



WHITE PAPER

**Energy efficiency considerations for aluminium
and zinc crucibles**

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Non Ferrous Foundries

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SYNOPSIS

Improving the energy efficiency of foundry operations reduces both energy costs and carbon emissions. It's a vital win-win for foundries under pressure to reduce their environmental impact, while staying cost competitive. Foundries should therefore consider switching to energy-efficiency crucibles, such as the ENERTEK crucible range from Foseco, even if this means challenging traditional price-based purchasing decision-making.

INTRODUCTION

Controlling energy consumption is a perpetual challenge for the foundry industry

Controlling energy consumption is a perpetual challenge for the foundry industry. But with energy costs rising in many regions and the industry's carbon emissions coming under increasing scrutiny as the world moves to mitigate the impact of climate change, there is renewed impetus to improve the energy efficiency of the metal-casting process.

This is particularly true in Europe, where changes to the EU Emissions Trading Scheme (ETS) will reduce both the overall number of allowances and the availability of the free allowances provided to energy-intensive industrial plants. The changes are designed to accelerate the process of decarbonization in the EU to meet tighter emissions reduction targets. With ETS allowances already over €50 per tonne, the expectation is that prices will continue rise, perhaps even doubling by 2030, while the phase out of free allowances will leave foundries exposed to high carbon costs. In Germany alone, for example, nearly 1 million tons of CO₂ are emitted every year in the production of about 1.7 million tons of non-ferrous metal casts.



In light of the changing circumstances, solutions that improve the energy efficiency of the metal-casting process are expected to gain increasing importance. Purchasing decisions will also need to focus more on sustainability and cost reduction over the lifecycle of a product, rather than simply on those with the lowest price tag.

CRUCIBLES AND ENERGY EFFICIENCY



THERMAL EFFICIENCY

Thermal behaviour and performance is so significant because it directly impacts energy consumption.

Crucibles are one such product where, traditionally, purchasing decisions have been made on the basis of price, rather than performance when in use. When performance is considered in the purchasing decision, it is often only the lifetime of the crucible that is taken into account by buyers. However, lifetime is not the performance parameter that has most impact on production costs or carbon emissions; that accolade goes to thermal efficiency.

Thermal performance is so significant because it directly impacts energy consumption. It is also a property that degrades over time as the crucible is used. The latter phenomenon can be controlled through careful design; it cannot however be eliminated altogether. The challenge therefore is not only to improve overall thermal efficiency but also to slow the rate at which degradation occurs over the life of the crucible.

Improving thermal performance can also have a beneficial impact on production output and quality. Faster melt times, for example, improve process efficiency and therefore productivity, with a knock-on improvement in energy efficiency, as the same energy input achieves greater melt volumes.

Moreover, crucibles with high thermal performance enable greater stability and control of metal temperature in holding applications, resulting in fewer rejects for temperature-related casting problems, such as shrinkage, pressure test failures and misrun/cold shut defects. Fewer rejects mean less reworking and recycling of metal, improving the energy efficiency per unit produced.

These benefits ultimately combine to provide a crucible that offers greater cost efficiency over the lifetime of the product, improved productivity (greater output for lower inputs) and reduced environmental footprint in the form of a significant decrease in the carbon intensity (via reduced energy use and higher process efficiency).

ENERTEK Energy Efficient Crucibles

Originally designed for aluminium applications but now also available for zinc oxide production, ENERTEK energy-efficient crucibles from Foseco are formulated and manufactured to capture the benefits outlined above. They are available in most standard shapes and capacities and can be designed to fit most crucible furnaces without changes to current operating practice. Customized solutions are also possible.

EXCELLENCE IN ALUMINIUM

For aluminium applications, ENERTEK crucibles are most suited to holding furnaces, particularly electrically-heated furnaces, although they can also be effective in gas-fired furnaces. Performance differentials compared to other crucible types will vary depending upon different factors but typically ENERTEK crucibles will deliver a 5-15% energy saving. Actual cost savings will naturally depend upon unit energy costs - however we have seen examples where a 5% energy reduction can result in > Euro 800 savings annually. (Figures 1 and 2).

Meanwhile, when it comes to temperature control during holding operations, the ENERTEK crucible has been proven to achieve a much smaller temperature variation within the liquid metal. Taking the example of an electric resistance furnace with an aluminium melt set temperature of 677°C, the ENERTEK crucible showed a delta of liquid metal temperature of only 26°C (Figure 3). In contrast, a lower conductivity crucible material showed much slower heating reaction inside the crucible and a temperature delta of 42°C (Figure 4).

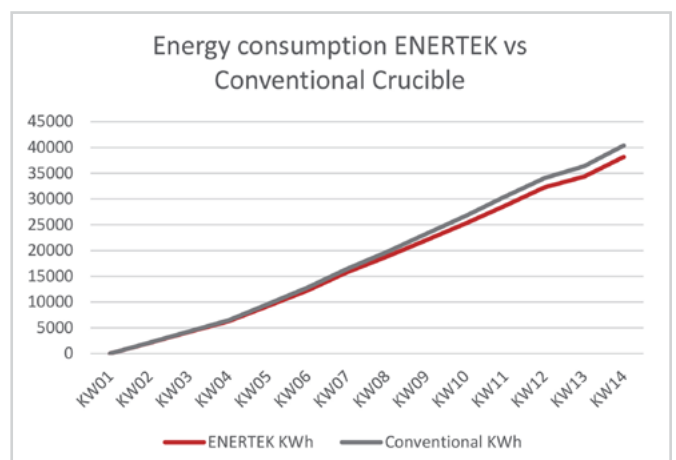


FIGURE 1. ENERTEK crucibles consume 5.5 % less energy over the first three months

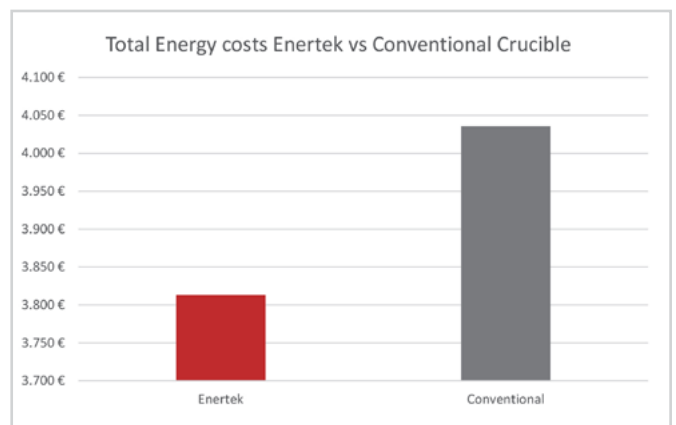


FIGURE 2. 5.5% lower energy consumption equates to a €222 energy cost saving over the first three months.

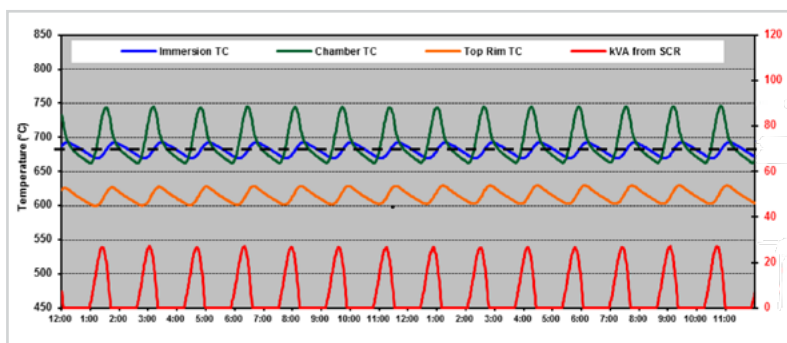


FIGURE 3.
Temperature distribution with
ENERTEK crucible $\Delta T = 26\text{ }^{\circ}\text{C}$.

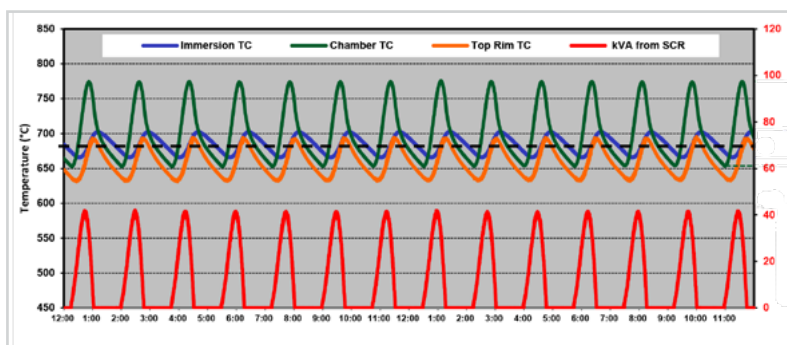


FIGURE 4.
Temperature distribution with
conventional crucible $\Delta T = 42\text{ }^{\circ}\text{C}$

FEATURES AND BENEFITS

The benefits outlined here are a result of extensive research and development (R&D) by Foseco. The features of this work are outlined in the below table, alongside the benefits derived.

Features:	Benefits derived
Analysis and modelling of thermal conductivity and specific heat capacity results in a deep understanding of the elements of crucible design and production.	Reduced energy required during melting and holding
Highest quality refractory materials are selected and formulated to maximize thermal conductivity in any given application.	
Precise processing and maximizing of density profiles through iso-static pressing in conjunction with proper material selection.	
Refractories that are designed to withstand the effects of use and ageing that can reduce thermal conductivity.	Minimal increase in thermal resistance over time
Proper balance and attention paid to baseline thermal conductivity in conjunction with stability of refractories as they age.	Maximized life time and energy savings
Energy reduction leads directly to reduced greenhouse footprint	Environmental advantages

ALUMINIUM Case Studies

ENERTEK crucibles don't just sound good on the pages of a white paper - they have been proven in practice.

An aluminium die-casting foundry was looking to reduce the energy costs and carbon footprint of foundry operations. The foundry operated a 1,000 kg capacity crucible for holding aluminium in an electric-resistance furnace, serving an automatic casting cell. Following the switch to ENERTEK crucibles, the foundry achieved a 13.4% reduction in energy consumption at the same production volume (Figure 5).

The result was overall cost saving of more than €1,200 per furnace (Figure 6) and a reduction in CO₂ emissions of 7,993 kg per year.

Another aluminium die-casting foundry, this time with a 900 kg crucible for holding aluminium in an electric-resistance furnace, was being hit with rising energy prices. With ENERTEK crucibles, the foundry measured a 4.2% drop in energy consumption at the same production volume over the 12-month lifetime of the crucible (Figure 7), resulting in an overall cost saving of €315 per crucible.

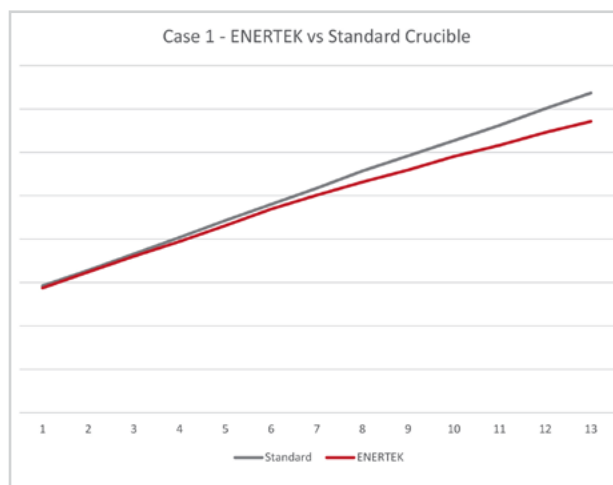


FIGURE 5. Total energy consumption over the life of the crucibles.

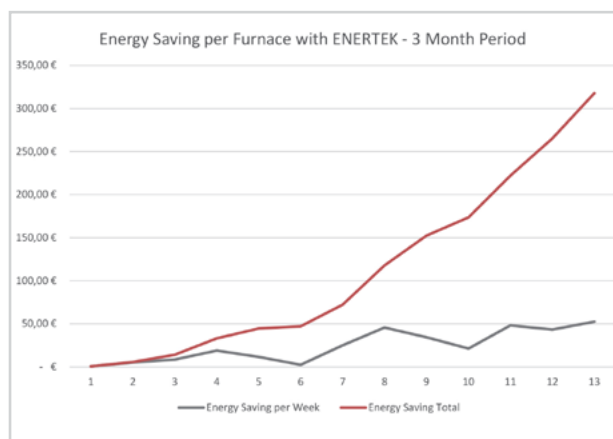


FIGURE 6. Weekly and accumulated energy savings in € per furnace.

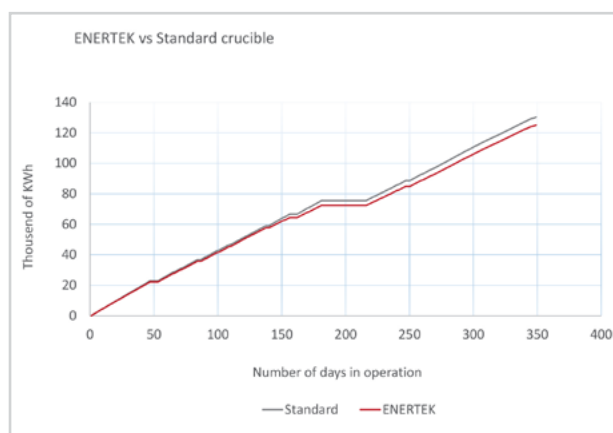
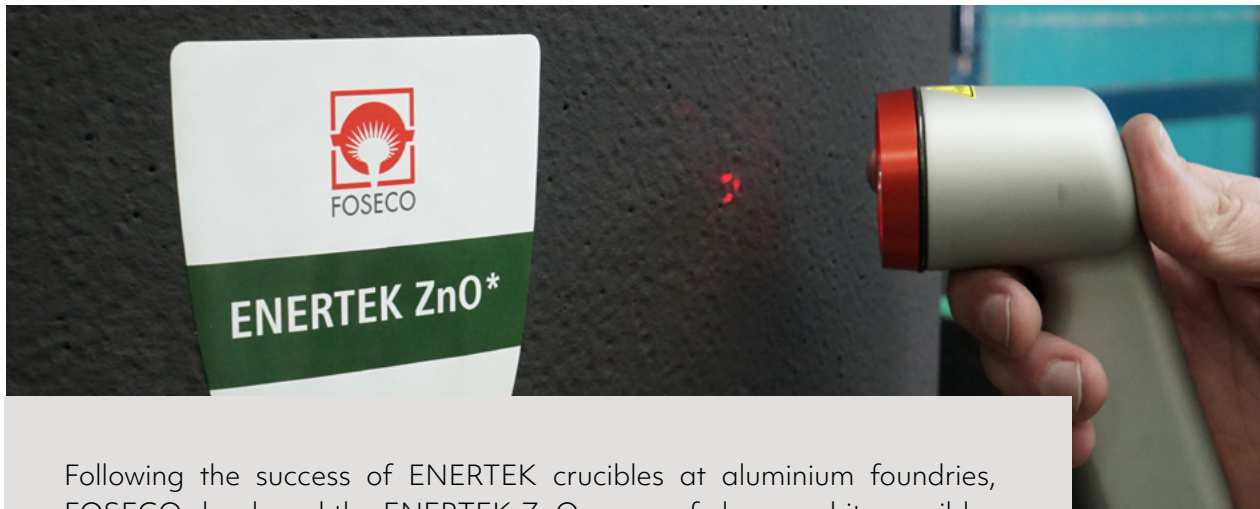


FIGURE 7. Total energy consumption over 12 months

ENERTEK FOR ZINC



Following the success of ENERTEK crucibles at aluminium foundries, FOSECO developed the ENERTEK ZnO range of clay graphite crucibles and retorts, which have been specially formulated to provide maximum performance in zinc vaporization operations for production of both zinc oxide and zinc powder.

Again, performance differentials compared to competitive crucibles will vary according to process parameters; however, savings of more than 30% have already been measured in several customer operations. Meanwhile, the faster melt rate that can be achieved using ENERTEK crucibles has resulted in up to 15% increase in productivity.

THE --- CONCLUSION

Energy consumption and environmental sustainability are two of the most important challenges facing today's foundries – and are the critical operation parameter for crucibles. The ENERTEK range of crucibles for aluminium and zinc applications helps foundries improve their performance in both areas. By prioritizing high thermal performance, ENERTEK crucibles improve energy and process efficiency, resulting in lower energy and production costs, as well as reducing the carbon intensity of metals production.

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