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STEELWORKS – GLASSWORKS – QUARRIES AND RECYCLING

A photograph of a large industrial steel plant interior. In the center, a large, glowing orange-red molten metal ladle is being poured into a large, circular, refractory-lined container. The scene is dimly lit, with the primary light source being the intense heat of the molten metal. The background shows various industrial structures, including metal walkways, railings, and pipes, all in a dark, industrial setting.

White Slag and Refractory recycling

1 000 000 T/y steel plant

technical and economic aspects



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FOREWORD

Circular economy and green economy are the new visions of the economy which propose an innovative view, respectful of man and environment.

The circular economy is opposed to the traditional model based on the linear principle "production-consumption-disposal", whereby each product is destined to reach the "end of life" with the landfill as its final destination. The circular economy is a system designed for the correct recovery of materials in subsequent production cycles, reducing waste as much as possible.

The green economy is aimed at reducing environmental risks and ecological criticalities, an economy with low carbon dioxide emissions and efficient in using resources.

And it is precisely to the respect of these needs that the proposed project is focused.



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MIX RECOVERED FROM WASTE



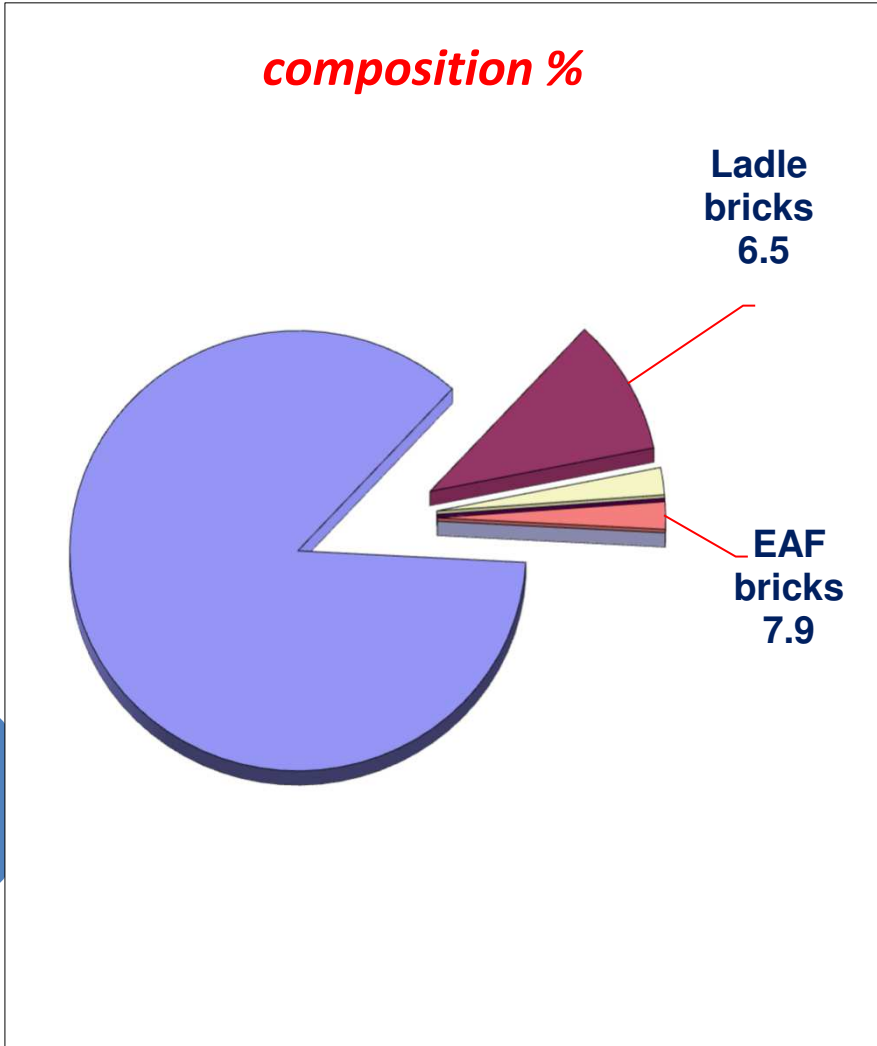
White slag
1.880 kg

+

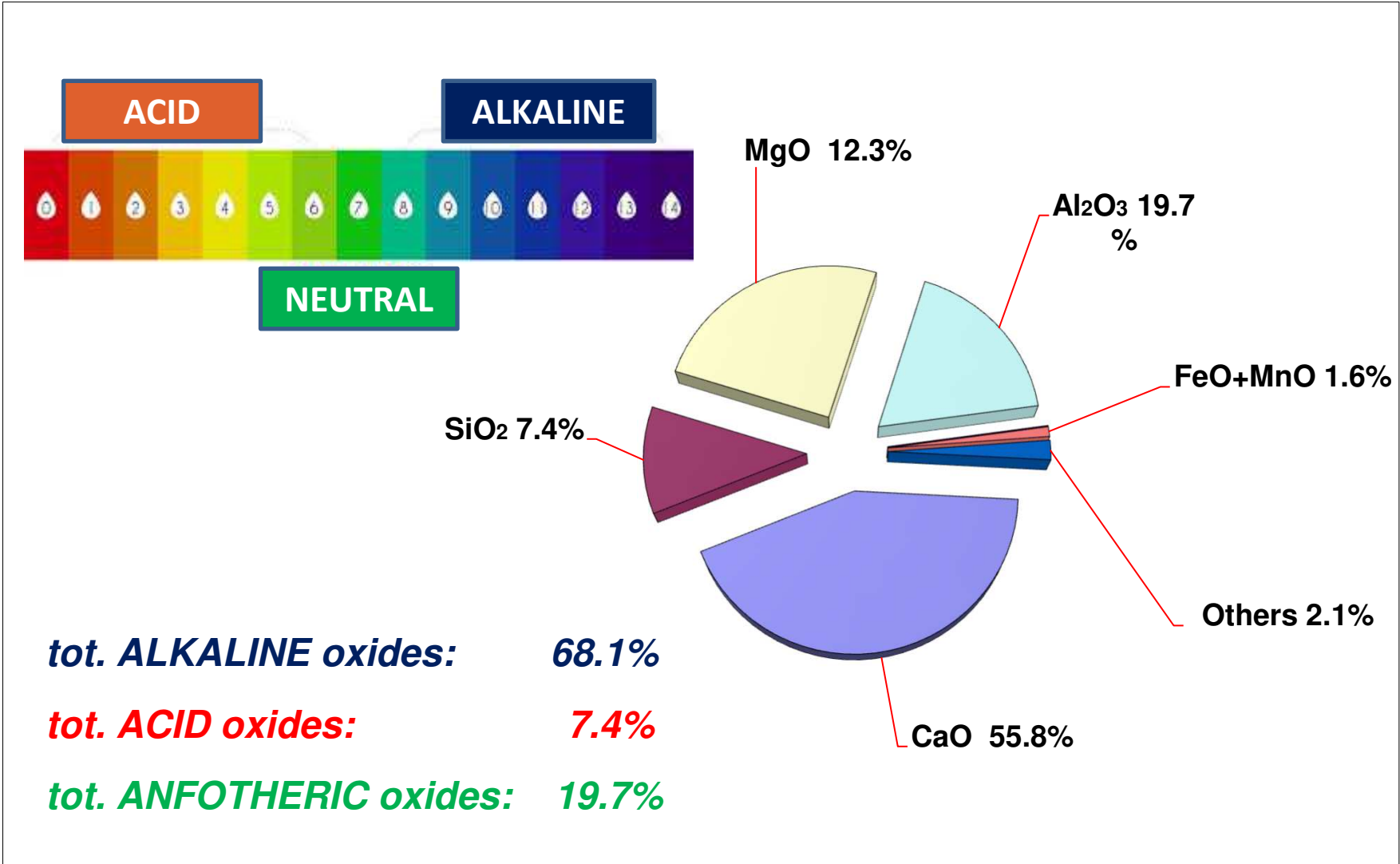


Refractory
317 kg

for each heat: 2.197 kg of optimized mix recovered



PHASES IN THE RECOVERED MIX





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NEW MIX FOR EAF SLAG PRODUCTION

“std” EAF conduct (with traditional raw materials)

Traditional raw material:

- 4.000 kg/heat of lime

conduct with recovered mix:

2.197 kg/heat of recycled mix

with:

947 kg di CaO active

+

216 kg di MgO active

for each heat:

Completed with **3.184 kg of lime**

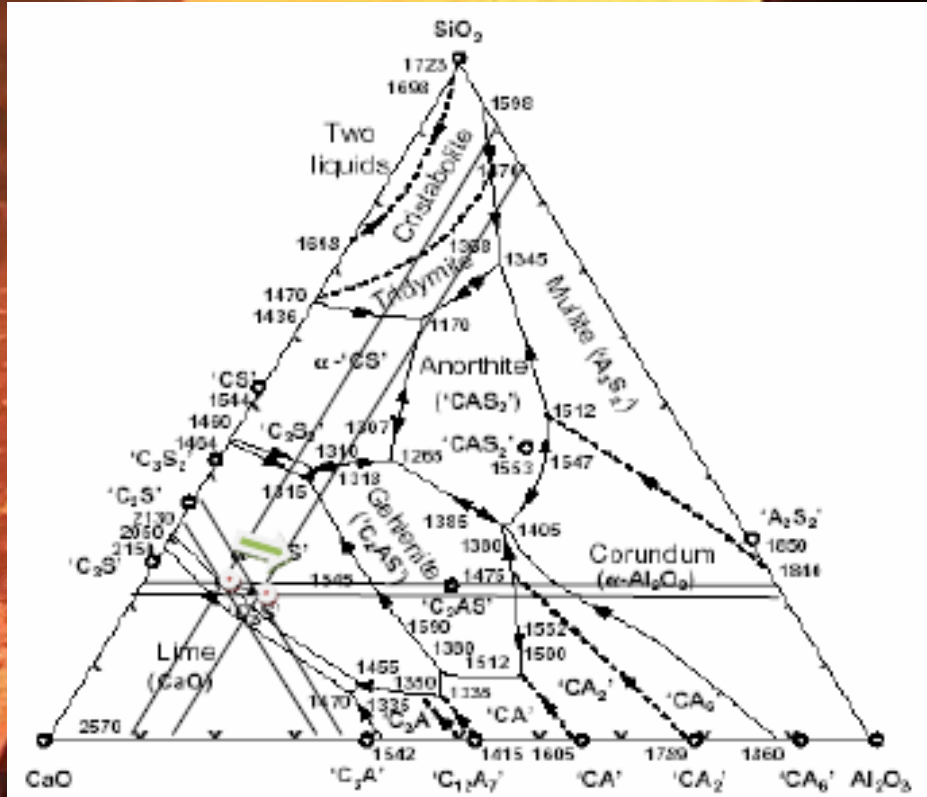
saving 816 kg of lime

integrating the slag with

216 kg of MgO useful to the process

CHEMICAL COMPOSITIONS EAF SLAGS

Oxides	Std flux	Mix recoverd
CaO	37.0%	36.3%
SiO ₂	12.6%	12.5%
MgO	4.0%	6.0%
Al ₂ O ₃	4.7%	7.8%
MnO	5.7%	5.1%
FeO	32.9%	29.4%
Cr ₂ O ₃	1.9%	1.7%
Other	1.2%	1.2%



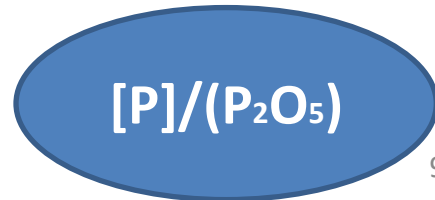


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EAF SLAGS COMPARISON

	<i>Std flux</i>	<i>Recovered mix</i>	Δ	$\Delta \%$
IB2	2.94	2.91	-0.03	-1
Optical basicity	0.82	0.81	-0.01	-1
Viscosity (poise)	0.662	0.781	0.119	18
dephosphorizing capacity	38.20	38.14	-0.06	-0.1
Sp factor	37.45	37.52	0.07	0.2



SOLID PHASES IN THE SLAGS

	STD MIX		RECOVERED MIX	
	% real	% required	% real	% required
MgO	4.0%	8.0%	6.0%	9.2%
MgO sol (Temp.)		8.1%		9.3%
Al2O3 correction factor		0.4%		0.8%
MgO necessary		7.6%		8.4%
MgO difference		-3.6%		-2.5%
C2S in the slags	0.0%		2.8%	
Total solid phases	4.0%		8.7%	
Difference	-3.6%		0.3%	
MgO Addition	383 kg		-	

ADVANTAGES OF THE EAF FOAMY LAG

*Presence of
MgO and C2S*

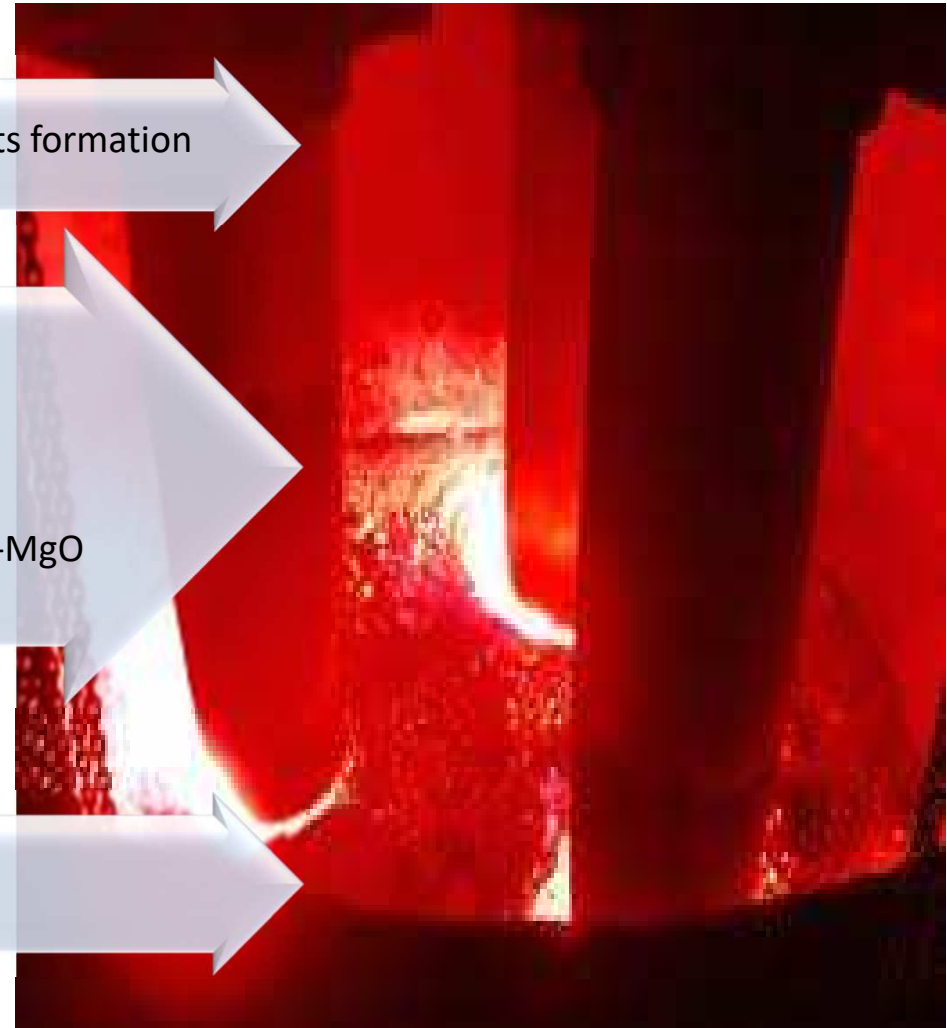
- solid phases necessary for its formation

*foamy slag
REDUCES:*

- electric arc noise
- electrodes consumption
- radiation losses
- power consumptions- kWh/t
- refractory consumption (FeO-MgO)
- nitrogen absorption in steel

*Important
advantages in terms
of energy savings*

- quantified around 7%





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HEATS COMPARISON

	Without recycling	With recycling	Δ %	Δ [Kg]
Lime	4.000	3.184	-20.4	-816
Dolomite	-	-	-	-
Recovered material	-	2.196	-	+2.196
Total additives	4.000	5.380	+34.5	+1.380
C recovered	-	17	-	+17
Black slag produced	10.500	11.833	+12.7	+1.333

	<i>std</i>	<i>mix recovered</i>	%
<i>surplus thermal energy</i>	-	+ 650 MCal(*)	
<i>energy with O2</i>	-	-	
<i>energy with burners O2/CH4</i>	-	-	
<i>energy with electricity</i>	-	+ 755 kWh	

(*) thermodynamic calculation does not consider the savings obtained with the foamy slag formation



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ECONOMIC BALANCE

	quantity for heat	specific consumption	specific cost (*)	Total
surplus electricity	755 kWh	7 kWh/t	€ 0,04	€ 30. 20
dololime saving	-	-	-	-
lime saving	-816 kg	-8 kg/t	€ 85,00	€ -69.36
carbon saving	-17 kg	-	€ 200,00	€ -3.40
steel recovery	120 kg	1 kg/t	€ 200,00	€ -24.00
refractory disposal in the landfills	-317 kg	-3 kg/t	€ 17,00	€ -5.39
white slag disposal in the landfills	-1.880 kg	-19 kg/t	€ 25,00	€ -47.00
TOTAL SAVINGS FOR EACH SINGLE HEAT				€ -118. 95

(*) the reference is the average Italian prices



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ANNUAL SAVINGS

	Quantity	um	N° trucks	
Heats	11.470	N°/year		
Lime saving	9.360	Ton/year	385	
Carbon saving	195	Ton/year	4	
White slag in the landfill	-22.950	Ton/year	920	
Refractories in the landfill	- 3.630	Ton/year	145	
N° total trucks			1.454	



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CONCLUSIONS

The attention to the environment has led to worldwide choices aimed at containing the negative effects induced by human activities, in fact:

" As part of the Kyoto protocol, the European Union has also undertaken to reduce its overall greenhouse gas emissions by 8% in the short term compared to 1990. This objective has been divided among the member states (...) and Italy is committed to reducing its overall emissions by 6.5% compared to 1990. "

For this reason, the recovery of white slag, in addition to entailing economic savings and technical advantages for each individual steel plant, leads to a significant reduction in CO2 emissions with consequent adaptation to the Kyoto protocol.