Cummins high performance lean burn gas generators – Technology of tomorrow, unleashed today!

- There are two basic types of reciprocating engines – spark ignition (SI) and compression ignition (CI). Spark ignition engines for power generation use natural gas as the preferred fuel, although they can also be set up to run on propane, gasoline, or landfill gas. Compression ignition engines (often called diesel engines) operate on diesel fuel or heavy oil.

- Diesel engines are increasingly confined to emergency standby because of spiraling fuel costs, storage issues and air emission concerns particularly in the West. Consequently, the natural gas-fueled SI engine is now the engine of choice for the higher-duty-cycle stationary power market and is driven by economic and environmental pressures for power density improvements (more output per unit of engine displacement), increased fuel efficiency and reduced emissions.

- A lean-burn gaseous fueled generator set is a very good alternative to diesel or stoichiometric gas powered generator sets.

- Lean-burn technology uses high air to fuel ratio (λ=1.7) and excess oxygen to gain overall output efficiency at greatly reduced NOx emissions. These efficiency levels often exceed those of equivalent sized diesel products. Exhaust emissions are significantly lower than stoichio¬metric gas engines (λ=1) and greatly reduced from a diesel.

Why is a lean burn gas generator more expensive than a diesel generator of the same size?

- Many natural gas spark ignition engines are derived from diesel engines, i.e., they use the same block, crankshaft, main bearings, camshaft, and connecting rods as the diesel engine. However, natural gas spark ignition engines operate at:

  1. Modest compression ratios in the range of 9:1 to 12:1 (compared with diesel engines in the range of 12:1 to 17:1) to prevent auto ignition and knock which can cause serious engine damage,
  2. Lower brake mean effective pressures (BMEP - 16 to 18 bar compared with 24 bar of diesel) and
  3. Peak combustion pressure levels (120 bar vs. 180 bar for diesel engine).

- Due to the essentially lower BMEP, the spark ignition versions of diesel engines often produce only 60 to 80 percent of the power output of the parent diesel. Consequently, the $/kW capital costs of natural gas spark ignition engines are generally higher than the diesel engines from which they were derived.

How does a lean burn gas engine behave when subjected to high starting torques?

- Lean-burn combustion technology results in more complete combustion of the gaseous fuel and cooler combustion temperatures. However, there is a trade off for the improved efficiency and emissions, which is:

1. The rapid starting as compared to a diesel engine and
2. High percentage of single step load acceptance capability.

- A diesel powered generator set is generally fast responding and able to pick up large load steps without reasonable voltage and frequency variation. Often a diesel can pick up 100 percent of rated power in a single step and recover quickly. The load step capabil¬ity of a lean-burn gaseous generator set is normally in a range of 10-75 percent. The difference in response is a result of the differences in fuel delivery systems of the CI and SI engine technologies. The wide range of percentage difference in SI engines is due to the various system technologies within the lean-burn spectrum.

What is the difference between lean burn engines designed for efficiency and performance?

- Within the spectrum of lean-burn technology generator sets there are two types, one optimized for performance (tolerance to temperature, altitude and load steps), the other opti¬mized for efficiency. The later uses a single large turbo charger as opposed to multiple turbo chargers. These higher efficiency models are designed primarily for operation parallel to a utility grid and pose challenges when operating in Island mode (not connected to a utility grid).

- The greatest trade-off of these single turbo models is the ability to pick up a large load in a single step. While Cummins multi-turbo units with twin governors, twin actuators, twin gas control valves can pick up a load step of 50-75 percent of rating with reasonable performance, single turbo, high efficiency models are limited to 10-25 percent of the advertised rating. Single turbo units can be utilized in island mode only after special attention is paid to the load step size and sequence.

Why the maintenance intervals of a lean burn gas generator high compared with a diesel engine?

- Operation of a lean burn SI engine at lower BMEP and smaller peak combustion pressures results in substantially lower loads on the engine components and the bearings. This when combined with cleaner combustion environment of natural gas keeps the lube oil cleaner and healthier for longer. As a result of these, spark ignition engines offers the benefits of substantially extended component life (to the order of twice and beyond) compared to their diesel parents. This is why we find time to overhaul of 60,000 hours and even beyond for a 16 BMEP SI engine.

What is the advantage of a lower BMEP SI engine over a higher BMEP machine?

- Some manufacturers of lean burn SI engines offer higher BMEP vs. Cummins (18 bar instead of 16 bar). Higher BMEP levels increase power output, improve efficiency, and result in lower specific costs ($/kW). BMEP is increased by forcing a larger mass of cooler and denser air through increased turbo charging (defined as air compression by a turbine driven by exhaust gases boosting air pressure on a 3:1 to 4:1 ratio), improved after-cooling (LT cooling circuit) etc. However, higher BMEP increases thermal and pneumatic stresses within the engine, and poses issues with regard to continued engine durability and reliability. We may also see increased engine oil consumption.

How does a lean burn engine respond to fuels other than natural gas?

- Lean-burn technology has the ability to operate on gas with a wide range of quality. A measurement called the Methane Number (MN) is used to determine fuel gas suitability as an engine fuel. Most natural gas has a MN from 70 to 97, and pipeline quality gas typically has an MN of about 75. Gas from landfills or sewage treatment facilities is typically of lower quality, but is often suitable for use in lean-burn engines. Cummins' lean-burn gas engine generators can operate on gas with a MN of 50 or greater, providing excellent fuel flexibility. However, gas with a MN below 70 may require derating of the generator output.