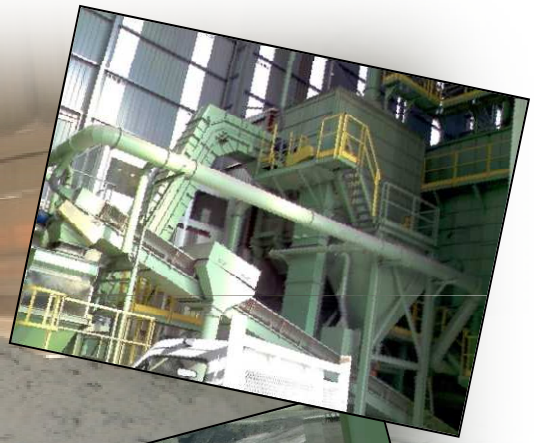
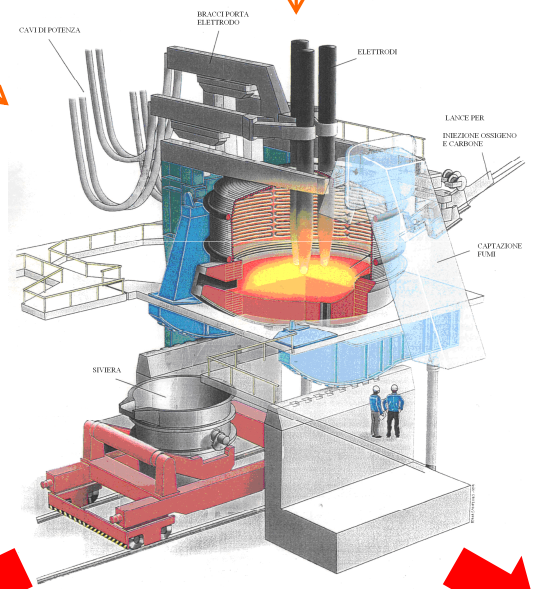
Ecology & Innovation



WHITE SLAG RECYCLING & EXHAUST REFRACTORIES

MATERIAL HANDLING SYSTEM
SEDE LEGALE IN VIA ALDO MORO, 16 25124 - BRESCIA (IT) INFO@MHSINDUSTRY.COM WWW.MHSINDUSTRY.COM

Introduction: Steel Production in the EAF



STEEL

WASTE

Diposal costs

Pollution

Main production wastes

FUME DUST

EXHAUSTED REFRACTORIES

MHS

BLACK SLAG

From EAF melting process

WHITE SLAG

from LF refining process

MHS

Waste's recycling...

FUME DUST

- Zinc Recovery (Zn)
- Lead Recovery (Pb)

BLACK SLAG

As inert is used in:

- Clinker
- Cement
- Asphalts
- Road foundations

"CLEANS" EXHAUSTED REFRACTORIES

They can be re-used

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…and what is the white slag?

The white slag consists of:

- Lime (silicate and free lime)
- Oxidation products of the bath
- Worn ladle refractory
- EAF slag

WHITE SLAG:
problem or resource?

White slag

Rich of free lime

Instable

Shattering
=
dust

Hydration
=
smell

White slag: RESOURCE! …No Waste!

Consideration about the WHITE SLAG:

- **Rich of lime and magnesia** in active form and completed by complex oxides stabilized chemically.

- **CaO e MgO : "precious" materials,** their production have high costs concerning:
  - Raw Materials consumption (limestone and dolomite)
  - Energy consumption (raw material calcination)
  - Pollution (CO_2 emission)

Invironmental Conservation

The guidelines of MHS Industry process, that recovers the active compounds, stabilizing the remaining materials as black inert slag, are the following:

To minimize energy consume **To optimize material recycling**

WHITE SLAG SHATTEERING

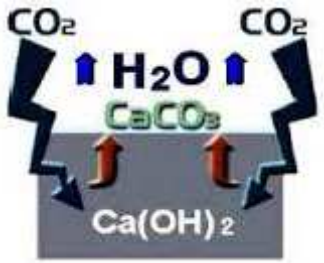
The white slag shattering occurs in 3 different ways:

Physical process

- Allotropic variation of di-calcium silicate (cooling)

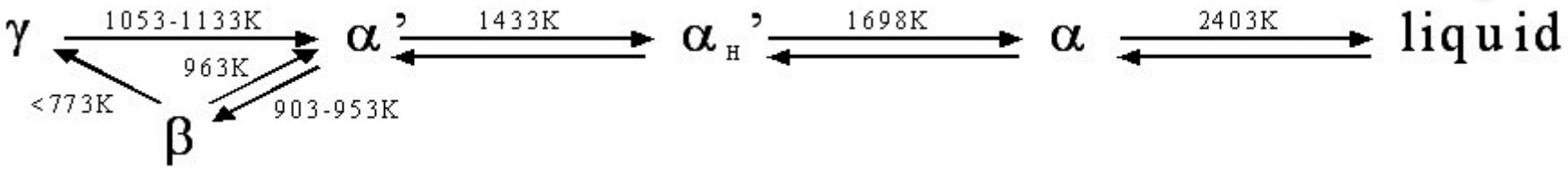
Chemical process

- Carbonation of free CaO
- Hydration of free CaO



Physical process

2CaO*SiO2: phases in T function



$2CaO.SiO_2$ is the main component of the white slag:

- **α phase** is stable to very high temperature
- During cooling down at 630°C the phase changes in **β** and below the 500°C it changes in phase **γ**
- The conversion **β-γ** is characterised by 10% increase volume that creates general internal tensions. Those internal tensions cause matrix shattering.

Chimical Process: Energy Problems

Carbonation of free lime
(CO2 from the air)
CaO + CO2 → CaCO3
100% increase of the volume

Hydration of free lime
(air humidity)
CaO + H2O → Ca(OH)2
100% increase of the volume
hydrates create serious olfactory problems

ADDITIONAL ENERGY DISSOCIATION

- **54 Mcal:** energy necessary to 1 mole of CaCO3
- **35 Mcal:** energy necessary to 1 mole of Ca(OH)2

MHS Industry proposal

MHS Industry exploits in his system the process of shattering controlled by the PHASE transformation of the C2S

MAIN PROBLEMS:

1°Problem: The shatteering process is exothermic and kinetically slow

2°Problem: The slag is a refractory inert – the heat transfer is low

3°Problem: To avoid carbonization and hydration

THE RIGHT WAY TO DEAL WITH THEM:

- Cooling the material core
- Controlling and accelerating the process

Efficacious heat exchanges and a **continuous shuffling** of the slag promote the kinetic of the process → **The shattering time will be reduced to 1 hour!**

Peculiarities of the MHS Industry Plants

In the process:

- **Isolate environment** with no air change: it avoids the slag carbonation and hydration
- **Indirect water cooling**: it increases the exchange coefficients and the temperature gradients
- **Continuous slag mixing:** it helps the powder separation and permits the renewal of the material close to the reactor exchange wall
- Simple **process parameters control**: treatment time, final temperatures, slag flow rate in the reactor.

In the plant:

- **Compactness:** shattering and dimensional selection realized the same reactor
- **Modularity**: it satisfy all the steel companies necessities
- **Continuous process:** easy to be managed and repeatability of results

USED REFRACTORIES

Typical refractories composition:

	LF	Tundish	EAF	
			wall	bottom
Lime (CaO)	54-58%	< 12%	2%	10-17%
Magnesia (MgO)	36-40%	50-90%	95%	55-80%
Carbon (C)	< 2%	-	3%	6%
Alumina (Al_2O_3)	1%	1-6%	< 0,5%	1%
Silica (SiO_2)	< 1%	10-20%	< 0,5%	1-3%
Iron Oxide (FeO)	-	-	-	10-15%

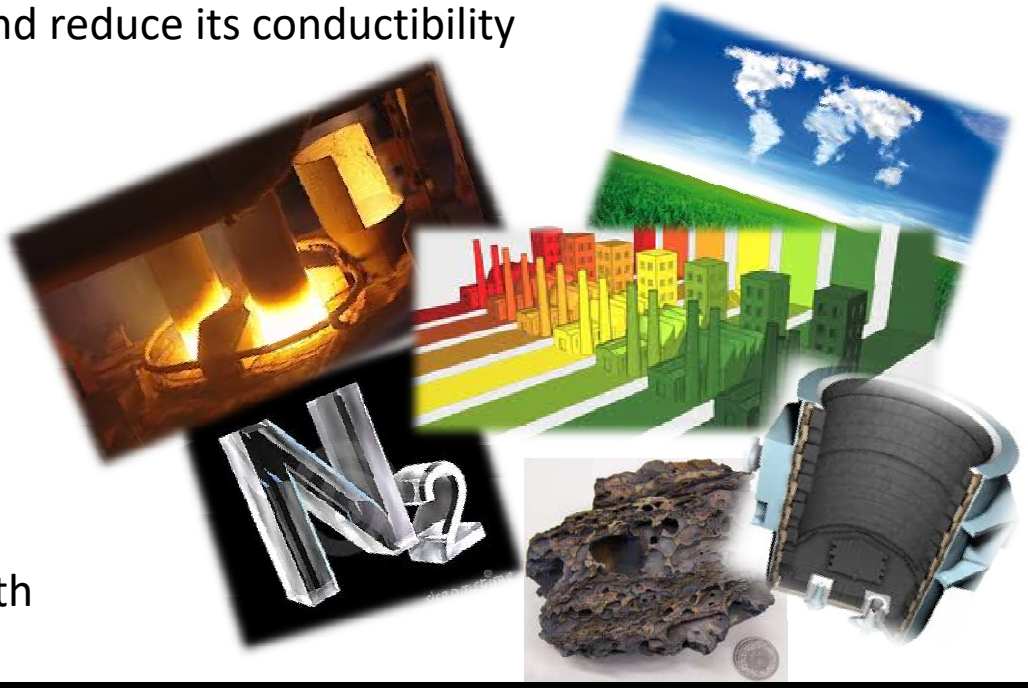
Refractories → reach of basic oxides - MgO – Their natural powdering needs very long times, so they are mechanically recovered by a crashing plant.

Foamy slag & Magnesia

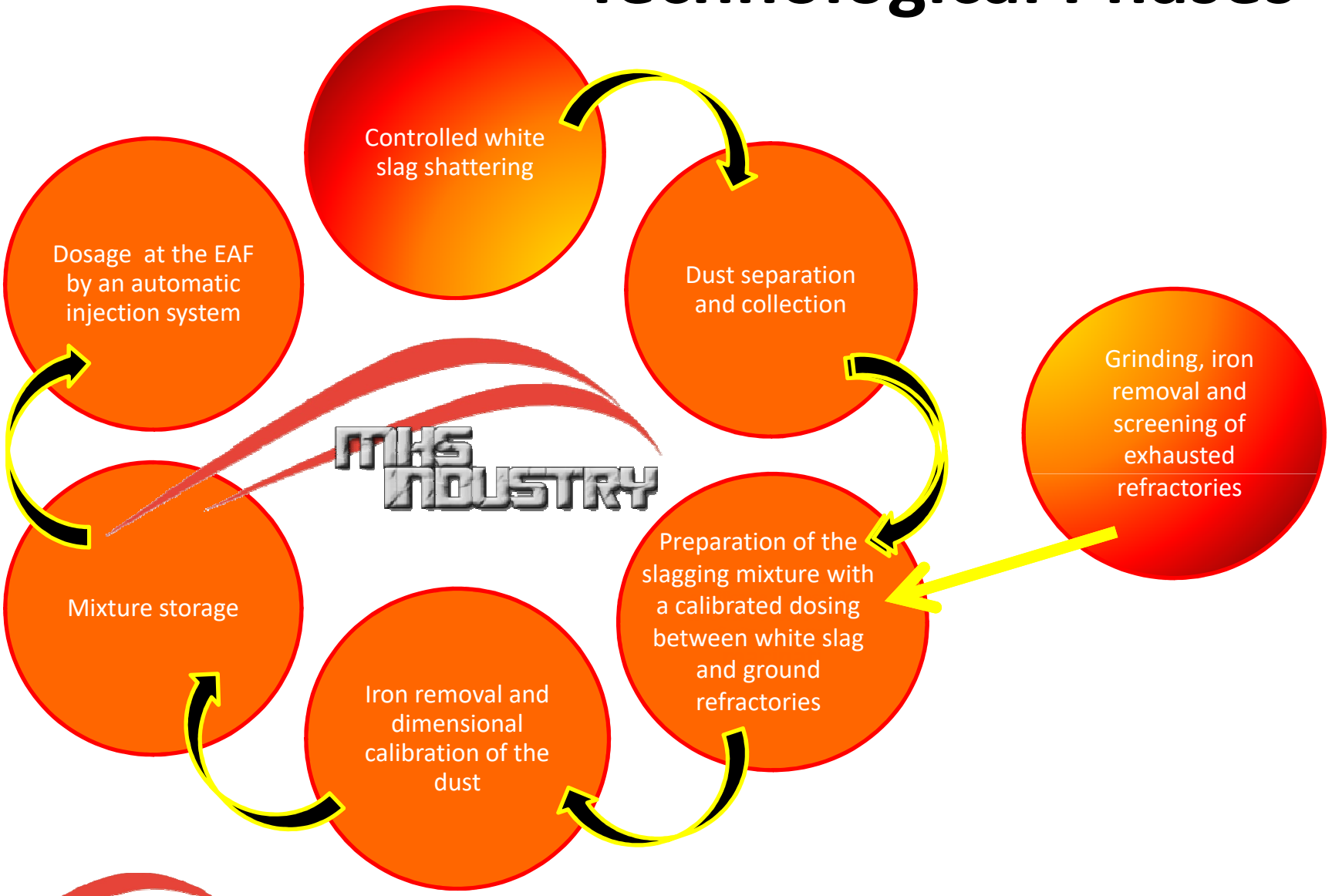
- **MgO fixes the FeO** making it less aggressive to the EAF refractories
- **MgO increases the viscosity** and reduce the surface tension of slag. These are the basic conditions to have foamy slag
- **MgO** creates suspended solid phases in the slag: they act as nucleation centres to the CO bubbles, that amplify the slag volume and reduce its conductibility

Foamy slag benefits:

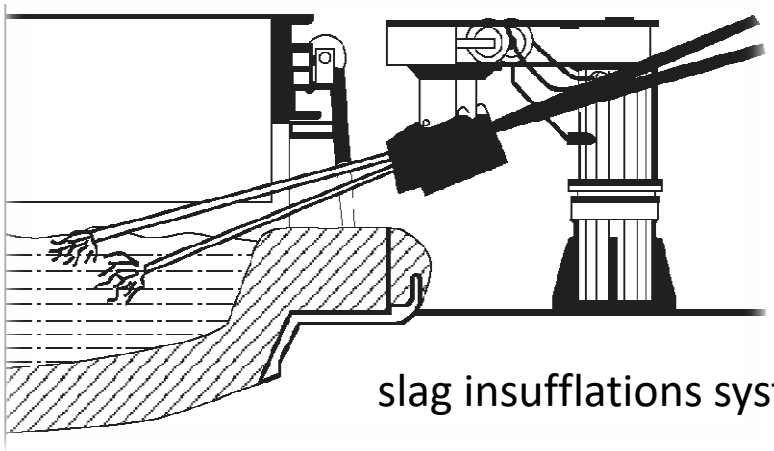
- EAF refractory savings
- Electrodes wear out reduction
- Energy consumption savings
- Electrical arc less noise
- Less nitrogen absorption in the steel bath



Technological Phases



Mixture Dosage into the Furnace



Additional Considerations:

The mixture dosage into the furnace, by the under slag insufflations system, allows to:

- Dissolve more rapidly the mixture injected into the slag due to the increased specific surface area of the material
- Improve the lime productivity
- Improve control of the chemical composition of the slag
- Reduce operating costs
- Improve environmental conditions
- Save maintenance costs of the transport system

MHS Industry technology : Benefits!

The MHS Industry technology solves the problem of the waste and of their landfill

IN WHICH WAY?

Same operability in EAF

- The final composition of the EAF production does not change
- The content in P or S does not increase
- Complete recovery of the metal inside the waste materials

Retrieve lime + basic oxides
inside White slag and Refractory
(CaO + MgO)

- Reduction of slagging consume
- No costs of slag and refractories disposal
- Automatic process
- Continuous and regular slagging dosage
- No “iceberg” formation into the EAF
- Total absence of dust It guarantees in the environment

Test: MHS Industry Research & Analysis

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LF SLAG and REFRACTORY RECYCLING QUESTIONNAIRE

Customer / Contact Person	/		
Address			
Tel. / E-mail	/	Date	

TECHNICAL INFORMATION

Plant Production				t/year
Daily Production				N° heats/day
EAF tapping weight				t liquid/heat
Operating days				days/year
Most common steel grade				% composition
EAF tapping temperature	LF tapping temperature			average - °C
EAF tap to tap	LF treatment time			average - min
Quantity lime in LF				Kg/heat
Other fluxes in LF – type and quantity				Kg/heat
Metal in the LF slag				% weight

Items	Quantity	u. m.	composition % FeO	CaO	MgO	SiO_2	Al_2O_3	TiO_2	MnO	Cr_2O_3	P_2O_5	S	C
PROCESS SLAGS													
EAF Slag		Kg/heat											
LF Slag		Kg/heat											
FLUXES in EAF													
LIME in EAF		Kg/heat											
DOLOLIME in EAF		Kg/heat											
OTHER fluxes in EAF		Kg/heat											
USED REFRACTORY													
EAF bricks		t/year											
EAF bottom refract.		t/year											
DELTA ROOF refract.		t/year											
LADLE bricks		t/year											
TUNDISH refract.		t/year											

ECONOMIC INFORMATION (optional)

Electricity cost						Euro/kWh
Lime cost	Dololime cost	Other fluxes cost				Euro/t
Iron scraps average cost						Euro/t
Cost for LF slag inertization and disposal plant						Euro/t
Cost for EAF slag disposal plant	Cost for refractory to disposal plant					Euro/t
Cost of money						%

NOTES:
N.B.: All supplied data will be kept strictly confidential and for our internal use only.

MHS Industry S.r.l
Società soggetta all'attività di ... Finanziamento di NIFIN srl

1 / 1

MHS Industry will study and deepen:

THE PROCESS ON THE SPECIFIC PLANT

Report

Study Layout

Returns and saving

MHS Industry transforms your SLAG…

…in MONEY!

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