Adoption of Silicates in Automotive Applications in Europe

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Content

- Silicate – prior and new IOB technology
- Process description and properties
- Area of application and examples
- Challenges by conversion to IOB
- Economic aspects of IOB
- Sand reclamation
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Sodium Silicate – the Oldest Cold Box Process

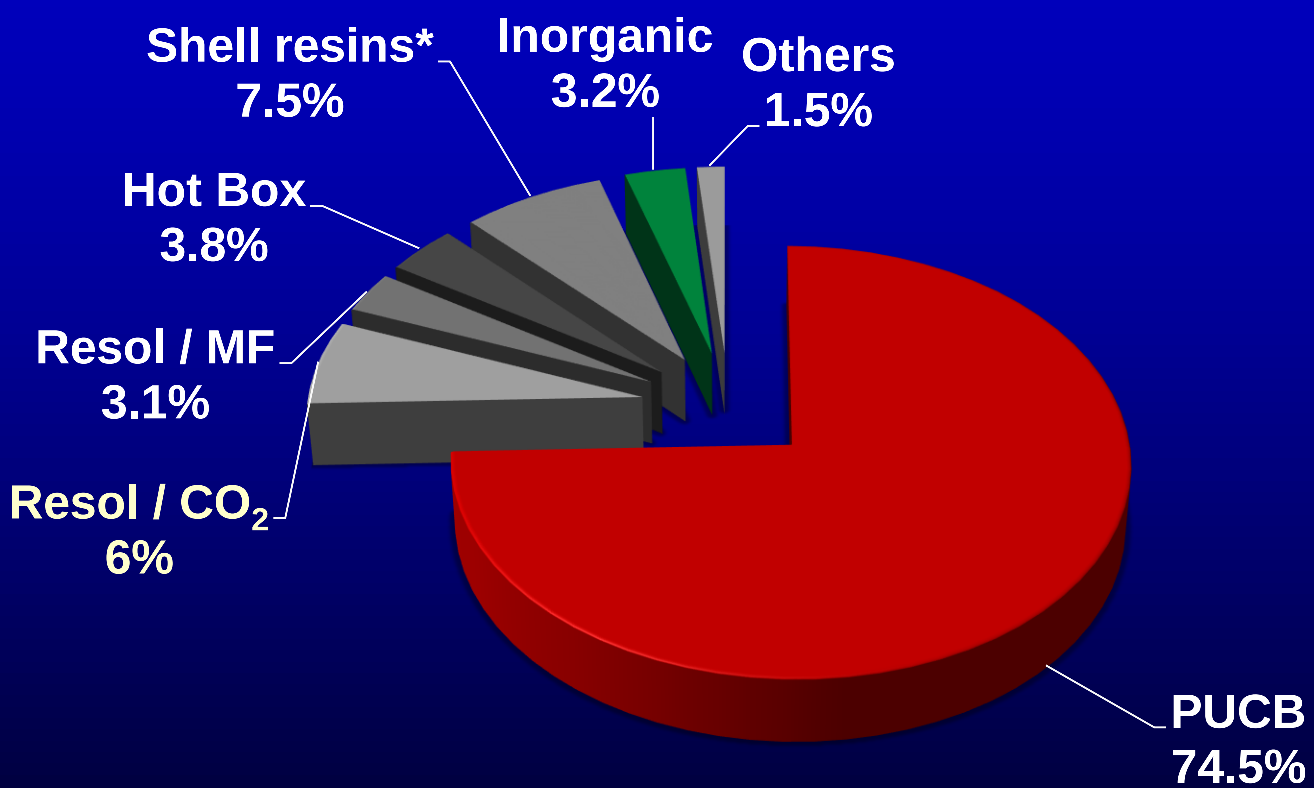
The use of Sodium silicate as a binder has a long tradition and is still successfully in place:

- **as a gas curing (CO_2) process for core making**
- **as a self curing (Ester) process for molding**

But the properties of the cores and molds manufactured using this process are often incompatible with actual requirements:

- ✓ **Low level of strength**
- ✓ **Low fluidity**
- ✓ **Poor shake out properties**
- ✓ **Limited degree of reuse of the reclaimed sand**

Market Share by Product Line for Core Manufacturing / 2013



2003 Innovation: Inorganic Core Production

Beach-Box process:

- **Emission-free**
- **Soluble in water**
- **Wet as well as dry decoring**
- **Recyclable**
- **Cycle times on Cold-Box level**

New Inorganic Binder Systems (IOB)

Salt binder

- M·E·G HydroBond anorganisches bindersystem
- LAEMPE FORMING FUTURE

Silicate binder

- HA GROUP
- AWB
- ASK CHEMICALS We advance your casting

CURING MECHANISM

Hydrobond	dehydration
Laempe / Kuhs	dehydration

CURING MECHANISM

Cordis	physical-chemical
AWB	physical-chemical
Inotec	physical-chemical

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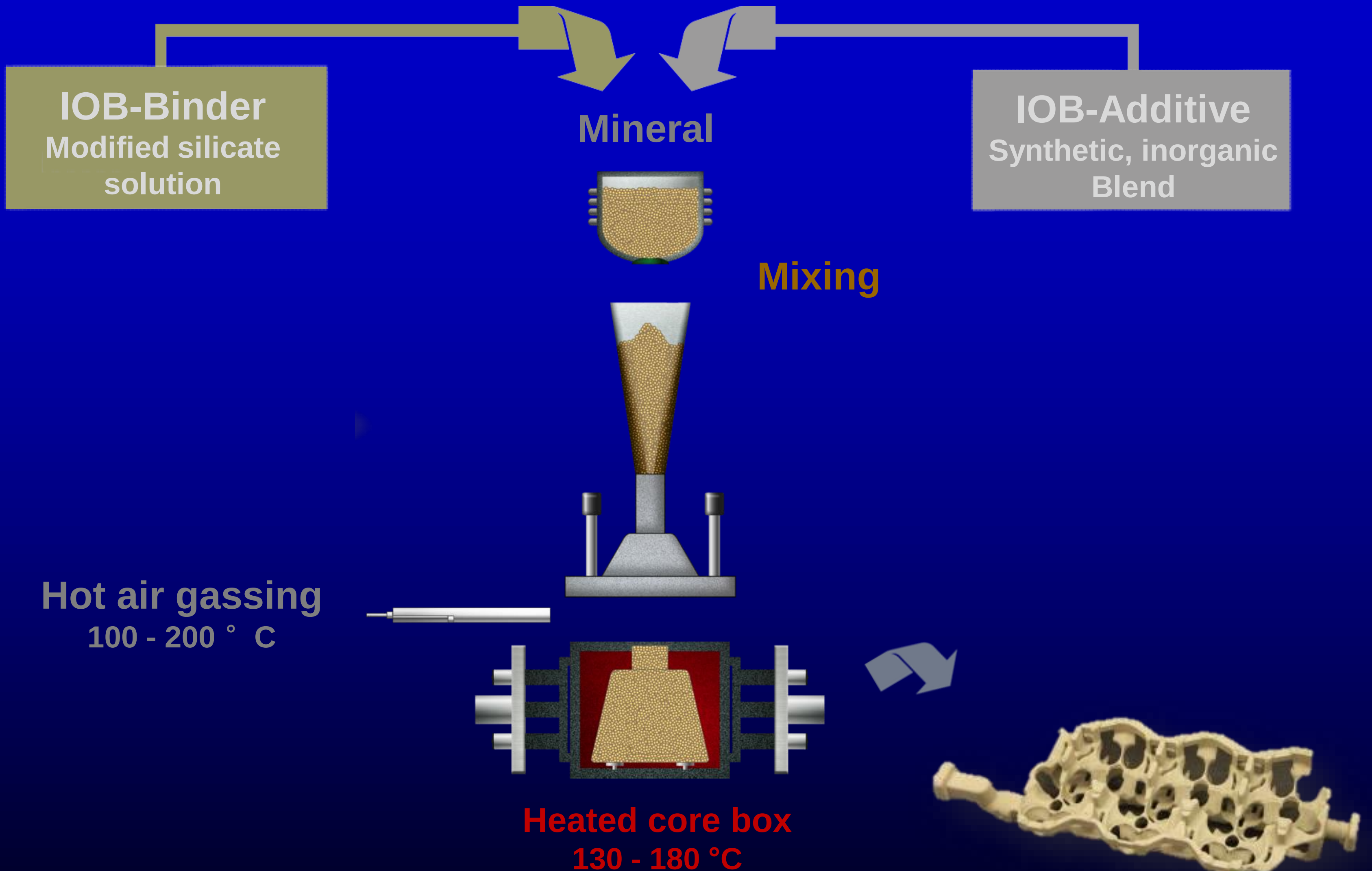
IOB - Process Description

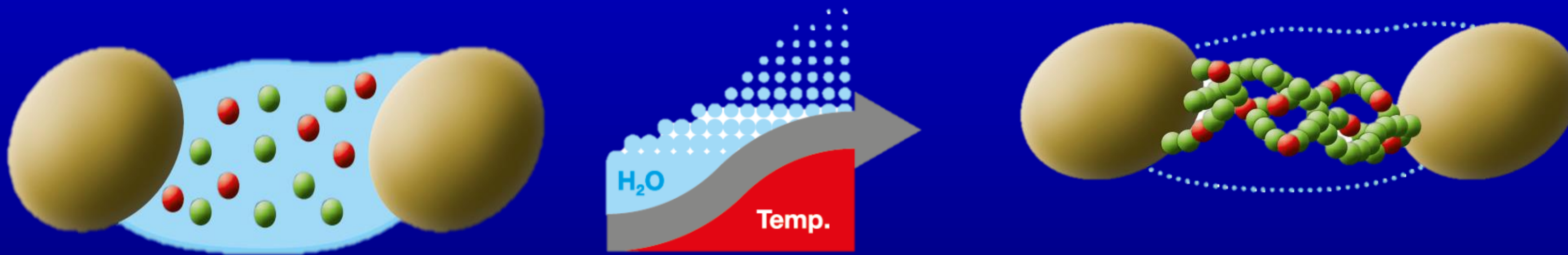


Modern Inorganic Systems

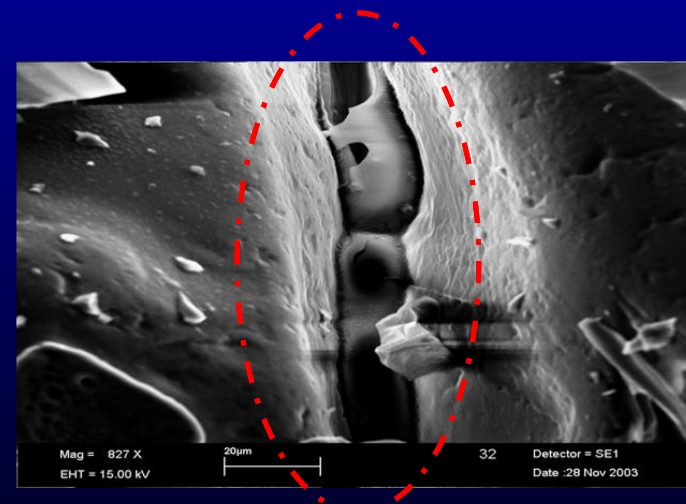
Binder **(modified alkali silicate solution)**

+

Additive **(synthetic, inorganic additives)**

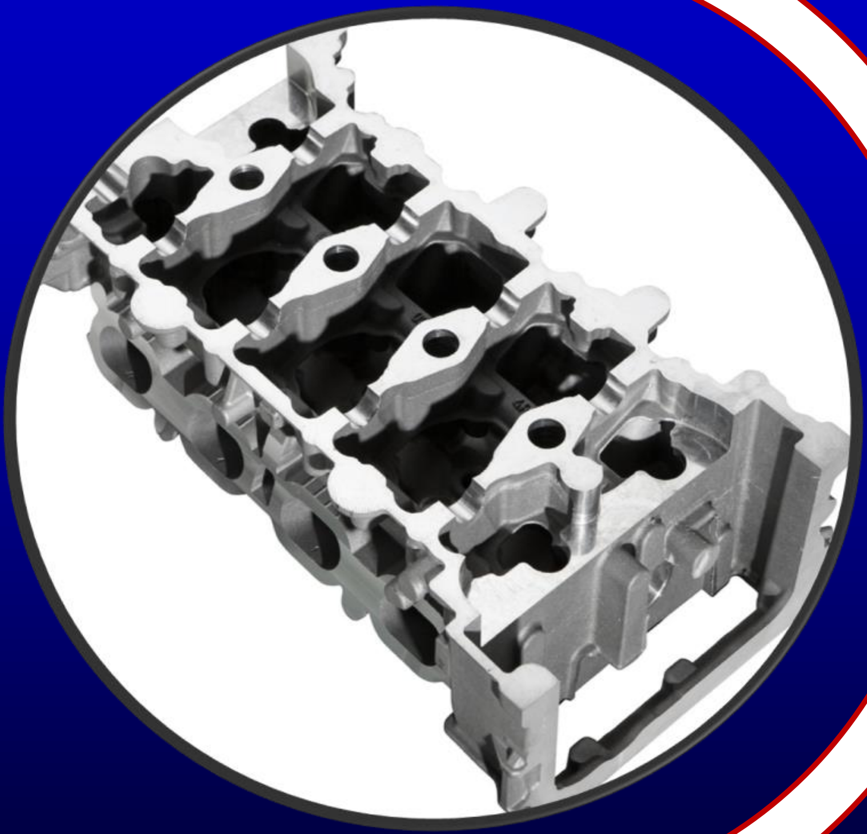


Binder + Additive Solvent water



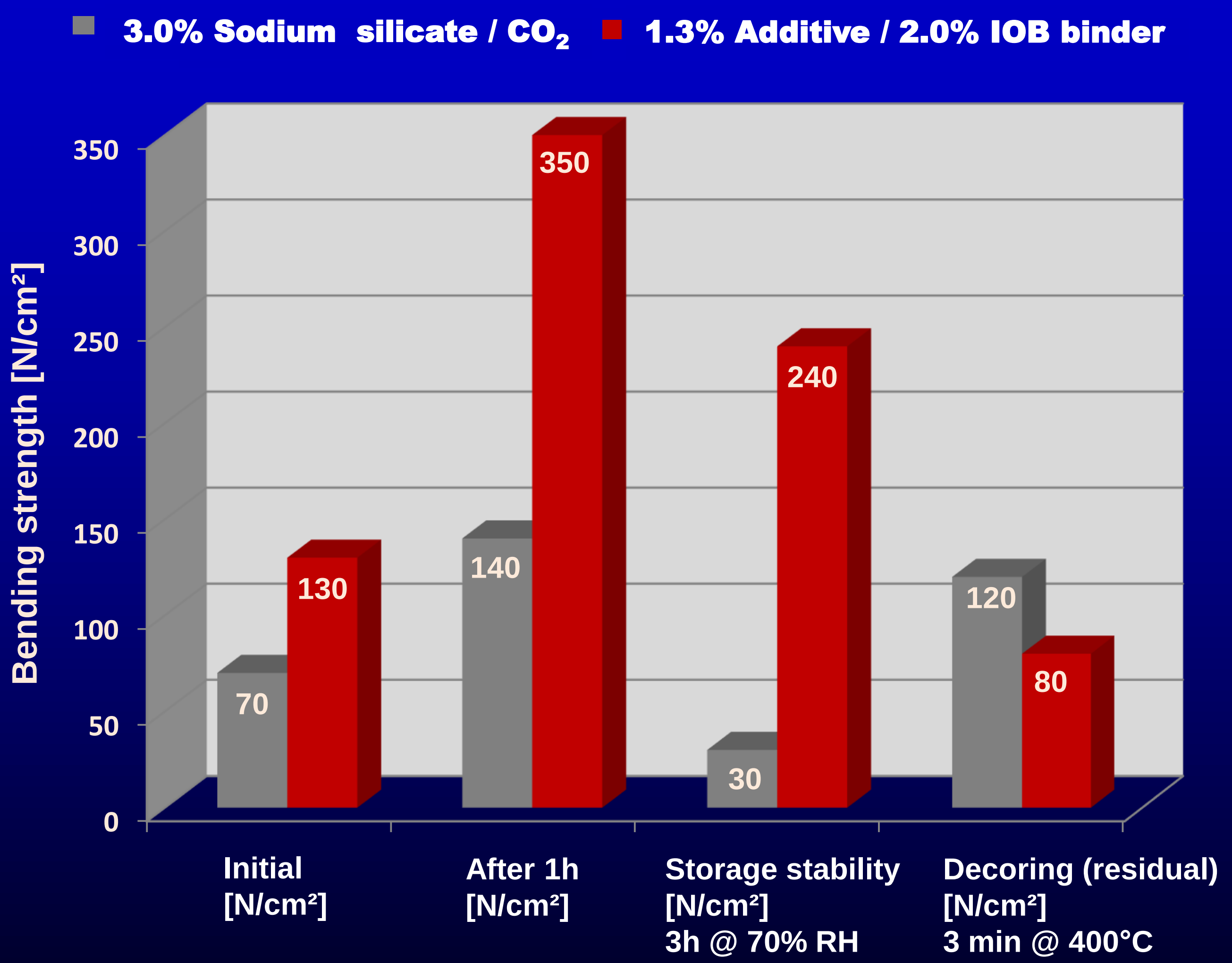
The IOB binder reacts with the reactive part of the additive and forms a three-dimensional network when initiated by temperature in an irreversible process.

Expectations Towards Inorganic Binders

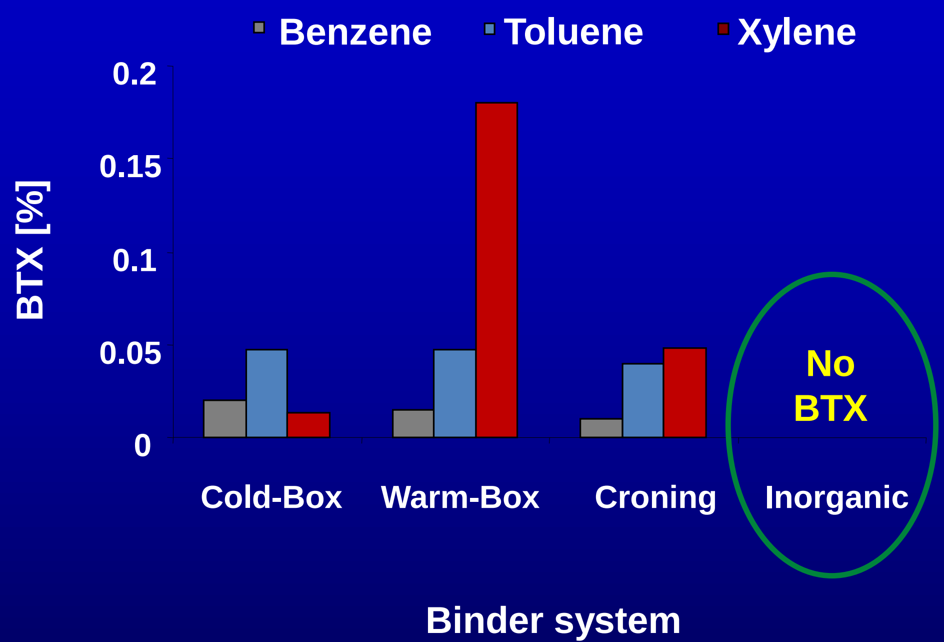


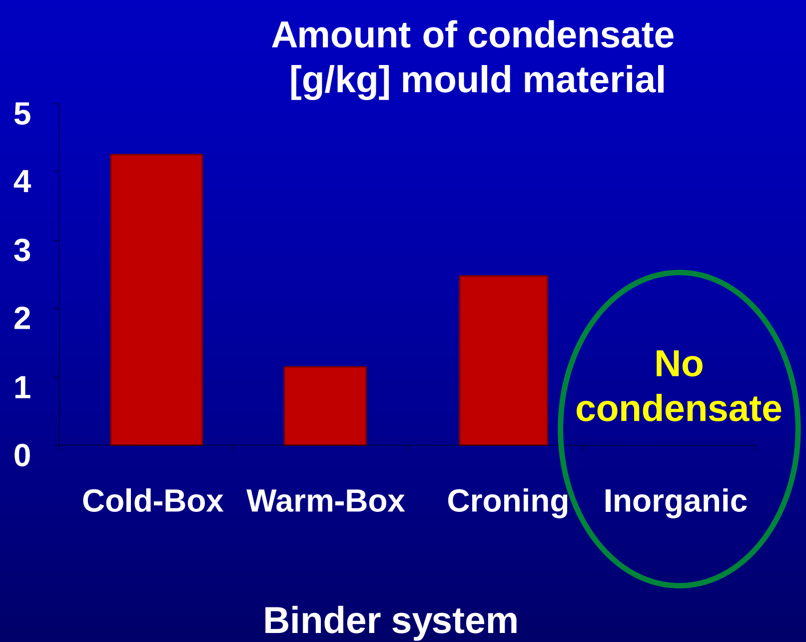
- No emissions
- Good storage stability
- High strength levels
- Good flowability
- Robotic handling
- No sand adhesion
- Easy decoring
- Cycle times comparable to Cold-Box

Bending Strength / Flowability Comparison



Emission Measurement under Thermal Load from Molten Metal





- **No condensate build-up**
- **No traceable pyrolysis products of the inorganic core binder**

Organic and Inorganic Binders

When exposed to heat (casting process) and during core production there are **no** unpleasant smelling gases, liquids and solids.

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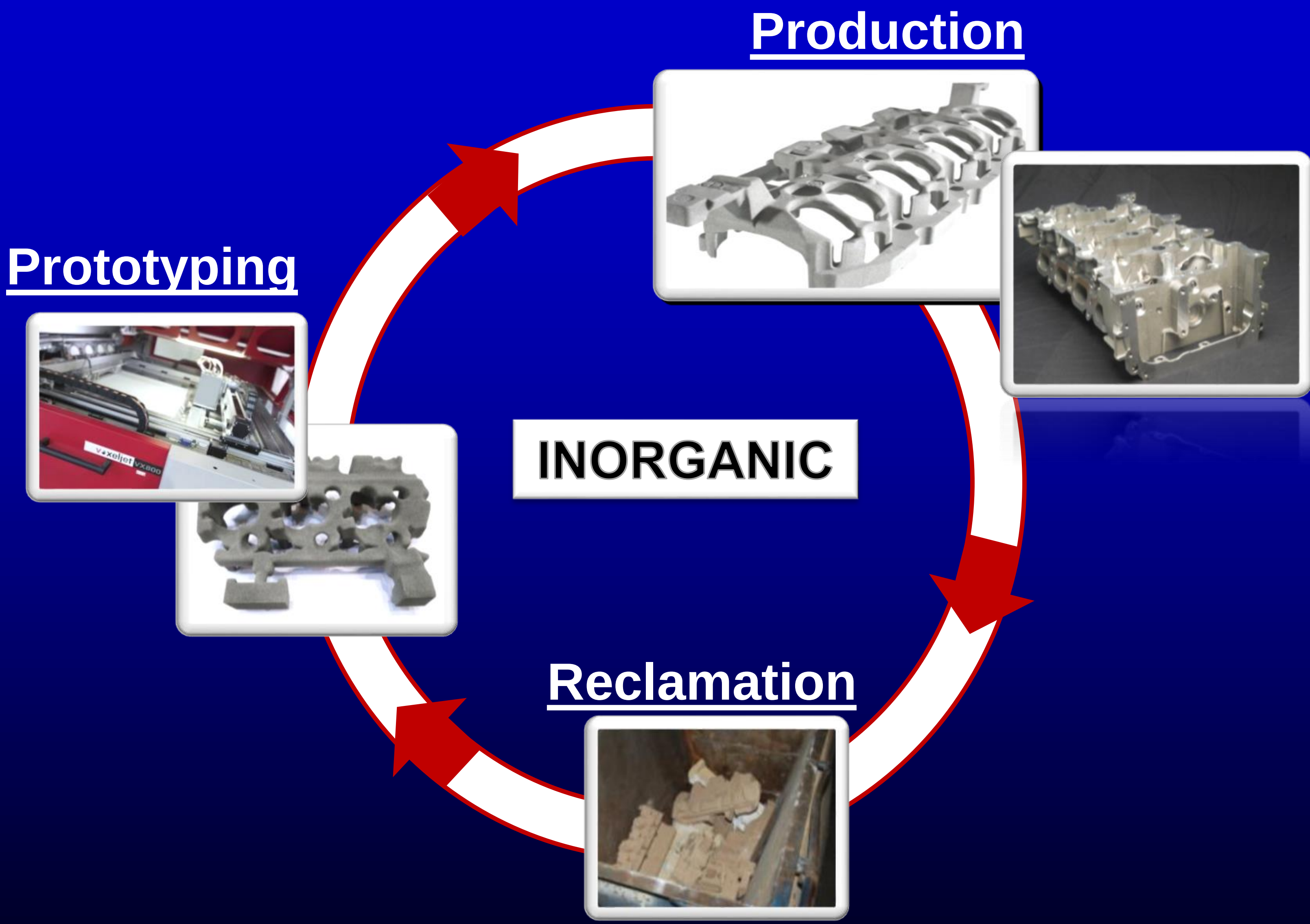
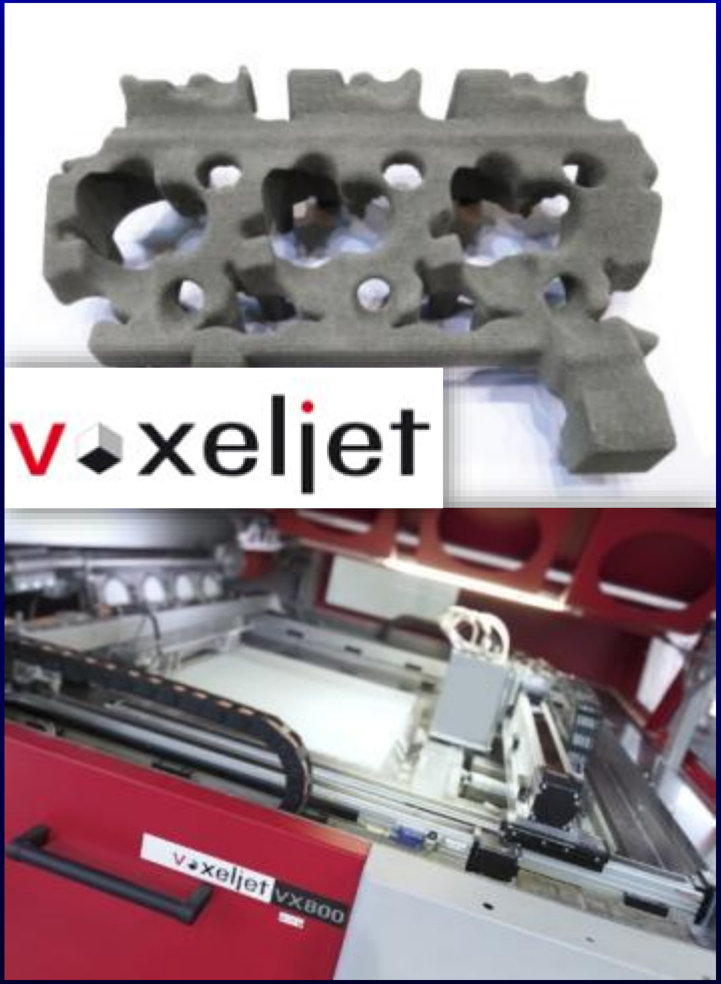
Area of Application



3D Printing

- 100% inorganic binder
- Environmentally friendly – no emissions during casting
- High core strength
- Low gas development
- High resolution and degree of accuracy



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IOB Mass Production @ Mahle

Air-cooled cylinder for chainsaws, brush cutters, grinders, blowers, plant or lawn mowers

Series production since 2006

IOB Mass Production @ KSM Castings

Common rail diesel injection pumps for Volkswagen, BMW and PSA

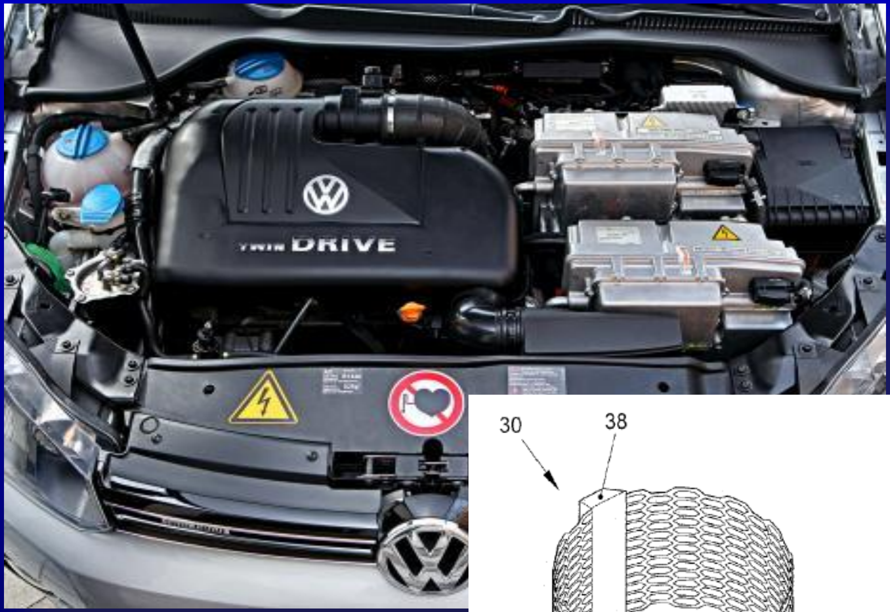

URKUNDE
Preis der Umweltallianz Sachsen-Anhalt
2010
SACHSEN-ANHALT
PREIS DER UMWELT ALLIANZ
2010
SACHSEN-ANHALT
Kategorie
„Nachhaltigste Prozessinnovation"
Der Preis 2010 würdigt herausragende und zukunftsweisende Umweltinnovationen von Unternehmen aus Sachsen-Anhalt.
Einsatz eines anorganischen Bindersystems und mineralölfreie Farbeindringprüfung
KSM Castings Wernigerode GmbH, Wernigerode
Schönebeck, den 16. September 2010
Im Namen der Umweltallianz Sachsen-Anhalt gratulieren
Prof. Dr. Wolfgang Böhmer

Series production since 2009

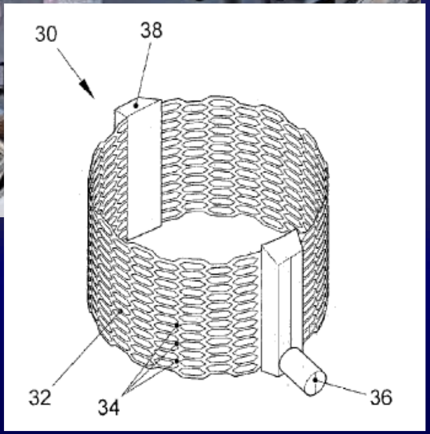
IOB Mass Production @ Volkswagen

Production of CH for EA 288

Production of CH for EA 211



E-Traction



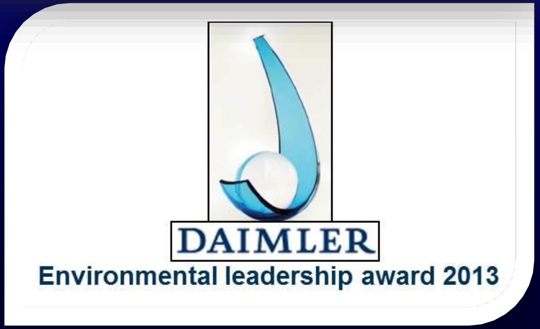
Source: eurocarnews.com; autozeitung.de

Patent DE 102010054496

Series production since 2005

IOB Mass Production @ Mercedes-Benz

Cylinder heads, crankcases M 270 / 274, M 133

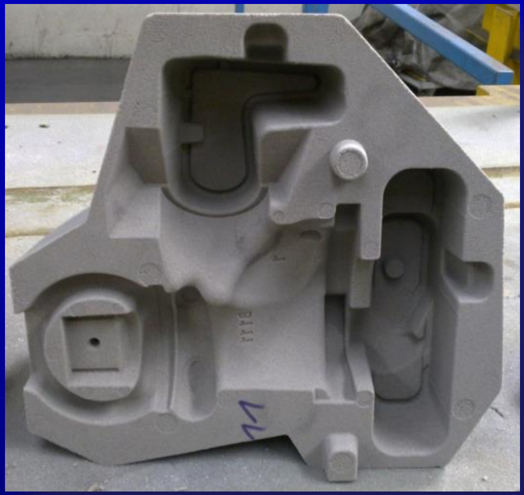


Series production since 2011

IOB in Steel Casting

Production of turbine housings in stainless steel

- The required surface finish can be achieved without additional coating
- Ability to control collapsibility by using special sands or blends with silica sand
- The roughness is equivalent to coated Cold-Box
- IOB does not affect the metallurgy and composition of the metal at the interface



IOB in Brass Casting

- **Mass production @ Hans Grohe**
- **Mass production @ Honeywell**
- **further…..**

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IOB Mass Production @ Mercedes-Benz

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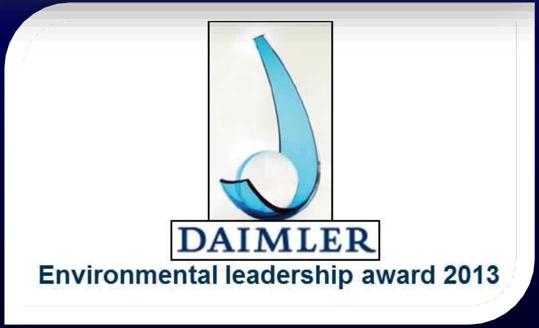


Series production since 2011

Structure of the Core Package

Top core approx. 18 kg

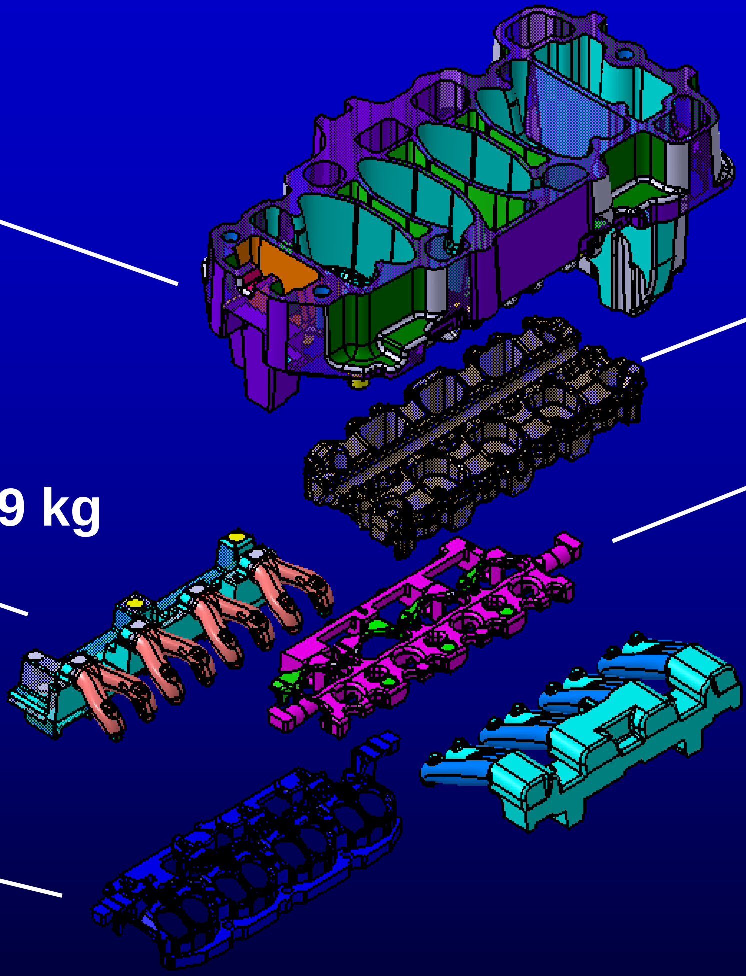
Oil chamber approx. 2.3 kg

Upper water jacket approx. 0.9 kg

Outlet approx. 1.9 kg

Inlet approx. 1.9 kg

Lower water jacket approx. 0.8 kg



Inorganic Binders Lead to Change

Core design

- Volume
- Geometry

Tool design

- Radii
- Heating

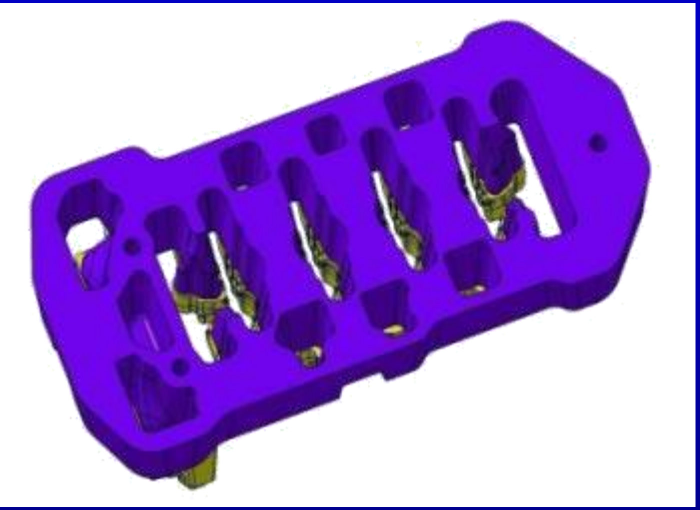
Core manufacturing and casting processes

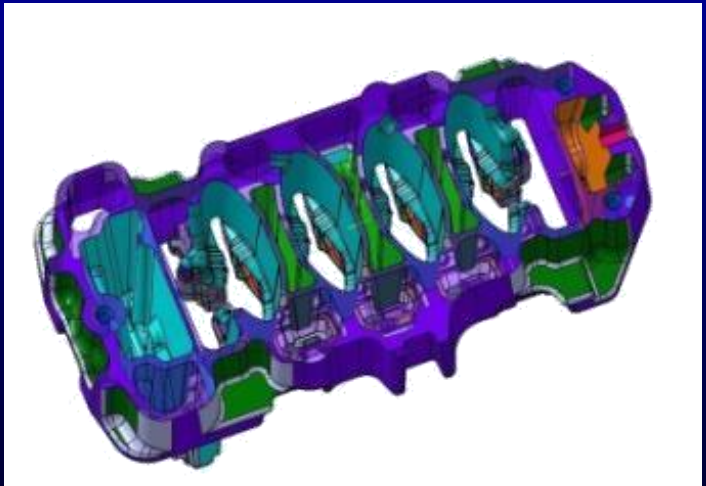
- Cycle time
- Design of the core shooter
- Decoring
- Sand regeneration

Changes to Top Core

**Start with Cold-Box,
series with inorganic binder**

- **Quantity of shooting nozzles and vents was adjusted**
- **The core volume was reduced by approx. 30 %.**
- **Shooting position of the core in the core box was rotated by 180°**

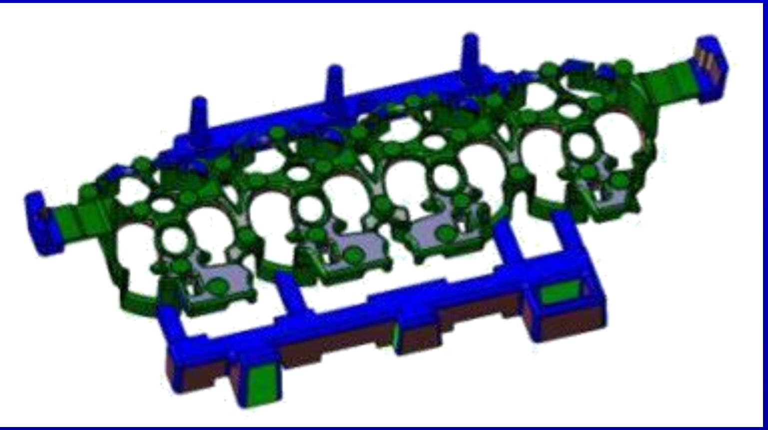


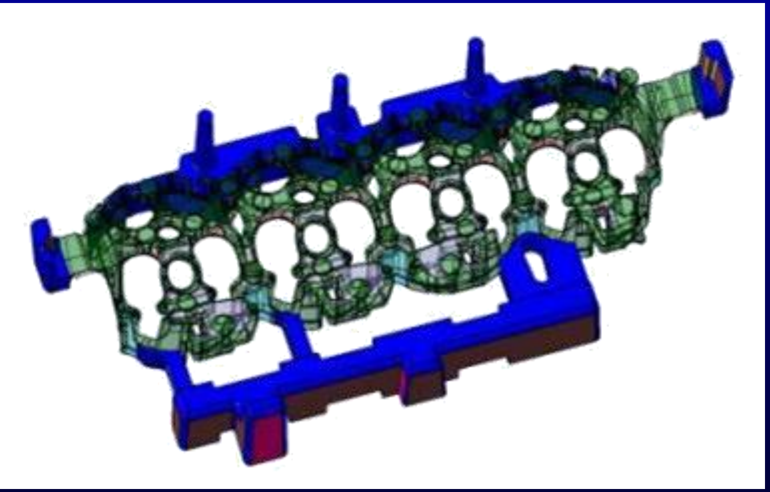


Changes to the Lower Water Jacket

**Start with Cold-Box,
series with inorganic binder**

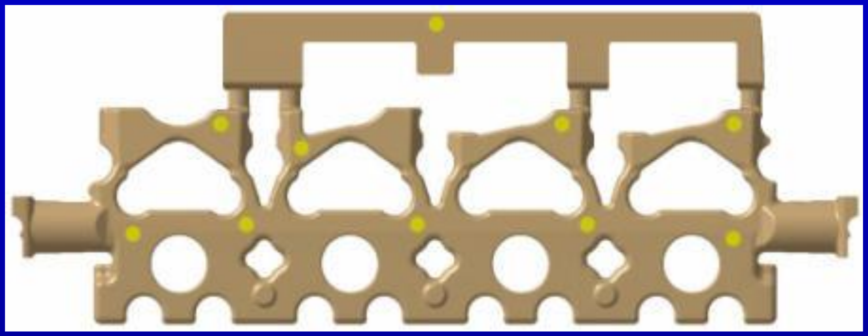
- **Quantity of shooting nozzles and vents was increased**
- **Core volume was increased by (approx. 2 %)**
- **Shooting position of the core in the core box was rotated by 180°**

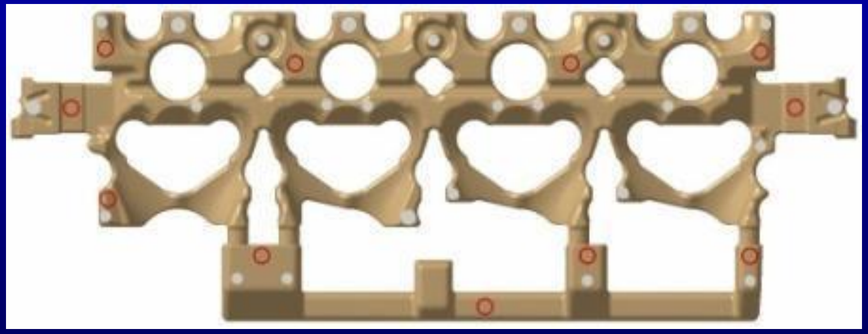




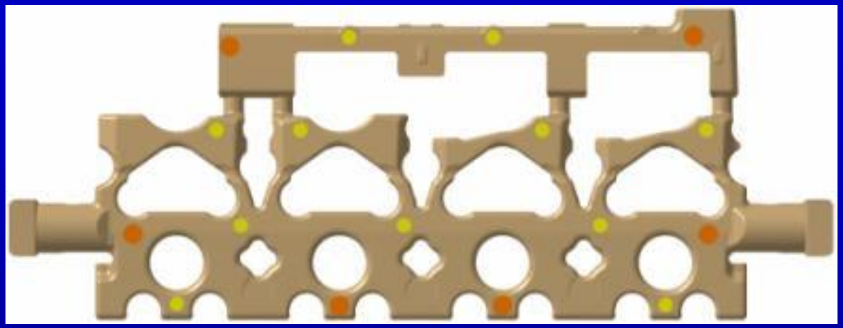
Inorganic Binder Water Jacket Core

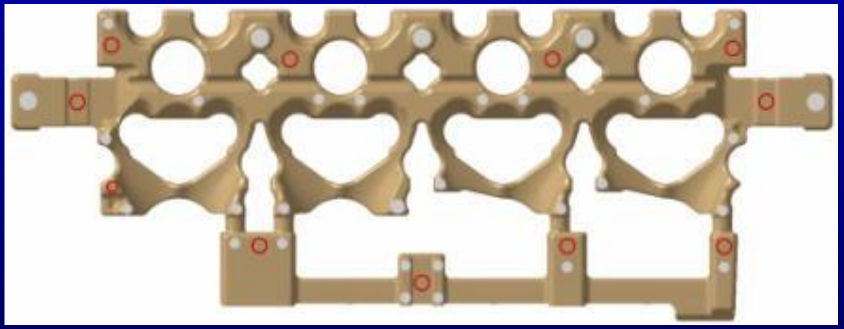
Version1





Version 4



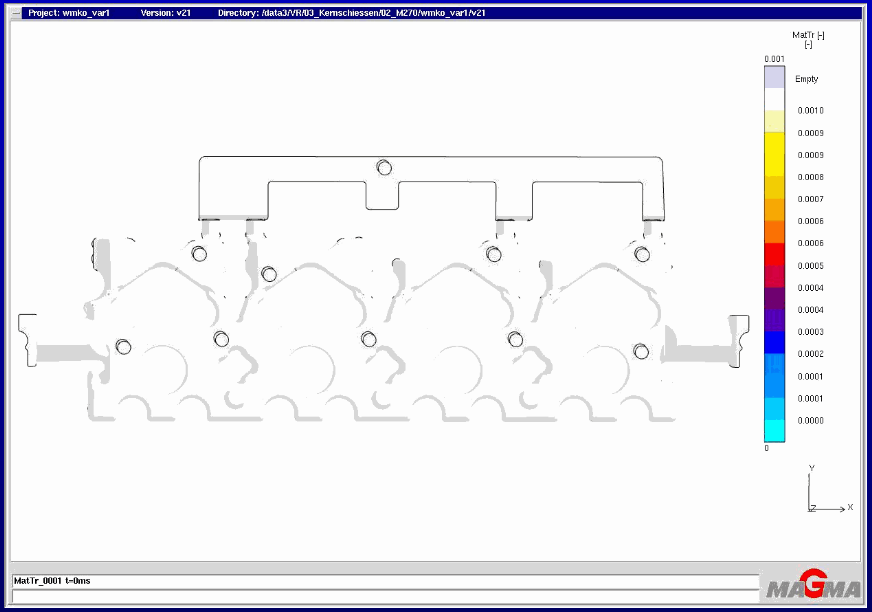


- **Shooting nozzle 11 mm**
- **Shooting nozzle 8 mm**
- **Vents**
- **Ejector**

Source: Münker Daimler AG

Inorganic Binder – Sand Flow Behind Nozzles

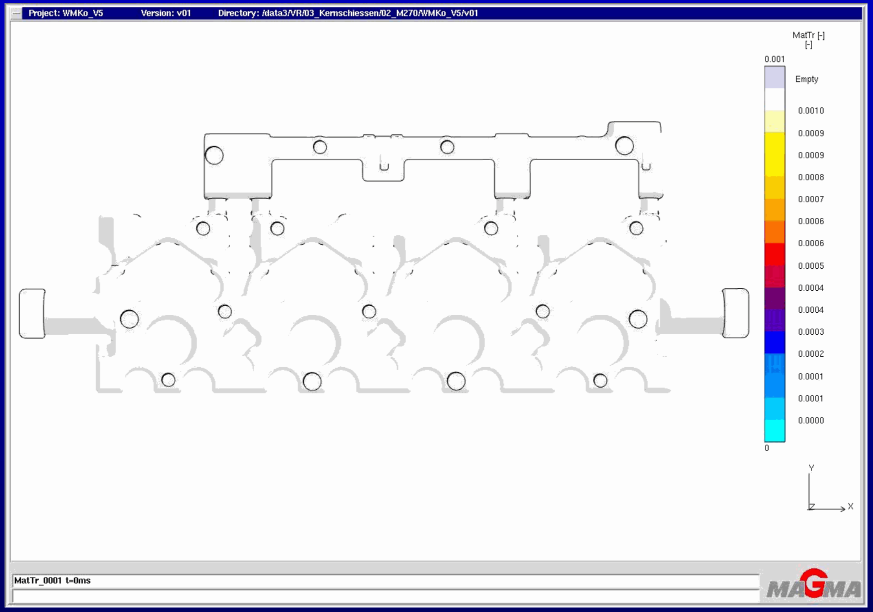
Version 1



Fewer nozzles

Filling time: 500 ms

Version 4



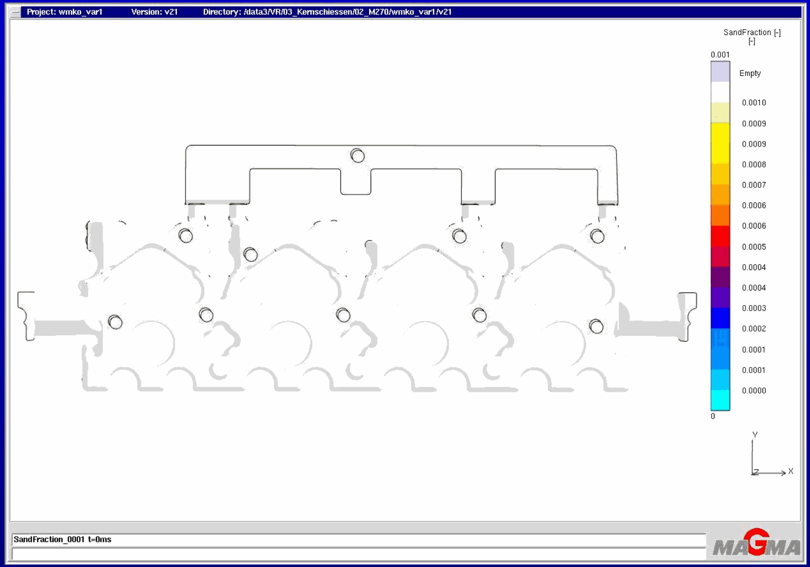
More nozzles

Filling time: 212 ms

Source: Münker Daimler AG

Inorganic Binder – Sand Compactibility

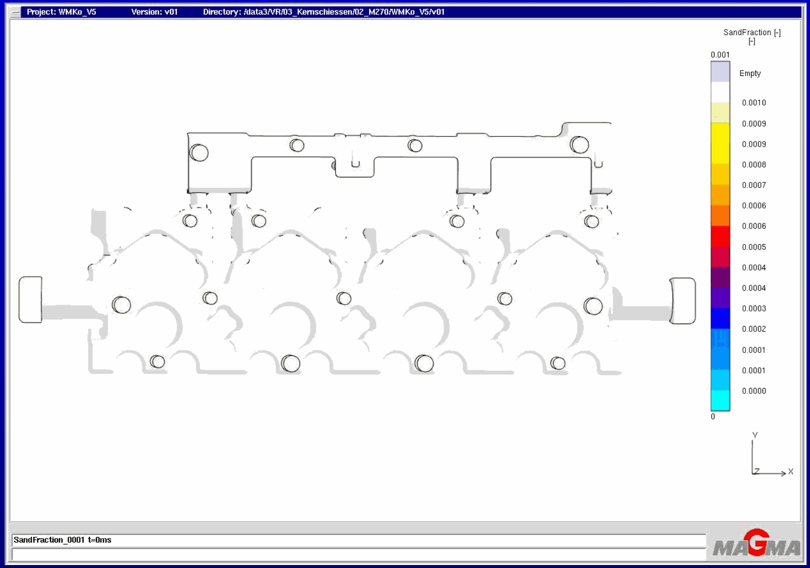
Version 1



- Long filling time
- Unbalanced filling
- Several less compacted areas

Not suitable for implementation in a tool

Version 4



- Shorter filling time
- Balanced filling
- Good campactibility of the core

Basic concept for tool manufacturing

Source: Münker Daimler AG

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Economic Aspects

Inorganic binder systems also have economic benefits. Looking at the cost-benefit ratio it becomes clear that the decision for inorganic binders is a financially viable option in the long term:

- **Most available equipment / systems can be used further** ➡
- **Cycle times that are common today are obtained** ➡
- **Binder costs are similar** ➡
- **No exhaust treatment in the core shop and the foundry** ✓

Economic Aspects

- **Automated core handling** ✓
- **Higher gravity die availability, less die wear** ✓
- **Similar or even better quality of castings** ✓
- **Stable and reliable process handling** ✓
- **Energy cost (tool heating, shooting head cooling)** ↑
- **Tool cost (heating, nozzles, vents)** ↑

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Reclamation of Inorganic Used Sand

1. Crush

2. Mechanical step
   - Remove residual binder from the sand grain by means of scrubbing or direct impingement

3. Thermal step
   - Embrittle the residual binder
   - Trigger condensation reactions

4. Cooling

5. Grading

Reclamation of Inorganic Used Sand

- 100 tons of inorganic used (spent) sand reclaimed
- Efficiency approx. 85 – 90 %
- 5 cycles
- No significant deviations from the parameters
- All cores manufactured using 100% reclaimed sand
- Approx. 2000 saleable castings manufactured

The reclamation of inorganic spent sand with residual binder is possible and reproducible.

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Conclusion

- Inorganic process is well established in series production of non-ferrous parts.
- Inorganic process is suitable for production of stainless steel thin wall complex casting.
- Conversion to inorganic process lead to several changes in the production
- The reclamation of inorganic sand is state of the art.
- Inorganic binder systems also have economic benefits.

Thank you for your attention!