

T-Mag™: High-yield, high-integrity magnesium permanent mould casting process

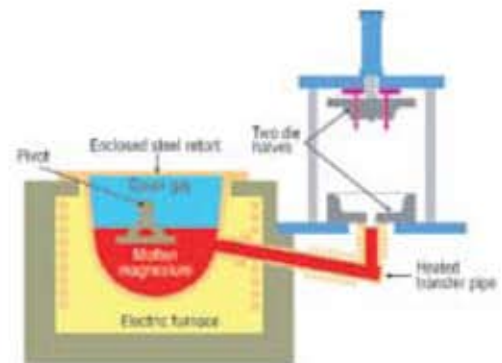


T-Mag™ is a new integrated casting technology for magnesium that significantly extends the capability and reduces the cost of permanent mould casting for a wide range of high-performance components.

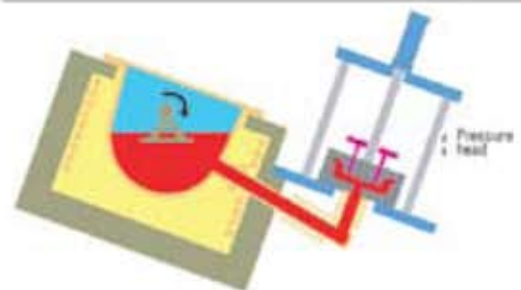
The T-Mag™ casting machine provides melting and casting operations in a single compact unit. It holds a furnace with an enclosed retort of molten magnesium alloy under cover gas atmosphere, connected to a die via a heated steel transfer pipe. When the machine rests in the horizontal position, the molten magnesium alloy in the transfer tube is just below the die. The die fills by gravity rather than by applied pressure.

During casting, the machine rotates forward at a controlled speed about a horizontal axis to allow molten magnesium to smoothly fill the die from the bottom. The machine comes to rest after a given angle of rotation is reached, and the head of molten magnesium above the casting assists feeding during solidification.

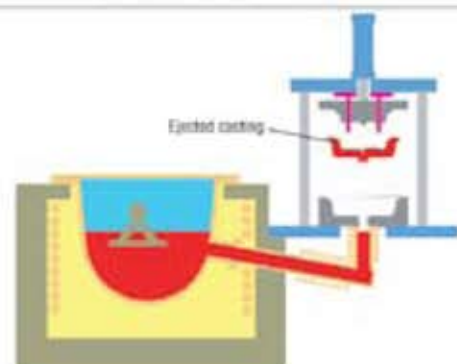
After solidification has progressed from the casting extremities to just beyond the gate, the machine rotates back to horizontal, causing the molten magnesium in the transfer tube to drop away from the small solidifying sprue. The machine rests in this position allowing the casting to develop sufficient rigidity to be ejected.



The T-Mag™ casting system, shown in starting position of the cycle



T-Mag™ machine in casting position



T-Mag™ machine in final position of casting cycle



As-cast magnesium motorcycle engine blocks, showing small sprue and sand cores.



Castings of magnesium wheel, machined and painted.



T-Mag magnesium motorcycle engine block castings; upper casting fettled and partially machined; lower castings after sand core shakeout.

How T-Mag™ compares with conventional casting technologies

T-Mag™ tooling and running costs are low and comparable to gravity or low-pressure permanent mould casting of aluminium.

Components made by the T-Mag™ process are suitable for high-integrity, high-strength applications, to which components made by high-pressure die casting are not normally suited. With T-Mag™, components can also be made using sand cores to produce complex internal features.

Dies for T-Mag™ are similar to those used for other permanent mould casting processes, with similar construction and comparable cost and manner of operation. T-Mag™ cycle times are faster than equivalent aluminium gravity permanent mould casting because of the lower embodied heat of magnesium for the same part volume.

Final cycle times achieved using the T-Mag™ process largely depend on the part and tooling design. For example, the unoptimised cycle time for a 3.1 kg T-Mag™ 10" x 4.5" automotive wheel rim made using air cooling is 4.1 minutes.

Commercially available coatings have given a satisfactory die coat performance, despite magnesium alloys being generally more aggressive towards die coatings than aluminium alloys. Die coatings have a significant role in all permanent mould processes, and continue to be evaluated and optimised.

Operating and consumable costs are comparable with those of an efficient aluminium gravity permanent mould casting cell. As the T-Mag™ furnace operates in an enclosed system, furnace cover gas consumption is minimised. Cover gas is used to inhibit magnesium burning or oxidation.

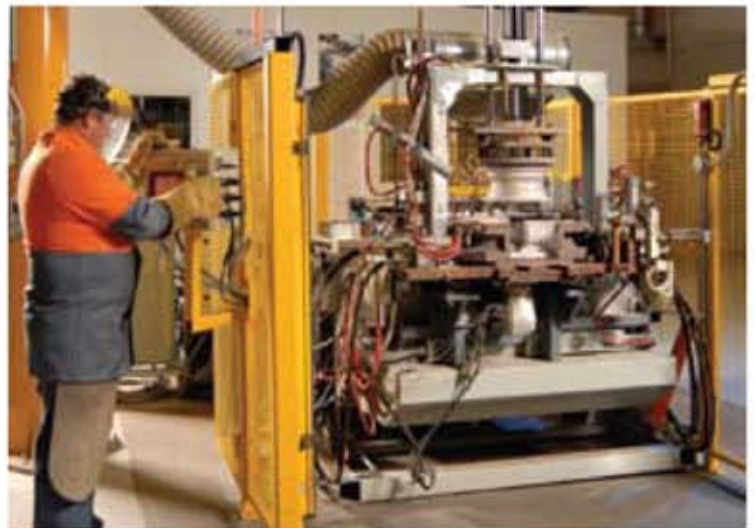
Typical consumptions of 0.005 kg/hour of SF₆ or AM-cover (HFC134a in CO₂ or N₂) have been recorded. Melt temperature is in the range of 700—740°C, depending on the alloy.

The basic T-Mag™ machine requires a dedicated operator. In the basic machine, ingot charging is done by the operator during the cycle, permitting continuous operation. It is anticipated that labour requirements will be reduced by automating the system, to a likely requirement of one supervisor per four machines. With several machines automated for operations such as casting take-out and core placement, a liquid metal charging system from a central melting furnace could be operated by a plant furnace operator.

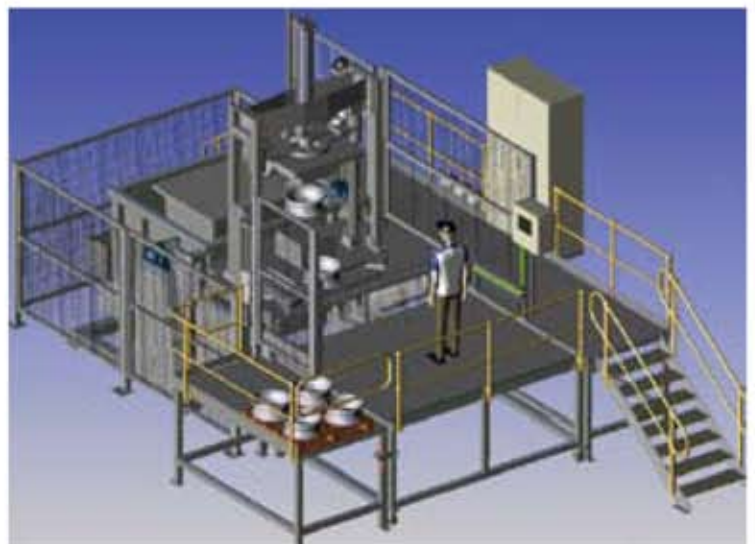
The T-Mag™ technology offers the automotive industry reductions in greenhouse emissions through a more energy efficient casting process, reduced cover gas consumption, and the ability to produce lighter weight automotive components.

T-Mag™ Pty Ltd will supply a turnkey package, machines and associated technologies for the manufacture of magnesium permanent mould castings to the international market.

A pilot T-Mag™ machine incorporating an 80-kg furnace has been used in an extensive CSIRO research and development programme to generate a number of successful demonstration casting products. As a result, a larger Mk II machine with a 500-kg furnace capacity has been designed and constructed by FLOTEK. The new machine will produce high quality production-size parts up to 15 kg in weight. T-Mag™ Pty Ltd plans to make three new production castings as part of its next phase of development.



The pilot T-Mag™ machine, with 80-kg furnace capacity.



A plan of the large T-Mag™ machine with 500-kg furnace capacity.

- compact
- low capital
- thermally efficient
- improved die life
- minimal cover gas consumption

Key Benefits

T-Mag™ Castings

- High-yield, typically 95%, which reduces recycling costs and maximises productivity
- High-integrity, heat treatable and weldable castings
- Internally complex shapes possible using sand cores
- Medium to large production quantities for a wide range of products in the automotive and other industries

T-Mag™ Equipment and Tooling Features

- Integrated melting and casting unit
- Compact equipment footprint for easy transport and installation
- Low capital, tooling and running costs
- Minimal cover gas consumption
- Thermally efficient electrical resistance heating
- Improved die life compared to aluminium permanent mould process (lower embodied heat and much lower dissolution rate of iron in magnesium)

T-Mag™ Pty Ltd joint venture

The T-Mag™ technology has entered a new phase of development through the establishment of a joint venture partnership. The joint venture, T-Mag™ Pty Ltd, combines the strengths of three companies working in the areas of alloy casting, foundry equipment development and automation, with the established research power of CSIRO, Australia's national science agency. The joint venture partners are:

- Alloy Technologies International (ATI), a specialist supplier of high-value cast alloy products, established as a provider of components to the automotive industry
- FLOTEK, a special purpose machinery manufacturer with expertise in manufacture and design of foundry equipment
- Sage Automation, a leading supplier of automated production systems, and
- CSIRO Light Metals Flagship and the CSIRO Division of Manufacturing and Materials Technology.

Commercial Opportunities with T-Mag™

T-Mag™ Pty Ltd offers manufacturers exciting opportunities in production of high quality magnesium alloy castings for the automotive and associated industries. We offer a range of services, including:

- Development of new casting applications
- Supply of a turnkey package of machine, tooling design, manufacture and process parameters.

T-Mag™ Pty Ltd actively seeks to establish commercial relationships, and we welcome your enquiries.

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