Understanding Alaska Fishing Vessel Energy Audits

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Outline

- What is Energy Efficiency
- Hull Power and Engine Efficiency
- A/C Electrical Generation and Loads
- D/C Electrical Generation and Loads
- Lighting
- Refrigeration System
- Hydraulic System
Ship Energy Efficiency: The Big Picture

![Diagram of ship energy efficiency showing various energy flows and losses.]

- Exhaust Loss to Atmosphere
- Useful Work (Electricity)
- Useful Work (BHP)
- Useful Work (THP)
- Slip, Cavitation Losses
- Transmission Losses
- Heat Loss to Sea
- Hull Resistance
- Propeller Thrust

& losses and waste (next page)
Electrical Energy when converted from one form to another by electrical equipment has an associated efficiency (waste energy).
Engine Fuel Efficiency
Brake Specific Fuel Consumption (BSFC)

- The engine efficiency measure of converting fuel into useful work
  - Lb of Fuel / HP-hr produced
  - Kg of Fuel/ kW-hr produced
- Factors Effecting BSFC
  - Load on Engine
  - Air Temperature
  - Condition of Engine
Measuring Engine Shaft Horse Power

During Survey: Propeller Shaft Power Measurements were done on 8 fishing vessels

Strain Gauge installed on Shaft

Intern Jacob Installing Strain Gauges on F/V Salty
Engine and Vessel Performance Curves

Insert Picture of Topaz or Myriad
Woodstock Cummins NH 220 Fuel Efficiency

BSFC G/kWh vs Horsepower
Woodstock

Cents/kWh at $3.75/gal
Woodstock

220hp 4 cycle Cummins NH220

Horsepower

BSFC G/kWh

Cent/kWh
Woodstock 39’ Power vs Speed
Woodstock, Stabilizer and Fuel Penalty

Fuel Cost:
1,000 NM/yr @ 5kts

With: $11,652
Without: $7,302
Difference: $4,344

Gallons/Nautical Mile

Speed overground, Knots

Woodstock no stabilizers
With Stabilizer
Salty: Gillnetter
Radio GM 3-71

Cents/kWh at 3.75/gal
Radio GM 3-71

Gal/NM

Gallons/NM

Speed

0 2 4 6 8 10

0 0.1 0.2 0.3 0.4 0.5 0.6
Topaz: Shaft HP vs Speed
Savage: Optimal Speed
Minimal Propulsion Fuel Consumption

Main Engine Fuel ($/NM)
Savage: Optimal Speed
Minimum Fuel and Maint. Cost (Aux and Main)

Total (Fuel and M&R) $/NM
A/C System: Generation and Load

Diesel Generators
Inverters
Loads:
  Motors
  Lights
  Heaters
Savage Generator kW-hour cost based on engine load

- 3304B Turbo
- 3304B NA High load
- 3304B Turbo High load
- Power(3304B Turbo)
- Poly.(3304B NA High load)
- Poly.(3304B Turbo High load)
A/C Power from Inverters
Square Wave Inverters

Square Wave Inverter

Shore Power
A/C Power from Inverters
Harmonic Distortion

Square Wave Inverter
Shore Power
A/C Power from Inverters
True Sine Wave Inverters

Sine Wave Inverter

Shore Power
Topaz Shore Power Load Test
Motor Efficiency

http://ngelmuelektro.wordpress.com/2011/06/24/motor-efficiency
Motor Efficiency and Savings

88% Standard Efficient Motor - 15 HP Circulating Pump
   Input Power: 17.04 HP
   Cost for 2000 hrs/yr (23%) operation: $8,898

92.4% Premium Efficient Motor - 15 HP Circulating Pump
   Input Power: 16.23 HP
   Cost for 2000 hrs/yr (23%) operation: $8,475

Annual Savings: $423/yr
   Initial Cost: $1,600
   Motor Life: 10 yrs
   Annual ROI: 16.4%
   Payback: 3.78 yrs

10 yr Motor Life Cycle cost
Motor Efficiency and Savings

68% Standard Efficient Motor - 1 HP Circulating Pump
  Input Power: 1.47 HP
  Cost for 2000 hrs/yr (23%) operation: $768
  Purchase Price: $321

82.5% Premium Efficient Motor - 1 HP Circulating Pump
  Input Power: 1.21 HP
  Cost for 2000 hrs/yr (23%) operation: $626
  Purchase Price: $446

Annual Savings: $141/yr
  Cost Difference: $125
  Motor Life: 10 yrs
  Annual ROI: 102.7%
  Payback: .89 yrs

http://www.baldor.com/products/
Topaz Steering Gear

Power (kW)

Savage Steering Gear #1 and #2

Date and Time

Power (kW)
Motor Variable Frequency Drives (VFD) Steering Gear, Fans, Pumps, Winches

VFD for Aux S.W. Cooling Pump
VFD on Hydraulic Steering
70% reduction in Energy Usage

Traditional Hydraulic Steering

VFD Controlled Steering Gear

$4,500 in Fuel / 5,000 hrs

$1,125 in Fuel / 5,000 hrs
DC System: Generation and Loads

Alternators and Efficiency ($/kWh)
Battery Chargers
Belts and losses
DC Loads
Refrigeration System
Energy Consumption of Different Refrigeration Compressors

Cumulative Energy - 24 hour

Total Consumed Energy (kWh)
Topaz RSW Compressor: Power and Compressor Discharge Pressure

- **180 PSI**: $18,000 Fuel / 2,000 hrs of operation
- **160 PSI**: $13,800 Fuel / 2,000 hrs of operation
- **140 PSI**: $13,800 Fuel / 2,000 hrs of operation
Hydraulic Systems:

Efficiency
Viscosity
Cleanliness
**HIGH EFFICIENCY LIGHTING**

- Fluorescent Bulbs and Ballast
  - T12 Bulbs and Ballast phased out
- Match Ballast to Bulbs
- Specs for Bulbs and Ballast
- LED
  - New Technology
  - Life and Lumen output improved
  - Cost decreasing
  - Ensure quality LED used
  - Thermal Management of LED
ENERGY STAR LABEL

ENERGY STAR LABEL REQUIREMENTS

- Must be a good investment
- Non-proprietary
- Must deliver same features and performance
- Energy savings and performance tested and verified
Thank You!