

PCI's Rich Catalytic Lean burn (or RCL[®]) system offers many desirable features for gas turbine applications, including ultra-low emissions and enhanced stability, without efficiency penalty and across a wide turndown range.

The system uses a rich catalytic reactor with air cooling and subsequent mixing of the reactor output with the cooling air to form a lean mixture for final combustion. This lean mixture can then be burned stably in a downstream combustion zone with lower NO_x and CO emissions and greater combustion stability than with DLN/DLE technologies. Since the catalytic reactor is operating under fuel rich/oxygen limited conditions, the same reactor can operate with a variety of fuels. The RCL[®] Combustor has been operated with multiple fuels including natural gas, syngas, low BTU gas, gasoline, refinery fuel gas and pre-vaporized diesel. Low BTU gases examined include Blast Furnace Gases (BFG) and highly diluted fuels such as landfill and digester gases. RCL[®] Combustors are insensitive to Wobbe index variation and have demonstrated ultra-low emissions (NO_x<3, CO<10 ppm) at 15-17 atm over a wide turndown.

Performance highlights include:

- Compact – can fit to existing engine envelopes and is retrofittable.
- High firing temperature (F-class) ; robust operation
- Long catalyst life (design life = 25,000 hours)
- Reduced combustion acoustics enabling improved component life
- NO_x <3 ppm and CO <10 ppm across wide turndown
- Pressure drop <5%
- No preburner required for operation

This technology has been demonstrated with natural gas DLE engines and delivers significant operating and cost benefits including :

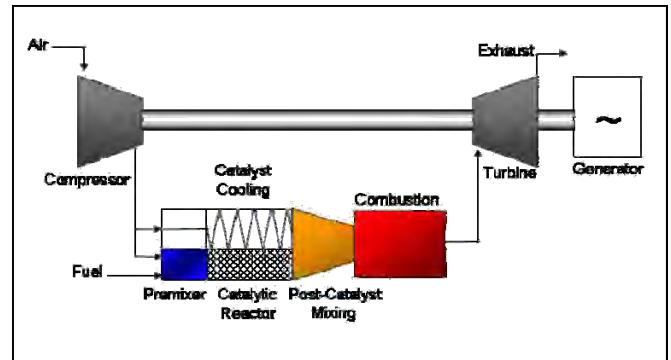
- Improved system turndown, operability and flexibility
- Extended catalyst life
- Reduced system capital and operating costs
- Robust reactor

Fuel flexibility demonstrated:

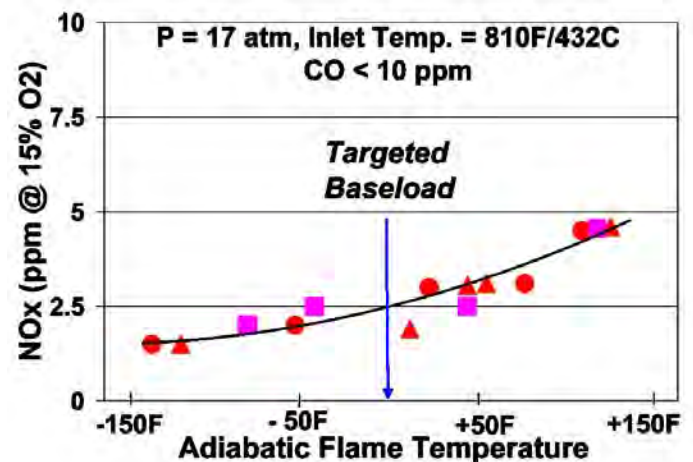
- Performance insensitive to composition of natural gas
- Delivers ultra-low emissions for high H₂ refinery gas
- Capable of operating with low Btu fuels



RCL[®] catalytic combustor



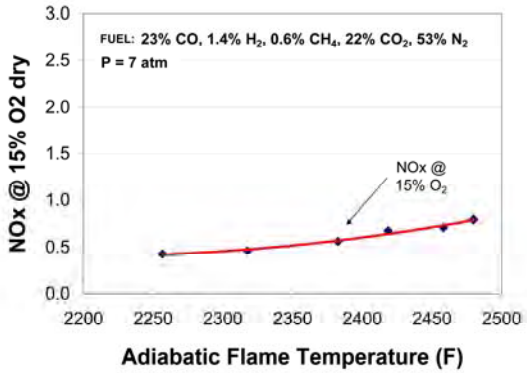
Typical RCL[®] system schematic



Reference: "Advanced Catalytic Pilot for Low NO_x Industrial Gas Turbines", *Journal of Engineering for Gas Turbine and Power*, GT30083, Vol. 125, pp 879-884, October 2003 .

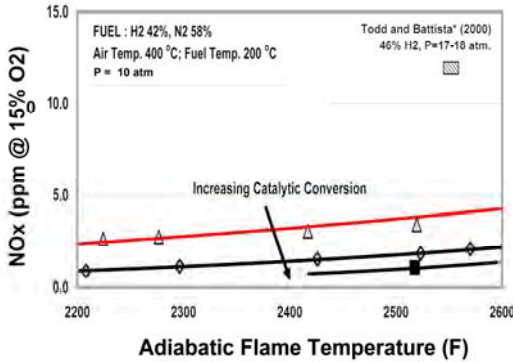
The tables on the following pages illustrate the performance and benefits of using the RCL[®] system with a variety of gas combinations.

RCL® Combustion of Blast Furnace Gas (BFG)



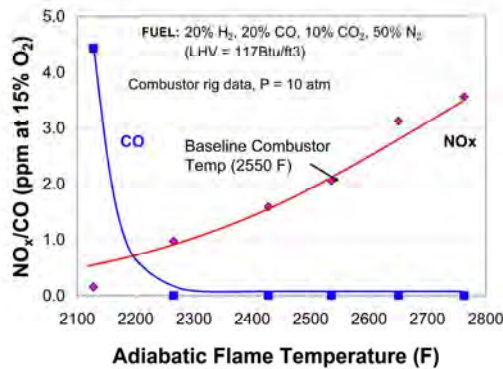
- Fuel Composition: 23% CO, 1.4% H₂, 0.6% CH₄, 22% CO₂, 53% N₂
- Significant diluent: peak (stoichiometric) flame temperature ~ 2700 F
- Ultra low, single digit NOx (1 ppm) and CO near-zero for combustion temperatures 2250-2500 F
- Catalyst provides good combustion stability with no co-firing for a difficult-to-burn fuel
- Successful operation on low Btu fuel gas (<90 Btu/SCF), with NOx and CO < 2 ppm

RCL® Combustion of Hydrogen (H₂)



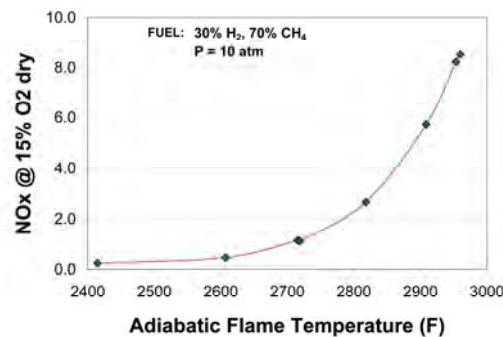
- Fuel Composition: 42% H₂, 58% N₂
- NOx < 3 ppm for combustion temperatures 2250-2500 F
- Robust operation at multiple hydrogen/nitrogen ratios.

RCL® Combustion of Low Emissions Syngas



- Fuel Composition: 20% H₂, 20% CO, 10% CO₂, 50% N₂
- NOx = 2 ppm @ IGCC F-engine baseload (2550 F comb. temp.)
- NOx < 3 ppm and CO near-zero for temperatures 2200-2700° F.
- Pressure drop < 5% for syngas operation
- Wide turndown.

RCL® Combustion of Refinery Fuel Gas



- Fuel Composition: 30% H₂, 70% CH₄, no diluent
- NOx < 3 ppm and CO near-zero for combustion temperatures < 2400-2800° F
- Pressure drop < 3% for natural gas / refinery gas
- Reactor preferentially converts H₂: delivers mainly CH₄ to downstream combustion zone.

Graphs taken from the paper "Rich-Catalytic Lean-Burn Combustion for Low-Single-Digit NOx Gas Turbines", *Journal of Engineering for Gas Turbines and Power*, January 2005, Volume 127, Issue 1, pp 27-35.

To learn more about how this technology may be applied in your gas turbine application, please contact:

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