



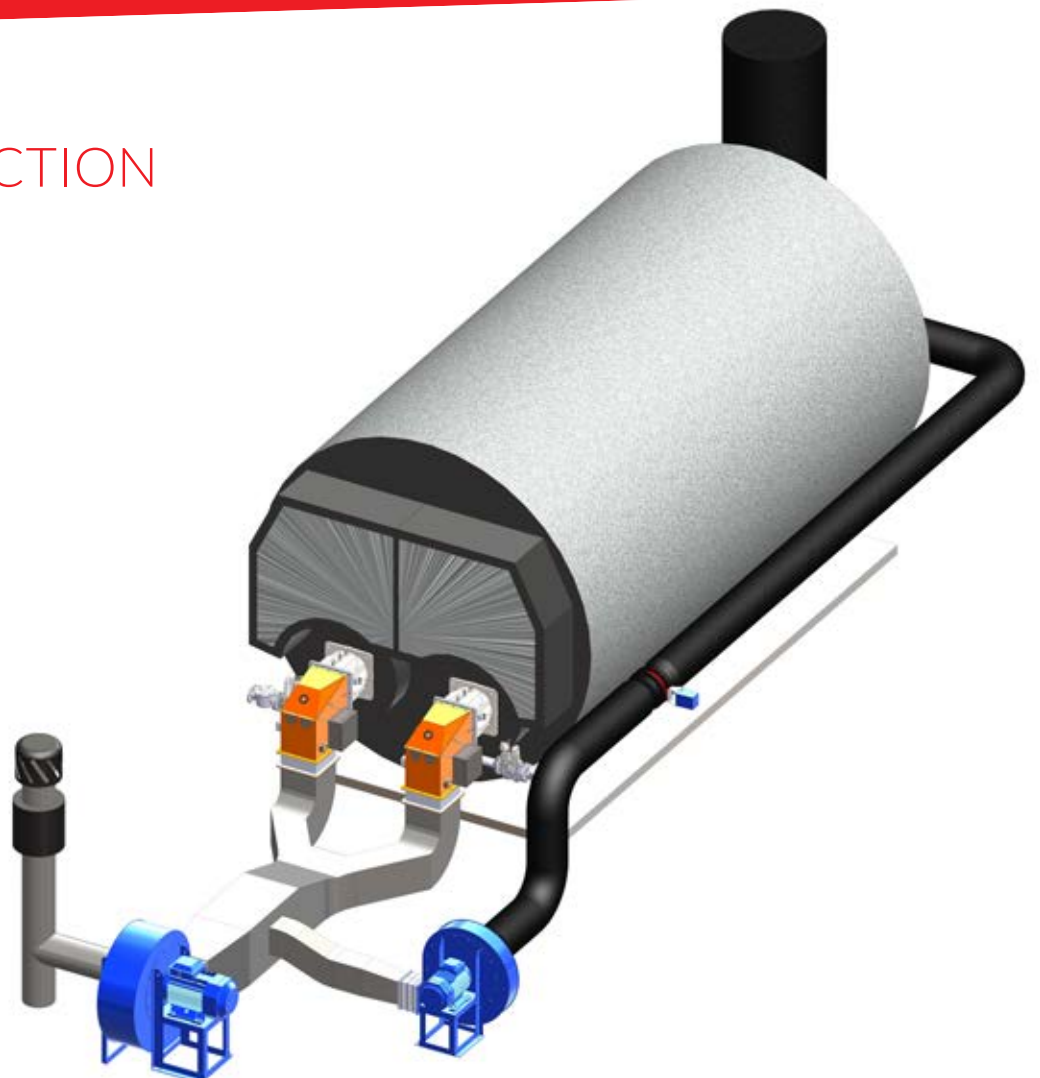
**FLUE GAS RECIRCULATION
FOR NOX REDUCTION**

baltur



FGR Flue Gas Recirculation

FOR
NOX REDUCTION



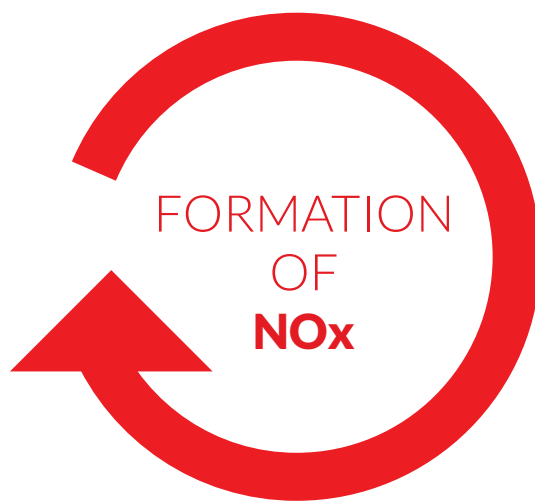


NITROGEN OXIDES

During combustion, oxygen (O_2) and nitrogen (N_2) present in the air can combine with each other in a number of ways, generating nitrogen oxides (NO_x). Among them, nitrogen monoxide (NO)

and dioxide (NO_2) are the protagonists in many pollutant processes and have an impact on health.

There are three main paths for the formation of NO_x :



1 **Thermal NO_x**

Related to flame temperature

2 **Quick NO_x**

Related to chemical reactions

3 **NO_x due to fuel**

Related to the amount of nitrogen in the fuel

FLUE GAS RECIRCULATION (FGR)

Recirculation of combustion products is a technique to reduce the flame temperature.

It consists in withdrawing a part of combustion fumes from the chimney and dilute them with combustion air, in order

to reduce the concentration of oxygen and increase the concentration of inerts (N_2 and CO_2), which in turn will absorb a part of the energy developed during combustion, thus reducing the flame temperature.



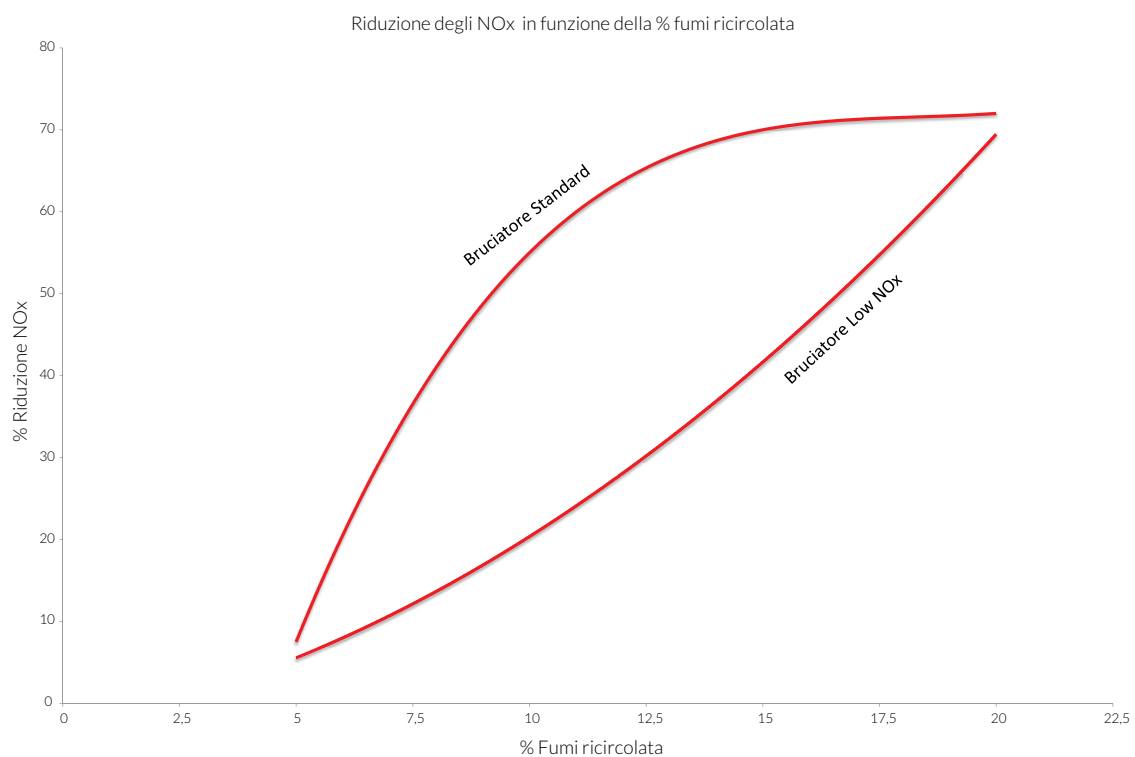
FGR APPLICATION

Fume recirculation system is successfully used in all hot water, overheated boilers and in steam generators.

REDUCTION OF NO_x

The effect obtained with this method for the reduction of NO_x, considering natural gas as fuel, is significant and is a function of:

- % of recirculated fumes
- type of burner used
- type of boiler





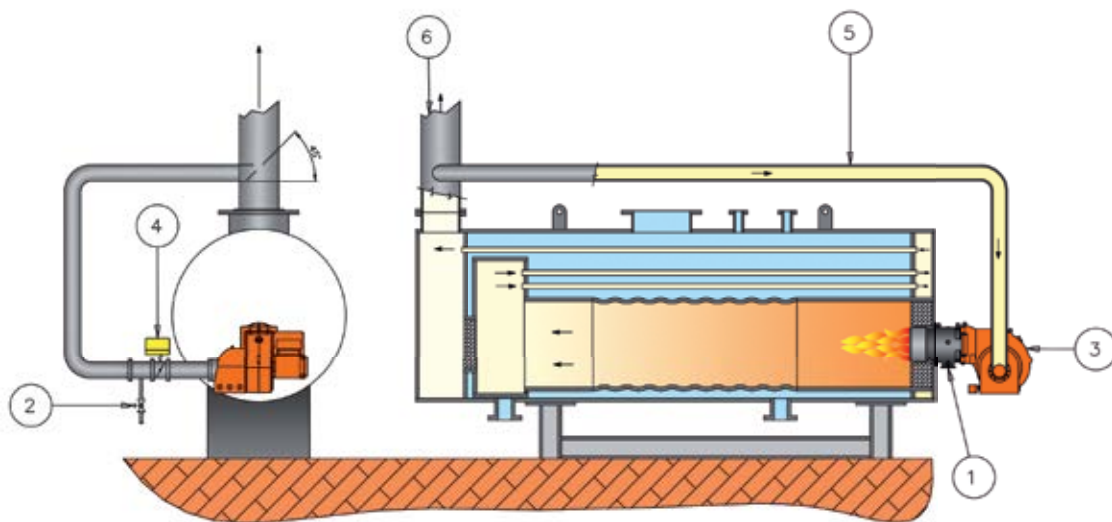
FGR FOR MONOBLOC BURNERS

For monobloc burners, the simplest method uses the burner fan to withdraw fumes from the chimney and mix them with combustion air. The fume flow rate adjustment is performed by using a servo-controlled throttle valve, managed by the electronic equipment of the burner.

This method allows to reduce the operating range of the burner, since the following occurs:

- a reduction of the amount of oxygen, at equal volume flow rate;
- an increase of combustion air temperature;
- a pressure drop due to the head losses in the recirculation ducts.

Diagram 1 - External gas recirculation for monobloc burners.



- 1** Gas inlet.
- 2** Condensate drainage valve.
- 3** Burner.

- 4** Fume damper with servomotor.
- 5** Duct for fume recirculation.
- 6** Chimney.



FGR FOR DUAL BLOCK BURNERS

Several plant solutions can be used for separated burners.

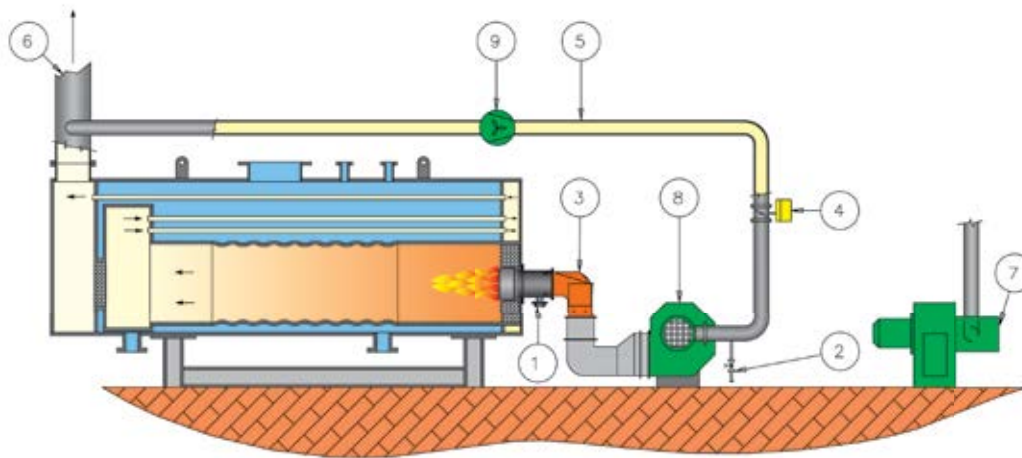
By keeping the original burner structure, it is possible to obtain:

- I) **External recirculation on the main fan intake** with adjustment of fume flow rate through a damper positioned on the recirculation duct (Diagrams in Fig. 2 and 3).
- II) **External recirculation through an auxiliary fan** with fume release downstream of the main fan and adjustment of fume flow rate through the damper, or through an inverter installed on the auxiliary fan (Fig. 4).

It is also possible to design the burner combustion head so that fumes are directly released in the combustion chamber. In this case there is:

- III) **External recirculation through an auxiliary fan** with fume release on the burner sleeve and adjustment of fume flow rate through the damper, or through an inverter installed on the auxiliary fan (Fig. 5).

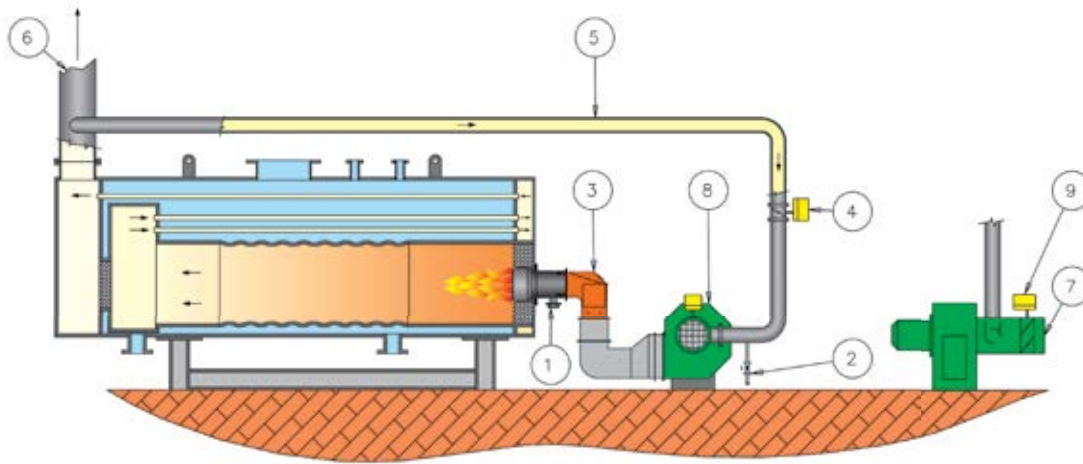
Fig. 2 - External gas recirculation for separated burners.
Fume release in the fan intake opening.



- | | |
|--------------------------------|----------------------------|
| 1 Gas inlet. | 6 Chimney. |
| 2 Drainage valve. | 7 Main fan intake opening. |
| 3 Burner. | 8 Main fan. |
| 4 Fume damper with servomotor. | 9 Fume recirculation fan. |
| 5 Duct for fume recirculation. | |

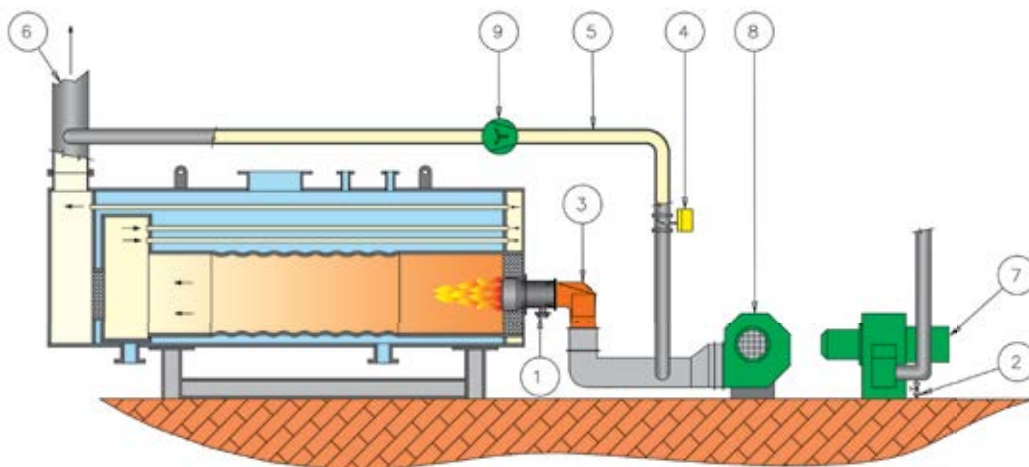


Fig. 3 - External gas recirculation for separated burners.
Fume release in the fan intake opening.



- | | |
|--------------------------------|-----------------------------------|
| 1 Gas inlet. | 6 Chimney. |
| 2 Drainage valve. | 7 Main fan intake opening. |
| 3 Burner. | 8 Fan. |
| 4 Fume damper with servomotor. | 9 Main fan adjustment servomotor. |
| 5 Duct for fume recirculation. | |

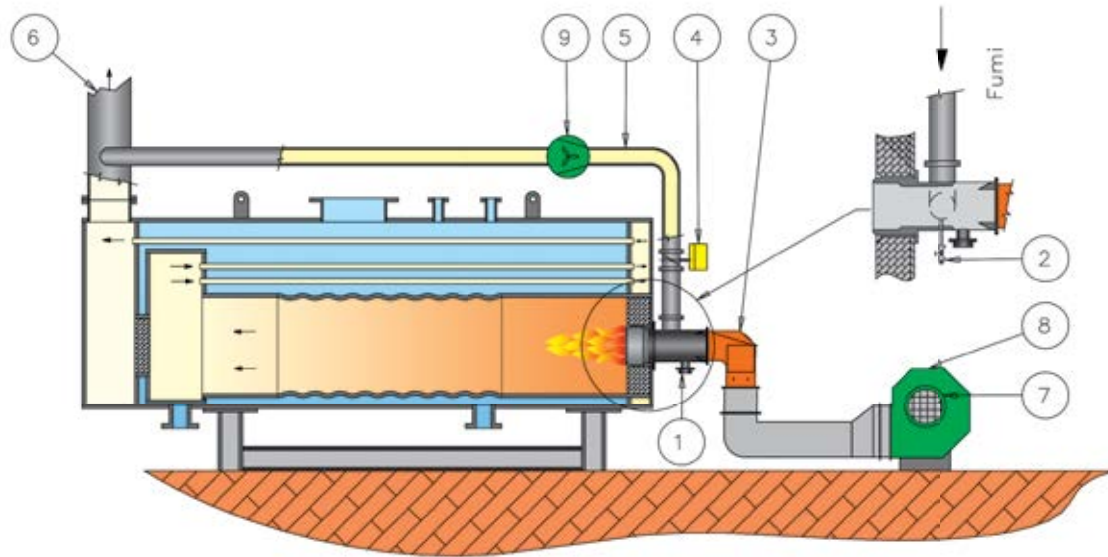
Fig. 4 - External gas recirculation for separated burners.
Fume release downstream of the main fan delivery.



- | | |
|--------------------------------|----------------------------|
| 1 Gas inlet. | 6 Chimney. |
| 2 Drainage valve. | 7 Main fan intake opening. |
| 3 Burner. | 8 Main fan. |
| 4 Fume damper with servomotor. | 9 Fume recirculation fan. |
| 5 Duct for fume recirculation. | |



Fig. 5 - External gas recirculation for separated burners.
Fume release on burner sleeve.



- | | |
|---------------------------------------|-----------------------------------|
| 1 Gas inlet. | 6 Chimney. |
| 2 Drainage valve. | 7 Main fan intake opening. |
| 3 Burner. | 8 Main fan. |
| 4 Fume damper with servomotor. | 9 Fume recirculation fan. |
| 5 Duct for fume recirculation. | |



MONOBLOC BURNER WITH FGR ARRANGEMENT.
(Fig. 1)



SEPARATED BURNER TO BE USED WITH DILUTION METHOD.
(Fig. 2 - Fig. 3 - Fig. 4)



SEPARATED BURNER TO BE USED WITH METHOD OF FUME RELEASE ON SLEEVE.
(Fig. 5)





How much recirculation?

There is not a default value, generally it depends on the type of application and the required NO_x emission values.

The assessment of the fume flow rate to be recirculated is performed by the Application Engineering technical department according to the information on the application, such as:

- NO_x values [mg/Nm₃] to reach;
- Type of boiler;
- Thermal output at furnace;
- Fuel type;
- P_{max}/P_{min} modulation range;
- Type of boiler operating fluid (hot, overheated water, steam, diathermic oil, etc.);
- Fume temperature at chimney;
- Chimney diameter;
- Estimated (or current) % of O₂ in fumes;
- System layout.





RESPECT FOR THE ENVIRONMENT



CONSUMPTION REDUCTION

CONCLUSIONS

The flue gas recirculation system (FGR) is a technique to reduce NOx emissions which is increasingly spreading thanks to the growing attention to environmental issues.

Today it represents the best compromise between **costs** and **benefits**, with a performance in terms of NOx reduction that is hard to reach with traditional burners.

The cost of FGR system implementation is relatively low if compared with the other methods for NOx reduction, and such system can be installed on existing plants.

With regard to the above, it is always recommended to contact the burner manufacturer for sizing and for the choice of fume recirculation system components.



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