Innovative Latest Technology and Measurement System of Refractory Coatings

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Coating – Definition

The importance of foundry coating in improving the surface quality of casting cannot be over emphasized. The application of mould and core washes creates a high thermal integrity barrier between the metal and the mould resulting in the reduction of thermal shock experienced by the sand system.

These thermal shock leads to series of surface defacts such as veining / finning, metal penetration,burn on/in, scab, erosion etc. The use of coating reduces the tendency of occurrence of these defects.

However, the understanding of the coating, its components, characteristics and mechanism of action is important.

Components of Coatings

A refractory coating should have the following characteristics

- Sufficient refractory properties to cope with the metal being poured
- Good adhesion to the substrate to prevent peel off
- No tendency to blistering, cracking or scaling on dry-ing
- Good suspension and remixing properties
- Minimize core strength degradation
- Good stability in storage

For a coating to achieve these characteristics, the coating will consists of

- Refractory filler
- Liquid carrier
- Suspension agents (Rheology control system)
- Binder agents
- Additives as shown in Fig. 1 (next slide)

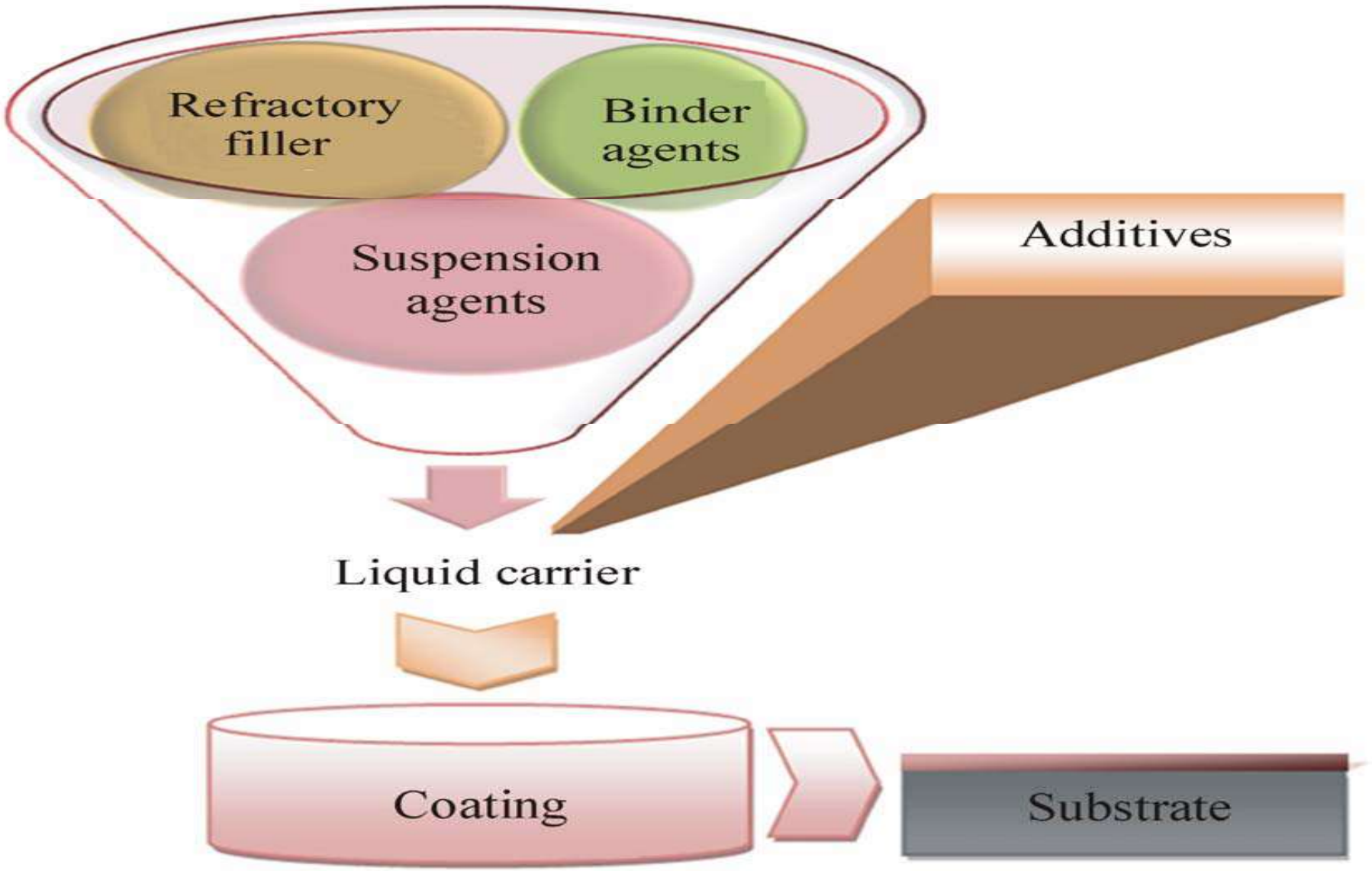

Refractory filler
Binder agents
Suspension agents
Additives
Liquid carrier
Coating
Substrate

Figure 1

Critical Properties

Application

- ✓ Ensure uniform coating layer without runs or sagging
- ✓ Optimum coating thickness
- ✓ Adequate drying: No moisture to avoid gas defects
- ✓ Good ‘in tank’ suspension & resistance to bacteria
- ✓ Satisfactory bond strength prior to casting
- ✓ Suitable rheology & application characteristics
- ✓ Suitable penetration of the coating & liquid carrier
- ✓ Correct ‘Matt or Gloss time’

Coating Parameters

To ensure that the coating of the correct layer thickness is applied at all times, it is essential to control the dilution of the coating. To maintain the consistent dry layer thickness.

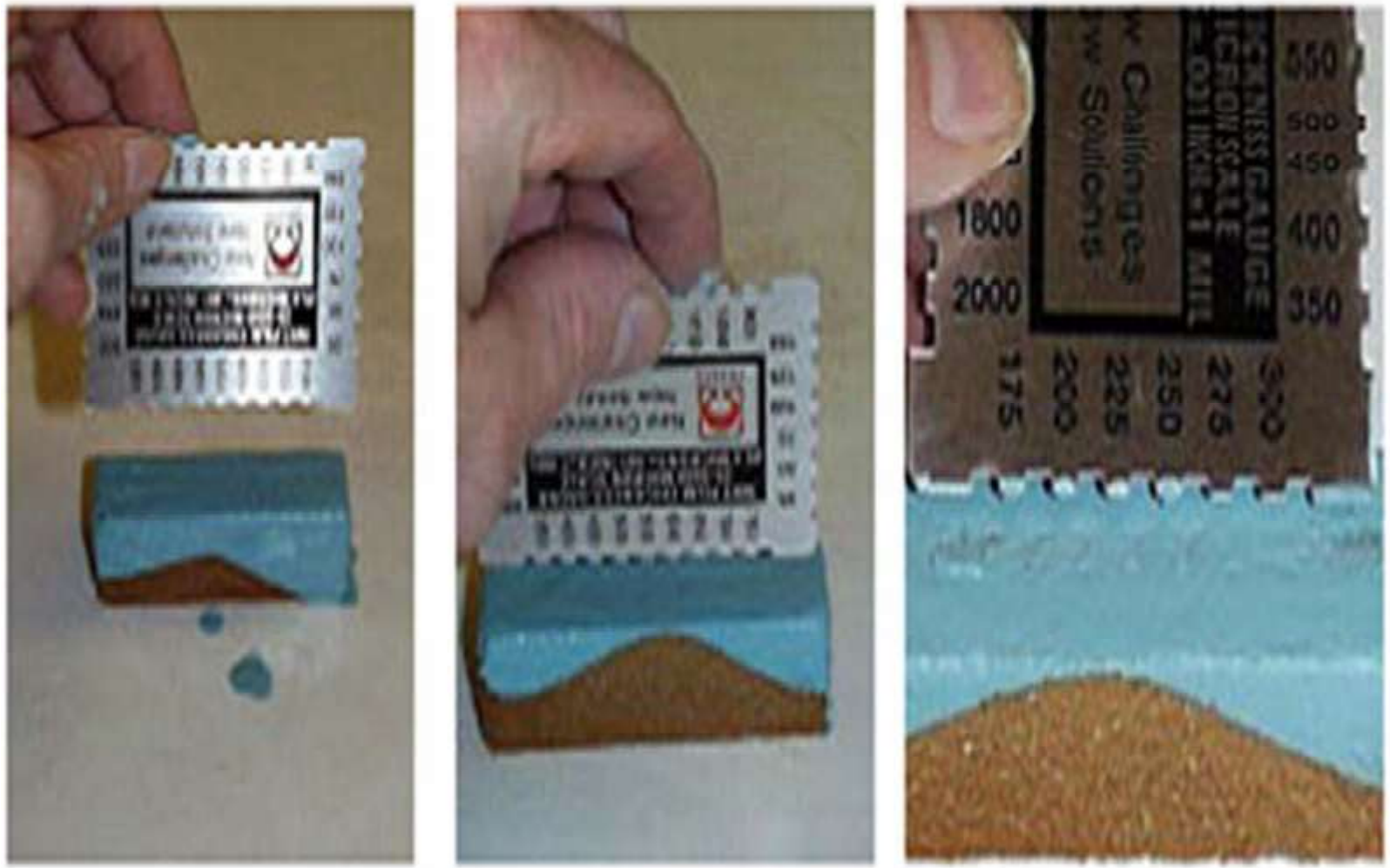
Following measure must be used:

1. Wet layer thickness

Coating dry layer thickness is difficult to measure, so what is generally done is to measure the wet coating layer thickness using the “ELCOMETER” wet film ‘comb’ as shown

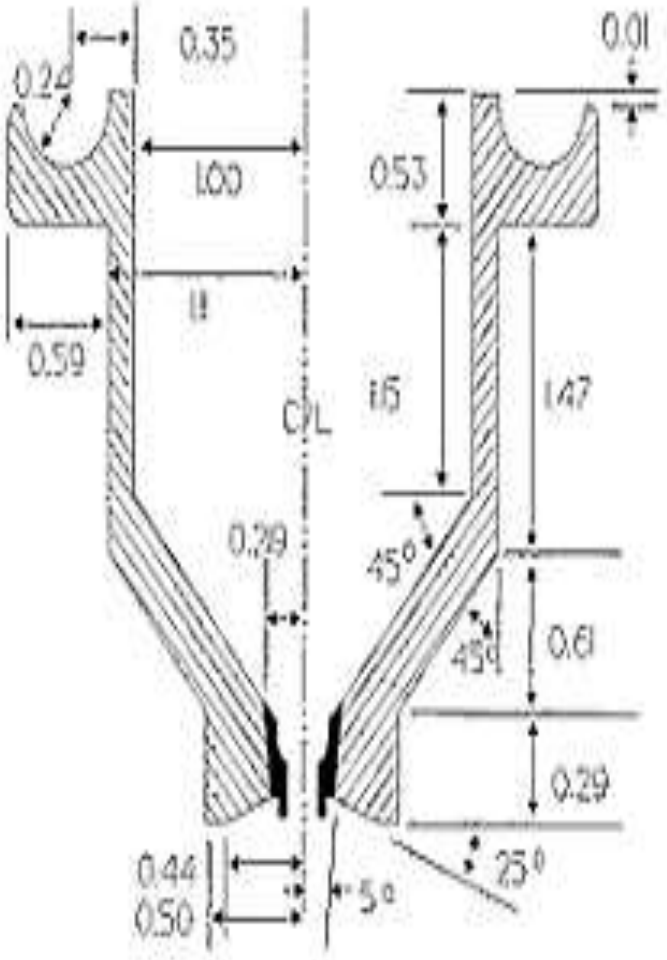
Wet film comb be perpendicular to the substrate andthe thickness of the coating lies between the biggest value Wet-Tooth and the smallest value dry tooth value.

As a rule of thumb dry coating thickness is 50% of the Wet coating thickness.



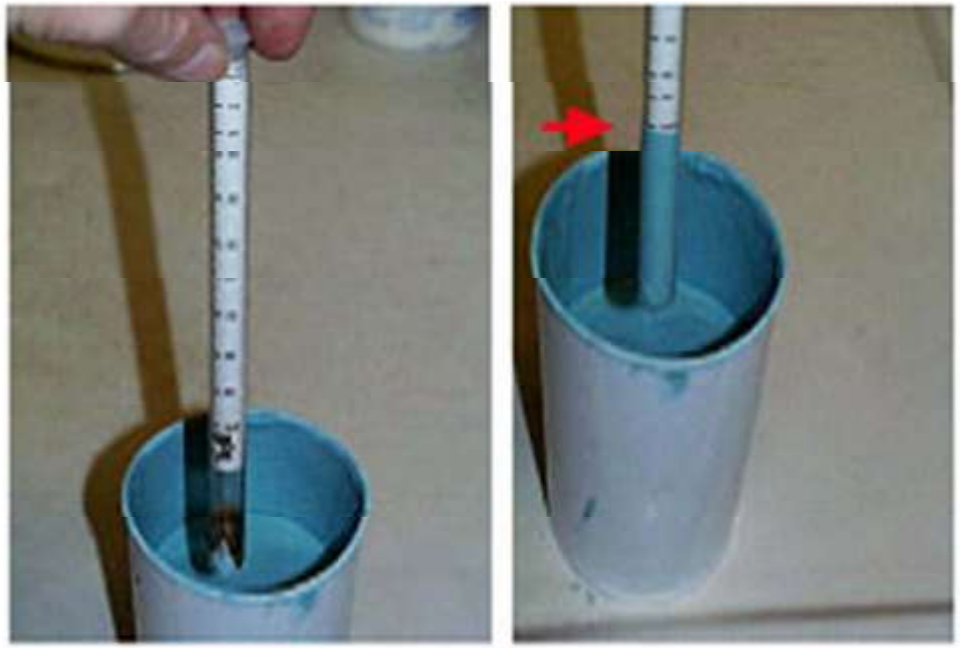
Viscosity

- Controls wet & dry film thickness
- Controls penetration in Sand grains
- No viscosity adjustment for Ready to use wash
- Viscosity adjustment & measurement are the most used coating application practice on shop



Baume

- Indication of Sp.Gravity & Coating 'body'
- The Baume test is appropriately used for low solids, Newtonian coating.
- The test also require that the coating be homogenous, at the correct temper and have no air bubbles.



Thermal Degradation

Rate of Settling

Penetration of Coatings on Mould or Cores surface

- The distance the coating penetrates in the core is an important feature of a coating's success. A coating that lies entirely on the surface of the core is not anchored well and will most likely spall away.

- A coating that penetrates too much will over-degrade the core strength, resulting in core scabs or broken cores.

- Coating penetration is also a function of core density. A core that is blown too tightly resists coating penetration, while one blown softly acts like a sponge and absorbs too much water

Effects of Matt Time

- The transition time from Gloss finish to Matt finish is the “Matt Time”
- Longer Matt Time is good for brushing application (50-60 seconds)
- Shorter Matt Time reduces Coating drips and runs for dip applications (20-30 seconds)
- Controlled Matt Time is suitable for Flood applications

Insulating Coating

- Insulating coatings are water-based, slurry refractory formulations containing a carefully engineered blend of balanced Rheology and highly advanced refractory technology.
- They are used to coat cores for the high-production casting of grey and ductile iron .
- Typical casting components produced using this coatings include Cylinder heads and blocks, brake rotors and hydraulic parts.
- Reduced of multiple coating layer application to single coating application.
- Reduced no of drying cycles for better core life
- Reduction in fettling cost
- Improve surface quality of the casting
- Increase productivity

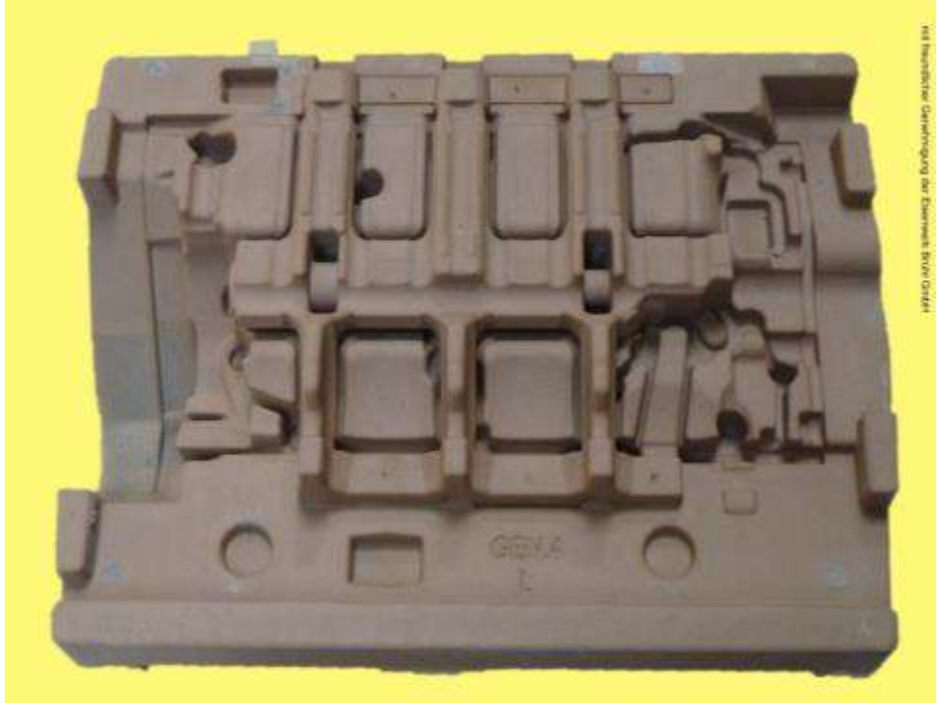
Wall thicknesses and tolerances for engine casting

Due to the high complexity of these castings the number is increasing especially in filigree thin and very complex cores. The risk of gas-related casting defects will increase.

Section through a core package in casting position by cutout over a range of core and a section of the corresponding cylinder block

Wall Thicknesses and Tolerances for Engine Casting

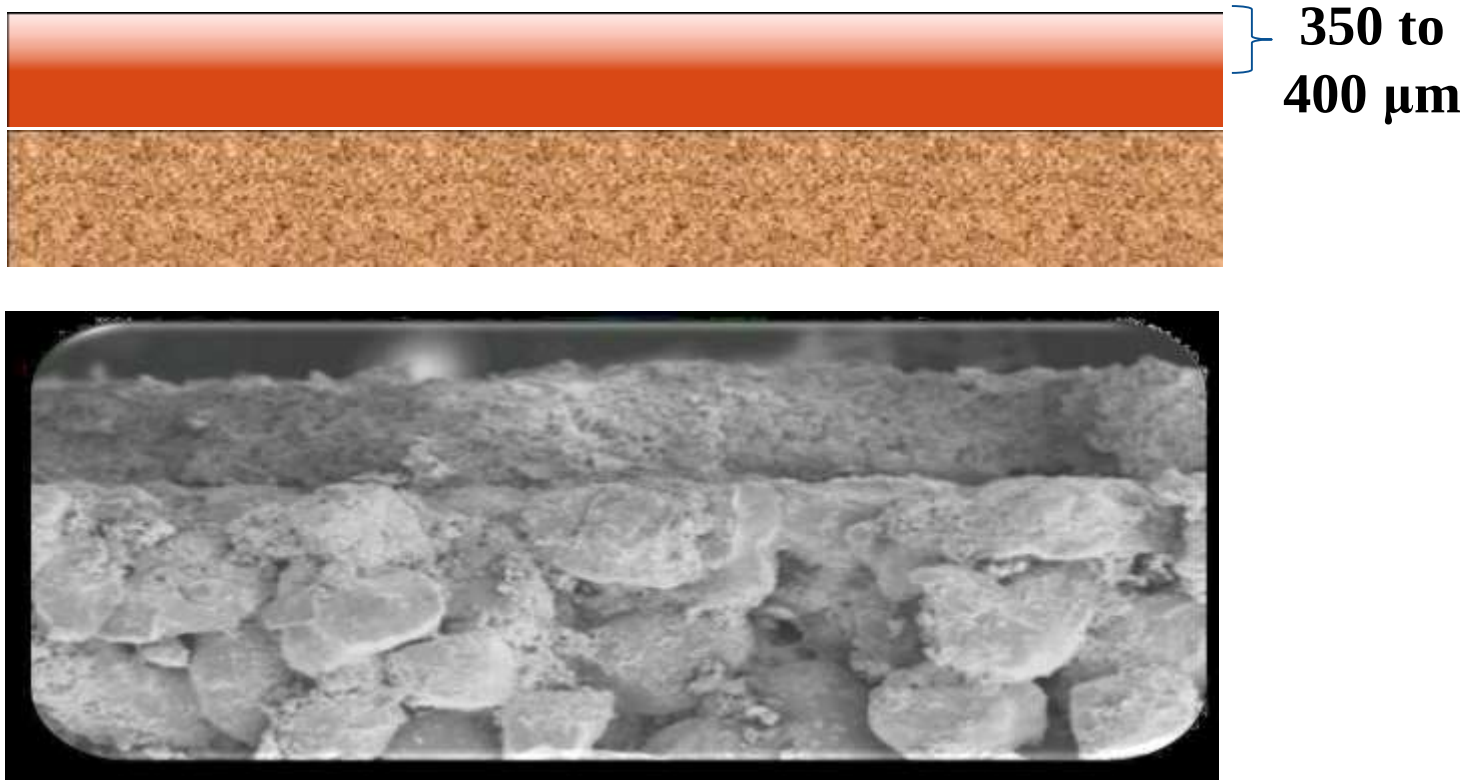
For the production of complex castings in the core package technology the use of more specific and tailored coatings to their production is necessary.



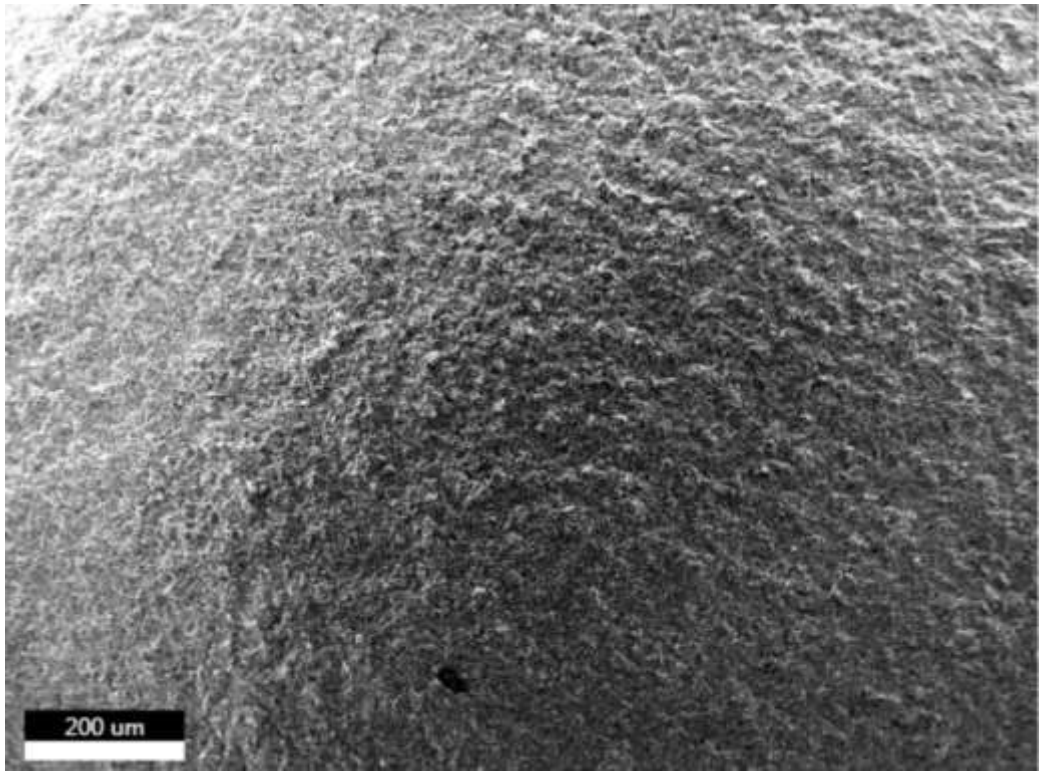
coated side part of a core package with integrated channel cores

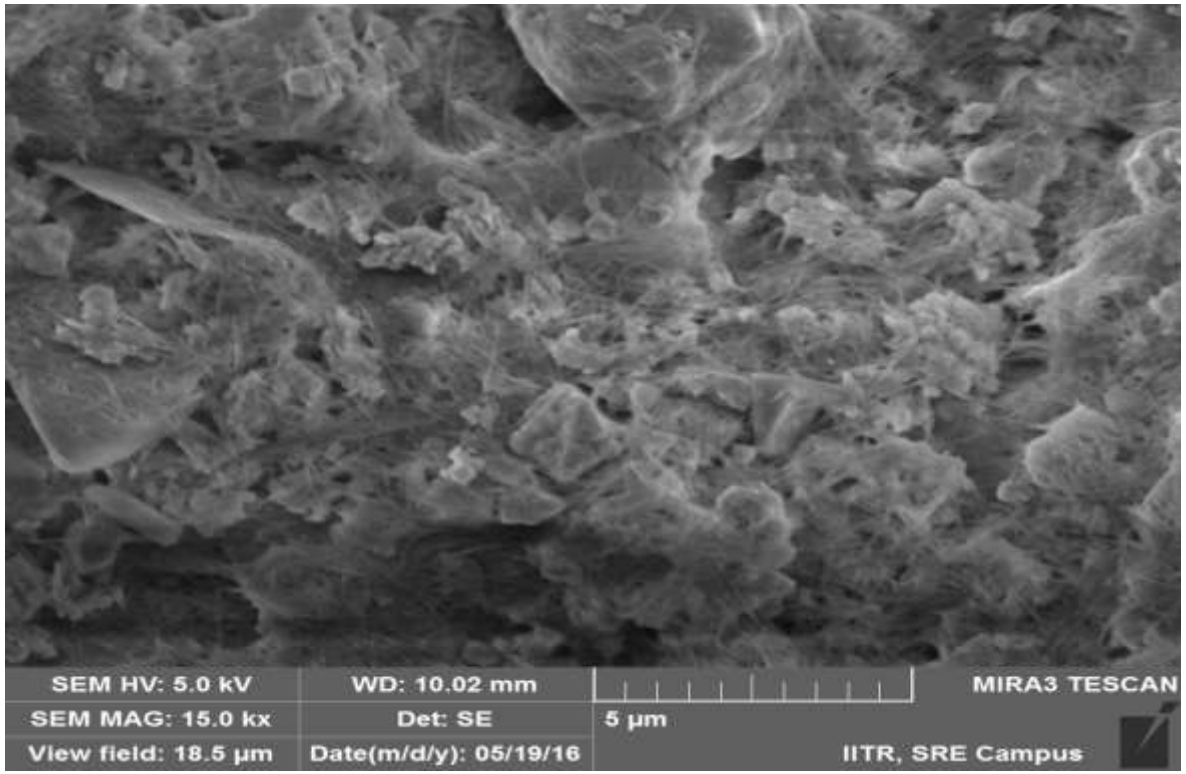
- **uniform application thickness**
- **very effective against sand expansion defects**
- **controlled gas permeability**
- controlled refractoriness

Wall Thicknesses and Tolerances for Engine Casting



Formulation of suitable coating which can be applied to eliminates casting defects such as veining or penetration and offer an excellent peel-off from the casting

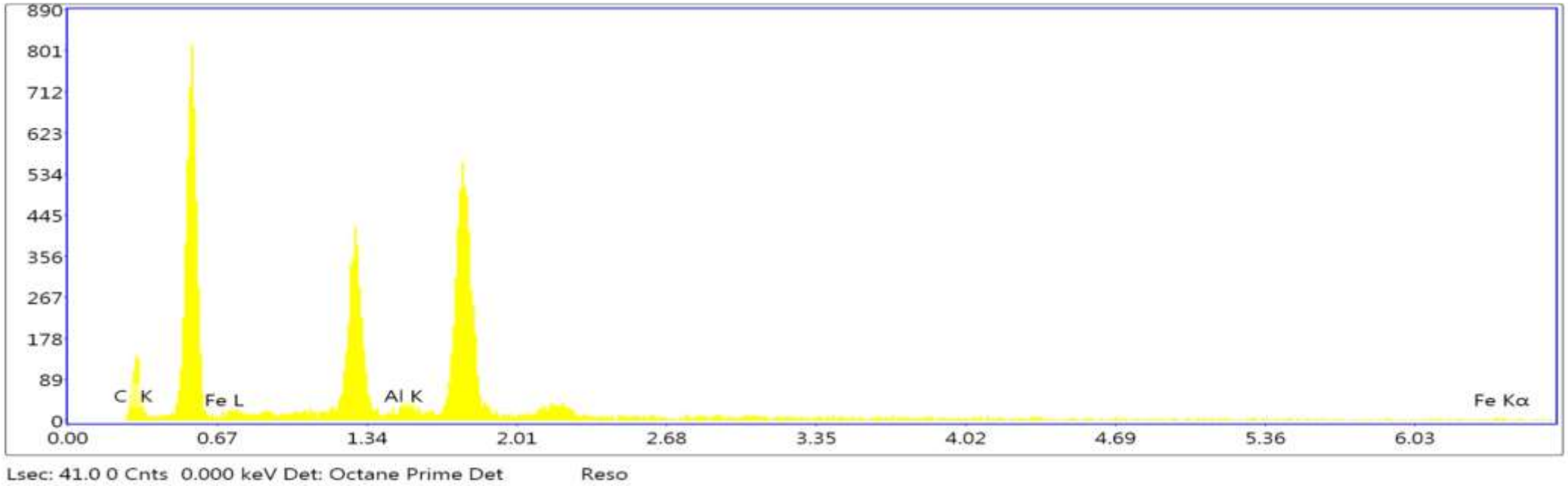




The surface morphology of the sample was investigated by FE-SEM (Field Emission-Scanning Electron Microscopy) (MIRA3 TESCAN, USA) operated at 5 mm working distance. EDX and electron dot mapping has done in same instrument.

kV: 10 Mag: 11 8 Takeoff: 34.4 Live Time(s): 41 Amp Time(µs): 7. 68 Resolution:(eV)125.6

Sum Spectrum

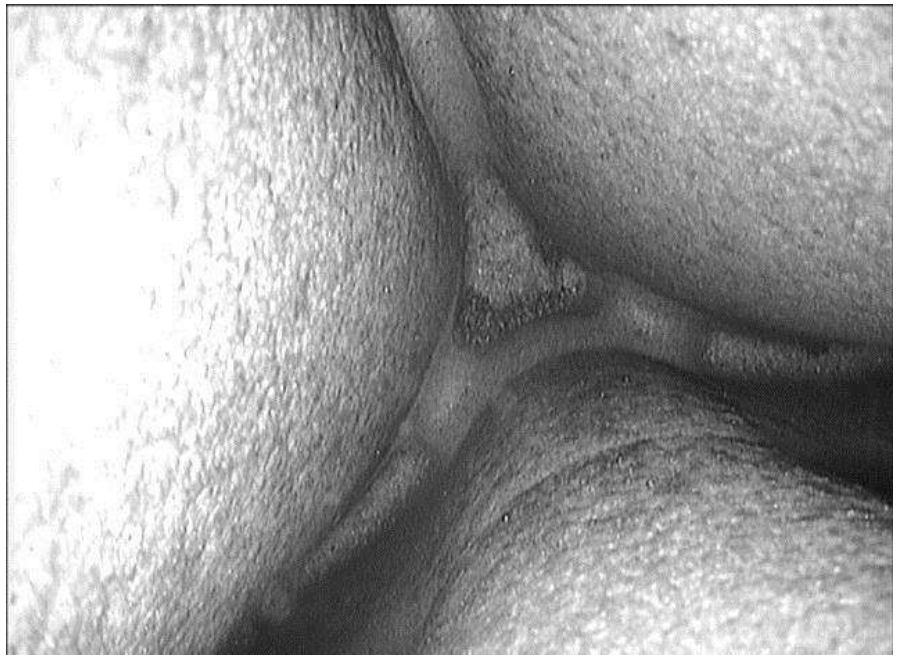


eZAF Smart Quant Results

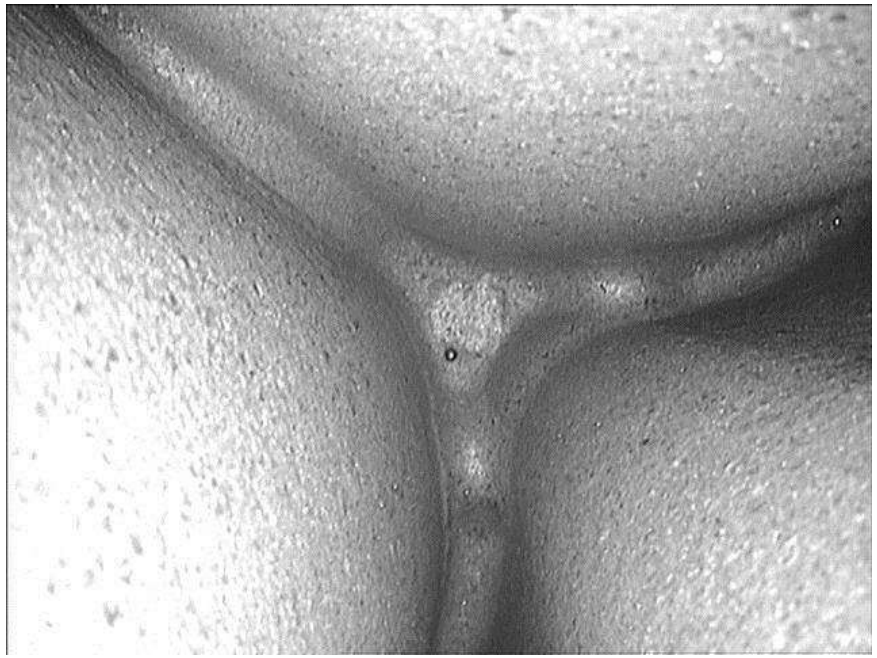
Element	Weight %	Atomic %	Net Int.	Net Int. Error
C K	80.84	91.52	14.2	0.05
FeL	4.54	1.11	0.5	0.02
AlK	14.62	7.37	6.1	0.17

Cleanliness after Casting / Peel-off of the Refractory Coating example

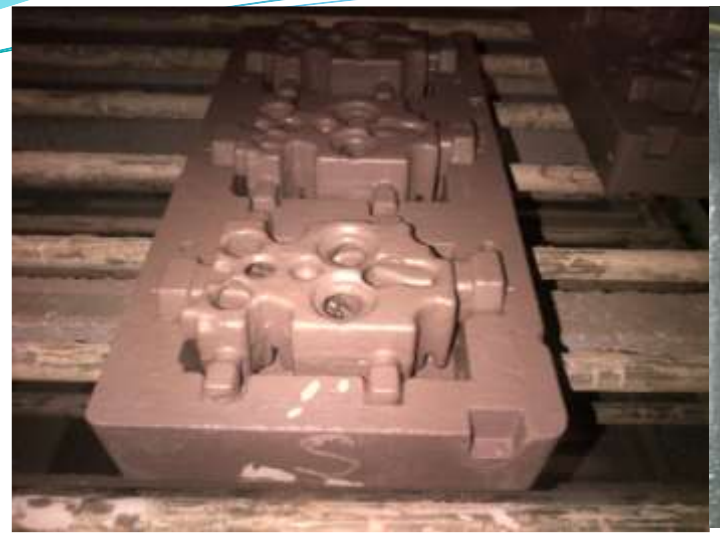
casting surface around the water jacket

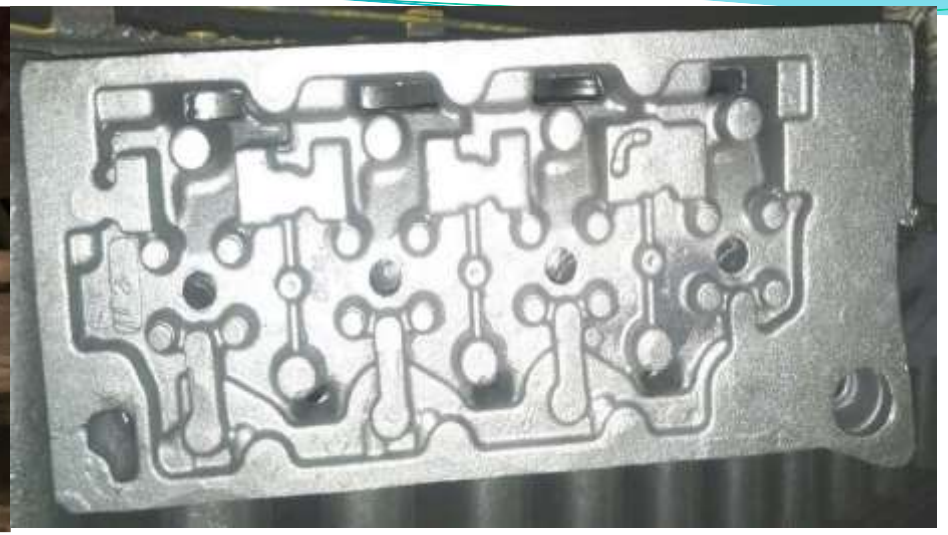


Extensive sticking of the refractory coating on the casting surface



No sand sticking found with using Forcoat 144





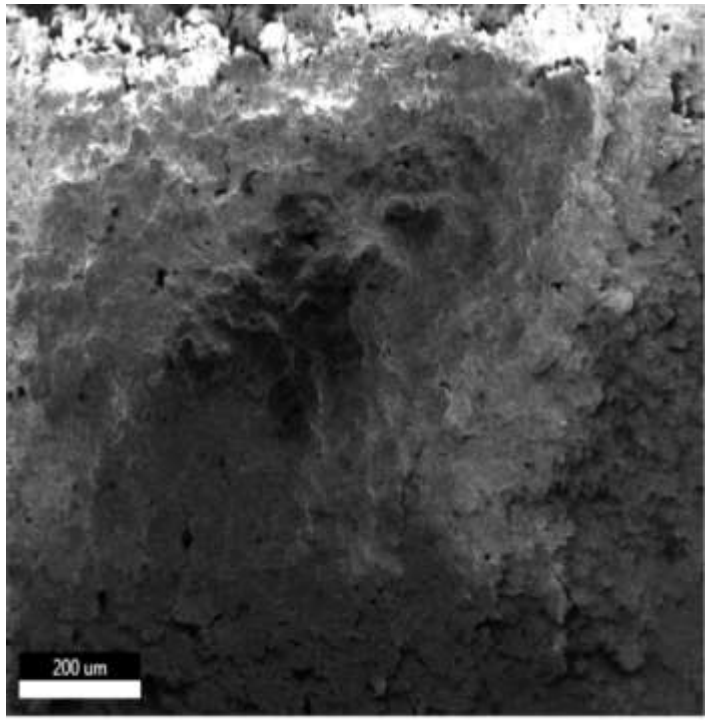
Solution for Automotive Industry
Alumino Silicate mix Refractory

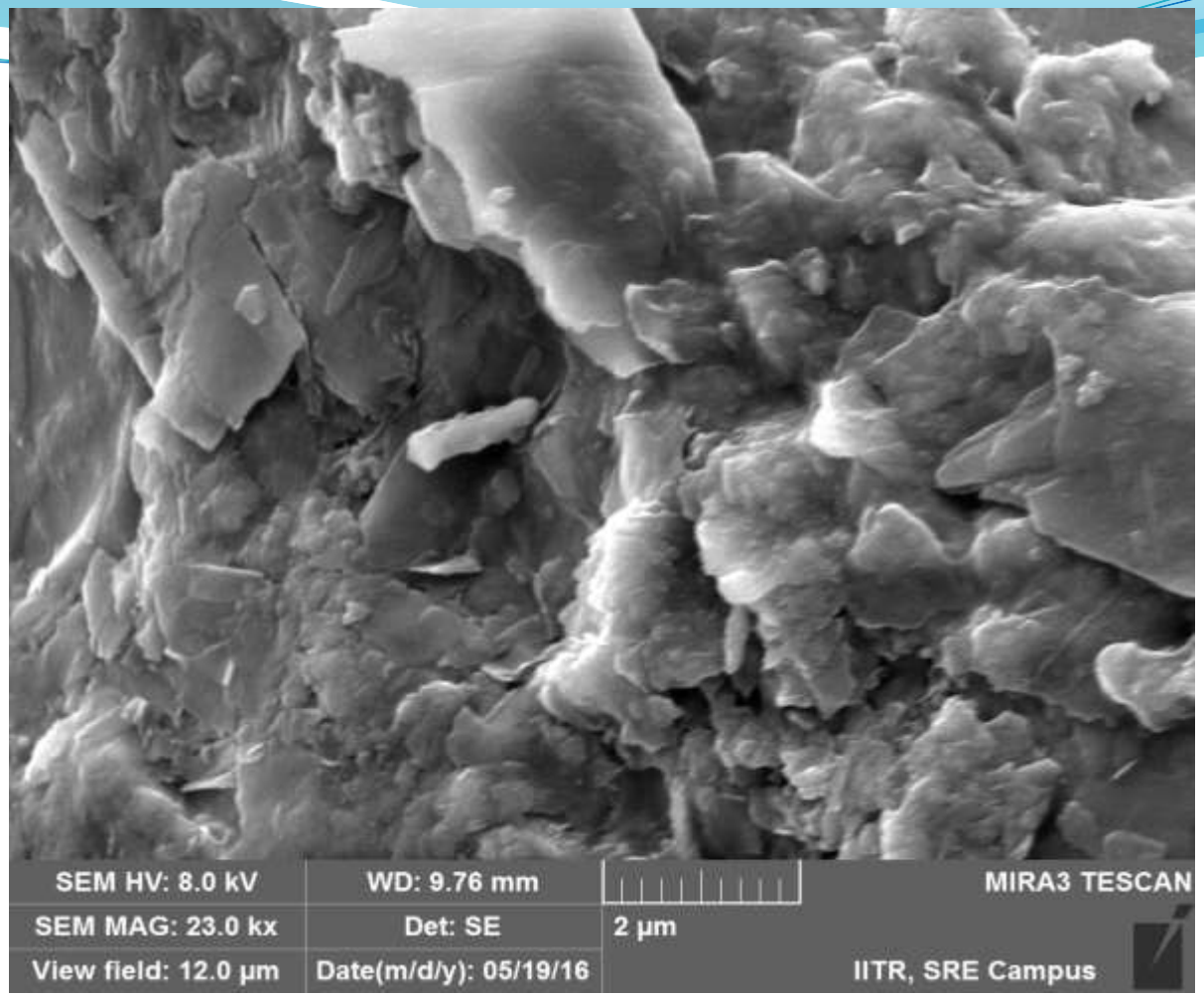
The Core made with Forcold and Forshell Binder System coated with Forcoat 144 Alumino-Silicate mix refractory aqueous wash applied by dipping.
Double dip application(1st layer with ZW and 2nd layer with GW) is replaced by single dip process. It reduces process time and also it is very economical.
The same used to make Casting of Cylinder Head for Mahindra.

Client: DCM Engineering Products, Ropar

Sulphur Block Coatings

- Coating have been developed that block the transport of Sulphur into the melt.
- Different mechanisms are available to maintain the targeted property.
- One is to reduce the transport of sulphur towards the interface with the metal by applying coatings with impregnating properties .
- Another mechanism is to use sulphur adsorbing component e.g calcium compounds in the coating.
- Sulphur block coating for ductile iron casting to prevent reversion of nodules to flack graphite at the surface of the casting.
- Forcoat 243/244 is a spirit based Sulphur block coating ideal for spraying and brushing applications for sand moulding, having excellent suspension and coverage properties,suitable for Ductile Iron





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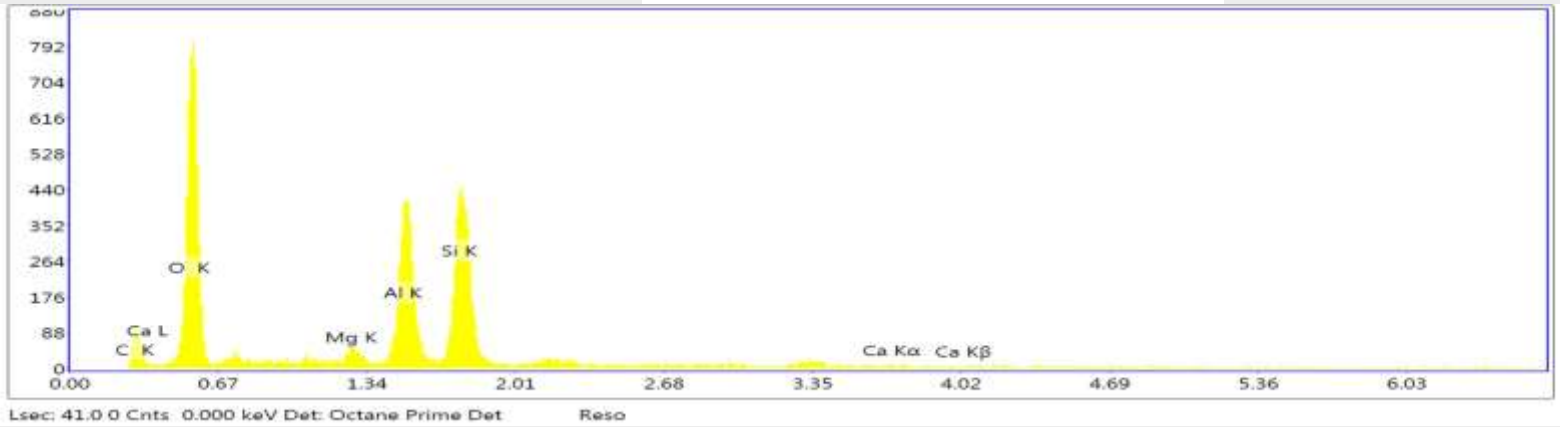

eZAF Smart Quant Results

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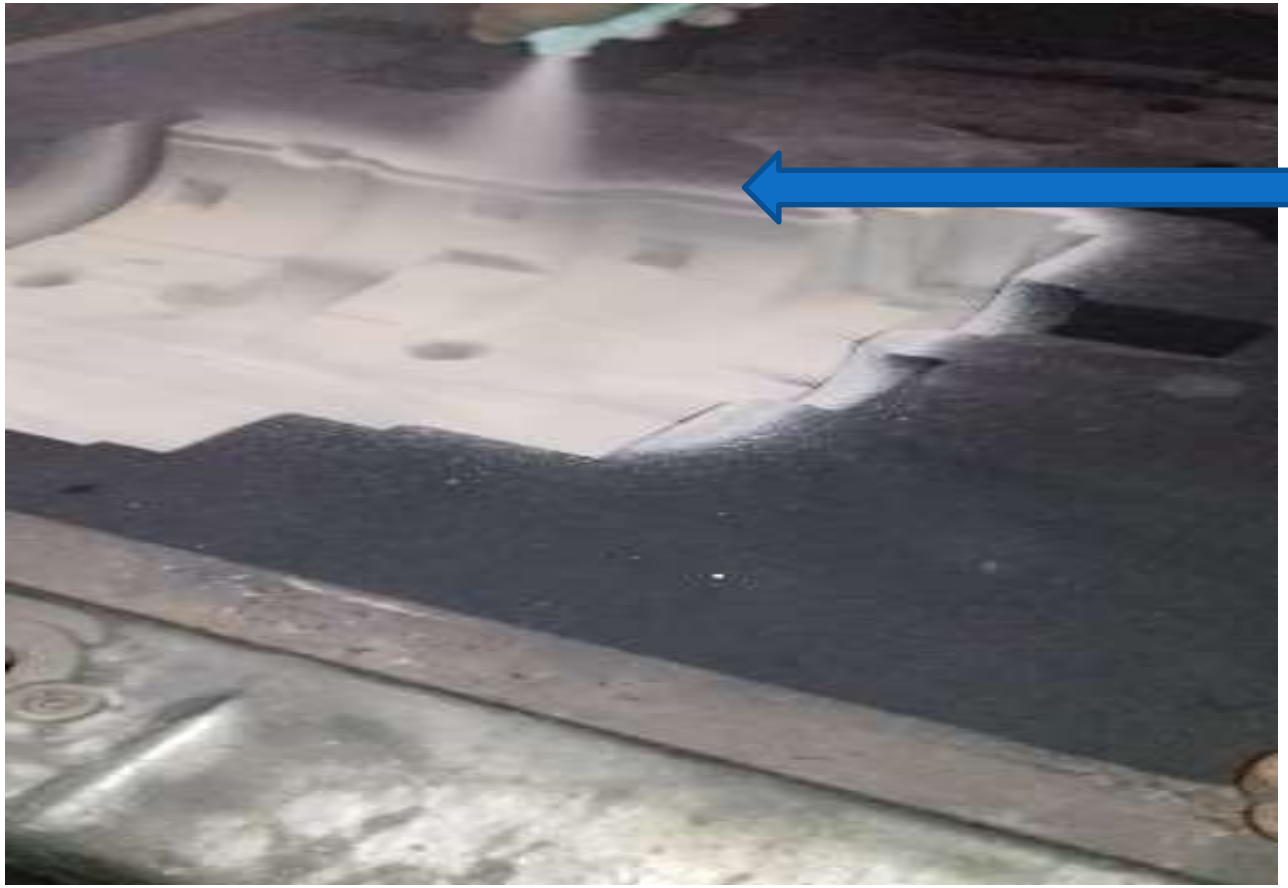
C K	6.68	10.77	4	0.11
O K	46.77	56.62	109.3	0.02
MgK	1.21	0.97	4.4	0.22
AlK	19.27	13.83	66.9	0.03
SiK	25.3	17.44	77.2	0.02
CaK	0.77	0.37	0.8	0.64

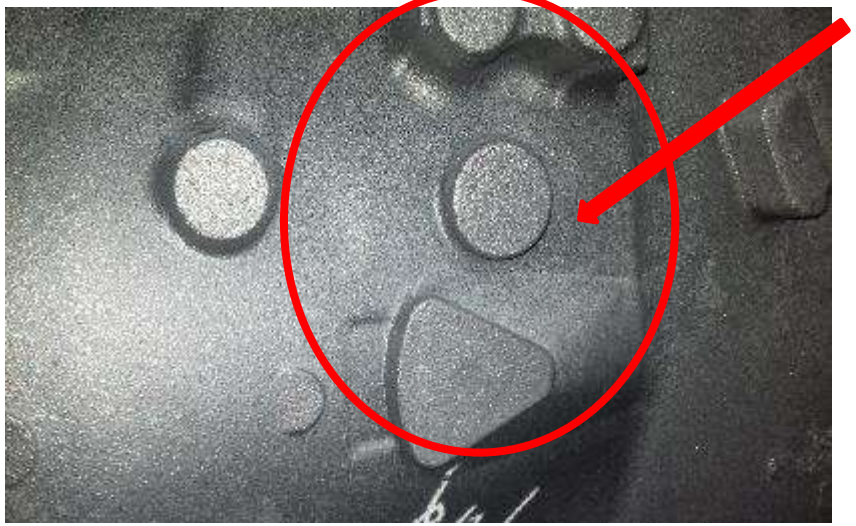
*Purpose of Trial- To improve surface finish of casting
*Uniform Coverage of Coating in mould cavity



During Spray uniform coverage of coating

Trial 1- Escort Transmission Case(After 1st Shot blasting)

With Sulphur block Coating



No Sand Sticking

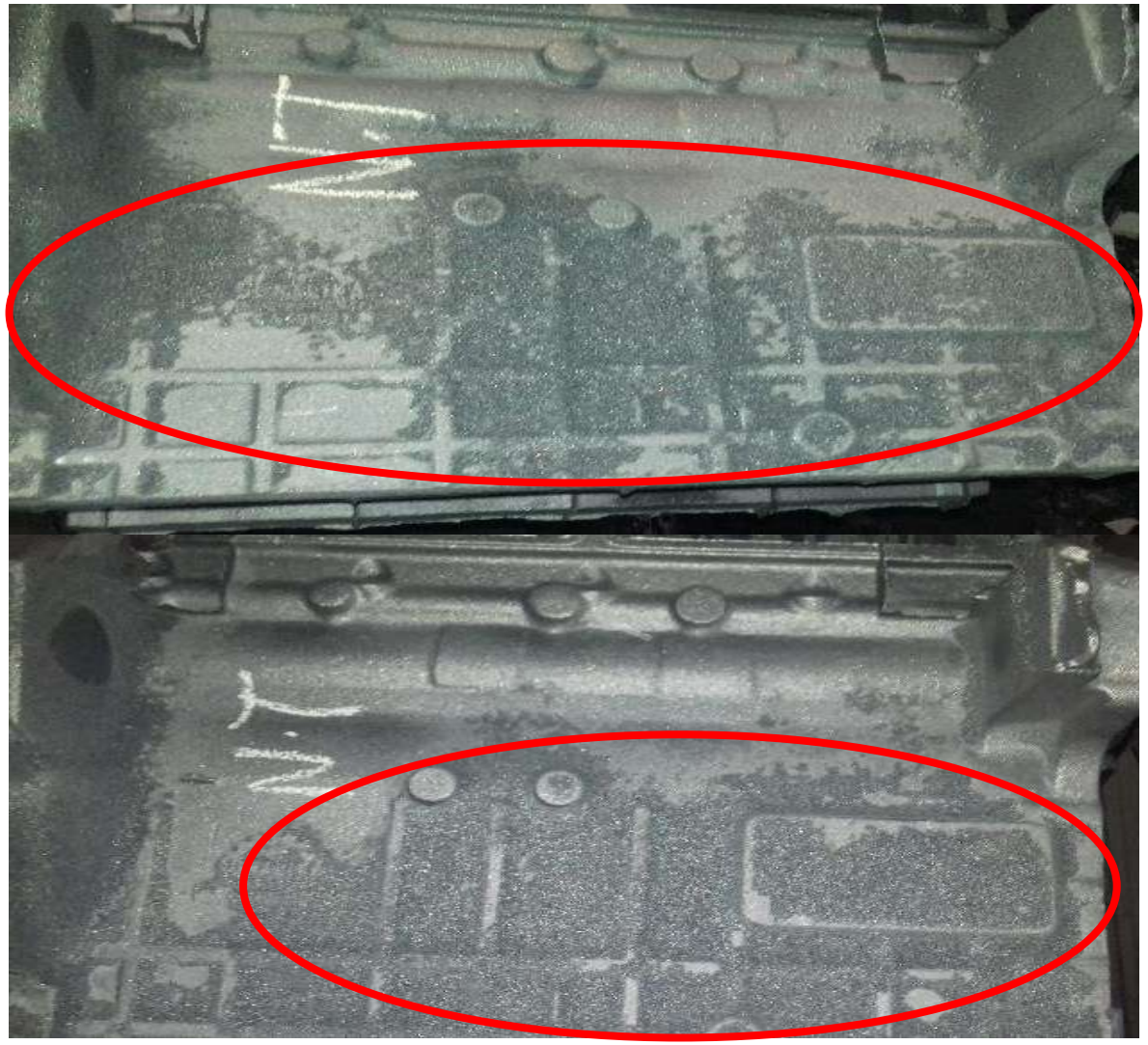
With Regular Coating

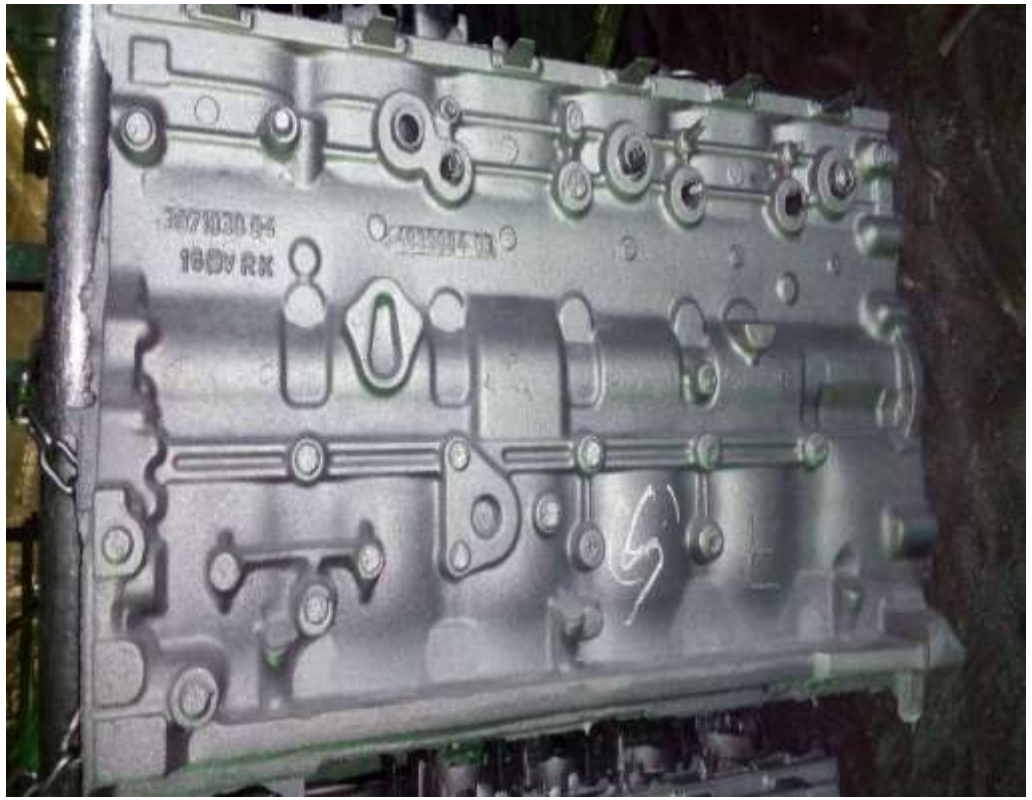
Sand Sticking

Trial 2- Sonalika 4 Bore Crank Case

With Sulphur block coating (No Sand Sticking)

With Regular Coating





sand mould coated with Forcoat-243

The same used to make Casting of B6 Cylinder block for Tata Cummins.

Client: Ashok Iron Works,unit-3

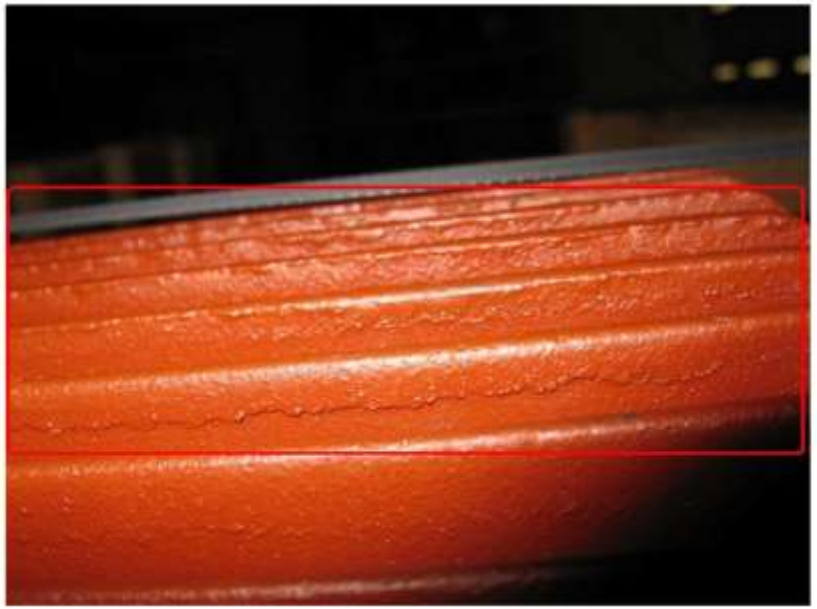
Mold of adapter casting made with Furan system First layer coated with Sulphur Block coating by brush application and second layer coated with zircon water base coating by brush application. In casting their was no Sulphur related defect.

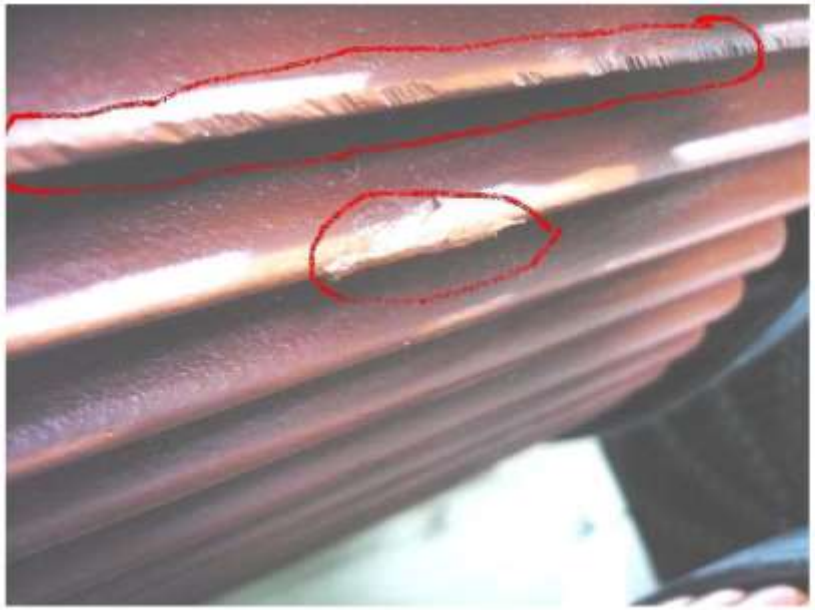
Client: LMW

Special Combination of Coating for Motorbody:

- Forcoat 111 is a zircon water coating with special combination of inorganic/organic suspender and binders results in high solids level which ensures rapid drying possible
- The results is an extremely compact , abrasion resistant coating
- It is preferred for use together with no bake binder systems for all type of molding materials
- FORCOAT-153 is a water based coating in Ready-For-Use form for Foundry applications
-
- Being based on high quality Zircon and Graphite, it imparts low reactivity to metal oxides and excellent performance at high temperatures
- It gives excellent coverage and followability
- It has got superior suspension property and ensures excellent finishing on heavy iron castings

Mould finish and Mould coating quality direct impact on cast surface quality are as per below picture





Solution for Power Industry

Zircon /Zircon- Graphite Mix Refractory

The Moulds made with Furfuran binder System. First layer coated with Forcoat 111 Zircon Water Base & Second layer of Forcoat 153 Zircon-Graphite Mix Refractory aqueous wash applied both by flow coating. The same mould used to make Casting of motor bodies for ABB and weight of the casting is 3.5 tons.

Client: Prashant Casting Pvt. Ltd., Rajkot

Recent Trends

Automation in Dip Coating

- Core assembly dipping - Offers higher productivity
- Robotic handling - Offers consistent coating & Offers high productivity

Solvent → Water-based Coating

- Gives uniform coating on bigger moulds
- Offers high productivity
- Operator in-dependent
- Superior casting surface finish

Rapid Drying Coating

- Offers lesser drying time for water-based coating
- Energy saving
- Relatively higher productivity

Multi Layer Coating to Single Dip Coating

- Offers high productivity
- Energy saving
- Offer lesser drying time

Conclusions

1. Controlled and optimum incorporation of all the ingredients in a coating makes it a superior choice in every application and helps to get the desired results, keeping environmental aspects in mind.

2. Coating in the foundry division have contributed only 1% of the total cost of the casting part . On the other hand the wrong selection or utilisation of a coating can lead for a gigantic amount of cleaning costs , which can increase up to 5 to 10% of the casting costs.

3. Correct coating applications will reduce casting defects

4 Correct coating choices are needed for each application

5 Coating thickness and even application is very important

6 New requirements for the coating materials and their compositions:

- to cope with the task of gas evolution or gas problems
- to enhance the release of the coating after casting
- to guarantee a constant working condition an automatic viscosity control has been developed

Thank you for your attention