June 2023

NO. 274

VESUVIUS
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FOSECO

FOUNDRY PRACTICE

The authoritative magazine for foundry engineers

- SINCE 1932 -

COATINGS

How coatings can improve economic, social, and environmental sustainability at foundries

COATINGS

Zircon-free refractory coating for iron and steel castings

MOULDING MATERIAL

New mould release agent reduces fire and environmental risk

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Supporting the transition to lead-free bearings in large diesel engines: the challenge for foundries

COATINGS

Density Controlled Coating or the benefits of intelligent automatic coating control

EDITORIAL

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Dear Readers,

Welcome to this special GIFA edition of Foundry Practice focussing on our products for the mould and core shop. It is not only about the products though, at Foseco we pride ourselves on delivering solutions to our customers that solve problems, and the product is only a small part of that solution. This approach is demonstrated effectively in the first technical article which brings together a number of underlying coating technologies to reduce the environmental impact of the foundry process in terms of energy consumption and a reduction of formaldehyde emissions; but ultimately enabling increased productivity and generating significant savings for the foundry. This theme of sustainability is then continued through further technical papers that focus on reducing naturally occurring radiation emissions by reducing zircon consumption and reducing volatile organic compound (VOC) emissions and reducing fire risks through the implementation of more environmentally friendly release agents. In both cases these sustainable solutions do not in any way compromise the product performance or the final quality of the castings produced.

Sustainability cannot only be considered in the isolation of individual customers, but must be taken holistically in a cradle to grave approach, and it is with that in mind that I am very keen to recommend another article. The article relates to an end-use market for castings and shows how by using the best performing coatings, residual particulates in engine blocks can be minimised and those remaining particulates are less damaging to bearings, meaning that lead can be eliminated from bearing material without detriment to performance.

When considering the performance of products it is essential to ensure the correct application and control; for coatings this starts with the correct dilution and homogenisation of the product to ensure the required layer thickness is applied repeatably without runs and drips. Foseco's dedicated team of application experts are available to offer advice and support to ensure the optimum performance of our products and this expertise is complemented by autonomous solutions such as the Intelligent Coating Unit (ICU) described in an article on pages 15-19, that will automatically control the density of the coating to ensure it is always at the correct application dilution.

We hope you enjoy the issue!

Tim Birch
Global Products Director – Coatings

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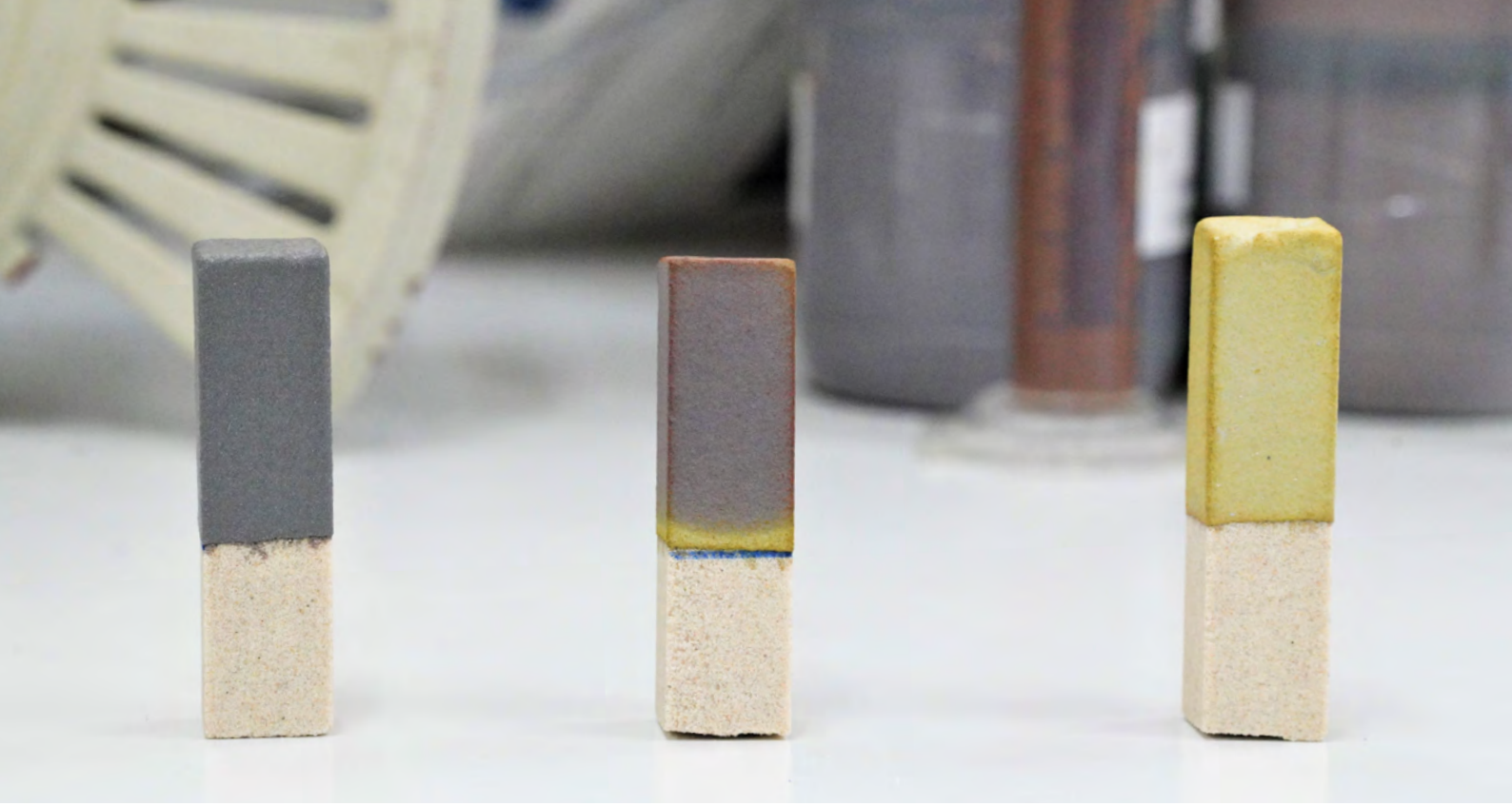


HOW COATINGS CAN IMPROVE ECONOMIC, SOCIAL, AND ENVIRONMENTAL SUSTAINABILITY AT FOUNDRIES

Author: Christoph Genzler, Foseco Nederland

The benefits of water-based coatings have been known for quite some time. As a result, their use has become common in the global foundry industry. However, they remain rare in some sectors of the industry, such as at jobbing foundries, where solvent-based coatings are still prevalent. The SEMCO* family of coatings offers the following range of features, which overcome the challenges traditionally associated with water-based coatings (longer and more costly drying processes; reduced mould shop productivity), while improving the overall health and safety of foundries.

- SEMCO FD for faster drying rates than traditional water-based products
- SEMCO CC colour-change-on-drying technology for an optimized drying process
- SEMCO FF to control formaldehyde emissions in compliance with the latest EU regulations

In addition, these coatings improve the quality of moulds/cores produced, helping to reduce rework and reject rates. Unique to the SEMCO FD-CC-FF family, these features can also be combined into one coatings solution that is tailored to the individual needs of the customer. The result is a family of coatings that supports foundries in cutting energy use – whether for drying or as a result of reduced rework/scrappage – and, with that, Scope 2 CO_2 emissions. As foundries struggle to control costs, reduce their environmental footprint, and meet net-zero targets, SEMCO water-based coatings are thus supporting the industry to become more sustainable and cost efficient than ever.

INTRODUCTION

The cost of energy has always been an issue of concern among foundries. Even the smallest increase can significantly impact business – and the rises we have seen in recent times are anything but small. Indeed, skyrocketing energy costs are threatening the short-term viability of the European foundry industry. With orthodox energy efficiency measures reaching their maximum potential to reduce consumption, other solutions are being sought.

In the medium to long-term, climate change and environmental issues continue to loom large. Meeting net-zero ambitions will require a concerted effort by the foundry industry to cut carbon emissions. There is some synergy here between the need to control energy costs and to reduce greenhouse gas emissions, since efforts to reduce energy consumption ultimately support both.

While the issues of energy and climate change attract much popular attention, far from mainstream headlines the regulation of other harmful substances continues to tighten. These may be more niche problems, yet they have a very real influence on the types of solutions needed to support every day foundry operations.

These brief brushstrokes paint a picture of an industry under stress. A significant part of the response to this must come through innovation and the adoption of improved practices. In this environment, even small improvements can reap large rewards. This paper will focus on one such area and discuss how foundries can reduce energy consumption, environmental risks, and protect worker health by adopting the latest innovations in core and mould coating technology.

HOW DO COATINGS HELP SOLVE THE CHALLENGES FACING FOUNDRIES TODAY?

Solvents (e.g., isopropanol, ethanol, or methanol) are the base for many widely-used coatings, particularly those used in the jobbing foundry sector. They are fast drying or burn-off quickly, which is advantageous both for mould shop productivity and for minimising the amount of energy consumed for drying. However, they are not without challenges. Solvents are expensive, can suffer supply disruption (as was the case during COVID-19) and emit volatile organic compounds (VOCs) into the environment. They can also cause respiratory health issues in workers, while there are restrictions on the storage and use of flammable substances.

Water-based coatings eliminate these issues and have been widely adopted by sections of the foundry industry, notably by automotive or similar mass core production foundries. But water-based coatings are also not without their drawbacks, particularly when it comes to drying speed and the cost of drying equipment. These disadvantages have hindered their uptake in the jobbing foundry sector. In addition, water-based coatings often contain formaldehyde (FH): a biocide that prevents the growth of microorganisms (e.g., bacteria or fungi). Microorganisms can influence the performance of the coating and impact the health of operators.

There is thus a need for a new generation of water-based coatings that improve the performance of their predecessors in terms of drying efficiency and resistance to microorganism growth. The SEMCO family of water-based coatings offers a range of features that do just this:

- SEMCO FD delivers faster drying rates than traditional water-based products
- SEMCO CC is a colour-change-on-drying technology that helps manage the drying process
- SEMCO FF reduces evolved FH emissions in compliance with the latest EU regulations

The remaining article will discuss these features in more detail, starting with SEMCO FD and SEMCO CC and the benefits they bring in terms of reducing energy consumption during the drying process.

IMPROVING DRYING RATES OF WATER-BASED COATINGS FOR JOBBING FOUNDRIES[1] – SEMCO FD

Drying is the key concern when it comes to water-based coatings. Slower drying rates compared to solvent-based alternatives reduce productivity in the drying line and increase energy consumption, adding to operating expenditure. As noted above, this is of particular relevance at the moment, given the very high cost of energy.

It is a fundamental fact of physics that to heat 1g of water by 1°C requires 4.186J (or 1cal). Meanwhile, the evaporation temperature of water is 100°C. These values cannot be changed. But what can be changed is the amount of water that needs to be evaporated to dry the mould or core. It is a simple equation: less water requires less energy to evaporate. And less energy reduces costs.

SEMCO FD coatings are a range of water-based coatings designed for flow coating applications in jobbing foundries, but formulated with a significantly higher solids content – and thus much lower water content – than is typical. They maintain the excellent rheological properties needed in flow coatings and are capable of building the required coating layer in one application, without runs or drips. The range is also available with different refractory filler combinations to suite most foundry needs:

- Pure zircon for the heaviest iron and steel castings.
- Aluminium silicate for heavy iron and smaller steel components.

The low-water formulation of SEMCO FD thus results in a water-based solution appropriate for use by jobbing foundries.

Benefits include:

- Short drying cycle times and related productivity benefits.
- Smaller, lower-cost drying facility requirements.
- Reduced energy consumption, and related costs and carbon emissions.
- Safer and healthier foundry working environment, as hazardous solvents are removed from the process.

In addition, the high solids content in SEMCO FD helps to protect against casting defects. This improves yield and reduces costs association with rejection and reworking costs – another perennial challenge for foundries.

Figure 1 shows approximate cost savings possible in a grey iron casting application when switching to SEMCO FD. (NB: these calculations were made before the current energy crisis and thus represent a conservative estimate of potential cost savings.) Drying costs are based on an estimated 3kg of coating per tonne of grey iron casting produced. At 30,000 tonnes per annum casting output, cost savings using SEMCO FD could amount to at least €40,000.

These benefits persuaded a global castings foundry specialising in ductile iron wind turbine castings to trial SEMCO FD coatings as part of its efforts to improve core shop output, accelerate coating drying rate, and reduce energy costs. The result was 50% faster core/mould drying cycles than traditional water-based coatings (Figure 2). Energy demand and calculated carbon emissions were also reduced proportionally.

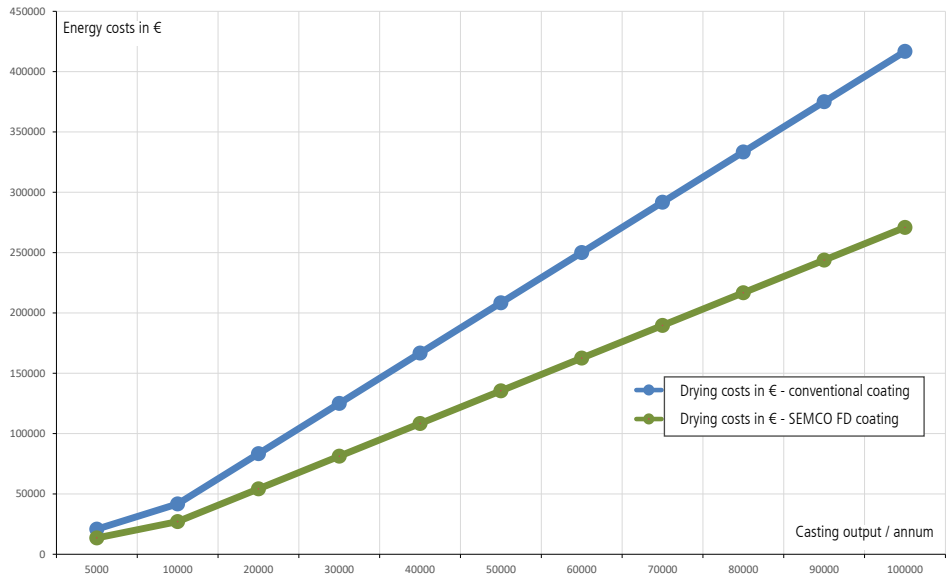


Figure 1. Approximate coating drying costs per annum versus casting output (at 2020 energy costs)

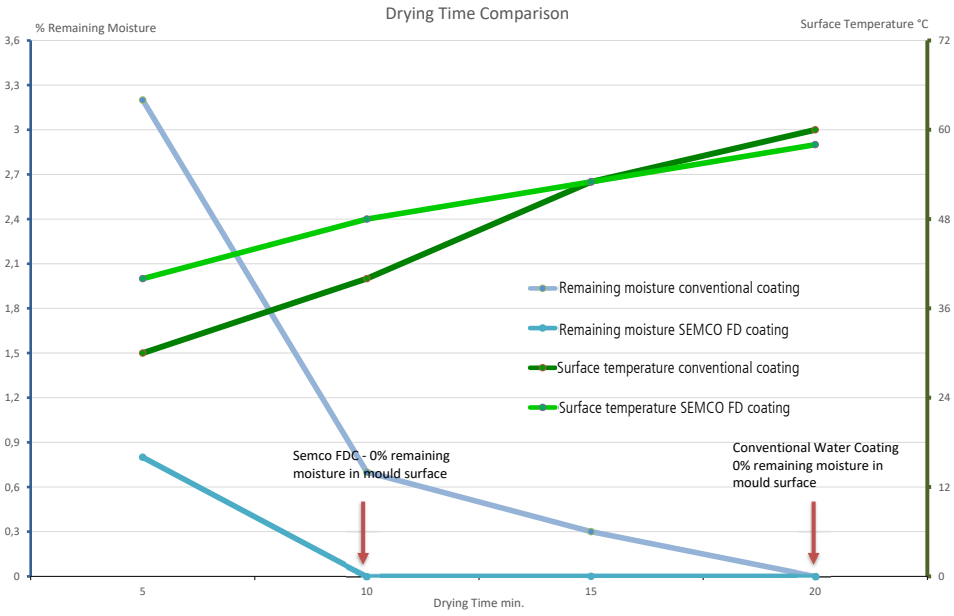


Figure 2. Drying times of a conventional water coating vs SEMCO FD coating at ductile iron foundry

Due to the flexibility of fillers available with SEMCO FD, the foundry was also able to utilize a lighter filler combination. This improved coating application and removed zircon from the foundry environment. The use of zircon is becoming an increasing concern to European foundries due to significant price volatility in zircon markets and a desire to eliminate the use of radioactive materials in the workplace. Zircon is a naturally occurring radioactive material, albeit at very low levels.

OPTIMISING THE DRYING PROCESS: COLOUR CHANGING COATINGS – SEMCO CC

The fact that things change colour as they dry will be familiar to anyone who has painted a wall or picked up a pebble on the beach. Foundries will also be aware that some coatings change colour from darker to lighter during the drying process. Usually, these colour changes are not distinct enough to allow accurate observation of drying progress. However, SEMCO CC water-based coatings utilise a clearly-visible surface colour change (e.g., green to yellow) to monitor the drying process and thus make it easier to manage effectively.

There are two primary benefits:

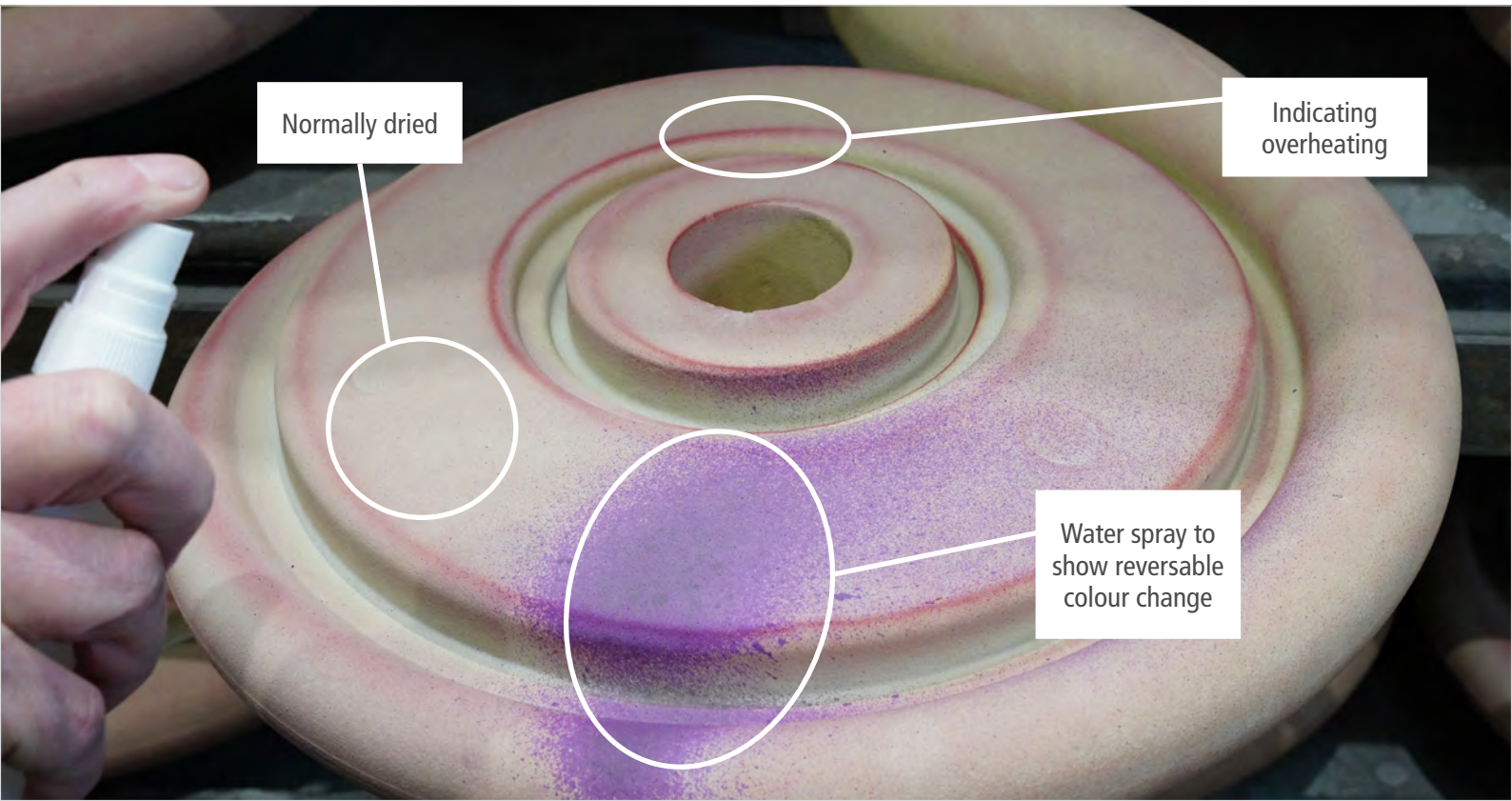
1. **By enabling operators to clearly see when the coating is dry, drying time and temperature can be accurately determined. Drying cycles can therefore be optimised to achieve complete drying in as short a time as possible, minimising energy costs (and resulting carbon emissions).**
2. **As the colour change is reversible, wet or humid cores are easily identified. This is important as the use of wet or humid cores can result in gas defects in the final casting. SEMCO CC coatings therefore have a role in preventing reject and rework.**

The colour change indicator can be integrated into almost every Foseco water-based coating and works with the following systems:

- Furane resin
- Phenolic resin
- Coldbox
- Shell process
- Lost foam

One foundry that has taken advantage of the benefits offered by SEMCO CC technology is Eissengiesserei Baumgarte GmbH in Germany. The Baumgarte foundry produces a range of castings for various industries, including general mechanical engineering, plant construction, railway engineering, vehicle manufacturing, and pumps and drive technology. By using the colour change indicator, Baumgarte successfully reduced energy costs and drying times with a consequent increase in productivity. The improvements resulted in energy cost savings of 20% per year.

Figure 3. By providing clear visualisation of drying progress, SEMCO CC coatings help optimise the drying process and prevent wet cores being used for casting.



PROVIDING A HEALTHIER AND SAFER WORKING ENVIRONMENT[2] – SEMCO FF

One of the key benefits of water-based coatings over solvent-based products is that they are safe to handle and store, and do not release VOCs into the foundry working environment. However, they are prone to attack by microorganisms, such as bacteria and fungi. These microorganisms may be detrimental to worker health; they also negatively impact coating performance by:

- Reducing pH
- Increasing sedimentation
- Causing syneresis
- Degrading flow properties
- Reducing edge coverage
- Increasing coating penetration leading to core breakage
- Changing wetting characteristics
- Causing cracking in the surface of the coating

To protect against microbial growth, water-based coatings often include biocides, which commonly contain formaldehyde (FH) for its antibacterial and antifungal properties. During the drying process, this FH is released, usually into the drying facilities, contributing to the foundry's overall FH emissions. FH is also emitted during pouring in the melt shop and during shake-out, due to decomposed binder components. The release of formaldehyde is a problem because the chemical is carcinogenic and mutagenic[3], and thus harmful to human health; it is regulated as such under EU law, which limits FH emissions levels to just 5mg/m^3.

Control of FH during the manufacture of moulds and cores is complicated by the fact that FH is released by other mould/core components, such as binders and additives. Other chemicals can also be converted into FH during various process steps, such as core blowing, drying and storage. Meanwhile, during the development of SEMCO FF coating technology, it was observed that the level of binder-related FH emissions depended on storage duration: only freshly-made cores and moulds were responsible for a substantial contribution to overall FH emissions levels.

SEMCO FF coatings take the first steps to solve this challenge by including a biocide that does not release FH during the drying process, which is the main area of concern since emissions are most concentrated here. Testing has demonstrated that FH emissions from fresh, as-made PUCB cores with a SEMCO FF coating are considerably lower than those from cores with standard coatings (Figure 4).

A similar impact is also seen when testing cores aged for 11 days (Note: FH emissions during the drying process of aged cores are much lower than from freshly-made cores) (Figure 5).

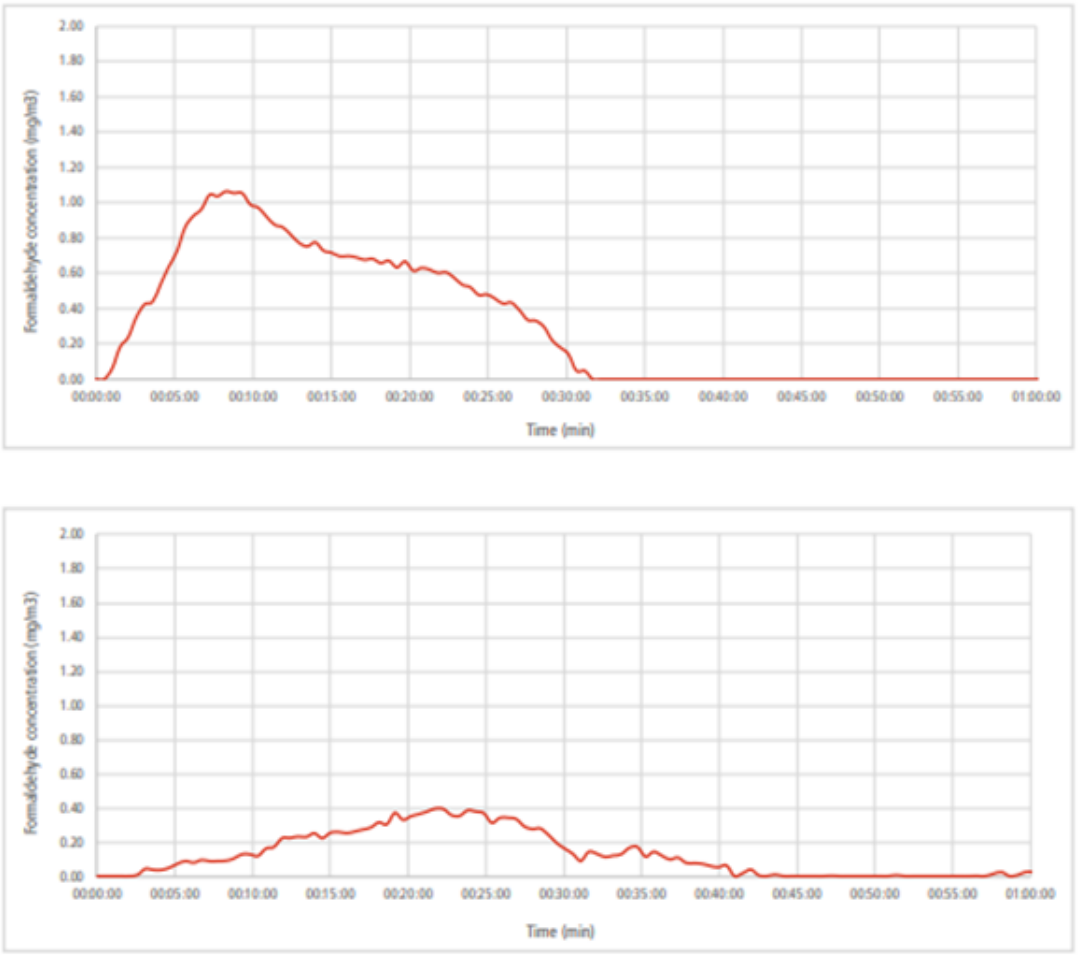


Figure 4. FH emissions from fresh, as-made PUCB cores with standard coating (top) and SEMCO FF coating (bottom).

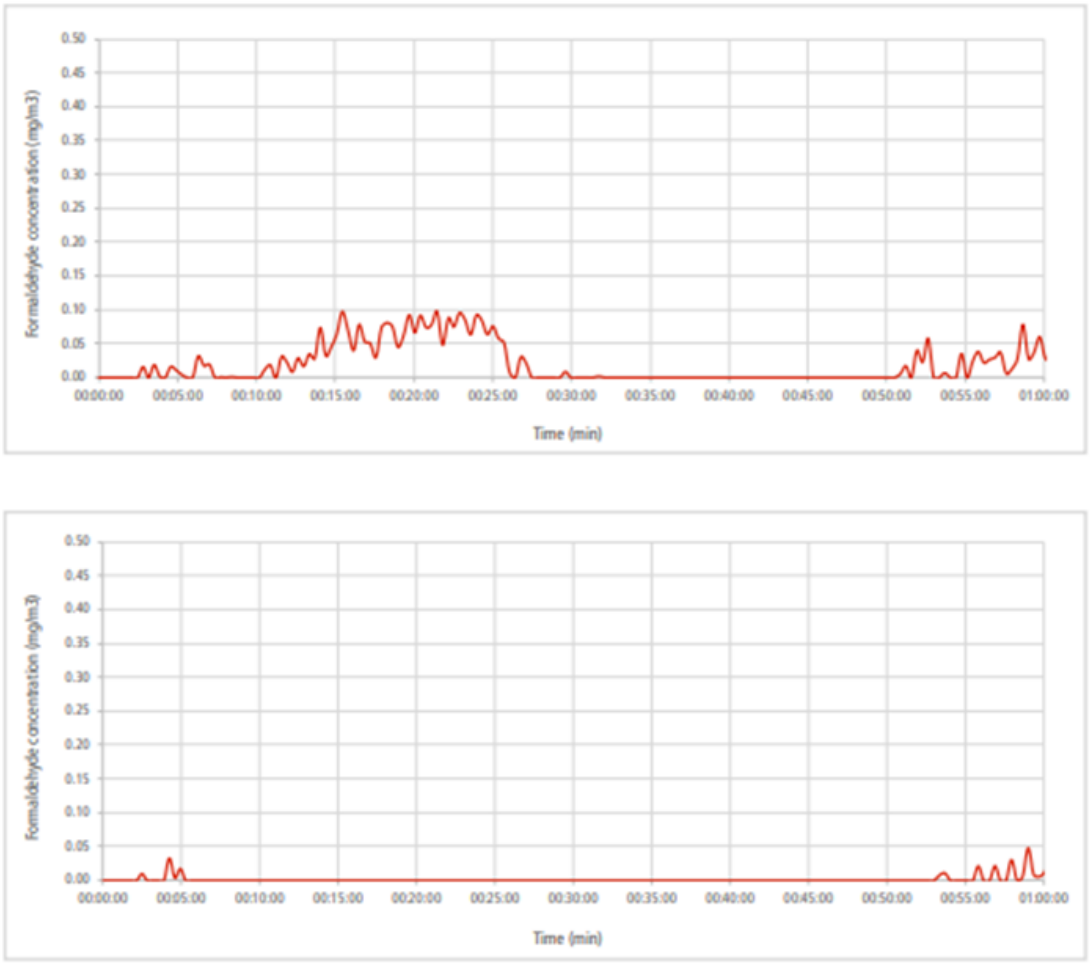


Figure 5. FH emissions from cores aged for 11 days with standard coating (top) and SEMCO FF coating (bottom).

These results demonstrate that SEMCO FF coatings can support foundries in complying with tightening FH emissions regulations, without the need for costlier and more complicated investments, such as new or upgrades to gas treatment systems. There is also potential for the future development of coatings that actually absorb FH emissions from other components of the mould or core, such as binders and additives; the coating could thus become a net-negative contributor to overall FH levels in the foundry.

CONCLUSION: SOLVING PROBLEMS WITH COATINGS – SEMCO FD-CC-FF

Coatings may only be a very small part of the foundry process but, thanks to recent innovation work, they can make a real impact on the challenges facing the casting industry. The SEMCO family of coatings are a case in point.

SEMCO coatings are fast drying and suitable for flow coating applications; they thus facilitate the adoption of water-based coatings in a wider range of applications, including at jobbing foundries previously reliant on solvent-based solution. These properties improve foundry efficiency and – critically – reduce energy consumption in the drying process. The addition of colour-change-on-drying technology only furthers the ability of foundries to optimise mould/core shop operations.

It is not just in the mould shop that the benefits of SEMCO coatings are felt. The ability to tailor refractory fillers means the coating can be specified to provide best results for the application and meet any specific concerns, e.g., the removal of zircon from the foundry site. Higher solids content results in moulds and cores that are less likely to cause casting defects, as does the ability to easily detect and avoid wet/humid moulds and cores. Reject and rework functions are thus reduced: a key aim of any foundry operator and a vital step in improving the yield and efficiency of the process. Finally, eliminating the use of solvents – and with the development of biocides that do not release FH – SEMCO coatings improve overall health and safety in the foundry.

Look at the big picture and the SEMCO family of water-based coatings thus fundamentally improve the sustainability of foundry operations in three senses. They improve financial sustainability by helping to cut costs and increase yield (profitability); they improve social sustainability by reducing the health and safety risks to which foundry workers are exposed; and they improve environmental sustainability by reducing both harmful emissions (VOCs, FH) and energy-related (Scope 2) carbon dioxide emissions. In this way, coatings can have a significant role in solving the foundry industries most pressing challenges.

REFERENCES

[1] This section is based on Genzler, C., 'Fast Drying Coating – The Conversion from Solvent to Water-Based Foundry Coatings' (Foseco International Ltd; 2020)

[2] This section is based on Genzler, C., 'Reducing Formaldehyde Emissions from Water-Based Coatings', Foundry Practice No. 270 (Foseco International Ltd; 2021)

[3] https://echa.europa.eu/registration-dossier/-/registered-dossier/15858/2/1

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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ZIRCON-FREE REFRACTORY COATINGS FOR IRON AND STEEL CASTING

Author: Enrique Pardo,
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Zircon-based refractory coatings are widely used in foundries around the world. However, the use of zircon is problematic due to it being a naturally occurring radioactive material (NORM). Prices for zircon have also risen steeply in recent years, and remain volatile. Foundries are therefore looking for refractory coatings that reduce or eliminate the use of zircon. In response to this market demand, Foseco has developed the TENO* Tec ZA zircon-free family of coatings, which have now been successfully applied at multiple foundries in Europe.

INTRODUCTION

The use of zircon-based coatings is widespread in iron and steel foundries, due to their high refractoriness. Zircon has a melting point of 2,100-2,300°C, and maintains physical and chemical stability, even at elevated temperatures. This enables zircon-based refractories to withstand the high thermal stresses involved in steel and iron casting applications, and so reduce or eliminate metal burn-on and penetration defects in the castings. However, zircon is a naturally occurring radioactive material (NORM). This has raised concerns within the industry about its use, with some companies placing limitations on the use of radioactive products. Prices for zircon have also risen significantly in recent years – due to increased demand from other industries and transportation costs – and remain volatile.

Seeing the need for novel refractory coatings that reduce or eliminate the use of zircon, Foseco developed a range of solvent-based, zircon-free coatings: TENO Tec ZA. This article discusses the successful use of TENO Tec ZA 7000 K at a foundry in Spain.

CASE STUDY

Piezas y Rodajes S.A. (PYRSA) is the largest low-medium alloy steel foundry in Spain, producing more than 18,000 tonnes of finished castings per year for the mining, construction, high-speed rail, and agricultural sectors. Of these, large-scale castings for the mining industry are PYRSA's major activity – a sector that is characterised by growing technical demands. PYRSA integrates four processes at its Monreal del Campo facility (Figure 1):

- Steel casting (three moulding lines)
- Mass heat treatment
- Surface heat treatment
- High-performance machining

Figure 1. PYRSA Monreal del Campo facility, Teruel, Spain.

As one of its business goals, PYRSA aims to use environmentally-friendly products and materials at its facility. Faced with a new European resolution advising against the use of zircon-based refractory coatings, the company was seeking a new low-zircon or zircon-free alternative that could still deliver the same quality of casting at the same cost of production.

Figure 2. PYRSA manufactures high-quality steel castings for the mining, construction, high-speed rail, and agricultural sectors.

NEW REFRACTORY COATINGS: TENO TEC ZA

Although zircon naturally emits radiation, it is not considered dangerous. However, it will be deTected and measured by a Geiger-Counter. Many foundries use these instruments to prevent entry of radioactive materials, often contaminated scrap metal, since this has been problematic in the past. When radioactivity is detected, it will result in alert in the foundry, regardless of the source. Companies are therefore interested in products that eliminate radioactivity from their production plants.

In collaboration with PYRSA, Foseco developed a new family of refractory coatings to minimise the use of zircon in the formulation. TENO Tec ZA coatings maintain the technical properties of zircon-based products, but by significantly lowering the use of zircon, they reduce exposure to radiation. In some cases, zircon is eliminated altogether. The new coatings do not therefore trigger radiation warnings in the foundry. TENO Tec ZA coatings also do not suffer from the same variability in production costs as zircon-based products. They therefore offer price stability that is competitive with (and at times of high zircon prices, lower than) zircon-based products. TENO Tec ZA coatings provide a very cost effective solution for eliminating zircon-based products and can reduce overall manufacturing costs, whilst delivering excellent casting performance.

TESTING TENO TEC ZA 7000 K AT PYRSA

PYRSA carried out a range of tests using the TENO Tec ZA 7000 K coating with very good results. In both different applications (brush, spray gun, flow coating and dipping) and in casting dimensions, the results were similar to previous zircon-based coatings. Importantly, there was no radiation detected in the mould/core shop and storage area when using the TENO Tec ZA 7000 K, meeting expectations of the Foseco R&D team.

PYRSA is just one of the foundries currently working with the new zircon-free coating formulation. The need for change has been felt by many large iron and steel foundries, and there are many now using TENO Tec ZA coatings with similar good results. The specific characteristics of the TENO Tec ZA can also be adapted to the needs of the foundry and geometry of the moulds/cores, e.g., to provide greater penetration, longer draining time, and elimination of drips. Following on from the success of these solvent-based coatings, a new range of SEMCO Tec ZA water-based coatings are now available.

Figure 3. TENO Tec ZA 7000 K zircon-free coating used at PYRSA.

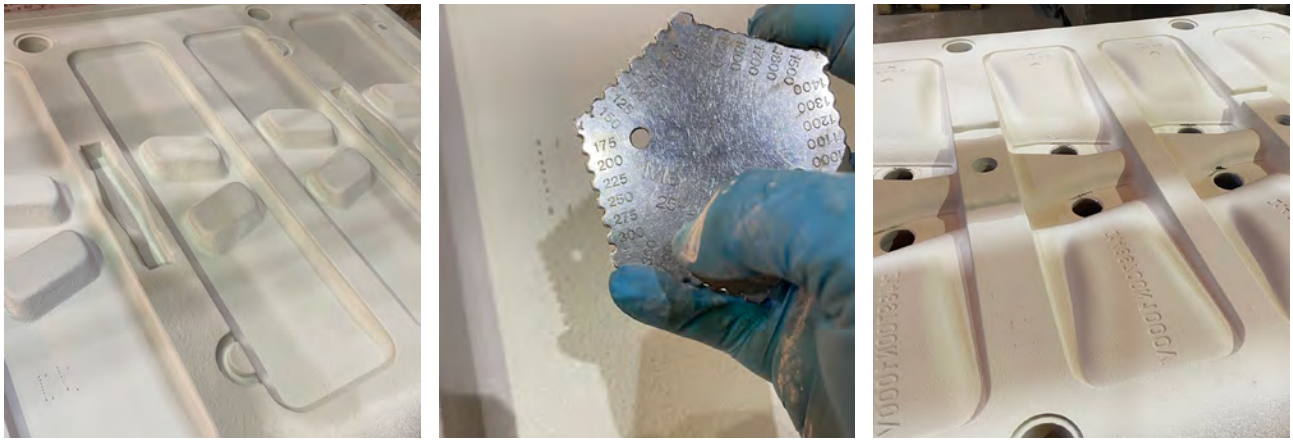

Figure 4. Homogeneous and smooth coating film. Spray gun, dipping and flow coating application.

Figure 5. Excellent results in massive castings. Free of burn-on and with good surface quality

SUMMARY

Foseco has developed a new family of refractory coatings (TENO Tec ZA) to replace zircon-based coatings. The new refractory coatings demonstrate the following characteristics:

- Reduce or eliminate natural radiation.
- High refractory efficiency. Good surface quality of cast parts.
- Easy application in a variety of methods (brush, spray gun, dipping, or flow coating). .
- Very uniform coated surfaces without runs or drips.
- Stable and competitive price.

ABOUT THE AUTHOR

Enrique has been with Foseco for 35 years and is currently Technical Director Iberia. In this role he is responsible for the development and application of our products in Spain and Portugal. He is also responsible for the supervision and monitoring of the Spanish manufacturing plants. It's a job where no two days are the same and it's never boring. In his free time, Enrique is passionate about sport, especially surfing. He also enjoys discovering new cultures through travel and reading.

GET IN TOUCH WITH ENRIQUE

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ENRIQUE PARDO
Technical Director Iberia

DENSITY CONTROLLED COATING OR THE BENEFITS OF INTELLIGENT AUTOMATIC COATING CONTROL

FOSECO

Author: Christoph Genzler, Foseco Nederland

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

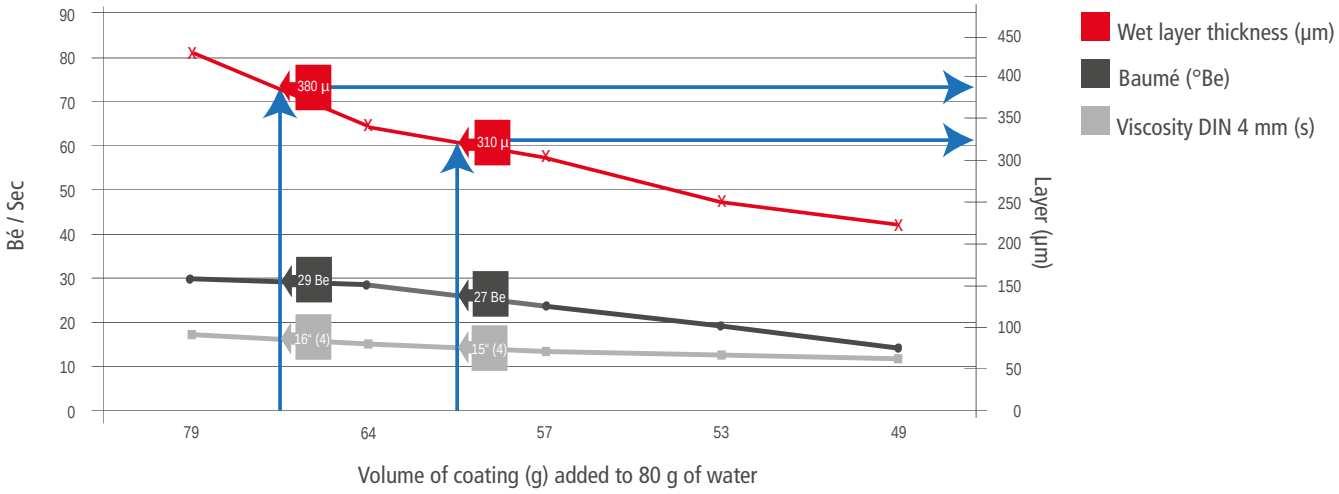
The ultimate measure of coating application is LAYER THICKNESS. However there is no reliable test to measure the consistency of coating layer thickness during application. Traditionally, it has been controlled manually using the Baumé test (which helps measure dilution consistency) and/or the flow cup 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.

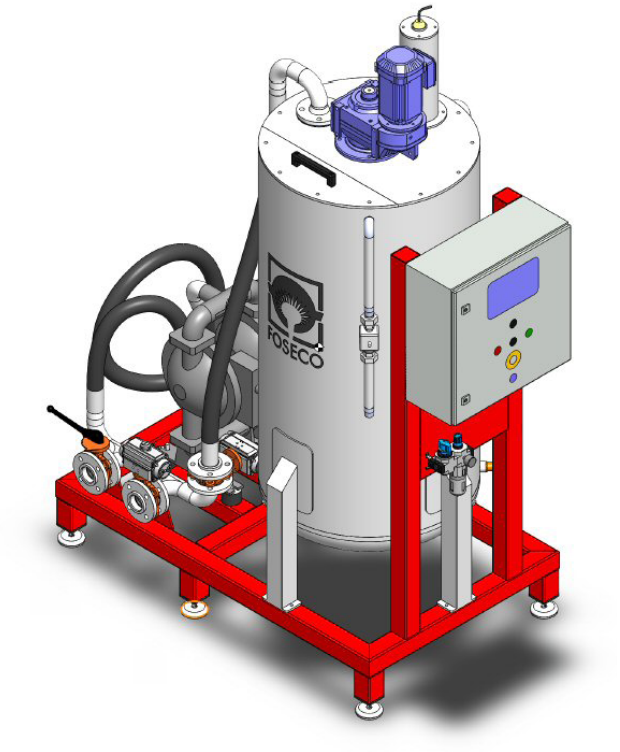

Figure 4: ICU-Modular - fully customisable

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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NEW MOULD RELEASE AGENT REDUCES FIRE AND ENVIRONMENTAL RISKS

FOSECO

Author: Enrique Pardo, Foseco, Spain

Due to concerns about the fire safety and environmental performance of existing petroleum-based green sand mould release agents, Foseco has developed the PARTISAL* 477 ECO family of release agents. These cost-effective, non-toxic agents deliver improved flammability resistance, while maintaining performance standards in terms of release efficiency, ease of application, and lubrication of (vertical) moulding machine components.

INTRODUCTION

Green sand moulding lines lie at the heart of the foundry: any delays, breakdowns, or damage here has the potential to cause significant disruption to foundry production. As a result, the use of release agents has become common in both horizontal and vertical green sand mould systems.

Applied between the mould and the pattern, mould release agents improve the ease and speed with which the mould can be removed from the pattern. They also help improve the quality of the mould, and thus reduce the incidence of mould-related casting defects.

Mould release agents have traditionally been manufactured from low-quality oils recovered during the refining process. For the most part, these petroleum-based products offer a low-cost and effective solution. But they are not without challenges, notably when it comes to their safety and environmental performance.

As a result, foundries were looking for a new type of moulding release agent that solved these issues. This paper will discuss the resulting development of PARTISAL 477 ECO to meet these enhanced demands.

THE NEED FOR A SAFER, CLEANER RELEASE AGENT

Many traditional release agents for moulds are classified as harmful, toxic, or dangerous under recent changes to EU legislation on base oils and organic additives. This poses a challenge for many companies that are pursuing a more environmentally-aware purchasing strategy.

Figure 1: Typical pictograms in old formulations

Figure 2: PARTISAL 477 ECO without any classification

These release agents also have relatively low flashpoints and have been responsible for a number of fires at foundries in recent years. These incidents have led to foundries reviewing and reinforcing their safety systems with technical measures and products that provide greater protection against the risk of fire.

After hearing from several different foundries with both horizontal and vertical green moulding lines, as well as suppliers of moulding machine, the Foseco development team concluded that there was a market need for a new family of mould release agents that would offer improved environmental and fire safety performance.

PARTISAL477 ECO release agents tick both of these boxes, being both non-hazardous (they are similar to food-grade lubricants) and having a high flashpoint.

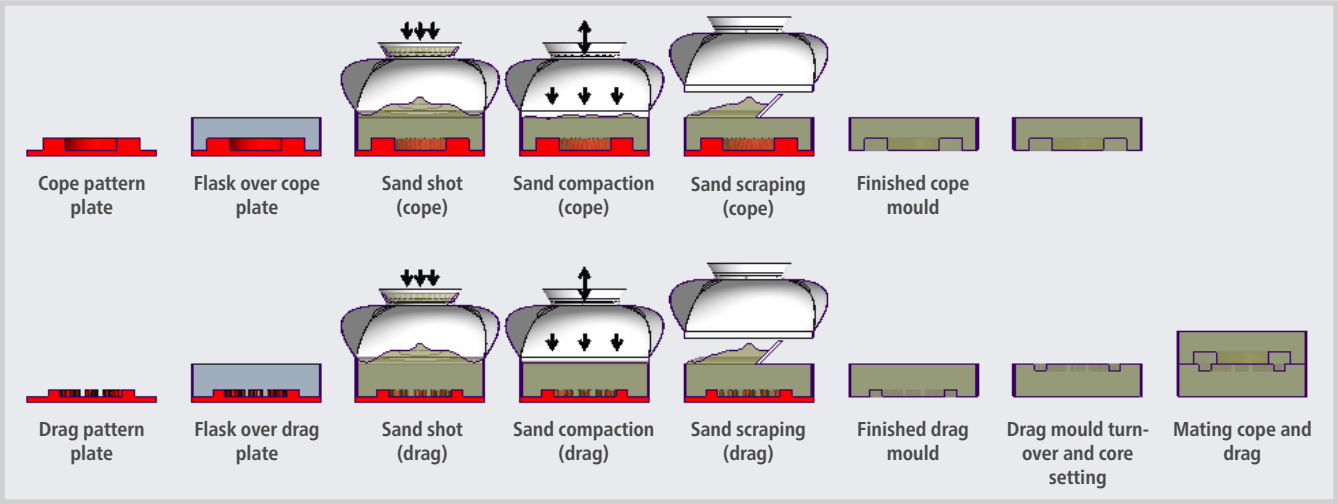


Figure 3. Horizontal sand moulding principle

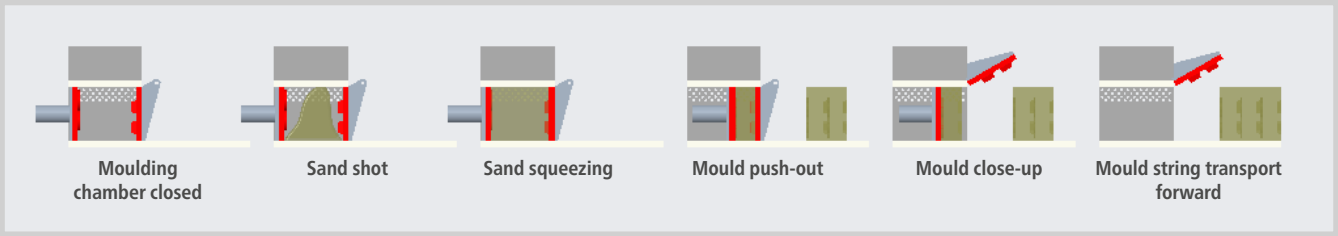


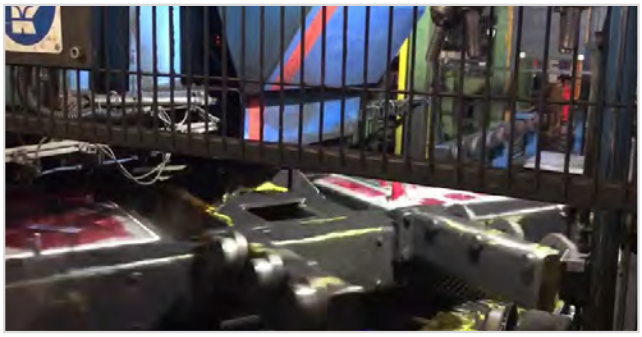
Figure 4. Vertical sand moulding principle

However, any new release agent must also at least match the basic functionality of traditional oil-based products in terms of release efficiency and ease of application. In these areas too, PARTISAL 477 ECO has been formulated to deliver highly-effective performance. And it had to fulfil all these requirements, while also delivering on cost.

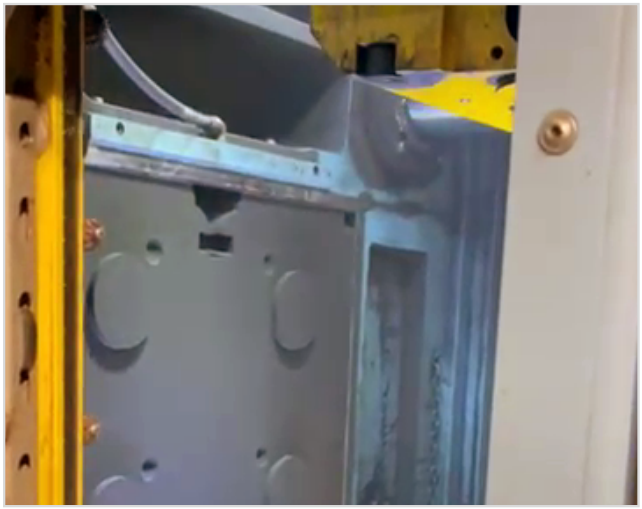
RELEASE EFFICIENCY

Release efficiency is key to productivity and surface quality of moulds – and thus the castings they produce. However, green sand moulds have a greater tendency to break during release because the plasticity of the green sand is fairly low. A range of factors, such as the temperature of the sand, and mixing of the sand with bentonite and water, can reduce that plasticity still further. At the same time, the geometry of moulds is becoming increasingly more complex, further complicating release.

Additionally, the application of a release agent between the pattern and the greensand mould can significantly improve release efficiency and reduce rejection due to mould breakage by more than 10%. During the development of PARTISAL 477 ECO, Foseco therefore investigated a range of different oily bases and additives with hydrophobic and surface-active properties in order to ensure the new offering met the standards required for release efficiency.



PARTISAL 477 ECO application on horizontal moulding line



PARTISAL 477 ECO application on vertical moulding line

EASE OF APPLICATION

If the use of a release agent is essential, so too is how that release agent is applied. If the application of the release agent is too thin, the protective film will not be created and the risk that the green sand mould will stick to the pattern will increase. The same is also true if the release agent is applied to thickly.

PARTISAL 477 ECO was developed to facilitate application using spray equipment to create a fine, homogenous film. Foseco also experimented with different types of spray equipment and nozzles to ensure good projection. The company's technical department is able to provide advice on the start-up of this equipment and ideal application pressures.

Figure 5: Very easy atomisation of PARTISAL 477 ECO

LUBRICANT EFFECT

A final important demand from both the manufacturers of green sand moulding lines and foundry maintenance teams relates to the lubricating effect that release agents can provide. This is particularly relevant in vertical moulding line. This helps to reduce wear of the mechanical components of the vertical moulding machine, improving component life, reducing maintenance requirements, and improving uptime of the machine.

Figure 6: PARTISAL provides a release effect in the mold formation chamber

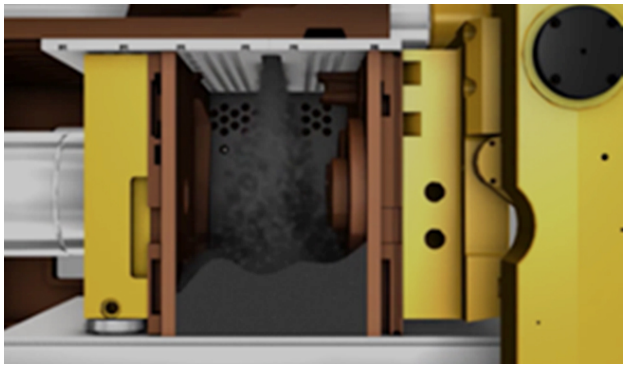


Figure 7: PARTISAL provides a lubricant effect on mobile equipment and work bed

SUMMARY

Foseco has developed the PARTISAL 477 ECO release agent that firmly meets the demands of both green sand casting foundries and manufacturers of those casting lines.

- Environmentally-improved product with a clean safety material safety data sheet.
- High flash point, reducing the risk of fire on green sand mould production lines.
- High de-moulding efficiency: it creates a homogeneous film with high release properties.
- Easy application: no clogging, good atomization for greater application efficiency.
- High lubricating power, which helps extend the life of moving parts.
- Competitive price.

ABOUT THE AUTHOR

Enrique has been with Foseco for 35 years and is currently Technical Director Iberia. In this role he is responsible for the development and application of our products in Spain and Portugal. He is also responsible for the supervision and monitoring of the Spanish manufacturing plants. It's a job where no two days are the same and it's never boring. In his free time, Enrique is passionate about sport, especially surfing. He also enjoys discovering new cultures through travel and reading.

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Technical Director Iberia

FOSECO

SUPPORTING THE TRANSITION TO LEAD-FREE BEARINGS IN LARGE DIESEL ENGINES: THE CHALLENGE FOR FOUNDRIES

Author:
Christoph Genzler, Foseco

The EU has restricted the use of lead-containing bearings in diesel engines. This poses a challenge for engine makers, who traditionally used lead in bearings to achieve satisfactory engine reliability. Its qualities as a dry lubricant protected the bearings from particulate contaminants, such as those left over from the casting process (moulding sand, and residues from the binder and the coating itself). To support the transition to lead-free bearings, SEMCO IC coatings are designed to significantly improve the removal of such casting debris from even the most complex of castings. In doing so, these coatings continue to set new standards when it comes to the ultra-low number of particles remaining in the as-cast condition.

The latest generation of SEMCO IC coating is also formulated so that any remaining coating particles are softer than the bearings. This eliminates the risk of wear to the bearing from coating residue.

INTRODUCTION

As greater performance and environmental demands are placed on engines by original equipment manufacturers and regulators alike, so too do the demands placed on component castings by engine makers. One trend has been a growing restriction on the use of lead (Pb) in bearing alloys used within commercial internal combustion engines (ICEs) and associated systems.

Lead has long played an integral part in engine bearings as part of traditional tri-metal bearings. Its relative softness and low melting temperature meant it effectively acted as an integral lubricant, offering a level of protection and flexibility to the bearing. Its use was therefore considered necessary to achieve satisfactory reliability in terms of seizure resistance, conformability, and debris resistance, particularly in larger engine sizes and engines operating in demanding environments.

THE LEAD-FREE BEARING CHALLENGE

However, for all its benefits, lead's toxicity has led regulators to progressively restrict its use. Lead-free bi-metal bearings are now the norm in light engines; since January 2022, the EU has also restricted the use of lead in heavy engines.

To understand why this presents a challenge, it is necessary to discuss the coatings applied to the sand cores used for casting an engine's complex inner geometries. These coatings protect the core from the superheated molten metal and facilitate knock-out after casting. They also help to reduce the number of particles remaining in those parts of the engines that are inaccessible to post-casting cleaning, although the coatings themselves may leave a ceramic residue on the surface of the casting.

These residual particles pose a problem because cast engine component surfaces are never completely smooth: there will always be some indentation or pitting of the surface. Residual particles can thus become caught in these indentations and are impossible to remove with current cleaning methods (e.g., shot blasting).

Now picture the engine running: fuel combustion causes dynamic loading onto the bearing of the crank shaft, resulting in vibration. Over the lifetime of the engine, this vibration will shake loose those casting residues. Moreover, from each particle that is shaken loose, vibration and friction will cause multiple new particles to be generated – all small enough to bypass filters.

Lead's lubricating properties protected the bearings against wear by these particles. In bearings that do not contain lead, however, that protection is removed, raising the risk of bearing damage. To counter this, the latest generation of SEMCO IC coating from Foseco is formulated so that any ceramic residue left on the casting is softer than the bearing.

This effectively eliminates the risk that coating residues will damage the bearings when the engine is running. The benefit is longer engine service intervals and improved engine reliability: key factors for any engine operator, but particularly so when the engine is used in applications that take it considerable distances from service facilities, such as in marine environments.

LOWERING CARBON EMISSIONS

In addition to supporting engine makers transition from lead-containing bearings, the new generation of SEMCO IC coatings also helps reduce carbon emissions generated during the casting process.

During pouring, carbonaceous materials in the coating combust and are released as carbon monoxide or carbon dioxide. The latest SEMCO IC formulation has been engineered to reduce the carbon content of the coating by replacing it with other minerals, and thus reduce the potential for carbon-based gas emissions.

COATINGS FOR INNER CLEANLINESS

SEMCO IC coatings continue to improve overall inner cleanliness of the casting, with one customer going as far to give SEMCO IC the 'new world record in terms of the super-low quantity of particles found after casting'. This not only ensures a cleaner casting is supplied to the engine manufacturer, but also has important benefits for the operating life of the engine, as particles remaining after casting will accumulate in the oil and coolant system.

SEMCO IC coatings therefore reduce the lifetime contamination of oil and coolant, extending engine service intervals, while improving engine performance (a properly cooled and lubricated engine runs more efficiently than an engine with blocked channels), and reducing the overall amount of oil and lubricant consumed by the engine.

Moreover, SEMCO IC coatings lower the occurrence of scabbing and veining defects, reducing the need for post-casting cleaning (lowering foundry production costs and reducing re-work), and creating the option to cast thinner engine geometries without facing casting problems.

CONCLUSIONS

As the demands of engine manufacturers and regulators become increasingly tighter, SEMCO IC coatings offer substantial benefits to the foundry when it comes to inner cleanliness and the need to eliminate the use of lead in bearings and bushings.

They are however just one weapon in the Foseco clean casting arsenal. From linings and slag coagulants to ensure a clean melt; filters, stoppers and nozzles for a clean pour; or coatings to minimize surface defects – Foseco's range of solutions supports foundries in their continuing quest to cast cleaner, improve yield and control costs.

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Three properties underpin SEMCO IC performance:[1]

- **Coating flake formation:** SEMCO IC has been engineered to form strong, well-defined ceramic flakes that readily detach from the surface of the casting and act as a carrier for other debris during knock-out. This helps to improve cleaning of the casting, even in the most inaccessible of areas.
- **Improved gas permeability:** during casting gas is released in the sand mould as the binder combusts. Without a sufficient degree of permeability to let that gas through, pressure will build up behind the coating and may result in premature flaking, scabbing defects and scrap. SEMCO IC offers better gas permeability than conventional coatings and thus improved resistance to scabbing.
- **Anti-veining:** standard vein block testing, comparing SEMCO IC with conventional coating products, has demonstrated SEMCO IC has higher resistance to vein formation, reducing the need for fettling.

REFERENCES

[1] For more detailed discussion of the properties of SEMCO IC, see Genzler, C., 'Coating for Improved Inner Cleanliness', Foundry Practice No. 269, pp. 3-10.

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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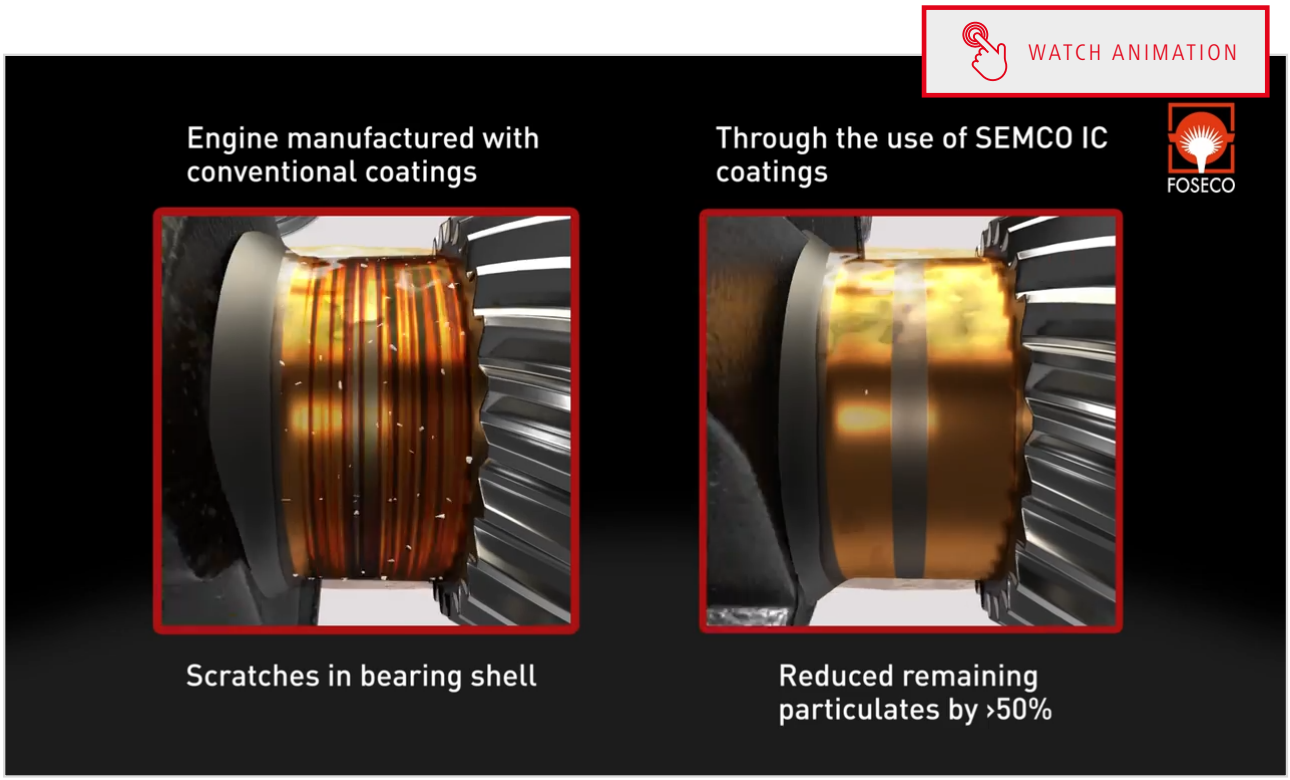

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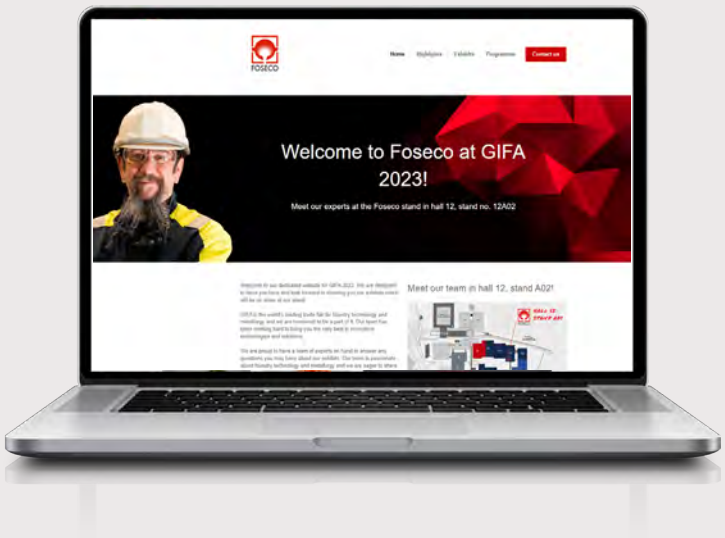

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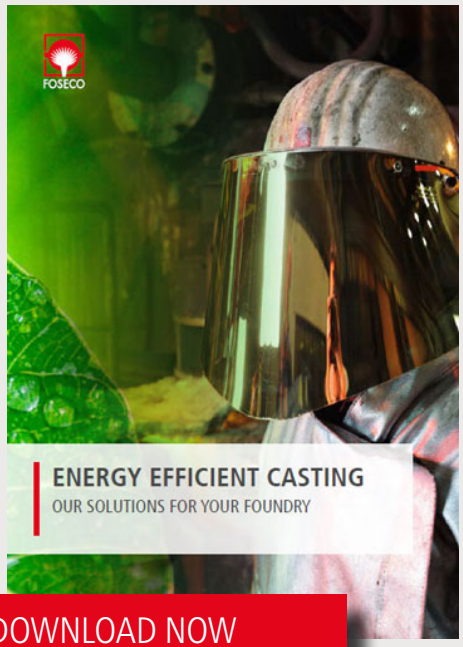

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ESCALATING COSTS OF ELECTRICITY AND GAS REQUIRE NEW SOLUTIONS FOR FOUNDRIES

It is more important than ever for foundries to control and minimise their energy consumption costs in order to remain competitive. The war in Ukraine has led to a drastic increase in energy costs. Energy-intensive industries, such as the foundry industry, are particularly impacted by this cost explosion.

While the industry has long contributed to sustainability in some areas, notably through the recycling of iron, steel and aluminium scrap, there is still much room for improvement in other areas, such as increasing energy efficiency.

Therefore, technologies and solutions that reduce energy consumption are becoming increasingly important. The good news is that today there are many ways to achieve this through the use of modern foundry consumables.

In our e-book "Energy efficient casting - Our solutions for foundries", we show you how our solutions for iron, steel and aluminium foundries help to save energy and reduce CO_2 emissions in the various areas of the foundry.

CASTING CLEAN STEEL: TODAY'S SOLUTIONS AND OPPORTUNITIES

Improving as-cast quality offers a range of benefits to steel foundries – from improved yield and lower production costs per piece, to reduced lead times and lower carbon emissions. Cleaner casting is not however something achieved by a single solution or process improvement. Casting defects have a range of causes and can occur at a number of points along the casting process. Minimising defects therefore requires the adoption of a range of solutions from melt to mould.

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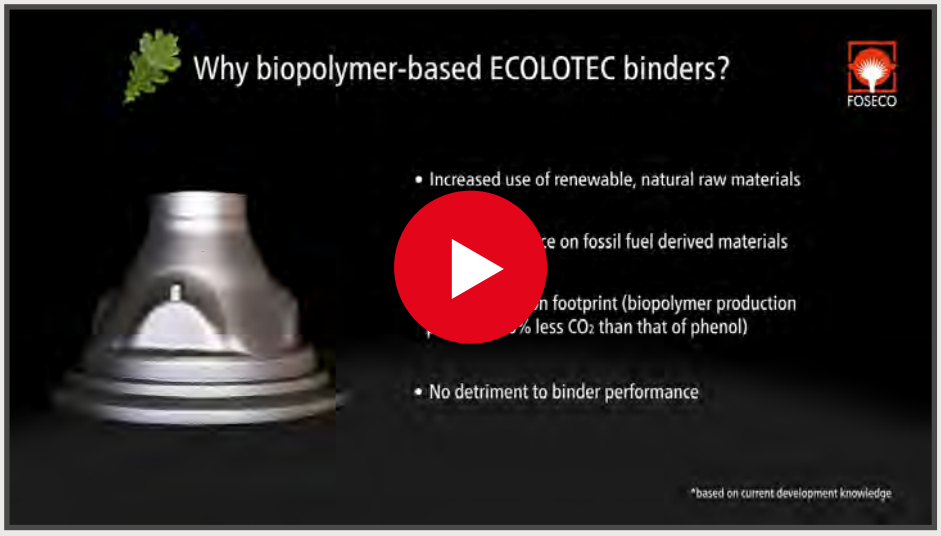

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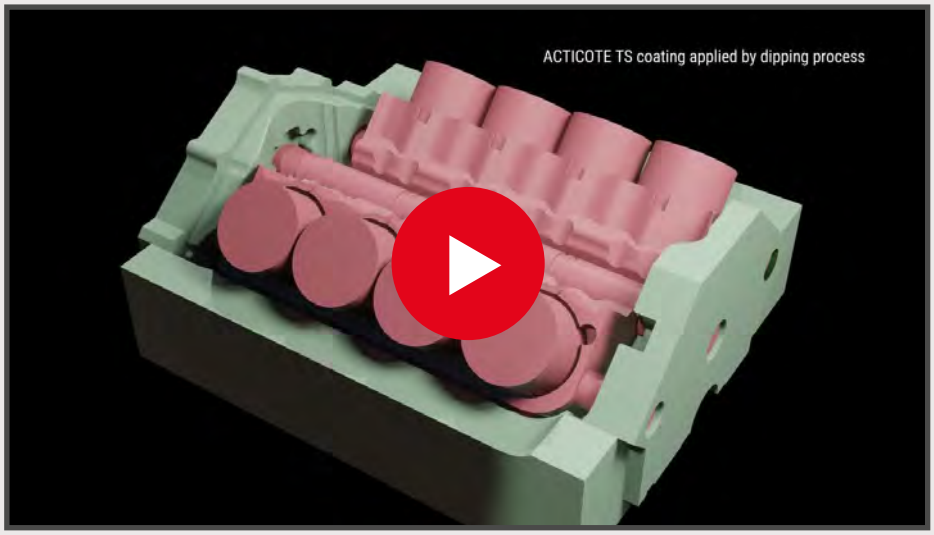

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