TECHNICAL EVOLUTION OF LEAN GAS BURNERS FOR STEELWORK PLANTS

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1 - FEEDBACK FROM EXPERIENCE

PILLARD has fitted over one hundred thermal installations (boilers, hot gas generators, industrial furnaces...) operating with low calorific value (LCV) steelworks process gas or other process gases, for an installed working capacity of over 2 500 MW.

Amongst PILLARD's references, we point in particular to the major Power Stations, using steelworks process gas, and noteably blast furnace gas as the base fuel :

- EDF Richemont Power Station 400 MW th
- EDF Dunkerque Power Station 320 MW th
- Sollac (Arcelor Group) Méditerranée 600 MW th (sur 4 chaudières)
- EMA Power – Dunaferr (Hungary) 500 MW th (sur 5 chaudières)
- B.P. Dunkerque 180 MW th

Fig.1 : EMA POWER - Dunaferr (Hungary)

The lean gas burner designed by PILLARD have evolved over time and from feedback from experience to enable its operation to be adapted to the needs of each site, to the particularity of the fuels and to their availability.

2 - GENERAL CHARACTERISTICS OF LEAN GAS BURNERS

The general characteristics of these burners are summarised as follows :

- Fuels with low LCV > 600 kcal/Nm^3
- Very low pressure > 50 daPa.
- Significant low LCV gas volumes > 100 000 Nm^3/hR
- Power per burner unit < 60 MW
- Able to fire in cold air with cold steel gas (LCV around 650 kCal/Nm^3), without rich fuel support.
- Possibility to operate with other fuels such as coke oven gas, steelworks gas, coal tar... and to accommodate up to 4 fuels (including 3 simultaneously per burner.

The technical developments of the lean gas burners described hereafter were guided by the following requirements :

- Increased flexibility in using the various fuels
- Savings in the amount of rich support fuel used
- Increase in the power per burner unit.

Two types of burner exist in the PILLARD range :

2.1 The PILLARD type "K" burner

This burner is simple, robust and characterised by the following :

- A peripheral injection of combustion air by rotating jets creating a non-adjustable swirl
- A central injection of the lean gas
- A central low pressure injector for alternative or support fuels
- A stabilisation refractory quarl
- LCV performance :
  - Maximum LCV acceptable without support, cold air : 720 kCal/Nm^3
  - Minimum LCV acceptable without support, hot air : 650 kCal/Nm^3

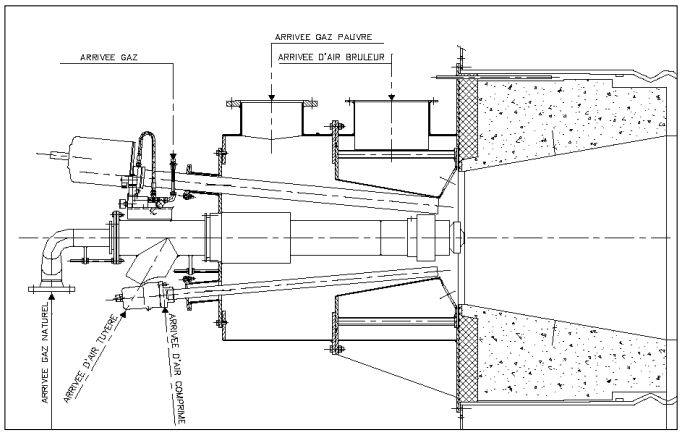
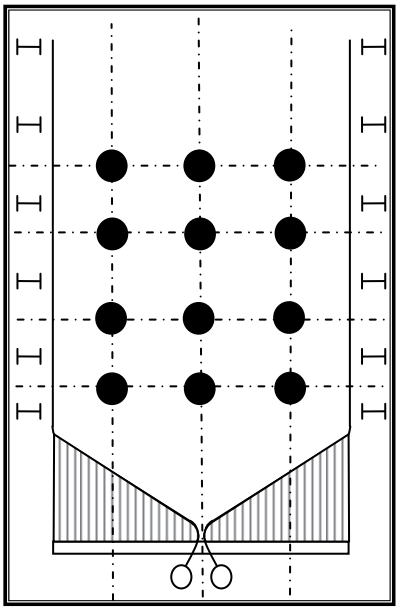


Fig.2 : PILLARD type K burner

Example : Burners at the EDF Power Station, Richemont (57) France :

- Power per unit : 35 MW
- Main fuel : Blast furnace gas PCI : 600 à 750 kCal/ Nm^3
- Alternative fuel : Heavy oil (or as a support if LCV < 650 kCal/Nm^3)
- Support fuel : Propane (start-up or LCV < 650 kCal/Nm^3)



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⇦ Fig.3 : Type K burner – EDF Richemont Power Station–400 MW boiler

2.2 - PILLARD KFT type burners

To ease simultaneous combustion of alternative fuels, thereby increasing operational flexibility, PILLARD developed the KFT burner with an adjustable air register, characterised by :

- A peripheral injection of lean gas through a windbox with a very low pressure drop
- A central air injection with an adjustable swirl air register enabling :
  - An optimised swirl adjustment according to the various fuels and furnace characteristics.
  - An improved mix with alternative rich fuels (coke oven gas, heavy oil, natural gas...) therefore allowing their simultaneous injectin in the air path together with the lean blast furnace gas, which is injected in periphery.
- The use of different injection technologies of various fuels (central gas pipe, gas ring, oil gun with assisted atomisation...) compatible with their simultaneous use.
- LCV performance without support :
  - Acceptable LCV with cold air 720 kCal/Nm^3
  - Acceptable LCV with hot air 650 kCal/Nm^3

Example : KFT B34 burner : Sollac (Arcelor Group), Fos s/mer (13) France :

- Power per unit : 35 MW
- Main fuel : Blast furnace gas LCV : 710 to 850 kCal/ Nm^3
- Alternative fuels : Heavy fuel (or support if LCV < 750 kCal/Nm^3)
  Coke oven gas
  Coal tar

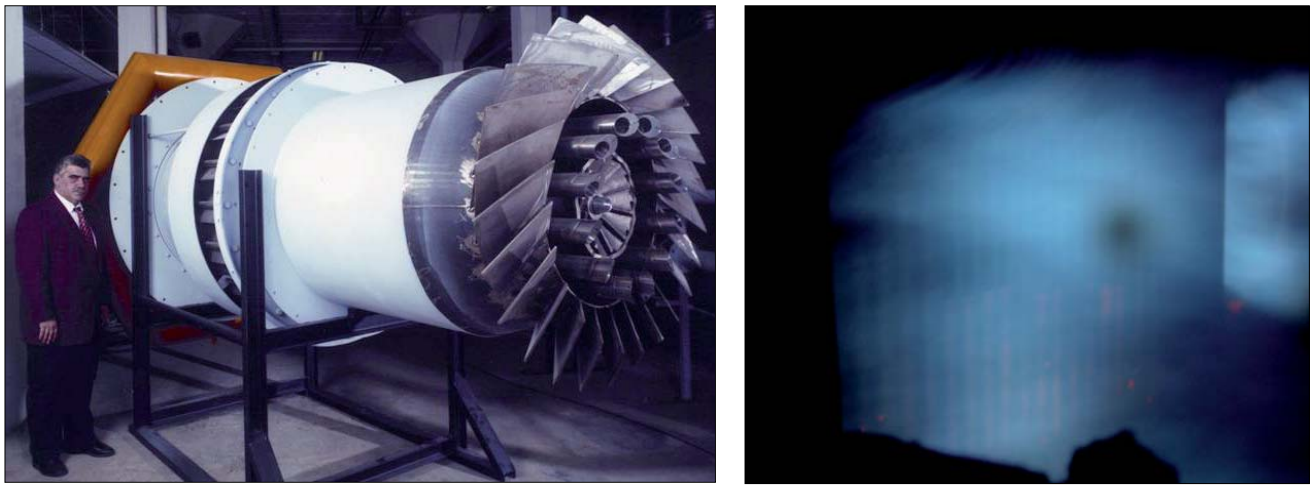

Fig.4 : 35 MW KFT burner, SOLLAC (Arcelor Group), Fos s/mer (13) France

To reduce or eliminate the potential use of a support fuel, and to increase the unit power of the burners (45 to 60 MW), improvements were made to the fuel/gas mixture in order to ensure stability in the absence of the hot point generated by the support fuel, and/or in spite of significant cold lean gas volumes implemented.

2.3 - The latest version of the KFT burner incorporated the follwing improvements :

- Injection of secondary air staged with adjustable flow allowing the injection of lean gas with very low LCV between two streams of air and for stabilisation of the flames at the refractory quarl throat.

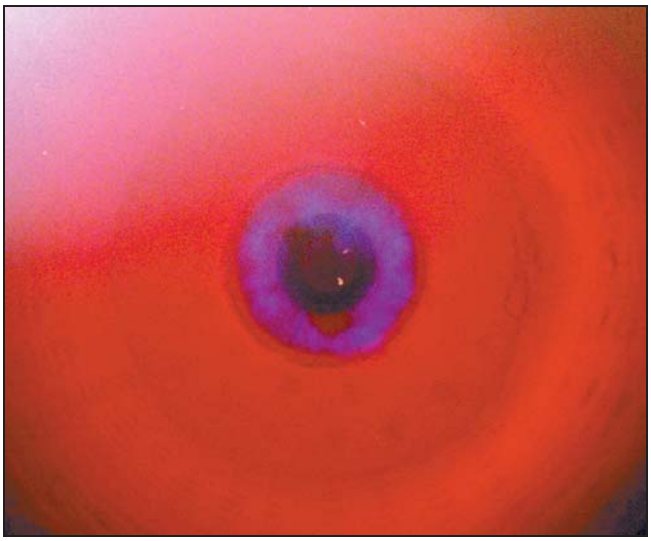

Fig.5 : KFT TBP burner flame

(Further details are the subject of a recent patent application and cannot therefore be divulged in this article).

This improvement has the advantage of further increasing the flexibility of optimization due to the fact that at start-up the air-lean gas mix staging can be adjusted, and, if useful, reduce the excess oxygen in the primary flame zone, which favourably influences its stabilisation and also the emission of NOx and CO at the furnace rear.

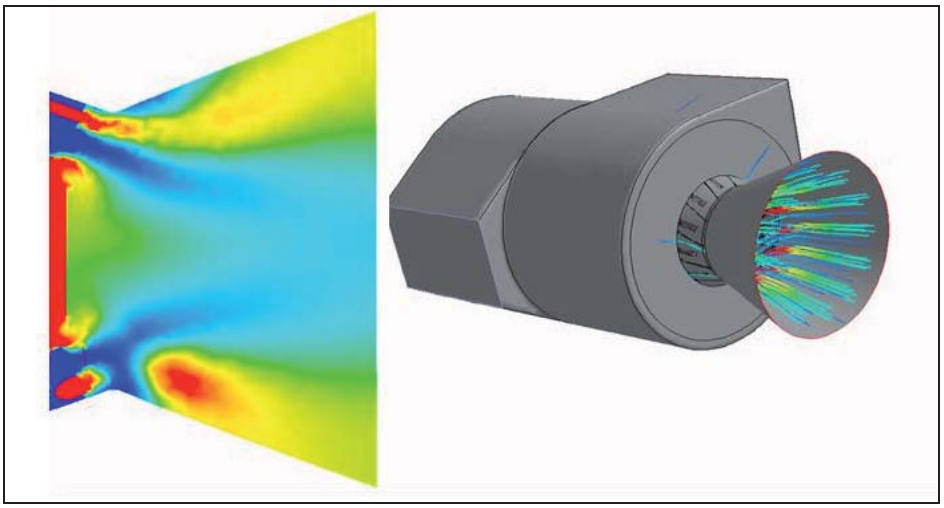

Fig.6 : KFT type burner : air / lean gas mix staging

3 - CONCLUSION

PILLARD's K and KFT burners are characterised, in addition to their operational flexibility with numerous simultaneous gases, by a good emission performance. Recent emission performance checks show :

- Reduced oxygen at nominal load (< 3% dry basis)
- NOx emissions << 100 mg/Nm^3 @ 3% O_2
- CO emissions << 100 mg/Nm^3 @ 3% O_2

Example of emission performance (2004) :
80 MW boiler / 4 KFT burners / Dunaújvaros – for EMA Power-Dunaferr (Hungary)
Load : 100 % : NOx : 24 mg/Nm^3 @ 3% d'O_2 / CO : Traces (< 10 mg/Nm^3 @ 3% d'O_2)

The 40 years experience in lean LCV gas combustion makes it possible for PILLARD to bring sure solutions, adapted to the multi-fuel availability at each site, with emission performances conforming to new European regulations.