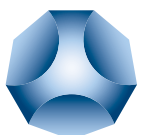
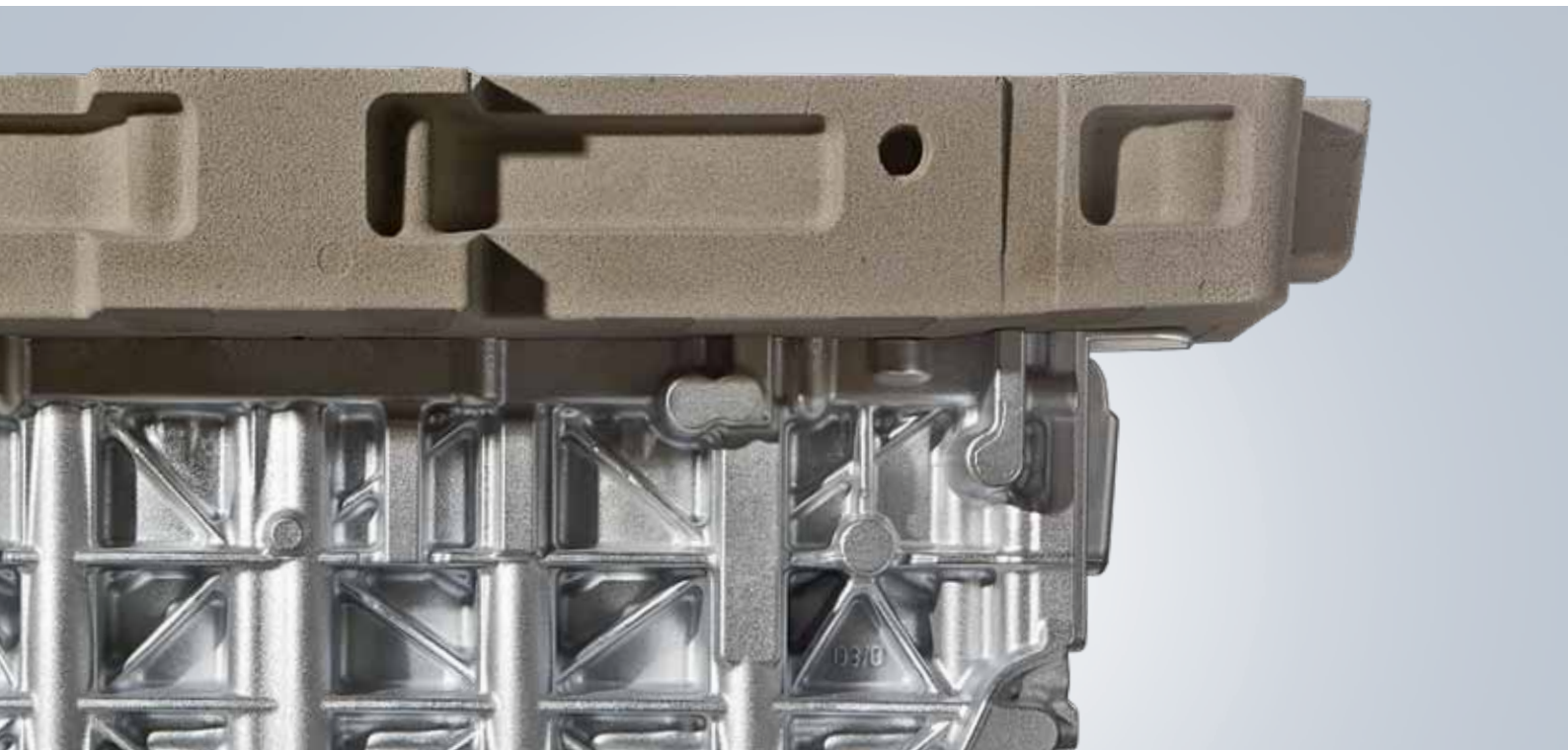




# INOTEC

Product Line Overview



# INOTEC technology – technological, economic and environmental benefits for foundries

The importance of the patented INOTEC technology and thus the quantities of inorganically produced castings are rising steadily. The technology is suitable for aluminum and iron casting as well as non-ferrous metal casting applications. The inorganic binder system constitutes a persuasive choice, especially in highly productive and challenging segments such as the manufacture of engine blocks and cylinder heads in permanent mold casting.

In addition to the clear environmental benefits, INOTEC technology scores points in particular with its technological characteristics and its impressive ability to improve productivity over conventional technologies.

The development of inorganic binder technology into a binder system ready for series production and the market was driven to a large extent by ASK Chemicals.

Embodying as it does the interaction between innovation-driven research and customer-driven development at the same time, ASK Chemicals always has the requirements of the market in mind. The economic, technological and environmental requirements of our customers were always the focal point during development of the patented INOTEC technology. In 2014, ASK Chemicals has been rewarded with the BMW Supplier Innovation Award in the Sustainability category for its achievements in this respect.

ASK Chemicals offers its customers solutions that go well beyond merely offering products. Our application technology and technical sales specialists always keep an eye on the process as a whole and offer our customers solutions that have been adapted to meet the relevant conditions and are precisely tailored to meet their requirements.

Our specialists' know-how is complemented by a broad range of services that offers our customers real added value. In this way, for example, our design services can be systematically deployed to optimize the process as a whole – from concept development to series production – thereby offering important savings and improvement potential for our customers.



- Patented technology
- Leading provider of inorganic binder technology
- Technological, economic and environmental benefits

# INOTEC binders and promoters for technology

Thanks to intensive research into the area of inorganic binder systems, the gap between Cold Box technology and the INOTEC system is being made ever smaller. Statements such as the following have been refuted and qualified many times: “Inorganic cores show a lower dimensional accuracy when casting, tend to have higher core fracture and are unstable in moisture and therefore cannot be coated with water. The waste sand cannot be regenerated, the casting surfaces show more sand accumulations, the cores have worse shake-out performance and inorganics are not suitable for iron casting” have been refuted and qualified multiple times. By contrast, INOTEC technology offers significant technological advantages for the foundry industry.

## INOTEC in iron casting

Inorganics have considerable potential in iron casting. In particular, problematic parts that require work with special sands or additives in combination with a coating against veining are predestined for use of inorganic binders since they show a much lower tendency towards veining – or indeed none at all – compared with organic systems.

## Technological benefits

- Reduction of sand adhesion and penetration
- Optimization of shake-out performance, enabling filigree water jacket cores to be removed safely from the casting
- Excellent dimensional accuracy during casting due to improved thermal stability
- Improved structural properties (shorter dendrite arm spacing)
- The use of water-based coatings in iron casting is also possible

### Reduction of sand adhesion and penetration in aluminum casting



INOTEC

Cold Box

### Improved dimensional accuracy due to higher thermal stability



Increased thermal stability



# ological advances

## New technological potential: central feeding concept

The absence of combustion residue offers new freedom to component developers. One impressive example of this is the new central feeding concept, which is used at BMW's Landshut plant for crankcases of future engine generations. Inorganic cores are used as central feeders here, thus minimizing the risk of sooting ventilation ducts in the low-pressure permanent mold. This concept is not feasible with organic cores.

The dendrite arm spacing (DAS) of the three feeding concepts is shown in the illustration below. It is apparent that the new central feeder concept leads to DAS advantages in all component areas. The warmest point (thermal center, binding of the feeder) and therefore the point with the highest local DAS is in the area of the lower dead center of the piston, a point that is not subject to excessive thermal or mechanical stress. The tension rod area also solidifies very quickly and can be influenced externally via the permanent mold. The tendency towards leaking after mechanical processing falls dramatically, and the sealing rates are miniscule.

	1 <sup>st</sup> generation permanent mold casting DAS [ $\mu\text{m}$ ]	2 <sup>nd</sup> generation permanent mold casting DAS [ $\mu\text{m}$ ]	3 <sup>rd</sup> generation permanent mold casting DAS [ $\mu\text{m}$ ]
Cylinder web	30	45	20–25
Bearing support	45–50	30	25



1<sup>st</sup> generation



2<sup>nd</sup> generation



3<sup>rd</sup> generation

Source: Anorganische Innovation für die neue Diesel-Spitzenmotorisierungen im BMW M55 Oxd: Konstruktion und Gießtechnik des Alu Kurbelgehäuses [Inorganic Innovation for the New Top-of-the-Range Diesel Engines in the BMW M55 Oxd: Design and Casting Technology of the Aluminum Crankcase]  
Dr. E. Weissenbek, B. Zabern; Giesserei-Praxis, 5/2013, pp. 175–181

# INOTEC is cost-effective

In addition to casting-related technical benefits, INOTEC technology offers process-related advantages over conventional processes. Particularly notable are the significant increase in productivity in the casting process and a drastic reduction in the consumption of resources for maintenance and servicing work.

## Economic benefits

- Shorter solidification times owing to lower permanent mold temperatures and thus shorter cycle times
- No buildup of condensate and therefore increased availability of permanent molds
- Much less cleaning required
- No need for air treatment
- Improved cast part qualities

### A cost-effective alternative

Due to the absence of organic components, the use of the INOTEC system does not result in the buildup of condensate, which in turn reduces the amount of cleaning involved. Investment in air treatment measures is also saved, making INOTEC a cost-effective alternative.



	Cold Box	INOTEC	
Solidification time in minutes	6	5.5	
Casts without cleaning / availability of permanent molds	15	257	
Cleaning time required within 24 hours in minutes	320	20	
Cast part output in units/hour	7.8	10.8	39%↑

Source: Anorganisches Bindersystem im Sandwich zwischen “Technology Push” und “Market Pull” [Inorganic Binder System Sandwiched Between “Technology Push” and “Market Pull”] from Giesserei 99 (2012), Issue 2, pages 52 et seq.

# INOTEC is an environmentally friendly product

The environmental benefit of INOTEC relies on the inorganic and water-based nature of this binder technology. The lack of harmful emissions during core manufacturing, core storage and pouring removes the need for elaborate ventilation and air treatment systems in the process chain.

## Environmental benefits

- No environmentally harmful emissions
- No buildup of condensate
- No unpleasant odors affecting employees
- Environmental friendliness confirmed by comparative environmental lifecycle assessment



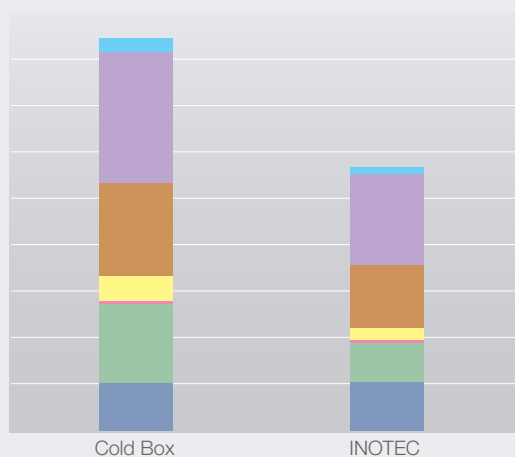
Comparative  
Life Cycle  
Assessment

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## INOTEC compared

A comparative environmental lifecycle assessment between the INOTEC system and a Cold Box system showed the best possible result for the INOTEC technology. INOTEC is more environmentally friendly than Cold Box technology. An environmental lifecycle assessment involves examining the potential environmental effects from the cradle to the grave, i.e., from the production of raw materials to the production and utilization of the product, right up to waste management or recycling (DIN EN ISO 14040: 2009). In the foundry, the utilization phase is divided into the following steps: Core production, casting, core removal and sand reclamation.



- Eutrophication potential
- Primary energy demand
- Abiotic depletion potential
- Photochemical oxidant formation potential
- Ozone depletion potential
- Acidification potential
- Global warming potential

INOTEC is better than the Cold Box system in all impact categories.

# Product portfolio

The INOTEC technology comprises a two component binder system of INOTEC (liquid binder) and INOTEC promotor (solid additive component). Depending on the requirements, INOTEC is available in “High Solid” (HS) and “High Compaction” (HC) versions as well as in the form of intermediate solutions made from both binders.

Binder	Properties
<b>INOTEC HS 1000</b>	Good strength levels; very low gas potential; no emissions; no buildup of condensate; typical application at 160–200 °C core box tooling temperature
<b>INOTEC HC 2000</b>	Very strong flow properties, Good compaction Core removal possible via mechanical and wet methods Very low gas potential, no emissions, no buildup of condensate Typical application at 160–200 °C core box tooling temperature
<b>INOTEC HS 3000</b>	Improved moisture resistance; good strength levels; Very low gas potential; no emissions; no buildup of condensate Typical application at 160–200 °C core box tooling temperature

The choice of the solid additive component, known as the INOTEC promotor, is determined by the metal being poured and the application. Depending on the core requirements, INOTEC promotors are available for specific core geometries (e.g. top cores, water jacket cores) or for universal applications.

Promotor	Application	Metal	Properties
<b>INOTEC promotor TC 4500</b>	Top cores	Aluminum	Reduces penetration and sand adhesion High degree of compaction 100 % inorganic
<b>INOTEC promotor WJ 4500</b>	Water jacket cores	Aluminum	Especially suitable for filigree / thin geometries Reduces penetration and sand adhesion High dimensional accuracy during casting Good core removal capability 100 % inorganic
<b>INOTEC promotor TC 4000</b>	Universal	Aluminum	Reduces penetration and sand adhesion High degree of compaction High dimensional accuracy during casting 100 % inorganic
<b>INOTEC promotor TC 5000</b>	Universal	Aluminum	Especially suitable for filigree / thin geometries Improved core removal Reduces penetration and sand adhesion High degree of compaction High dimensional accuracy during casting Improved moisture stability 100 % inorganic

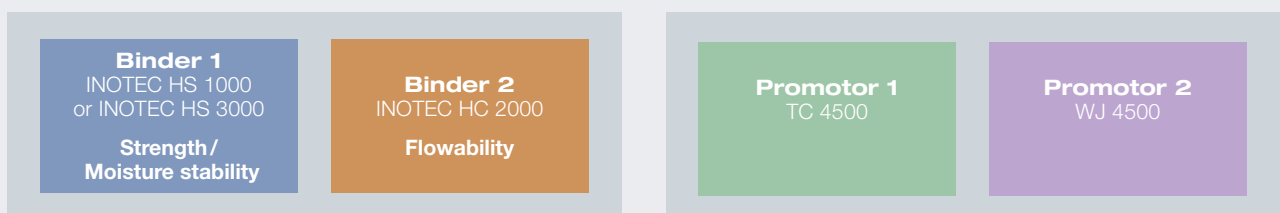


The INOTEC tooling kit approach allows easy and tailor-made adjustments by applying mixtures of INOTEC (e.g. INOTEC HS 1000 and INOTEC HC 2000, 1:1) and INOTEC promotors (e.g. INOTEC promotor TC 4500 and INOTEC promotor WJ 4500, 1:1). This tooling kit approach enables the regulation of specific core properties with on-site available binder materials. A specific example for this approach is given below for the manufacturing of aluminum cylinder heads.

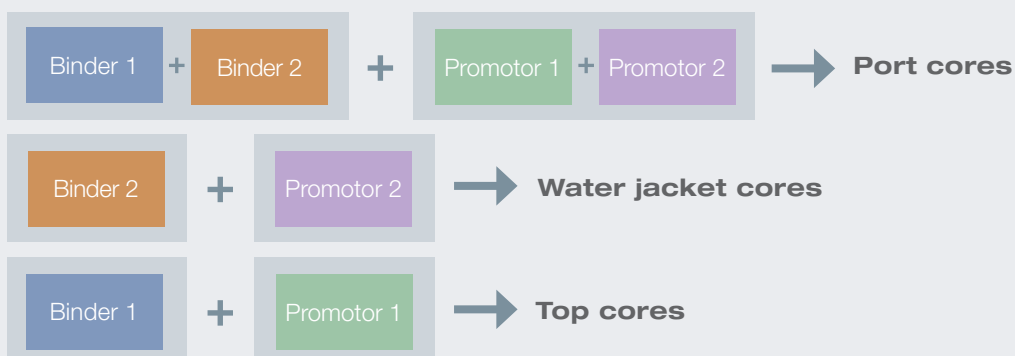
INOTEC	INOTEC promotor	Application	Properties
HS 1000 + HC 2000 (1:1)	TC 4500	Top cores	Reduces penetration and sand adhesion; high degree of compaction; 100 % inorganic
HS 1000 + HC 2000 (1:1)	WJ 4500	Water jacket cores	Especially suitable for filigree / thin geometries; reduces penetration and sand adhesion; high dimensional accuracy during casting; good core removal capability; 100 % inorganic
HS 1000 + HC 2000 (1:1)	WJ 4500 + TC 4500 (1:1)	Port cores	Especially suitable for filigree / thin geometries; reduces penetration and sand adhesion; high dimensional accuracy during casting; good core removal capability; 100 % inorganic

#### INOTEC modular system for variable core geometries and complex casting part series

The INOTEC system is suited for the adjustment of sand core characteristics depending on the type and geometry of the core. For this purpose, different INOTEC binder system components with specific characteristics are used in a defined mixing ratio in order to meet the specific demands of the respective sand cores with a moderate material consumption.



#### Exemplary blends:



# Added Value for our Customers

## Technical service and sales – for complete process transparency

Technical service and sales at ASK Chemicals offer our customers comprehensive expertise in all areas of foundry technology and metallurgy. We offer a comprehensive service that focuses on the production process as a whole and helps customers not only to cut costs but also to enhance their processes. ASK Chemicals also conducts casting defect analyses and offers its customers the opportunity to have tailored training sessions on the customer's own premises.

## Benefits

- Improved decision-making thanks to greater transparency
- Reliable recommendations
- Quick response
- Customized solution development
- Cost-in-use reporting (i.e. savings)
- Casting defect analyses
- On-site training sessions

## Our pilot foundry – more than just state-of-the-art

ASK Chemicals offers fully equipped test foundries at its sites in Hilden and Dublin (Ohio). Modern core shooting machines allow ASK Chemicals to replicate the process on the customer's own premises, perform troubleshooting and systematically advance technologies and products in collaboration with our R&D department.

### Highlights

- Ultramodern core shooting machine on an industrial scale for all current processes
- Advanced core shooting machine on a laboratory scale for quality assurance and process control
- Mold production, including all inorganic processes
- Melting of flake graphite and nodular graphite cast iron up to 100 kg (220.46 lb)
- Melting of aluminum up to 160 kg (352.74 lb)
- Metallurgical studies, e.g. spectral analyses of iron and aluminum structures



## Design Services – for perfect casting results

Our Design Services team monitors the entire process from the development of the design concept and validation right up to the production of the cast part prototype. Our engineers have a wide range of experience and a clear understanding of all aspects of foundry technology and metallurgy. Our Design Services team has the right combination of design, production and simulation expertise, co-operates with external companies and service providers, and enjoys extensive industry experience. ASK Chemicals' simulation service offers wide-ranging technical knowledge and understanding combined with state-of-the-art simulation programs (MAGMA, Novacast, FLOW-3D and Arena-Flow®).

### Benefits

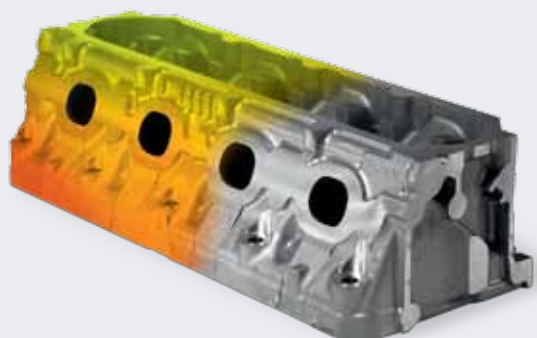
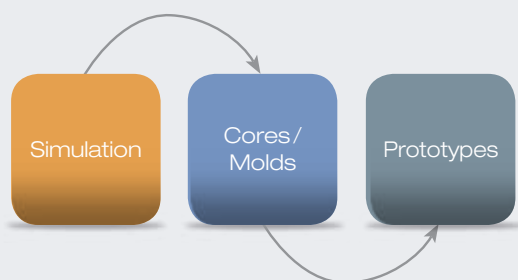
- Higher productivity and optimized catalyst consumption
- Manufacturing process design, including inorganic technology
- Calculation of optimal feed
- Optimized design and manufacture of model plates, core boxes and molds
- Less scrap
- Shorter product launch times
- Quicker time to market

### Simulation services

The simulation of casting processes provides foundries with invaluable casting mold information. Specifically, this benefit allows for the optimization of gating and feeding systems, overflows, venting design and risers. Moreover, it provides critical insight into the influences and effects directly related to casting integrity, such as cooling and heating measurements, filling and solidification times.

### From the idea to the prototype

ASK Chemicals supports your entire process from the concept to prototype production. Your benefit: you enjoy wide-ranging expertise from a single source.



## Research and development – for innovation near you

Our Research and Development department performs both innovation-driven groundwork as well as market and customer-driven development. Interaction between these three areas is of fundamental importance in terms of offering our customers technologically sophisticated products and efficiency-enhancing solutions at all times. Through close cooperation and the constant exchange of ideas with our application technology and technical sales specialists, research and development at ASK Chemicals is always in tune with the market and also maintains a presence on the customer's own premises.

### Benefits

- Many years of experience
- Global presence and availability
- Comprehensive knowledge of the regional sand types and technological requirements
- Short response times for our customers
- First-class equipment

## Comprehensive research and development services

### Pilot foundry

- Fully equipped research foundry
- Mold production, mold/core package assembly and casting
- "Real world" foundry process representation

### Metallurgical investigations

- Comprehensive examination of the graphite structure and metallic matrix: graphite size, number of nodules, degree of dispersion, nodularity, ferrite/pearlite ratio
- Preparation of metallurgical reports

### Sand laboratory

- Examination of high-temperature materials
- Testing of tensile strength, compression and transverse loading
- Sand characterization and analysis

### Product development and technical support

- Casting defect analysis
- Full spectrum chemical and polymer analysis
- Product, process and test method development





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