«Efficient and Economic Application of Coatings»

«Verimli ve Ekonomik Kaplama Uygulamaları»

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(Metko HA)

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EFFICIENT & ECONOMIC APPLICATION OF COATINGS

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Foundry Cost Implications

- Casting defects are costing the foundry industry due to scrap and rework.
- This can be influenced by incorrect coating application.
- Coating application is important and it is also essential to applying the coating correctly and efficiently.
- This presentation describes problems associated and illustrates ways to help avoid them.
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Refractory Coating Definition

- Refractory coatings are dried, heat resistant refractory layers.
- They form a dense cover which protects bonded sand moulds from molten metal.

**Reason for coating:**

To work together in producing the perfect casting by eliminating casting defects leaving a smooth cast finish.
What is achieved by coating

- Optimised surface finish
- Resistance to Veining by insulation of the core
- Opposing Metal Penetration & Burn on defects
- Reduction of mould scabbing
- Enhanced casting release
- Barriers against metal mould reactions
Veining Defect Control

**Formation:** Mould or core sand expands stress builds and cracks form.

**Influencing factor:** Alpha to beta phase Expansion of Quartz sand @ 575°C by occupies a 1.3 vol % expansion

- High insulating coatings help delay phase change until solidification occurs
Metal Penetration Resistance

- High temperature mechanical or chemical breakdown of the bonded sand & eventual metal penetration & fusion.
- Thinner core sections are especially prone to problems
- Coating needs to stable, withstand high pour temperatures & abrasion during casting
Critical Properties - Application

- Ensure uniform coating layer without runs or sagging
- Optimal 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
- Coating should wet the core or mould adequately
- Suitable penetration of the coating & liquid carrier
- Correct ‘Matt or Gloss time’
Brush Coat Considerations

- Choose quality brushes to suit size of mould, clean them regularly
- Ensure there is adequate coating volume on the brush
- Brush in a smooth motion directionally. Train all operators to follow the same practice.
- Build adequate thickness with layering to avoid cracking.
- Be wary of brushing after coating has ‘matted out’. Longer matt time is beneficial.
- Ensure an even coverage without brush marks. This versatile application can be carried out in most locations.

Shear rate $D = \frac{V}{Y}$

$D = \text{velocity of brush (m/s)} / \text{coating thickness (m)}$
Spray coating considerations

- Ensure the suitable spray nozzle for process & coating type (0.8 – 2.5mm)
- Control feed & spray pressure to suit application ideally (2- 3 bar) to avoid dry spraying
- Move the gun before applying the trigger reducing overspray & apply square to the mould
- Application distance guide: 200-500 mm (gun to mould). Spray with an oscillating movement to gradually build thickness without runs or tear formation.
- Spray direct to mould corners so that each adjacent wall is coated evenly
- Brushing may still be required for deep crevices & areas difficult to reach with spraying
- Always Clean out spray gun after use. Spray application is environmentally dusty.
Flooding procedure considerations

- Flooding and dipping are the most productive applications. Robotic systems are available.
- 100-200 litre holding vessels are set in the region of 2 bar pressure & pumped through.
- Coat the mould in a constant action top to bottom, left to right.
- Deep pockets are reachable & consistent layer thickness on vertical mould surfaces can be achieved by flooding.
- Empty excess coating from deep crevices by tilting the mould.
- Wait for coating to matt out before tilting the mould back: reducing flow marks.
- Sieve out any contaminated sand in the sieve unit.
Manual and Robotic Dip Practice

- Ensure compliance with handling regulations in local area. Extra personnel or cranes & robots may be needed for large cores.
- Dip method or program should be constant. This includes dip time, hold time and removal time.
- Ensure all core pockets are tilted & removed of excess coating.
- A uniform coating layer should be applied without runs or sagging.
- Coating should have matted out after turning the core and placing ready for drying.
- Use a dip tank with pump recirculation ensuring homogenous & consistent application.
- Ensure viscosity & thickness is rechecked and constant.
- Clean robot & dip tank of dried coating to avoid bacterial pick up.
Process Control

- Control coating layer film thickness
- Monitor Viscosity: flow time or baume. Consider HA automated control
- Ensure coating is homogenous following preparation
- Clean coating area, dip tanks, equipment regularly to avoid bacteria problems
- Control contamination from sand, filter etc.
- Ensure coating or working area is not subject to big variations in temperatures. This effects coating performance and consistency
Coatings Applied Too Thin

- Molten metal heat and abrasion from metal flow breaks down the thinner coating layer too easily allowing metal to penetrate into the sand
- Thin coating may not insulate the thermal expansion of the core sufficiently, resulting in stress cracks and relative veining
Veining - Effect of coating thickness

- The correct coating thickness can sometimes be the difference between veining defects and no defects at all – Test coatings A

- Incorrect coatings will not perform irrespective of the thickness – Test coating B

- Choice of coating at suitable thickness is the key to success
Coatings Applied Too Thick

- Sagging & Run marks on the castings
- Increased tendency for entrapped gas
- Cracking of the coating layer
- Coating abrades or lifts off to form scabs
Effect of inadequate process control

- Coating is applied too thin resulting in limited protection of the mould or core
- Coating is applied too thick making it brittle, crack, lift off and harder to dry
- Coating thickness needs very careful control!
- Failure to control will increase defect rates in the foundry
Demands placed on coating of cores and moulds have increased.

In order to achieve optimal casting results, the benefit of homogeneous, consistent and evenly distributed coating layers is of increased importance.

HA in conjunction with OAS - AG have developed a series of systems ranging from smaller dipping tanks to complete automatic coating preparation plants.

Flood basins, dip tanks as well as entire storage terminals can be custom developed to suit each application & customer requirements.
Coating preparation & auto-control plant

- An optimum coating process is achieved with a system custom suited to the particular foundry application.

- Coatings can be dipped robotically or manually and any adjustments to the coating are made automatically to ensure that a consistent coating application is made each time.
Coating preparation & auto-control plant

- Viscosity & density measurements are adjusted automatically using a dosing system that feeds coating or liquid carrier at a consistency that coating is applied at stable and desired thicknesses.
- Levels of coating in the application area are automatically refilled.
- The entire testing equipment is installed outside the tank to prevent contamination of the sensors by the coating as well as wear and tear by the abrasive materials.
- The system includes a washing cycle for the sensor system internally & the disposal of the flushing agent is therefore not needed.
The design of the plant with sealed components reduces any evaporation of the product during use, avoiding need for modification of the coating due to water or alcohol evaporation.

Equipment can be delivered as a complete system for central processing of the coating or installed at an individual station or dip tank. The plant technology used is tailored to suit varied types of coating.

The extensive range auto control systems can be adjusted and optimized to all coating application processes in various fields of the foundry industry.

Good quality coating control ensures a more consistent production of castings with improved levels of overall cast quality.
Critical Properties During Casting

- Must achieve suitable surface finish
- Adequate permeability to release any gases. HA ensures coating permeability suits the application by coating structure
- Suitable refractoriness & thermal stability of coatings are needed
- Good bond strength & resistance to abrasion by metal.
- Adequate ‘keying in’ and coating penetration to prevent mould or core erosion
- Suitable coating release or peel-back needed so that no residue is left internally in the casting
Carrier types used Worldwide

- Solvent - Isopropanol (IPA)
  - Ethanol
  - Methanol
  - Chlorinated Solvents
  - Reclaimed solvents

- Water - Purity varies including pH
  - These changes effect the coating!
Solvent carrier considerations

- Reasons for choice is mainly price driven globally
- Performances vary due to heat of combustion, boil point and flash point. Different solvents effect the coating performance

**Isopropanol**  HC-30.4 MJ/Kg, Bp = 82 C, Flash point = 12 C

*Higher heat of combustion* (burns hotter), Lower rate of evaporation (Bp 82C)

Easy ignition, Very low tendency for filler separation & allows longer brushability with most gel systems

**Ethanol**  HC-28.9 MJ/Kg, Bp= 78 C, Flash point = 13 C

Fairly high heat of combustion, med evaporation rate, *Least easy Ignition* (often has 5% water, lowering further). Low tendency for filler separation.

**Methanol**  HC-19.9 MJ/Kg, Bp= 65 C, Flash point = 11 C

*Lower heat of combustion (burns cooler). High evaporation rate*, Easiest ignition, Higher tendency for filler separation, shorter brushability. Is a Toxic solvent and should be used with care.

**Reclaimed solvents**

Ensure good consistency, not recommended due to variability
Efficient application summary

- Correct coating applications will reduce casting defects
- Correct coating choices are needed for each application
- Solvents for dilution effect coating performances
- Coating thickness and even application is very important
- Process control should be monitored carefully in the foundry
- Operator training (manual) / or correct settings (robot) are vital to ensure consistent application.
- New automated coating control systems are now available to improve consistency in our modern foundries
Thank you for your attention