DENSITY CONTROLLED COATING OR THE BENEFITS OF INTELLIGENT AUTOMATIC COATING CONTROL

FOSECO

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The Foseco Intelligent Coating Unit (ICU) was introduced in 2019 to improve the handling and application of mould/core coatings in ferrous foundries. It thus offers a way for foundries to improve process reliability, as well as casting quality. Further developments of the ICU concept since then have led to the launch of new modular and integrated solutions that extend its use to a wider range of foundries, and show payback on investment within a year of installation. The very latest innovation is the first handheld density measurement tool, which has been released as a replacement for traditional Baumé and flow cup testing when manual coating control is required.

INTRODUCTION

Technologies that improve casting quality are a top priority for foundries. Benefits are far reaching. High-performance foundry coatings are an important remedy for many casting defects – and thus a crucial tool for improving casting quality. Coatings are also necessary for achieving a high-quality surface finish, particularly in castings with complex internal geometries. And they create a barrier between the mould/core and the molten metal, reducing thermal shock to the mould/core and associated defects (such as veining, metal penetration, burn-on/in, scabbing, rat-tailing, and erosion).

This ultimately results in fewer rejects and less rework, improving foundry productivity and delivering a more energy- and materials-efficient casting process. At the same time, a foundry that can assure customers of its high casting quality is better placed to meet customer demand, especially for thinner wall sections and more challenging casting geometries.

The benefits of high-performance coatings is however dependent on the quality of their application: adequate and consistent coating layer thickness is essential to avoid coating-related defects and ensure efficient coating use. In contrast, poor coating application control may undermine the performance of the coating, and thus result in subpar castings, excessive rework, and high scrappage, as well as unnecessarily high expenditure on coating through non-optimal use (over-consumption).

COATING CONTROL

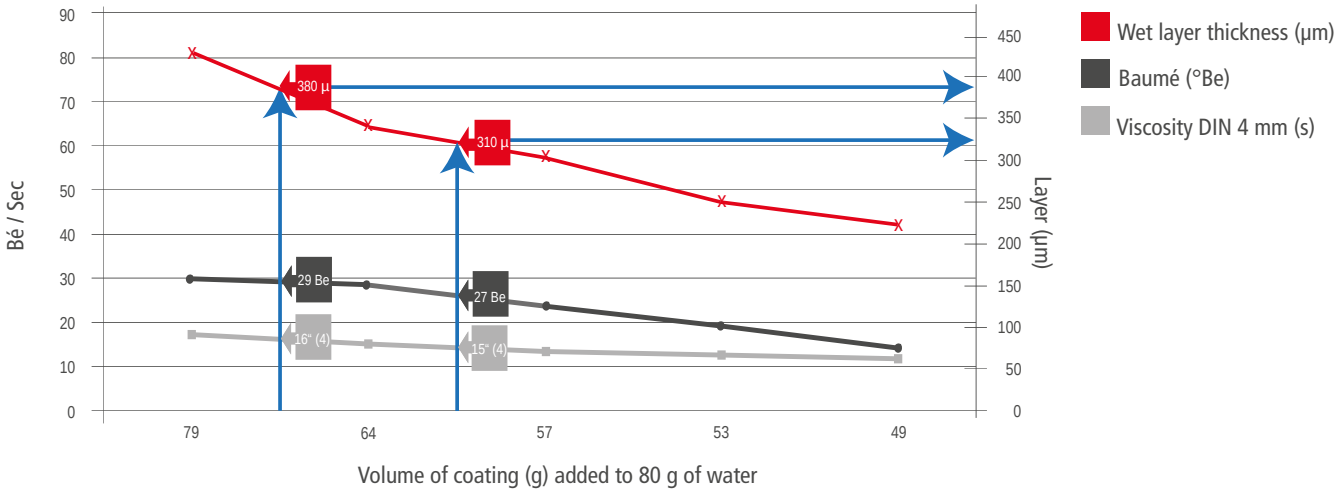
The ultimate measure of coating application is LAYER THICKNESS. However there is no reliable test to measure the consistency of coating layer thickness during application. Traditionally, it has been controlled manually using the Baumé test (which helps measure dilution consistency) and/or the flow cup test (which measures viscosity). However, the accuracy of both methods relies on a range of variables, including operator consistency, coating temperature, core temperature, ambient foundry temperature, and the energy put into a coating by pumping and mixing.

Foseco introduced density measurement for coating application control in 2008, taking advantage of the fact that coating density closely correlates to the applied coating layer. The Intelligent Coating Unit (ICU) built on this idea to offer continuous density monitoring and control. The ICU concept has since been developed further with a range of new systems now available to suit different operating needs:

- ICU-Pro: the 'mother' unit on which all subsequent ICU units are based.
- ICU-I: integratable with customer dip tanks.
- ICU-Modular: a lower-cost solution for foundries with limited space or that want a tailored solution.
- ICU-Continuous to serve multiple end users without the need for a buffer tank.

Foseco has also developed the Density Measurement Tool (DMT): a unique device that offers the benefits of density measurement in a handheld format.

Figure 1: Coating baumé and viscosity vs. wet layer thickness



ICU-PRO[1]

The ICU-Pro is the original intelligent coating unit concept and is available for both solvent-based and water-based coatings. It delivers the following advantages:

- Consistent and predictable coating applications (layer thickness).
- Automatic dosing of coating or dilutant to maintain optimum density and avoid over-mixing.
- Optimised processing of diluted coating to maintain coating quality (avoid contamination, extend coating life).
- Continuous, automatic monitoring and recording of coating density.
- Reduced maintenance and downtime.
- Fully ATEX approved system – compliant with latest regulation 2014/34/EU.

How does the ICU-Pro achieve this? It begins with the pressure sensors, which are embedded in the coating homogenisation tank and facilitate monitoring of coating density (density being linearly related to the pressure difference between two fixed depths[2]). These sensors are designed to survive in harsh operating conditions, such as those found in foundries, with few moving parts and maintenance-free components. Robust and reliable – with operating life up to 10 years – they also provide a high degree of accuracy. It is now possible to achieve a maximum tolerance of 0.1% of the desired value.

Using the measurements provided by the pressure sensors, a PLC-based control unit continuously monitors coating density in the tank, comparing this to the target density and adjusting to deliver the required coating thickness. In the event of a discrepancy between the measured and ideal densities, the control unit will automatically add water or raw coating to bring the measured density back within the defined parameters.

The control unit is also responsible for controlling mixer timing and speed to ensure coating homogeneity. Meanwhile, the propellor geometry has been designed to minimise shear load on the coating, which – if too high – can negatively impact the rheological properties of the coating and thus change the structure of the coating layer: something that is essential to avoid.

The coating is then supplied to one or more coating application stations from the ICU tank for use. Returned coating is filtered through a double -filter system to remove contaminants, such as moulding/core sand, and returned to the mix tank for checking and re-homogenisation.

Monitoring each pressure reading automatically also allows the control unit to determine any sedimentation of the coating (e.g., due to bacterial contamination[3]), something that was not possible with earlier technologies. Increased sedimentation rate may indicate rheological changes to the coating, which (as mentioned above) are essential to avoid. By monitoring sedimentation, users are thus able to identify any such changes and take remedial action.

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Figure 2: ICU-Pro - Complete coating preparation and application control for water and solvent coatings

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ICU-I

For all the benefits of the ICU-Pro, many foundries do not require a central coating preparation plant. But this does not mean that the benefits of the ICU are beyond the reach of such foundries. The intelligent coating control functions of the ICU can instead be integrated directly into the dip tank. The ICU-I can thus be customised to the specific foundry application, for use with dip tanks of any size, and ensures that replenishment of raw coating or dilution medium takes place without delay.

The latest installation of the ICU-I concept took place at Silbitz Guss GmbH, the oldest and largest foundry site of the Silbitz Group. Silbitz Guss is a classic jobbing foundry. It offers a range of services in the iron, steel, and stainless steel segment, manufacturing cast parts for (among others) the wind power, machine tools, construction, mining, and railway industries.

The coating in the existing dip tank at Silbitz Guss was conrolled manually. Although this is conventional operating procedure at foundries around the world, manual operation can result in large variation in coating density, which causes unacceptable changes to coating layer thickness. Good coating practice could also not be reproduced, as it was dependent on the operator. This led to a significant amount of time-intensive and costly rework.

To solve the issues and deliver improved core shop quality – without reducing productivity – Foseco worked with Silbitz Guss to integrate the ICU concept into the dip tank. An adapted combination of dipping and flow tank was also implemented for all core sizes in one unit. In doing so, the coating process was successfully stabilised, relieving the workload on Silbitz employees and significantly reducing rework. This led to significant savings per year in scrap and coating costs. Foundry productivity was also improved.

Figure 3: ICU-I - Integrated Density Control and Adjustment in combined Flow Coating and Dip Tank

ICU-MODULAR AND ICU-CONTINUOUS

The ICU-Modular and ICU-Continuous solutions are the latest additions to the ICU family, available for water-based coating:

- The ICU-Modular is a lower-cost solution for foundries with lower coating demand, space constraints, or other bespoke requirements. Based on the original ICU concept it offers similar benefits in terms of coating preparation, continuous monitoring and adjustment, and application, all of which are optimised to the highest levels available in the industry. This minimises coating waste and ensures consistent drying times; maintenance and noise are also significantly reduced.
- When multiple coating applications have to be controlled, the ICU-Continuous can be used – without the need for an intermediate buffer tank. Density measurement occurs in a bypass system connected to the main preparation tank, which can then be used to supply application-ready coating to whatever end use is required (e.g., dip tanks, flow coaters, spray systems, etc.) in unlimited volumes.

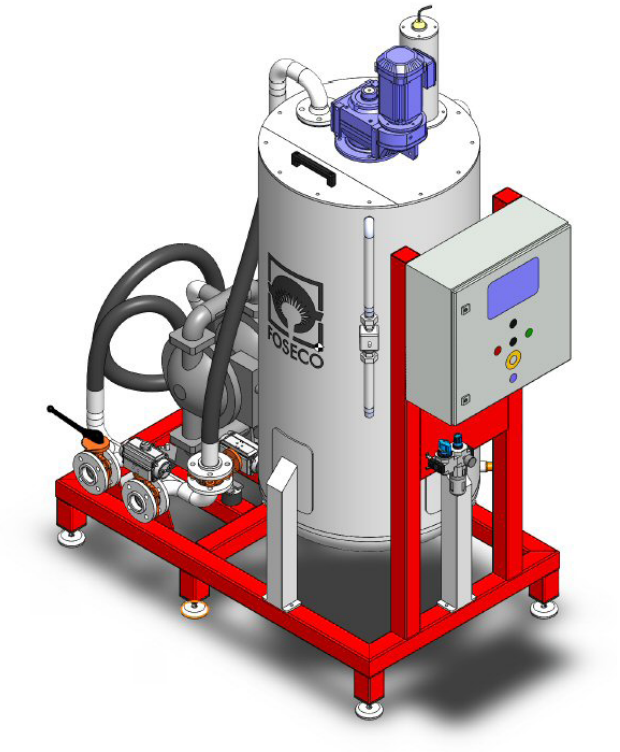

Figure 4: ICU-Modular - fully customisable

A UNIQUE SOLUTION: DENSITY MEASUREMENT TOOL

The DMT is designed to replace current Baumé and flow cup testing when manual control of coatings density is required, and is the only handheld density measurement tool in the industry. As noted above, the accuracy of these traditional methods can vary greatly depending on a wide range of factors – most notably, the skill and consistency of the operator.

The DMT removes this variability from the process, offering a high degree of accuracy and reproducibility of results. It is also easy to use. The device is simply submerged in the coating reservoir for a minimum of eight seconds before taking a reading. The results are however significant: improved coating preparation, adjustment, and application – minimising coating waste and ensuring consistent coating performance.

The easy-to-use design also extends to maintenance. Very little is needed by way of upkeep (although we do suggest both measurement pipes be flushed clean with water after taking a measurement). The DMT is compliant with EU Machinery Directive 2006/42/EC, comes with a rechargeable battery and, if maintenance is ever needed, is designed to allow very easy access.

Figure 5: DMT - Denisty Measurement Tool

CONCLUSION

Mould and core coatings may only be micrometers thick, but their influence on casting quality – and so the economics and sustainability of foundry operations – should not be underestimated. By adopting the latest coating control technologies, foundries can reap significant rewards in terms of reduced scrappage and rework time. Coating use can also be optimised to eliminate over-consumption and waste.

By enabling quick and accurate determination of coating density, the ICU family of solutions facilitates continuous and automatic measurement and adjustment of coatings, so that the ideal coating thickness for the casting application is achieved. Meanwhile, the DMT brings similar benefits to contexts where manual coating control is required.

NOTES

1. This section draws extensively on: Genzler, C., 'Automated Intelligent Coating Concept for Ferrous Foundries' Foundry Practice no. 269 (2019), pp. 11-16.
2. For a more detailed discussion of the relation between pressure and density, see Genzler, C. (2019), p. 12.
3. On bacterial contamination, an optional UV treatment unit is available for the treatment of dilution water. This avoids the use of chemicals that may degrade the life of the coating and thus also reduces waste.

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ABOUT THE AUTHOR

Christoph has worked in the foundry supply industry for 34 years and is currently European Product Manager Coatings. In this role he is responsible for helping customers find the most suitable coating products for their application, raw material selection and approval, best practice transfer and marketing of coatings. Christoph enjoys interacting with customers, talking to different people, meeting different cultures and last but not least... solving problems. In his spare time he likes to ride his motorcycle or bicycle.

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