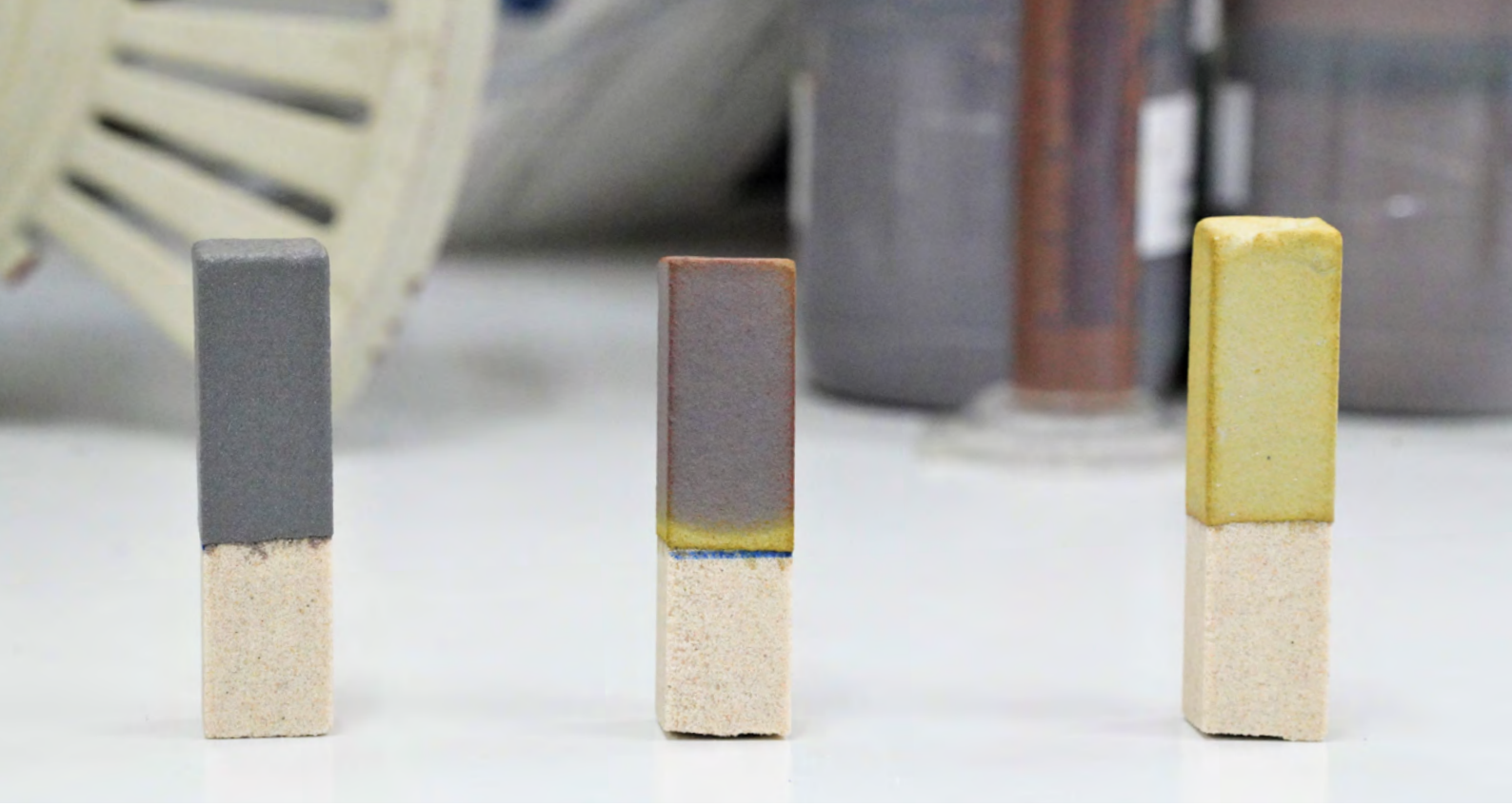

HOW COATINGS CAN IMPROVE ECONOMIC, SOCIAL, AND ENVIRONMENTAL SUSTAINABILITY AT FOUNDRIES

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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.

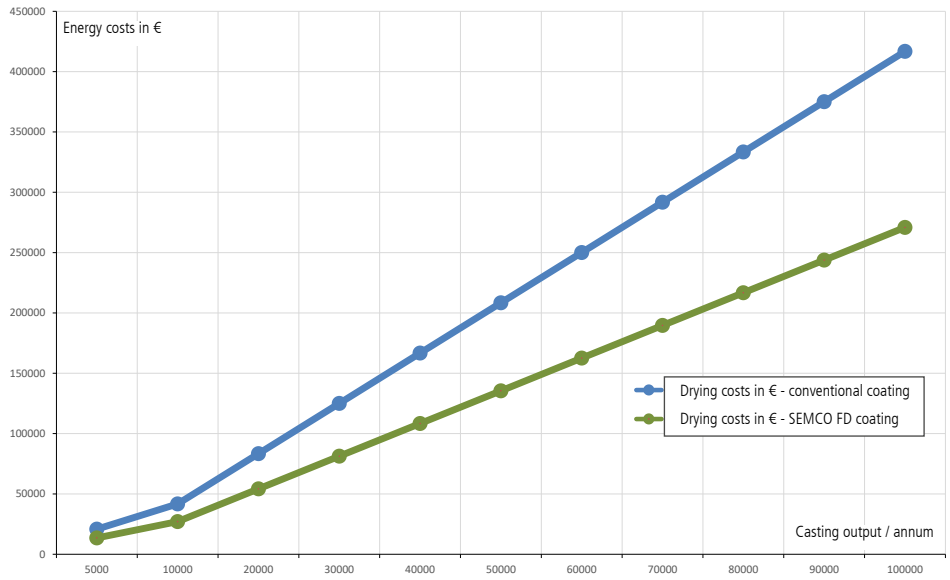


Figure 1. Approximate coating drying costs per annum versus casting output (at 2020 energy costs)

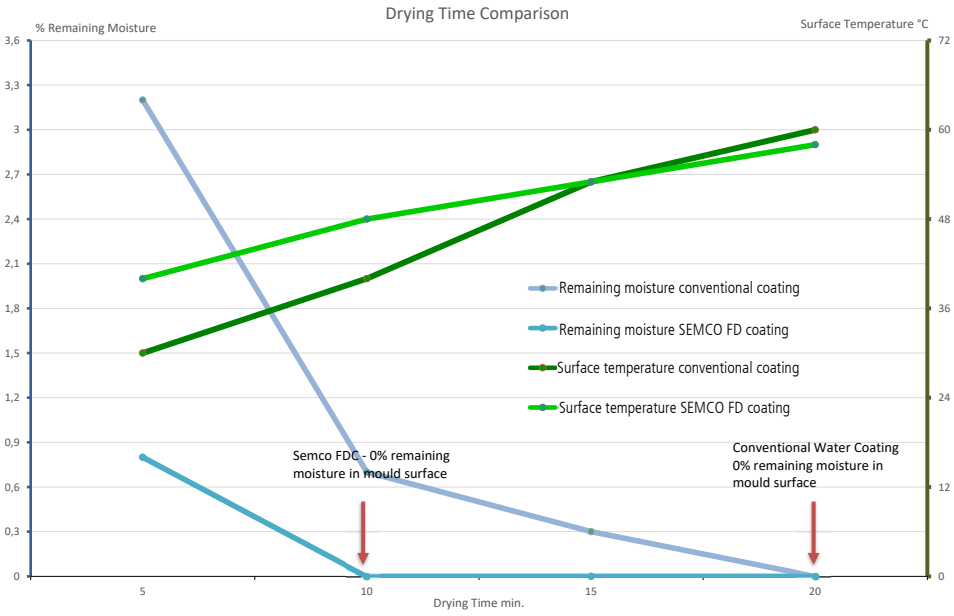


Figure 2. Drying times of a conventional water coating vs SEMCO FD coating at ductile iron foundry

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:

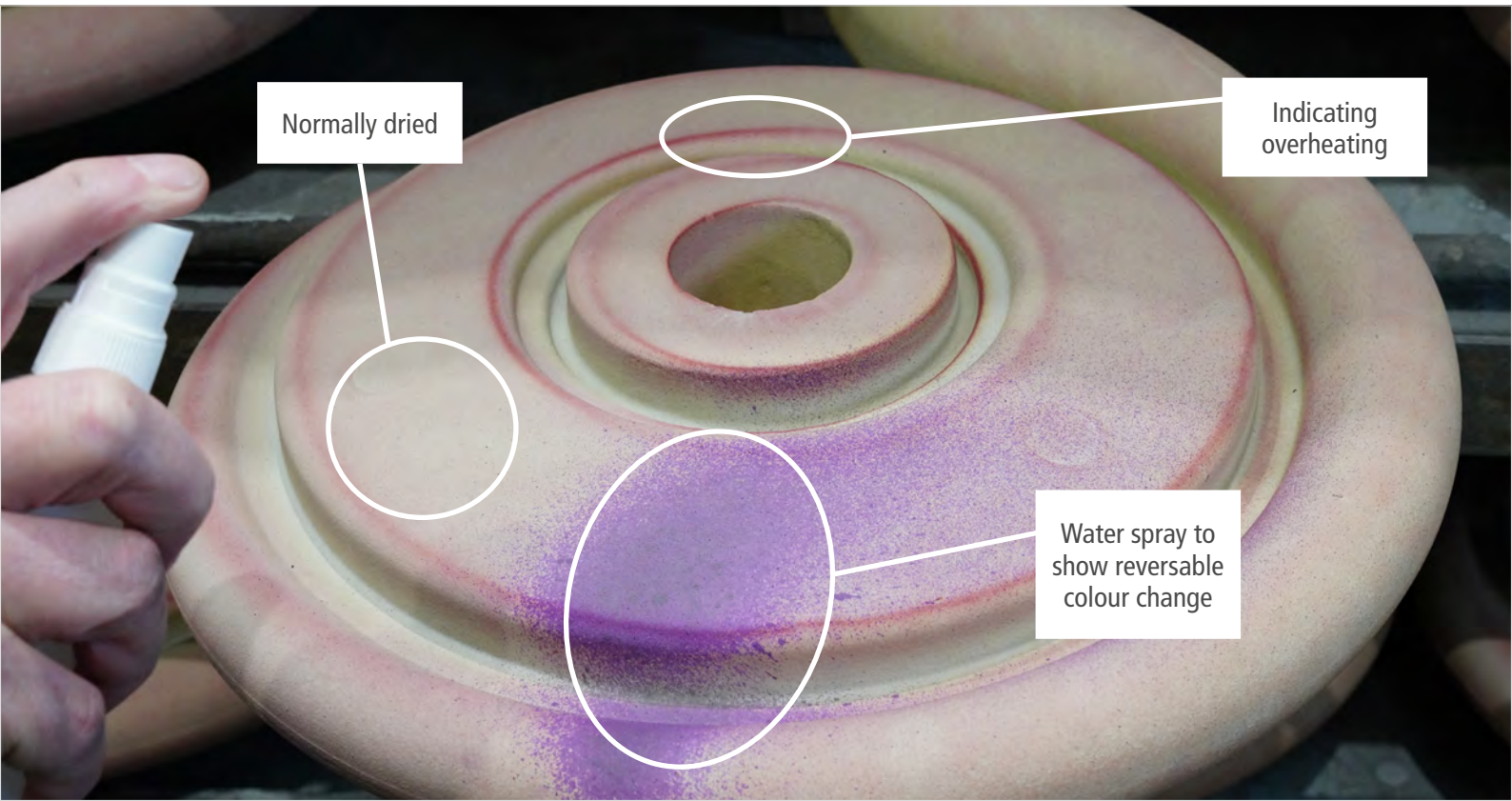
1. **By enabling operators to clearly see when the coating is dry, drying time and temperature can be accurately determined. Drying cycles can therefore be optimised to achieve complete drying in as short a time as possible, minimising energy costs (and resulting carbon emissions).**
2. **As the colour 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).

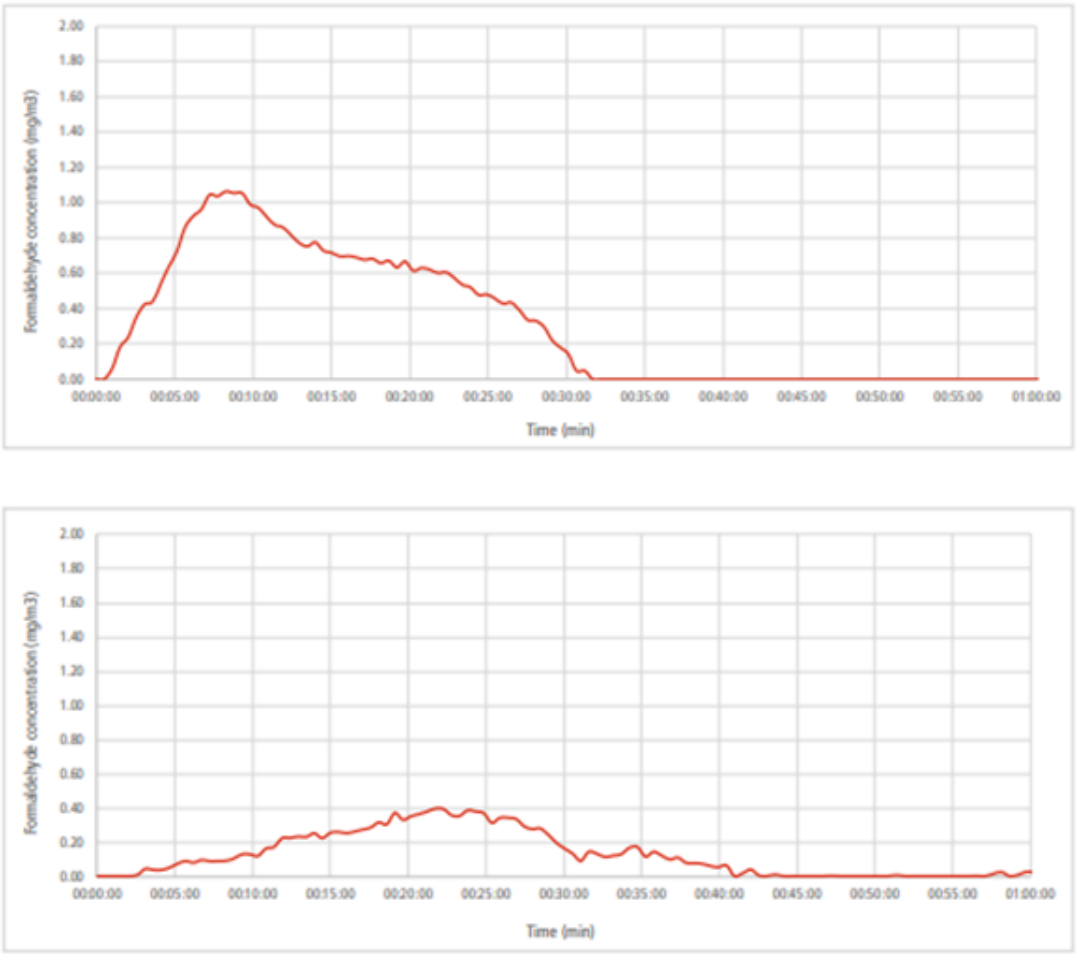


Figure 4. FH emissions from fresh, as-made PUCB cores with standard coating (top) and SEMCO FF coating (bottom).

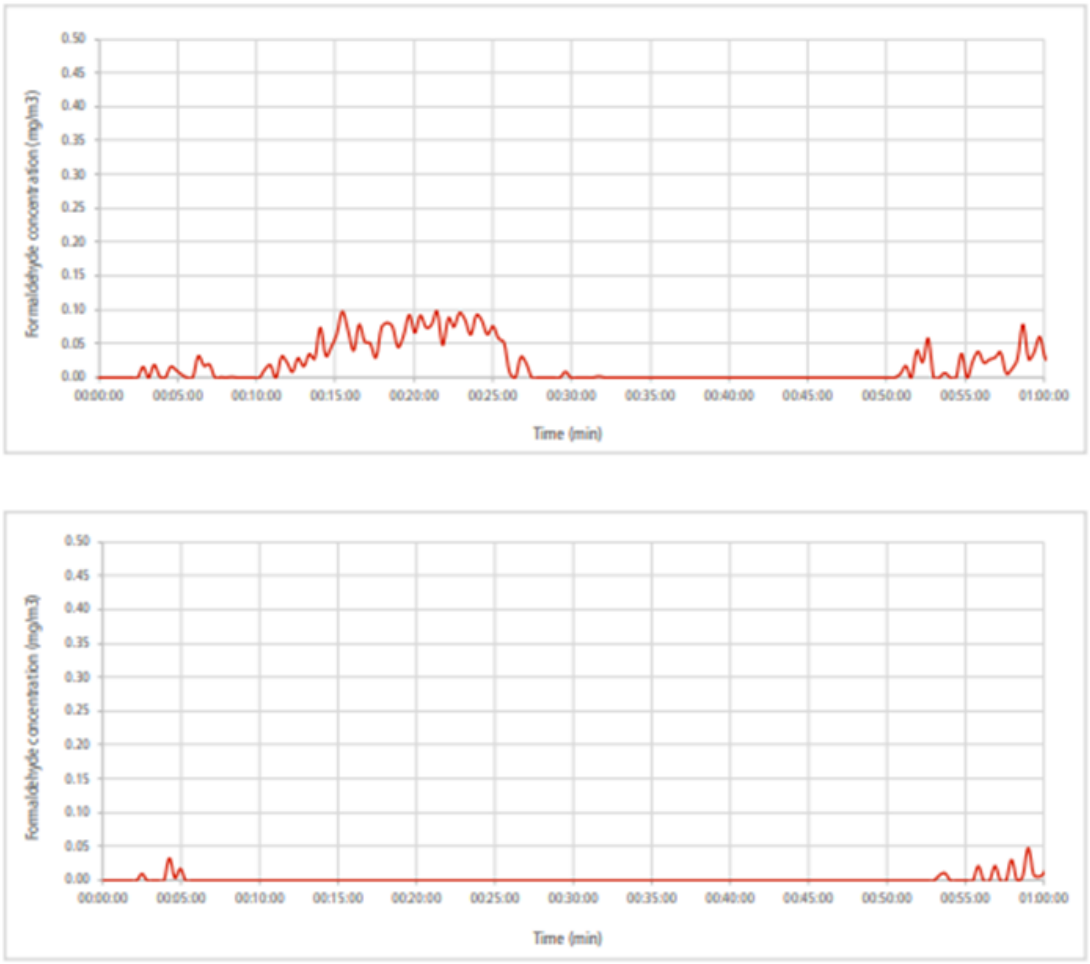


Figure 5. FH emissions from cores aged for 11 days with standard coating (top) and SEMCO FF coating (bottom).

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

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