Lean Burn Gas Generator Sets

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ABSTRACT

The use of lean burn natural gas engines over the years has been well proven to meet the ever-growing demand of important criteria, such as fuel efficiency, emissions performance, air regulations, reliability, durability and power density, of any reciprocating engine used in electric power generation.

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INTRODUCTION

With the ever-developing world of reciprocating gas engines, never has there been a time more progressive than today that we see technologically advanced, fuel efficient and economical gas engines. One such combustion technology that has often been successful across several electric power generation applications is the use of lean burn technology in gas engines. Lean burn gas engines can operate at higher loads, offer lower emissions, clean and consistent electricity and better efficiency and be more efficient overall.

LEVEL SETTING: LEAN BURN & RICH BURN

Lean burn gas engines are characterized by lower fuel consumption and lower emissions than rich burn engines operating at a balanced stoichiometric ratio (air-fuel ratio or Lambda is unity). The higher efficiency of lean burn engines is primarily due to their ability to achieve a higher power for a given displacement. Comparing two similar sized rich burn and lean burn engines producing similar power at similar efficiencies, the temperatures produced by a rich burn engine don't make achieving the power density of lean burn practical. A **rich burn** engine is characterized by excess fuel in the combustion chamber during combustion (oxygen in exhaust typically ranges from 0.5%-0.6%), while a lean burn engine is characterized by excess air in the combustion chamber (oxygen in exhaust is typically >6%).

Characteristics of lean burn and rich burn

Lean Burn

- Lower exhaust temperature
- Lower exhaust NOx and CO emissions
- Higher power density
- Better fuel efficiency

Rich Burn

- Higher exhaust temperatures
- Higher NO_x emissions (due to higher exhaust temperatures)
- More complete fuel consumption
- Lower power density

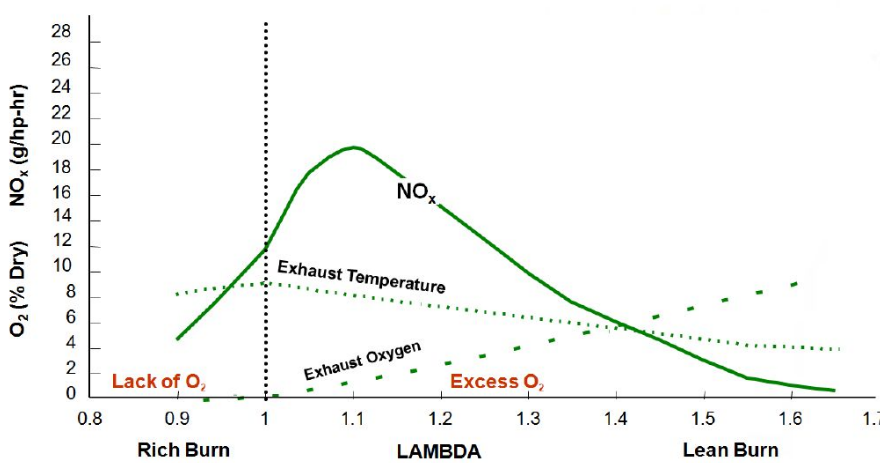

Figure: The graph above shows the effects of progressively leaner air/fuel mixtures

Lean burn engines use less fuel for a given amount of air—usually up to twice the amount needed for complete fuel combustion—making them more cost effective in terms of fuel consumption and releasing fewer greenhouse gases. Air dilution effectively cools down peak combustion temperatures in the cylinder, reducing NOx production and allowing lower engine-out emissions without the need for an aftertreatment system in many applications. This lean combustion process has the additional advantage of reducing the knock (detonation) probability, allowing for higher brake mean effective pressure (BMEP) levels (loads) and optimized combustion. This results in higher power density and usually produces better fuel efficiency.

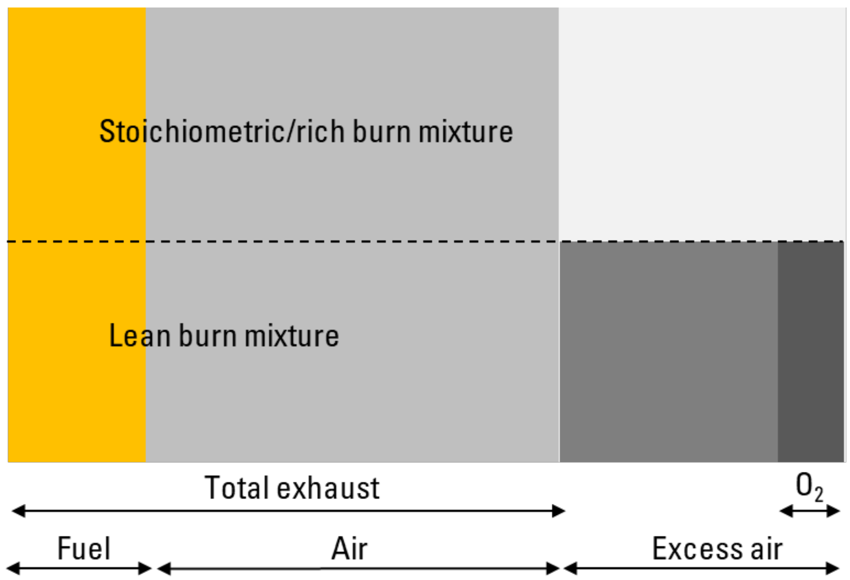

Figure: Rich burn combustion air/fuel ratio (top) vs. Lean burn combustion air/fuel ratio (bottom)

The lean burn concept is an impressive technology used to design a low-emissions natural gas engine. Using an efficient air-gas management system—in addition to sophisticated engine technology—helps lean burn gas engines meet government-initiated emissions regulations. This air-gas management system not only helps with controlling emissions levels but also the resources and costs of an expensive aftertreatment typical to a rich burn system, which uses a three-way oxidation catalyst to reduce NOx produced due to higher cylinder temperatures, not to mention the demands of generating continuous, affordable and dependable electrical power.

Controlling the engine with modern microprocessor-based technologies—like the Electronic Control Modules (ECM) managing the microprocessor-based throttle and the air-fuel ratio control pushing pre-mixed air and gas into the engine cylinders and ignition, providing constant feedback to the ECM by NOx, temperature and pressure sensors—makes the lean burn engine gas management system more reliable than ever. With air-gas mixer systems, standby and demand response applications with lean burn engines can achieve 100% block loads while meeting NFPA requirements.

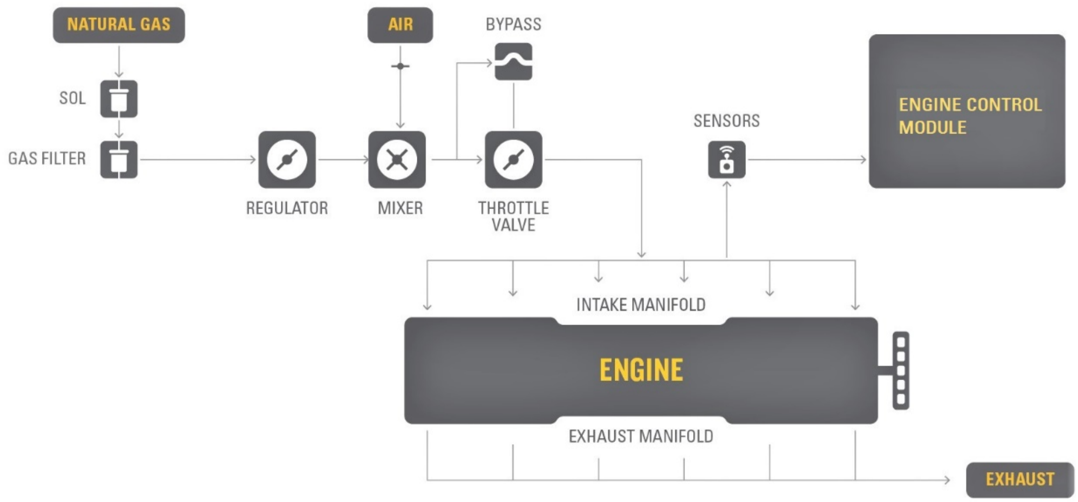

Figure: Cat® Lean burn technology for natural gas engines used on 350-500 ekW Cat CG18 Genset

Geographical approach and Sustainability

Over the years, the demand for electrical power produced by gas engines has grown at a stable pace due to strict emissions laws and ever-growing utility power costs. Regions susceptible to hurricanes, water and wastewater applications and projects on the coastline leading to the risk of diesel contamination have made the use of gas engines even more relevant and the desired choice for several contractors and engineers.

With a relentless focus on maintaining the lowest emissions and considering global weather conditions, lean burn engines used for producing electrical power can be considered a timely solution to more stringent environmental regulations in the new era united collectively with lower fuel consumption and CO2 emissions.

LET'S DO THE WORK.™

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