MATCHING LOW NO_x BURNER AND HEAT GENERATOR

The procedure to match a burner and evaluate the emissions attainable by a thermal unit can be divided in a few simple steps. The first one is to check the operating point of the generator and select a suitable burner size. The next step is to calculate the thermal load of the combustion chamber and use this data to estimate NO_x emissions.
In the case of standard boilers, proceed in the following way.

Introduction
To choose the proper burner, the following data are necessarily required:
- Boiler type
- Burner input
- Backpressure in the combustion chamber
- Dimensions of the combustion chamber included the reverse smoke chamber
- NO_x emissions requested, 80, 50, 30 mg/kWh.

The counting procedure is divided into three steps:
- choosing the burner;
- choosing the depowenty burner output to obtain the correct emissions;
- choosing the combustion head length.

CHOOSING THE BURNER
To clearly explain the procedure about choosing a suitable burner, please follow the example:

Boiler type	3 pass
Furnace input	5.000 kW
Backpressure in the combustion chamber	8 mbar
Dimensions of the combustion chamber	Length L = 4.000 mm (4 m)
Smoke reverse chamber	Length L = 250 mm (0,25 m)
Total length of the calculation	Length TL = 4.250 mm (4,25 m)
Diameter	Diameter D = 1.100 mm (1,1 m)
Calculation combustion chamber volume	D x D x 0,78 x TL
	1,1 m x 1,1 m x 0,78 x 4,25 m = 4,01 m^3
Calculation thermal load	5.000 kW /4,01 m^3 / 1.000 = 1,25 MW/m^3
Gas type	Natural gas

Procedure
First, identify the burners whose requested output is included within their performance curves.

BURNER SELECTION FOR NO_x < 80 mg/kWh

Reference conditions
- Measurement tolerances according to EN 676 standard
- Temperature: 20 °C
- Dried flue gases
- Barometric pressure: 1013 millibars
- Relative humidity: 70 % (equivalent to 10 g H_2O/kg of air)
- Boiler temperature: 110 °C
- Fuel: G20 (natural gas, 100 % CH_4)
- Three-smoke pass boiler

PERFORMANCE CURVE OF THE BURNER

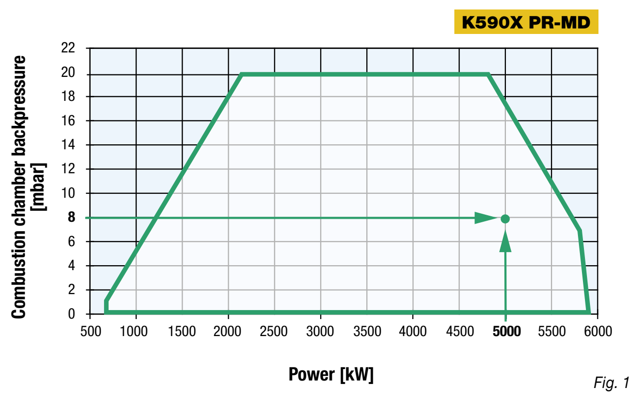


Fig. 1

NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD

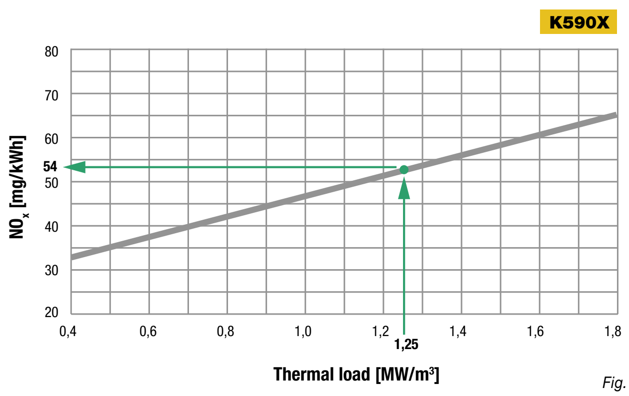


Fig. 2

The required operating point is inside of Low NO_x burner model K590X (Fig. 1).

In the thermal load - NO_x diagram (Fig. 2) of the selected burner, find the calculated thermal load, draw a vertical line to meet the the NO_x curve and read the value on the ordinate.

In the example , it is possible to estimate an emission of approximately 54 mg/kWh at 3% O_2 of NO_x.
Diagrams of the various models are given on the following pages.

COMBUSTION HEAD LENGTH SELECTION

The final step is to check combustion head dimensions, in relation to combustion chamber, because they are a critical parameter to obtain the expected emissions.
Two conditions should be met:
1) It is recommended that the diameter of the chamber is 2,5 to 3 times larger than the diameter of the burner combustion head.
2) The low NO_x combustion head must penetrate 150÷200 mm into the combustion chamber.

In the cited example, the boiler chamber diameter was 1.100 mm, so the optimal combustion head diameter lies in the range between 350 mm and 440 mm.
The dimensional table on page 101 shows that K590X combustion head diameter is equal to 360 mm, thus the first condition is met.
Regarding the combustion head length, suppose the boiler door is 370 mm thick, refractory included. The combustion head must penetrate at least 150 mm as said above, thus the long combustion head variant is selected (530 mm). The short combustion head (430 mm) is insufficient as it only penetrates by 60 mm into the combustion chamber. In this case we have 160 mm.
To properly install the burner, please refer to Fig. 3 to the side.
Of course, it is possible to carry out the reverse procedure as well: given an emission limit that cannot be exceeded by design, the NO_x diagram provides the admissible thermal load for a given heat generator. This way, designer can select a suitable boiler based on project specifications and required power. In any case, burner combustion head dimensions must be checked to complete the matching procedure.

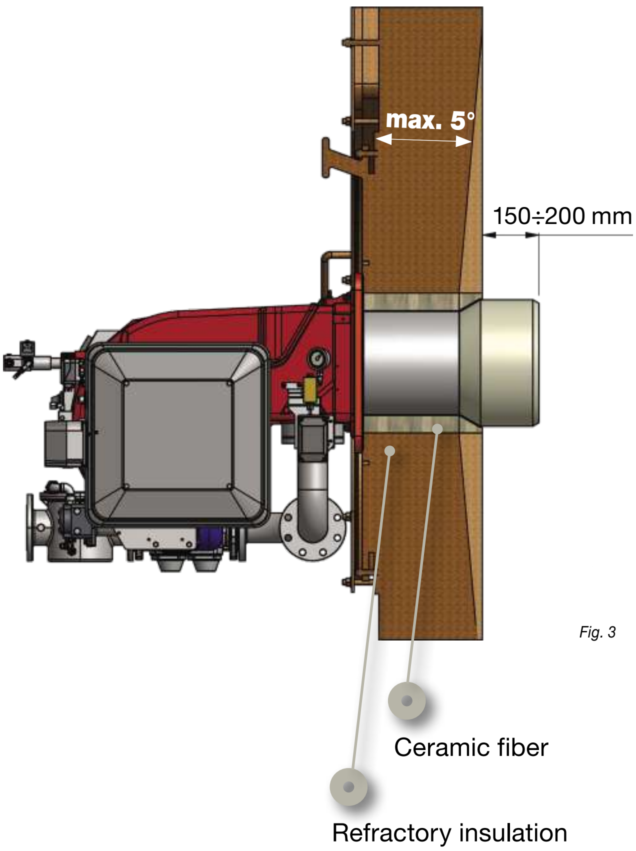


Fig. 3

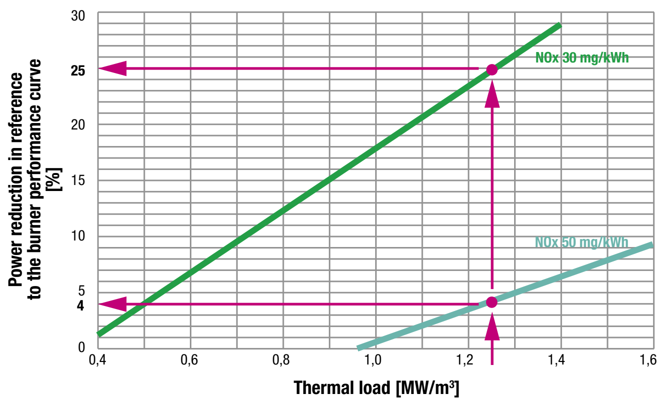
Reverse flame boilers: contact our Technical Department.

BURNER SELECTION FOR NO_x < 50 mg/kWh and < 30 mg/kWh

With NO_x < 50 mg/kWh and < 30 mg/kWh we need to have a smoke recirculation (FGR).
The smoke recirculation decreases a percentage of the performance curves and increases the backpressure in the combustion chamber. This percentage depend also of the thermal load of the combustion chamber.
In order to select the correct burner we can calculate the depowering percentage needed.

SELECTION 1: K590X...FRG

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE

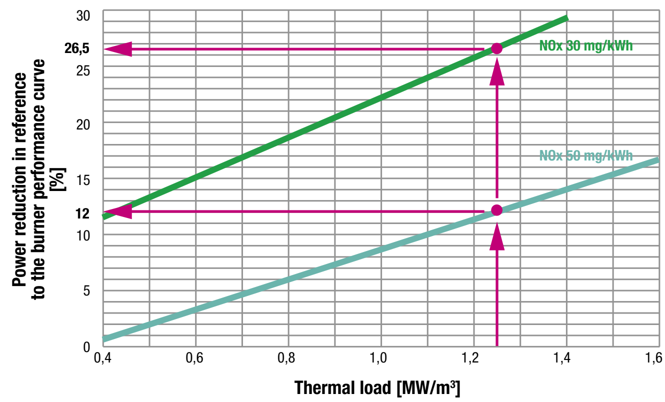


< 50 mg/kWh
In the selection 1 with the thermal load 1,25 MW/m³, the percentage of the depowering of the burner is 4 %.

< 30 mg/kWh
In the selection 1 with the thermal load 1,25 MW/m³, the percentage of the depowering of the burner is 25 %.

SELECTION 2: K750X...FGR

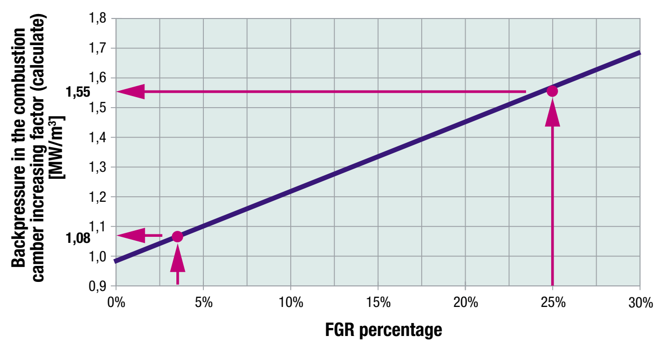
OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



< 50 mg/kWh
In the selection 2 with the thermal load 1,25 MW/m³, the percentage of the depowering of the burner is 12 %.

< 30 mg/kWh
In the selection 2 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 26,5 %.

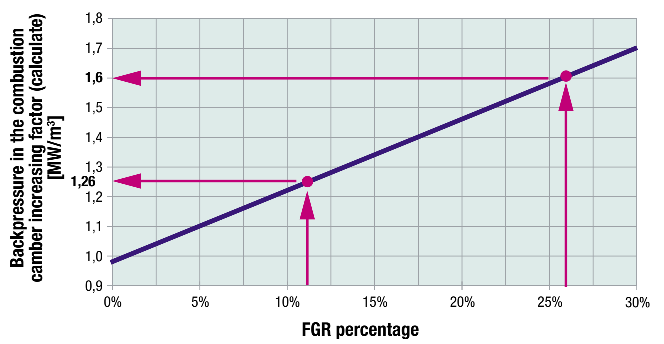
BACKPRESSURE IN THE COMBUSTION CHAMBER INCREASING FACTOR CHART (CALCULATE)



< 50 mg/kWh
In the selection 1 with the thermal load 1,25 MW/m³ the percentage of the depowering of the burner is 4 %, and the backpressure in the combustion chamber increases
8 mbar x 1,08 = 8,6 mbar.

< 30 mg/kWh
In the selection 1 with the thermal load 1,25 MW/m³, the percentage of the depowering of the burner is 25 %, and the backpressure in the combustion chamber increases
8 mbar x 1,55 = 12,4 mbar.

BACKPRESSURE IN THE COMBUSTION CHAMBER INCREASING FACTOR CHART (CALCULATE)



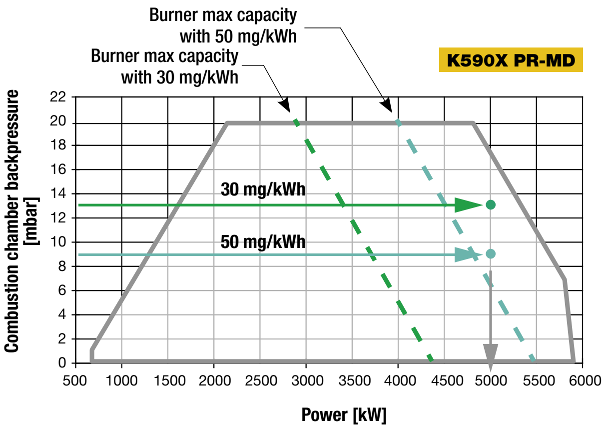
< 50 mg/kWh
In the selection 2 with the thermal load 1,25 MW/m³ the percentage of the depowering of the burner is 12 %, and the backpressure in the combustion chamber increases
8 mbar x 1,26 = 10,08 mbar.

< 30 mg/kWh
In the selection 2 with the thermal load 1,25 MW/m³, the percentage of the depowering of the burner is 26,5 %, and the backpressure in the combustion chamber increases
8 mbar x 1,6 = 12,8 mbar.

MATCHING LOW NO_x BURNER AND HEAT GENERATOR

SELECTION 1: K590X...FGR

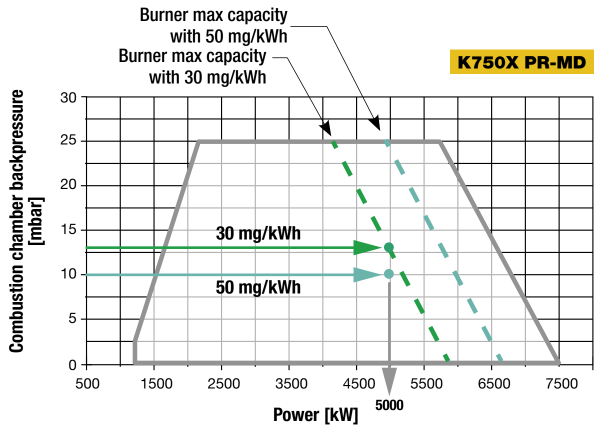
OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



The burner K590X in the selection 1 is outside of the performance curve, for this reason we can not choose this burner.

SELECTION 2: K750X...FGR

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



The burner K750X in the selection 2 is correct because is inside of the performance curve with emissions 50 and 30 mg/kWh.

COMBUSTION HEAD LENGTH SELECTION

In the cited example, the boiler chamber diameter was 1.100 mm, so the optimal combustion head diameter lies in the range between 350 mm and 440 mm.
The dimensional table on page 101 shows that K750X combustion head diameter is equal to 419 mm, thus the first condition is met.
Regarding the combustion head length, suppose the boiler door is 370 mm thick, refractory included. The combustion head must penetrate at least 150 mm as said above, thus the long combustion head variant is selected (530 mm). The short combustion head (430 mm) is insufficient as it only penetrates by 60 mm into the combustion chamber. In this case we have 160 mm.
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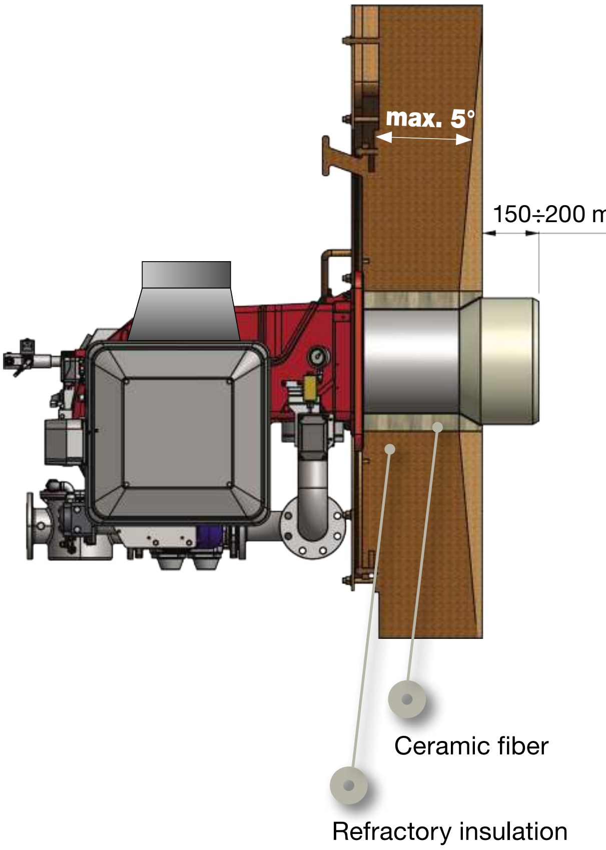
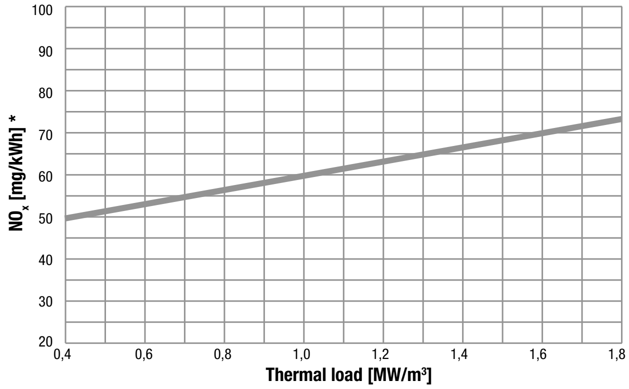


Fig. 4

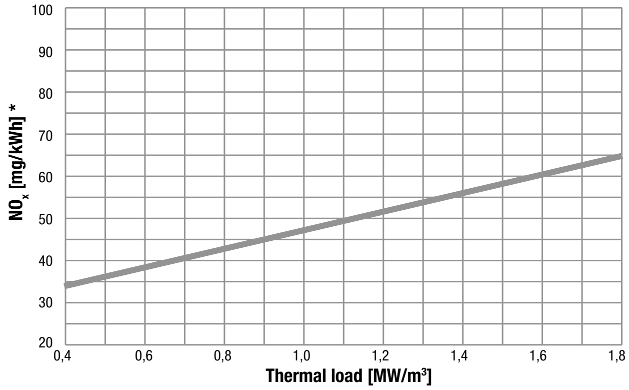
Reverse flame boilers: contact our Technical Department.

NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD

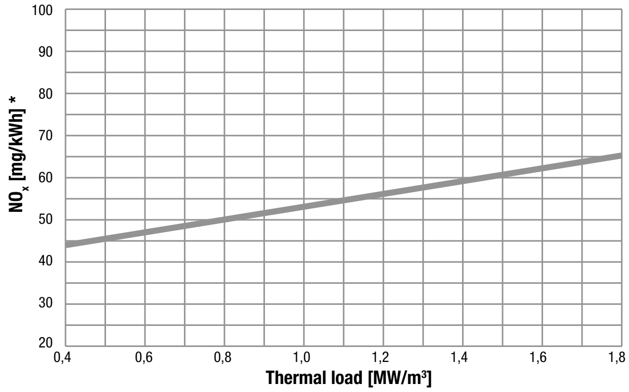
RX92R **HRX92R...MG**



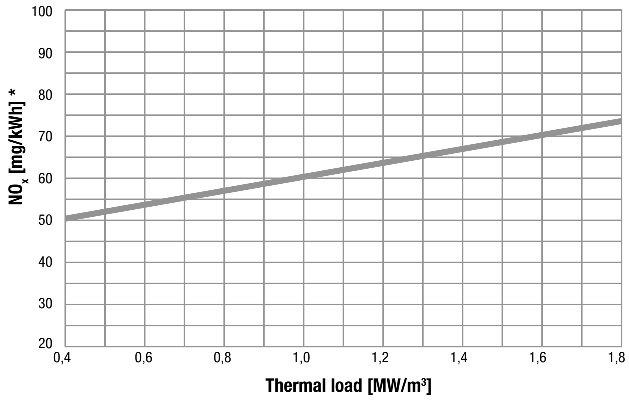
RX92.1 **HRX92.1...MG**



G225X **G225X...MG**



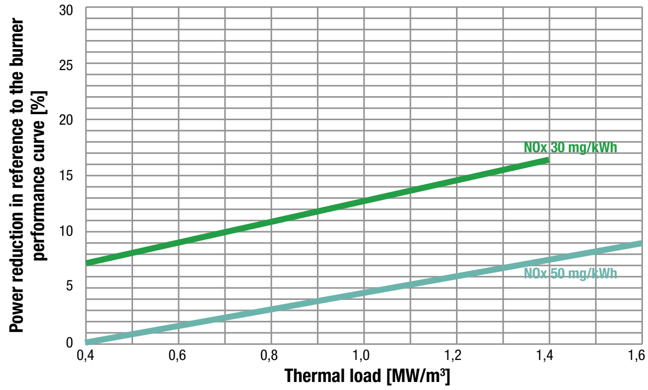
G270X **G270X...MG**



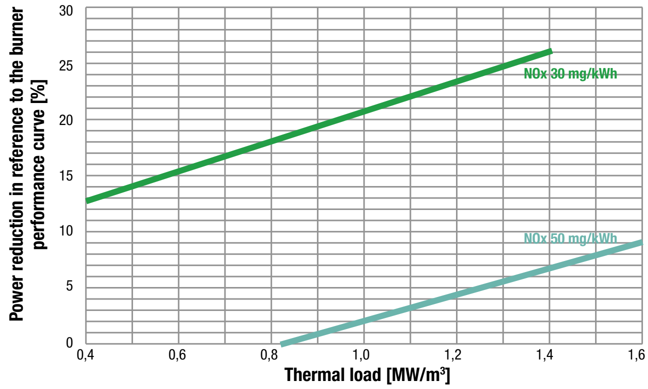
* According to UNI EN 676 correction method; p amb 1013 mbar; t amb 20°C; h 10 g/kg.

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE

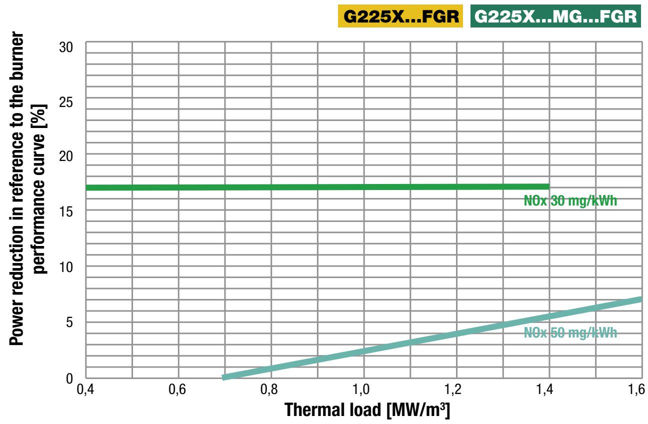
RX92R...FGR **HRX92R...MG...FGR**



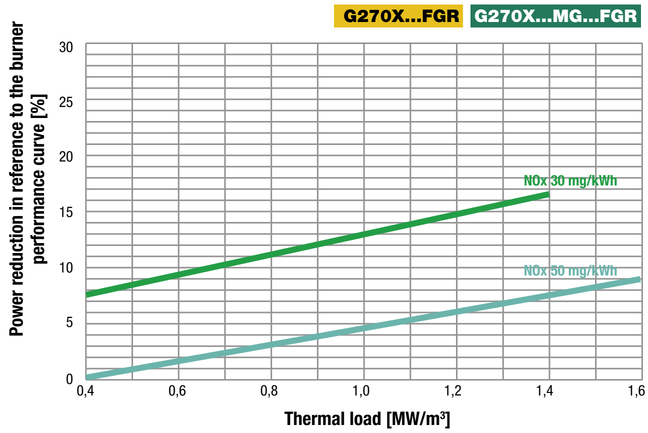
RX92.1...FGR **HRX92.1...MG...FGR**



G225X...FGR **G225X...MG...FGR**



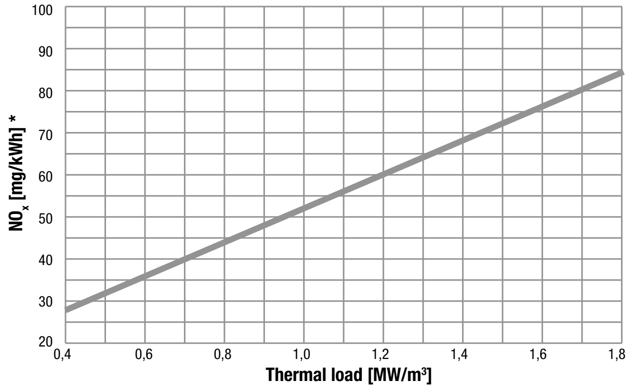
G270X...FGR **G270X...MG...FGR**



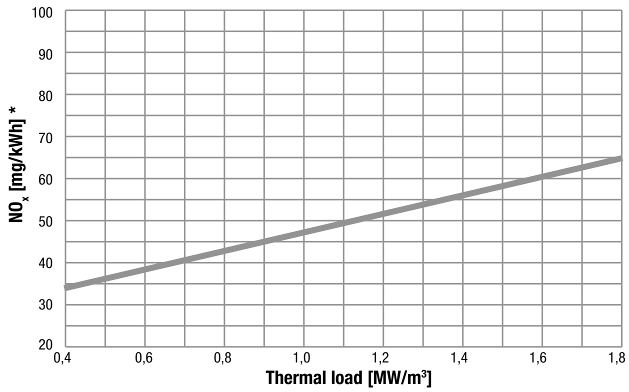
MATCHING LOW NO_x BURNER AND HEAT GENERATOR

NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD

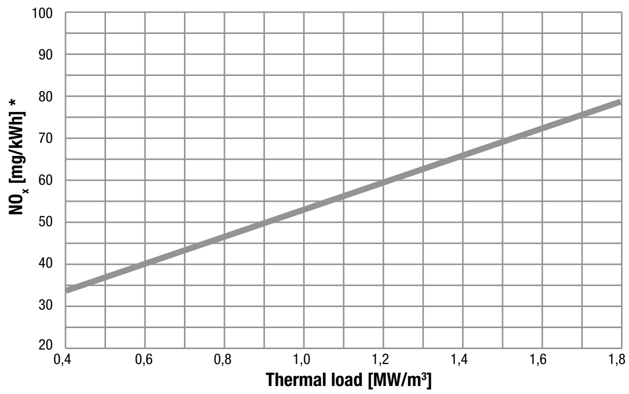
G325X **G325X...MG**



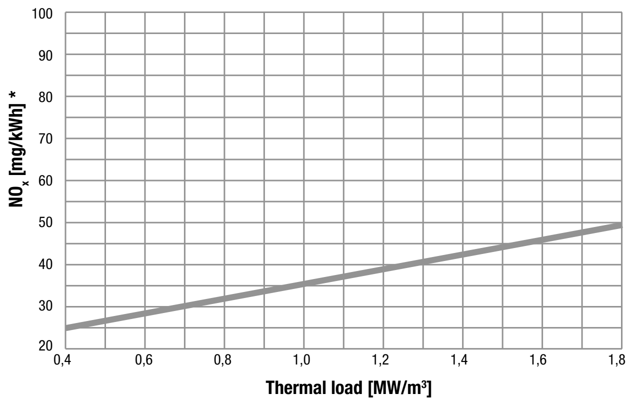
H365X **H365X...MG**



H440X **H440X...MG**



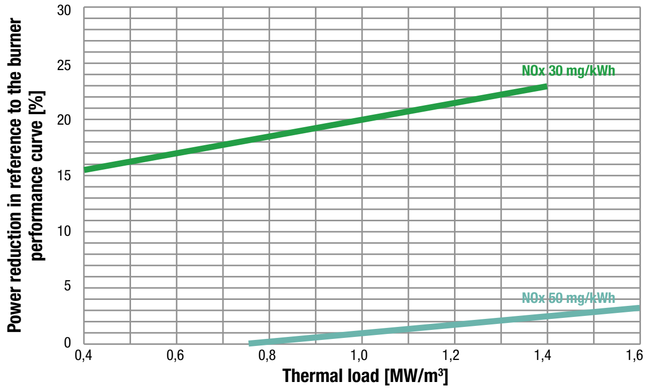
H500X **H500X...MG**



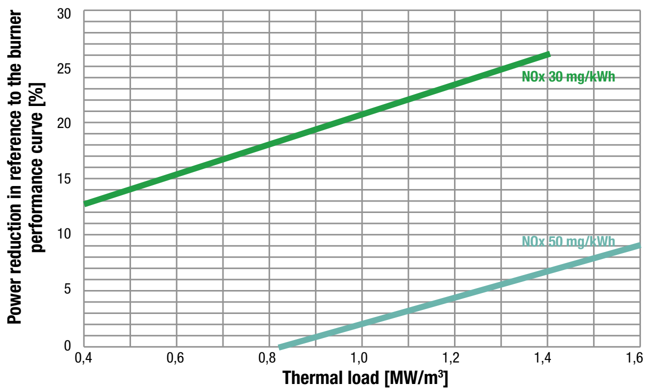
* According to UNI EN 676 correction method; p amb 1013 mbar; t amb 20°C; h 10 g/kg.

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE

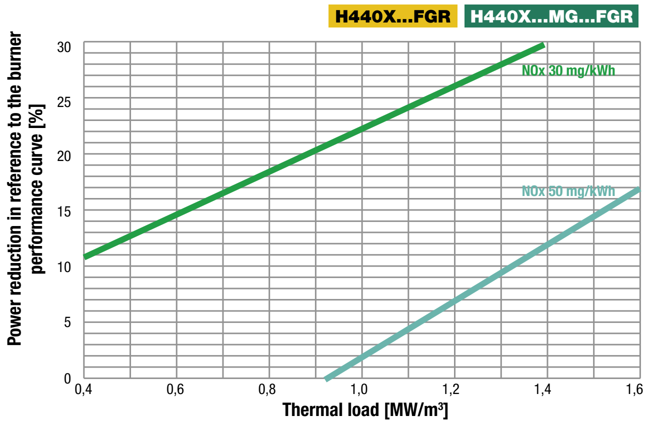
G325X...FGR **G325X...MG...FGR**



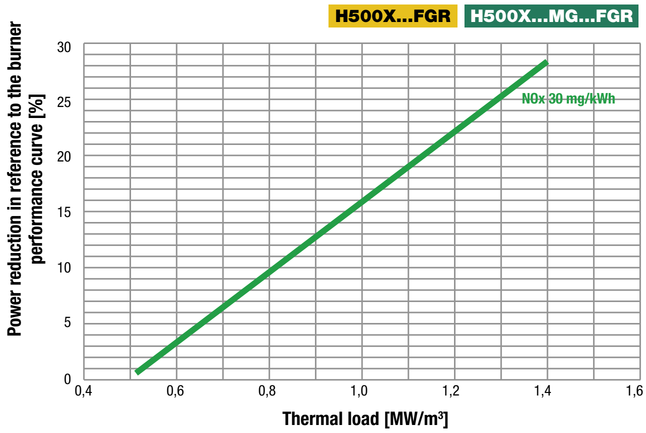
H365X...FGR **H365X...MG...FGR**



H440X...FGR **H440X...MG...FGR**



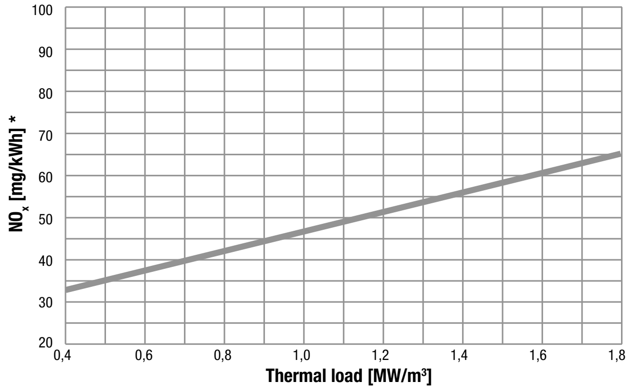
H500X...FGR **H500X...MG...FGR**



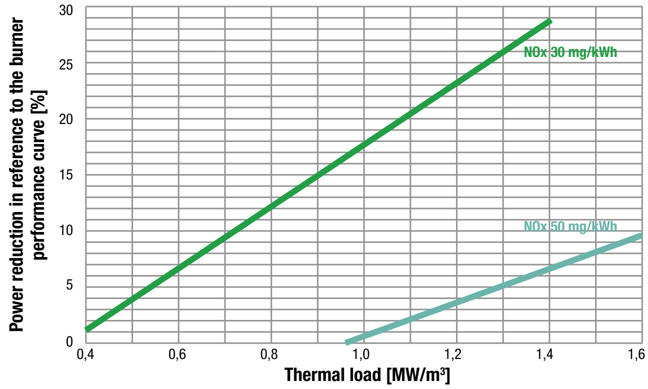
NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE

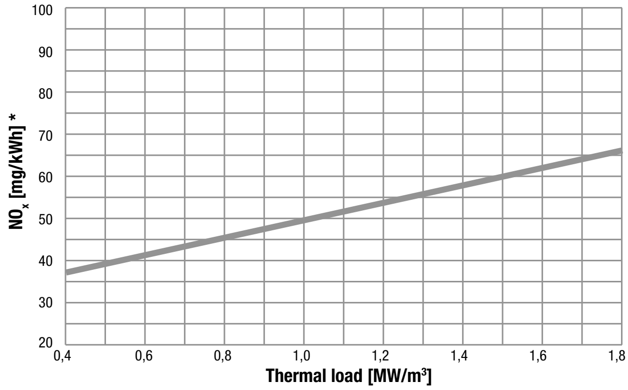
K590X **K590X...MG**



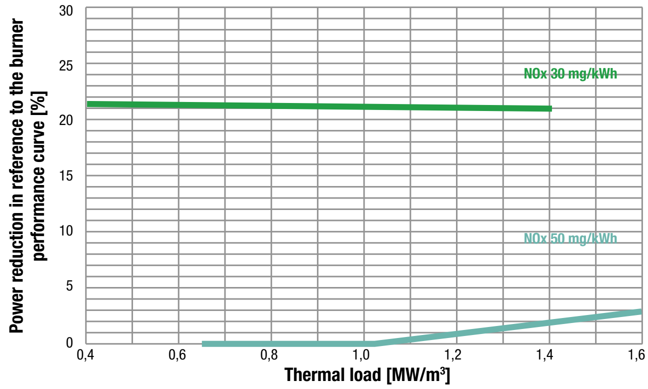
K590X...FGR **K590X...MG...FGR**



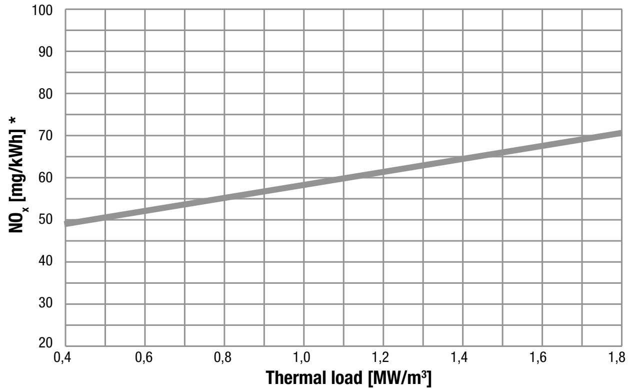
K660X **K660X...MG**



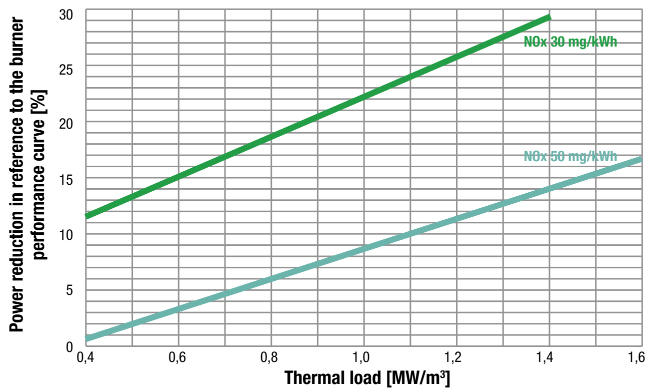
K660X...FGR **K660X...MG...FGR**



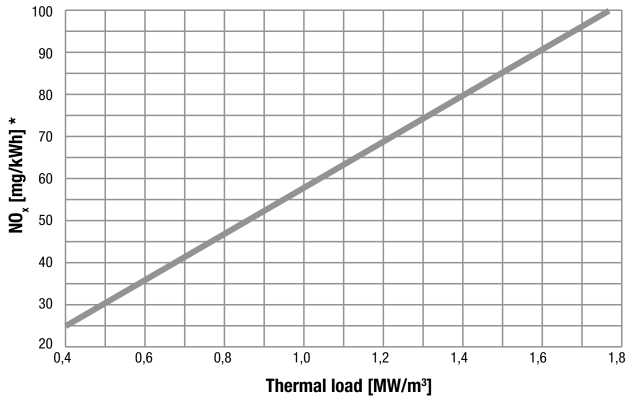
K750X **K750X...MG**



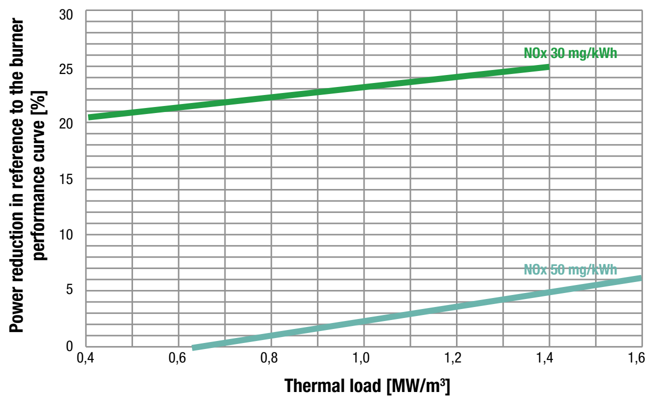
K750X...FGR **K750X...MG...FGR**



N880X **N880X...MG**



N880X...FGR **N880X...MG...FGR**

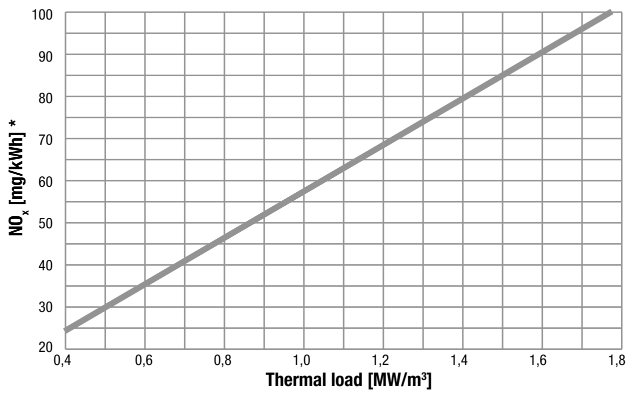


* According to UNI EN 676 correction method; p amb 1013 mbar; t amb 20°C; h 10 g/kg.

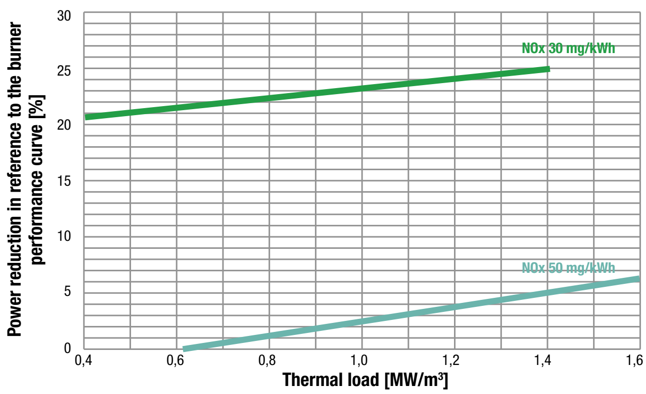
MATCHING LOW NO_x BURNER AND HEAT GENERATOR

NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD	OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE

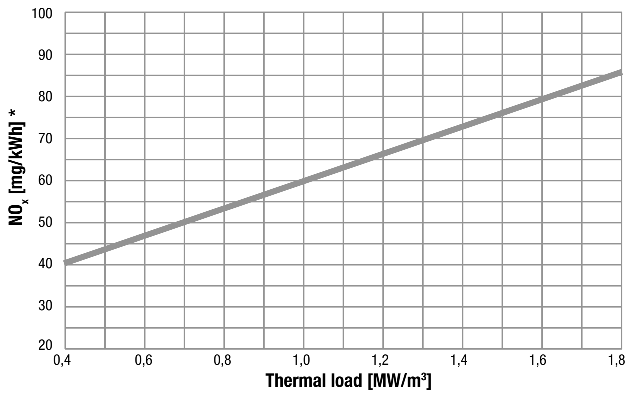
N925X **N925X...MG**



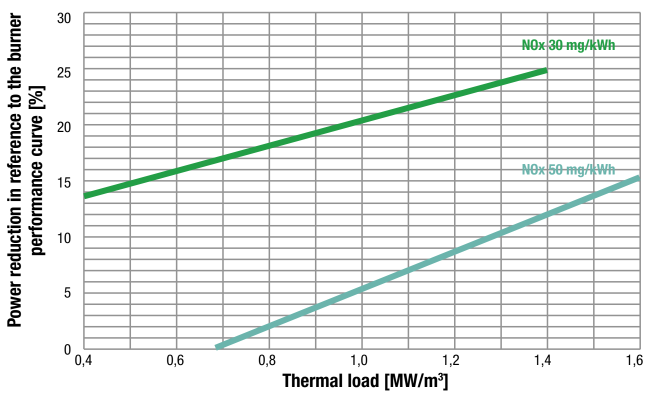
N925X...FGR **N925X...MG...FGR**



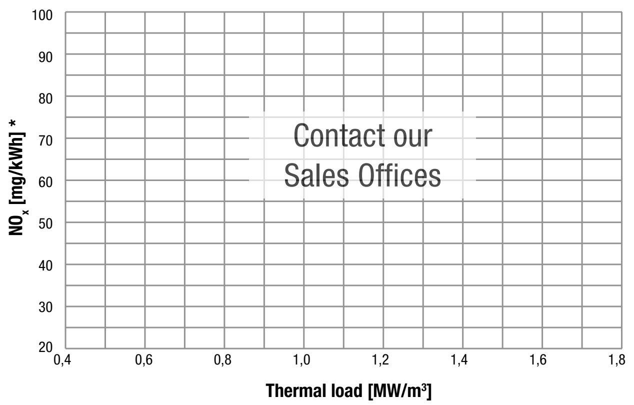
N1060X **N1060X...MG**



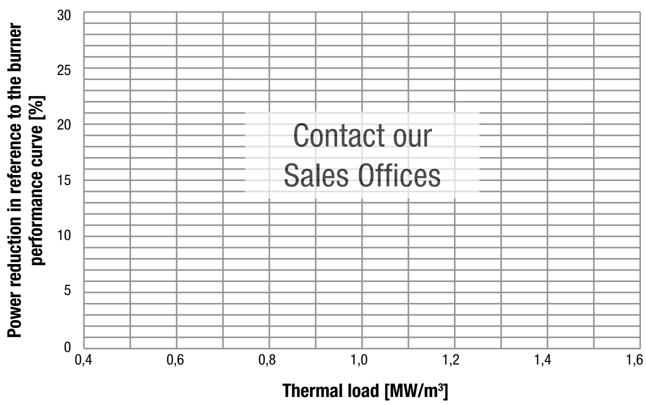
N1060X...FGR **N1060X...MG...FGR**



RX2050 - RX2060 - RX2080
HR2050 - HR2060 - HR2080...MG



RX2050-RX2060-RX2080...FGR
HR2050-HR2060-HR2080...MG...FGR



* According to UNI EN 676 correction method; p amb 1013 mbar; t amb 20°C; h 10 g/kg.