Session Chairperson
Hirokazu Hayashi (MINO Industry Co.,Ltd)

JD26-18

The Application of Laser Technology in Die Casting

DAIICHI JITSUGYO CO., LTD. ● REITO KOBAYASHI

Using laser cutting machines capable of cutting thick aluminum helps optimize the casting process and improve furnace efficiency. The possibility of cutting thick sections now enables not only gate cutting but also the fine cutting of main runners and long overflows. It is now possible to feed return material from the casting process back into the melting furnace in a finely broken state. We propose the benefits of improved melting efficiency through increased material filling rates in the melting furnace and process simplification via a combined laser machine equipped with functions beyond gate cutting.

JD26-19

High-speed, high-precision in-mold dynamic displacement sensor and analysis software for analyzing defect mechanisms in die-casting dies

KMC.inc ● Seiki Sato Ph.D. Shinichi Abe Ph.D.

In die-casting manufacturing, casting defects and faults such as porosity, cracks, poor casting surface, and poor flow are the biggest problems. Currently, post-casting corrections have become a routine process, hindering profits. While previous engineers have worked to identify these defects and faults, the underlying mechanisms remain a mystery. While it has been said that 70% of defects and faults are caused by the mold, the high pressure and high temperatures inside the mold exceed 700°C create a need for a sensor that can visualize the mold interior under these adverse conditions. This section introduces a wireless in-mold sensor with simplified wiring that can measure the pressure, temperature, and mold opening status with high speed and precision. Installing this sensor inside the mold enables dynamic displacement measurement within the mold during mass production. In addition, combining it with a thermosensor that monitors the surface temperature of the die-casting mold allows for visual sensing from both inside and outside the mold, thereby elucidating the mechanisms behind casting defects and faults.

JD26-20

Simple testing method for ductility in aluminium alloy diecast - punch fracture test

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Haruka Miyake
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Toyota Industries Corporation Ryosuke Sato, Hisao Kamiya
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DENSO CORPORATION Naoto Uesaka

Structural parts for vehicle bodies must be designed to ensure sufficient safety during use, which necessitates product quality and control not previously required of aluminium alloy die-casting. However, products manufactured by die-casting tend to include uneven complex material structures and/or casting defects due to the material composition, molten metal flow, and complex solidification process. The die-casting tends to have poor ductility and considerable variability in product properties, making quality control challenging. In this study, we focus on punch fracture testing, which allows specimens to be easily extracted from products and is expected to be applicable to in-line product control. The results of a punch fracture test conducted as collaborative research by the Non-Ferrous Casting Research Group in the Tokai Branch of the JFS are presented and the characteristics of the test method are also mentioned.

Session Chairperson
Kazuhiro Koike (Akiba Die Casting.Co.,Ltd)

JD26-21

Direct Observation of Flow Behavior during Plunger Advancing and Gate Ejection in Aluminum Alloy Die Casting

Daido University ● Yuki Seo, Yukiya Tanaka, Yasuhiro Maeda, Dr.Eng.
Ryobi Limited Akihito Hasuno, Dr.Eng. Yasushi Mochida

The flow behavior of molten aluminum alloy in the sleeve changes when conditions such as ladle tilting speed and plunger advancement speed in die casting change. The authors used the SPH particle method, which takes into account the oxide film on the molten aluminum alloy, to investigate the flow behavior in the sleeve during ladle pouring and plunger advancement through both experiments and simulations. However, previous studies focused on visualization of the flow in the sleeve. In this study, in addition to investigating flow behavior in the sleeve, an experimental device was modified to enable simultaneous visualization of the sleeve and cavity, and the influence of several flow behaviors in the sleeve on cavity injection behavior was investigated. This enabled the flow results to be observed from a different perspective than when using a water model or when visualizing the flow in the sleeve and cavity separately.

JD26-22

Automatic Construction of Die Casting Quality Evaluation Indices Using Numerical Simulation Results

Hitachi Industry & Control Solutions, Ltd. ● Ph.D. Naoya Hirata

This study proposes a method for automatically constructing quality evaluation indices for die casting processes by utilizing numerical simulation results. Originally, Ozaki et al. at Okayama Prefectural University proposed a framework to automatically generate quality evaluation indices by mechanically and statistically linking CAE analysis results with product inspection data. In this study, while retaining their approach as the basis for factor selection, manual factor selection is additionally introduced to enhance interpretability and research novelty. The effectiveness of the proposed evaluation framework for improving the quality of die casting products is investigated and discussed.

j-dec Session Chairperson
Ph.D.Naoya Hirata (Hitachi Industry&Control Solutions,Ltd.)

JD26-23

Erosion-resistant clad metal for Al die casting industry

Vision tech ● Hong MyoungSoo
Champion Korea Kim KyoungHun

Damage to shot sleeves and plunger tips during the aluminum die casting process and their solutions.
A desirable shot sleeve must have the following characteristics,1) no thermal deformation, 2) small leaching rate by molten aluminum, and 3) the ability to control breakage chill.
Shot sleeves made of SKD61 have a significant amount of residual stress, which causes plastic deformation that give rise to a banana phenomenon in the process of repeated molten metal pouring. Large deformation occurring at the feed port causes the molten metal to flip over due to the vibration of the plunger tip operation, which results in inclusions being mixed into the product. To solve these problems, the reinforcement of shot sleeves and plunger tips by clad metal technology is proposed. Features of Clad Metal Technologies are:
1 It is an economical method of molding and sintering in various ways, such as using metal powder as a paste or attaching a flexible sheet.
2. Coating with W-Co-Cr and Mo-Co-Cr, and these alloys have higher value for money than repairing with Stellite® alloys by welding.
3. The alloy has very low wettability with aluminum, with $\theta>120°$, and very low reactivity, making it highly resistant to leaching.
4. It suppress the banana phenomenon of the sleeve.
5. The same technology can be expanded to squeeze pins, runners, insert molds, and sprues.

JD26-24

Estimating inclusion quantity from the measurements of DI and dissolved hydrogen for Al melt

PSS Inc. ● Chong Ook PARK
FUJI BC Engineering co., Ltd. Manabu ITO

The major types of defects present in molten aluminum can be classified into two groups: (1) substances in a dissolved state, such as hydrogen or sodium, and (2) substances in an independent solid phase, such as various inclusions of Al_2O_3, $MgAl_2O_4$, AlN, Al_4C_3, and AlB_2.Hydrogen dissolved in molten aluminum, which leads to porosity defects in aluminum castings, can be measured using thermal conductivity–based (Alscan) or, solid-state electrochemical(AlproH) methods. Alternatively, reduced pressure testing (RPT) is widely used in industrial environments to estimate the level of dissolved hydrogen. However, quantifying the amount of inclusions remains a challenging task. Several techniques have been developed for this purpose, including PoDFA (Porous Disc Filtration Analysis), LiMCA (Liquid Metal Cleanliness Analyzer), and the K-Mold test etc. Despite their effectiveness, these methods are often expensive, time-consuming, require specialized equipment, and are difficult to implement in routine factory operations.
In this paper, we propose a method to estimate the inclusion content in molten aluminum using measurements of hydrogen concentration (S) and density index (DI). Based on these parameters, a cleanliness diagram was constructed to represent melt quality as a function of hydrogen concentration(S) and DI. Finally, the proposed model was validated by comparing the hydrogen concentration (S) and DI values measured before and after the degassing process, as well as through cross-sectional microstructural observations of the specimens.

JD26-25

Intelligent adaptive straightening systems for structural castings no heat treatment = no distortion?

Zenith Engineering Co.,Ltd. ● Kentaro Higaki
Laubinger + Rickmann GmbH & Co. KG Philipp Hettich

Usage of Al castings is increasing for large, complex, structural parts. Most structural castings are made from AlSi10MnMg-T7 for best flow, thinnest walls and high elongation. However, most Gigacastings are made of AlSi7MnMg alloys in F plus Paint-Baking. A general misinterpretation happens: no heat treatment equals no distortion. Besides solution heat treatment, distortion can occur due to unbalanced solidification, sticking during ejection, quenching, worn tooling etc., and this causes variation. Straightening in a trim press is difficult, as it would require no variation and no torsion. Therefore, our intelligent automatic straightening system has been developed and over 160 machines have been installed globally. With self-learning algorithms, it can both measure the part and then straighten the part optimally to meet tolerance requirements. This presentation will show the challenges of distortion in large castings.

j-dec Session Chairperson
Masaaki Koiwa (SHIBAURA MACHINE.CO.,LTD.)

JD26-26

Mechanism of laminations occurrence in hydraulic control components for automobiles

OSAKA CYUO DIE CASTING CO., LTD ● Shigeki Kanda

One of the defects with die casting is the laminations after shot blasting. There are many problems with laminations. For example, it is difficult to detect laminations immediately after die casting and there is a possibility that laminations peel off and cause a malfunction after assembled the parts. Therefore, it is difficult to take measures against leaks and it is necessary to take preventive measures. In this study, focus on the laminations in hydraulic components for automobiles. We conduct prototypes under various casting conditions and consider the mechanism of laminations occurrence.

JD26-27

Improvements to enhance the service life of Ti matrix composite shot sleeve

TYK CORPORATION ● Sadayasu Takayama,Shinji Kajita
Akihiro Katoh

Our Ti matrix composite shot sleeves feature excellent heat retention property. The sleeve contributes to improved quality and yield in aluminum alloy die casting by reducing cold flakes. Currently, the most important issue regarding the life of the sleeve is damage caused by heat checking at the impact area of hot metal. This becomes particularly noticeable when the machine size is large. While the improvement has been seen by implementing cooling structures, the effect remains insufficient. This time, we will verify the difference in cooling effectiveness based on the timing of cooling water flow. Additionally, we propose a new material structure at the impact area of hot metal as a countermeasure against damage caused by heat checking.

JD26-28

Defect case study and the mechanism to vacuum die casting in ADC12

RYOBI LIMITED ● Yasuyuki Mizukusa
Masaki Fukushima, Anzu Ii

The cause of the leakage defect is the contamination of the heterogeneous mass. And the heterogeneous mass of unknown to conventional knowledge is increasing. The factor was estimated to be the pre molten metal flow that occurs during vacuum drawing, which is unique to vacuum die casting. As verification of this, we made a sample of the short shot and investigated it in detail. Then, it was not caused by the scattering molten metal. There is a possibility that the pre molten metal will conflict with the gate mold and then move into the cavity after being quenched. Here are some examples that were estimated to be high possibilities. In addition, the conditions under which the vacuum pre metal flow can be reduced are indicated.
In addition, we introduce another defective pre metal flow unique to vacuum die casting, and the contents of the investigation of the cause and the results of the analysis are introduced. And we introduce examples of countermeasures.