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Green Steel Initiatives Supported by CERO Waste Refractory Recycling, Circular Metallurgical Additives and Enhanced Slag Engineering

To achieve sustainability in the refractory and steel industries, adopting a circular economy represents the most effective approach. RHI Magnesita and MIRECO facilitate a closed-loop system by coordinating efforts among refractory producers, end-users, and recyclers. Alongside CERO (Continuous Economic Recycling Optimisation) Waste, this approach also includes circular metallurgical additives and slag engineering solutions. CERO Waste comprises the collection, sorting, reuse assessment, and disposal, as well as legal management of used refractory materials. This process generates circular minerals that can substitute primary resources in circular refractory products and sustainable metallurgical additives, thereby maximising refractory recycling rates, decreasing CO_2 emissions, and significantly reducing landfill waste. A slag engineering consultancy service delivers deep insights into metallurgical process optimisations, the application of green metallurgical additives, and slag compatibility with refractory linings. Furthermore, research and development activities, such as laboratory and industrial-scale investigations, have demonstrated that circular additives exhibit the required dissolution behaviour, thereby dispelling misconceptions surrounding their performance. Three studies conducted in electric arc furnaces, basic oxygen furnaces, and secondary metallurgy ladles are described that highlight the benefits associated with circular metallurgical additives while also addressing topics such as MgO saturation, slag foaming, desulphurisation, and alloy savings. Using e-tech slag modelling tools, these studies demonstrate the added value of combining metallurgical, refractory, and circular economy expertise to advance green steel production in steel plants.

Introduction

Reducing greenhouse gas emissions is an urgent priority across industries, with the steel sector facing significant pressure due to its energy-intensive processes and growing global commitments to achieve net-zero emissions by mid-century. Many steelmakers already monitor emissions across their product life cycles using Product Carbon Footprints (PCFs), which track greenhouse emissions from the initial stages of production up to the factory gate—also known as the “cradle to gate” approach. Environmental Product Declarations (EPDs) expand this scope by incorporating additional environmental impacts, establishing PCFs and EPDs as essential tools for tracking climate-friendly product performance.

Despite these advancements, a consistent framework for classifying and evaluating “Green Steel” based on emissions remains underdeveloped. However, the International Energy Agency has proposed baseline emission thresholds, defining criteria for near zero emission steel and low emission steel in both integrated and electric arc furnace (EAF) steel production (Table I), stipulated on a sliding scale that depends on steel scrap use [1]. The near zero emission threshold for crude steel production without scrap input is set at 400 kg of CO_2 equivalent per tonne (kg $CO_2e/t_{crude\ steel}$), which decreases to 50 kg $CO_2e/t_{crude\ steel}$ when production relies entirely on 100% scrap [1]. These definitions provide a foundation for explicitly favouring sustainable products, for example in public procurement processes.

Slag additives play a vital role in reaching these emission thresholds, as their PCFs—influenced by calcination and premelting—significantly contribute to the overall PCF of steel. Consequently, steel producers are increasingly interested in circular refractory management and sustainable additives with low PCFs.

Table I.

International Energy Agency proposed emission thresholds for near zero and low emission steel, stipulated on a sliding scale that depends on steel scrap use [1]. Abbreviations include kg of CO_2 equivalent per tonne of crude steel (kg $CO_2e/t_{crude\ steel}$).

	Integrated steel production (without scrap use) [kg $CO_2e/t_{crude\ steel}$]	EAF steel production (100% scrap) [kg $CO_2e/t_{crude\ steel}$]
Near zero emission steel	400	50
Low emission steel	2400	300

MIRECO's Expansion and Contribution to the Circular Economy

Established as a joint venture between RHI Magnesita and Horn & Co. Minerals Recovery, MIRECO provides crucial support to steelmakers in adopting green steel practices aligned with the aforementioned requirements. The two companies—a circular refractory manufacturer with strong R&D capabilities and metallurgical expertise, and a refractory recycler with decades of experience in sorting, processing, as well as material and waste management—joined forces to offer comprehensive, customised solutions tailored to meet the unique requirements of each steel plant.

With a platform covering Europe, MIRECO operates multiple off-site recycling facilities in Germany, Austria, France, Sweden, Poland, Kosovo, and Italy, as well as on-site solutions at steel plants in, for example, Duisburg, Bremen, and Dillingen (Figure 1). MIRECO is committed to the continued expansion of its on-site and off-site capabilities, as demonstrated by the 2024 acquisition of Refrattari Trezzi Srl., in Italy. While a high proportion of used refractories are sourced from steel plants, MIRECO also collaborates with other high-temperature industries, such as the cement and lime sector, to reclaim and process additional refractory materials.

MIRECO—the key force in closing the cycle—offers a range of products and services including:

- CERO (Continuous Economic Recycling Optimisation) Waste: Refractory recycling and optimised waste management.
- A comprehensive portfolio of circular raw materials for refractory production [2].
- Sustainable metallurgical additives customised for different process demands.
- Slag engineering solutions using RHI Magnesita's e-tech modelling tool and on-site trial supervision.

CERO Waste: Closing the Loop in Refractory Material Recycling

Traditional refractory materials often follow a linear life cycle, with products being discarded after use. In addition, historical decisions by refractory producers and steelmakers to avoid products containing circular raw materials also contribute significantly to waste accumulation and the loss of valuable secondary resources. An alternative opportunity lies in adopting MIRECO's CERO Waste approach, which unlocks the potential of secondary materials through circular refractory products and sustainable metallurgical additives. This CERO Waste framework is founded on a long-term partnership model that enables continuous circular development aimed at avoiding landfilling practices.

Figure 1.
MIRECO's recycling sites in Europe.

1 Horn & Co. RHIM Minerals Recovery GmbH
(a) Bremen
(b) Duisburg
(c) Siegen-Weidenau + Wenden-Hünsborn
(d) Weitefeld + Betzdorf
(e) Dillingen
2 RHIM Mireco Mitterdorf GmbH, Mitterdorf
3 Mireco SARL, Entzheim
4 Mireco AB, Fragersta
5 Horn & Co. Polska Sp. z o.o., Lazy
6 Mireco sh.p.k.
(a) Deçan
(b) Prishtina
7 Refrattari Trezzi Sri., Merlino

Figure 2 illustrates the collaborative partnership between the customer, MIRECO, and RHI Magnesita, within the CERO Waste cycle. The customer, positioned at the top, provides used refractory material to MIRECO, where the material is sieved, sorted, and cleaned, resulting in two main circular raw material types: A finer fraction that is typically used for nonrefractory applications such as circular metallurgical additives (e.g., slag conditioners) and a coarser fraction that is reintroduced into refractory production. Circular raw materials for refractory products are provided to a refractory producer—primarily RHI Magnesita—to manufacture new circular refractory products delivered back to the customer. This closes the refractory life cycle loop, maximises material value recovery, and reduces landfilling to below 2%.

CERO Waste is subdivided into four key steps, which are illustrated in Figure 3 and presented in the video "MIRECO – Unser CERO WASTE-Konzept" [3]. These steps include:

- Collection point management: In this initial step, the entire refractory material flow is mapped across all involved stakeholders—starting from lining demolition to the final material destination. This process requires time, as well as a transparent and cooperative partnership with the steelmaker.
- Material sorting: In the second step, to maximise the yield of recyclable raw materials, the various used refractories are sorted into the required qualities. This process combines manual sorting with advanced laser-based technology—a core competence of MIRECO and RHI Magnesita.
- Reuse: During the third step—the innovative phase—potential reuse pathways are collaboratively evaluated with the refractory producer and the end user. This has the greatest impact on reducing CO_2 emissions and minimising landfill.
- Disposal: In this final step, MIRECO manages the disposal of any remaining materials, ensuring responsible handling in full compliance with legal and environmental regulations.

Figure 3.

The 4 steps of CERO Waste, which create a continuous process enabling the best value creation of used refractories.

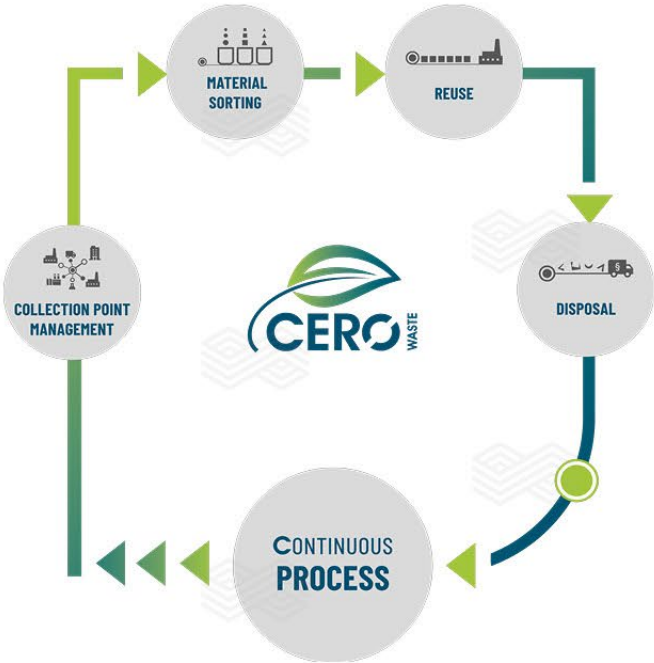
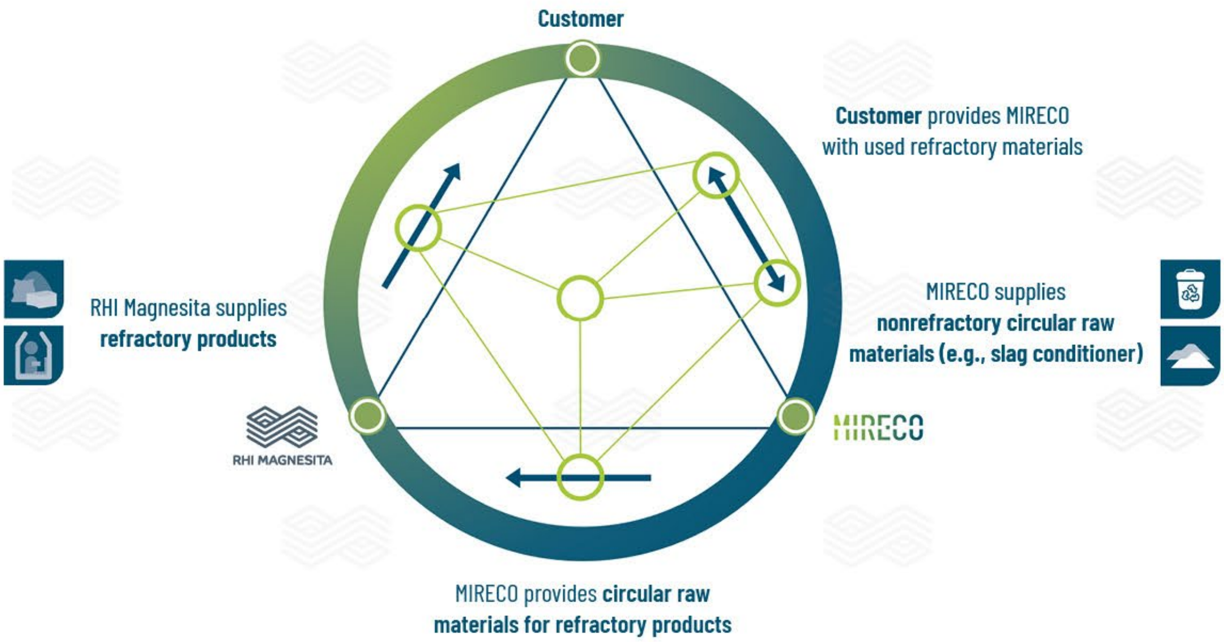


Figure 2.

The closed CERO Waste cycle resulting from a collaborative partnership between the customer, MIRECO, and RHI Magnesita.



To provide a clearer and more concrete understanding of CERO Waste, Table II presents an overview matrix of three selected cases at different steelmaking customers. For each example, the areas of refractory generation and handling, the 4 steps of CERO Waste, material streams and management, as well as associated benefits, were examined and documented.

Case A represents a typical on-site solution at an integrated steel mill serving a whole region with several steel plants, operating under a material and service contract with processing of all used refractory material performed directly on-site. A portion of the material is sent to a final treatment facility to produce new refractory products and metallurgical additives while another share is used directly as circular

Table II.

Overview matrix of three selected cases (A, B, and C) where the CERO Waste approach is in operation to unlock the potential of secondary materials through circular refractory products and sustainable metallurgical additives for the steel industry.

Category	Metric	A	B	C
Steel plant	Annual steel production [tonne/year]	6 million	4 million	0.5 million
Refractory generation and handling	Used refractories generated [tonne/year]	~20000	~10000	~2500
	Used refractory material streams within the steel plant [tonne/year]	~3000	~2000	~1300
	Used refractories to MIRECO [tonne/year]	~17000	~8000	~1200
	Recyclability	Medium	Medium	High
4 steps of CERO Waste	Collection point management	Yes	In progress	Yes
	Material sorting	On-site	Discontinuous on-site	Off-site
	Reuse	Refractory and nonrefractory circular raw materials		
	Disposal by MIRECO	Very low	Very low	Very low
Circular raw materials for refractory applications	Circular raw materials generated for refractory applications [tonne/year]	~3000	~4000	~300
	Circular refractory products used at the steel plant	Medium	Medium	High
Circular raw materials for nonrefractory applications	Circular raw materials generated for nonrefractory applications [tonne/year]	~14000	~4000	~900
	MgO-based circular metallurgical additives generated by MIRECO [tonne/year]	~8000	~2500	~750
	Alumina-based circular metallurgical additives generated by MIRECO [tonne/year]	~2000	~1500	~150
	MIRECO MgO-based circular metallurgical additives used at the steel plant [tonne/year]	–	~3500	~5000
	MIRECO alumina-based circular metallurgical additives used at the steel plant [tonne/year]	–	~2500	~300
	Blast furnace sinter bed application at the steel plant [tonne/year]	4000	–	–
Benefits	Added value	High	High	High
	Landfill avoided	Yes	Significantly reduced	Yes
	Reused at steel plant in circular refractory products	Medium	Medium	High
	Nonrefractory circular raw material application (e.g., circular metallurgical additives and sinter bed)	Medium	High	High
	CO_2 savings from circular metallurgical use at steel plant	Low	High	High

blast furnace additives and in other applications. The disposal ratio for refractories is moderate, as the recyclability of used refractory types is rated medium to high due to the majority share of doloma-based products in use that are challenging to reintroduce into refractory production. Additionally, the efficiency of material presorting presents an opportunity for improvement and is underway.

Case B operates a discontinuous on-site solution at an integrated steel plant, where service personnel are sent once a defined volume of used refractories has accumulated. The material is then sorted and processed, entering dedicated material streams for refractory and nonrefractory reuse. A portion is transported to RHI Magnesita and MIRECO plants for final treatment and the production of refractory raw materials and circular metallurgical additives. As the collection point management is not yet optimised, a high amount of fines with an unstable specification range is generated, contributing to higher landfill volumes. However, the process is growing organically and is being continuously refined to achieve the optimal recycling ratio.

Case C operates under a pure material contract, whereby all used refractories are transferred to MIRECO facilities. The materials are sorted into dedicated streams for refractory and nonrefractory applications. Circular metallurgical additives are then supplied by MIRECO back to the steel plant for use in both primary and secondary metallurgy. Recyclability of the applied refractory lining concepts is quite efficient. Additionally, dismantling procedures are well established, enabling effective presorting and very low landfill volumes. As a result, this customer benefits fully from the CERO Waste approach, representing a best-practice implementation.

To date, MIRECO has enabled over 100 European customers achieve a more efficient circular economy, generating more than 255000 tonnes of circular raw material products annually and offering a range of additional services. Furthermore, MIRECO introduced a Decarbonisation Award to recognise its customers' success in reducing CO_2 emissions. In 2023, the award was presented to GMH Gruppe and Swiss Steel Group, each achieving approximately 10000 tonnes of CO_2 equivalent savings annually [4,5].

Circular Metallurgical Additives

Metallurgical additives serve crucial functions in iron and steelmaking, as slag chemistry directly impacts refining processes like dephosphorisation, desulphurisation, and slag foaming. These additives are typically classified into basic oxides, which assist in CaO and MgO saturation, and fluxing oxides, which aid in fluidising the slag [6]. In 2023, 126.3 million tonnes of steel were produced in the EU-27, with 45% originating from integrated steel plants and 55% from EAF steel mills [7,8]. Assuming slag generation of over 160 kg per tonne of steel [9], this corresponds to a substantial total slag volume and, consequently, a huge demand for slag-forming additives.

As previously described, MIRECO sources used refractories through CERO Waste and other approaches. Due to handling and processing, even preseparated materials contain a significant percentage of fine particles (see page 99). Therefore, all incoming material is sieved, sorted, and cleaned in the same way. The coarser fraction is subsequently processed into circular raw materials for new refractory products and the finer fraction is primarily converted into circular metallurgical additives. With an approximate 1:1 ratio of fine to coarse fractions, the two resulting material streams are interdependent. This mutual reliance aligns with an industry-specific interpretation of the European Union Waste Framework Directive [10] and recent developments in EU shipment regulations [11], commonly referred to as the "no-out, no-in" principal. It highlights the need to maintain balanced material flows—ensuring that materials re-enter the production cycle sustainably and that no recyclable stream is left unmanaged. Unlike mined primary raw materials, the availability of circular raw materials and circular metallurgical additives is intrinsically linked—each depends on the generation and utilisation of the other.

Circular metallurgical additives contribute to environmentally friendly steel production, with PCFs as low as 0.05 tonne of CO_2 equivalent per tonne of additive ($t\ CO_2e/t_{additive}$)—less than 10% of conventional slag formers such as lime, which can be around 1.84 $t\ CO_2e/t_{additive}$ (Table III). Additionally, these sustainable products are cost-competitive, offering a price advantage of approximately 10%, as they do not require calcination or premelting and are unaffected by fuel price volatilities. From a chemical perspective, the MgO content protects a basic refractory lining from slag corrosion, while carbon serves as both an energy source and a reducing and/or slag foaming agent. Compared to synthetic premelted slags, recycled alumina products offer advantages such as accompanying oxides that reduce the melting point and a specific surface area up to ten times higher than that of conventional additives, making them a competitive alternative to calcium aluminate slags and even a potential substitute for CaF_2 [12]. Given their high application volumes and frequency, circular metallurgical additives can lead to substantial carbon emission savings—driving growing interest and adoption among steel producers. MIRECO offers a general portfolio of circular metallurgical additives (see Table III), comprising standard grades of basic and fluxing oxides that can be tailored to the specific requirements of each steel plant. Currently, more than 100000 tonnes of these additives are sold annually on the European market, with a distribution ratio of approximately two-thirds basic oxides to one-third fluxing oxides.

For steel producers, selling their used refractories to MIRECO and sourcing circular metallurgical additives in return provides multiple strategic and operational benefits. This closed-loop approach ensures a reliable, long-term supply of metallurgical additives with consistent quality, while eliminating the need for in-house crushing and blending operations. By outsourcing the processing of used refractories, steel plants also reduce internal handling and logistics costs. In addition, the stable chemical composition of MIRECO's products supports improved process control and metallurgical performance. Financially, this model can be advantageous, as the sale of used refractory materials may generate revenue, while simultaneously lowering the overall PCF of steel production.

Dissolution behaviour

When evaluating the use of circular metallurgical additives, it is important to address existing biases against reclaimed materials, sensitivity to freight costs, and the critical requirement for effective dissolution. Since refractory products—particularly those containing fused MgO (i.e., periclase)—are designed to withstand high-temperature corrosive environments for as long as possible, it was essential to thoroughly investigate the solubility of MgO-containing circular additives in slag. Laboratory experiments involving the dissolution of different MgO carriers in steelmaking slags under static conditions demonstrated that accurately assessing MgO solubility requires a combination of chemical and microtextural analyses, including X-ray fluorescence (XRF), X-ray diffraction (XRD), and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX) [13,14].

Based on the aforementioned studies, industrial trials have shown that circular MgO additives exhibit good solubility in both EAF and basic oxygen furnace (BOF) processes, even in MgO-oversaturated slags [6,15]. In a comprehensive EAF slag engineering study [15], the dissolution behaviour of dololime, spent MgO-C (containing up to 60 wt.% fused MgO), and spent doloma was compared. To ensure a consistent MgO saturation level, equivalent amounts of each

Table III.

Examples of MIRECO's standard circular metallurgical additives, which can be tailored to customer requirements, and standard slag formers. Abbreviations include tonne of CO_2 equivalent per tonne of metallurgical additive (t $CO_2e/t_{additive}$). Figures for dololime and lime are assumptions based on the best available technique reference documents.

	Product	MgO [%]	CaO [%]	SiO_2 [%]	Al_2O_3 [%]	Fe_2O_3 [%]	TiO_2 [%]	C [%]	CaF_2 [%]	t $CO_2e/t_{additive}$
Basic oxides	MgO 55	55	20	5	10	5		8		0.05
	MgO 75	75	6	5	5	5		5		0.05
	MgO 80 A7	82	1.5	0.5	8	0.7				0.05
	Dololime	35	62							1.84
	Lime	1	96							1.84
Fluxing oxides	TE 80	3	2	11	78	2.5	2	2		0.05
	TE 85	2.5		7.5	85	0.7	0.4	6		0.05
	TE 90	2.5	2.5	1.8	90	0.8	0.1			0.05
	Rehcal 10	6	15	9	55	2			10	0.05
	CFA 40–60	2.5	20	5	20	0.6	0.5		50	0.05

MgO carrier were added accordingly. The average results indicated no significant differences in the dissolution behaviour between the three materials. XRF and XRD analyses were performed on all slag samples from the trial. In the few instances where periclase was detected by XRD, the findings were corroborated using light microscopy and SEM-EDX. In addition, those samples with high MgO concentrations were analysed microscopically, including SEM-EDX, to determine the extent of MgO dissolution and identify the phases in which it was incorporated.

In the conducted trials, analyses indicated that MgO had dissolved in 98.5% of the 231 slag samples taken during 78 heats. A representative SEM image is shown in Figure 4a, where a MgO-oversaturated slag was targeted by applying spent MgO-C fines. The observed melilite matrix (Ca-Al-Mg-silicate) contained various spinel phases, with no undissolved MgO detected. The presence of undissolved periclase (Figure 4b) was only observed in three slag samples, which all originated from heats conducted immediately after gunning maintenance. Additionally, industrial trials demonstrated good solubility and no negative impact on desulphurisation efficiency when ladle furnace (LF) slags were fluxed with circular alumina carriers instead of conventional premelted additives, even enabling the complete elimination of CaF_2 [12].

Slag Engineering Solution

Various industrial-scale trials to evaluate circular metallurgical additives across different steelmaking units have been performed with RHI Magnesita providing metallurgical expertise and slag optimisation software. The resulting slag engineering solution, which supports the circular economy approach, comprises on-site fact finding, design and execution of short- and long-term trials to achieve process improvements and cost savings with circular metallurgical additives, as well as rolling out new optimised standard operating procedures. Furthermore, it includes access to the e-tech slag modelling tools, which offer detailed insights into specific slags and can enhance the overall metallurgical processes [16].

e-tech

The e-tech platform is a collection of online slag modelling tools available through RHI Magnesita's Customer Portal [17]. This secure digital environment also supports users with a wide range of operational data, including order status, refractory performance metrics, scope 3 CO_2 emissions from consumed refractory products, and gunning material consumption figures [18]. The e-tech tools are employed to identify opportunities for process optimisation. In the following section, their application is demonstrated through industrial studies, where "Foamy Slag" was used for the EAF [15], "Quick Foam" and "Slag Splashing" for the BOF [6], and "Slag Optimisation" and "Kinetic Desulphurisation" for the LF process [12].

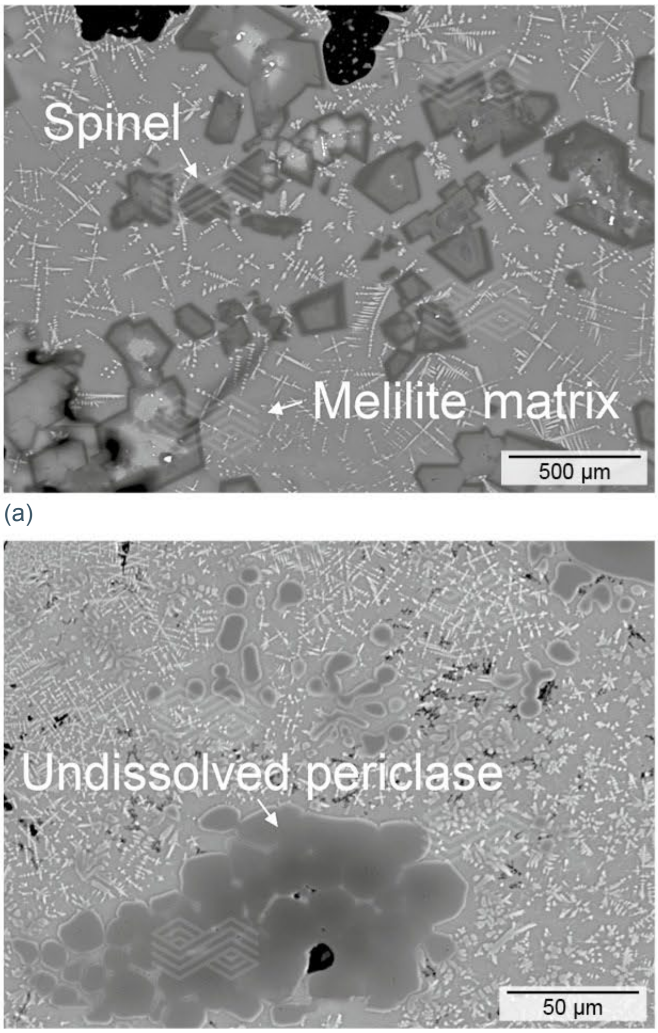
Industrial case studies

Three case studies—each focused on a specific steelmaking unit (i.e., EAF, BOF, and LF)—highlight the positive impact of MIRECO's and RHI Magnesita's solutions on green steel production. In all cases, measurable benefits were achieved, including cost savings (i.e., €0.3–€1.0 per tonne of steel), decreased specific refractory consumption (i.e., up to 20%), and CO_2e emission reductions (i.e., 10–15 kg $CO_2e/t_{crude\ steel}$) were achieved. Table IV provides an overview matrix of the conducted studies.

For the EAF trials, MIRECO's circular metallurgical additives—containing MgO and carbon—were pneumatically injected, and the most efficient time slots for promoting slag foaming and protecting the refractory lining were identified [15]. Key savings and benefits observed in these EAF trials conducted at Marienhütte Graz (Austria), in collaboration with Primetals Technologies, were:

Figure 4.

SEM images showing (a) a representative slag sample with no undissolved MgO and (b) a rare instance of a sample containing partially undissolved periclase [15].



(a)

(b)

- Approximately 65% reduction in MgO pickup from the brick lining and gunning mix due to optimised slag chemistry, leading to greater residual brick thickness (measured manually and via laser), as well as decreased gunning mix consumption.
- Excellent slag foaming, tracked using the electrode regulation system, contributing to better energy efficiency and reduced process noise.
- 12% reduction in anthracite consumption during the refining period.
- Sustained operational success: Four years after the initial trials, the plant continues to follow the standard operating procedure established with circular metallurgical additives.
- Potential for broader application: Currently, extending the use of circular metallurgical additives into secondary metallurgy is being examined.

The BOF trials were conducted using both sieved and briquetted circular metallurgical additives at various process stages, specifically targeting the challenge of MgO saturation. The total cost of ownership analysis revealed annual savings in the six-digit euro range, supported by the following advantages [6]:

- Extended BOF lining lifetime and reduced gunning requirement, leading to increased productivity due to less frequent gunning maintenance and reduced downtime for relining.
- Lower lime input while achieving optimised dephosphorisation.
- Reduced alloy costs.
- Elimination of refractory landfilling.

Stahlwerk Thüringen (Germany), is committed to sustainability through a green steel strategy focused on stepwise improvements in process efficiency and reduced resource consumption. Therefore, an industrial feasibility study was conducted to evaluate whether conventional fluxes used for desulphurisation in the LF could be replaced by a high-alumina circular metallurgical additive [12]. The trial series enabled an appropriate balance between desulphurisation rate, additive application, slag volume, and purging gas consumption to be determined. During the replacement of calcium aluminate and fluorspar with a cost-effective, low carbon footprint slag fluxing agent, additional benefits were determined, including:

- Elimination of fluorspar use and the associated ground water pollution from slag containing fluorine.
- Increased desulphurisation efficiency.
- Decreased alloy requirement.

Prior to the LF trials at Stahlwerk Thüringen, the use of MIRECO's circular metallurgical additives in the EAF had become standard practice, further demonstrating how RHI Magnesita's metallurgical expertise can support steel plants in achieving their sustainability goals.

Table IV.

Overview matrix of the industrial trials conducted with MIRECO's circular metallurgical additives [6,12,15]. Abbreviations include total cost of ownership (TCO), kg of CO_2 equivalent per tonne of crude steel (kg $CO_2e/t_{crude\ steel}$), and not applicable (NA).

Furnace type	EAF	BOF	LF
Furnace size [tonne/heat]	40	120	100
Annual production [tonne/year]	400000	1000000	900000
Circular metallurgical additive used	MgO 75	MgO 75	TE 80
Replaced conventional metallurgical additive	Dololime	Dololime	CaAl additive + CaF_2
TCO savings from circular metallurgical additives [€/year]	6-digit	6-digit	6-digit
CO_2e emission savings from circular metallurgical additives [kg $CO_2e/t_{crude\ steel}$]	~10	~10	~1
Monitored heats	240	70	70
Slag samples taken	500	140	120
Slag sample analyses (i.e., XRF, XRD and mineralogy)	850	200	190
Residual brick thickness	Increased	Increased	Increased
Gunning mix savings	Yes	Yes	Yes
Slag foaming improvement	Yes	-	NA
Carbon injection savings	Yes	NA	NA
Alloy savings	NA	Yes	Yes

Conclusion

Embracing sustainable practices in the steel industry is crucial for minimising environmental impact and meeting global climate goals. MIRECO's and RHI Magnesita's initiatives—such as the CERO Waste approach, circular metallurgical additives, and slag engineering solutions—represent important advancements for the transition to a circular economy in steel manufacturing. By enabling closed-loop recycling, offering low-carbon alternatives to conventional additives, and optimising slag chemistry, these innovations reduce CO_2 emissions, minimise landfill waste, and deliver measurable economic benefits for steel mills.

Industrial case studies have clearly demonstrated that using circular materials can maintain—or even improve—process efficiency in EAFs, BOFs, and LFs. Furthermore, concerns regarding the full dissolution of circular additives have been effectively addressed and shown to be unfounded. The development of digital tools, such as the e-tech platform, further supports steel plants to optimise operations and valorise recycled materials. By addressing challenges relating to raw material variability and overcoming biases against secondary materials, MIRECO is helping to drive the steel industry towards greater sustainability. As steelmakers increasingly adopt these practices, the sector is advancing towards achieving its green steel goals, paving the way for a climate-resilient future.

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