incl. alloying elements amount to around 6 kg CO2eq per kg material for the magnesium part and around 5 kg CO2eq per kg material in case of the aluminium parts. The weight of the magnesium door parts amounts to 6.6 kg using an AZ91 alloy. The aluminium part (A356 alloy) which is used for component comparison weights 8.5 kg which is a weight difference of 22 %. The relation of aircraft weight and fuel consumption is taken from the DLR model VAMP zero. For the component example in this report, the fuel consumption is calculated for an A320. The correlation of fuel consumption and aircraft weight is analysed for a flight of 4,100 km and an operating empty aircraft mass of 41 t.

Only few flights are necessary to reach a break-even point for the amortization of higher emissions during component production. Due to the very high energy consumption of an aircraft during its flight, the absolute emission saving potential justifies the use of lightweight materials. Compared to the emissions of the use phase, the emissions of the magnesium pathways are almost equal to the aluminium reference. In any case, only a few mid-haul flights are necessary to compensate higher emissions of the use phase. In the examples shown in Figure 13, five or less flights are necessary for emissions compensation. If magnesium is produced via the RIMA or QSLM process, the production emissions are even lower compared the aluminium reference. Apart from the high annual mileage and greenhouse gas emissions, aircrafts have a long lifetime of up to 30 years which would lead to an even higher lifetime emission saving potential of almost 250 t Co2eq.

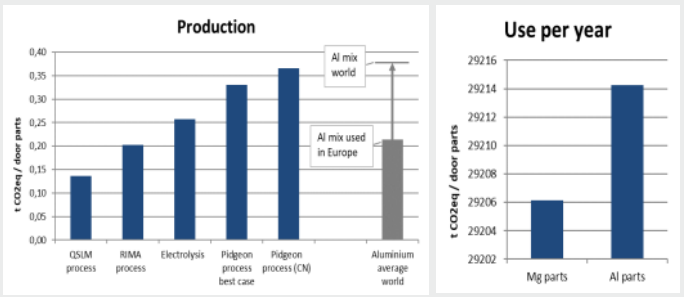


Figure 7: Greenhouse gas emissions from production of aircraft parts (left side) compared to annual GHG emissions during aircraft operation (right side)

5 Conclusions

Magnesium Production

- Emissions from magnesium production in the Pidgeon process have been reduced since 2011 (reference year of the 2013 LCA study). Yet, considering a potentially growing market for carbon neutral components in the car market, further improvements in magnesium production need to be achieved with a higher share of renewable energy. As the number of plants that have been surveyed for this study is limited, single plants can be below or above the figures presented in this study.
- Further reduction of the overall cradle-to-gate process emissions are possible, e.g. when using FeSi from alternative sourcing, though it is a question of further external factors whether this will happen or not. In future studies on magnesium production and application, the FeSi supply should be subject to further sensitivity analysis.
- The magnesium production site in Qinghai, China is a promising way to reduce the impacts from primary magnesium production. First calculations on the greenhouse gas emissions resulted in the lowest greenhouse gas emissions of all magnesium pathways that are currently in operation. The increased output of the Qinghai plant bears the potential of becoming a game changer for the world average magnesium. Other processes in Canada and Australia that are currently in planning stage show similar low CO2 emissions and potential savings.

Magnesium Recycling

- The use of secondary material is a critical factor. Both aluminium and magnesium have established pathways for recycling and reusing scrap from parts production (post-industrial scrap) which is used for high quality secondary alloys. Though aluminium comes with an established end-of-life recycling loop, the actual content of secondary material that comes from end-of-life products into automotive components is less certain. Reuse of industrial scrap and of scrap from end-of-life vehicles are both important. Yet from a product's LCA perspective, recovery and reuse of materials from end-of-life vehicles is crucial.
- The share of end-of-life scrap of magnesium needs to be increased in the future. Though it would be technically feasible, a lack of established value-added chains for end-of-life magnesium scrap reduces the potentials of a functional recycling of magnesium parts.

Magnesium Use

- The use of magnesium in both transport application analysed in this report results in lower greenhouse gas emissions over the whole life cycle. The source of primary magnesium influences the point where higher emissions of the production phase are compensated. According to present literature (World Aluminium 2017, European Aluminium 2018), aluminium likewise shows a large range of emissions from primary production depending on its geographic source. The actual difference of emissions in such product comparison highly depends on the component characteristics and the material sourcing. Therefore, it is difficult to give generalized statements about the emission savings for these lightweight materials.
- The high fuel reduction potential for aircraft leads to extremely fast amortization of emissions from the production stage. The aviation industry should use more magnesium from this point of view.

References

Bell, Nia, Rachel Waugh, and David Parker. 2017. "Magnesium Recycling in the EU - Material Flow Analysis of Magnesium (Metal) in the EU and a Derivation of the Recycling Rate." prepared for International Magnesium Association.

ecoinvent Center. 2019. Ecoinvent Version 3.6. www.ecoinvent.org.

Ehrenberger, Simone, and Mascha Brost. 2015. "Life Cycle Assessmentofa New Pidgeon Process at Kar Mineral - Summary of Results." Stuttgart, Germany. https://www.karmadencilik.com.tr/Download/pdf/LCA_Study_Summary.pdf.

Ehrenberger, Simone, Hajo Dieringa, and Horst E. Friedrich. 2013. "Life Cycle Assessment of Magnesium Components in Vehicle Construction." Deutsches Zentrum für Luft- und Raumfahrt. http://elib.dlr.de/87332/.

European Aluminium. 2018. "Life-Cycle Inventory Data for Aluminium Production and Transformation Processes in Europe." https://european-aluminium.eu/resource-hub/environmental-profile-report-2018/.

Fackler, H., and R. Berkmortel. 2016. "Design and Optimization of Magnesium Cross Car Beam for the New Mercedes GLC." In . Rome, Italy.

Fournier, Joel. 2017. "Results of Environmental Analysis - Confidential Table," February 2017.

Friedrich, H.E., Elmar Beeh, and S. Ehrenberger. 2018. "Next Generation Car's Requirements, Constraints and Potentials for Magnesium Lightweight Concepts with Integrated Functions." In . Old Windsor, UK.

ISO 14040. 2006. Environmental Management – Life Cycle Assessment – Principles and Framework.

ISO 14044. 2006. Environmental Management – Life Cycle Assessment – Requirements and Guidelines.

Kim, Hyung Chul, and Timothy J. Wallington. 2016. "Life Cycle Assessment of Vehicle Lightweighting: A Physics-Based Model To Estimate Use-Phase Fuel Consumption of Electrified Vehicles." Environmental Science & Technology 50 (20): 11226–33. https://doi.org/10.1021/acs.est.6b02059.

Koffler, C., and K. Rohde-Brandenburger. 2018. "Correction to: On the Calculation of Fuel Savings through Lightweight Design in Automotive Life Cycle Assessments (The International Journal of Life Cycle Assessment, (2010), 15, 1, (128-135), 10.1007/S11367-009-0127-z)." International Journal of Life Cycle Assessment 23 (7): 1525–26. https://doi.org/10.1007/s11367-018-1474-4.

Koffler, Christoph, and Klaus Rohde-Brandenburger. 2010. "On the Calculation of Fuel Savings through Lightweight Design in Automotive Life Cycle Assessments." The International Journal of Life Cycle Assessment 15 (1): 128–35. https://doi.org/10.1007/s11367-009-0127-z.

Magontec. 2017. "Magontec Qinghai - The World's Greenest Magnesium Alloy Producer." http://magontec.com/wp-content/uploads/2018/02/Magontec-Brochure_FINAL_Web2_SinglePages.pdf.

Meng 2020, personal communication of former CMA member.

Nuss, P., and M. J. Eckelman. 2014. "Life Cycle Assessment of Metals: A Scientific Synthesis." PLoS One 9 (7): e101298. https://doi.org/10.1371/journal.pone.0101298.

Paterson, David. 2020. "Research, Development and Demonstration Application for Latrobe Magnesium - Confidential Information," May 2020.

Rohde-Brandenburger, K., and C. Koffler. 2019. "Reply to Kim et al. (2019): Commentary on 'Correction to: On the Calculation of Fuel Savings through Lightweight Design in Automotive Life Cycle Assessments' by Koffler and Rohde-Brandenburger (2018)." International Journal of Life Cycle Assessment 24 (3): 400–403. https://doi.org/10.1007/s11367-019-01585-y.

Russ, D., J. Sandilands, and V. Hasenberg. 2012. "Dataset for Magnesium Production at Rima Industrial." Leinfelden-Echterdingen: PE International.

USGS. 2020. "Magnesium Metal." https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-magnesium-metal.pdf.

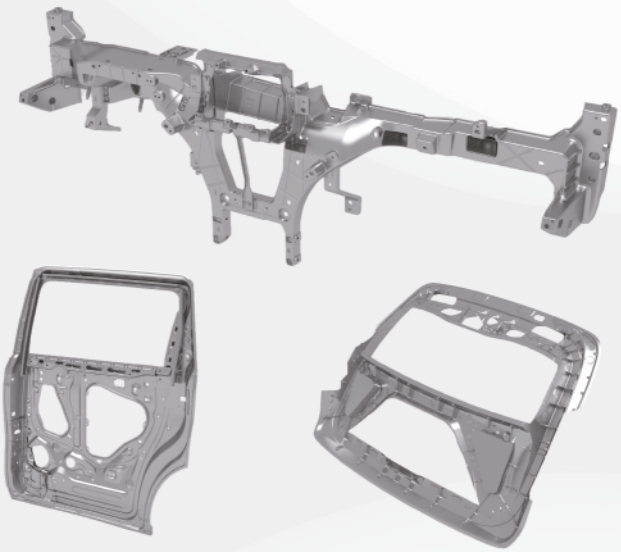
World Aluminium. 2017. "Life Cycle Inventory Data and Environmental Metric for the Primary Aluminium Industry." Http://www.world-aluminium.org/media/filer_public/2017/06/28/lca_report_2015_final.pdf.



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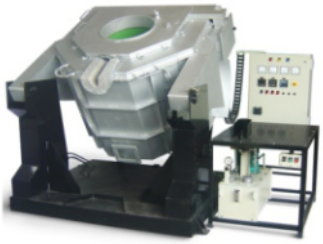


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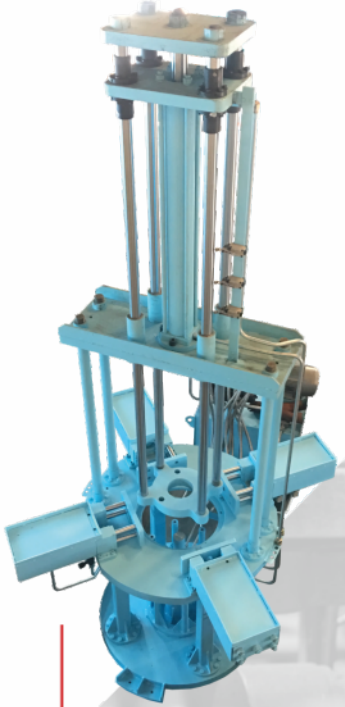


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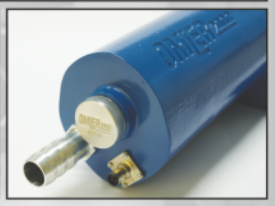
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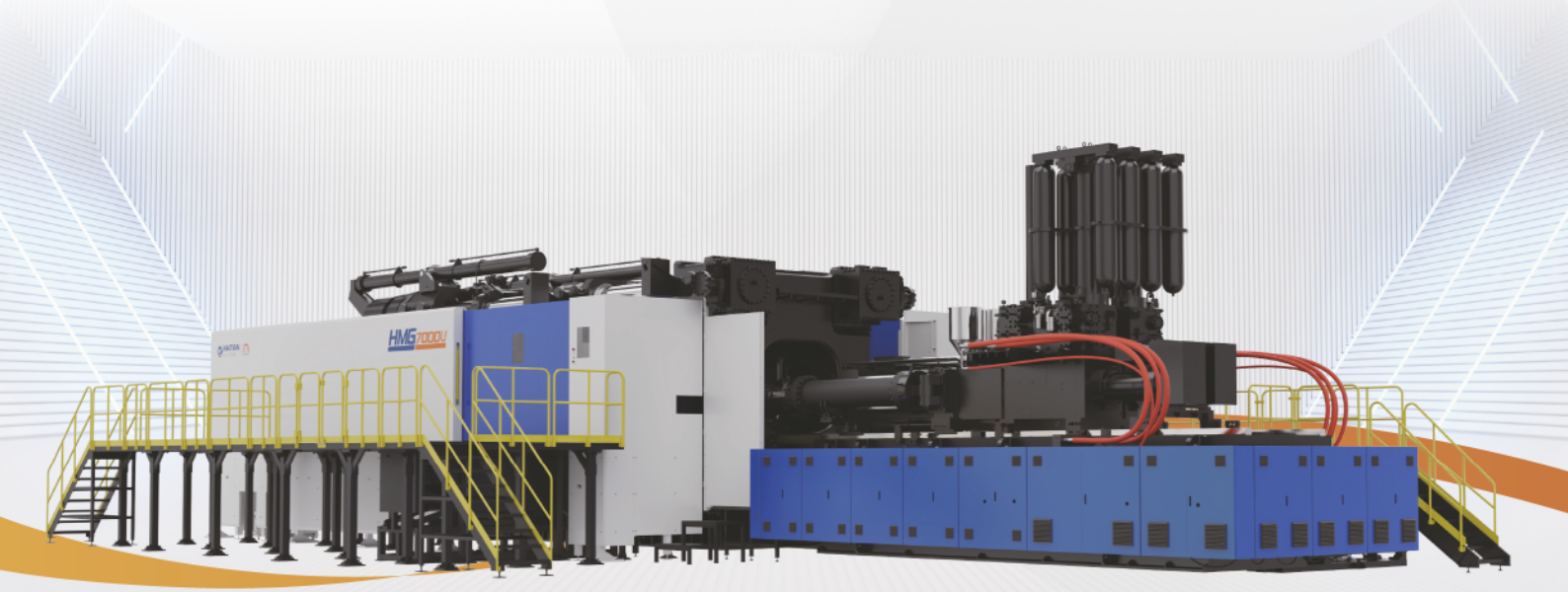
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