Coating application consistency

Introduction

With the ever increasing quality demands placed on ferrous castings, in terms of the complexity of the cast components and the need for improved surface integrity, the use of mould and core coatings has become paramount. Typically the coating operation accounts for less than 2% of the manufacturing cost of a casting, yet this small investment in premium performance coatings can have a significant ecomomic impact by eliminating or reducing significantly the costs of scrap and casting re-work associated with surface defects such as:

- ❑ Sand expansion defects (Veining)
- ❑ Burn-on
- ❑ Metal penetration
- ❑ Scabbing.

For optimum performance and economic return on investment it is essential that coatings are used consistently, and previous papers [1] have discussed suitable coating application methods such as flow coating and dipping, and the control of the product to ensure consistent layer thickness application.

In recent years there has been a significant trend away from solvent (isopropanol or ethanol) based products to water-based coating technology, this has taken place for a number of reasons:

- ❑ Increased price volatility of solvents
- ❑ Reduced environmental impact of water-based products (ISO 14001)
- ❑ Reduced storage of dangerous goods
- ❑ Availability of improved drying technology
- ❑ Improved compatibility with core and mould binders.

It should however be acknowledged that the use of water-based coatings requires additional testing procedures and control to ensure consistent application and casting quality.

Effect of temperature on applied coating layer thickness

The viscosity of water-based coatings tends to be more sensitive to changes in temperature than equivalent solvent-based products. The example of a typical water-based coating is shown in Figure 1, and it can be seen that relatively small changes in temperature can result in significant variance in viscosity. These variations in viscosity can be directly related to:

- ❑ Variation in applied coating layer thickness
- ❑ Increased formation of runs and drips during application.

These will subsequently be reflected in reduced surface fininsh, due to the replication of runs or drips and an increased level of surface defects such as burn-on and veining if the coating layer is too thin or scabbing if the layer is too thick.

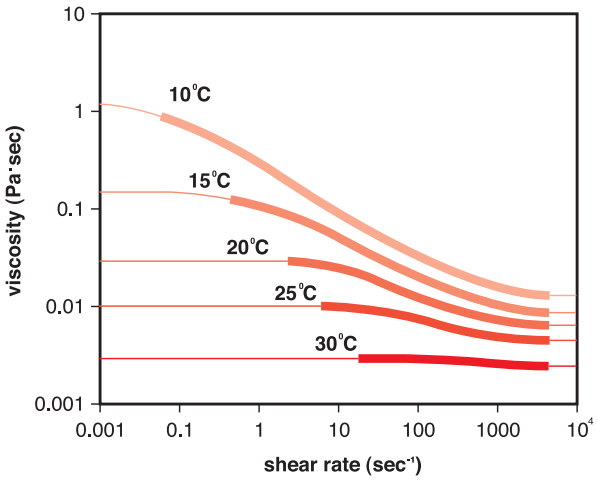

Figure 1 Effect of varying temperature on viscosity of a water-based coating

To overcome variations in applied layer thickness due to temperature related viscosity variations, control equipment is available from a number of suppliers. There are generally two approaches to overcoming this problem, the simplest method is to control the temperature of the coating within the dip tank so that viscosity variations do not occur. There are also more sophisticated systems which continuously measure the viscosity of the coating and compensate for changes by the addition of water or undiluted coating, these systems have the added benefit of also compensating for viscosity changes due to evaporation. The preferred option is a combination of both methods described, i.e minimise variance in temperature and then compensate for any additional changes in viscosity.

Effect of bacterial attack on water-based coatings

One of the main disadvantages of water-based coatings, when compared with solvent-based products, is that they are prone to attack from bacteria. The bacteria thrive in a water-based environment and feed on the natural raw materials used within the coating formulation, destroying the rheological properties of the coating and leading to:

- ❑ Accelerated sedimentation
- ❑ Changes in flow characteristics, leading to run and drip formation
- ❑ Reduced edge coverage
- ❑ Graphite flotation
- ❑ Changes in wetting properties and layer deposition
- ❑ Syneresis
- ❑ Cracks in dry coating layer.

Additionally, in the process of breaking down materials within the coating, by-products are created which not only can cause a noxious odour but more importantly the release of endotoxins leading to skin irritations and in the most extreme cases sickness, fever and asthma attacks.

Water-based coatings will usually contain some level of biocide, however using excessive levels of biocide can have an effect on the health and safety labelling of the product. The biocide addition ensures that bacteria present in the raw materials is neutralised and the residual biocide protects the product during storage and use under normal conditions by restricting bacterial growth. However if subsequent contamination of the coating increases the bacteria levels to a point at which the biocide is neutralised, then the bacteria will grow exponentially and destroy the coating properties.

In use, coating can become contaminated through many routes, but it is usually related to poor housekeeping in relation to the cleanliness of storage and dipping tanks, pipework and tooling. Even where housekeeping and cleanliness is at a high level, contamination can still occur through the use of a contaminated source of water used for coating dilution. If the dilution water is identified as a problem Foseco can provide a pre-treatment solution which sterilises the water prior to its use as a dilutant.

There are also non-bacterial agents that reduce the effectiveness of biocides, one example of this is the effect of residual amine within polyurethane coldbox cores, which both neutralises the biocide through chemical interaction and acts as a food for some bacteria types, encouraging increased growth rates.

It is recommended that foundries using water-based coatings adopt a good housekeeping policy, ensuring regular cleaning and sterilisation of all tanks, pipework and associated tooling. Additionally regular audits and sample testing will highlight areas of concern, such as dead-areas within tanks and pipework where old coating can build-up. Simple tests can be used to monitor dip-tanks, for example regular measurements of the pH of the coating will indicate bacterial attack when the pH value drops and dip slide tests (figure 2), can be used on a regular basis to monitor changes in both the coating and water used for dilution.

Figure 2 Dip slide showing bacterial growth due to contaminated water source

If under the worst circumstances the coating becomes contaminated with bacteria, the only solution is to dispose of the coating and thoroughly clean and sterilise all coating related equipment.

Conclusion

As with all coatings, process control is the key to optimising the performance and ensuring that the coating delivers benefits in terms of defect reduction and surface quality. With water-based coatings the need for process control goes beyond application and layer thickness control, and requires a higher level of temperature control or compensation and good housekeeping and cleanliness to ensure the rheological properties are maintained and not influenced negatively through bacterial attack.

References

1. Foundry Practice 235