

Revamping LOW NO_x burners the tangentially fired boilers N° 7 & 8 of the 500 MW Dunaújvaros Thermal Power Station (Hungary)

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1 – BACKGROUND

EMA Power, an American-Hungarian company, has been supplying utilities (steam, electricity, demineralised water, hot water and compressed air) since 1997 to the DUNAFERR factory in Dunaújvaros, first site of the steel industry in Hungary producing 1 300 000 t/an. EMA Power is equally responsible for supplying heat to the urban heating network and steam to the Dunaújvaros Paper Factory.

Today, as Hungary enters the European Community, and the Hungarian Steel Industry is privatisated, improving the environmental conditions is a must for the lasting development of EMA Power and DUNAFERR.

This is why, EMA Power, in partnership with VEIKI RT Engineering (State owned and formerly called 'The Hungarian Institute for Electrotechniques and Electricity Generators') have decided to improve their environmental performance as well as the safety level of the five main boilers of a 500 MW total heat release. The fixed goal is to halve NO_x emissions in order to comply with European standards.



Fig.1 : Dunaújvaros Thermal Power Station

The main steam boiler characteristics are :

Boiler N°	Type of Firing	Heat Release	N° of Burners	Revamping by PILLARD
7	Tangentiel	86	8	Complete
8	Tangentiel	86	8	Complete
9	Frontal	196	9	Under commissioning
5	Tangentiel	66	8	Under fabricaton
6	Tangentiel	66	8	Under fabrication

- Fuels :

- Special Fuels of the Steel Industry
 - Coke oven gas COG
 - Average LCV 17 MJ/Nm³ or 4060 kcal/Nm³
 - Typical Composition (% vol) H₂ : 59 % CH₄ : 25 % CO : 9% NH₃ < 0.5 g/Nm³
 - Blast gas furnace BFG
 - Average LCV 3 MJ/Nm³ or 720 kcal/Nm³
 - Typical Composition (% vol) H₂ : 2.0% CO : 21.54% CO₂ : 18.9 %
- Traditional Fuels Heavy Fuel Oil n°6 (nitrogen content < 0,3%), and natural gas

2 – THE TECHNICAL SOLUTION SELECTED FOR THE BOILERS n° 7 & 8

2.1 – Choice of new burners

The solution chosen by PILLARD and VEIKI consisted in specialising the type of (LOW NO_x) burner by type of fuel.

- For the rich fuels (coke oven gas COG, natural gas, heavy Fuel n°6), PILLARD “GRC LONOXFLAM” burners are used at the level n°1 of the boiler. Such burners are using several techniques of our staging separation of flames leading to a huge reduction of NO_x (see PILLARD patents N°s 95.402538.3 (1995), 98.430018.6 (1998), 00.430024.0 (2000)).



Fig.2 : PILLARD “GRC LONOXFLAM” burner
seen from the furnace



Fig.3 : PILLARD “GRC LONOXFLAM” burner
seen from the rear

- For the lean fuel (blast furnace gas BFG), PILLARD “KFT” LOW NO_x burners are used at the level n°2 of the boiler with or without support by a rich fuel.



Fig.4 : PILLARD “KFT” LOW NO_x burners
external view



Fig.5 : Flames of the PILLARD “KFT” burners

Such disposition of the burners not only allows to optimise the NO_x reduction, but also to maximise the residence time for the heavy fuel oil (n°6) flames.

2.2 - Complementary Techniques

In addition to the use of the “Best Available Techniques” for the LOW NO_x burners, two additional complementary techniques have been applied :

1/ Combustion Staging with “REBURNING” and “OFA (OVERFIRING AIR)” :

- Level 1 (+ 3,05 m) : rich fuel combustion slightly under stoichiometric to avoid NO formation
- Level 2 (+ 6,05 m) : lean fuel combustion creating a “reburning” zone
- Level 3 (+ 7,05 m) : injection of “OFA (overfiring air)”.

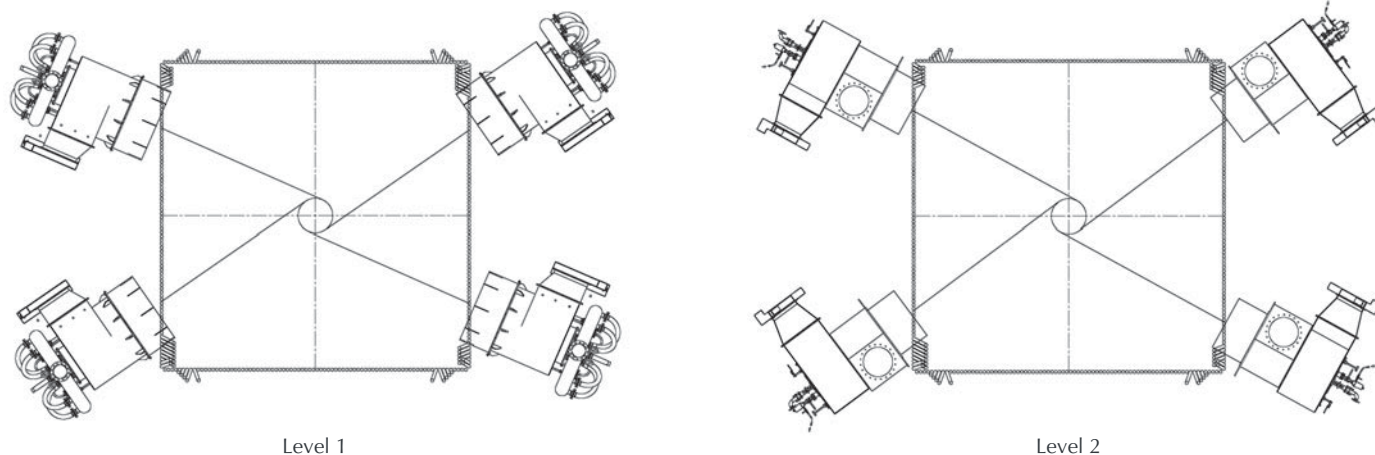


Fig.6 : Disposition of the burners on the boilers

2/ Flue gas recirculates (FGR) in the combustion air :

The FGR% is adjustable from 0 to 20%, the current retained rates bear 6% when firing heavy oil n°6, 18% when firing natural gas, 12% when firing coal oven gas.

3 - DESIGN BY PILLARD OF THE LOW NO_x BURNERS AND OF THE BMS (Burner Management System)

3.1 - PILLARD “GRC LONOXFLAM” burners fitting the boiler n°8

The total heat release of the 4 burners is 85MW (21.5 per unit) and provides for 90% of the normal boiler load. They are “tri-fuel” type, as able to fire :

Fuels	Max Heat Release	LCV	Turndown ratio per burner
Coke oven gas	11 MW	16,7 MJ/Nm ³	1 to 3
Natural gas	17 MW	34 MJ/Nm ³	1 to 6
Heavy fuel oil n°6	17 MW	41 MJ/kg	1 to 5

3.2 - PILLARD “KFT” burners

The total heat release of the 4 “KFT” burners is 44 MW (11 per unit). They are installed above the “GRC LONOXFLAM”.

Fuels	Max Heat Release	LCV	Turndown ratio per burner
Blast Furnace Gas BFG	11 MW	≥ 3 MJ/Nm ³	1 to 3
Blast Furnace Gas BFG (+) sustain of natural gas (0,6 MW)	11 MW	≥ 3 MJ/Nm ³	1 to 5

3.3 - PILLARD BMS (Burner Management System)

We have to point out the extreme flexibility of use which has been specified by the user :

- choice of any fuel per burner,
- simultaneous combustion of several fuels,
- modulating each fuel independently per burner,
- taking into account the real LCV value of the COG and BFG.

We had to design a BMS allowing for such flexibility but ensuring a fail-safe operation and maximum availability of the boiler. It has been designed on the basis of a SIEMENS S7400 fail-safe PLC interfaced with the Digital Control System of the user.

4 – EMISSION LEVEL MEASUREMENTS OF THE BOILER N°8 (O₂, NO_x, CO)

When operating with only one fuel

Fuel		Coke Oven Gas COG		Heavy Fuel n°6		Natural Gas		Blast Furnace Gas BFG	
		Measured	Guaranteed	Measured	Guaranteed	Measured	Guaranteed	Measured	Guaranteed
Boiler load	%	50		75		75		50	
Heat Release	MW	41		64		63		41	
Burner load	%	92.7		96		94		94	
Comb. Air T°	°C	150 - 170		150 - 170		190 - 200		190 - 200	
O ₂	%	1.2		2.7		1.5		3.8	
NO _x (@ 3% O ₂)	mg/Nm ³	136	150	255	300	83	300	24	50
CO (@ 3% O ₂)	mg/Nm ³	0	100	0	100	0	100	0	100

When operating with 2 or 3 fuels simultaneously

Operational Case		Case 1	Case 2	Case 3	Case 4	Case 5
		Measured (*)				
Boiler load	%	76	99.6	74.2	112	65.9
Natural heat release	MW	0	0	37.8	9,4	0
COG heat release	MW	23	0	25.3	0	40.9
Heavy fuel n°6 heat release	MW	0	43.9	0	54.8	15.1
BFG Heat release	MW	41.65	40.8	0	31	0
Comb. Air T°	°C	212	235	168	232	163
O ₂	%	1.3	1.8	1.8	1.8	1.6
NO _x (@ 3% O ₂)	mg/Nm ³	82	127	165	246	201
CO (@ 3% O ₂)	mg/Nm ³	0	0	0	0	0

(*) Values as measured (they have not been subject to a guarantee)

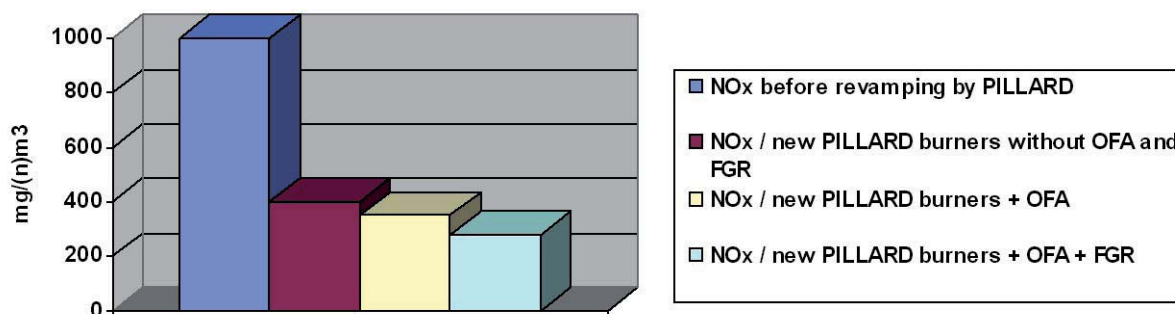


Fig.7 : Measurements at the site when firing Heavy Fuel Oil N°6 = Reduction of NO_x obtained

5 - CONCLUSION

The use of PILLARD LOW NO_x techniques associated to a clever disposition of burners facilitating the implementation of "REBURNING", "OVERFIRING AIR" and "FGR" led to :

- A very good exploitation flexibility
- NO_x emissions reduced 2 to 3 times, when firing any fuels
- A global solution which avoids to use SCR or SNCR systems whose maintenance and exploitation costs are very high and which (now) oblige the user to check continuously the ammonia (NH₃) rejection at stack.