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WHITE PAPER

THE SUSTAINABILITY ADVANTAGE

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Ferrous Foundries

VESUVIUS

CONTENT

EXECUTIVE SUMMARY

Sustainability is a defining theme of the modern industrial landscape, particularly in energy-intensive industries, such as iron and steel foundries, and is often associated with increased regulation and costs. But strong positive business cases can be made for adopting more sustainable technologies and practices, particularly as they impact energy and resource consumption. This white paper will discuss current best practice available to ferrous foundries that underline the advantages such sustainable business choices can bring to financial, environmental and social performance indicators.

INTRODUCTION
Sustainability

Financial sustainability is not incompatible with improving environmental sustainability, the two often go hand in hand.

Sustainability is a defining theme of the modern industrial environment. This is most often associated with the need to reduce atmospheric emissions of CO_2 in order to mitigate the negative effects of climate change. As important as this undoubtedly is, sustainability is a much broader topic that encompasses a range of environmental, social and economic actions.[1,2]

Sustainability is also not a simple or linear process: progress in one area can create challenges in others. For example, goals to reduce poverty and its associated challenges are predicated on economic development through inclusive and sustainable industrialisation. UN Sustainable Development Goals therefore aim to increase manufacturing's contribution to GDP and employment in developing countries.[3]

With 90% of all manufactured goods relying on metal castings,[4] this bodes well for the foundry sector. But it also means that foundries are likely to come under increasing pressure to make their processes as sustainable as possible in order to ensure a sustainable basis for manufacturing growth. And while the industry is a long-standing contributor to sustainability in some areas, most notably through the recycling of scrap iron and steel,[5] in other areas, such as energy and resource efficiency, there is still much room for improvement.

The good news is that there are solutions available today for the most pressing sustainability challenges. In the remainder of this white paper, we will consider some of these under the themes of energy efficiency, resource intensity, pollution control and, finally, Foundry 4.0. We do so, while recognising that financial sustainability is not incompatible with improving environmental sustainability.[6,7] Indeed, by optimising energy and resource use, the two often go hand in hand.

IMPACT AREAS

ENERGY EFFICIENCY

Metal casting is known for its high energy consumption, low energy efficiency and high CO_2 emissions.

According to one study, "on average, the energy consumed by a foundry shop far exceeds that which it is predicted to use based on theoretical calculations [...] due to inefficiencies associated with the activities of metal melting and casting [...] Opportunities to improve energy efficiency of a foundry operation, significantly [reduce] environmental impact while maintaining the sector's competitiveness in the process." [8]

Melting accounts for 30% of energy consumption in the foundry. Improving the efficiency of this process is therefore a key concern.[9] This can be achieved in a number of ways. For example, by improving yield, output is maintained but less material is melted. Improving thermal efficiency by reducing heat losses, shortens melt times, reducing the energy input required per melt. High thermal efficiency also reduces the energy required to hold a continuous supply of liquid metal of consistent composition and quality for casting, another major area of energy consumption in the foundry. [9]

Solutions to these challenges take a range of forms. Pattern redesign with FEEDEX VAK sleeves, for example, helped improve metal yield at one manufacturer of liner castings for large compressors from 40% to 70%, resulting in a reduction in CO_2 emissions of 2.62kg per casting. This was achieved because FEEDEX sleeves are able to operate efficiently within a small surface area and under complex application conditions. This means they can be used even in moulds where limited space would usually preclude the placement of a feeding system that could improve metal yield.

In addition to improving yield, other processes were simplified and costs lowered by the FEEDEX VAK sleeves. The feeders are delivered ready to use and, due to the smaller neck of the feeder, the contact area with the cast 45% smaller, significantly reducing the need for post-casting fettling. This latter benefit is significant, as post-casting processes are a key area for improvement when thinking about energy consumption. Reworking (or having to return for recycling) casts consumes energy: eliminating the need to do so is therefore a good way to improve energy efficiency. It also reduces costs and improves productivity.

Avoiding rework only involves optimising casting processes, for example, with FEEDEX VAK sleeves or KALPUR direct casting for automatic green sand moulding lines, but also

ensuring the quality of the molten metal. This can be achieved with filtration technologies, such as the SEDEX and STELEX ranges, which remove non-metallic inclusions. To go full circle, SEDEX and STELEX filters also better control flow into the mould, producing a better cast and reducing the need for post-cast reworking.

Energy consumption is also lowered through the use of insulating lining systems, such as the KALTEK range of products for ladle lining, which lower heat loss and reduce preheating times. For example, at a foundry in France the use of KALTEK ISO 60 BF halved ladle lining time, reduced drying time from 9 hours to just 1 hour, and shortened the preheat from 4 hours to just 1 hour – while improving lining lifetime by 35%. Due to the longer service life of the refractory lining, the total amount of treated iron could be increased from 750 t to 1150 t.

Meanwhile, SEMCO FD fast dry water-based coatings reduce the consumption of energy for drying. At a foundry specialising in wind turbine castings, for example, the use of SEMCO FD shortened core/mound drying cycles by 50%, improving energy consumption by 50% with a consequent improving in CO_2 footprint. Handling was also made easier and safer due to the application of a lighter filler combination and the removal of zircon from the foundry.

RESOURCE INTENSITY

Improving yield not only impacts the energy efficiency of the process, it also improves resource efficiency, the second critical element in foundry sustainability, when you consider that new steel products contain only 30% recycled steel.[10]

The abovementioned technologies to optimise pouring, reduce casting defects and the need to clean casts, and reduce non-productive or wasted metal are again important here. But so too are technologies that extend meantime between replacement of components and consumables. Longer equipment lifecycles both reduce the amount of waste produced by foundries (and therefore contributes to the aim of Zero Waste) but also the quantity of raw material consumed by suppliers of equipment and consumables, such as Foseco. There are also health and safety benefits gained by limiting the exposure of workers to man-machine interactions.
Linings are particularly relevant when it comes to extending lifetimes and reducing waste, the following examples demonstrate:

- A TRIAD Z 160 lining with VESBOND binder applied to the iron transfer ladle at an Italian automotive foundry improved service life from 16 to 25 days – or from 4032 tons to 5600 tons of metal handled. It was also possible to repair the lining and re-use the ladle for a second run.

- A TRIAD Z 189 lining applied to a launder as a high-volume American foundry producing ductile iron castings extended service life to six days initially, compared to three days under the previous practice, with subsequent launders used for two weeks with periodic cleaning.
- The use of KELLUNDITE 859 dry vibratable lining for coreless induction furnaces increased the lifetime of 30 ton capacity furnace at European foundry by 25% over previous solutions, while also improving the consistency of lifetime.

Meanwhile, VAPEX multi-life nozzles overturn the tradition of replacing the nozzle with each shot. The new zoned nozzle for multiple uses can be used as often as the VISO stopper. VISO stoppers and VAPEX nozzles can also be supplied in reusable clipcrates or metal boxes, again helping to reduce waste.

POLLUTION CONTROL

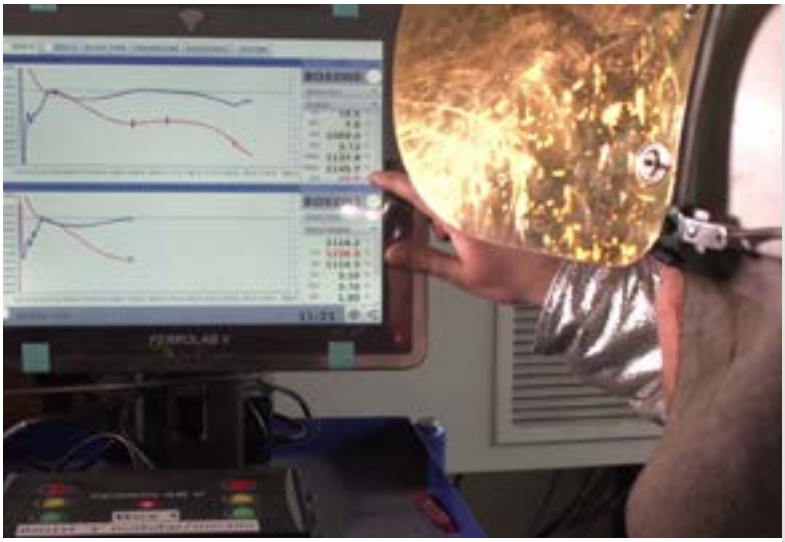
Regulation of air pollutants is constantly evolving and tightening, requiring similarly constant innovation to enable foundries to continue to meet the requirements.

This can be via equipment, such as gas treatment systems, but there is also a growing range of solutions that remove these harmful elements at the source.

For example, the water-based coatings, such as the SEMCO range, replace solvent-based offerings, while inorganic binders, such as SOLOSIL binders, replace organic binders. Both remove harmful chemicals from the foundry and help to eliminate potential emissions, without the need for expensive and potentially complicated investments in gas treatment systems.

As mentioned earlier, however, advances in one area can create challenges in others. The use of water-based coatings is another example of this, as these are vulnerable to attack by micro-organisms. This threat is commonly neutralised by the addition of a biocide that slowly releases formaldehyde. But with regulation of formaldehyde emissions tightening, notably in the EU, the latest innovations must be both water-based and formaldehyde-free coatings, such as the SEMCO FF coating.

Powder-based coatings, meanwhile, help to reduce waste and lower transportation costs and emissions. INSTA coatings, for example, are about half the volume of slurry-based alternatives and do not require the use (and subsequent disposal) of plastic buckets or drums for transport.



FOUNDRY 4.0

Today's production can be networked in such a way as to be highly flexible and precisely tailored to customer requirements.

A final piece in the sustainability puzzle is the use of the latest digital technologies to improve foundry processes – an innovation dubbed Foundry 4.0. Digital solutions offer the ability to network, monitor and precisely control processes as never before. This results in foundries that are more efficient and productive, bringing both financial and environmental sustainability benefits.

The Intelligent Coating Unit (ICU), for example, automates the process of measuring and controlling the dilution of refractory linings to ensure the correct consistency is maintained and the optimum properties for application are maintained. At a foundry in the UK, this resulted in uniform coating layer thickness, reducing coating waste and increasing core shop productivity by 25%. Casting scrap and rework requirements were also reduced.

The new FERROLAB V measuring system, meanwhile, provides advanced easy-to-use thermal analysis of liquid iron, resulting in consistent quality, less variation in casts, and ultimately a reduction in scrap rates. It does this by precisely monitoring the melt and compensating for changes in the feed material with precise addition of inoculants and magnesium carriers. This ensures the correct physical properties of the base iron are maintained and controls nucleation, microstructure formation and shrinkage.

SOURCES

1. Radtke, E. and Vogt, M., Fußabdruck und seine komplizierten Implikationen, Geisserei Online (07 January 2021) https://www.giesserei.eu/magazin/fachartikel/2021/ein-fussabdruck-mit-folgen/
2. PAGE, I., Environmental, Economic and Social Sustainability in Foundries, SPOTLIGHTMETAL (13 March 2019): https://www.spotlightmetal.com/environmental-economic-and-social-sustainability-in-foundries-a-806710/
3. UN Sustainable Development Goal 9. 2.
4. American Foundry Society, Castings in Our World Factsheet: https://afsinc.s3.amazonaws.com/Documents/Marketing/Castings_Enduse.pdf
5. USGS, Mineral Commodity Summaries, January 2021: Iron and Steel Scrap: https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-iron-steel-scrap.pdf
6. American Foundry Society, Sustainability in Metalcasting: https://www.afsinc.org/sustainability-metalcasting
7. Kareta, N., The Metal Industry does not Harm the Environment, SPOTLIGHTMETAL (15 November 2019): https://www.spotlightmetal.com/the-metal-industry-does-not-harm-the-environment-a-883570/
8. Pinto, B. and Shi., W., Thermally-Efficient Crucible Technology: Fundamentals, Modelling, and Applications for Energy Savings, Foundry Practice No. 266 (March 2019), pp. 3-12.
9. Salonitis, K., Zeng, B., Mehrabi, H. A., and Jolly, M., The Challenges for Energy Efficiency Casting Processes, Procedia CIRP 40 (2016), pp. 24-29.
10. worldsteel, Steel Facts: What is Steel? https://www.worldsteel.org/about-steel/steel-facts.html

THE CONCLUSION

With its complete range of foundry products and expertise, Foseco offers solutions that ready the foundry industry to overcome the sustainability challenge in all of its forms. Through our parent company, Vesuvius, we are also committed to sustainability in our own operations via the Vesuvius Sustainability Strategy, which includes commitments to the following:

- Fight climate change by reducing our own CO2 emissions and helping our customers reduce their own CO2 footprint with the use of our products and services. Our objective is to reach a net zero carbon footprint at the latest by 2050.
- Engage in the circular economy by reducing the amount of waste we generate, recovering more of our products after they have been used, and increasing the usage of recycled materials.
- Extend our sustainability commitment to our suppliers and encourage them to progress.
- Improve safety and wellbeing at work both for our employees in our facilities and for our customers

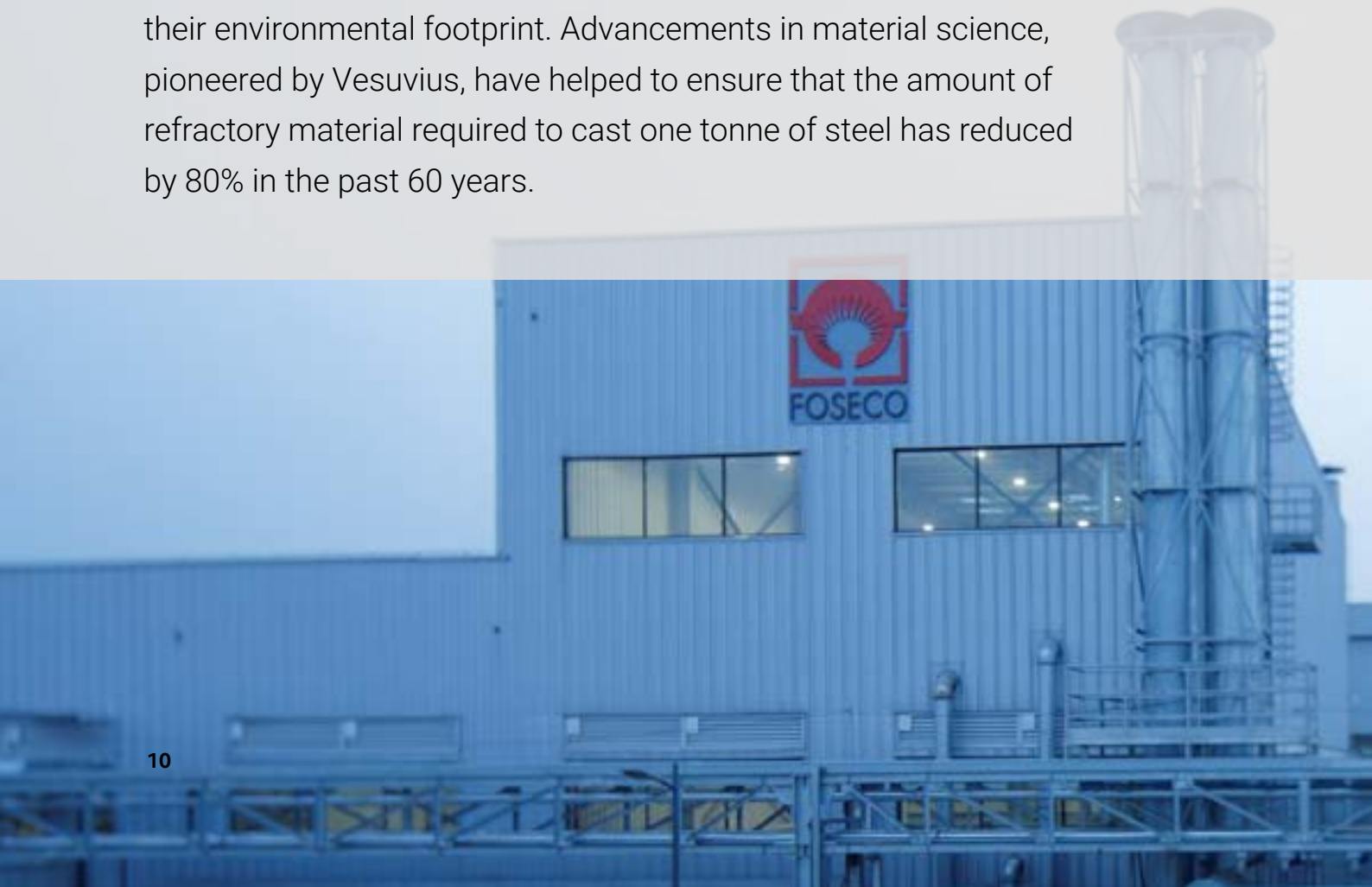
Economics and the environment are often played off against each other. But as we have seen throughout this white paper, this is a false dichotomy. Indeed, the two often accompany each other in technologies and solutions that reduce the consumption of energy, that optimise yields, that improve the longevity of foundry equipment and ensure the quality of castings, and that reduce the production of harmful pollutants.

Achieving sustainability is not however the outcome of one company's efforts. It is a collective approach to the way we act and operate as an industry. Only together, we can forge the future of the foundry industry, today.

THE FOSECO SUSTAINABILITY TOOLBOX

... HOW OUR PRODUCTS CAN CONTRIBUTE

Sustainability has always been at the heart of our business. Our technology has helped our customers improve their processes and their environmental footprint. Advancements in material science, pioneered by Vesuvius, have helped to ensure that the amount of refractory material required to cast one tonne of steel has reduced by 80% in the past 60 years.



FEEDEX VAK SLEEVES

FEEDEX VAK self-centring feeder sleeves offer minimum footprint and contact area, optimum mould sand compaction and constant feeder volume for improved yield, easy knock-off, and minimum fettling work.

KALPUR DIRECT POURING

KALPUR direct pouring for automatic green sand moulding lines improves yield and cast quality by reducing fettling and non-metallic inclusions, lowing turbulence-related defects, and improving directional solidification.

SEMCO FF COATINGS

SEMCO FF formaldehyde-free coating designed to reduce formaldehyde emissions in compliance with the latest EU regulations.

INTELLIGENT COATING UNIT

Intelligent Coating Unit (ICU) automates the coating process to deliver consistent layer thickness and ensure optimised coating performance.

INSTA COATINGS

INSTA powder-based coatings reduce packaging waste and transportation costs and emissions, compared to ready-for-use coatings.

FILTERS

SEDEX and STELEX filters enhance casting quality by removing non-metallic inclusions and providing better control of mould fill.

SEMCO COATINGS

SEMCO water-based coatings eliminate the health, safety and environmental issues that arise with solvent-based coatings, such as the release of VOCs and solvent-related respiratory conditions.

SOLOSIL BINDERS

SOLOSIL inorganic binders are a range of low-viscosity, high-performance sodium silicate binders with advanced breakdown agents.

TRIAD Z LININGS

TRIAD Z castable linings for cupola melting increase campaign life, with high resistance to slag erosion, in an easy-to-mix solution that requires no post-application curing.

SEMCO FD COATINGS

SEMCO FD a fast-drying coating that reduces energy consumed by the drying process, while maintaining product performance.

KALTEK LADLE LININGS

KALTEK insulating ladle linings for iron and steel alloys improve thermal and energy efficiency, while ensuring metal quality in metal transfer vessels.

KELLUNDITE LINING SYSTEMS

KELLUNDITE lining systems for coreless induction furnaces help reduce waste and energy consumption with increased refractory life and reduced sintering time.

VAPEX MULTI-LIFE NOZZLES

VAPEX multi-life nozzles overturn the standard practice of replacing nozzles after one shot and can be used as often as the VISO stopper for a safer working environment, higher productivity, and less waste.

A BETTER TOMORROW

Vesuvius & Foseco

VESUVIUS

From our very beginnings, our core business has been to improve our customers' operational performance. This delivers a number of environmental benefits, including reduced consumption of materials, less scrap and waste and improved metal yield and energy consumption, which result in lower CO_2 emissions.

2020 marked a new beginning in this journey.

We set an overarching objective to reach a net zero carbon footprint at the latest by 2050.

We became signatories to the UN Global Compact, making a formal public commitment to support its principles on human rights, labour, environment and anti-corruption, and to engage in activities which advance the development of the UN's Sustainable Development Goals.

Our goal: to create a better tomorrow for our planet, our customers, our people and our communities.

FIND OUT MORE AT: VESUVIUS.COM/SUSTAINABILITY

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