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www.foracepolymers.net

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ALUMINIUM GDC TECH GREAT DIE CASTING

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Dear Readers,
We always look forward to your Feedback and comments on the Journal. Please do write to us.

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'Guruprasad', 1st Floor, 37/4/A, 6th Lane, Prabhat Road, Pune 411 004 INDIA
Tel: +91 20 2567 0808, 2567 2555 | Mobile: +91 9764711315
gdctech@arkeycell.com, arkeyconference@arkeycell.com
www.gdctechforum.com

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What is Aluminium Die Casting?

C. Surianarayanan - Consultant, Email : c.surianarayanan@gmail.com

Aluminum die casting is a manufacturing process that involves injecting molten aluminum alloy into a steel mold, or die, to produce complex-shaped parts with high precision and consistency.

It's widely used in various industries such as automotive, aerospace, electronics, and consumer goods due to its versatility, cost-effectiveness, and ability to create intricate designs with excellent dimensional accuracy.

Over the years, aluminum die casting has evolved significantly in several aspects

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Over the years, aluminum die casting has evolved significantly in several aspects

- **Materials:**

The development of advanced aluminum alloys has expanded the range of properties that can be achieved, including improved strength, corrosion resistance, and thermal conductivity. This allows manufacturers to tailor the material properties to specific applications.

✶ **Process Efficiency:**

Continuous advancements in die casting technology, such as improved die designs, automation, and process control systems, have led to increased productivity, reduced cycle times, and minimized scrap rates. These improvements enhance the overall efficiency of the manufacturing process.

✶ **Surface Finish and Quality:**

Innovations in die surface coatings, lubricants, and mold design techniques have resulted in smoother surface finishes and higher-quality castings. This is crucial for applications where aesthetics and precision are paramount.

✶ **Environmental Sustainability:**

Efforts to reduce energy consumption, minimize waste, and optimize recycling processes have made aluminum die casting more environmentally friendly. Additionally, the shift towards using recycled aluminum alloys further enhances the sustainability of the process.

✶ **Integration with Other Technologies:**

Integration with other manufacturing technologies, such as computer-aided design (CAD), simulation software, and additive manufacturing, has enabled faster prototyping, improved design optimization, and streamlined production workflows.

✶ **Quality Assurance:** The implementation of rigorous quality control measures, including real-time monitoring, inspection techniques, and statistical process control, ensures consistent quality and reliability of die-cast components.

Diversification of Applications:

Aluminum die casting has expanded into new application areas, including lightweight automotive components, electronic enclosures, and medical devices, driven by ongoing innovation and demand for high-performance materials.

Overall, the evolution of aluminum die casting has been characterized by continuous innovation, driven by advancements in materials, technology, and process optimization, resulting in higher quality, efficiency, and versatility for manufacturers across various industries.

What is Aluminum Die Casting? The Process Explained

1. The Advantages of Aluminum Die Casting
2. The Top Considerations During Part Design
3. How it Compares to Green Sand and Permanent Mold Casting
4. Options for Machining and Finishing
5. The Most Common Aluminum Die Casting Alloys

The Advantages of Aluminum Die Casting

High Strength-to-Weight Ratio:

Aluminum die castings exhibit excellent strength-to-

weight ratios, making them ideal for applications where lightweight components with high structural integrity are required. This characteristic is particularly beneficial in industries such as automotive and aerospace, where weight reduction is crucial for fuel efficiency and performance.

Complex Geometries:

The die casting process allows for the production of intricate and complex shapes with high precision and consistency. This versatility in design enables the manufacturing of parts with features such as thin walls, fine details, and complex geometries that may be challenging or impossible to achieve with other manufacturing methods.

Cost-Effectiveness:

Aluminum die casting is a cost-effective manufacturing process, especially for high-volume production runs. The relatively low cost of raw materials, combined with the ability to produce net-shaped parts with minimal secondary machining, results in reduced production costs compared to alternative manufacturing methods.

Excellent Surface Finish:

Die-cast aluminum parts typically have smooth surface finishes with tight tolerances, eliminating the need for additional finishing operations such as polishing or grinding. This not only saves time and labor but also ensures consistent quality and aesthetics across production batches.

Rapid Production:

The die casting process is highly efficient and capable of producing large quantities of parts in a relatively short amount of time. With rapid cycle times and minimal setup requirements, manufacturers can achieve high production rates, meeting tight deadlines and demand fluctuations effectively.

Thermal Conductivity:

Aluminum is an excellent conductor of heat, making die-cast aluminum parts well-suited for applications requiring efficient heat dissipation or thermal management. This property is advantageous in various industries, including electronics, automotive, and industrial equipment.

Corrosion Resistance:

Aluminum alloys used in die casting are inherently corrosion-resistant, offering protection against rust and degradation in harsh environments. This makes aluminum die-cast components durable and long-lasting, even when exposed to moisture, chemicals, or outdoor conditions.

Recyclability:

Aluminum is highly recyclable, and die-cast aluminum parts can be easily recycled and reused with minimal loss of material properties. This contributes to the sustainability and environmental friendliness of the manufacturing process, reducing waste and conserving resources.

The Top Considerations During Part Design

When designing parts made from aluminum, several unique considerations come into play due to the specific properties of this material.

Here are some top considerations for aluminum part design

By carefully considering these factors during the design process, engineers and designers can develop aluminum parts that meet performance requirements, are cost-effective to manufacture, and leverage the unique properties of this versatile material.

Material Properties:

Understand the specific properties of aluminum, including its lightweight nature, high strength-to-weight ratio, excellent corrosion resistance, and good thermal and electrical conductivity. Design parts to leverage these properties effectively.

Alloy Selection:

Aluminum alloys offer different combinations of properties suited for various applications. Consider factors such as strength, hardness, formability, machinability, and corrosion resistance when selecting the appropriate alloy for the intended use.

Manufacturability:

Design parts with aluminum's manufacturing processes in mind, such as casting, machining, extrusion, and sheet forming. Optimize the design to maximize the advantages of each process while minimizing potential limitations and production costs.

Structural Integrity:

Ensure that the part's design provides sufficient strength, stiffness, and durability to withstand expected loads, stresses, and operating conditions. Consider factors such as wall thickness, fillets, ribs, and reinforcement features to enhance structural integrity while minimizing material usage.

Heat Dissipation:

Aluminum's high thermal conductivity makes it suitable for applications requiring efficient heat dissipation, such as electronic enclosures, heat sinks,

and automotive components. Design parts with features that facilitate heat transfer and dissipation, such as fins, thermal vias, and surface treatments.

Surface Finish:

Aluminum parts can have various surface finishes, including anodizing, polishing, brushing, and powder coating. Consider the desired appearance, corrosion resistance, and functional requirements when selecting a surface finish for the part.

Joining Methods:

Choose appropriate joining methods for assembling aluminum parts, such as welding, adhesive bonding, mechanical fastening, or clinching. Consider factors such as joint strength, integrity, and compatibility with the material and manufacturing process.

Corrosion Resistance:

Although aluminum has inherent corrosion resistance, certain environments may still pose corrosion risks. Design parts with appropriate surface treatments, coatings, or alloy selections to enhance corrosion resistance and prolong the part's lifespan, especially in harsh or corrosive environments.

Weight Optimization:

Leverage aluminum's lightweight nature to design parts with reduced weight while maintaining structural integrity and performance. Consider material thickness optimization, ribbing, and topology optimization techniques to achieve weight reduction without sacrificing strength or functionality.

Cost Efficiency:

Balance performance requirements with cost considerations to develop cost-effective aluminum parts. Optimize the design to minimize material waste, machining time, and assembly complexity, while maximizing the utilization of standard sizes and stock shapes to reduce material costs.

How Aluminium casting Compares to Green Sand and Permanent Mold Casting

Aluminum casting processes, including green sand casting and permanent mold casting, offer distinct advantages and disadvantages compared to each other.

Here's a comparison of these three casting methods

Green Sand Casting:

Process: Green sand casting involves packing a mixture of sand, clay, water, and additives around a pattern to create a mold cavity. Molten aluminum is then poured into the mold, and after solidification, the sand mold is broken to retrieve the casting.

Advantages:

Low cost: Green sand molds are relatively inexpensive to produce compared to other casting methods.

Flexibility: Green sand molds can accommodate complex shapes and are suitable for small to large-scale production runs.

Good surface finish: Green sand casting can achieve relatively smooth surface finishes.

Disadvantages:

Lower dimensional accuracy: Green sand casting may have lower dimensional accuracy and tighter tolerances compared to other methods.

Limited to non-ferrous metals: Green sand casting is typically used for non-ferrous metals like aluminum, brass, and bronze.

Permanent Mold Casting:

Process: Permanent mold casting involves using a reusable metal mold made from materials like steel or cast iron. The mold cavity is created by machining the mold halves to the desired shape. Molten aluminum is then poured into the mold, where it solidifies before being removed.

Advantages:

Higher dimensional accuracy: Permanent mold casting can achieve tighter tolerances and better surface finishes compared to sand casting.

Longer mold life: Permanent molds can be used repeatedly, making them suitable for medium to high-volume production.

Faster production: Permanent mold casting generally has shorter cycle times compared to sand casting.

Disadvantages:

Higher initial cost: Permanent molds are more expensive to produce initially compared to sand molds.

Limited to simpler shapes: Permanent mold casting is more suitable for simpler part geometries compared to sand casting.

Limited flexibility: Once the mold is made, it cannot be easily modified, limiting design changes during production.

Aluminum Casting:

Process: Aluminum casting is a broad term that encompasses various casting methods used specifically for aluminum alloys, including sand

casting, permanent mold casting, die casting, and investment casting.

Advantages and Disadvantages:

1. The advantages and disadvantages of aluminum casting depend on the specific method used (e.g., sand casting, permanent mold casting) and factors such as cost, dimensional accuracy, surface finish, production volume, and part complexity.

2. Aluminum casting methods offer the advantages of lightweight construction, excellent corrosion resistance, high strength-to-weight ratio, and the ability to produce complex shapes.

In summary, green sand casting is more suitable for low to medium-volume production of complex parts with lower dimensional accuracy, while permanent mold casting is better suited for higher volume production of simpler parts with higher dimensional accuracy.

The choice between these methods depends on factors such as cost, production volume, part complexity, and required quality.

Options for Machining and Finishing of castings

When it comes to machining and finishing aluminum castings, several options are available to achieve the desired surface quality, dimensional accuracy, and functional requirements.

Here are some common methods used for machining and finishing aluminum castings:

Machining:

CNC Machining:

Computer Numerical Control (CNC) machining is a versatile process for milling, turning, drilling, and other operations. It offers high precision, tight tolerances, and the ability to produce complex geometries.

Turning:

Turning operations are used to create cylindrical features on aluminum castings, such as shafts, threads, and grooves. CNC turning centers can achieve precise dimensional control and surface finishes.

Milling:

Milling operations remove material from the surface of aluminum castings using rotary cutters. CNC milling machines can produce intricate shapes, pockets, and contours with high accuracy.

Drilling:

Drilling is used to create holes of various sizes and depths in aluminum castings. CNC drilling machines can produce precise hole locations and diameters.

Grinding:

Grinding operations can be used to achieve tight tolerances, smooth surface finishes, and precise geometries on aluminum castings. Surface grinding, cylindrical grinding, and centerless grinding are common grinding processes.

Finishing:

Deburring:

Deburring removes sharp edges, burrs, and excess material from aluminum castings to improve safety and aesthetics. Methods include manual deburring, tumbling, vibratory finishing, and abrasive blasting.

Surface Treatment:

Surface treatments such as anodizing, chromating, painting, powder coating, and electroplating can enhance the appearance, corrosion resistance, and wear properties of aluminum castings.

Polishing:

Polishing operations can achieve mirror-like surface finishes on aluminum castings by removing surface imperfections and scratches. Mechanical polishing, chemical polishing, and buffing are common polishing techniques.

Shot Peening:

Shot peening is a surface treatment process that bombards aluminum castings with small metal or ceramic particles to induce compressive stresses, improve fatigue resistance, and enhance surface finish.

Heat Treatment:

Heat treatment processes such as solution heat treatment, aging, and stress relieving can improve the mechanical properties, dimensional stability, and machinability of aluminum castings.

Assembly:

Assembled aluminum castings may require additional processes such as welding, brazing,

adhesive bonding, or mechanical fastening to join multiple components together.

The selection of machining and finishing methods for aluminum castings depends on factors such as part geometry, dimensional tolerances, surface finish requirements, production volume, cost considerations, and specific application needs.

It's essential to choose the most appropriate methods to achieve the desired quality and functionality efficiently.

Finishing operations:

Painting & Powder coating of the castings

Painting offers a wide range of color options, finishes, and decorative effects, making it suitable for various aesthetic and functional requirements. However, painted surfaces may be susceptible to chipping, scratching, and fading over time, especially in harsh environments.

Finishing operations such as painting and powder coating are commonly used to enhance the appearance, corrosion resistance, and durability of aluminum castings.

Here's an overview of each process

Painting:

Painting aluminum castings involves applying a liquid coating, typically through spraying, brushing, or dipping, to achieve a desired color, texture, and finish. The painting process generally consists of the following steps:

Surface Preparation:

The surface of the aluminum casting must be cleaned and prepared to ensure proper adhesion of the paint. This may involve degreasing, chemical cleaning, sanding, or abrasive blasting to remove contaminants, oxidation, and roughness.

Primer Application:

A primer coat is often applied to the aluminum casting to improve adhesion, corrosion resistance, and paint durability. The primer helps seal the surface and provides a smooth base for the topcoat.

Topcoat Application:

After the primer has dried, one or more coats of paint are applied to the aluminum casting to achieve the desired color, finish, and appearance. The topcoat may be applied using spray guns, brushes, or rollers, depending on the requirements.

Curing:

Once the paint has been applied, the aluminum casting is typically cured in an oven at elevated temperatures to promote cross-linking and curing of the paint film. This improves adhesion, durability, and resistance to environmental factors.

Finishing :

After curing, the painted aluminum casting may undergo additional finishing steps, such as sanding, polishing, or clear coating, to achieve the desired surface texture and gloss.

Powder Coating:

Powder coating is a dry finishing process that involves applying a powdered polymer resin to the surface of aluminum castings through electrostatic attraction, followed by curing to form a durable, protective coating. The powder coating process typically includes the following steps:

Surface Preparation:

Similar to painting, the surface of the aluminum casting must be cleaned and prepared to ensure proper adhesion of the powder coating. This may involve degreasing, chemical cleaning, sanding, or abrasive blasting.

Powder Application:

The powdered polymer resin is electrostatically charged and sprayed onto the grounded aluminum casting, where it adheres evenly due to electrostatic attraction. The powder coat may be applied in one or more layers to achieve the desired thickness and coverage.

Curing:

After the powder coating has been applied, the aluminum casting is cured in an oven at elevated temperatures to melt and fuse the powder particles into a continuous film. The curing process promotes cross-linking and polymerization, resulting in a durable, chip-resistant coating.

Cooling and Finishing:

Once cured, the powder-coated aluminum casting is cooled to ambient temperature and may undergo additional finishing steps, such as sanding, polishing, or clear coating, to achieve the desired surface

texture and appearance.

Powder coating offers several advantages over traditional liquid painting

Both painting and powder coating can effectively enhance the appearance and performance of aluminum castings, providing durable and attractive finishes for a variety of applications.

The choice between the two processes depends on factors such as desired aesthetics, performance requirements, environmental considerations, and cost.

In conclusion, aluminum casting offers a versatile and efficient manufacturing solution for producing a wide range of complex parts with excellent strength-to-weight ratios, corrosion resistance, and dimensional accuracy.

Whether through processes like green sand casting, permanent mold casting, or die casting, aluminum castings are integral to numerous industries, including automotive, aerospace, electronics, and consumer goods.

Furthermore, the flexibility of aluminum casting methods allows for the production of intricate geometries, customized designs, and cost-effective solutions, making it a preferred choice for both prototyping and large-scale production. Additionally, the ability to efficiently machine and finish aluminum castings further enhances their versatility and applicability in various applications.

Overall, aluminum casting continues to play a crucial role in modern manufacturing, offering a combination of lightweight construction, exceptional mechanical properties, and cost-effective production methods that meet the evolving demands of today's industries.

My Career in Aluminium Die Casting Industry

Bharathi Aruchamy, Managing Director, Jai Nidhi Automation

Myself is an example for this article.I am Bharathi Aruchamy,basically a textile bacground person entered in to Mechanical engineering industry in 2010 without any background knowledge with 15 employees.With hard work and dedication i made my mind to start a manufacturing industry without knowledge.I saw a die casting machine first time in life on the day when my new PDC machine was installed.so i think this is enough that i can write my article here.Here goes,

Diecasting is a challenging industry and a women in die casting is again a big task . But for a women if her goal is defined and if she is allowed free of hands by her family and society,she can easily manage any industry.Nowadays many women are entering in to die casting industry with out any fear in operating.unlike all other industries,this industry is bit a risky one due to the heat where woman's are sensitive and effects health but nowadays,technology has improved a lot and there is no need to be under the heat always.Once the machine is automated,she can monitor the work from her system.

Women with strong will power and determination can enter in to this industry and manage the entire operations.As government is focusing on women empowerment,we as a women should jointly hold our hands together and prove to this world that nothing is impossible for a women to succeed in this world and can say loudly with a quote IF NOT WOMEN WHO CAN !!!

Women are playing a major role in automotive industries and many OEM's are placing women employees in their production and manufacturing plants,many OEM's have introduced plants operated by only women employees alone .This is giving encouragement to many other women to enter in to this industry. Myself,after 10 years of experience in diecasting,stood as an example to many women in my region to enter in to this industry and also to my daughters to enter in to this field and now my daughter after her MBA,is now entering in to this industry.

So i can say within few years we can see many young players (women) to this industry as owners,operators,quality inspectors and soon.Many diecasting entrepreneurs are nowadays encouraging and allowing their wife and daughters to die casting industry without any fear.This shows that women empowerment is increasing inside the minds of all and women are taking this challenge to prove their talents.

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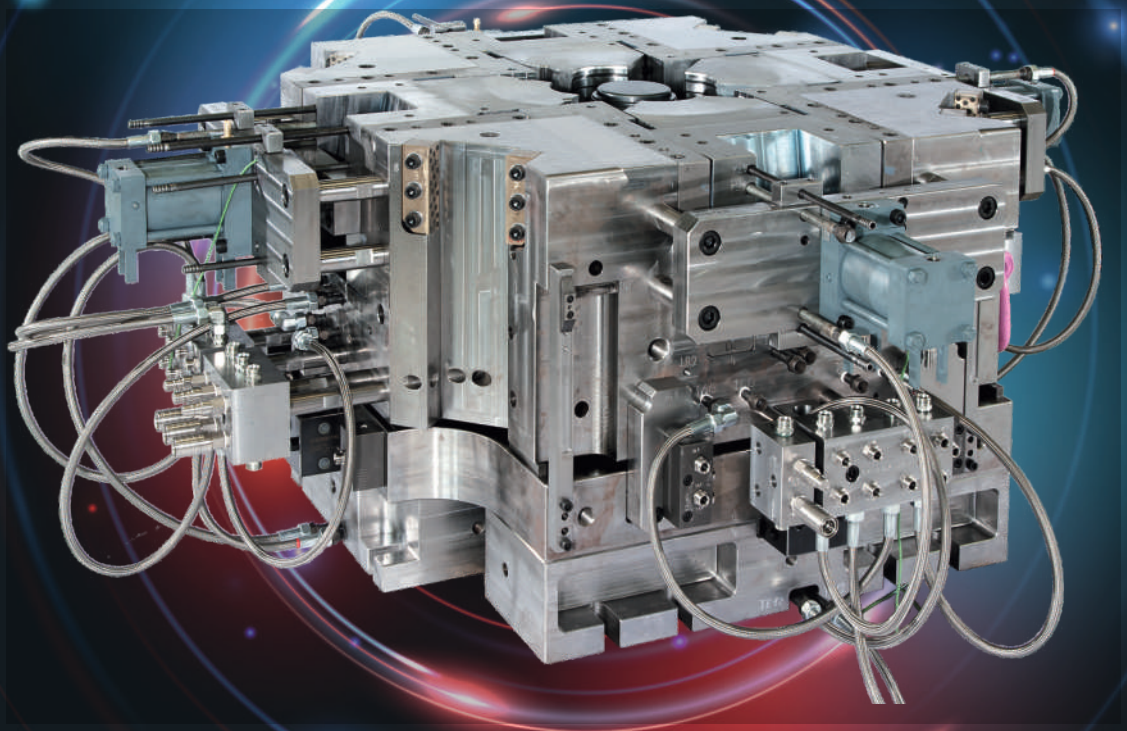

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Process FMEA: Aspects less explored

Pramod Gajare, Consultant, pramodgajare2013@gmail.com

The FMEA (Failure Mode & Effect Analysis) method was started in late1940s by the U.S. military and over the period it got developed in sophisticated way through contribution of various agencies in Aerospace, Aviation, Automotive and other industries.

This document identifies

- ways in which a product / process can fail to meet critical customer requirements
- severity (seriousness) of the probable failure
- possible occurrence rate
- actions for avoiding the failures.

From the start of 21st century the FMEA is widely adopted in most of the areas of industry. However, during implementation of FMEA some of the aspects are given less importance or these are less explored. This article is aimed to enlighten the readers on some of these areas related to Process FMEA. Although the process FMEA is also known as PFMEA, for simplicity the phrase FMEA is used in this article.

Management

Active involvement of management is of prime importance. This is because the risks identified are ultimately will be associated with and will be borne by the management only. Management should depute the personnel to form a FMEA team. The necessary infrastructure and resources should be provided to this team. Time to time encouragement and motivation should be given to them.

FMEA should not be treated merely a document that is to be submitted to customer.

The Team

FMEA is not a single person job. As indicated above people from various disciplines should be involved in this team. The functions may include Development, Quality, Engineering, Design Manufacturing, Marketing, Purchase, Maintenance, HR and other relevant one. The people with responsibility and authority in their working area must be selected.

It is important to involve customer's representative in this team. This is because only customer has detailed knowledge about the product, criticality and risks associated with the product features.

The team leader should ensure that the members are given training on FMEA process. The team approach ensures inputs and collaboration from all affected functional areas for the FMEA development.

Here are some basic guidelines for good teamwork.

- Understand the process
- Keep an open mind to change
- Maintain a positive attitude
- Never leave in a silent disagreement
- There is no rank or position
- Create a blameless environment
- Practice mutual respect every day
- Treat others as you want to be treated
- One person, one voice—no position or rank
- There's no such thing as a dumb question

Timing

Timeliness is one of the most important factors for successful implementation of an FMEA program. As referred in AIAG manual – It is meant to be a "before-the-event" action, not an "after-the fact" exercise. For the best results, the FMEA must be done before the implementation of a process. When it is done so in advance, the changes in process can be implemented easily and inexpensively. Actions resulting from an FMEA can reduce or eliminate the chance of implementing a change which otherwise would lead to a great concern. Ideally the process FMEA should be initiated before the tooling and manufacturing equipment is developed and purchased. Sometimes corrections in the tooling and manufacturing equipment are either very costly or not possible, which can be avoided by starting FMEA activity well in advance.

An FMEA should not be considered as a single event. It is a long-term activity that helps and guides the process development to ensure potential failures are evaluated and actions are taken to reduce their risk. One of the key factors of continual improvement is retaining knowledge from past learning. The past historical data about "Things gone wrong; things gone right" (TGW-TGR) can be used as a starting point for the next FMEA program of similar product and process.

The Format

Various types are formats are used across the industry. The structure of the format depends mainly on the needs of the organization and the requirements of customers. Basically, the format should address following:

- ✓ The functions, requirements, and deliverables of the process being analysed,
- ✓ Failure modes when functional requirements are not made,
- ✓ Effects and consequences of the failure mode,
- ✓ Potential causes of the failure mode,
- ✓ Actions and controls to address the causes of failure mode, and,
- ✓ Actions to prevent recurrence of the failure mode.

Define customer

The company to whom we supply the castings is our customer. There is no doubt about it. But the meaning of customer is not limited to this only. It is important to identify the customers correctly as the spectrum of impact of failure can be identified correctly.

Typically, there are four major customers which are to be considered.

End user: The person or organization that will utilise the product.

OEM or Tier 1 supplier: The manufacturing and assembly plant of the OEM/ Tier 1 supplier.

Supply chain: This includes manufacturing plants where next operations like machining, painting, powder coating etc. are performed. Even the next operation in our production process is considered as a customer. Government regulations: Government agencies that regulate and monitor compliance to safety and environment specifications.

Define scope

This is one important step the team has to do at the initial stage. The boundary of FMEA analysis is established as it defines what is included and what is excluded. Following are the questions that help to define the scope;

- Who is the customer?
- What process components are to be included in analysis?
- Which support systems of process to be included in the study?
- To what extend the input materials should be studied during analysis?
- What are the product material requirements and constrains? (Example: Hydrogen pickup by the molten Aluminium alloy)
- Whether packaging, storage, and transit is to be considered as a part of this analysis?

Review the process

The review makes the team members familiar with the process. It helps to identify the main components of the process (operations of process … as most of us are familiar with this phrase) and determine the function or functions of each of those components. It also ensures that you are studying all components of the process.

Use the process flow chart and label each component with a sequential serial number. These reference numbers are to be used throughout the FMEA process. For each component, list down its intended function or functions. Many components have more than one function. The function of the component is what value addition that component performs or provides

Brainstorm potential failure modes

Potential failure mode: Any manner in which the component or process step could fail to perform its intended function or functions. Use list of components and related functions, brainstorm as a team the potential failure mode or modes for each function. There could be more than one failure modes.

Do not take any shortcuts here. This activity requires thorough workout. Where the operations are human dominated, consider all possible abuses, their effects and counter actions. For example;

- ✓ misuses,
- ✓ manipulations,
- ✓ mishandlings,
- ✓ misapplications,
- ✓ mistreatments

Potential Effects of Failure

An effect means the impact a failure could make if it occurred. Determine the effects associated with each failure mode. Some failures will have effect on the customers whereas the others have impact on the environment, the facility and even the next operations.

Define the effects in descriptive and detailed terms that are meaningful to the product or system

performance. With the vague definition of effect, it will be difficult to identify or reduce the true potential risk.

Severity Ranking (S)

For each and every effect identified assign a severity ranking. This ranking is an estimate of how serious an effect could be, if it occurs. For determining the severity consider the impact of the effect on the customer, on the downstream operations, or on the personnel operating the process. The severity ranking is based on a relative scale ranging from 1 to 10. The ranking of "10" indicates the effect has a dangerously high severity leading to a hazard without warning. On the other hand, the ranking "1" denotes the severity is extremely low.

Standard ranking scales (for severity, occurrence and detection) are made available by various agencies. One can develop their own scale to suit the requirement of the organization. Whichever ranking scale is selected, the same ranking scales for PFMEAs should be used consistently throughout your organization. This helps to compare the RPNs from different PFMEAs to one another.

Occurrence Ranking (O)

The next step is to consider the potential cause or failure mechanism for each failure mode and then assign an occurrence ranking to each of the causes or failure mechanisms. The occurrence ranking is based on likelihood, or frequency at which the failure would occur. Since the potential failure mode is known, previous historical data can be used to know at what frequency the similar defect has occurred and accordingly the ranking can be given.

Similar to the severity ranking, the occurrence ranking is based on a relative scale ranging from 1 to 10. The ranking of "10" indicates the failure mode occurrence is very high, and happens all the time. On the other hand, the ranking "1" denotes the probability of occurrence is remote.

Detection Ranking (D)

The controls that are currently in place for each failure mode related to product or process need to be identified. Based on this the detection ranking can be assigned.

A control can be related to one of the following three categories;

1) The failure mode itself
2) The cause or mechanism of failure
3) The effects of the failure

There are two types of controls.

Preventive controls:

When applied this type of controls prevent a failure mode or the cause of failure from occurring.

Indicative controls:

When applied this type of control detect a failure mode or cause of failure or effect of failure after it has occurred.

This concept can be very well understood through the example of "Temperature Controller" and "Temperature Indicator" that are widely used on the shop floor.

It is important to understand here that the preventive control can not relate to an effect. When the failures are prevented an effect of failure can not exist.

Similar to the severity and occurrence ranking, the detection ranking is based on a relative scale ranging from 1 to 10. The ranking of "1" indicates that the chance of detecting a failure is certain. On the other hand, the ranking "10" denotes the highest probability of non-detection. Basically, it means that there are no controls in place to prevent or detect.

Risk Priority Number (RPN)

A relative risk ranking is given by Risk Priority Number (RPN). The higher the RPN, higher the potential risk. It is calculated by multiplying the three rankings together.

RPN = Severity Ranking X Occurrence Ranking X Detection Ranking.

The RPN is to be calculated for each failure mode and effect.

As each of the above referred three ranking scales range from 1 to 10, the RPN will always be between 1 to 1000. The higher the RPN, higher the relative risk.

The improvement efforts can be prioritized using RPN.

Merely focusing on high RPN may not be always effective for prioritising. Hence different approaches are used in some organizations. The approaches are mainly focusing on;

- Severity and Occurrence (SO = S x O)
- SOD, the non-arithmetic combination of Severity, Occurrence and Detection. (Example If S =8, O=4 and D=6; then SOD is 846)
- SD, the non-arithmetic combination of Severity, and Detection. (Example If S =8, and D=6; then SOD is 86)

- RPN is greater than some threshold limit, (say 42 for example) for the Special characteristics identified by customer.

Develop the Action Plan

Taking actions results in reducing the RPN. The RPN can be lowered by lowering any of the three rankings (Severity, Occurrence or Detection) individually or in combination with one another.

Reduction in Severity ranking is the most difficult one as it involves a physical modification to the process equipment or layout.

Reduction in Occurrence ranking can be possible by removing or controlling the potential causes. Mistake-proofing tools are used many times to reduce the frequency of occurrence.

Reduction in Detection ranking can be possible by improving the process controls in place. This includes typically following:

- Adding Fail-safe shut-downs
- Alarms, signals (sensors or SPC)
- Validation practices such as set-up procedures, calibration programs
- Preventive maintenance

The action plan must be SMART (Specific, Measurable, Achievable, Realistic and Time bound)

Implementation of Action Plan

In most of the cases the action plans identified are of simple nature. With correct definition of 'who, what, when' the actions can be completed easily as the responsibly and target dates are clearly defined. In case the action plan is a fairly large-scale project, conventional project management tools such as Gantt Charts will be required to keep track of the project.

Update the PFMEA

After the action plans are completed successfully and the results are as desired, the new RPN is calculated. The PFMEA is updated to include the new controls and new levels of Severity, Occurrence and Detection rankings as the case may be.

Linking PFEMA and Control Plans

The control plans are to be developed in parallel with the PFMEA.

The control plans are meant to create a structured approach for control of process and product characteristics with specific attention to the characteristics that are important for the customer. The control plan also includes the thought-out reaction plans in case an out-of-control condition occurs and provides means for documentation and communication of control methods.

Just like PFMEA the control plan is a live document; and it is to be updated when there is a revision in PFMEA and vice versa.

Annexture A

Points to remember

The PFMEA is a living document and it should be updated time to time.

PFMEA is to be initiated before or at the feasibility stage and before the production tooling is finalised.

PFMEA should include all manufacturing operations starting form receipt of raw material to dispatch to the customer.

Make sure that the scope is clearly defined

The serial numbers assigned on the flow chart for each component are to be used throughout the FMEA as well as control plan.

No shortcuts during brainstorming for potential failure mode

Use specific words to define the potential effects

Best way is to use the same ranking scales (for severity, occurrence and detection) for PFMEAs consistently throughout your organization.

Historical data of defects and the frequency at which it occurred is the best way to decide the occurrence ranking.

Mistake-proofing or Poka-Yoke is the best preventive control

The improvement efforts can be prioritized using RPN. However, that is not the only way.

Reduction in Severity ranking is the most difficult. Focus on Occurrence and Detection helps a lot for reducing the Potential risk.

The PFMEA finally leads to generation of effective control plan.

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ALUMINIUM GDC TECH GREAT DIE CASTING

GREAT DIE CASTING TECHNOLOGY FORUM

GDCTECH 2024

Theme

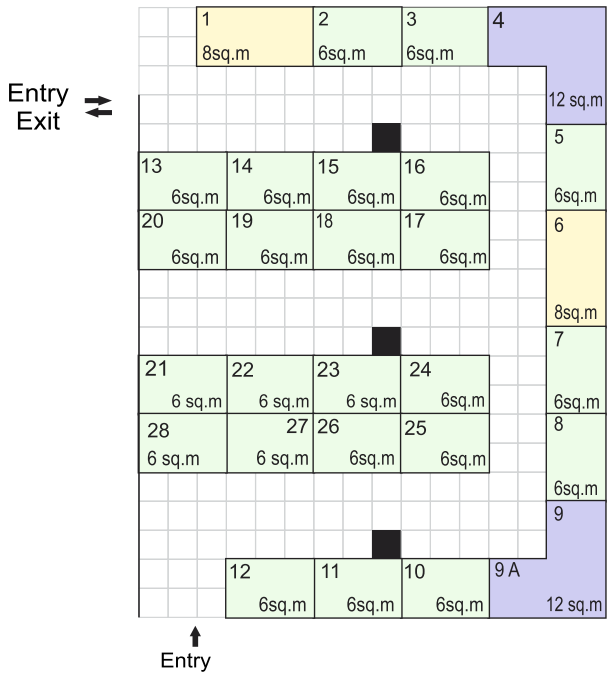
Smart Factory for the Sustainable Growth

Date : 19-20 (Thu-Fri) SEPTEMBER 2024
Venue : The Pride Hotel, University Road, Pune - 411005

TOPICS

- Sustainability in Die casting Industry
- Die Casting Technologies in New Mobility
- Business Strategies for Growth
- Skill Development
- Digitalization & AI
- Innovation in Die Casting Technologies

EXHIBITION LAYOUT



Stall Details (Non Ac)

Stall Area	Stall Size	Total Stall	Total Sq. Mtr.	Constructed Stall Facilities	Rate (Rs)	Rate USD
6 Sq. Mtr.	2m x 3m	24	144	1 Table, 2 Chairs, 3 Spotlights, 1 Plug Point, Facia, Carpet, 1 Dustbin One Delegate Free & additional delegates Rs. 6000/- + GST each	40,000/- + GST	825
8 Sq. Mtr.	2m x 4m	2	16	1 Table, 2 Chairs, 3 Spotlights, 1 Plug Point, Facia, Carpet, 1 Dustbin One Delegate Free & additional delegates Rs. 6000/- + GST each	45,000/- + GST	920
12 Sq. Mtr.	L Shape	2	24	2 Table, 2 Chairs, 4 Spotlights, 1 Plug Point, Facia, Carpet, 1 Dustbin Two Delegate Free & additional delegates Rs. 6000/- + GST each	65,000/- + GST	1340
	Total	28	184			

* Exhibitors are free to Attend Technical Conference

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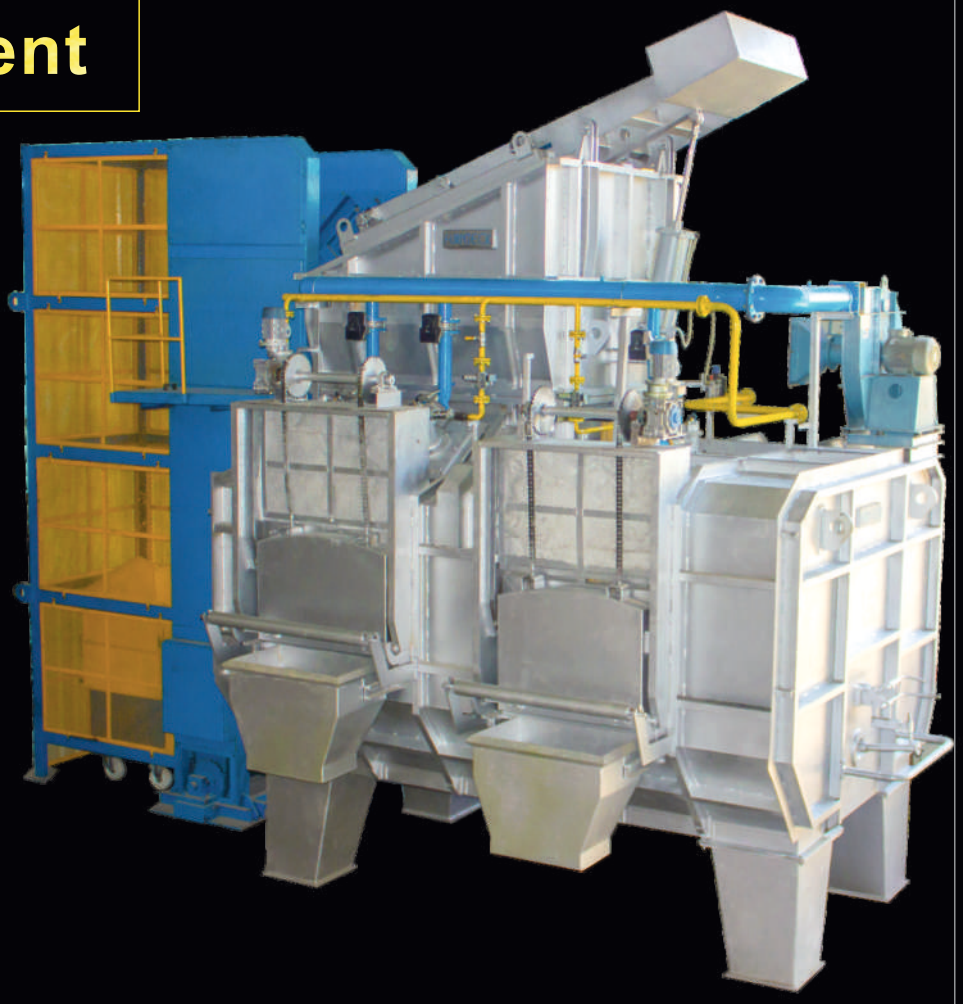

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Ultrasonic Testing

Vishwas Kale, Managing Director, Vijayesh Instruments Pvt Ltd, Pune
vish1945@gmail.com

This method is used for the detection of internal and surface (particularly distant surface) defects in metals. This is based on echo sounding principle. Ultrasound is generated by a piezoelectric transducer. In this method, frequency is usually in the range of 1 MHz to 6 MHz. The velocity of these waves propagation in solids is related to the Young's Modulus for the material. It is characteristic of that material. Ultrasonic energy is considerably attenuated in air. Its beam propagated through a solid will; on reaching an interface (e.g. a defect, or the back wall) between that material and air reflect a considerable amount of energy in the direction equal to the angle of incidence. For testing the oscillating crystal is incorporated in a hand held probe, which is applied to the surface of the material under test. To allow the transfer of energy across the small air gap between the probe and the test piece, a layer of liquid (known to as 'couplant'), usually oil, water or grease, is applied to the surface. The crystal does not oscillate continuously but in short pulses, between each of which it is quiescent. Piezoelectric materials convert electrical pulses to mechanical oscillations, but also convert mechanical oscillations into electrical pulses.

So it is a generator of sound waves as well as a detector of returned pulses. The crystal, when it is quiescent, is in a state to detect returned pulses. The pulse takes a finite time to travel through the material to the interface and to be reflected back to the probe. The standard method of presenting information in ultrasonic testing is by means of a LCD flat screen, in which horizontal movement of the spot from left to right represents time elapsed. The rate of the spot is such that it gives the appearance of a horizontal line on the screen. The system is synchronised electronically so that at the instant the probe receives its electrical pulse the spot begins to traverse the screen. An upward deflection (peak) of the line on the left hand side of the screen is an indication of this occurrence.

This peak is usually termed the initial pulse. Whilst the base line is perfectly level the crystal is quiescent. Any peaks to the right of the initial pulse indicate that the crystal has received an incoming pulse reflected from one or more interfaces in the material. Since the spot moves at a very even speed across the tube face, and the pulse of ultrasonic waves moves at a very even velocity through the material, it is possible to calibrate the horizontal line on the screen in terms of absolute measurement. The use of a calibration block produces a reflection from the back wall a known distance away from the crystal together with variable controls on the flaw detector. This allows the screen to be calibrated in units of distance.

Therefore, determination is possible of origins of returned pulses obtained from a test piece. It is therefore possible to discover a defect between the surface and the back wall, but also to measure its distance below the surface. It is important that the equipment is properly calibrated. It is in itself not able to discriminate between intended boundaries of the object under test and unintended discontinuities. The operator must be able to identify the origin of each peak. Further as the pulses form a beam it is also possible to determine the

plan position of a flaw. The height of the peak is roughly proportional to the area of the reflector. Probing all faces of a test piece not only discovers the three-dimensional defect and measures its depth, but can also determine its size. Two-dimensional defects can also be found but, unlike radiography, it is best that the incident beam impinges on the defect as near to right angles to the plane as possible
warnings.

Using the property that the velocity of sound in any material is characteristic of that material, some materials can be identified by the determination of the velocity. This can be applied, for example in S.G. cast irons to determine the percentage of graphite nodularity.

This process can also be automated and is now in use in many foundries.

Advantages of Ultrasonic Testing

- Testing possible of thickness and lengths up to 10 meters.
- Determination of position, size and type of defect is possible
- Quick test results.
- Portable.
- Can be made very sensitive if required.
- Can be fully automated.
- Access to only one side of test sample needed.
- No consumables.

Limitations of Ultrasonic Testing

- Permanent record or data logging possible only if such software systems are used
- Indications require proper interpretation
- Very thin sections may be difficult to check

However, it is worth using this technique!

Articles for GDCTECH Journal

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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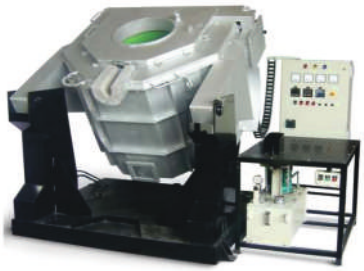

Electrical Hydraulic Tilting Furnaces

Nitrogen Degassing Machine (auto)

Density Index Unit

Other Products for the Aluminium Industry

- Electrical Furnaces (Crucible)
- Fuel Fired Furnaces
- Electrical & Fuel Fired Tilting Furnaces
- Heat Treatment Furnaces
- Rotary Degassing Unit
- Density Index Unit

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GDCTECH's INDUSTRY VISIT – SIGMA ENGINEERED SOLUTIONS – A SMART FACTORY

Sometimes feedbacks on factory visits are restricted to "it was just the usual stuff", "nothing different", "it was all buffed up", etc. In contrast, we were awestruck by the recent factory visit organized by GDCTECH to SIGMA ENGINEERED SOLUTIONS.

The visit was organized on May 7th 2024. GDCTECH did flawless communication regarding initial announcement of the visit, members' registration for the visit, sending regular reminders and required instructions as per the company rules.

25 members of GDCTECH registered for the visit. Everyone assembled at the entrance of SIGMA Electric, exactly at 9:45 am. SIGMA's security personnel escorted all to company's conference room, where excellent arrangements were made by SIGMA for the initial orientation.

Adorned with safety gears we all hit the floor right after the orientation. For the next three to four hours we all were spellbound by SIGMA's excellent implementation of Total Productive Maintenance (TPM).

SIGMA started their journey of TPM in 2018. Today, the entire plant is well organized, fully connected, mostly paperless, mistake proofed (poka-yoke), clean, safe- no accidents in last whole year, well communicated with electronic displays, and 100% employee involvement.

From initial 70-75% OEE at TPM kickoff, almost all SIGMA's machines are now at 85-90% OEE. We witnessed at least 3 to 4 line improvements where ergonomics of line operator was the main focus. To list a few, mechanism was designed that will raise the pallets up automatically as the operator consumes components from it (saving operator bending), good air ventilation throughout the floor to save operators from scorching heat, etc. The entire plant is well marked with walkways and signs. We were shown a state of the art training room for operators where one could see different training videos on a big LCD projector and also physically see and try out various cut sections, switches, wires, sensors, that they have to handle while working on a machine.

We could witness TPM in every employees working habits at SIGMA. Process ownership was percolated from management to the floor personnel. "Your machine, your responsibly" is followed by everyone at the floor. Interestingly, we could see posters of superman, Barbie doll, cute cartoon fish displayed on machines to increase visibility. Surely it helps a bit to keep the employees happy.

MMM – Manager Model Machine

In implementing TPM, 'resistance to change' pops up as a hurdle, which is a basic human mentality. To overcome this, SIGMA's managers decided to trickle down the TPM from top to bottom in the organization. An oldest machine (23 years old) with plethora of problems and worst OEE, was chosen as MMM (Manager Model Machine). Managers from all departments worked on that machine diligently and improved its OEE significantly. Once everyone saw that managers are folding up their sleeve, getting on the floor and whatever they did actually improved OEE of the machine; building trust for TPM in their minds became much easier. One by one all the machines, workstations, departments and the entire plant were added to TPM.

The visit started at plant-1 and ended in plant-2 couple of kms away. Both the plants were equally impressive. Around at 1:30pm, the visit was concluded with Q&A session, a thank-you note by Shri R. T. Kulkarni and felicitation of the SIGMA team by Shri Bajrang Lohia, with a memento as a token of appreciation. It was followed by tasty lunch buffet arranged by SIGMA.

After the lunch, all of us departed with fresh ideas in our minds, for making businesses SMART and in effect more profitable.

GDCTech Crossword #2
The Cue: HPDC

Solution to GDCTECH Crossword #2 - Ref: April 2024 Issue

B								C	O	L	D	C	H	A	M	B	E	R	
I	H							H				L			O		X		
S	E							I				A			V		T		
C	A	V	I	T	Y	F	I	L	L	T	I	M	E		I		R		
U	T	A	N			I		L				P			N		A		
I	E	C	J			X		V			F	I			G		C		
T	X	U	E			E		E			I	N			H		T		
I	C	U	C			D		N			L	G			A		O		
E	H	M	T			H		T			L	F			L		R		
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	R	A	C	C	U	M	U	L	A	T	O	R							I
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.....

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- Casting movements only through conveyers or AGVs.
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- Training room / DOJO room for operators Training
- Implementation of Industry 4.0

- Minda Industries Ltd has set up fully integrated manufacturing facility for Alloy wheel 2 wheeler.
- Facilities include state of art infrastructure for Foundry, Machining and Painting (Powder Coating & Liquid Painting) providing one stop solution
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- Location: Supa Industrial Area- 86 KM from Pune Airport
- Land: 20 acres
- Built-up: 24000 sq. mtr.
- Capacity: 4 Million Wheels p.a. , expandable up to 6 Mn


Robotic CNC Cells


Smart Conveyers


Auto Storage System


Product Portfolio

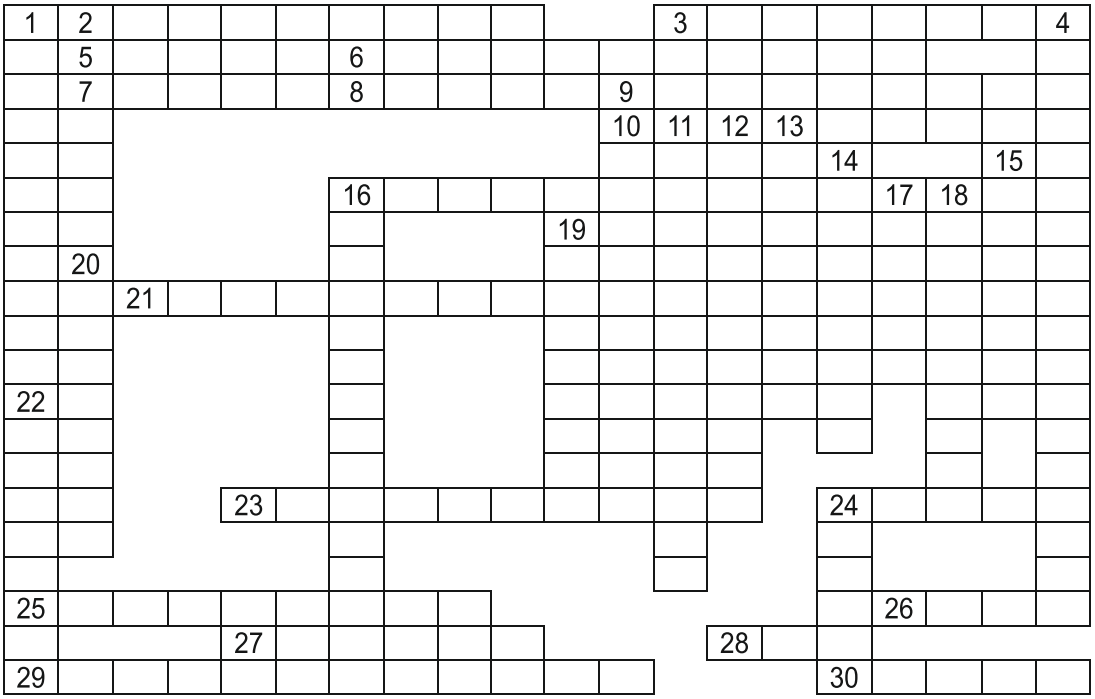

AGVs


CNC Robot


Pouring Robot

GDCTECH CROSSWORD #3
The Cue: Dies and Moulds

Compiled by: Pramod Gajare Consultant (pramodgajare2013@gmail.com)



Clues Along:

1) This is directly adjacent to the gate.
3) They generate holes in the casting.
5) The least area in pressurised gating system.
6) In most of the cases these are placed in moving half of the die.
7) It never runs.
8) It feeds the molten metal to the casting and helps to reduce shrinkage.
9) This holds as well as actuates the cores.
13) A passage connecting runner or overflow with a die cavity.
16) A die with two or more different cavities producing different parts.
21) A core used primarily to reduce the amount of metal in the casting and to avoid section with excessive thickness.
23) An arrangement designed to remove heat from the die or from specific region within a die.
24) This is used in the die cavity to produce local chilling for increasing the solidification rate.
25) This houses the die cavity.
26) This forms a hollow region in the casting.
27) Curved juncture of two surfaces that would otherwise meet at a sharp corner.
28) The preciseness with which two parts must be fitted together.
29) This holds and also actuates the ejector pins.
30) Ratio of casting weight to the input weight.

Clues Across:

1) Passages to and from the cavity through which the molten metal must flow.
2) These help to remove air from the cavity.
4) The parting line that changes suddenly from one level to another.
10) Through this the metal enters the cavity from the centre of the part.
11) The maxim um taper that is allowed by the casting's specifications.
12) Most common type of heat sink.
13) These ensure registry between two die halves.
14) These are used to assure correct registry between the parts of the die.
15) This block of steel forms a base for the die casting die.
16) A passage in the die to circulate cooling media.
17) This joins the gooseneck to the sprue hole.
18) The vertical feeder system.
19) A recess in a die connected to die cavity by a gate remote from the ingate.
20) This reservoir is designed to reduce turbulence and air aspiration.
22) In most of the cases ejector pins are placed in _____ _____ half.
24) A recess in the die in which the casting is formed.

Top Performance for Structural Parts

Oskar Frech GmbH + Co. KG, Schorndorf

Oskar Frech GmbH + Co. KG and Spartan Light Metal Products, USA are joined by a trustworthy collaboration in diecasting technology.

Spartan Light Metal Products, headquartered in St. Louis, Missouri, USA is one of the world's leading manufacturers of aluminum and magnesium components for diecasting. The company's three production plants in the USA (Hannibal, Mexico, Missouri and Sparta, Illinois) demonstrate exceptional expertise when it comes to conventional diecasting and mechanical processing lines, assembly and dies for producing products for the automobile industry and consumer goods. Some of the company's renowned customers from the automobile industry include Toyota, GM, Ford and Honda.

The collaboration between Spartan Light Metal Products and Oskar FRECH traces its roots to the 1970's. A number of hot chamber machines for magnesium components was delivered in 1979. In recent years, Spartan has been equipped with various products and technologies from the FRECH Group, such as temperature control technology from the Austrian Oskar FRECH subsidiary Robamat.

Spartan's expansion into structural parts

In order to ensure future competitiveness and the further strategic development of the company's product/application portfolio, investment in structural part production was seen as having great potential for growth.

Construction of the 4th plant in Mexico, Missouri, USA was officially announced in January of 2018. Ground-breaking for a new 135,000 square meter building with its own production facilities for multiple, fully-automated diecasting cells, including processing and logistics, for the production of ready-to-install structural cast components followed in August of 2018.

Image: New hall in Mexico, Missouri, USA

This new, highly modern infrastructure will help to fulfill the requirements of OEMs for CO2 reduction through lightweight construction using diecasting applications in Al/Mg structural parts. The goal is to actively engage in the growing market for new components of electric drives.

In the first expansion stage, complex aluminum structural parts will be produced for the vehicle manufacturers.

Image: Fully automated cell (front view)

Image: Fully automated cell (rear view)

The first GDK4100S diecasting cell with 44,000 kN locking force was successfully commissioned in October of 2020, following a construction period of only 8 weeks to start of production in the plant. Challenges and travel restrictions due to the corona virus had no effect on the construction time. Integrated worldwide with highly qualified on-site personnel and online remote support for global assistance, FRECH USA Service enabled smooth construction of the GDK4100S.

Image: Successful machine acceptance on site

The second GDK4100S diecasting cell is currently being delivered; SOP is scheduled for early 2021.

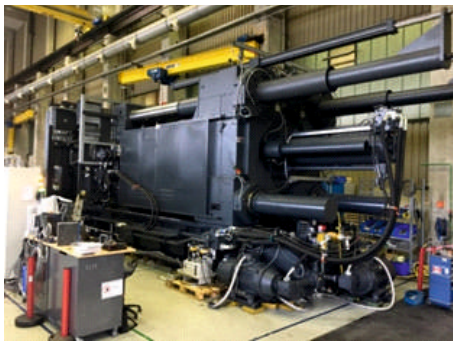


Image: Function test of the second GDK4100S diecasting machine at Oskar Frech in Germany

Convincing FRECH performance

The casting unit was given high priority in the machine selection process. The performance of the 2100 kN, real-time controlled casting unit from Oskar Frech provides maximum flexibility for structural, chassis and engine components. Its properties make it particularly well suited for thin-walled and thick-walled components. Chief among these convincing dynamic properties are the acceleration of ≥650 m/s² for magnesium and a maximum velocity (V2) without metal of up to 11 m/s.

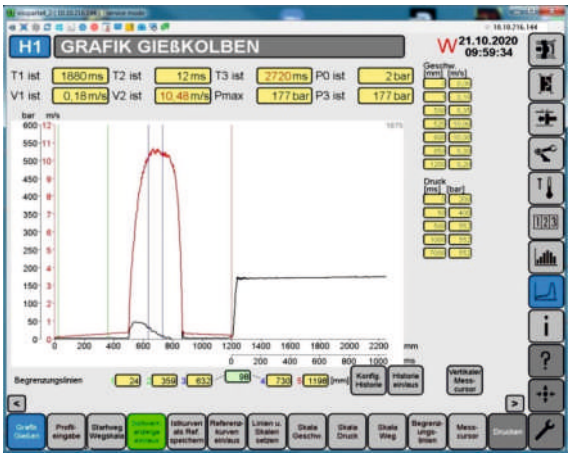


Image: Velocity performance GDK4100S

Low accelerated masses allow hardly any pressure peaks as well as short pressure rise times of 20 ms at maximum specific die pressure, as a result of the interior intensifier through which flow occurs. These technical properties, among others, were crucial decision-making criteria in favor of FRECH.

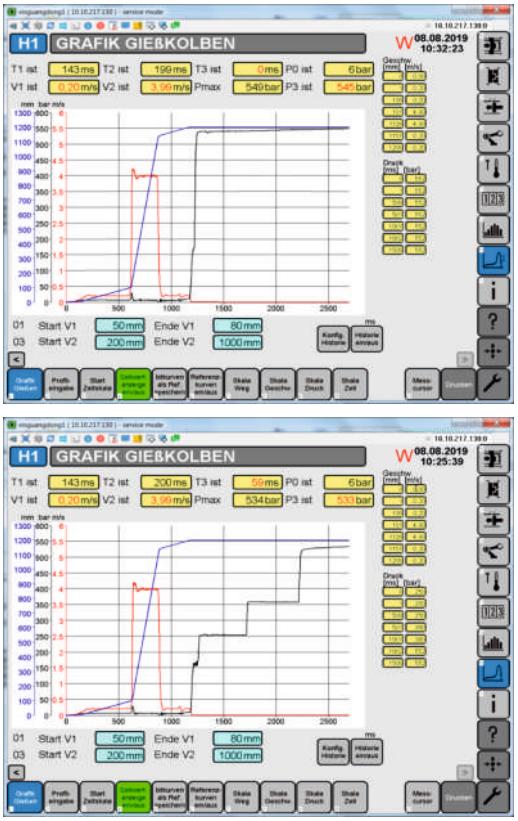


Image: Pressure performance GDK4100S

A patented and optimized hydraulics concept, which reduces the number of valves in the new machine generation of the GDK series by up to 30% and also has a very quiet FC drive, enables easy maintenance with the best possible accessibility and energy savings of up to 50% compared to the previous series.

Image: The first model GDK4100S diecasting machine was commissioned

The combination of a high-resolution position sensor system and rapid processing of the high-end real-time control with the fastest runtimes enables the GDK machine to have unparalleled and high repetition accuracy as well as process stability at a machine capability of cmk ≥1.33.

The locking unit of the 3-plate GDK series, known around the world as especially robust and reliable, also ensures a low TCO over the long term.

Efficiency with high system availability

In addition to quality and process stability, powerful productivity of every system component with a high degree of availability in continuous operation is required for economic success. This prerequisite is particularly fulfilled by the robust heart of the system. The optimized kinetics/kinematics of the locking unit's 3-plate design allows for shorter overall lengths than in the case of 2-plate machines already on the market, despite the knee joint. Among other things, the tank volume required for operating resources could be halved as a result of innovations in hydraulics. Opening and closing times of less than <13 sec as well as permanently high availability are achieved, even in machines used over many years.

Image: Tank area

Variables influencing casting parameters are compensated with repeatable accuracy via the controlled casting unit. The tolerances of the casting process and all quality-related process parameters are permanently monitored.

With state-of-the-art equipment, the installed systems fulfill the necessary prerequisites for the future successful growth of Spartan Light Metal Products with challenging new applications from the fields of e-mobility and structural casting.

As a result of the close collaboration by Spartan with powerful partners, the customer's requirements for the complex casting cell concept were able to be met in nearly turnkey fashion. Open communication combined with trust and a high level of engineering expertise were the success factors here.

We wish Spartan Light Metal Products great success with their new, fully automated diecasting cells.

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CONGRATULATIONS

SIGMA ENGINEERED SOLUTIONS

Sigma Pune Unit II, Unit III and VKIA Jaipur received prestigious JIPM TPM Excellence Award at International Business Center, Kyoto, Japan

I am would like to share with you a significant accomplishment of Sigma Pune (Unit II, III) and Jaipur VKIA while taking a big leap in the journey of excellence. Sigma India's three units which consist of 6 plants challenged Global award of JIPM (Japan Institute of Plant Maintenance) for the year 2023.

The details of Units and Plants are:

- Unit II Pune – A2/A3 Plant
- Unit III Pune -A4 Plant
- VKIA Jaipur – J0, J1, J2 and J3 plant

On 20th March,24 Sigma Unit II, Unit II and VKIA Jaipur received JIPM TPM Excellence Award at International Conference Center, Kyoto, Japan.

As a part of Award process there are two assessments (Stage 1 and Stage 2) carried out by JIPM assessors from Japan. Stage 1 and 2 assessments were conducted by distinguished and senior assessors from JIPM- Japan

- Jaipur VKIA by Prof. Testsuo Miyamura and Prof. Kimio Ishikawa
- Pune unit II by Prof.Shigenobu Nomura and Prof. Hiroshi Takano
- Pune unit III by Prof. Shigenobu Nomura and Prof. Hiroshi Takano

Team at Pune and Jaipur has put up focussed efforts for last five years to achieve this milestone.

GREAT DIE CASTING TECHNOLOGY FORUM

"GDCTECH's Coffee-TALK", with ActionCOACH. Month of May 2024.

On Saturday, May 25th, GDCTECH arranged its monthly coffee-TALK after a break of few months. This month's speaker was Shri. Sanjay Chaturvedi, a highly experienced person in the business coaching field. The talk was attended by 25-30 people.

Mr. Chaturvedi has coached over 300+ businesses in past 14 years. His enthusiasm and style of presenting kept the audience involved, motivated and smiling all the time.
The topic was "6 ways to make a profitable business system". The training on this topic by ActionCOACH is a journey of an employee / manager / business owner from excuses, denial and blame; to ownership, accountability and responsibility.
He started with the definition of a successful business. It was penned as "an commercial, profitable enterprise, that works without you!". Mr. Chaturvedi guided the audience in a very fantastic, enjoyable and understandable way to acquire this goal.

The whole lecture is available on internet at below link...
https://youtu.be/ZAikDB83eD8?si=KEzmjLS_OLSfmETN

GDCTECH's coffee-TALK is planned every month on the 4th Saturday. We welcome all GDCTECH members and their friends to attend this FREE session; not just to hear the amazing speakers, but also to enjoy our tasty coffee :)

Advait Athavale
Chairman Coffee-TALK committee
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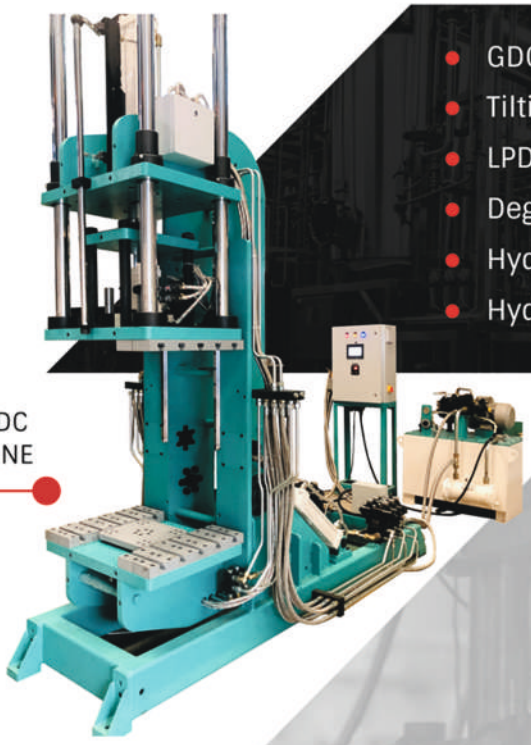

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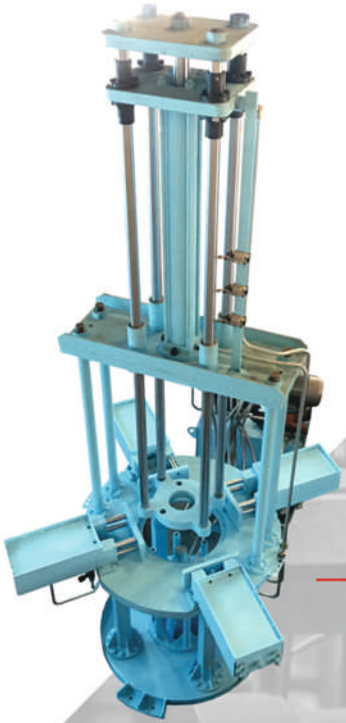

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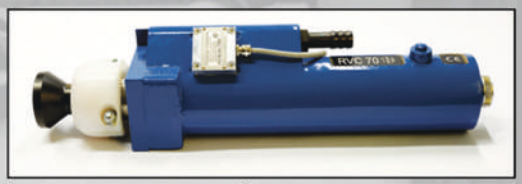

Address : Gat No. 228, Barane Wasti, Behind D-Mart Mall,
Moshi - Dehu Road, Moshi, Pune - 412105. MH. India.
Mobile : +91 93251 96727 / 98236 71338
E-mail : pramod.j@jbengineering.co.in, rahul.b@jbengineering.co.in

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