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**7<sup>th</sup> International Ankiros Foundry Congress**  
**7. Uluslararası Ankiros Döküm Kongresi**



**«New Coatings and Additives Concepts: An entire approach for defect and residue free castings»**

**«Yeni Kaplamalar ve Katkı Malzemeleri ile Hatasız ve Kalıntısız Döküm»**

**Dr. Reinhard Stötzel, Hilden**  
**Christian Koch, Hilden**  
**Ismail Yilmaz, Hilden**  
**Hasan Dağlı, Ankara**  
**(ASK Chemicals)**

**3.Oturum: Döküm Teknolojileri Demir - Çelik**  
**3rd Session: Casting Technologies Iron - Steel**

**Oturum Başkanı/Session Chairman: Seyfi Değirmenci (Componenta Döküm. Tic. San. A.Ş.)**





# **New coatings and additives concepts**

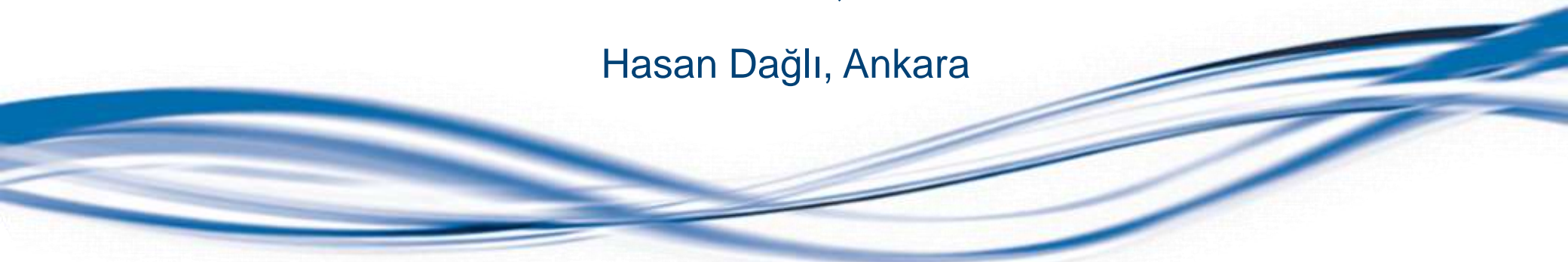
## **An entire approach for defect and residue free castings**

Dr. Reinhard Stötzel, Hilden

Christian Koch, Hilden

Ismail Yilmaz, Hilden

Hasan Dağlı, Ankara





## Trends & Challenges in the Foundry market

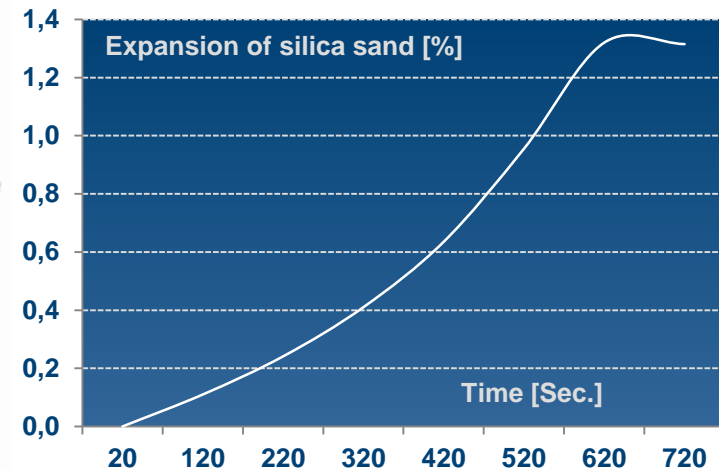
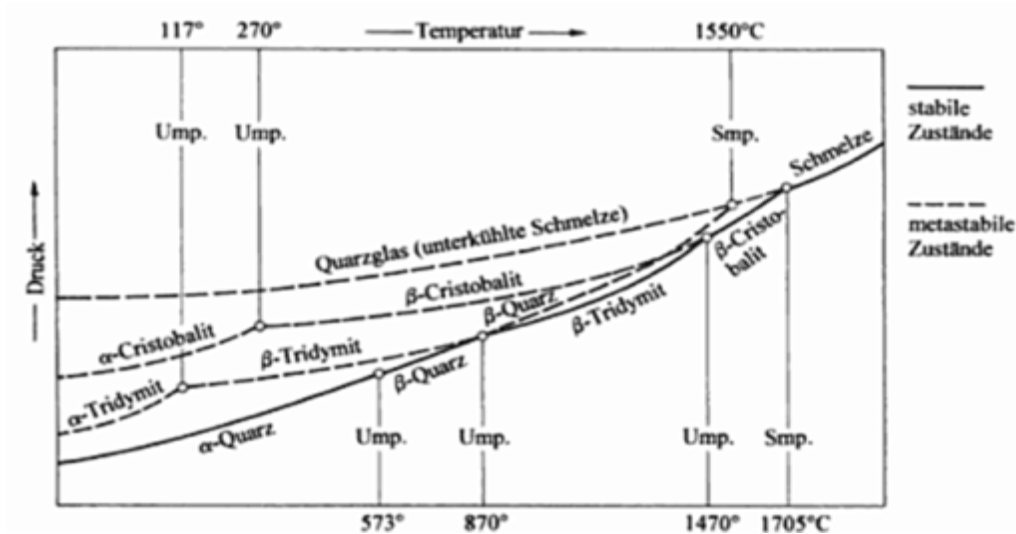
- ✓ Downsizing in the automotive industry require more precise casting dimensions
  - Core package
  - Low layer or no coating
  - Reproducible coating layer
- ✓ Productivity will be one important driver for competitiveness
- ✓ More environmental pressure are forced on foundries
- ✓ Energy resources are limited, and will have an effect on the casting costs

## Why do we need sand additives?

- ✓ To avoid casting defects:  
such as veining's, linked to the sand expansion, lead to rework and often to scrap
- ✓ To keep the process stability (irregularities in process)  
Considering many special casting conditions (geometry, temperature, material grade, etc.), the properties of molding material, binders and core coatings are not enough to guarantee process-reliable and profitable casting production
- ✓ Cost Saving:  
Omission or reduction of special sands (chromite...)  
Casting without coating process



## Why do we need sand additives?



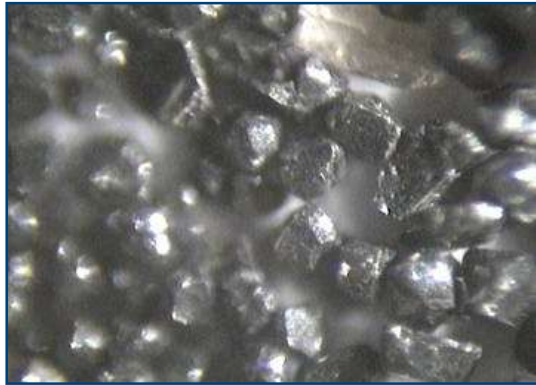
- During the conversion from  $\alpha$ - $\text{SiO}_2$  to  $\beta$ - $\text{SiO}_2$ , the sand grains expand by approx. 1.3%.
- This leads to enormous stress inside the core as well as at its surface.
- Cracks form at the core surface which fill with liquid metal, resulting in casting defects commonly known as veining.







## Special sands and minerals



***Chromite***



***J-Sand***



***Zircon sand***



***Ceramic beads  
(e.g. Cerabeads, bauxit sand)***

### Advantages:

- Very efficient against casting defects
- Low gas emissions

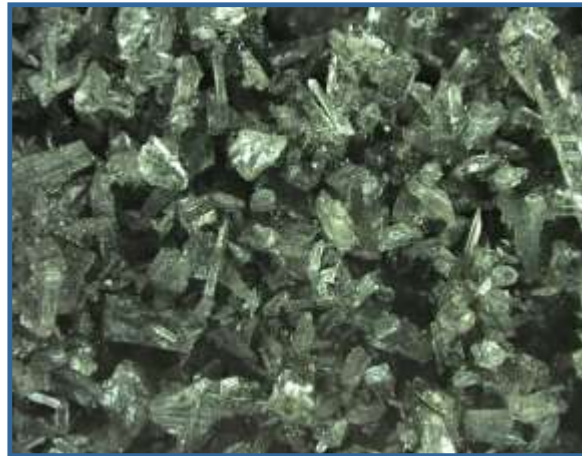
### Disadvantages:

- Very high material costs
- Effects on green sand

## Comparison of different sand additives



Organic

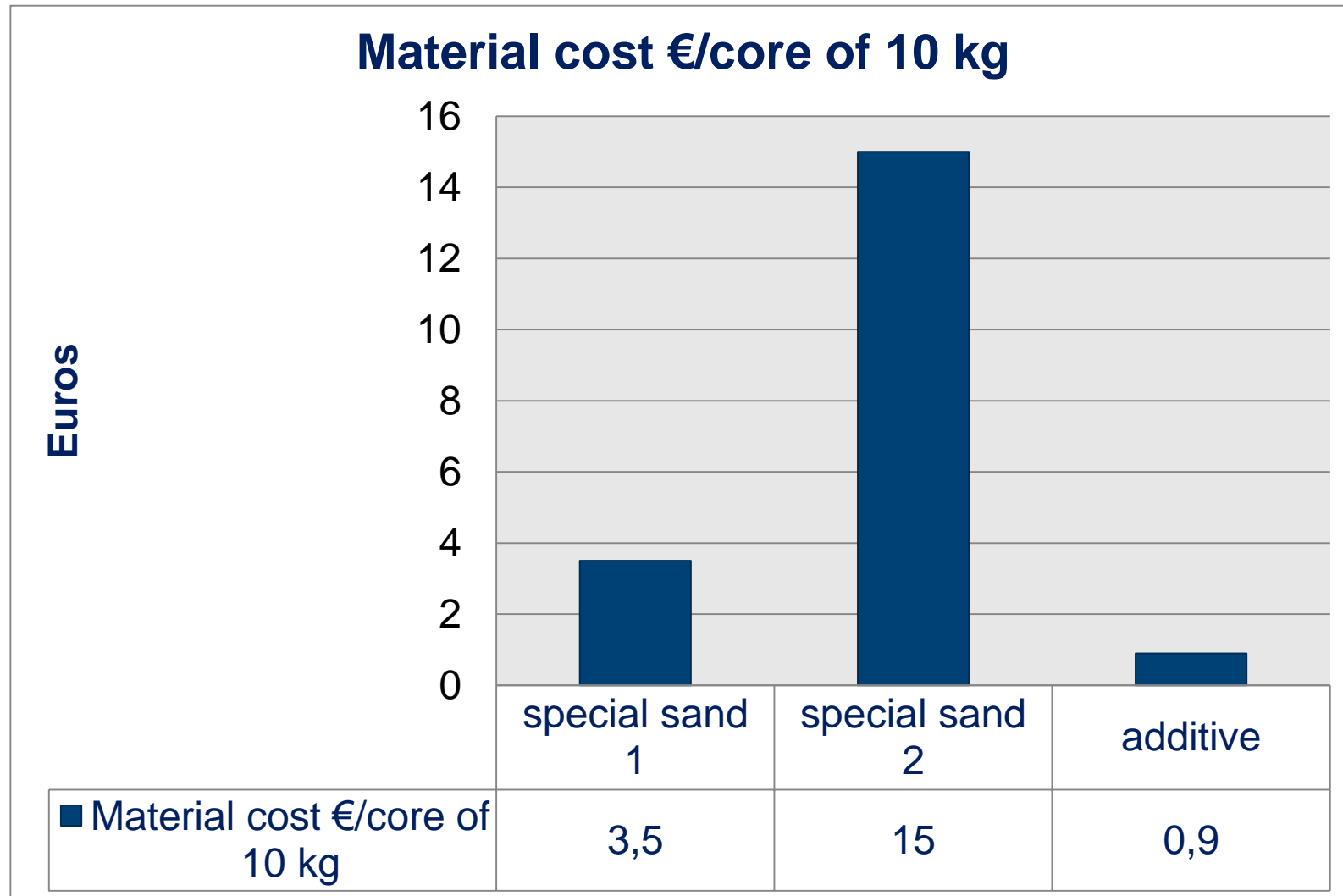


Hybrid



Inorganic

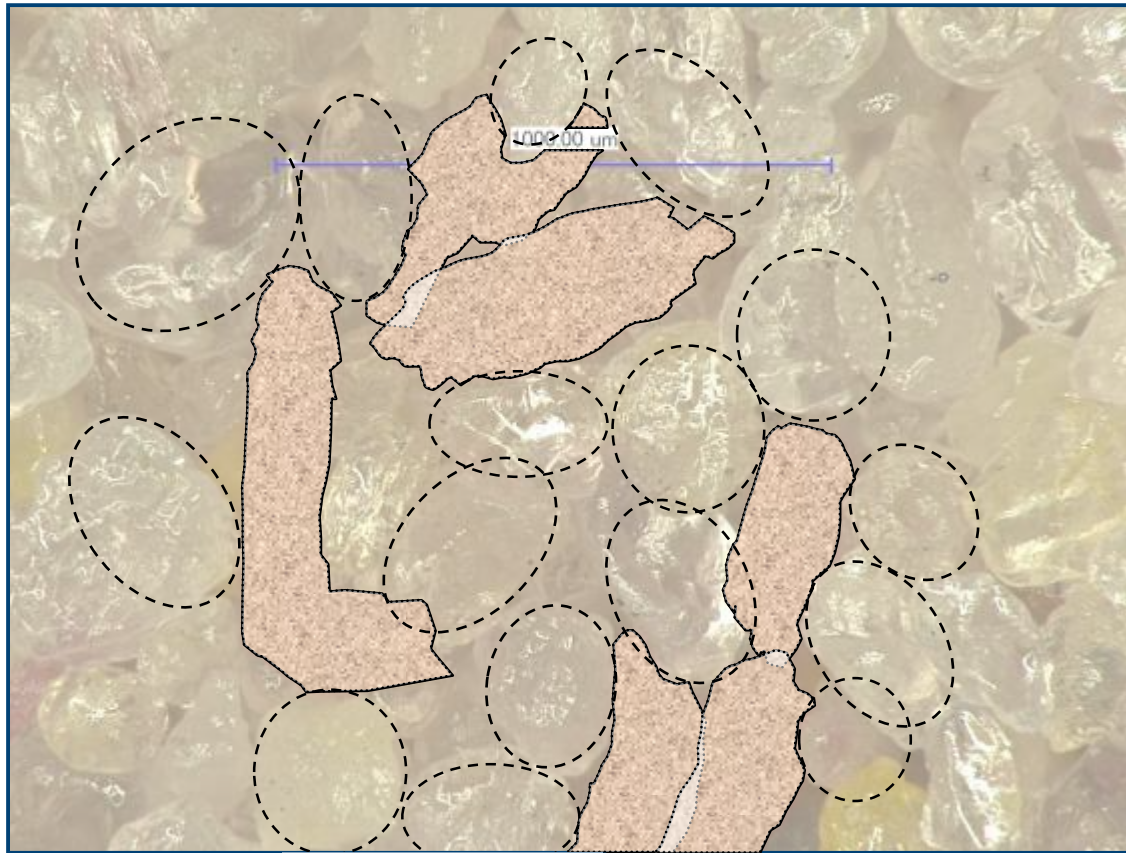
## Comparison of different sand additives







## How do sand additives work?



- The organic components will burn, carbonize and soften in the pouring process.
- The sand grains are thus able to expand into the recently formed spaces



## How do sand additives work?



- The minerals develop a pasty transition phase which acts as a buffer against silica expansion and absorb more stress before cracking
- Negative thermal expansion

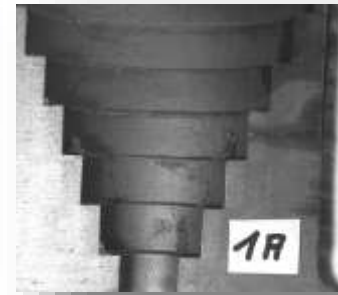
## Requirement Profile

- ✓ Reduction of
  - Expansion defects (e.g. veining)
  - Deformation
  - Penetration
  - Burn in
  - Gas defects
- ✓ Low addition rate
- ✓ Neutral odor
- ✓ Low dust formation
- ✓ Compatibility with coating
- ✓ Strength profile according to the application (neutral or as a breakdown promoter )
- ✓ Low gas and emission evolution
- ✓ Dimensional accuracy
- ✓ Low core box staining
- Economical advantage

# „Engineered Sand Additives“ (ESA's)

**ESA 1** with chromite sand and silica sand

Stepcone test  $\Rightarrow$  partial coated & uncoated



100 pt chromite sand  
no additive  
 $\Sigma$  1.5% CB-Binder

**Result:**

- heavy penetration



50 pt chromite sand  
50 pt H32 + 5% ESA 1  
 $\Sigma$  2.1% CB-Binder

**Result:**

- Better surface



50 pt chromite sand  
50 pt F33 + 5% ESA 1  
 $\Sigma$  2.1% CB-Binder

**Result:**

- Almost clean surface





# „Engineered Sand Additives“ (ESA's)

## **Standard sand mixture:**

100% chromite sand,  
0.75% Binder per part

## **Probemischung:**

50% chromite sand,  
50% fresh silica,  
4% ESA 4  
0.70% Binder per part

**Possible costs reduction    €150.000**



Water gallery  
water channel core





# „Engineered Sand Additives“ (ESA's)

## Cylinder head

Standard recipe:

30 % chromite sand AFS 50  
30 % chamotte sand AFS 50  
40 % silica sand AFS 50

5 % Additive



Trial:

100 % silica sand  
3 % ESA 2

# „Engineered Sand Additives“ (ESA's)

**Cylinder-head, water jacket core:**

Standard recipe:

100 % J Sand

1,5 % organic additive



Trial:

50 % silica sand

50 % J Sand

4 % ESA 3





# „Engineered Sand Additives“ (ESA's)

Thyssen Krupp Waupaca  
– Tell City, IN

Brake rotor cores:

1.5% ESA 5 addition  
vs. 4% normal addition

Casting

- 100 castings
- Alternated on line with production cores to ensure same conditions





# „Engineered Sand Additives“ (ESA's)

Furan warm box cores converted to new additive August, 2010

Continuing to operate at low additive levels

No increase in veining

No production issues





100 % silica sand H 32  
2 % ESA 3  
coated





# „Engineered Sand Additives“ (ESA's)

Portuguese sand 65/70 AFS + 1.7% CB Binder + 3% ESA 1 uncoated  
Previous practice: IPA/graphite coating





# „Engineered Sand Additives“ (ESA's)

Previous 2,4 % additive, coated  
Now 2,4 % ESA 3, uncoated



Center bearing,  
Ductile Iron, 125 kg casting weight



# „Engineered Sand Additives“ (ESA's)

Comparison SiMo-Manifold  $\Rightarrow$  coated and uncoated



100 T silica sand blend (H32/H33)

$\Sigma$  1.2% CB-Binder  
- coated



100 T silica sand blend (H32/H33)

+5% ESA 1  
 $\Sigma$  1.6% CB-Binder  
- uncoated

# „Engineered Sand Additives“ (ESA's)

## Brake caliper:

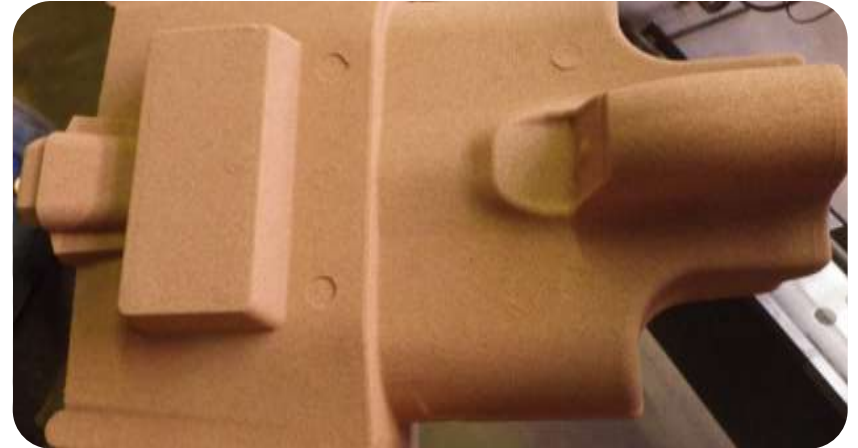
Standard recipe:

100 % silica sand, no additive, coated

Now (introduction phase):

100 silica sand

4 % ESA 2, uncoated





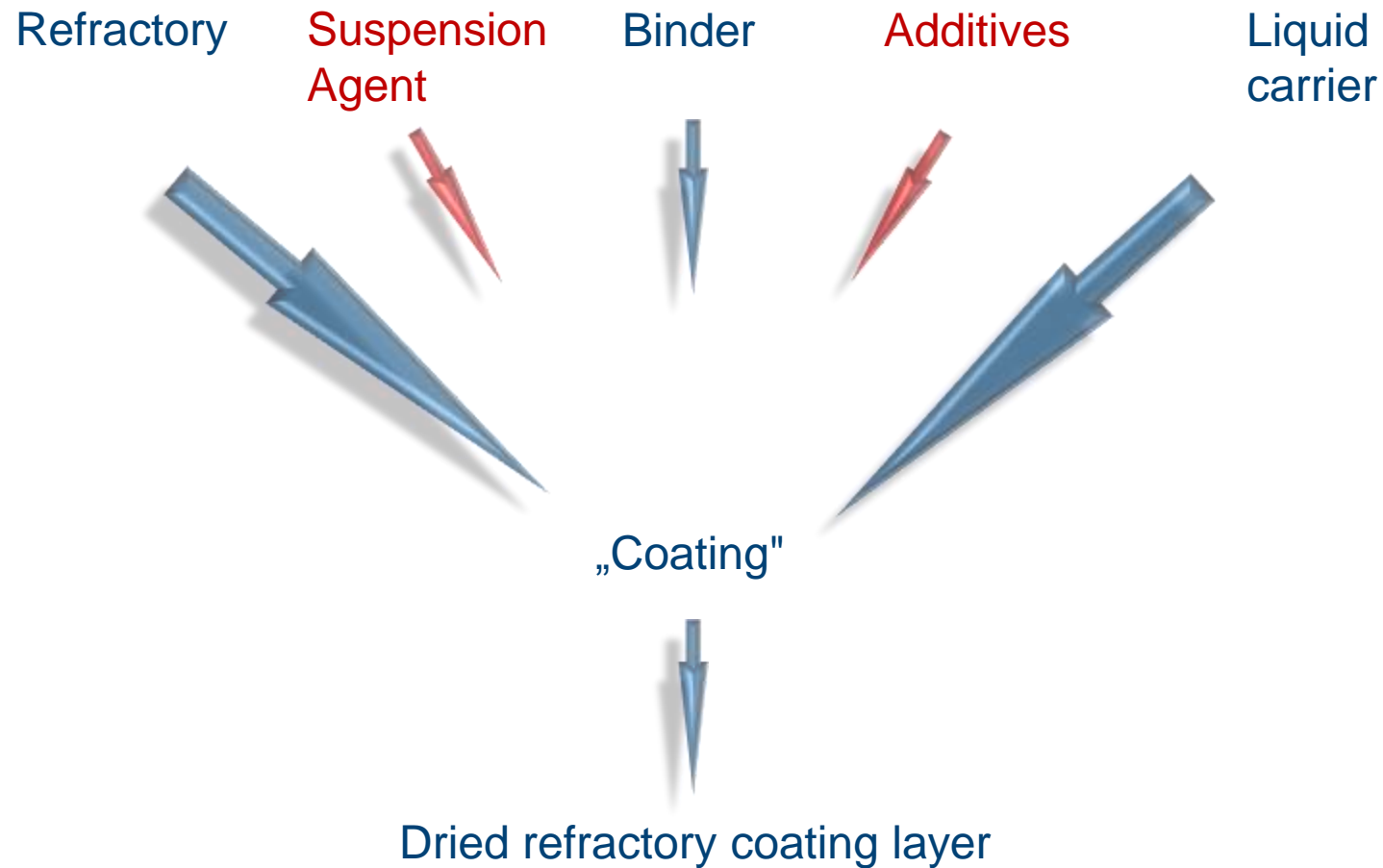


# Enhanced Coatings

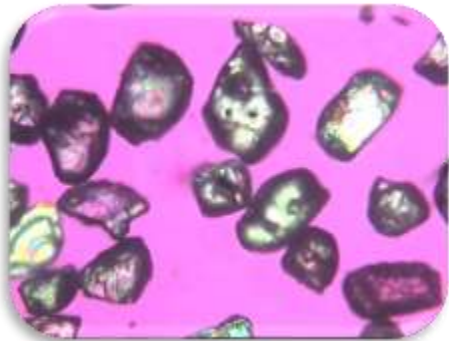




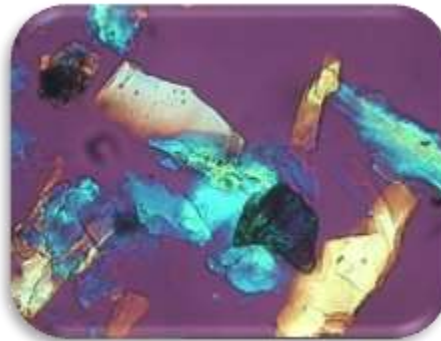
# How Are Coatings Designed



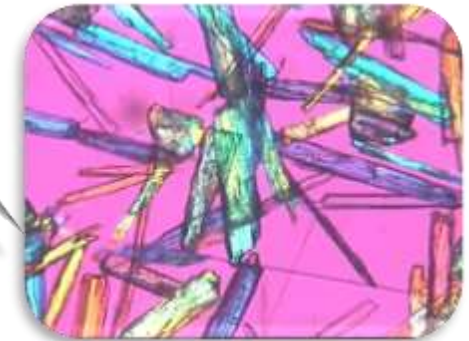
# Types of Coatings



Grains



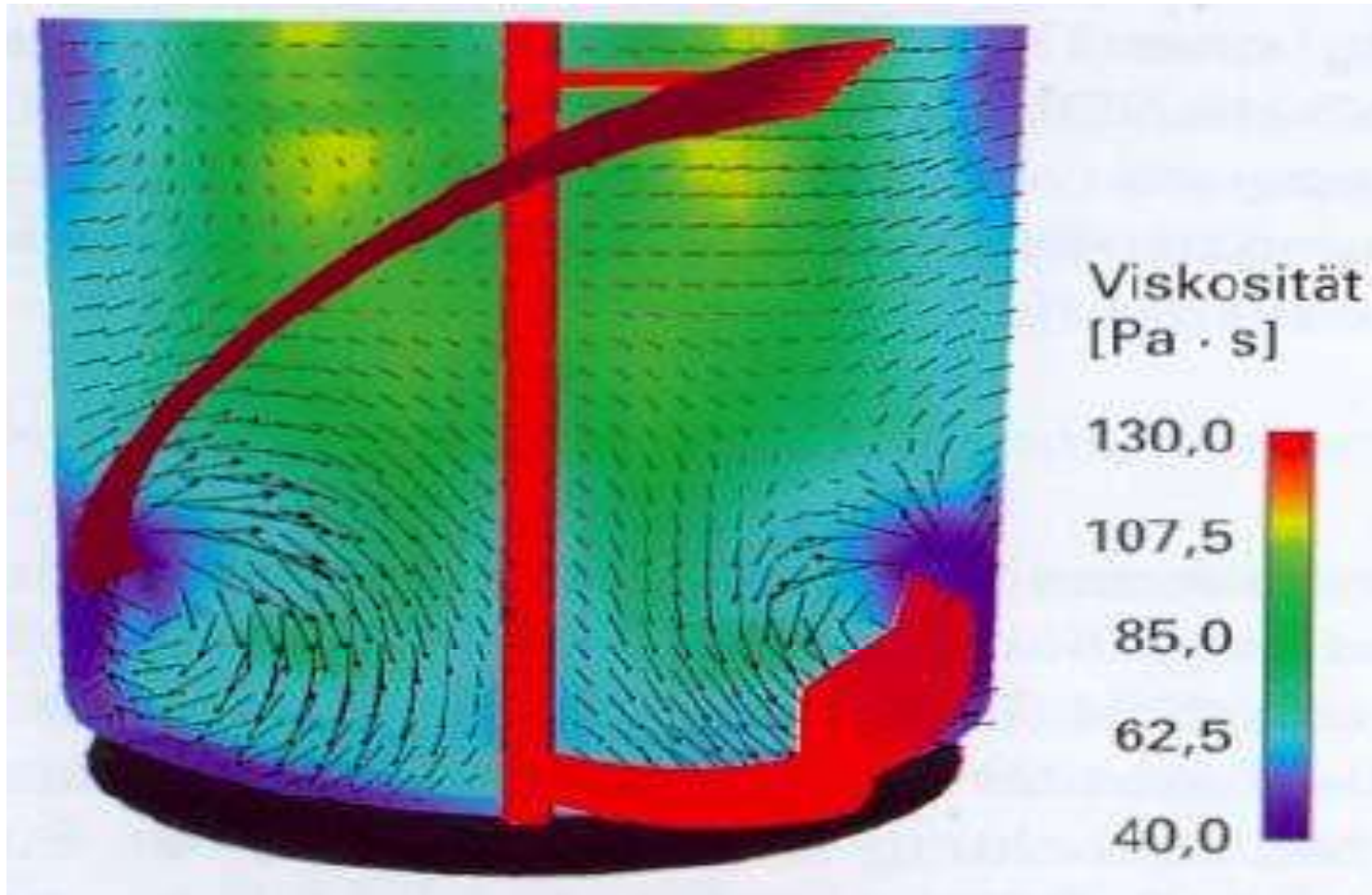
Plates



Refractory	Density g/cm <sup>3</sup>	Meltingpoint °C	Morphology	Chemical formula	Application
Zircon-silicate	4,6	2200	angular	ZrSiO <sub>4</sub>	Steel
Corundum	4,0	2050	angular	Al <sub>2</sub> O <sub>3</sub>	Steel
Magnesite	3,7	2800	angular	MgO	Manganese steel
Mullite	3,16	1700	angular	3 Al <sub>2</sub> O <sub>3</sub> · 2 SiO <sub>2</sub>	Iron
Graphite	2,3	3700	Plates	C	Iron, Aluminium
Kaolinite	2,65	> 1700	Plates	Al <sub>2</sub> ((OH) <sub>4</sub> /Si <sub>2</sub> O <sub>5</sub> )	Iron
Pyrophyllite	2,8	1600	Plates	Al <sub>2</sub> ((OH) <sub>2</sub> /Si <sub>4</sub> O <sub>10</sub> )	Iron, Aluminium
Talc	2,8	> 1000 max. 1430	Plates	Mg <sub>3</sub> ((OH) <sub>2</sub> /AlSi <sub>4</sub> O <sub>10</sub> )	Iron, Aluminium
Mica	2,85	> 900	Plates	KAl <sub>2</sub> ((OH) <sub>2</sub> /AlSi <sub>3</sub> O <sub>10</sub> )	Iron, Aluminium



## The Importance of Rheology



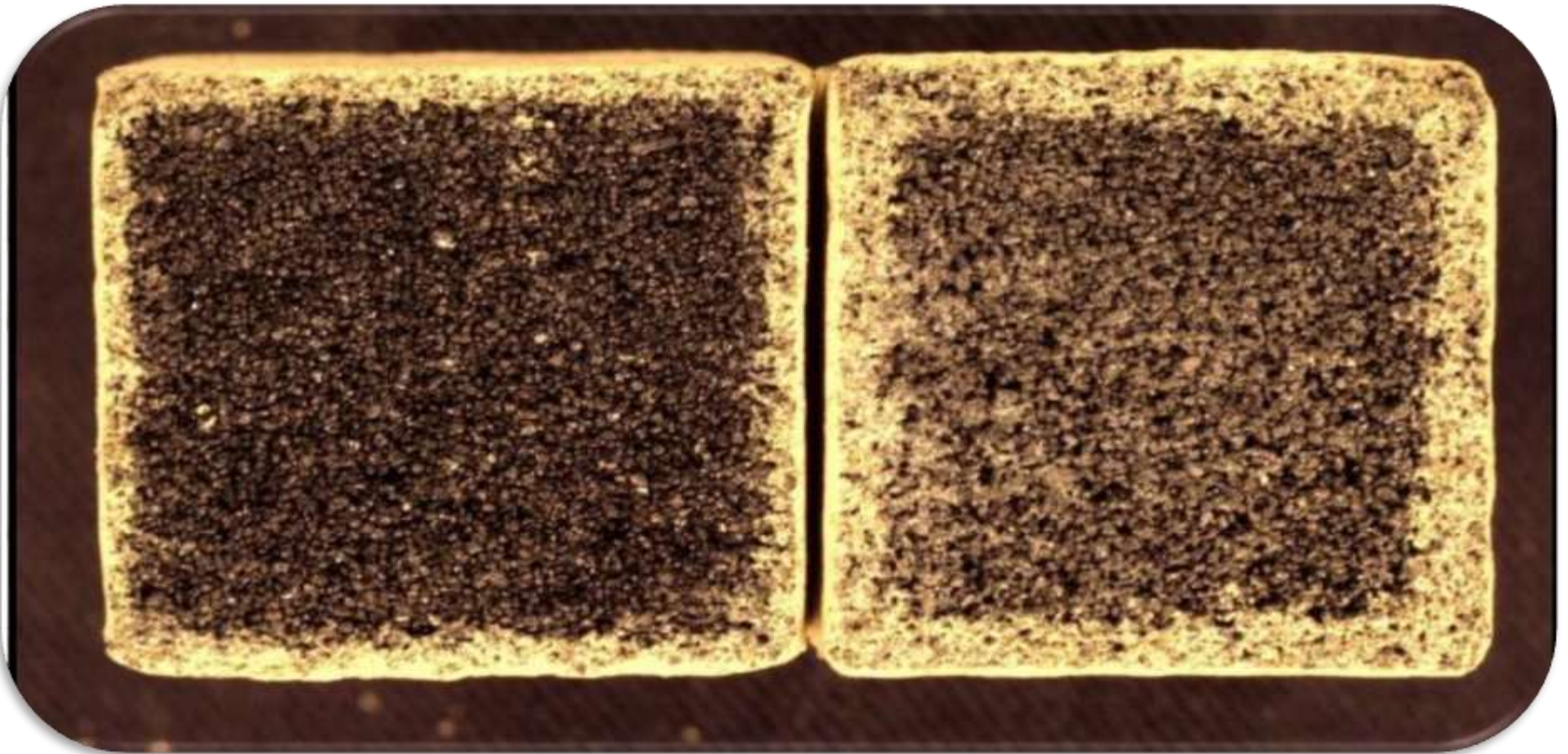
## The Importance of Rheology





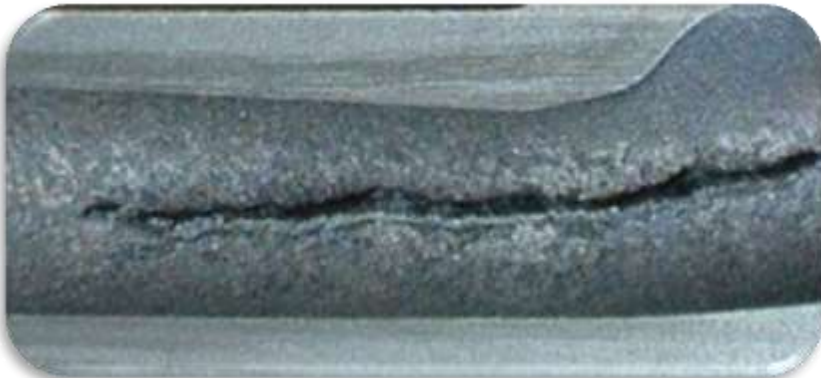


## Crankcases/Blocks





## Crankcases/Blocks



## Crankcases/Blocks

Casting	Fettling		Savings
	S	Miratec	
3-cyl. head SISU	8.57 min.	5.27 min.	38.5%
4-cyl. block DEUTZ 2009	34.00 min.	27.97 min.	17.7%
4-cyl. head DEUTZ 2009	13.87 min.	7.44 min.	46.4%

Casting	Brake disc veining		Savings
	S	Miratec	
VW DISALINE	15%	5%	38.5%

## Crankcases/Blocks

### MIRATEC® MB Types



## Washing or New Core Wash?

Millennium: IT Problem?

Metal bearings are banned to be used in vehicles.

The alternative materials don't have emergency running properties

The oil filters have only a limited capacity

Therefore: Residual contamination requirements are restricted to less than 300 to 1000 mg/part, depending on the car company





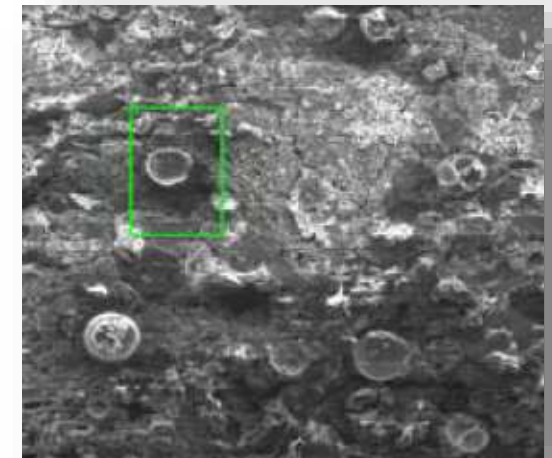
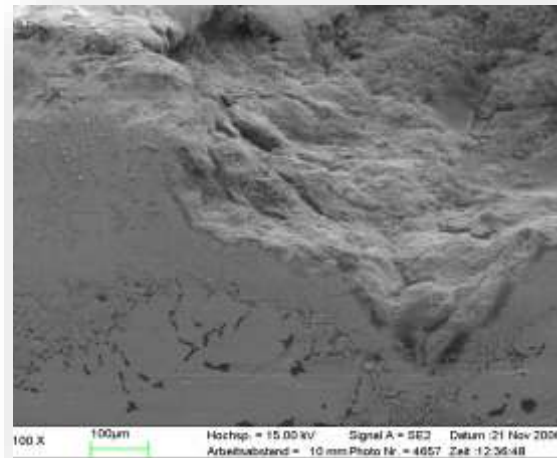
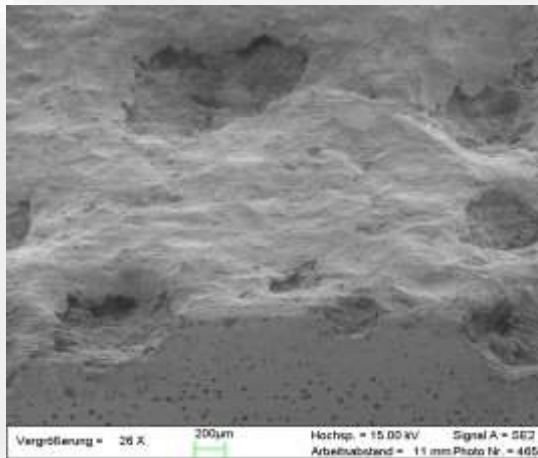
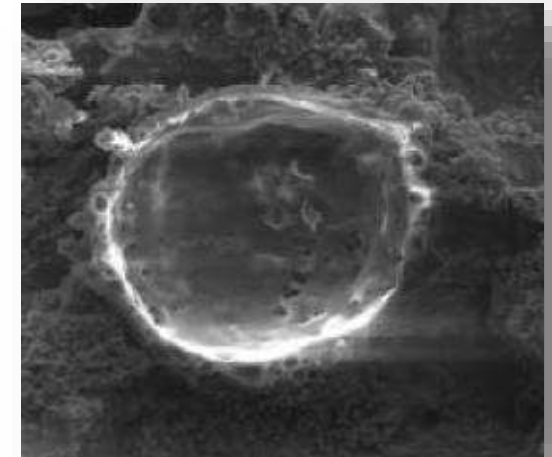
## Washing or using New Core Wash?





# Coatings to Prevent Adhesion

- Formation of liquid  $\text{FeO}_x$ -Phase
- Scarred surface with holes
- Reaction layer and products
- Expanded structure



## Coatings to Prevent Adhesion

1 flaky



2 powdery



# MIRATEC® TS

The special coating for clean motor block casting

ASKCHEMICALS  
We advance your casting



## Special coating for clean motor block castings

### APPLICATION

Essential requirement of motor block castings is easy peeling of the coating in internal casting geometries as well as the avoidance of deposits in the casting component.

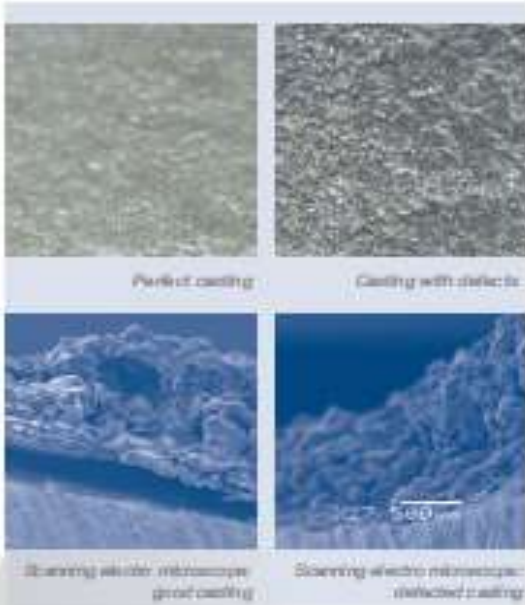
MIRATEC® TS coating from ASK Chemicals is the ideal solution to perform the high demands of clean and perfect motor block castings.

Particular benefits with special properties of MIRATEC® TS:

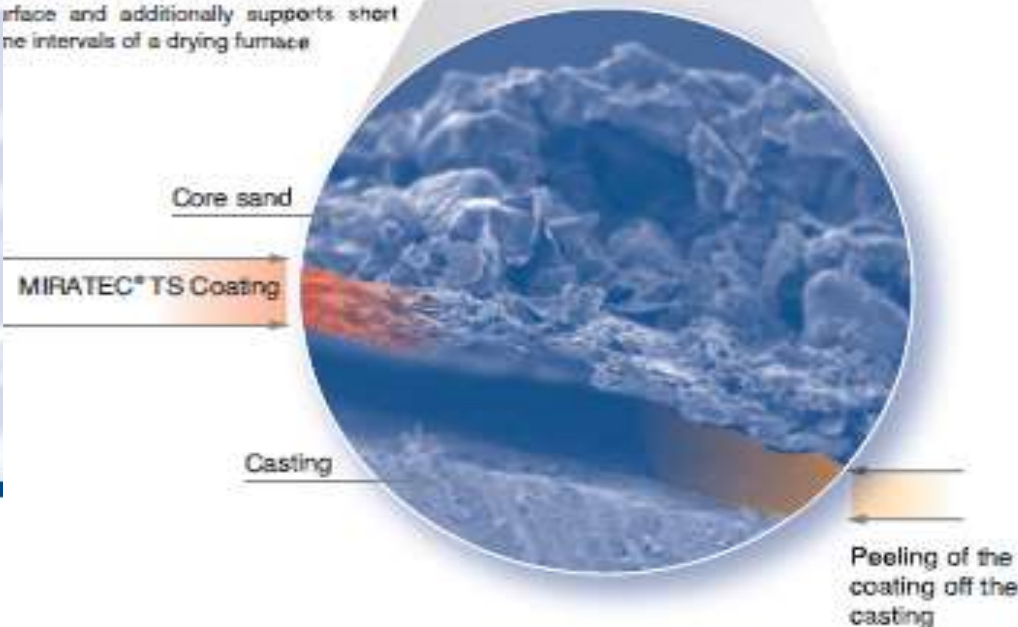
Most suitable for thermally stressed sand cores  
Avoids usual defects which can occur with motor block castings like veining, penetration or gas porosity are to be avoided by an improved adhesion of refractory material

Lowest possible gas permeability even with very thick coating layers due to an exactly balanced combination of refractory material

Contains special penetration inhibitor which stops the migration of water into the sand core surface and additionally supports short drying intervals of a drying furnace



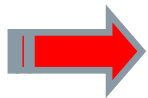
- Easy peeling of the coating in internal casting geometries that are difficult to access for shot-blasting
- Cost savings due to reduced cleaning efforts
- Significantly less deposits in the motor part
- A water based coating for environmentally friendly conditions in your foundry
- Suppression of casting defects like veining, penetration or gas porosity







## Cylinder Heads



Veining + penetration + scabbing (+ gas) incl. oil channels etc.  
= veining + penetration





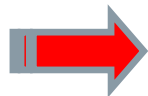
# Cylinder Heads



MIRATEC® CH Types



## Vented Brake Disks



Veining + penetration + gas

## Vented Brake Disks



MIRATEC® BD Types

## Summary

- ✓ With the New ESA's sand properties are enhanced:
  - Elimination of special sands
  - Reduced addition rates
  - Elimination of the coating process especially on Ductile Iron castings
- ✓ Novel MIRATEC™ TS Coatings provide defectfree castings with the required minimum residue for automotive castings



# Thank you!



# THANK YOU FOR YOUR ATTENTION

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