On-Board Electrical Use D.C. Systems

Alaska Fisheries Development Foundation

University of Alaska Sea Grant Marine Advisory Program

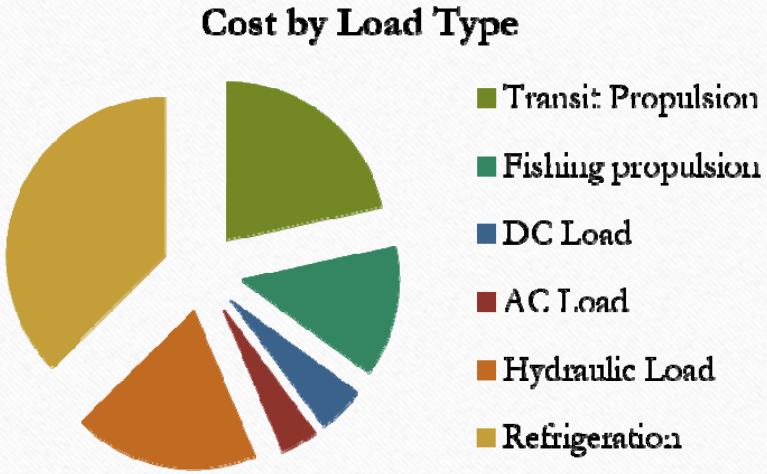
Alaska Longline Fishermen's Association

Virtually all fishing vessels have DC (direct current) electrical systems

Nominally 12-volt, commonly operate at 13.5 volts and over 14 volts while charging.

Some vessels have 24-volt, 32-volt or 48-volt DC systems. The higher the voltage the lower amperage required. Lower amperage allows the use of smaller wires for heavy loads (such as engine starting).

DC systems run navigation electronics, cabin and running lights, bilge pumps and other light loads.



D.C. power drawn from an engine

- draws energy from that engine
- imposes a fuel penalty that can be measured.

Belt-driven alternator off main engine.

Many vessels have second alternator or oversized alternator to meet DC demands on board.

Some use solar panels or wind chargers to augment DC supply.

Energy stored in “starting” and “house” battery banks.
The two battery types differ physically.

Starting and house banks should be isolated from one another.

DC System: Generation and Loads

Alternators and Efficiency ($/kWh)
Battery Chargers
Belts and losses
DC Loads

DC power is not free.

DC Electrical Systems

- A DC alternator: 1 hp per 25 amps @ 13.5 volts, 337.5 wats per hp, or 3 hp per kW
- DC generation efficiency a function of:
  - engine Brake Specific Fuel Consumption
  - alternator design efficiency
  - drive belt efficiency
  - engine room and alternator temperature
- Common alternators are 45-55% efficient. Premium efficiency units – 75-85%
- Standard V-belt is 93% efficient; v-rib and synchronous belts more efficient

DC System
Alternator Efficiency: 45% to 85%

DC Load: Ave. **800 Watts**
Hours Fishing and Transit = 1,549 hrs
Engine BSFC 228 g/kWh = $0.29/kWh
Fuel Cost before Alternator Losses:
$360

Alternator input power for 800 Watt:
45% Efficient: **1,778 Watts**
85% Efficient: **941 Watts**

Baseline From McCrea Energy Analysis Tool

DC Generation Efficiency Comparison

McCrea DC Load from Energy Analysis Tool: Ave 800W
Hours Fishing and Transit = 1,549
Energy Cost: Engine BSFC 228 g/kWh = $0.29/kWh
Fuel Cost before without Losses: $360

Engine Power to Belt Drive 45% Efficient Alternator (1,775 W)
V Belt 90% Efficiency: 1,976 W
Fuel Cost: $857
Energy Cost: $0.69/kWh

Engine Power to Belt Drive 85% Efficient Alternator (941 W)
Synchronous Belt 98% Efficiency: 960 W
Fuel Cost: $408
Energy Cost: $0.32/kWh

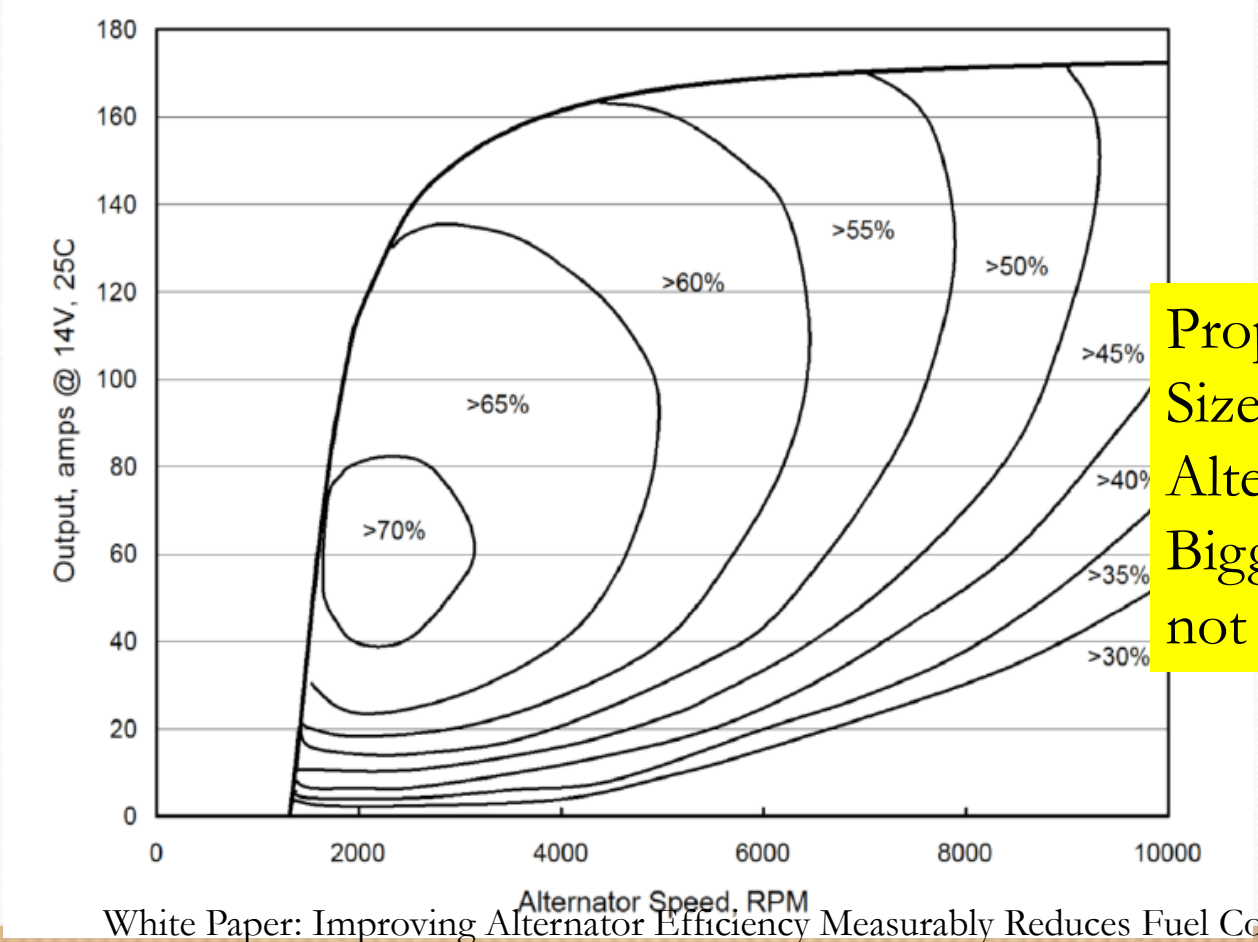
Savings with Efficient Equipment: $449/year

DC Electrical Systems

What Fishing Vessel Energy Audit Project Revealed:

- DC electrical costs range from $388 to over $1000 per season.
- With common technology, DC power is costing $.70/kW/hr.
- Lighting, small refrigerators, autopilot pumps are major consumers.
- Installed alternators frequently are not matched to DC power demands, nor to battery acceptance rates.
- Alternators are rated at higher speeds than normal use so output frequently is lower than rating. Output at idle is minimal.

Alternator Efficiency: Load and Speed



Properly Size Alternator Bigger is not Better

White Paper: Improving Alternator Efficiency Measurably Reduces Fuel Cost:
Mike Bradfield, MSME, Remy Inc

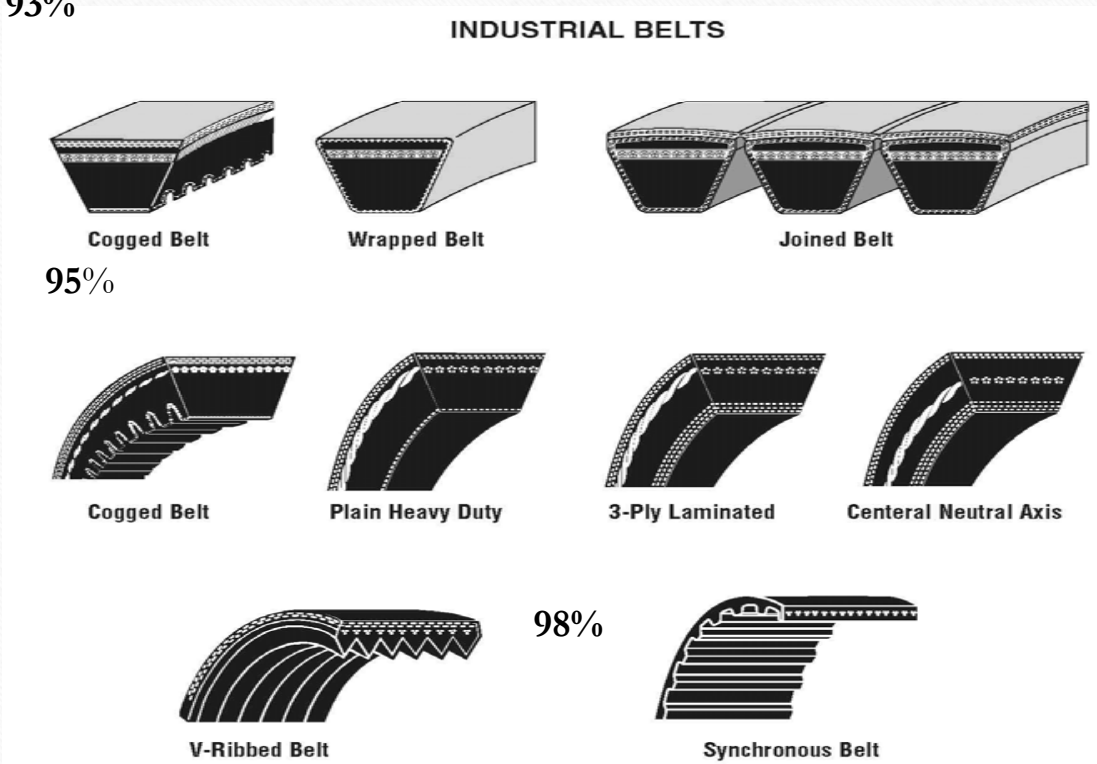
DC Electrical Systems

- **Energy Conservation Measures**

- Turn off lights, fans, appliances, pumps, etc. when not needed.
- Switch to v-rib, cogged or synchronous drive belt. Maintain proper belt tension and prevent slippage.
- At replacement time select premium efficiency alternator (not “high output”)
- Select motors, pumps and fans based on power rating.

DC Power Generation
Belt Losses: Engine to Alternator

93%



Efficiency Varies by:

- Belt Type
- Tension
- Pulley Size

- Slippage decrease efficiency ~5%

Energy Loss and Efficiency of Power Transmission Belts, Third World Energy Engineering Congress, The Association of Energy Engineers

DC Electrical Systems

More ECMs

- Size pulley so that alternator runs at design speed (commonly 4500-6000 rpm).
- Match alternator to load, and to acceptance rate of batteries. Use "smart regulator"
- Maintain battery condition, eliminate current losses, to minimize recharging.
- Replace incandescent bulbs with CFL or LED.

Questions?

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http://seagrant.uaf.edu/map/fisheries/fishing-vessel-energy-audit/

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