Diesel Generator

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Overview

1. What is a diesel generator
2. Diesel vs gasoline
3. Diesel generators and the grid
4. Diesel generator Maintenance
5. Enhancements in diesel generators
6. Hybrid diesel generator
What is a diesel generator
Diesel generator history

• The first electromagnetic power dynamo was built by Michael Faraday in 1831 which produced a small DC voltage. “Faraday Disk”

• In 1882, a British electrician, J. E. H Gordon built a large two-phase alternating current generator

• Diesel engine was developed by Rudolf Diesel in the 1890’s

• February 17, 1897 was the first successful test at 26.2% efficiency (steam engine was 6% and gasoline was 12%)

• 70,000 working diesel engines by the end of 1912

1 cylinder, four-stroke, water-cooled, air injection of fuel
Output: 14.7 kW (20 hp)
Fuel consumption: 317 g/kWh (238 g/hp-hr)
Efficiency: 26.2%
Number of revolutions: 172 min-1
Displacement volume: 19.6 L
Bore: 250 mm
Stroke: 400 mm
Basics of diesel engine operation

https://www.britannica.com/technology/diesel-engine
Diesel genset parts

1. Engine
2. Alternator
3. Fuel System
4. Voltage Regulator
5. Cooling & Exhaust Systems
6. Lubrication System
7. Battery Charger
8. Control Panel
9. Main Assembly Frame

https://dieselgeneratordirect.uk/how-does-a-diesel-generator-work.html
Diesel vs gasoline
Diesel vs. gas engine

ADVANTAGE of Diesel

- Evaporates slower than gasoline -- its boiling point is actually higher than the boiling point of water.
- Less refining to create diesel fuel, which is why it used to be cheaper than gasoline
- Higher energy density than gasoline. (30% more)
- Less frequency in maintenance
- Less hazardous to start a fire

ADVANTAGE of Gasoline

- Lighter and more compact
- Fuel does not “gel” in cold temperatures as diesel does
- Lower maintenance cost
- Faster response to load changes
Diesel vs natural gas generator
Diesel vs. natural gas generator

ADVANTAGE of Diesel

- Lower installed cost ($856/kW vs $920/kW)\(^1\)
- Longer lifespan
- Less hazardous to start a fire
- No spark plugs or wires reducing frequency of maintenance and operating cost
- On-site fuel supply since natural gas is typically piped in

ADVANTAGE of Natural Gas

- Fuel does not “gel” in cold temperatures
- Quieter when in operation
- Combined Cooling, Heating and Power is typically paired with natural gas generators
- Cost of fuel is typically cheaper when available
- Emissions of sulfur, nitrogen and carbon dioxide are considerably low

\(^1\) https://www.eia.gov/electricity/generatorcosts/
Diesel vs propane generator
Diesel vs. propane generator

**ADVANTAGE of Diesel**

- Longer lifespan
- Less hazardous to start a fire
- No spark plugs or wires reducing frequency of maintenance and operating cost (up to 3x)
- Fuel is typically cheaper
- Lower capital costs in generators 30kW or greater

**ADVANTAGE of Propane**

- Long fuel shelf life
- Quieter when in operation
- No “wet stacking” issues
- Emissions of sulfur, nitrogen and carbon dioxide are considerably low
- Better suited for small generators such as homes and small loads
Diesel generators and the grid
Generator ratings

- **Prime Power**
  - Application: Isolated grid which diesel generator is used to provide power to variable loads
  - Maximum power accessible at the variable load for an unlimited number of hours per year
  - Recommended that variable load does not exceed 70% average of the prime power rating during any operational period of 250 hours
  - If running at 100% prime power, yearly hours should not exceed 500
  - 10% overload capability for a 1 hour period within a 12 hour cycle of operation

- **Continuous Power**
  - Application: Constant loads not attached to a utility (i.e. mining, agriculture, military, etc.)
  - Provides power at 100% constant load for unlimited number of hours each year

- **Standby/back-up Power**
  - Application: Loads that require standby or backup power such as hospitals
  - Most commonly rated generator sets
  - Supply back-up or emergency power for a limited duration during a power outage
  - No overload capability built into the units
  - Typically do not run in conjunction with a public utility source
  - Sized for a maximum of 80% average load factor and roughly 200 hours per year
Diesel generator grid locations

Off Grid Military Base

Diesel Power Plant (Main Source or Microgrid)

Industrial Diesel Back-up

Home Diesel Back-up
Diesel generator maintenance
Maintenance schedule

- Maintenance schedule varies by manufacturer on a daily, weekly, monthly and annually basis
- Typical Maintenance ($0.02/kWh)
  - Lubrication
    - Oil and filter change
  - Cooling
    - Cooling fluid level
  - Fuel System
    - Fuel filter change and fuel polishing
  - Testing Battery
    - Voltage, terminal cleaning, specific gravity, electrolyte level
  - Routine Engine Exercise
    - Test under load (>33%) every 30 days or monthly
  - Cleaning
    - Visual cleaning
  - Exhaust System
    - Inspect gasket and seals for leaks

https://na.eventscloud.com/fileuploads/404b1c4a2df40a9a2f6a4c51da33d56b_PlannedMaintenancePres.31311-Copy.pdf
Load Bank Testing

- Detects potential deficiencies in system which may appear in extended operation.
- Insures full rated output capacity.
- Removed potentially damaging deposits commonly referred to as “wet stacking” in the combustion chamber and exhaust system which may have accumulated under lightly loaded operation.
- Re-seat piston rings in the cylinder walls or liners.
- May be required annually by local code or regulations.

Standby generator load bank test

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Enhancements in diesel generators
Enhancements

- **GOAL** – Improve Fuel Efficiency and Decrease Emissions
  - Better fuel injection transfer from tank to valves
  - Removing sulfur from the fuel that clog up and reduce performance
  - Analog to digital controls allowing for better optimization and operation of generator operation
  - Exhaust Gas Recirculation (EGR) and Selective Catalytic Reduction (SCR) reducing emissions
Hybrid diesel generator
AC diesel generator and energy storage
DC diesel generator and energy storage
Benefits

Monthly Savings

- Runtime – 60%
- Diesel Fuel – 528 gallons
- CO$_2$ – 5.5
- N$_2$O – 74kg
- Noise Pollution

THANK YOU

Questions

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