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Abstract

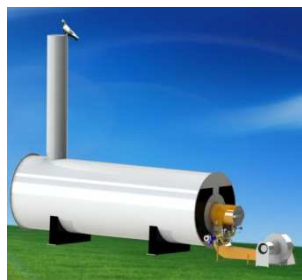
Babcock Wanson is a leading player recognized as a specialist with high added value and technical expertise in its market : industrial boilers. These boilers are used by manufacturers who use steam in their process (food, paper, chemistry, packaging, ...). Its economic model is dual and combines sales of equipment and services: more than 640 people, half of whom are dedicated to service. The company has an extensive geographic diversification over Europe: 2 manufacturing plants in France (Nérac) and Italy (Milan).



Babcock Wanson designs and manufactures its own burners. BW's position as both boiler and burner manufacturer provides high levels of performance and reliability.

As part of its development strategy, Babcock Wanson has successfully developed a new range of Ultra Low NOx burners to maintain its leading position in industrial boilers with an evolving environmental regulation. Development began in 2013 and results in industrial demonstration tests in 2015.

Research and Development was carried out on a test boiler of 8 MW with the following objectives:



- Improving energy efficiency :
 - Large turn down ratio 1 to 12
 - Reduction of excess air : Excess air less than 15 % over the entire operating range
- Reducing the environmental impact by reducing NOx emissions : NOx emissions lower than 60 mg/Nm³@3%O₂ on dry exhaust gas

The Ultra Low NOx gas burner **Modulo +** range achieves these performances in industrial operating conditions over a power range of 6 to 22 MW.

Description of the technology and its performances

Techniques involve are primary measures for the reduction of NOx emissions at the source, without using secondary techniques and in particular the technical SNCR (Selective Non Catalytic Reduction) or SCR (Selective Catalytic Reduction). This feature required the design of a second gas supply train and the realization of a ventilation performance improvement study.

The objectives of reducing NOx and improving energy efficiency are achieved by taking into account the following four elements :

- Simultaneous exploitation and control of the different principles of reduction of NOx emissions at source: design of this prototype burner is based on staging of gas injection and techniques of flame separation
- Maintaining combustion stability despite the staging of combustion : steady state behaviour, transition behaviour during rapid conditions, behaviour and resistance to excess air.
- Maintaining combustion quality : flame appearance, noise, limit the antagonism NOx / CO-Dust (accepted level CO < 5 ppm) and control flame dimensions (length and diameter)
- Industrial feasibility: possibility of assembly / disassembly and maintenance, combustion air pressure specifications and fan power.

Module + is available for gaseous fuel applications. It has a specific combustion head and a dual supply gas train and needs a O2 control system.

Results of the demonstration tests (tests done on the 8 MW Babcock Wanson test bench) are presented below :

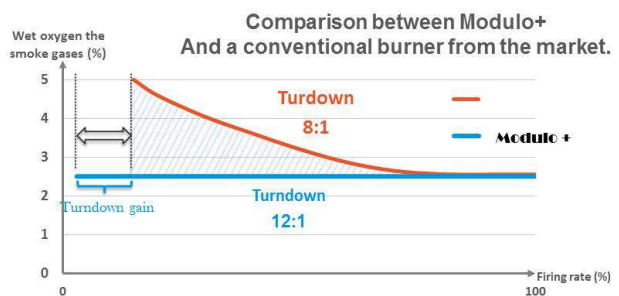
NOx emissions

Reference	European norme EN 676	French regulation ICPE rubrique n°2910
Conditions of warranty	The NOx value is the average of values measured at minimum, average and nominal loads	Maximum value for all loads
	The measurements are performed with a combustion air temperature 20 ° C and relative humidity 70% (10 g / kg)	Measurements done in industrial operating conditions
	The tolerance on the measurements during the test is ± 10 ppm (equal to ± 20.5 mg).	No tolerance on measurements.
Emission limit value	NOx ≤ 80 mg/Nm ²	NOx ≤ 100 mg/Nm ²
Emissions warranty with MODULE +	NOx ≤ 60 mg/Nm ³	NOx ≤ 80 mg/Nm ³

Efficiency

The two main assets of the **Module +** burner are :

- Large turndown ratio 1 to 12 : lower minimum load avoid stop and start burner cycles (reduced periods of pre-ventilation and associated energy losses) Ex : A boiler at 60% average load and 3 stops / restarts per hour = gain of over 1%
- Excess air lower than 15 % on the entire operating range : direct increase in efficiency Ex : -1% O2 dry ⇔ + 0,6% of efficiency (0,3% if economizer)



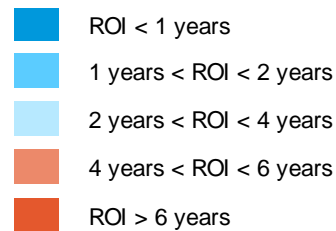
Comparing a standard Low NOx gas burner and Modulo +, on a fire-tube boiler with economizer and O2 regulating system, we obtain following results:

Gain Modulo +	Annual average load value			
	20%	40%	60%	70%
Estimated gain of efficiency	1,20%	0,80%	0,60%	0,40%

Economics : Estimated return on investment



The technical review assesses the additional costs of new burners compared to a currently marketed standard burner, the economic review estimates the operating gain provided by these new products. Then we can easily calculate the return on investment of these two technologies. Four cases are selected for the study.



Performances : Reduction of polluting emissions and energy saving on first commercial and industrial reference, VALPACO



Figure 1 : 1st installed Modulo + in VALPACO

In May 2015, commissioning of a 8 t/h Babcock Wanson (BWD80) equipped with a **Modulo + 330** burner in VALPACO plant (printer in north of France).

Burner power	kW	500	1 035	1 842	3 612	4 417	5 813
Burner load	%	8,6	17,8	31,7	62,1	76,0	100,0
O ₂	%	3,10	3,10	2,60	3,00	2,60	3,10
CO	ppm	0	1	0	2	0	3
NOx à 3%	mg/Nm ³	78	74	72	64	66	64
Efficiency	%	97,2	96,3	96,9	95,1	96,0	95,3

Its installation has shown this new burner already capable of achieving new standards of performance, confirming the laboratory tests.

Development status

After three years of development (2013 → 2016), **Modulo +** burners are now on the stage of commercial scale. The first Modulo + is already commissioned in the VALPACO plant. As a result of this first realization, two additional commissioning have been performed at the beginning of 2017.

Modulo + applications are industrial boilers. These boilers are used by manufacturers who use steam or hot water in their process : food, paper, chemistry, packaging, pharmaceutical, heating....

Customer	DSM	SANOFI
Activity	Chemistry	Pharmaceutic
Location	France (59)	France (60)
Steam production	8,5 t/h	10 t/h
BW burner	Modulo + 330	Modulo + 340
Date of commissioning	31/01/17	02/02/17
<i>Résultats</i>		
Turn down ratio	1 to 12	1 to 12
O ₂	2,8%	2,9%
NOx à 3%	64 mg/Nm ³	43 mg/Nm ³