MORE
HIGHLIGHTS
NEWS FROM THE STEELMAKING WORLD

TAP TO TAP
min -2,4

POWER-ON
min -1

PRODUCTIVITY
t/h +8

BOOSTING
PRODUCTIVITY

and

ENERGY SAVING

at

KROMAN CELIK'S
EAF

(TURKEY)

ELECTRIC ENERGY
kWh/t -25
kWh/st -22,7

LIME + DOLOLIME
Kg/t -0,7
lb/st -1,4

OXYGEN
Nm3/t +1,5
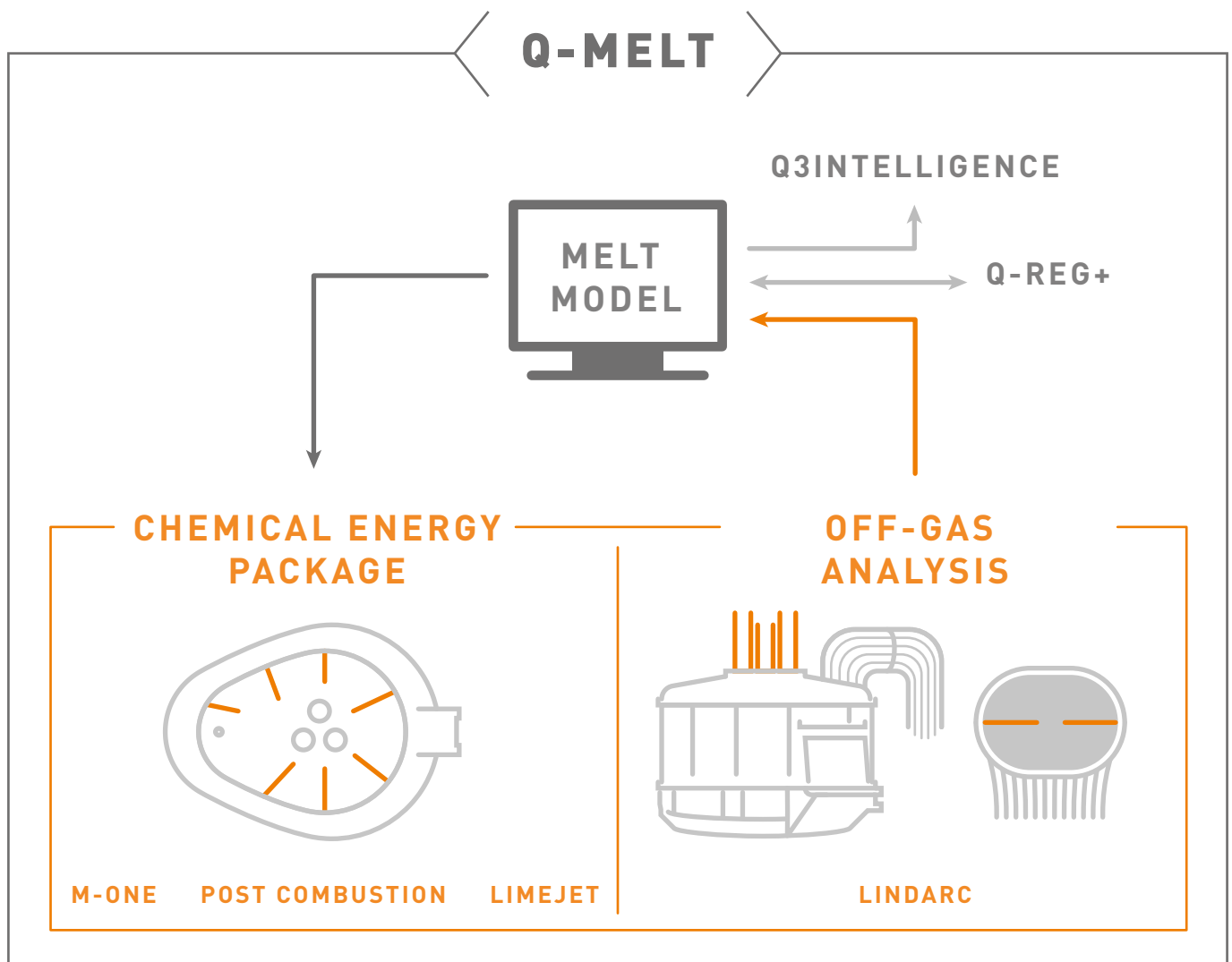scf/st +50

COAL
Kg/t -3,8
lb/st -7,5
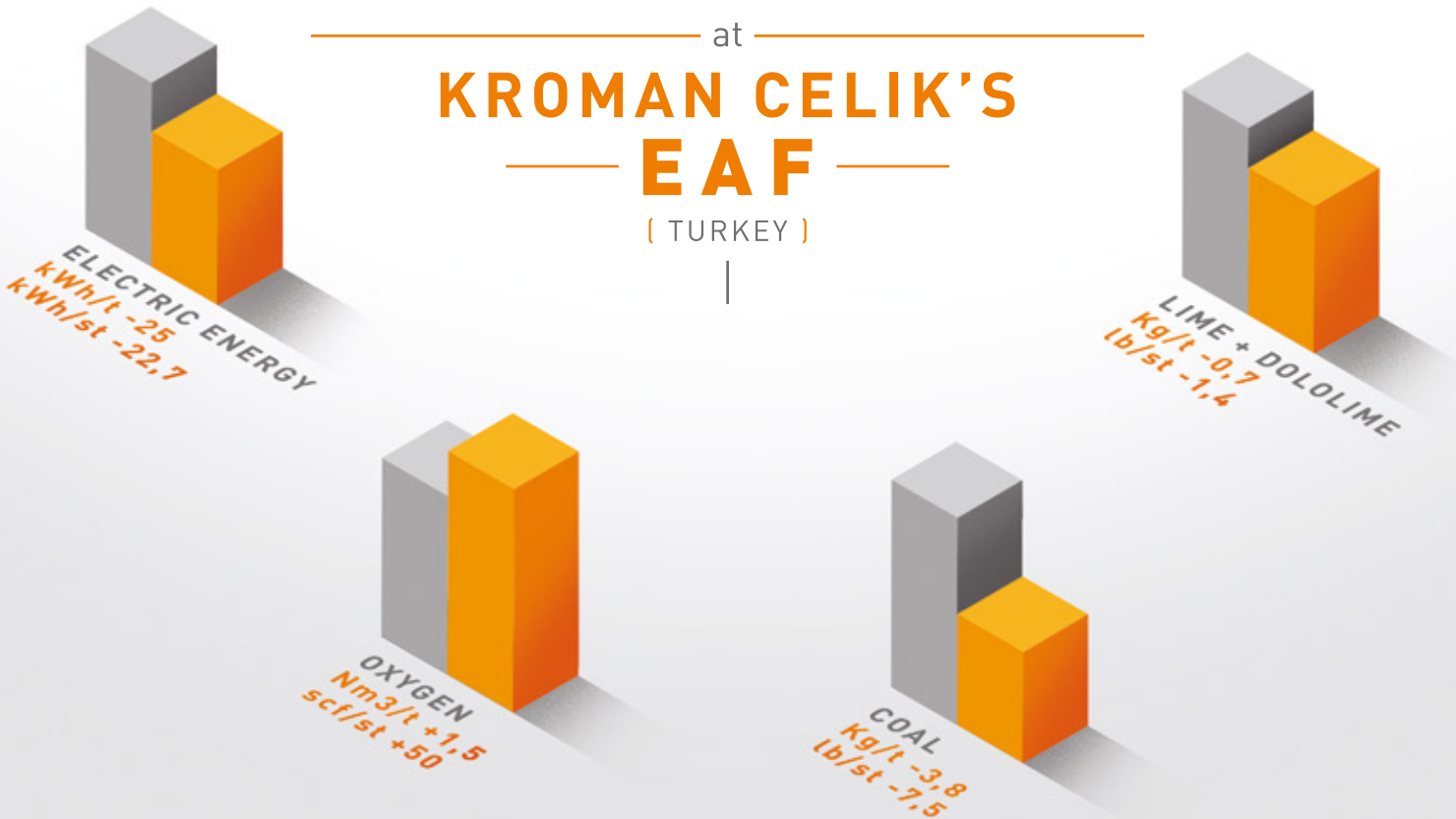
BOOSTING EAF PRODUCTIVITY AND ENERGY SAVINGS BY ENHANCED CHEMICAL PACKAGE AND ADAPTIVE PROCESS CONTROL AT KROMAN CELIK

KROMAN CELIK located in Gebze Osmangazi region (Turkey) is a producer of reinforcing bars and wire rods. Its total annual production exceeds 1.3 million tons. Since 2010, their EAF has been operating with a complete MORE sidewall injection system and DANIELI Q-REG electrode regulation with excellent results.

In July 2016, KROMAN CELIK chose to upgrade their 150 ton (165 ton) EAF with the state of the art DANIELI Q-MELT process control and with the latest MORE side wall injection technologies with the aim to:

• improve the EAF productivity
• reduce operative costs

The Q-MELT is DANIELI's latest development. Its purpose is to reach complete automatic control in each stage of the EAF melting process. It can adjust the electric power input, optimize the combustion process within the furnace shell, control slag and steel metallurgy and every other operation needed during the EAF melting cycle.

Q-MELT

MELT MODEL

Q3INTELLIGENCE

Q-REG+

CHEMICAL ENERGY PACKAGE

OFF-GAS ANALYSIS

M-ONE   POST COMBUSTION   LIMEJET

LINDARC

MELT MODEL

The MELT MODEL is the core of Q-MELT automation system. Process data is collected, clustered and filtered, extracting the average values and deviation trends of key process variables. These average and standard trends are used to create a kind of "furnace process fingerprint" which represents the expected track of "normal" process behavior. Comparing the real-time data with the expected trend, the system performs a dynamic process control, adjusting specific process parameters.

MELT MODEL TRENDS PAGE

THE MAIN FEATURES ARE:

• It implements a statistical approach to identify process deviations in real-time

• It dynamically adjusts the oxygen injection to hit the final carbon % and steel temperature without over-oxidizing the heat

• It integrates several process models to track the %C, temperature and O_2 content in the steel bath to approach tapping with the right chemistry

Q3INTELLIGENCE

The Q3INTELLIGENCE is a powerful web-based software tool for multi-dimensional analysis of the melting process and EAF performances. Thanks to its advanced data models and a user friendly graphic interface, advanced data analysis across different production processes can be done.

Q3INTELLIGENCE PROCESS DATA ANALYSIS

THE MAIN FEATURES ARE:

• It allows continuous EAF data collection from all production areas directly from Level 2 database

• It performs synchronization, normalization and qualitative analysis of all collected process data

• It provides personalized reports and analysis tools for the main process parameters such as production, consumptions, delays, costs, quality and process variables

Q-REG+

The Q-REG+ is DANIELI's most recent version of its dynamic electrodes regulation which now integrates new process controls such as Foaming Slag Control, Dynamic Arc Control and an innovative real-time irradiance supervisor (Q-RAY) which controls and balances the thermal loads on the water cooled panels.


Q-REG+ OWERVIEW

THE MAIN FEATURES ARE:

• It adjusts the electrical set-points dynamically to keep the EAF running in a stable manner

• It keeps the highest active power until the end of the heat without creating severe stress to the panels

• It integrates a dynamic foamy slag control that monitors slag conditions and adjusts electric arc and carbon/lime injection set-points

CHEMICAL ENERGY PACKAGE
LAYOUT

OXYGEN JET #3

M-ONE #3 **P.COMB. #2**

LIMEJET #2

M-ONE #4

M-ONE #1

LIMEJET #1 **M-ONE #2** **P.COMB. #1**
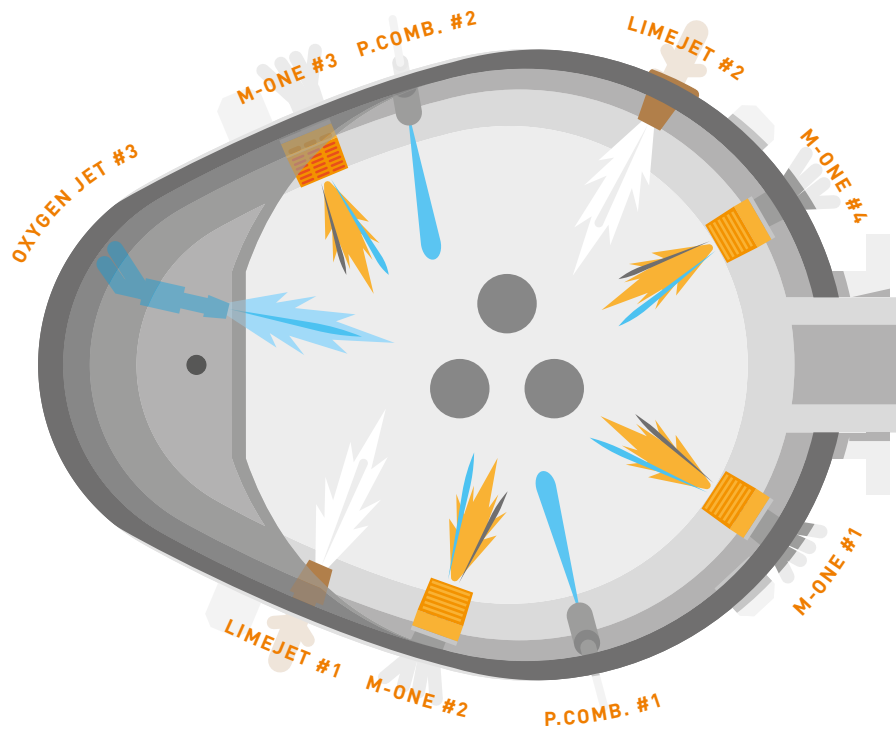
M-ONE

M-ONE is the most advanced side-wall injector which integrates three functions in a single unit.

THE MAIN FEATURES ARE:

• Mixed swirled flame burner
• High efficiency supersonic coherent oxygen lancing
• High momentum coal injection

POST COMBUSTOR

The post combustor is a dedicated tool to manage the post combustion within the EAF shell by injecting low speed oxygen during every melting phase, following the real-time furnace atmosphere oxidation level, optimizing electrical energy consumption during scrap melting.

THE MAIN FEATURES ARE:

• Maximization of the post-combustion inside the furnace

• Dynamic control of the oxygen flow rate by the CO_2 and CO readings from the off-gas analysis system

LIMEJET

The LIMEJET is a side-wall injector specifically designed to inject grain sized slag formers with a speed up to 80 m/s (260 ft/s) to penetrate the thick slag layer from a distance of up to 1,5 m (5 ft).

THE MAIN FEATURES ARE:

• Mixed swirled flame burner
• High momentum lime injection
• Refractory hot spots protection

LINDARC
REAL TIME OFF-GAS ANALYSIS

LINDARC

The LINDARC off-gas analysis technology, with lasers installed on the fix duct, just after the secondary gap, uses the technique of "Tunable Diode Laser Absorption Spectroscopy" (TDLAS) to obtain exact data of various gas species in the EAF off-gas system in real time.

This data is used to further optimize the EAF melting process, controlling fuel and oxygen post combustion.
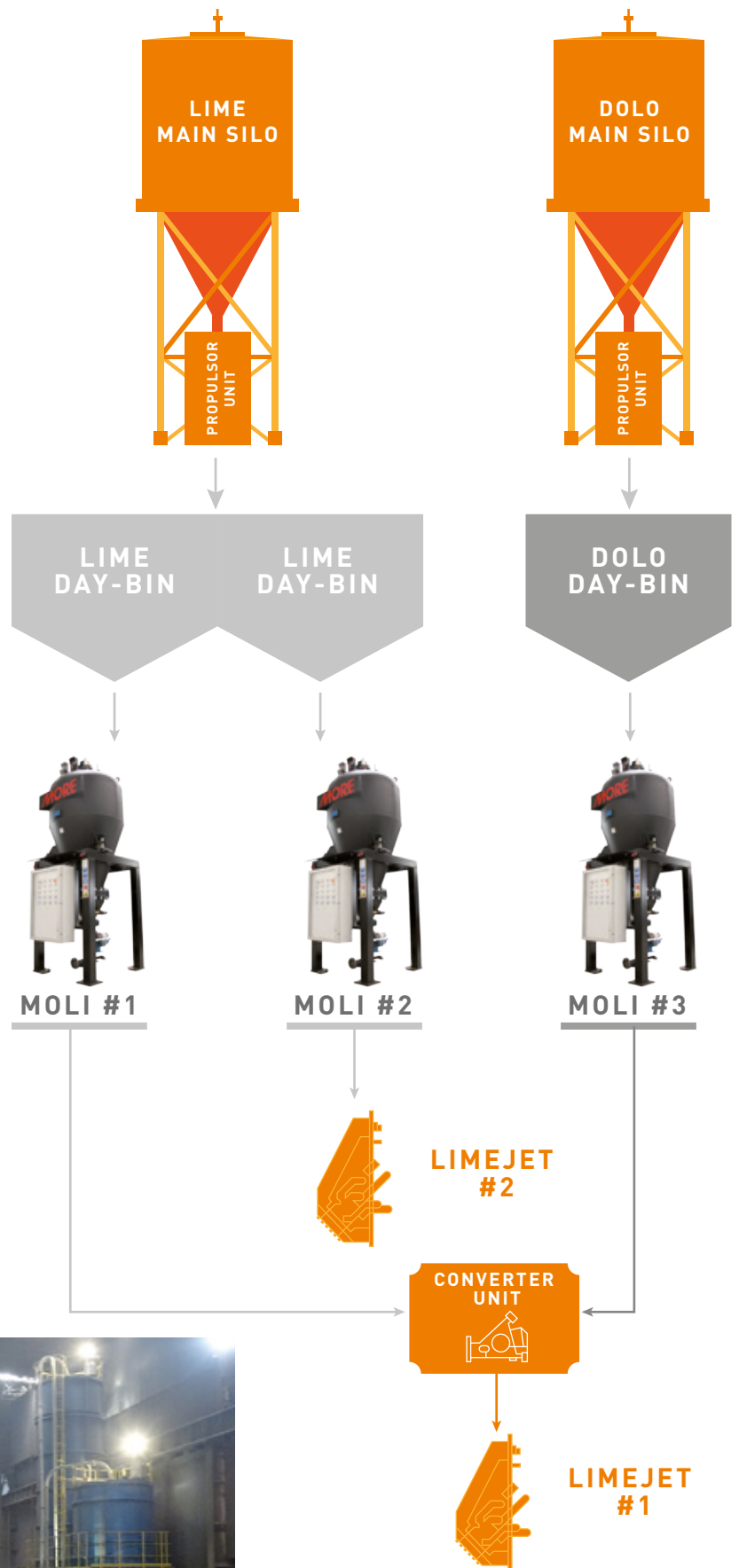

THE MAIN FEATURES ARE:
- CO, O_2, CO_2, H_2O and off-gas temperature measurement
- Fast response time (less than 2 seconds)
- Dynamic Water Leak Detection

LIME AND DOLOLIME PNEUMATIC INJECTION

Pneumatic fluxes injection has several advantages compare to conventional loading practices.

Thanks to the Q-MELT automation, the dynamic regulation of the correct feeding rate of lime and dololime enables a complete control of slag conditions throughout the process. Proper slag management improves slag foamability and dramatically changes the heat input efficiency and the refractory lifetime.

The design of the lime and dololime injection system at KROMAN CELIK's EAF included two LIMEJET injectors installed on the furnace hot spots. One injector is connected with a MOLI dispenser for lime injection only, the other one is connected with two MOLI dispensers in order to inject either lime or dololime alternatively, through a remote controlled switching valve.

LIME MAIN SILO

DOLO MAIN SILO

PROPULSOR UNIT

PROPULSOR UNIT

LIME DAY-BIN

LIME DAY-BIN

DOLO DAY-BIN

MOLI #1

MOLI #2

MOLI #3

LIMEJET #2

CONVERTER UNIT

LIMEJET #1

LIME AND DOLOLIME SILOS AND DAY-BINS

EAF TECHNICAL DATA

Start up (year)	**2010**		Hot heel weight	**25 t (27 st)**
Power supply type	**AC**		Productivity	**175 t/h**
EAF Supplier	**DANIELI**		Annual Production	**1.300.000 tpy (1,430,000 stpy)**
EAF Type	**EBT**		Inner panel diameter	**7200 mm (23.6 ft)**
Tapped steel weight	**150 t (165 st)**		Transformer nominal rating	**140 MVA**

M-ONE	**4 x 2100 Nm3/h (1305 scfm)** Supersonic/coherent oxygen injection mode
	4 x 4 MW Mixed Swirl Flame burner mode
	4 x 40 Kg/min (90 lb/min) Carbon injection mode
	4 x FLASH-STOP Backfire preventing system
OXYGENJET	**1 x 2100 Nm3h (1305 scfm)** Supersonic/coherent oxygen injection mode
	1x 4 MW Mixed Swirl Flame burner mode
LIMEJET	**2 x 200 Kg/min (440 lb/min)** Lime injection mode
	2 x 4 MW Mixed Swirl Flame burner mode
POST COMBUSTOR	**2 x 1000 Nm3/h (620scfm)** Low speed oxygen

MOCA 25	**3 x 2500 l (660 gal)** Carbon dispenser
MOLI 30	**5 x 3000 l (792 gal)** Lime dispenser
LINDARC	Real time off-gas analysis system
Q-REG+	Advanced Electrode regulation system with foaming slag management
Q-MELT	Dynamic melt model control of electrical and chemical profiles
OXYGEN VALVE STAND	Valve stand to measure, regulate and control oxygen requirements
NATURAL GAS VALVE STANDS	Valve stand to measure, regulate and control natural gas requirements
L1 AND L2 AUTOMATION	PLC and HMI automation
Q3INTELLIGENCE	Web-based software for multi dimensional-analysis

RESULTS

Results achieved after Q-MELT installation

The EAF retrofit was completed in 9 days only and the first heat was performed at the beginning of March 2017. The learning curve has been very fast with a rapid ramp up of the productivity. The new Q-MELT adaptive process control have significantly improved EAF operations, achieving the guarantee values just after few weeks of operation.

The results achieved so far are only the first step of the continuous improvement development plan agreed between KROMAN CELIK, MORE and DANIELI team.

PRODUCTIVITY	t/h	**+8**
POWER-ON	min	**-1**
TAP-TO-TAP	min	**-2.4**
ELECTRIC ENERGY	kWh/t	**-25**
	kWh/st	**-22.7**
OXYGEN	Nm3/t	**+1,5**
	scf/st	**+50**
NATURAL GAS	Nm3/t	**+0,3**
	scf/st	**+10**
COAL	kg/t	**-3,8**
	lb/st	**-7.5**
LIME+DOLOMITE	kg/t	**-0,7**
	lb/st	**-1.4**

MORE