

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	950 kW
Backpressure in the combustion chamber	6 mbar
Dimensions of the combustion chamber	Length L = 1.750 mm (1,75 m)
Smoke reverse chamber	Length L = 250 mm (0,25 m)
Total length of the calculation	Length TL = 2.000 mm (2,0 m)
Diameter	Diameter D = 680 mm (0,68 m)
Calculation combustion chamber volume	D x D x 0,78 x TL 0,68 m x 0,68 m x 0,78 x 2,0m = 0,72 m ³
Calculation thermal load	950 kW / 0,72 m ³ / 1.000 = 1,31 MW/m ³
Gas type	Natural gas

Procedure

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

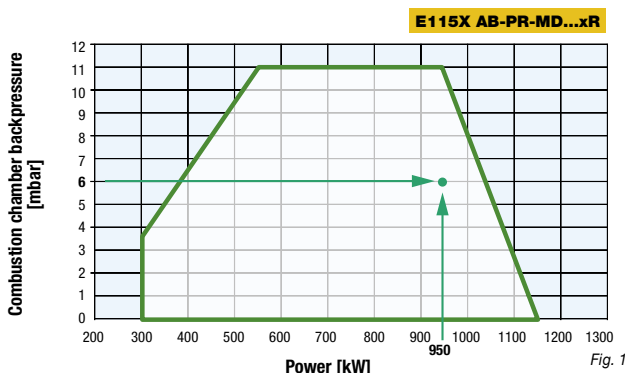
BURNER SELECTION FOR NO_x < 80 mg/kWh

Reference conditions

- Measurement tolerances according to EN 676 standard
- Temperature: 20 °C
- Dried flue gases
- Barometric pressure: 1013 millibars

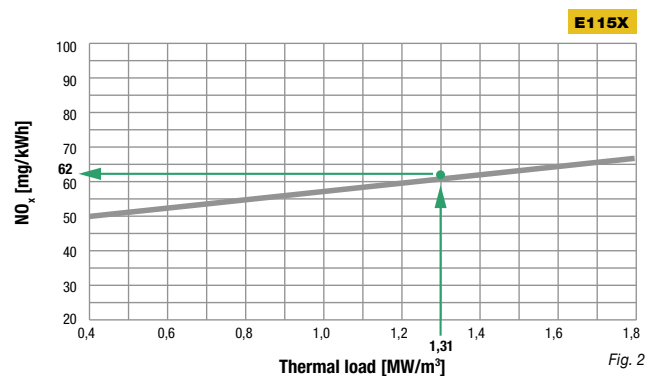
- Relative humidity: 70 % (equivalent to 10 g H₂O/kg of air)
- Boiler temperature: 110 °C
- Fuel: G20 (natural gas, 100 % CH₄)
- Three-smoke pass boiler

PERFORMANCE CURVE OF THE BURNER



The required operating point is inside of Low NO_x burner model E115X (Fig.1).

NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD



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 62 mg/kWh at 3% O₂ of NO_x. Diagrams of the various models are given on the following pages.

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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 680 mm, so the optimal combustion head diameter lies in the range between 215 mm and 270 mm.

The dimensional table on page 95 or 100 shows that E115X combustion head diameter is equal to 219 mm, thus the first condition is met.

Regarding the combustion head length, suppose the boiler door is 219 mm thick, refractory included. The combustion head must penetrate at least 150 mm as said above, thus the long combustion head variant is selected (390 mm). The short combustion head (305 mm) is insufficient as it only penetrates by 85 mm into the combustion chamber.

In this case we have 170 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.

Reverse flame boilers: contact our Technical Department.

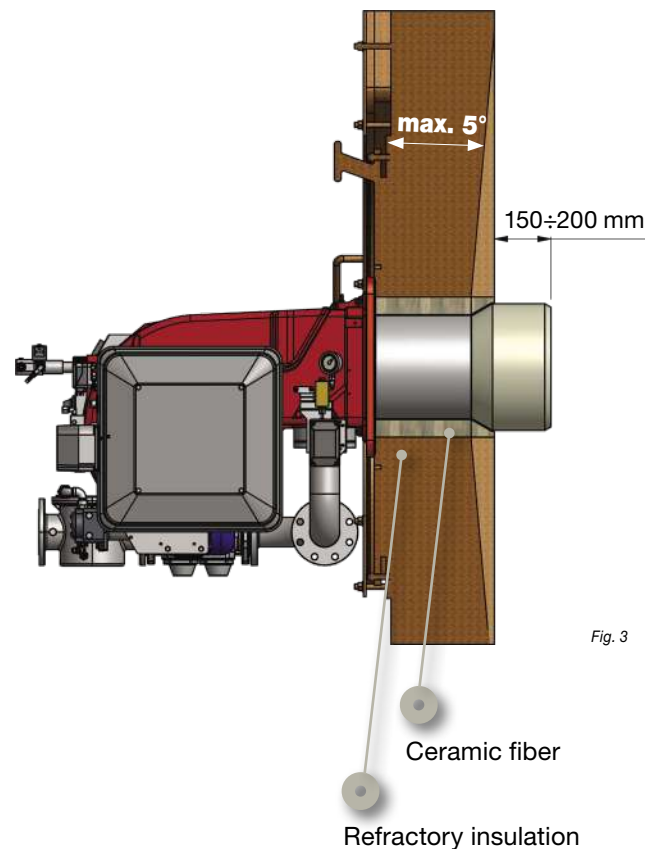


Fig. 3

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

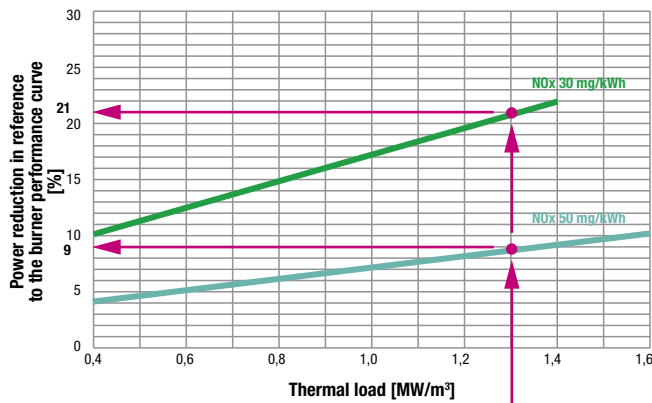
With NO_x < 50 mg/kWh and < 30 mg/kWh we need to have a smoke recirculation (FGR).

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: E115X

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



< 50 mg/kWh

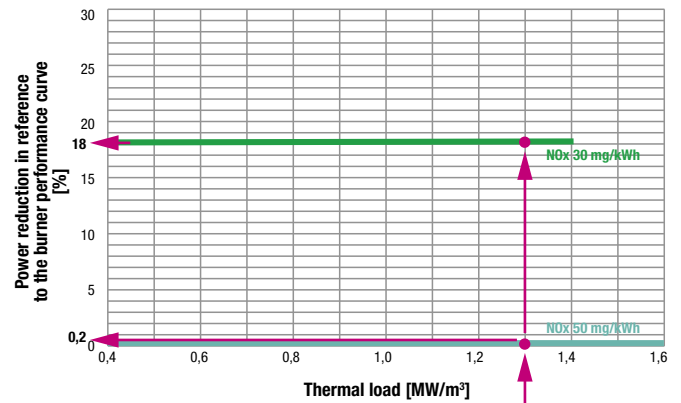
In the selection 1 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 9 %.

< 30 mg/kWh

In the selection 1 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 21 %.

SELECTION 2: E150X

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



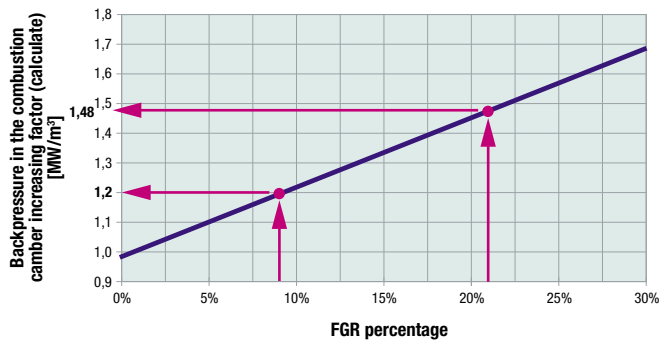
< 50 mg/kWh

In the selection 2 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 0,2 %.

< 30 mg/kWh

In the selection 2 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 18 %.

BACKPRESSURE IN THE COMBUSTION CHAMBER INCREASING FACTOR CHART (CALCULATE)



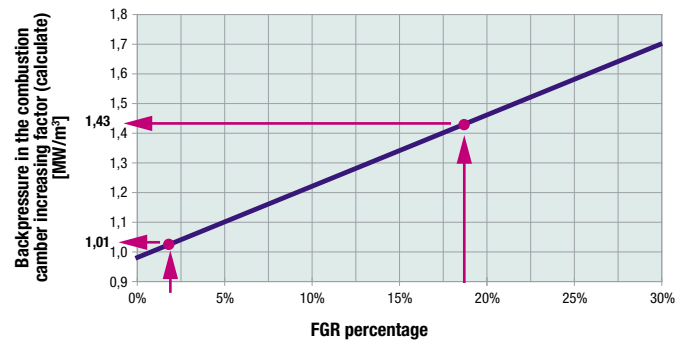
< 50 mg/kWh

In the selection 1 with the thermal load 1,31 MW/m³ the percentage of the depowering of the burner is 9 %, and the backpressure in the combustion chamber increases 6 mbar x 1,2 = 7,2 mbar.

< 30 mg/kWh

In the selection 1 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 21 %, and the backpressure in the combustion chamber increases 6 mbar x 1,48 = 8,9 mbar.

BACKPRESSURE IN THE COMBUSTION CHAMBER INCREASING FACTOR CHART (CALCULATE)



< 50 mg/kWh

In the selection 2 with the thermal load 1,31 MW/m³ the percentage of the depowering of the burner is 0,2 %, and the backpressure in the combustion chamber increases 6 mbar x 1,01 = 6,06 mbar.

< 30 mg/kWh

In the selection 2 with the thermal load 1,31 MW/m³, the percentage of the depowering of the burner is 18 %, and the backpressure in the combustion chamber increases 6 mbar x 1,43 = 8,58 mbar.

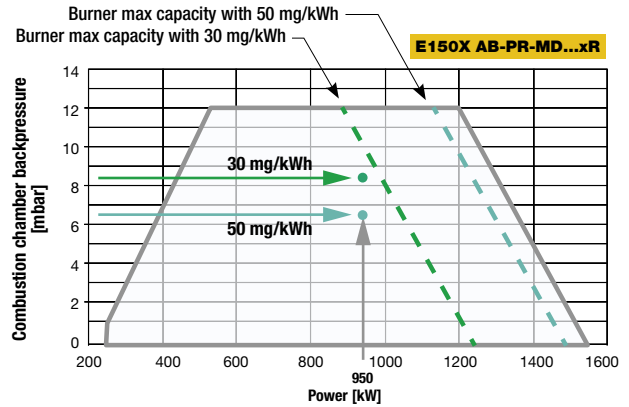
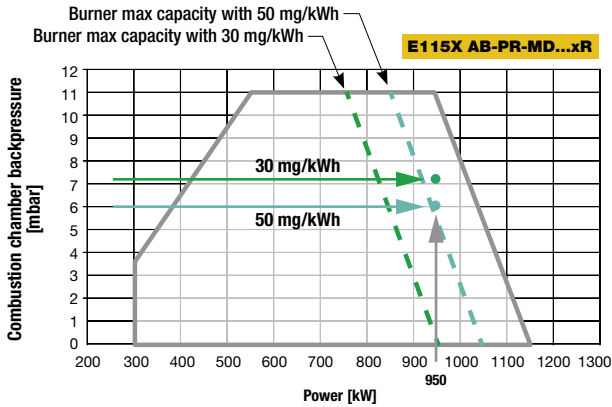
MATCHING LOW NO_x BURNER AND HEAT GENERATOR

SELECTION 1: E115X...FGR

SELECTION 2: E150X...FGR

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE

OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



The burner E115X in the selection 1 is outside of the performance curve, for this reason we can not choose this burner.

The burner E150X 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 680 mm, so the optimal combustion head diameter lies in the range between 215 mm and 270 mm.

The dimensional table on page 95 or 100 shows that E150X combustion head diameter is equal to 259 mm, thus the first condition is met.

Regarding the combustion head length, suppose the boiler door is 220 mm thick, refractory included. The combustion head must penetrate at least 150 mm as said above, thus the short combustion head variant is selected (400 mm).

The long combustion head (500 mm) penetrate too much (280 mm) into in the combustion chamber.

In this case with short combustion head we have 180 mm.

To properly install the burner, please refer to Fig. 4 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.

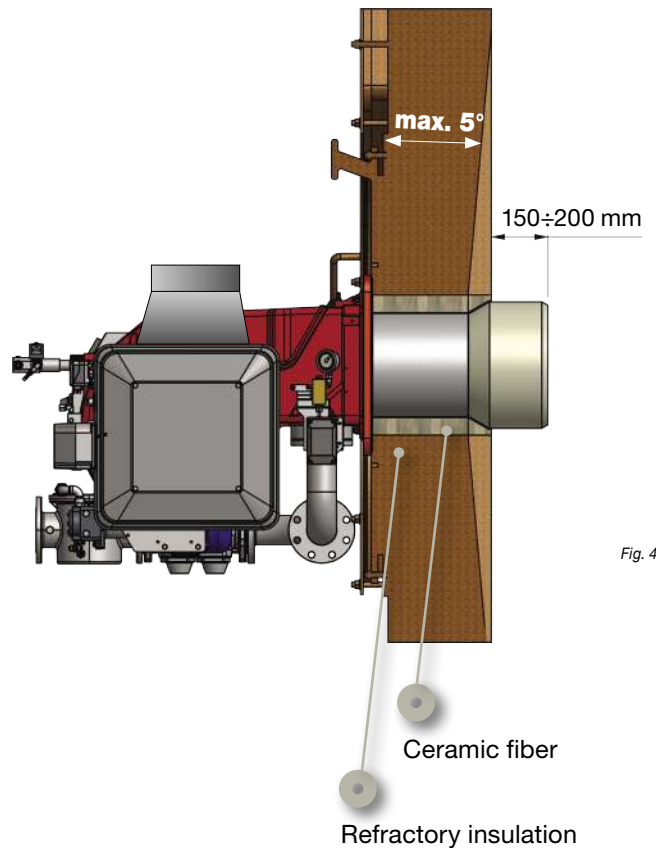
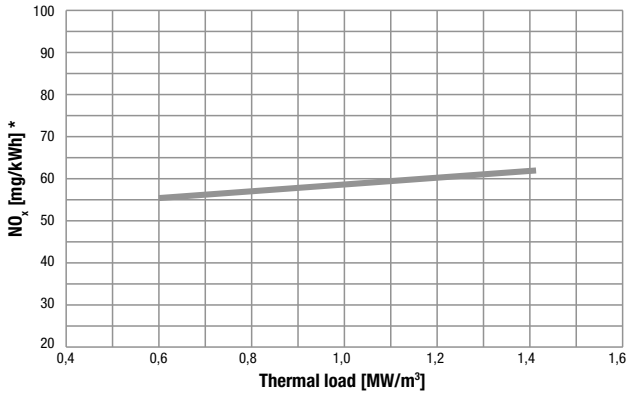


Fig. 4

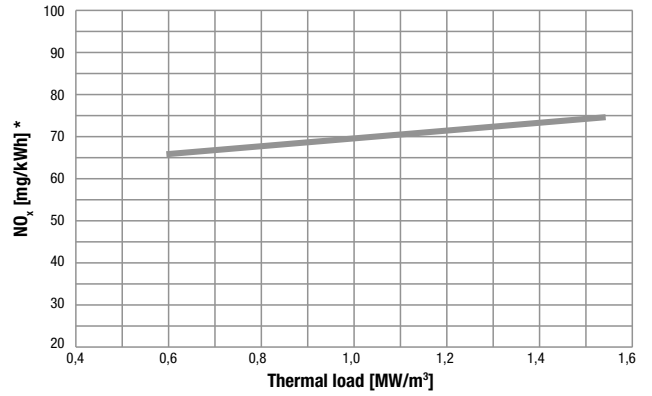
Reverse flame boilers: contact our Technical Department.

NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD

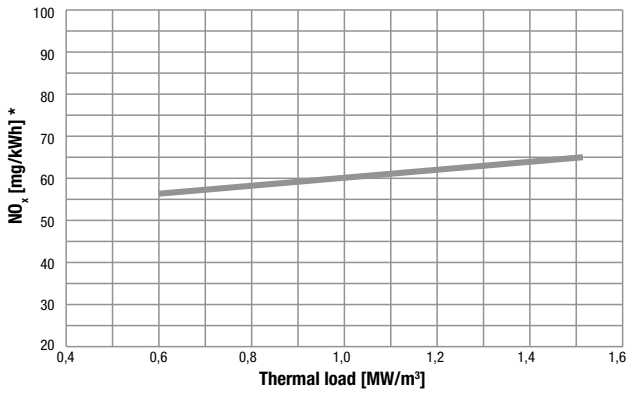
NGX70



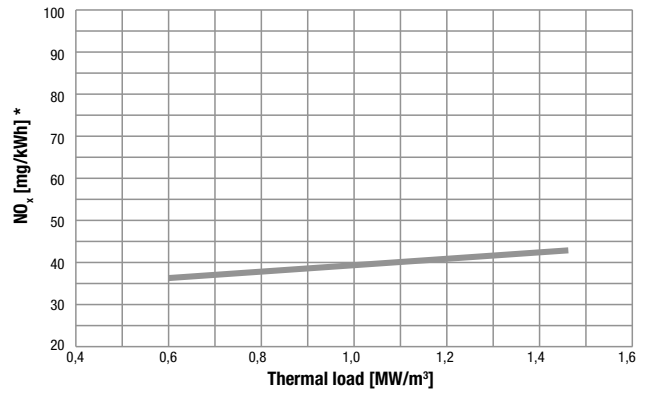
NGX120



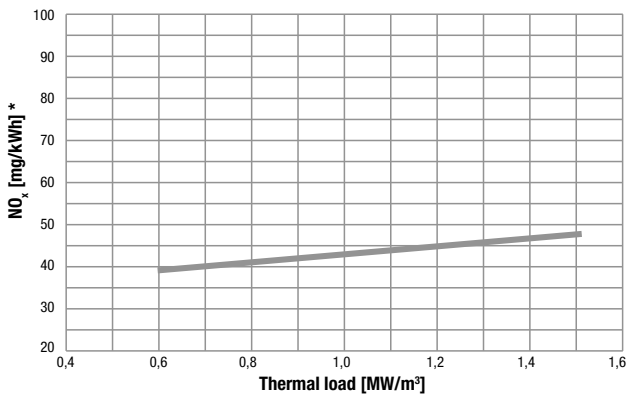
NGX200



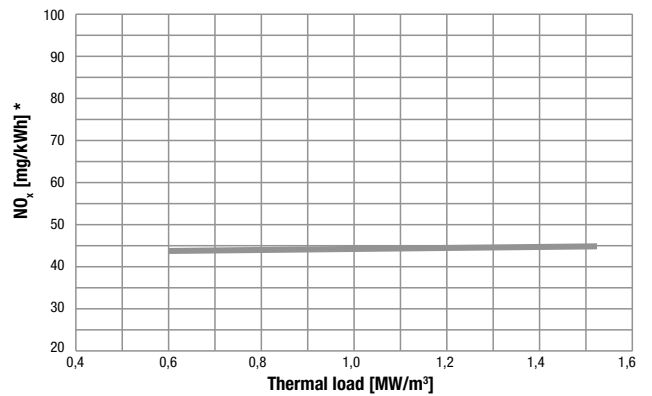
NGX280



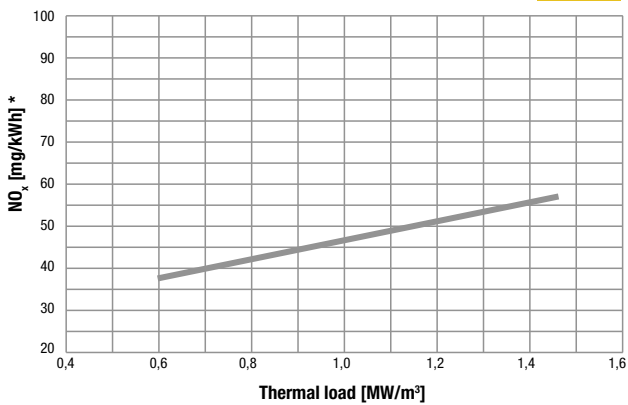
NGX350



NGX400



NGX550

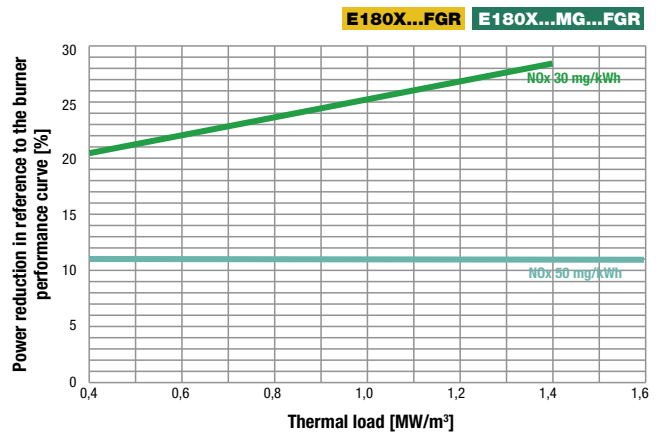
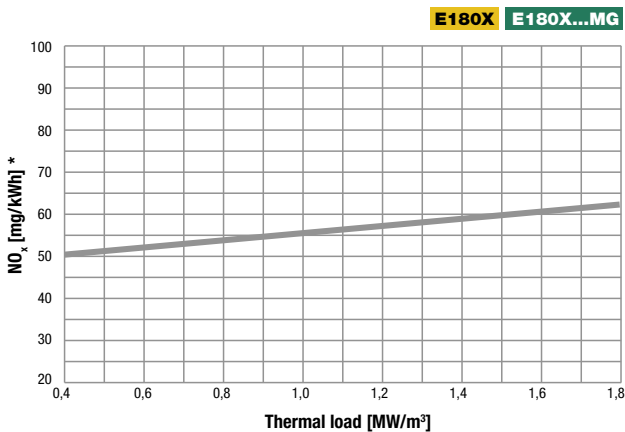
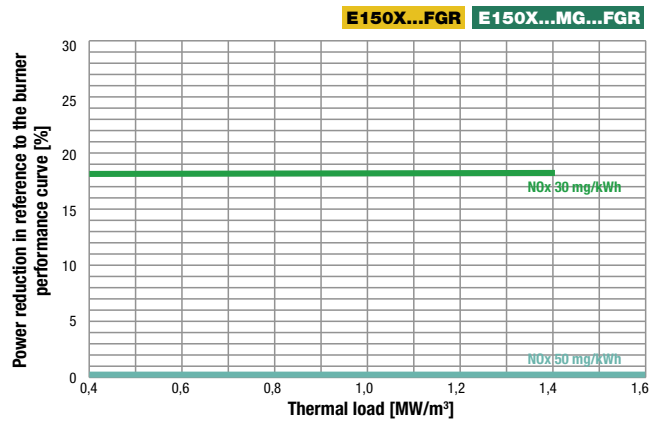
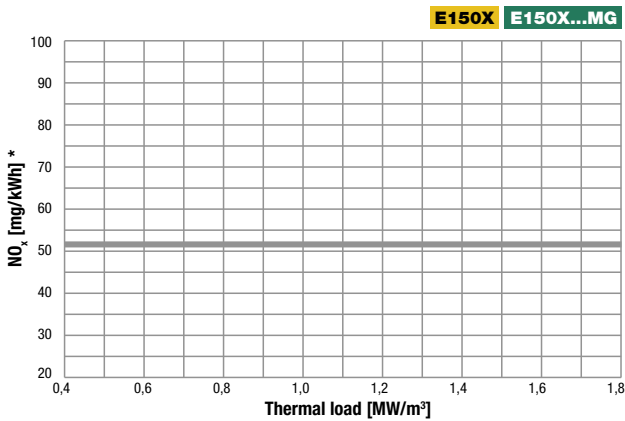
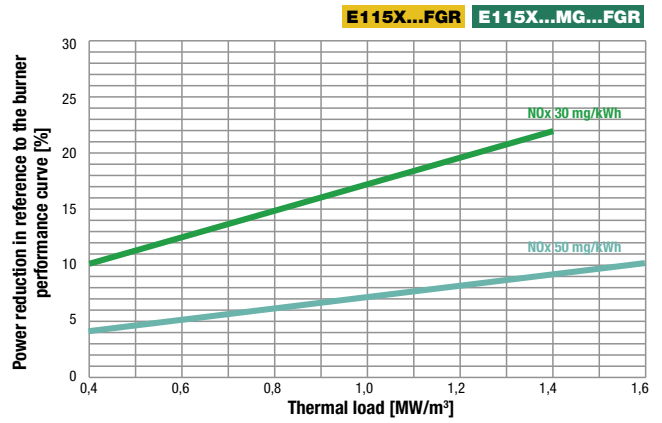
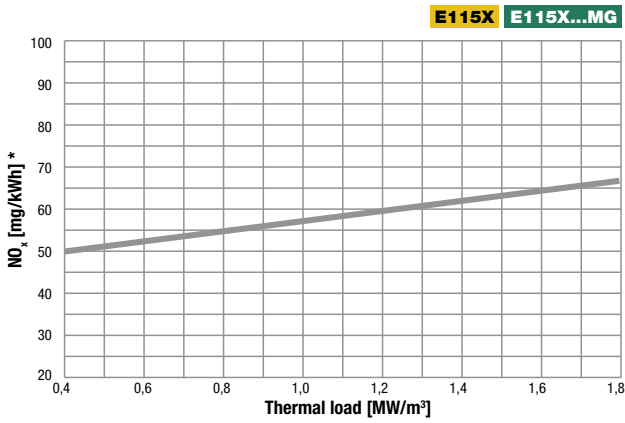
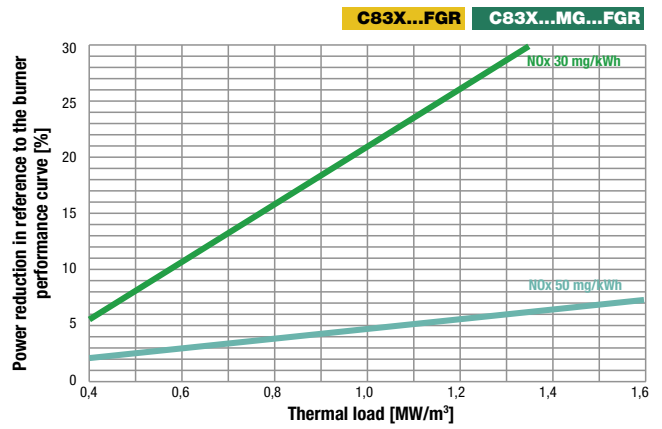
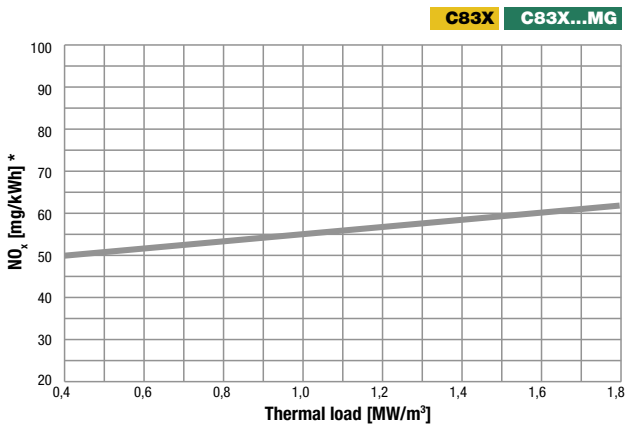


* According to UNI EN 676 correction method; p amb 1013 mbar; t amb 20°C; h 10 g/kg.

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NO_x DIAGRAM IN REFERENCE TO THE THERMAL LOAD

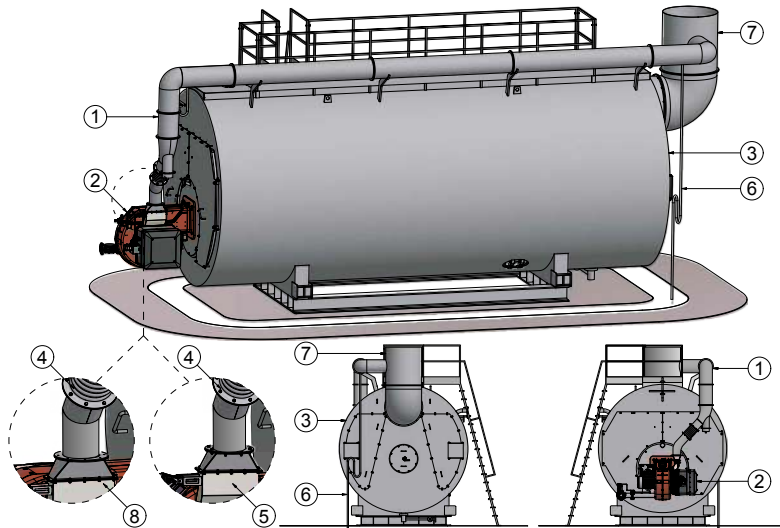
OUTPUT REDUCTION IN REFERENCE TO THE BURNER PERFORMANCE CURVE



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

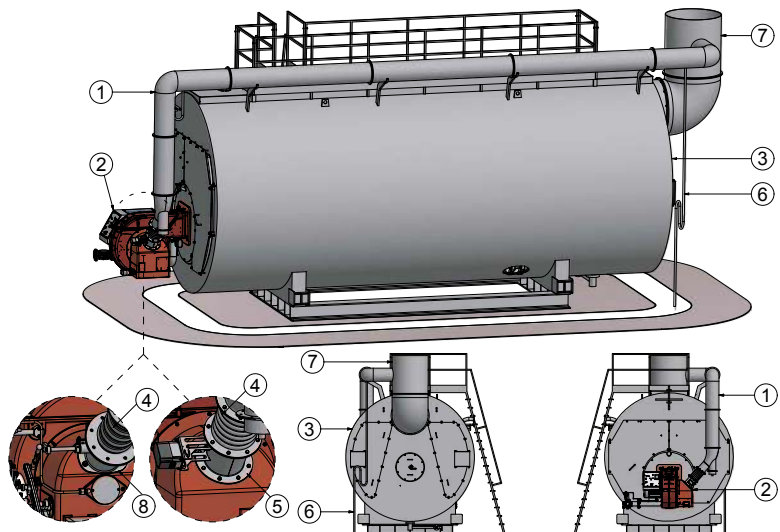
BOILER/BURNER INSTALLATION WITH FGR

BURNER WITH AIR INLET SILENCER



- Legend
- 1 - FGR pipe
 - 2 - Burner with air inlet silencer
 - 3 - Boiler
 - 4 - Antivibrating joint
 - 5 - FGR system 30 mg/kWh
 - 6 - Condensate drain
 - 7 - Chimney
 - 8 - FGR system 50 mg/kWh

BURNER WITHOUT AIR INLET SILENCER



- Legend
- 1 - FGR pipe
 - 2 - Burner without air inlet silencer
 - 3 - Boiler
 - 4 - Antivibrating joint
 - 5 - FGR system 30 mg/kWh
 - 6 - Condensate drain
 - 7 - Chimney
 - 8 - FGR system 50 mg/kWh

BURNER LIGHT-OIL: ADDITIONAL DAMPER FOR EXCLUSION FGR

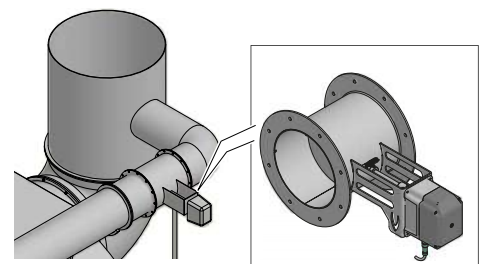
For burner Natural gas / light oil operation it is recommended to use an additional damper to close the flow of recirculation gas FGR.

Option 1: Damper with actuator

Connect the actuator to the electrical predisposition inside the electrical panel

Option 2: Damper manual

Damper manual with Opening / Closing signaling microswitches to be connected to the electrical predisposition inside the burner electrical panel.



Additional damper with actuator on chimney (option 1)

For the use of the FGR during light oil operation, please consult our sales offices.