ROVALMA

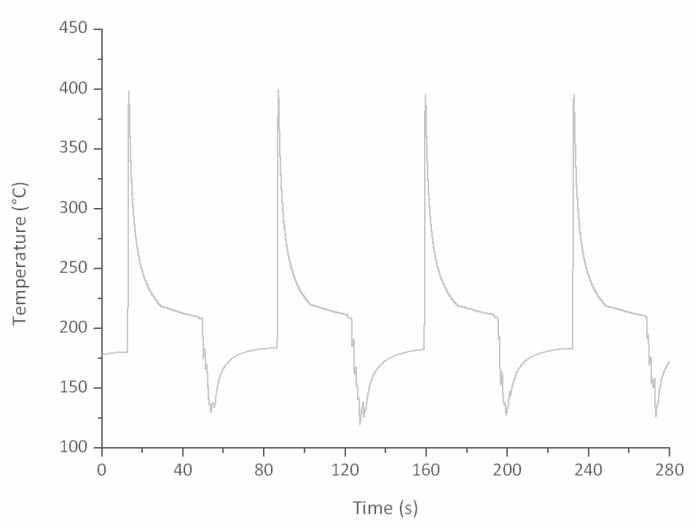
THE STEEL INNOVATOR

Tool Steels for Die Casting

Die Casting Dies in the Heart of Die Casting Processes

Die casting dies, as the heart of the die casting process, fulfill two functions: forming the component into its shape, and extracting the heat from the liquid alloy, thus that the component can solidify.

In order to avoid premature fracture of the die by thermal shock, the die is usually heated up, generally to a temperature over 100°C, before the alloy is poured into the die. When the alloy has been poured or injected into the die, the heat of the liquid alloy starts to be removed through the die, which makes the die surface temperature increase suddenly to much higher temperatures of > 450°C. For the complete solidification of the alloy inside the die, the heat must be extracted from the liquid alloy through the die. The cooling of the die, normally to a temperature of 150-250°C for each casting cycle at steady state production, is generally effectuated through cooling lines that have been drilled underneath the die cavity surface during the die construction process. In High Pressure Die Casting Processes (HPDC), external cooling is also often used by spraying water based lubricant through a robot while the die is opened. The figure below shows an example of the die temperature variations during the production of a component with a hot chamber HPDC machine.



The cyclic variation of the die surface temperature generates important cyclic thermomechanical loadings, which often can end up causing cracking at the die surface in form of heat checking, corner, edge and radii cracks thermal shock cracks, especially in HPDC and squeeze casting applications. Thereby, the die cooling strategy and mechanism are also important factors that impact directly on the die durability in die casting processes.

Dies Casting Dies - the Brain Teasers of Die Designers and Die Casters

Die construction costs for die casting dies are high and can amount to serval hundred thousand Euros, depending on the size and geometry. These high costs are mainly related to the time-consuming machining processes and the geometrical configuration of the die, while the die material has a relatively small cost share in the total invest costs of the die manufacturing. When it comes to the die design many aspects must be optimized, such as the yield rate, ensuring a complete filling of the die, the cleanness of the produced components, the cooling system ensuring the required pattern of solidification, shrinkage porosity and dimensional deviations from the component shape to be casted, stable and short cycle times, etc.

Mode, Speed and Pattern of Heat Extraction make a Big Difference

All of the above aspects are related to how the heat is extracted from the component, and how and how fast the die is cooled to prepare it for the next cycle. One of the brain teasers for die designers is related to the limitation of the cooling line design. On the one hand, it is nearly impossible to make the cooling lines closely conform with the geometry of the die cavity, when they are conventionally machined by drilling. On the other hand, the cooling lines cannot be brought very close to the surface because of the risk of gross catastrophic cracking from the cooling lines to the surface. Resulting from this, the corners, bumps and other geometrical intricacies of the cavity become a challenge for the down-cooling. Hot spots and the related problems, such as soldering, shrinkage porosity, long cycle times and production instability are common die cast problems. Also, the excessive external cooling of such zones, often jeopardizes the durability of the entire die in high pressure die casting applications.

The Optimal Die Steel Must Respond to Many Optimization Criteria

With regard to the optimal choice of the die material to ensure the best die productivity and die durability, the different stakeholders along the die construction chain and its usage are faced with many important questions. Die and product designers must answer the question, if the cooling capacity of the chosen die steel will be enough to comply with the technical specifications, especially in terms of porosity and cycle time. Die constructors on the other hand will optimize the selection of the die material according to purchase price, delivery time, machinability and best solution for a specific die as indicated by die designers and die casters. Component casters will wonder, how to obtain the shortest possible cycle times and a stable production without jeopardizing the component quality and the die durability. The ultimate question of the component buyer will be how to attain the cheapest possible component price for a given component quality requirement.

Innovative Die Material Solutions for Die Casting by ROVALMA

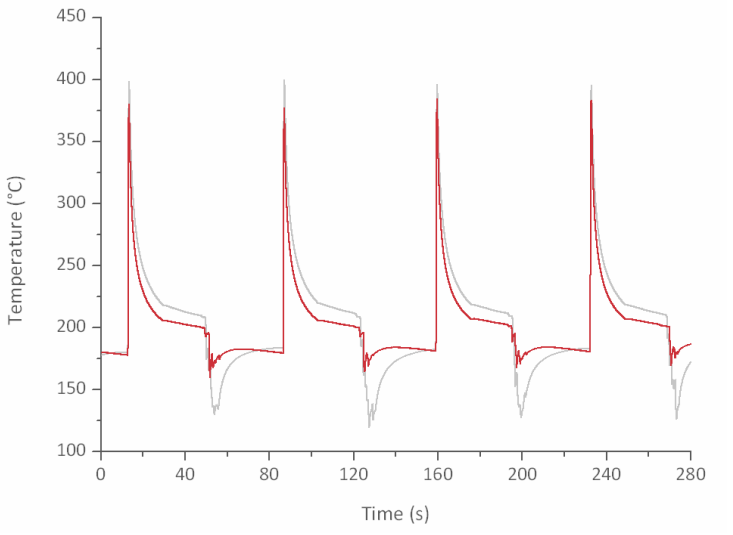
Based on 40 years of experience in tool materials and on the know-how of our dedicated scientists and technicians in the development, production and application of tool materials, ROVALMA has generated breakthrough die material solutions for many engineering applications. For the manufacture and usage of die casting dies, ROVALMA provides a comprehensive material solution package of different die material grades to respond to the diverse technical requirements of the different casting processes and optimization criteria of die designers, manufacturers, users and component buyers.

To fight against hot spots, porosity, slow cooling, long cycle times and other problems related to the slow cooling of conventionally employed die materials, ROVALMA invented and pioneered the application know-how of High Thermal Conductivity Tool Steels. Nowadays, two grades of theses tool steels are especially tailored for different die casting applications: HTCS®-130 DC and FASTCOOL®-20.

	Thermal Conductivity	Costs	Max. Hardness	Heat Treatment
1.2344 (H13) ESR			54 HRc	Harden+Temper
HTCS®-130 DC			52 HRc	Harden+Temper
FASTCOOL®-20			420 HB	Pre-hardened

The thermal conductivity of these high performance tool steels is around twice that of conventional hot work tool steels. With these tool steels, ROVALMA offers a unique solution to fight against thermally related problems, in particular shrinkage porosity, slow cooling, shrinkage related dimensional deviations, and long solidification times. FASTCOOL®-20 is a revolutionary die cast steel pre-hardened to 400 ± 20 HB, differing from conventional harden & temper die steels by offering a homogeneous property distribution from the surface to the core of the die, combined with high thermal conductivity.

For die casters, both grades allow to increase productivity through higher production process stability (less hot spots, less soldering, better cooling), shorter cycle times, faster heating and cooling of the die and better component quality. FASTCOOL®-20 furthermore enables a considerable decrease in die manufacturing lead times. Component buyers appreciate the increased flexibility in component geometry (reduced thickness and more complex geometries) and reduced component cost and delivery times).



ROVALMA's EFICAST-3 and EFICAST-4 tool steel grades have been modified to provide the highest quality, high performance tool steel grade alternatives to the conventional tool steel grades EN/DIN 1.2343 and 1.2344/AS. EFICAST grades are produced and refined by using the latest production technology for melting, forging and thermal processing to obtain the highest possible level of purity, isotropy, refined microstructure and fracture toughness. ROVALMA applies a comprehensive and strict quality control to ensure compliance with the highest quality standards for die cast materials, such as NADCA recommendations.

	Thermal Conductivity	Costs	Max. Hardness	Heat Treatment
EFICAST 3-ER			54 HRc	Harden+Temper
EFICAST 3-RR			54 HRc	Harden+Temper
EFICAST 4-ER			54 HRc	Harden+Temper
EFICAST 4-RR			54 HRc	Harden+Temper

Designer & Provider of First-Class Tool Materials

ROVALMA, S.A. provides innovation in tool materials. Thanks to comprehensive research, innovative design and development, most recent production techniques as well as in depth quality control, we have achieved significant advances in the knowledge about material forming processes and generated important know-how regarding the production and optimal usage of our materials for a specific application. As a result, we can provide you with first-class tool steels for cold and hot work material forming processes and outstanding technical assistance.

Note

In order to fully exploit the advantages and the potentials of ROVALMA's high performance tool steels, we offer our customers the support of our Application Engineering Service. Our highly qualified and dedicated engineers can assist you in selecting the optimized grade for your application and provide you with the corresponding technical recommendations. It is our mission to increase the competitive-advantage of our customers and support them in achieving the highest possible cost-effectiveness.

You can access our service directly by sending an email to: ae-fast@rovalma.com.

ROVALMA, S.A. carries out ongoing research for many applications regarding the usage of the materials here presented. This research often brings along significant advances in the knowledge of a given process and thus important information regarding the best possible usage of the materials for a specific application. We strongly recommend to get in contact with ROVALMA, S.A. for the latest information regarding a specific application.

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