

# EGCR-2008

---

## Introductory course

1. Introduction to Caterpillar Gas Engines
  - A. Sizes and horsepower ranges
  - B. Why use natural gas as fuel
  - C. Applications of natural gas engines
    1. Gas compression
    2. Landfill, Biogas
    3. LPG
2. Basic operational characteristics of natural gas engines
  - A. Caterpillar engines are 4 stroke, spark ignited engines
  - B. Types of ignition are magneto, electronic, ADEM III
  - C. Dry and wet ignition coils are used depending on the engine model and age.
  - D. Built on a diesel engine frame (block, heads, crankshaft)
  - E. Power is limited on diesel engines by structural limitations
  - F. Power is limited in natural gas engines by thermal limitations.
  - G. Diesel engines admit a constant air volume per stroke with fuel varying by the amount injected into the cylinder.
  - H. Natural gas engines vary the amount of air/fuel mixture entering the cylinder using a carburetor.
3. Rich burn (Stoichiometric) vs. Lean burn
  - A. Exhaust temperature comparison load vs. temp gas/diesel: gas rich/lean
  - B. Exhaust emission comparison  $\text{NO}_x$  in rich and lean burn and also  $\text{NO}_x$  formation in the cylinder.
  - C. Explain  $\lambda$  and compare stoichiometric vs. Lean Burn
4. Methane Number and Cat Methane Number Program
  - A. Methane Number, Engine Timing, and detonation
  - B. Analogy to Octane Number
  - C. Difference between Detonation and Preignition
  - D. Root Causes of detonation (fuel mixture, reactive radicals in end gasses)
  - E. Factors Influencing Detonation/Preignition
    1. Fuel Characteristics
    2. Compression Ratio
    3. Mixture Temperature
    4. Ignition Timing
    5. Load (BMEP)
    6. Air/Fuel Ratio
  - F. Fuel quality and filtration
    1. Removal of Abrasives,  $\text{H}_2\text{O}$ , Sulfur, Halides, Light Ends (Pentane, Heptane etc.)
    2. Effect of fuel contaminants on engine
    3. Removal of contaminants
5. Carburetor operation and adjustment, Emissions adjustment.
  - A. Explain operation of IMPCO Carburetors
  - B. Emission screw (Power Valve) adjustment
  - C. Emissions adjustment at full load ( $\text{NO}_x$ ,  $\text{O}_2$ )
  - D. Why it is better to use  $\text{NO}_x$  to adjust emissions

6. Sensors
  - A. O<sub>2</sub>,
  - B. H<sub>2</sub>O temp/press
  - C. Oil temp/press
  - D. Magnetic speed pickup
  - E. Speed/Timing (Hall Effect) sensor
  - F. Manifold Air Press
  - G. Cyl. Inlet Air Temp
  
7. Wastegate, boost control, aftercooler
  - A. Operation and Effect
  - B. How a Wastegate works
  - C. Purpose of Aftercooler, effect on performance
  
8. Gas regulators and balance line
  - A. Regulators job
  - B.  $\Delta P_1 - \Delta P_3$
  - C. Minimum Gas Pressure Calculations
  
9. Ignition Systems
  - A. Magnetos
  - B. EIS
  - C. A3

**Instructor: Rob King**