



FREEDOM OF CREATIVITY: COATINGS & ADDITIVES FOR ENHANCED CASTING PROPERTIES

H. Kakac, Dr. R. Stötzel, C. Koch, I. Yilmaz

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



AGENDA

- ✓ Why do we need sand additives?
- ✓ How do the sand additives work
- ✓ Properties of various sand additives
- ✓ Experiences and practical results

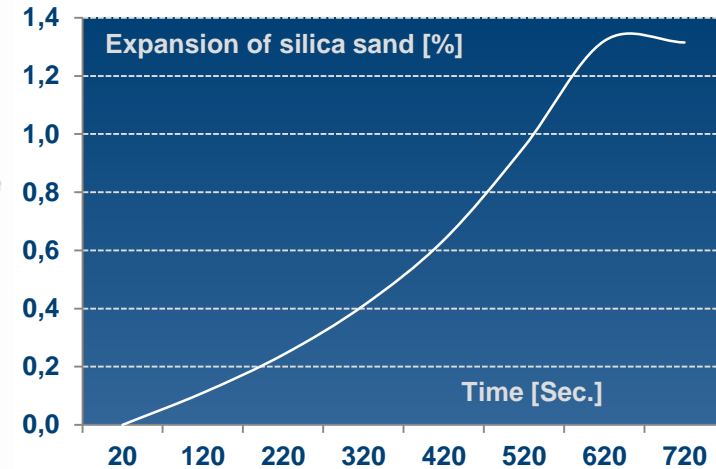
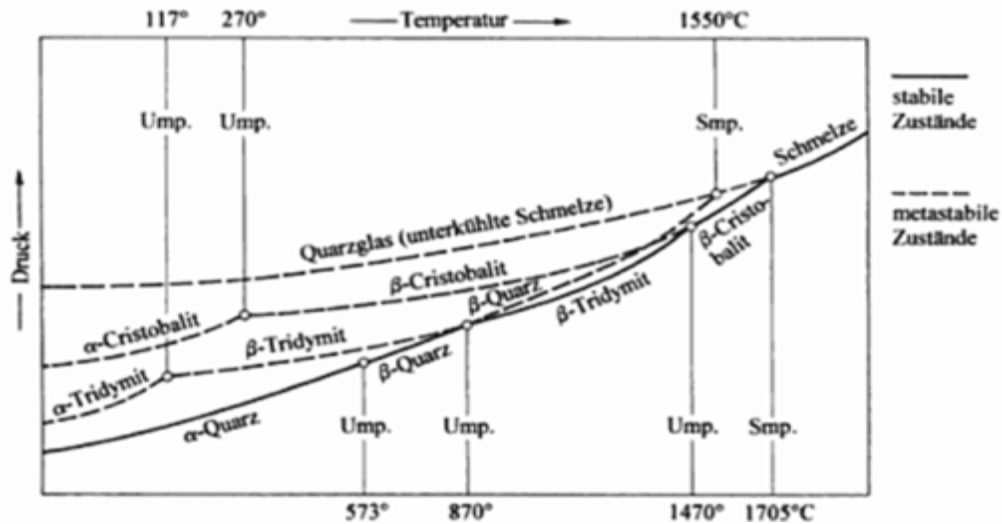


WHY DO WE NEED SAND ADDITIVES?

- ✓ To avoid casting defects:
such as veinings, 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



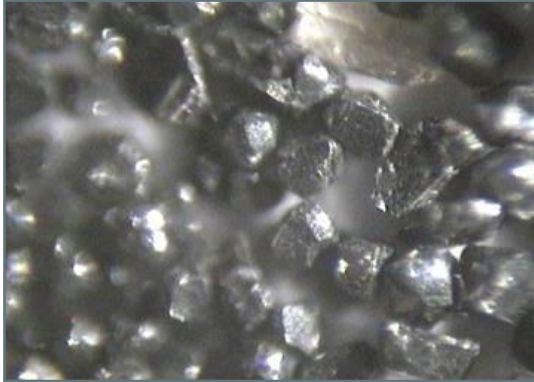
WHY DO WE NEED SAND ADDITIVES?



- ✓ During the conversion from α - SiO_2 to β - 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 SAND AND MINERALS



Chromite



J-Sand



Zircon sand



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

Advantages:

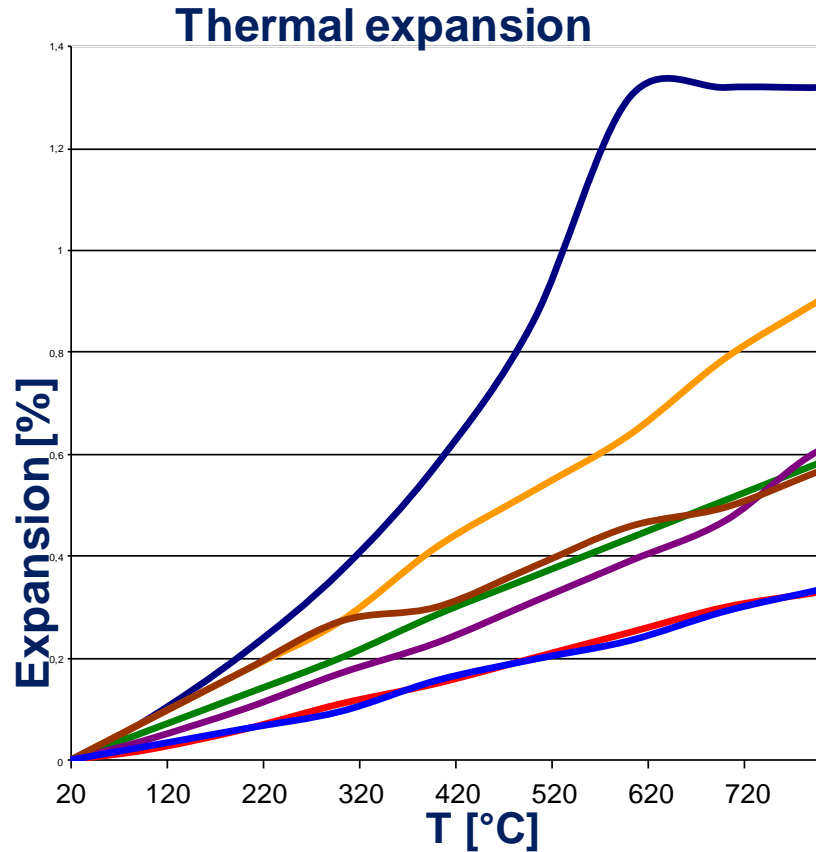
- Very efficient against casting defects
- Low gas emissions

Disadvantages:

- Very high material costs
- Effects on green sand
- Disposal cost



SPECIAL SAND AND MINERALS



Sand type (bulk density)

Quarz (1,50 kg/dm³)

Olivin (1,85 kg/dm³)

Kerphalite (1,70 kg/dm³)

Chromit (2,50 kg/dm³)

Schamotte (1,35 kg/dm³)

Cerabeads (1,60 kg/dm³)

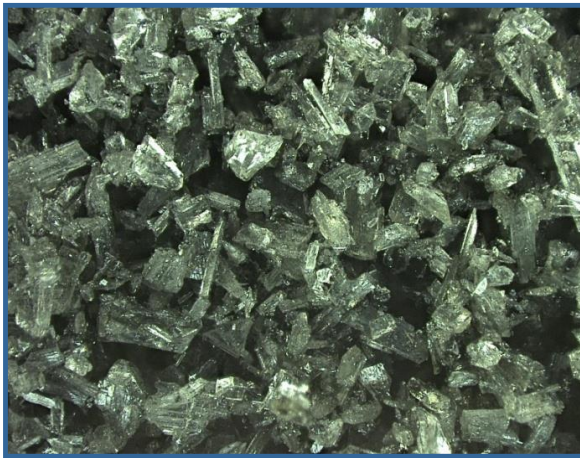
Zirkon (2,80 kg/dm³)



COMPARISON OF DIFFERENT SAND ADDITIVES



Organic



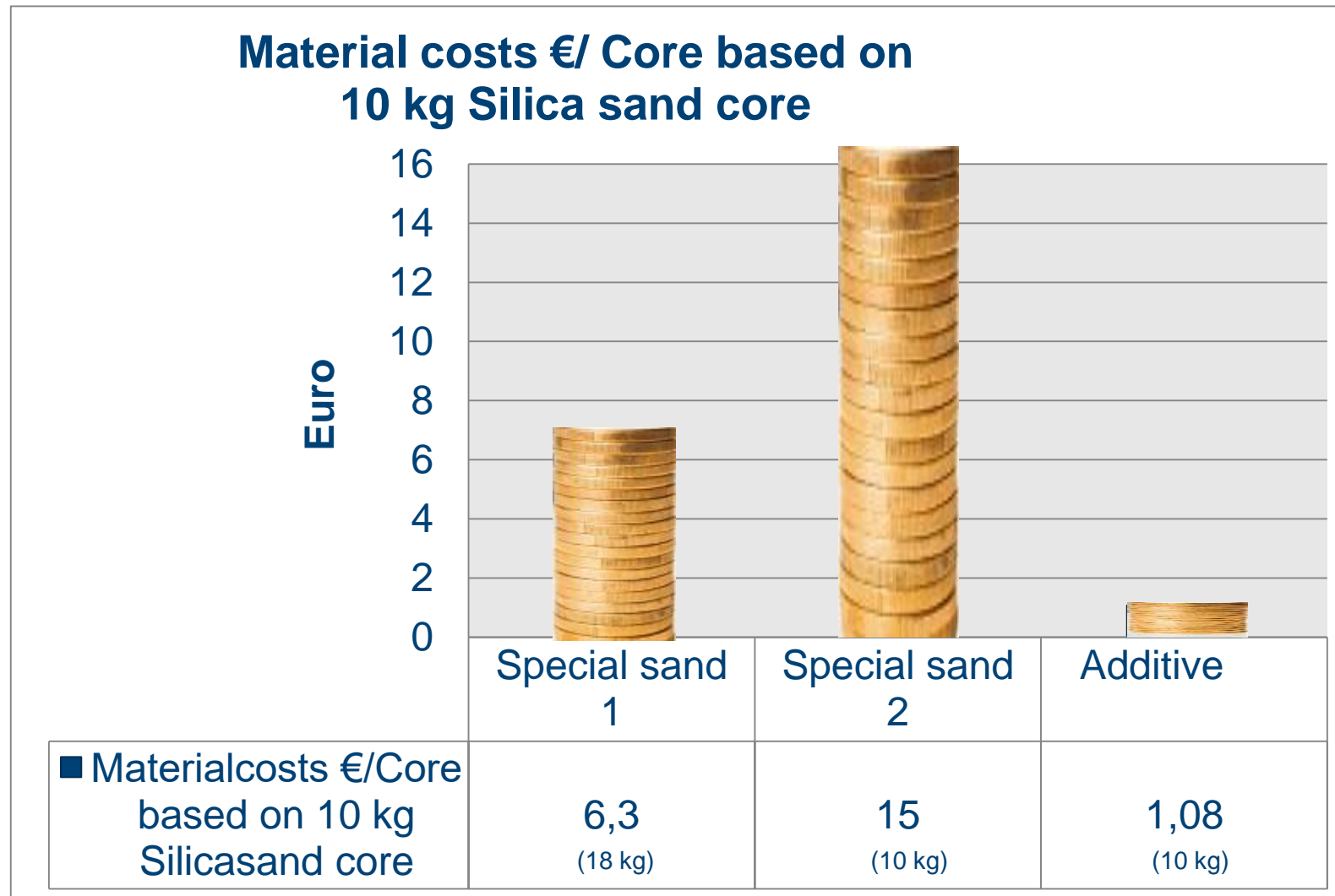
Hybrid



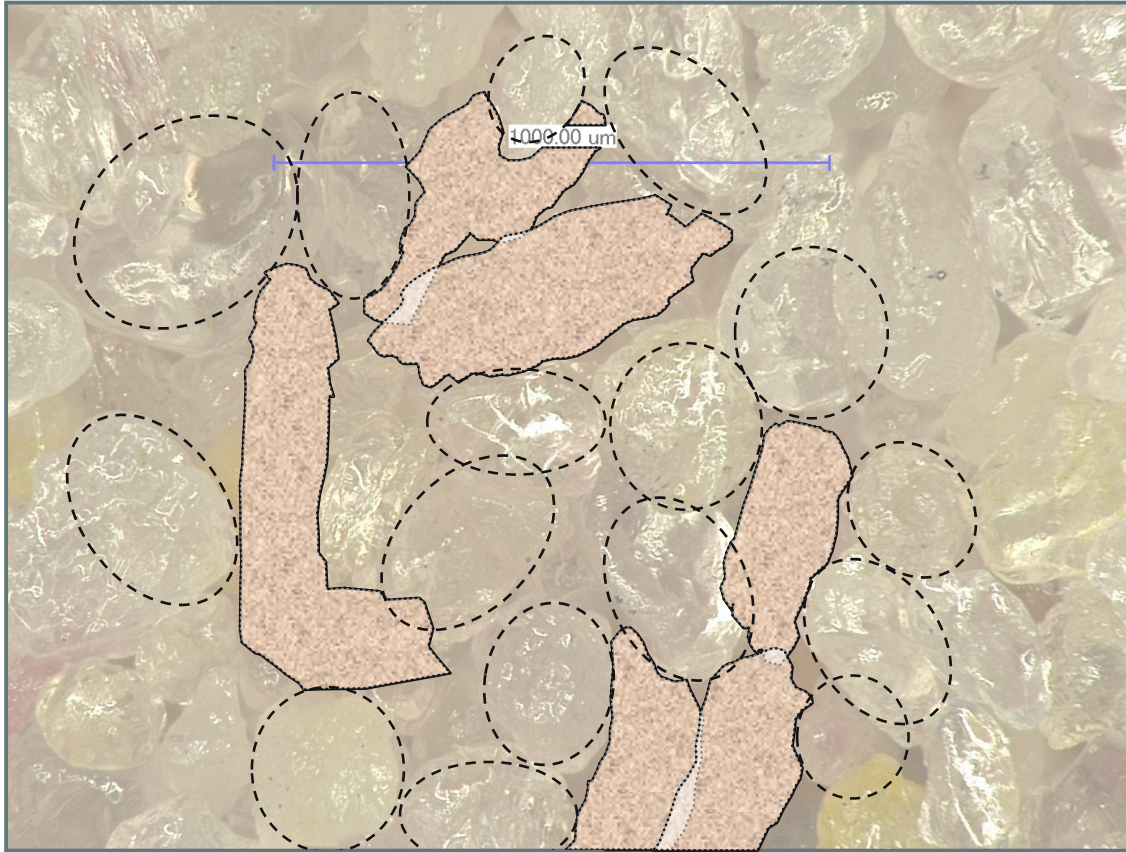
Inorganic



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

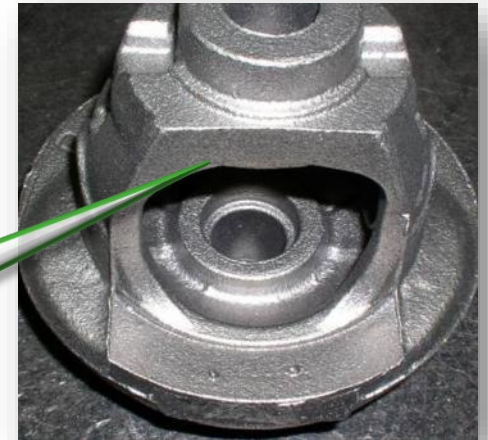
- ✓ Reduction of
 - Expansion defects (e.g. veining)
 - Deformation
 - Penetration
 - Burn in
 - Gas defects
- ✓ Low addition rate
- ✓ Neutral odor
- ✓ Low dust formation
- ✓ Compatibility with coating
- ✓ Strength profile according to the application (neutral or as a breakdown promoter)
- ✓ Low gas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



REQUIREMENT PROFILE



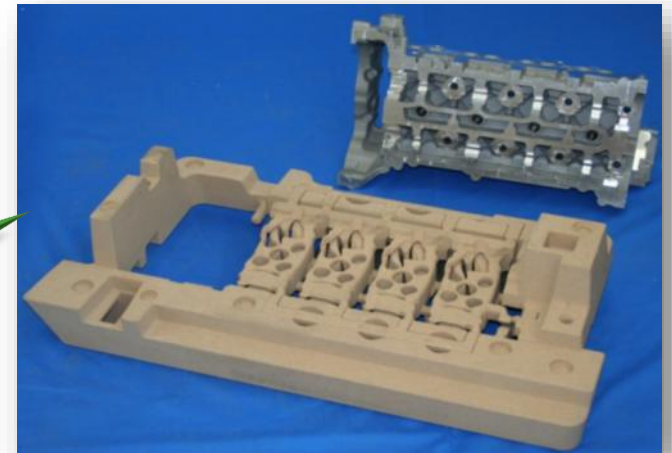
Complex core packages



Casting without coating



High-alloy steel demanding high casting temperatures



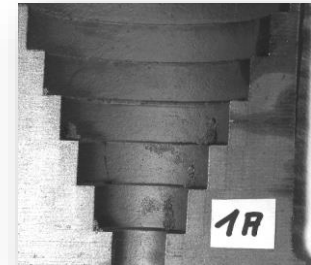
Thin-walled castings and core geometries



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
 Σ 1.5% CB-Binder

Result:

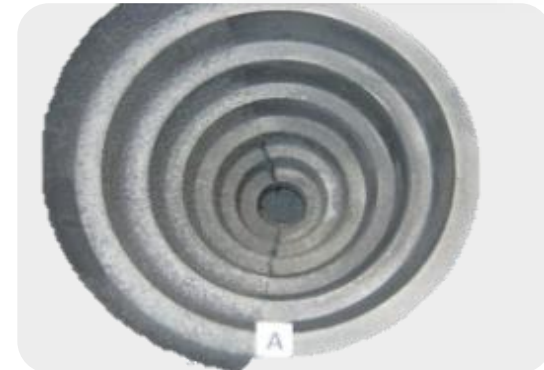
- heavy penetration



50 pt chromite sand
50 pt H32 + 5% ESA 1
 Σ 2.1% CB-Binder

Result:

- Better surface



50 pt chromite sand
50 pt F33 + 5% ESA 1
 Σ 2.1% CB-Binder

Result:

- Almost clean surface



ENGINEERED SAND ADDITIVES (ESA'S)

Standard sand mixture:

100% Special sand,
0.75% Binder per part

Probemischung:

50% Special sand,
50% Silica sand,
4% ESA 4
0.70% Binder per part

Possible costs reduction 6 digit € saving



ENGINEERED SAND ADDITIVES (ESA'S)

Cylinder head

Standard recipe:

60% Special sand mixture
40 % silica sand
5 % Additive

Trial:

100 % silica sand
3 % ESA 2



ENGINEERED SAND ADDITIVES (ESA'S)

Cylinder-head, water jacket core:

Standard recipe:

100 % Special sand

1,5 % organic additive

Trial:

50 % Silica sand

50 % Special 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



ENGINEERED SAND ADDITIVES (ESA'S)



Brake Disc:

Standard recipe:

100 % Silica sand H 32

3,0 % Additive (organic)
coated

Now:

100 % silica sand H 32

2 % ESA 3
coated



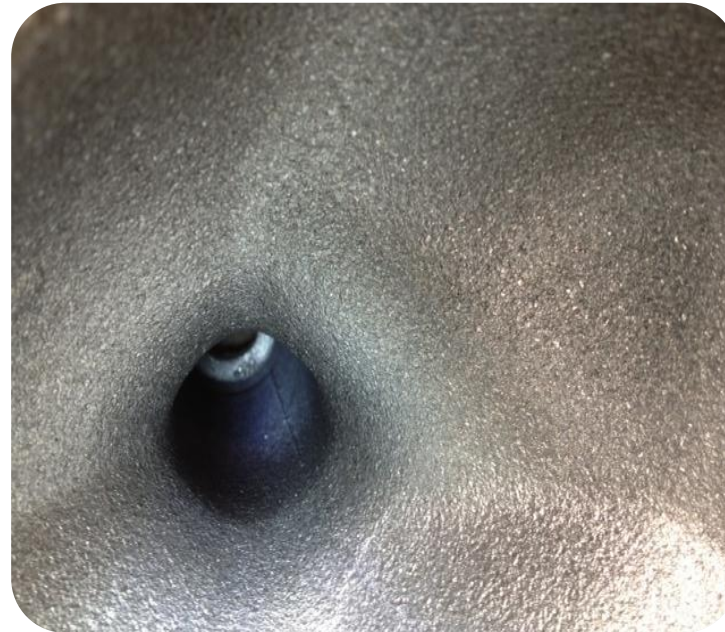
ENGINEERED SAND ADDITIVES (ESA'S)

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

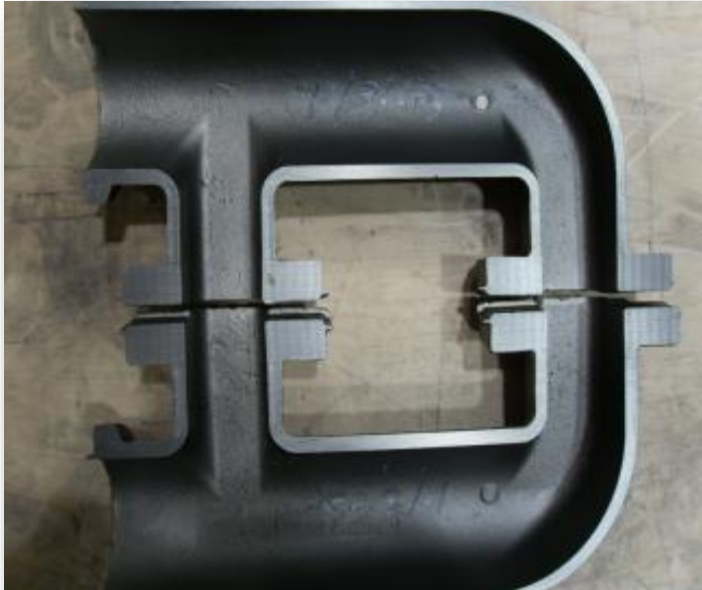


Center bearing,
Ductile Iron, 125 kg casting weight



ENGINEERED SAND ADDITIVES (ESA'S)

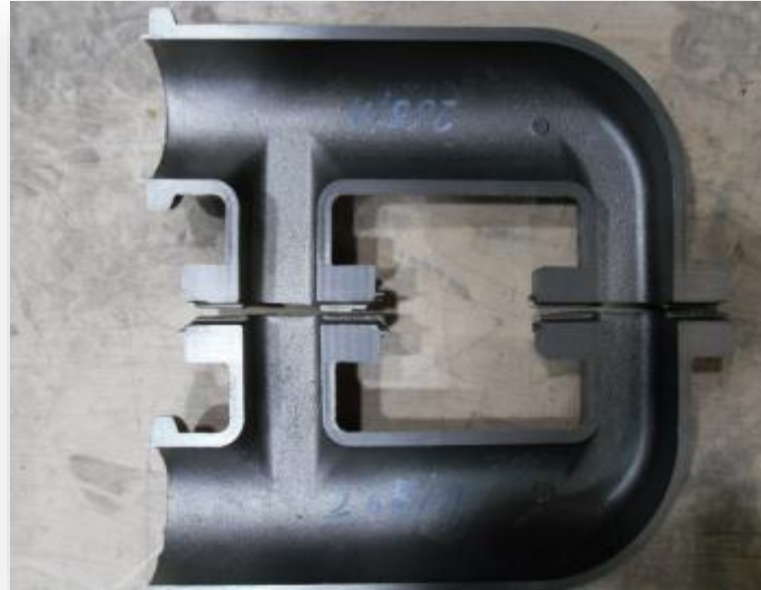
Comparison SiMo-Manifold \Rightarrow coated and uncoated



100 T silica sand blend (H32/H33)

Σ 1.2% CB-Binder

- coated



100 T silica sand blend (H32/H33)

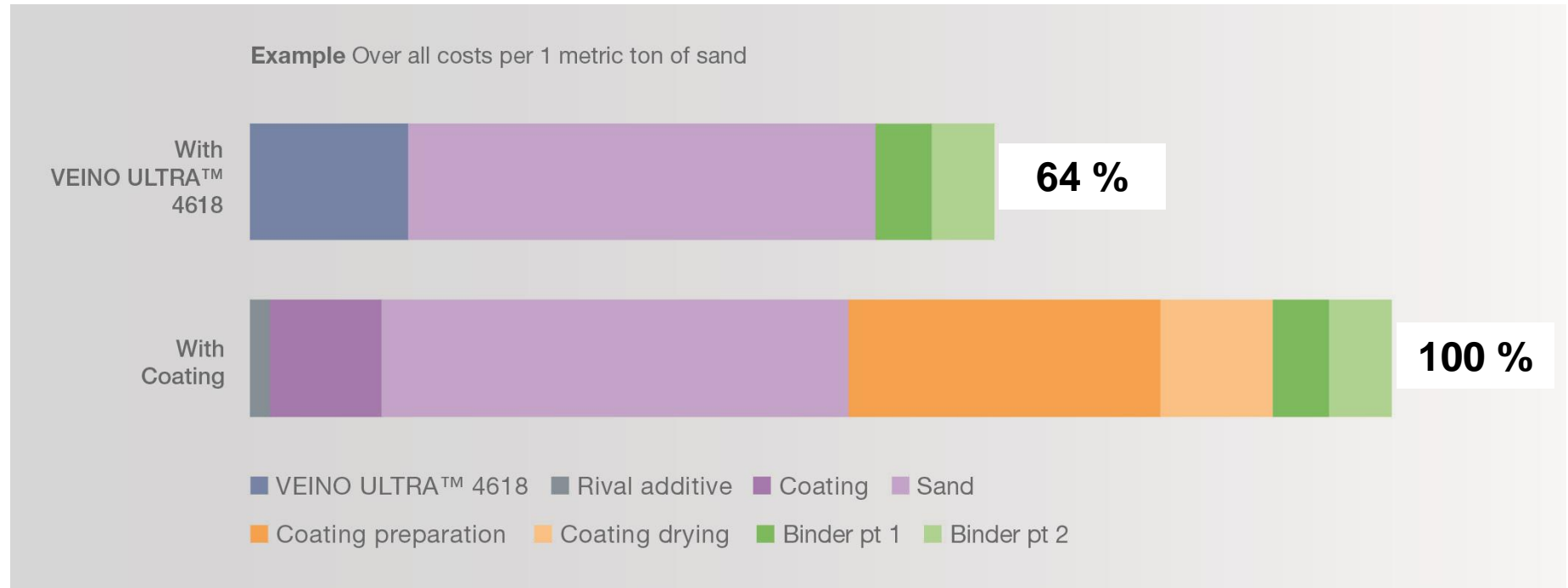
+5% ESA 1

Σ 1.6% CB-Binder

- uncoated



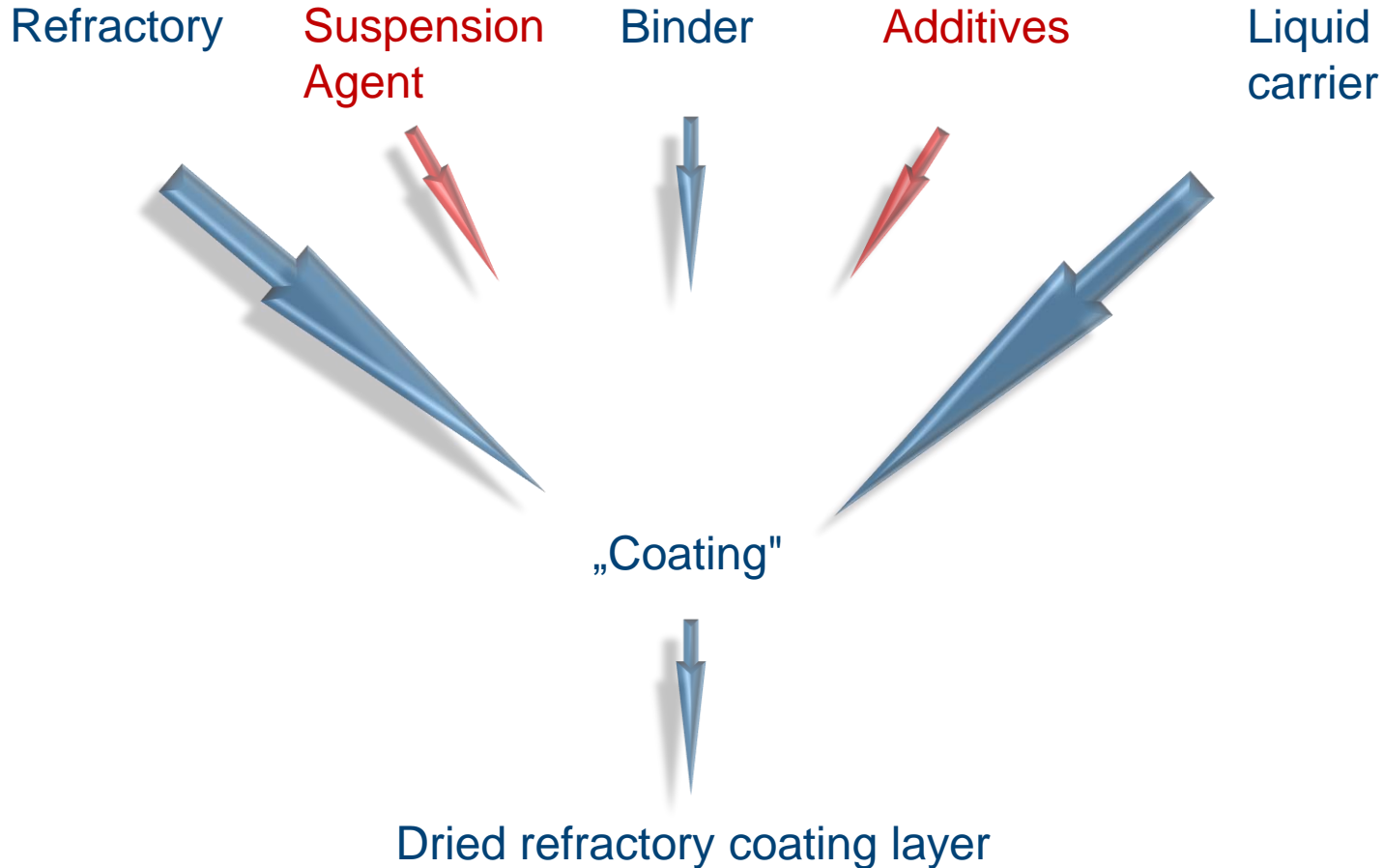
ENGINEERED SAND ADDITIVES (ESA'S)



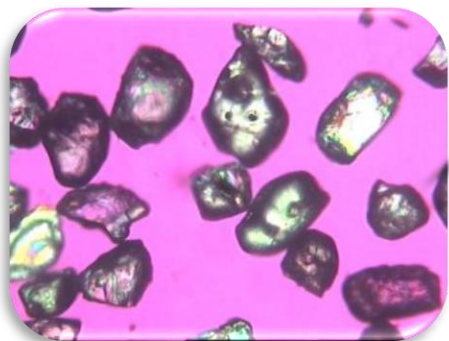
ENHANCED COATINGS



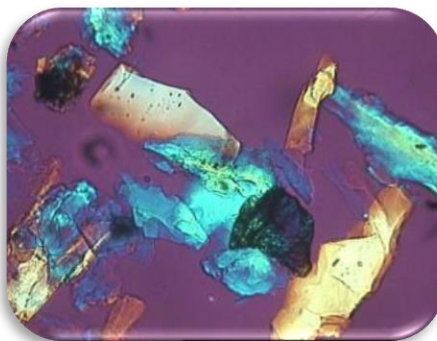
HOW ARE COATINGS DESIGNED?



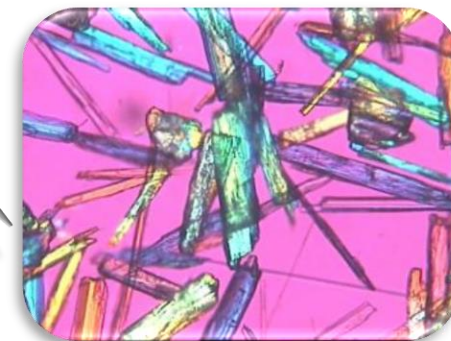
TYPES OF COATINGS



Grains



Plates



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



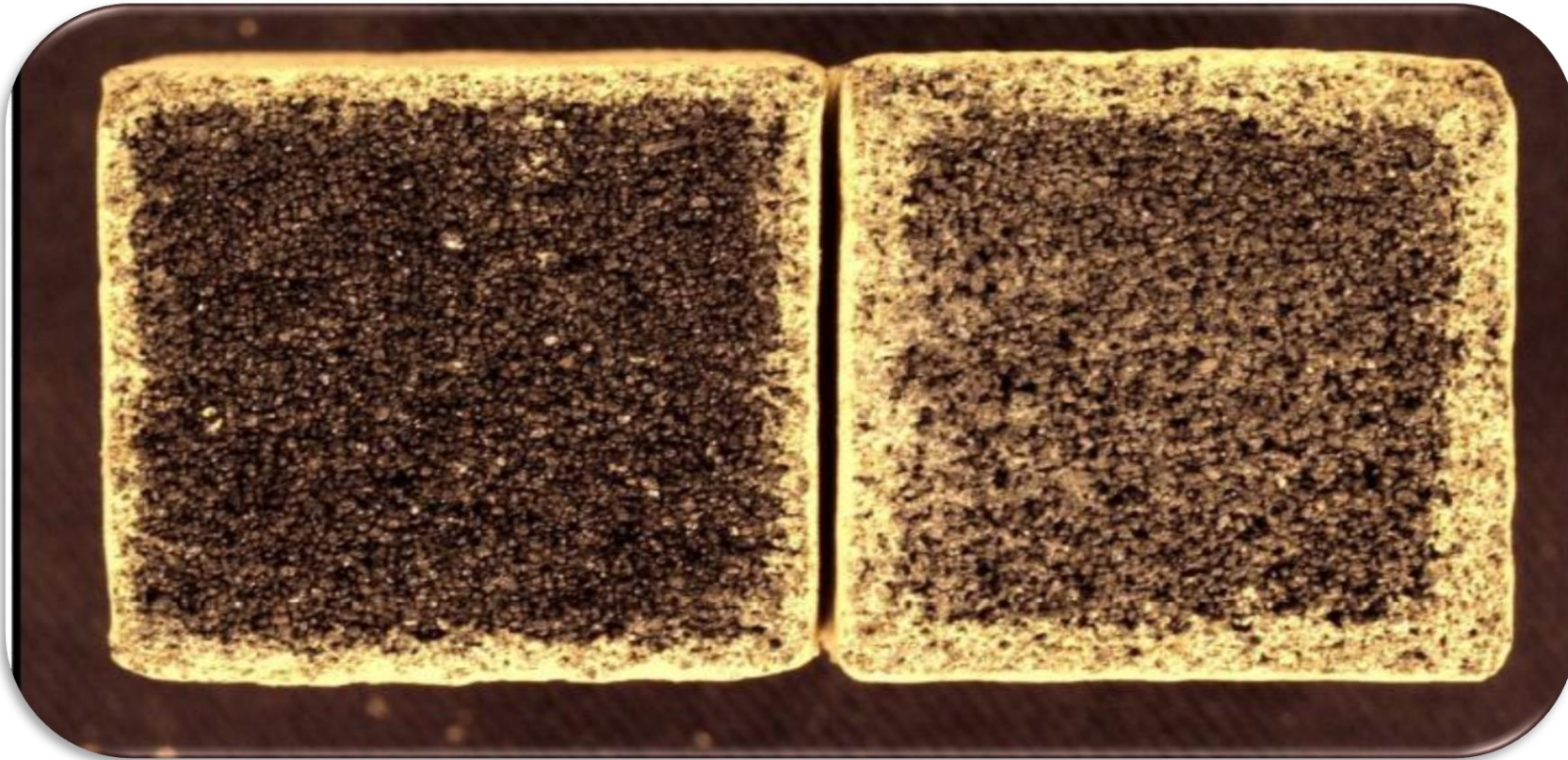
Viskosität
[Pa · s]

130,0
107,5
85,0
62,5
40,0

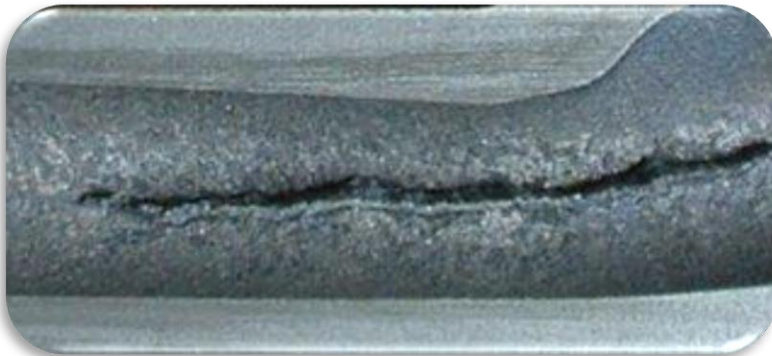
THE IMPORTANCE OF RHEOLOGY



CRANKCASES / BLOCKS



CRANKCASES / BLOCKS



CRANKCASES / BLOCKS

MIRATEC MB Types



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	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%



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

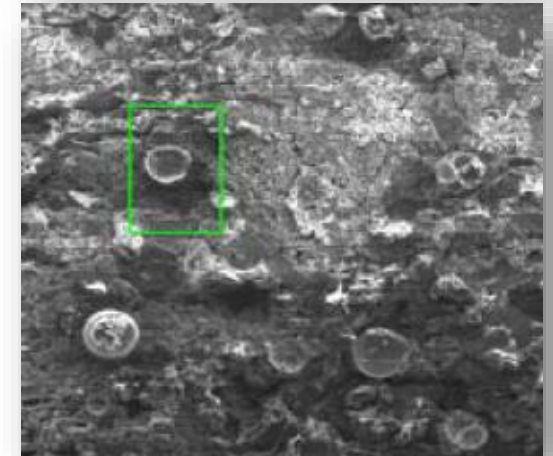
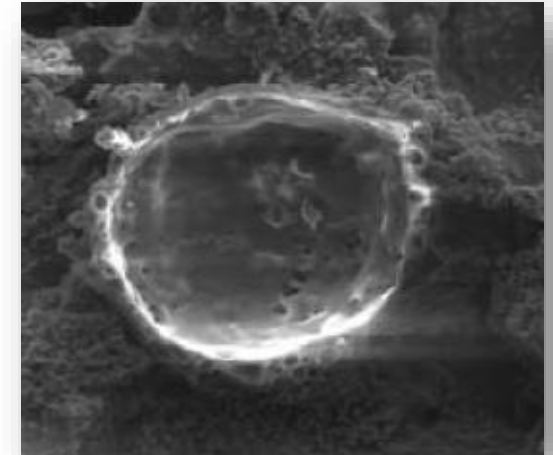
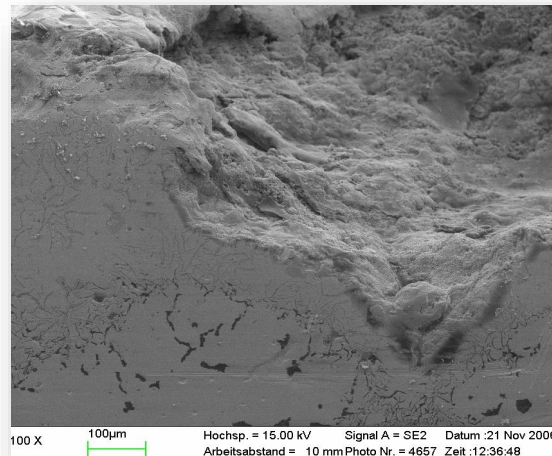
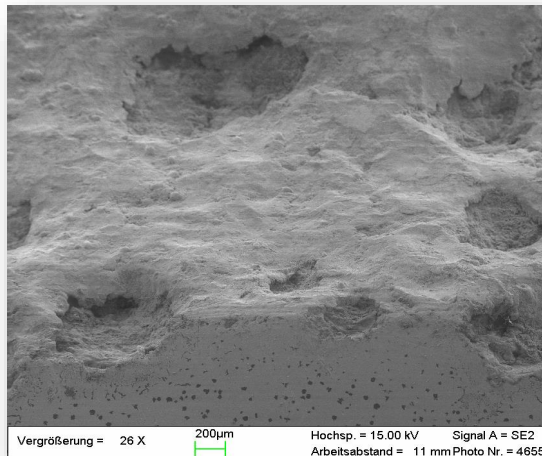


WASHING OR NEW CORE WASH?



COATINGS TO PREVENT ADHESION

- Formation of liquid FeO_x -Phase
- Scarred surface with holes
- Reaction layer and products
- Expanded structur



COATINGS TO PREVENT ADHESION

1 flaky



2 powdery



CORE PACKAGES



MIRATEC® TS Types



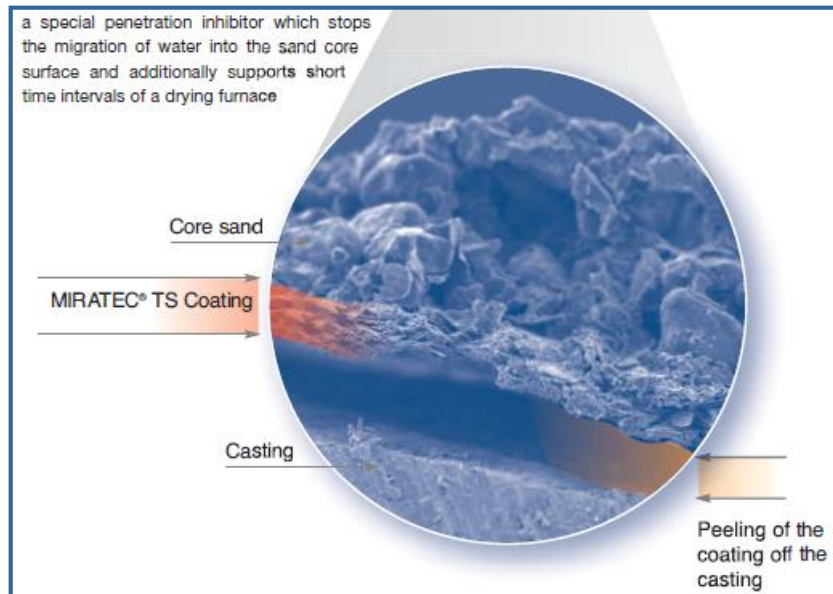
MIRATEC TS CONCEPT: TO REDUCE RETAINING RESIDUE

Assumption: OPTIMAL coated cores – independent of geometry



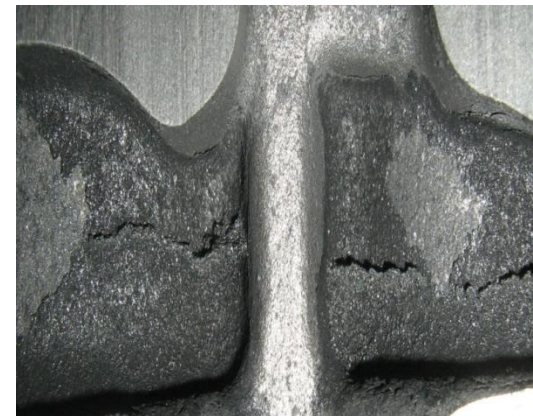
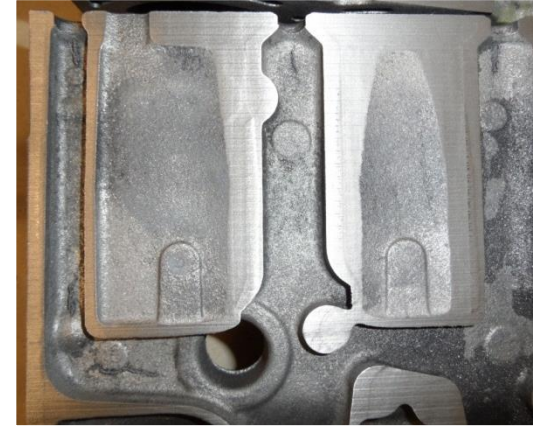
MIRATEC TS CONCEPT: TO REDUCE RETAINING RESIDUE

How does it work?



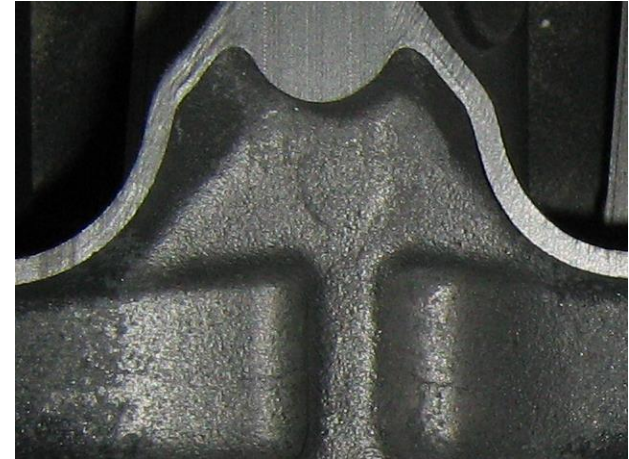
MIRATEC TS CONCEPT: TO REDUCE RETAINING RESIDUE

Casting surface before:



MIRATEC TS CONCEPT: TO REDUCE RETAINING RESIDUE

Casting surface with MIRATEC TS:



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 defect-free castings with the required minimum residue for automotive castings





THANK YOU FOR YOUR ATTENTION

Christian Koch, Ismail Yilmaz

ASK Chemicals GmbH, Reisholzstraße 16-18, D 40721 Hilden

Tel.: +49-211-71103-24

info@ask-chemicals.com

www.ASK-chemicals.com