Die casting paves the way **for the body-in-white of tomorrow.**

A revolution is taking place in the automotive industry. Instead of assembling a large number of stamped individual steel parts, a few aluminum castings are replacing large parts of the vehicle body. This saves weight, costs and leads to a more sustainable overall balance of the vehicle. However, this presents foundries with completely new challenges. These can be mastered with an optimized die-casting cell.

Significant advantages and new potential

Aluminum die casting opens up completely new possibilities in the production of the body-in-white. The process becomes simpler and faster because joining processes such as welding, gluing or riveting are no longer required. Experts also reckon that up to 300 robots per production line can be eliminated. Taken together, this means that up to 30 percent less production space is required. The cost savings resulting from die-casting production are considerable, and investment costs are reduced.

In addition to time, space and cost advantages, other attractive potentials are opening up. By using secondary aluminum or primary aluminum obtained with renewable energies, casting can become virtually CO2-neutral, which improves the sustainability of the entire vehicle. With die-casting production, a reproducibly higher component quality can also be achieved, and the joining precision of the overall structure is higher.

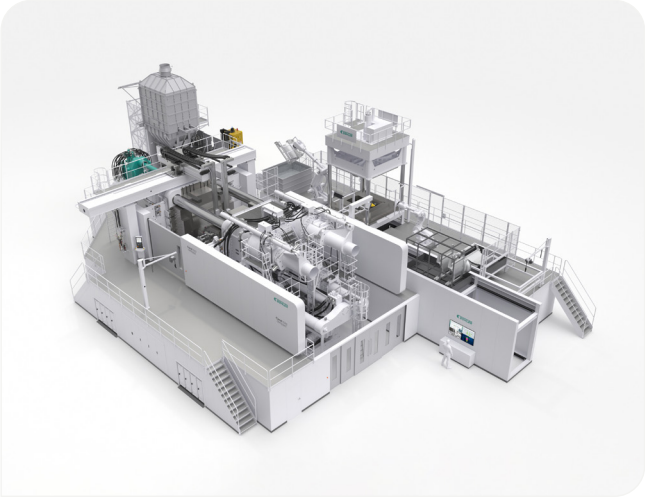
Holistic new approach

The production of ever larger vehicle body parts by die casting is pushing back the boundaries of what was previously known. From component design to alloy selection, melting, dosing, tempering, spraying, casting, removal, cooling, deburring, marking, and final handling of the parts, processes must be reconsidered and thought through as a whole. Bühler Die Casting therefore not only supplies the right die-casting machines, but also guides customers worldwide to the right solution including the complete die-casting cell and its integration into the entire body shop.

Component design as a decisive factor

The basis for efficient production is already created in the planning phase with a component design suitable for die casting. If the casting process uses less pressure and a lower filling speed, this increases the die service life and reduces the costs per component. This is because die costs are a cost driver, especially for such large components as a vehicle rear underbody. Irrespective of this, attention must also be paid to unavoidable wear. Clever segmentation of the die, for example with exchangeable inserts at points subject to higher stresses, enables targeted, selective replacement of worn die parts.

Costs can also be saved with self-hardening alloys, typically $AlSi_7MnMg$, $AlMg_4Fe_2$ or similar. Cast components thus already meet the mechanical requirements as-cast, so that additional heat treatment to improve the microstructure can be omitted.



Carat 840 cell with human for scale:
The die-casting cell for body-in-white production is gigantic: The picture shows the size ratios compared to a human being.

Metal feeding in large quantities

Whereas in a traditional foundry the molten metal used to be delivered by forklift truck from the smelter, which is usually located in an adjacent building, the new dimensions of the body-in-white production require new approaches. A shot weight of 100 kg and cycle times of around two minutes define a melting requirement of around three tons of metal per hour. Today, this corresponds to the hourly demand of a medium-sized foundry with seven or eight machines. This suggests placing the melting furnace in the immediate vicinity of the machine and integrating it into the cell in the best possible way. With such an arrangement, the return material can also be melted directly in the cell. This conserves resources because the transport routes for the material are kept as short as possible.

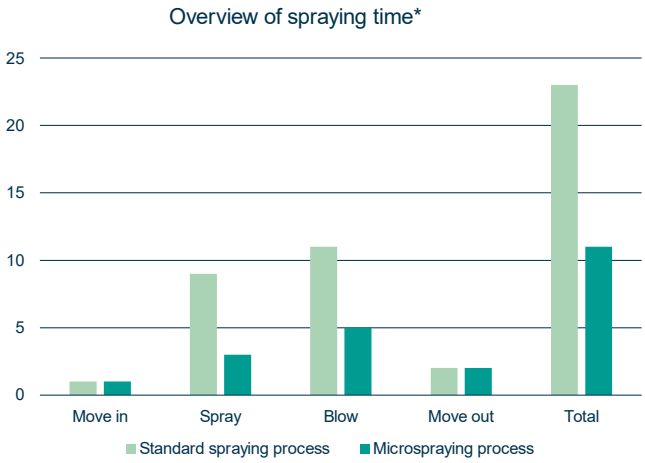
Challenging tempering of the die

Complex, large-format geometries place high demands on temperature control within the die, because parts of consistently high quality can only be produced with precisely controlled, reproducible temperatures. The ‘classical’ way of increasing the number of temperature control units per die side is not very practical and hardly economically viable. The multi-zone temperature control system used by Bühler, on the other hand, reduces the number of heating and cooling units required and thus the complexity of the control. In conjunction with temperature and flow monitoring, it is also possible to determine the amount of energy which is discharged from the die per circuit. This allows a balance to be set, which is essential for a constant, stable casting process.

In close cooperation with die makers and the specialists of the temperature control unit manufacturers, the ideal number of temperature control circuits for the respective die is determined, thus minimizing the number of units required. Quick couplings between the temperature control units and the die also ensure that die changeover times are reduced.

Efficient spraying

Spraying has a major influence on the cycle time. Large dies, the long travels of the spray arms and the opening stroke of the machine require that attention be paid to the thermal balance of the die, already in the design stage. The better the thermal balance is already controlled via the die and its cooling channels, the more likely it is that significant time savings can be achieved with solutions for targeted microspraying.



*depending on the thermal balance of the die, the spraying time can vary

Microspraying reduces spraying time and saves release agent, compressed air and water.

In combination with optimized, internal die cooling, the use of the microspraying technique is recommended. Since the die no longer needs to be cooled by the spraying process, it is sufficient to apply only a thin layer of release agent. This recognizably reduces the spraying time and saves release agent, water, compressed air and thus energy. At the same time, the die service life is significantly extended.

Dynamic casting process

Finally, the casting process itself is the central element of the die-casting cell. If components the size of a rear underbody are to be cast in one piece, care must be taken at the design stage to design the wall thicknesses in such a way that the die can be filled at all. This is because, depending on the component, the liquid aluminum must overcome a flow path of up to three meters.

In order to achieve complete die filling, the injection unit requires enormous force, with the dynamics of the second phase being particularly decisive: In order to keep filling times short, ingate speeds of over 40 m/s are necessary. A quality-determining factor here is that this speed must be kept constant over a longer period of time, even when the process parameters are changed. Bühler therefore controls the injection unit in real time so that the same ingate speed is always maintained even with the smallest changes in temperature or feed rate, thus ensuring the same filling time.

Moreover, the forces at the end of the filling process, which could result from the piston hitting the filling opening, should not be underestimated. If the resulting pressure peak is not absorbed, the opening force of the liquid metal can exceed the locking force of the machine. The die then opens, the metal splashes out and the dimensional accuracy of the components is lost. Therefore, the braking action of the piston at the end of the filling process also determines the quality. With a hydraulic system pressure of 210 bar and the resulting reduced mass of the casting cylinder, the Bühler Carat provides unrivaled dynamics for this purpose: Targeted braking prevents impact and enables die filling close to the injection limit.

The following numerical example can show how challenging this task is: The piston of the injection unit has a diameter of about 300 mm, and together with the piston rod it weighs several hundred kilograms. Within 100 milliseconds, this part must be accelerated so that the die for thin-walled parts with a filling distance of up to three meters can be filled — in order to then brake it abruptly and prevent the piston from hitting the die.

Here, one must not underestimate the metal and air velocity in the casting channel. The shape of a rear underbody, for example, encloses around 30 liters of volume that must be evacuated. To avoid supersonic air velocities, which would increase resistance, large venting cross sections are required. For this purpose, Bühler offers SmartVac, an integrated vacuum system which measures and monitors all relevant vacuum parameters and assigns them directly to the casting process. This allows up to four evacuation points on the die and one point on the casting chamber to be vented simultaneously and independently of each other.

Deburring and recycling

After removal and inspection of the component, trimming usually follows. Due to the large dimensions of the components, classic trimming presses come into question for this. Laser cutting can be an elegant alternative, as state-of-the-art robotics even allow fine trimming of the casting. The downside here, however, is that the investment costs for such a solution are currently still rather high.

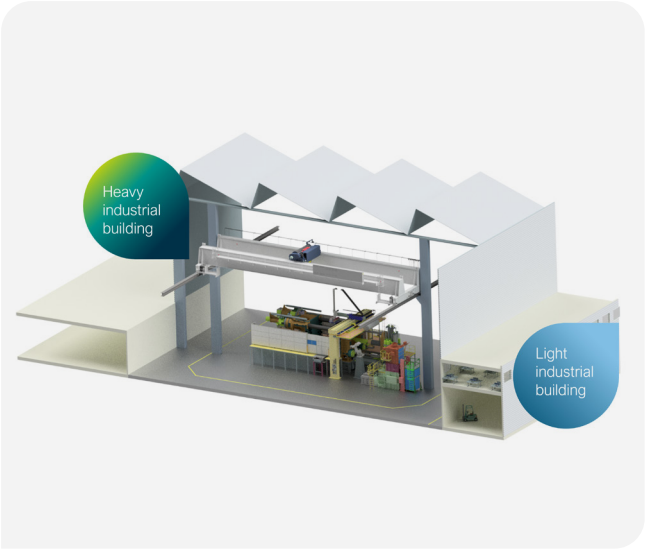
Ideally, the crusher is also located in the die-casting cell. In this way, return material and scrap can be crushed on site and fed directly into the adjacent melting furnace. The return material alone usually accounts for around 40 percent of the cast weight, which can thus be refed into the material cycle within the die-casting cell.

Demanding logistics

The handling of such large components is very complex and can no longer be done by hand. Each process step must therefore be automated, and the removal and delivery to the next processing step — the body shop — must be well thought out. Transport logistics from one location to another, possibly over longer geographical distances, is not practical for components of these dimensions. Shop-in-shop solutions, such as those already successfully practiced by other suppliers to the automotive industry, should be examined here. For foundrymen who then want to produce body components ‘in line’, this may give rise to a new business model.

Separation of the die-casting facility from the downstream processes

With the machine dimensions described above and a machine weight of around 600 t, the die-casting area requires a heavy industrial building and adequate foundation and floor load capacity. Crane hooks with lifting distances of up to 15 m require a building height of 20 m, and die weights of 140 to 200 t require crane systems with a load-bearing capacity of 125 to 160 t. For cost reasons, it makes sense for this purpose to make only the necessary area of the hall suitably accessible, because a light industrial standard is sufficient for the processes downstream of die casting.



Overview building:
A well thought-out concept for the separation of buildings for heavy industry and light industry is essential to save costs.

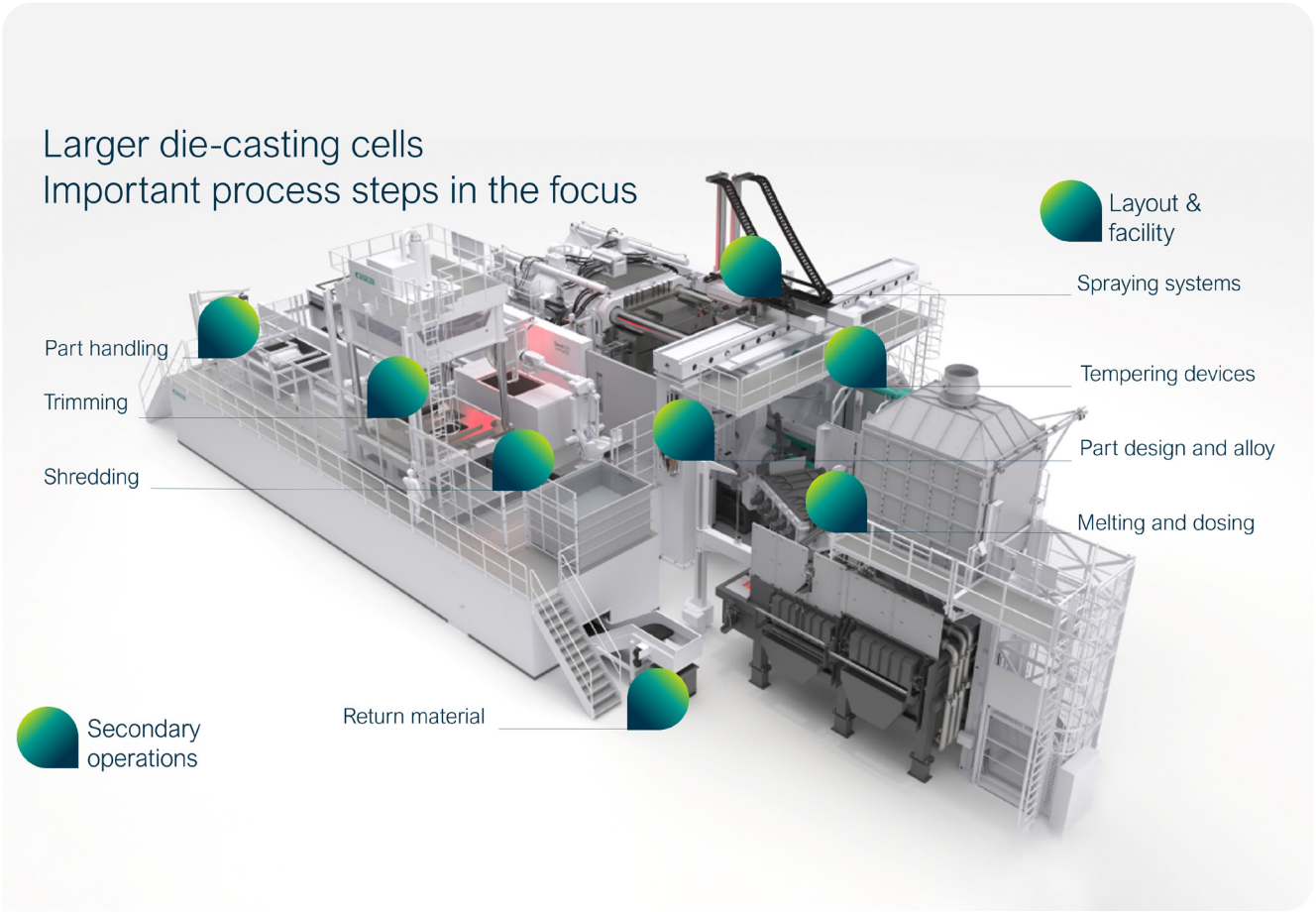
Bühler as a partner

New, larger die-casting systems make it possible to produce the entire rear or front underbody in one piece. This enables automakers to simplify production, reduce costs and create a more sustainable vehicle overall.

As the market leader for large die-casting solutions — with a market share of over 50% of the installed base — Bühler knows the needs and challenges of the industry better than anyone else.

The company supports its customers in the design and engineering of complete cells and supplies the customer-specific, holistic solution. This includes the optimization of cell design, processes, and workflows, digital integration into production control and planning, and the integration of peripheral equipment and the melting furnace. In addition, Bühler provides advice on part design, alloy selection, process simulation, die development, engineering, robot simulation, and even overall process optimization up to the body shop. Experienced technicians ensure smooth commissioning and training of the employees at the die-casting cell.

Production sites and technology centers in Europe, Asia, and the US, as well as more than 100 service stations distributed worldwide, guarantee proximity to customers and perfect support over the entire service life of the plant.



Die-casting production in the spotlight :
The die-casting process includes melting - dosing - tempering – the die - spraying - casting - removal - cooling - deburring - marking - parts handling.

Two-platen technology

Increasingly complex and larger die-casting components require die-casting systems with high locking forces. At the same time, short changeover times, reproducibly high dimensional accuracy of the components produced, and the highest possible system availability are prerequisites for efficient production at minimum cost. Bühler's two-platen technology provides the decisive advantages over conventional machines for this purpose:

— **Automatic die height adjustment:** Since the locking force is applied via the four tension cylinders located on the tie bars, the die height can be adjusted automatically with the moving cylinder, which saves valuable time during die changes.

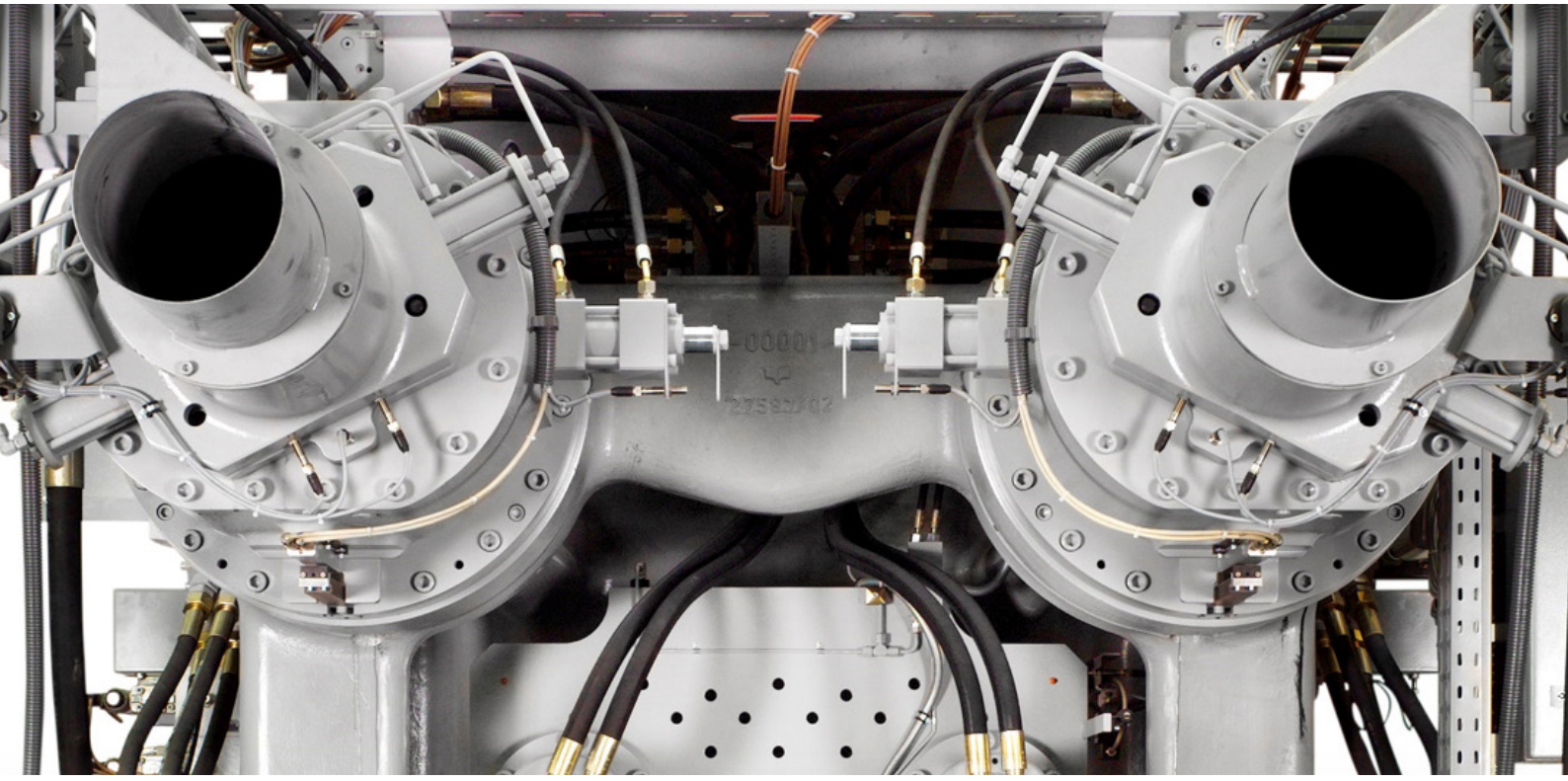
— **Less flash:** The high rigidity of the locking system and the precise control and reproducibility of the casting process reduce flash formation. This protects the die, causes less scrap and minimizes the effort required for deburring.

— **Fewer bearing points:** A smaller number of lubrication points reduces maintenance and operating costs, extends plant service life and thus increases availability.

— **Reduced machine length:** Older machines can be replaced by more efficient and automated two-platen systems in the same space.

— **Uniform locking force distribution:** The uniform tie bar loads lead to a longer machine service life.

Bühler has been successfully using two-platen technology for 15 years in its Carat series. The machine, which is available in 17 sizes with locking forces ranging from 10,500 to 92,000 kN, is characterized by optimum process flexibility, a casting process that is gentle on the die, low operating costs, and extremely simple application. The drive technology of the Carat is optimized for low electrical energy consumption. Compared to conventional die-casting machines, the connected load is up to 27% lower. The injection unit is available in three versions and is based on the proven Bühler 'Shot Control' technology, with real-time control of the entire filling and post-pressure phase.



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