G-STEEL PUBLIC COMPANY LIMITED

Repositioning of EAF Burner to Increase Consistency of Injection and Consumption of Oxygen via Oxygen Lance

SUMMARY OF THE OPTION

G-STEEL Public Company Limited is a manufacturer of approximately 1.8 million Hot Rolled Coils (HRC) per year and located in the Rayong province in Thailand.

Energy used by the Electric Arc Furnace (EAF) consists of electricity, natural gas and chemical energy in the form of oxygen, which is the catalyst of an exothermic chemical reaction. An assessment of the EAF found that specific energy consumption (5.15 MBtu/ton liquid steel) was about 10% higher than the industrial benchmark (5.11 MBtu/ton liquid steel). The main reason was that chemical energy (O_2) was only 3.7% of the total energy required to produce one ton of liquid steel, which is 18% lower than the industrial benchmark.

To reduce the EAF's electricity consumption, the company's Team recommended to reposition one of the burner, to ensure that the burners cover the entire EAF. This increased the consistency and the amount of oxygen injected into the EAF via the oxygen lance.

This modification required a one-off investment of US$ 10,000 and generated net annual savings of US$ 3,840,000. The overall payback period of this option would therefore less than 1 day. The implementation is expected to reduce the electricity consumption by 69.5 GWh/year, which is equivalent to greenhouse gas emission reductions of 42,943 ton CO_2 per year.

KEY WORDS

Iron and Steel, Thailand, Furnaces and Refractories, Floor Burner

OBSERVATIONS

Electricity, natural gas, and oxygen (O_2, used as a chemical energy source) are used to generate heat for producing liquid steel in the Electric Arc Furnace (EAF). Costs for electricity consumed by the EAF dominate the company's production cost. More than ten parameters affect the electricity consumption of the EAF, although the impact of some parameters cannot be assessed.

Oxygen is injected into the EAF via a lance and reacts with liquid steel, comprising of iron (Fe), carbon (C), and small amounts of manganese (Mn) and silicon (Si). The oxidation reaction between oxygen and elements like Al (aluminum), Si, Mn and Fe is exothermic and therefore using oxygen decreases electricity consumption (see Figure 1) and natural gas consumption. The injection of oxygen also causes slag foaming (i.e. with additional carbon) and decarburization of the liquid steel in the case of hot metal charging or DRI (charging with higher carbon content).

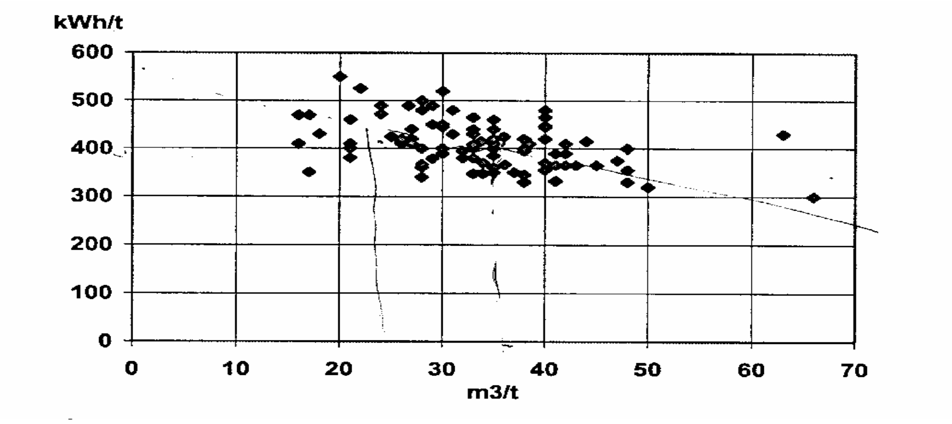


Figure 1: Variation in effectiveness of oxygen in reducing the electrical energy consumption of the electric arc furnace

An assessment of the EAF energy consumption found that (see Table 1):

- Energy consumption by the EAF at G-Steel (5.15 MBtu/ton liquid steel) was about 10% higher than the industrial benchmark (5.11 MBtu/ton liquid steel)
- Chemical energy (O_2) used by the EAF was only 3.7 % (0.19 MBtu/ton) of the total energy (5.15 MBtu/ton) required to produce one ton of liquid steel. This is 18% lower than the industrial benchmark (0.23 MBtu/ton).
- An increase in 5% of chemical energy (O_2) consumption could reduce the electricity and natural gas consumptions by 12% and 28%, respectively.

Table 1: Energy used by EAF before Improvement (per ton liquid steel)

	Electricity		Carbon		Oxygen		Natural Gas		Total
	KWh/ton	MBtu/ton	Kg/ton	MBtu/ton	Nm3/ton	MBtu/ton	Nm3/ton	MBtu/ton	
G-Steel	430	4.52	7	0.19	31	0.19	7	0.25	5.15
Bench mark	392	4.21	16	0.44	38	0.23	9	0.32	5.11

OPTIONS

The company's Team recommended to reposition the burner as illustrated in Figure 2 in order to increase the oxygen injection. Burner 1, which was located at the door (i.e. door burner) was shifted towards burner 2 (i.e. wall burner) as shown in Figure 2. This way all burners are positioned at locations to cover the entire cavity of the EAF. The repositioning of the burner increased the consistency and the amount of oxygen injected into the EAF via the oxygen lance.

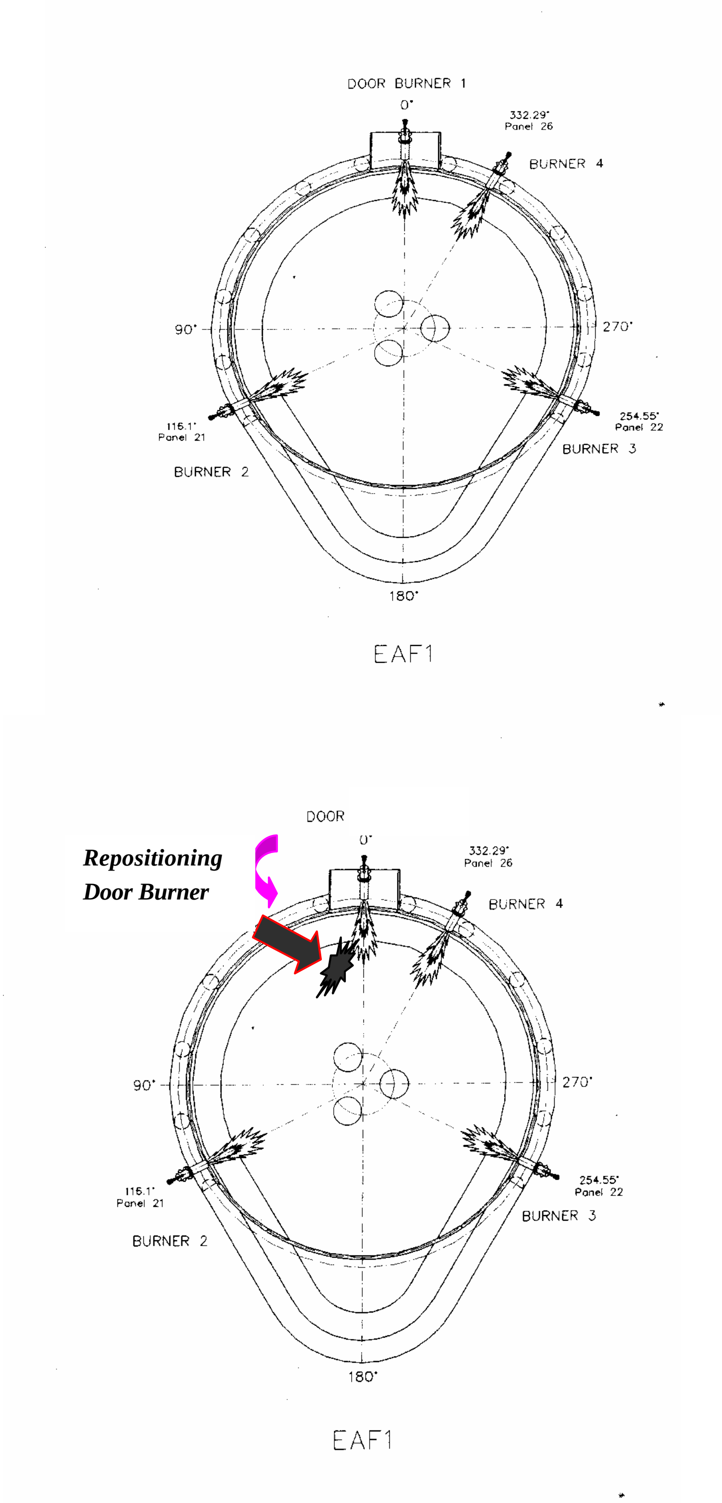


Figure 2: Repositioning of Door Burner

The repositioning of door burner increased the oxygen consumption by more than 6%. As a result, the electricity consumption of the EAF was reduced to 378.55 kWh/ton liquid steel, and the total energy was reduced to 4.55 MBtu/ton liquid steel, which is more than 3% lower than the benchmark figure, as shown in Table 2.

Table 2: Energy used by EAF after Improvement (per ton liquid steel)

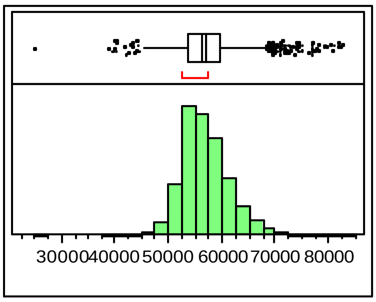
	Electricity		Carbon		Oxygen		Natural Gas		Total
	Kwh/ton	MBtu/ton	Kg/ton	MBtu/ton	Nm3/ton	MBtu/ton	Nm3/ton	MBtu/ton	
G-Steel	378.55	4.06	4.09	0.11	32.88	0.20	4.91	0.18	4.55
Bench mark	392	4.21	16	0.44	38	0.23	9	0.32	5.11

Figure 3 shows the energy measurements, which were obtained from the company's monitoring system and that was improved through the participation in the GERIAP project. The financial and environmental results are summarized below.

Month Group=1

Distributions

active_energy



Quantiles		
100.0%	maximum	82500
99.5%		75535
97.5%		66900
90.0%		62500
75.0%	quartile	59500
50.0%	median	56200
25.0%	quartile	53700
10.0%		52000
2.5%		49700
0.5%		45800
0.0%	minimum	25100

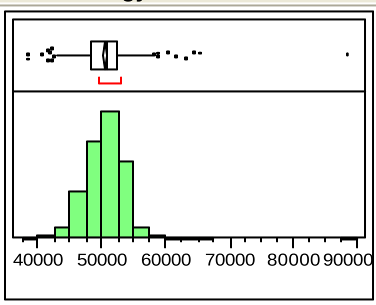
Moments	
Mean	56881.864
Std Dev	4605.5071
Std Err Mean	63.071387
upper 95% Mean	57005.51
lower 95% Mean	56758.218
N	5332

Before Repositioning Door Burner

Month Group=2

Distributions

active_energy



Quantiles		
100.0%	maximum	88600
99.5%		64560
97.5%		56000
90.0%		53800
75.0%	quartile	52400
50.0%	median	50700
25.0%	quartile	48500
10.0%		46400
2.5%		44400
0.5%		41700
0.0%	minimum	38300

Moments	
Mean	50447.894
Std Dev	3373.453
Std Err Mean	117.02379
upper 95% Mean	50677.591
lower 95% Mean	50218.197
N	831

After Repositioning Door Burner

Figure 3: Active energy distribution per heat

Financial benefits

- Investment: US$ 10,000
- Annual operating costs: not given
- Annual cost savings: US$ 3,839,168 (69,487,200 x 0.05525) [2]
- Payback period: < 1 day {(10,000/3,839,168) x 12 months x 30 days}

Environmental benefits

- Electricity consumption reduction: 69.5 GWh/year, calculated as follows:
  - Electricity consumption before implementation: 56,881 kWh/heat
  - Electricity consumption after implementation: 50,447 kWh/heat
  - Electricity consumption per heat (= melting operation): 6,434 kWh/heat
  - Numbers of heats per month: 900
  - Electricity reduction per heat: 56,881-50,447 = 6,434
  - Electricity reduction per year: 6,434 kWh x 900 heats x 12 months = 69.487 GWh
- Annual CO_2 emission reduction: 42,943 ton CO_2 (69.5 GWh x 1000 MW/GW X 0.618 tons CO_2/MWh in Thailand)

FOR MORE INFORMATION

GERIAP National Focal Point for Thailand
Ms. Peesamai Jenvanitpanjakul
Director of Environmental, Ecological and Energy Department
Thailand Institute of Scientific and Technological Research
196 Phahonyothin Rd., Chatuchak, Bangkok 10900, Thailand
Tel: + 66 2 5791121-30 ext. 2102
Fax: + 66 2 5796517
E-mail: peesamai@tistr.or.th
Website: www.tistr.or.th

GERIAP Company in Thailand
Mr. Thongporn Kanokpranatut
Senior Department Manager, Government Liaison
G-Steel Public Company Limited
SSP Tower 3, 18th floor,
88 Silom Road, Suriyawong,
Bangrak, Bangkok 10500, Thailand.
Tel: + 66 2 6342222 ext. 1131
Fax: + 66 2 6343839
Mobile: 0-1908-4033
E-mail: thongpornk@g-steel.com
Website: www.g-steel.com

Disclaimer:
This case study was prepared as part of the project "Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific" (GERIAP). While reasonable efforts have been made to ensure that the contents of this publication are factually correct, UNEP does not accept responsibility for the accuracy or completeness of the contents, and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication. © UNEP, 2006.