GE
Oil & Gas

LHE Liners
to Reduce NOx Emissions

Benefits

- ☐☐☐ Increased production
- ☐☐☐ Higher efficiency
- ■■■ **Compliance with environmental regulations**
- ☐☐☐ Availability and Reliability
- ☐☐☐ Life extension

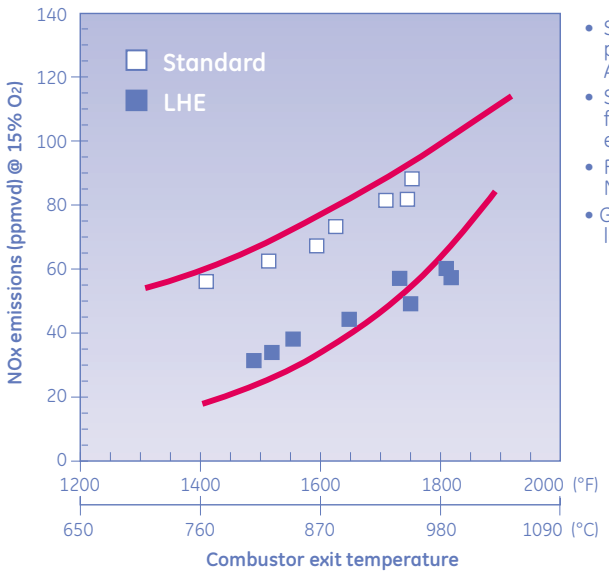
LHE liners **reduce NOx emission levels** and can be installed **without modifications** at the first scheduled maintenance inspection.
NOx emission reduction depends on the Frame model type: 20% NOx reduction is normally achieved.

What it is

LHE liners have a new louver or slot pattern, which reduces NOx emissions. All of these hi-tech liners have a Thermal Barrier Coating (TBC) coating to improve life. The crossfire tube collars have hard facing applied (on liners and crossfire tubes) to reduce wear. The option of applying hard facing to the fuel nozzle collars is also available upon request.
The figure on the right compares an MS5001P LHE liner to a standard liner. The liner to the right is the LHE liner. It has extra holes near the head (flame) end and also has a different louver pattern compared to the standard liner.

What it is

GE Oil & Gas have extensive field experience with these liners. The earliest version of this design was first introduced in the Frame6 and has run successfully on several units with thousands of fired hours. The first application on the MS5001P with dual fuel capability was in 1986. A field test was performed to evaluate all parameters, and this liner has been in operation in over 130 units.
The first application of an LHE liner on an MS5002 was in 1997.
Field test data for MS5002 simple cycle LHE liners are shown on the right.



- Symbols are field test points collected in Alaska, September 1997
- Solid lines are expectations, from scaled lab NOx emissions
- Field test confirmed -40% NOx reduction at base load
- Good agreement between lab and field

How it works

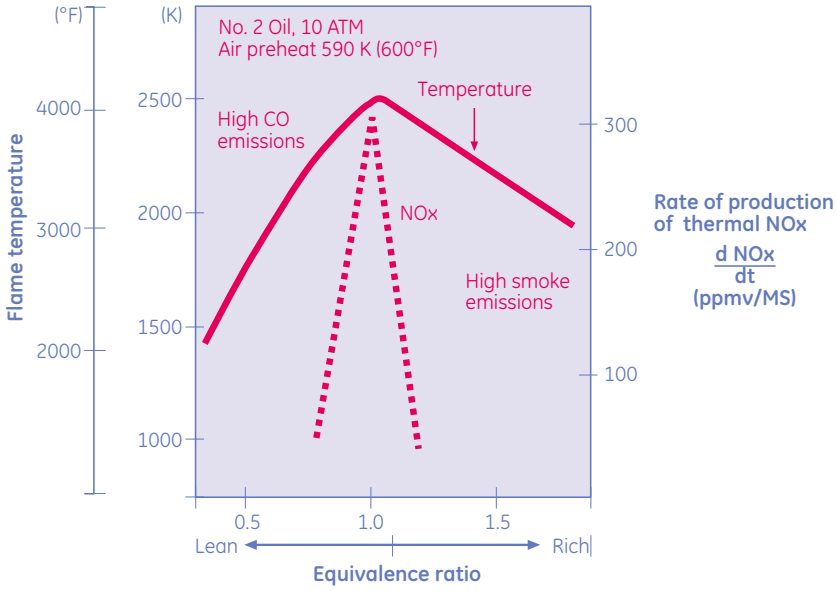
Since the overall combustion system equivalence ratio must be lean (to limit turbine inlet temperature and maximize efficiency), the first efforts to reduce NOx emissions were naturally directed toward designing a combustor with a leaner reaction zone. As most gas turbines operate with a large amount of excess air, some of this air can be diverted toward the flame end, which reduces the flame temperature.
Leaning out the flame zone (reducing the flame zone equivalence ratio) also reduces the flame length, and thus reduces the residence time a gas molecule spends at NOx formation temperatures. Both these mechanisms reduce NOx. The principle of a LHE liner design is shown on the right hand figure.
It quickly became apparent that the reduction in the primary zone equivalence ratio at full operating conditions was limited because of the large turndown in fuel flow (40 to 1), air flow (30 to 1) and fuel/air ratio (5 to 1) in an industrial gas turbine.

Furthermore, the flame in a gas turbine is a diffusion flame, since the fuel and air are injected directly into the reaction zone. These parameters essentially limit the LHE liner technology to a maximum NOx reduction of 40%. Depending on the liner design, and the ambient conditions, the actual reduction achieved varies from 15% to 40%.

Scope of Supply

LHE liners are directly interchangeable with standard advanced technology liners.
The scope of supply includes:

- LHE Cap and liner arrangement with TBC coating
- Crossfire tube set
- Crossfire retainers



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