Energy audit methodology of thermal systems

Training Programme
Energy Conservation in Foundry Industry

11-13 August 2014
Indore
Energy audits - TERI’s experience

- Pioneered energy audits in India
- Highly experienced multi disciplinary team of about 30 engineers at Delhi & Bangalore
- 1500+ assignments on detailed energy audits completed
- Bank of latest portable instruments/software
  Temperature pressure, flow, electricity, water analysis, illumination, gas analysis and softwares (simulation, efficiency calculation)
- Good networking with major equipment suppliers
- Feedback system/post energy audit assignments
Major systems/equipment covered

- Boilers and insulation
- CHP/Cogeneration
- Steam usage
- Compressors and compressed air networks
- Blowers/Fans
- Pumps

……..Contd.
Major systems/equipment covered for Industrial Energy Audit

- Electrical systems
- DG sets
- Cooling towers
- Refrigeration and air conditioning
- Lighting System
Preliminary Energy Audit (PEA)

Uses existing, easily obtainable data

Step 1: Identify quantity & cost of energy
Step 2: Identify consumption at process level
Step 3: Relate energy input to production thereby highlighting areas of immediate improvements

Typical output
- Set of recommendations for immediate low cost actions
- Identification of major areas/projects which require a more in depth analysis.

Duration: 1 - 2 days (plant visit) 2-3 days (report writing)
Detailed Energy Audit (DEA)

- Conduct diagnostic studies with accurate measurements
- Detailed analysis of systems/equipment
- Determination of system/equipment efficiencies; compare with design values and recommend measures for improvements

Typical output

- Set of recommendations - short/medium/long term
- Provide cost-benefit analysis of recommended measures

Duration: 7-10 days (field work) and 3-4 months (data analysis and report writing)
## Areas and Levels of Energy Savings

<table>
<thead>
<tr>
<th>Level 1: Efficient operation of the existing plant (good housekeeping measures)</th>
<th>Area 1: Energy production and distribution (plant auxiliaries)</th>
<th>Area 2: Energy usage within processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E.g. reducing compressed air leakage, reducing pressure settings of air compressor, adjusting the air-to-fuel ratio in a boiler etc</td>
<td>E.g. adopting Best Operating Practices in a Furnace, improved insulation, reducing downtime etc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 2: Major improvements in the existing plant (retrofits and revamps)</th>
<th>Area 1: Energy production and distribution (plant auxiliaries)</th>
<th>Area 2: Energy usage within processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E.g. installing VFD in air compressor, adopting energy efficient motors and pumps, using FRP blades in cooling towers, energy efficient lighting etc</td>
<td>E.g. installing mechanical feeding system for furnace, changing the refractory/insulation material, better fan/air control system, burner control etc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 3: New plant or process designs</th>
<th>Area 1: Energy production and distribution (plant auxiliaries)</th>
<th>Area 2: Energy usage within processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E.g. new screw type air compressor, energy efficient boilers etc</td>
<td>E.g. improved DBC design, energy efficient aluminum melting furnace, energy efficient heat treatment furnaces etc</td>
</tr>
</tbody>
</table>
Targets for Energy saving

Top-down approach

• **Top-down approach**
  - +ve – easy method
  - –ve – no insight into real potential

Bottom-up approach

• **Bottom-up approach**
  - +ve – rigorous approach
  - –ve – requires knowledge of thermodynamic/ process engineering.
Energy Usage & Production Level

- Energy usage is function of
  - Product mix
  - Weather
  - Throughput

- Consumption operation of plant at high output helps to improve energy efficiency

Energy consumption versus output for a typical process

- 'Fixed' energy consumption
- 'Variable' energy consumption
Monitoring & control

- Monitoring refers to regular, systematic measurement of energy use in relation to production (rather than one-shot analysis as in an energy audit)

- Features of good monitoring system
  - Good instrument
  - Short time period between measurements
  - Norms & targets against which to compare measured energy usage
  - Knowledge of control action needed
  - Control systems to implement action.
Parallel units/plants

- Load balance to optimise energy efficiency

<table>
<thead>
<tr>
<th>Plant</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P</td>
</tr>
<tr>
<td>2</td>
<td>P</td>
</tr>
<tr>
<td>3</td>
<td>P</td>
</tr>
</tbody>
</table>

- If total output required = 3P
  Then run all 3 Plants flat out.

- If total output required = 2P
  May be belts to run 2 flat out (max. .......) and shut down the third
Energy management planning

- Make Commitment
- Assess Performance & Set Goals
- Create Action Plan
- Implement Action Plan
- Evaluate Progress
- Recognize Achievements
- Re-Assess
Boiler efficiency
Boiler efficiency

Efficiency evaluation

Direct method
- Easy & quick
- Few parameters
- Few instrumentation
- Accurate measurement
- Chances of large error
- No clue on low efficiency
- No clue on losses

Indirect method
- Heat loss method
- Calculate all losses
- Efficiency = 100 - losses
- Needs more parameters
- Needs more instruments
- More accurate
Heat losses from the boiler

- Dry flue gas loss
- Loss due to CO in flue gas
- Loss due to hydrogen and moisture in fuel
- Loss due to moisture in air
- Blow down loss
- Unburnt losses
- Sensible heat loss in ash (if applicable)
- Surface heat loss
Reduction in excess air and flue gas temperature

<table>
<thead>
<tr>
<th></th>
<th>Existing conditions</th>
<th>Improved conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen (%)</td>
<td>5.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Flue gas temperature (°C)</td>
<td>196</td>
<td>170</td>
</tr>
<tr>
<td>Thermal Efficiency (%)</td>
<td>73.21</td>
<td>75.33</td>
</tr>
<tr>
<td>Fuel consumption (MT/hr)</td>
<td>11.61</td>
<td></td>
</tr>
<tr>
<td>Fuel savings (MT/hr)</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Fuel saving per annum (MT)</td>
<td>2589</td>
<td></td>
</tr>
<tr>
<td>Monetary savings (Rs. Lakh)</td>
<td>57.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Coal cost = Rs. 2200 per MT)</td>
</tr>
</tbody>
</table>
Insulation

• Insulate all steam/condensate pipes, condensate/hot water tanks with proper insulation (mineral wool). The heat loss from 100 feet of a bare 2 inch pipe carrying saturated steam at 10 bar is equivalent to a fuel loss of about 1100 litre of fuel oil per month

• Insulate all flanges by using pre-moulded sections because heat loss from a pair of bare flanges is equivalent to the loss of 1 foot of non-insulated pipe of same diameter
Compressed Air Systems
## Air Compressors

<table>
<thead>
<tr>
<th>Reciprocating</th>
<th>Screw</th>
</tr>
</thead>
<tbody>
<tr>
<td>High pressure (&gt; 10 bar) or Low volume (50-60 cfm)</td>
<td>Low pressure requirement (6-7 bar max)</td>
</tr>
<tr>
<td>Lowest full load power consumption, most efficient</td>
<td>Good for variable loading</td>
</tr>
<tr>
<td>High maintenance cost</td>
<td>VFD compatible</td>
</tr>
<tr>
<td>Not VFD compatible</td>
<td>Low maintenance cost</td>
</tr>
<tr>
<td>Lowest first cost</td>
<td>Highest full load power consumption</td>
</tr>
<tr>
<td></td>
<td>Moderate first cost</td>
</tr>
</tbody>
</table>
Performance of air compressor

Checking Free Air Delivery (FAD)

Observe the average time required to fill the air receiver (after isolating from the system and emptying it completely)

\[ FAD = \frac{(P2 - P1) \times V}{(P1 \times t)} \]

- FAD = pumping capacity of the compressor (m³/minute),
- V = volume of the receiver (m³),
- P1 = atmospheric pressure (1.013 bar absolute),
- P2 = final pressure of the receiver (bar absolute),
- t = average time taken (minutes)

If FAD is 20% less than design, compressor needs overhauling
Leakage test

Leakage (L) = \( \frac{FAD \times t_1}{t_1 + t_2} \)

- L = Leakages (m³/min)
- FAD = Actual free air delivery of the compressor (m³/min)
- \( t_1 \) = Average on load time of compressor (min)
- \( t_2 \) = Average unload load time of compressor (min)

Shut off compressed air operated equipment (or conduct test when no equipment is using compressed air).

Power wastage at 7kg/cm²

<table>
<thead>
<tr>
<th>Orifice dia</th>
<th>Air leakages (scfm)</th>
<th>Power wasted (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/64”</td>
<td>0.406</td>
<td>0.08</td>
</tr>
<tr>
<td>1/32”</td>
<td>1.62</td>
<td>0.31</td>
</tr>
<tr>
<td>1/16</td>
<td>6.49</td>
<td>1.26</td>
</tr>
<tr>
<td>1/8”</td>
<td>26</td>
<td>5.04</td>
</tr>
<tr>
<td>¼”</td>
<td>104</td>
<td>20.19</td>
</tr>
</tbody>
</table>

(m³/min = 35.31 cfm)

Specific power consumption

\[
\text{Specific power (kW/100 cmm)} = \frac{\text{Actual power} \times 100}{\text{FAD (m³/min)}}
\]
Leak Test: Example

- Compressor capacity (CMM) = 35
- Cut in pressure kg/SQCM = 6.8
- Cut out pressure kg/SQCM = 7.5
- On load kW drawn = 188 kW
- Unload kW drawn = 54 kW
- Average ‘On-load’ time = 1.5 minutes
- Average ‘Unload’ time = 10.5 minutes

Comment on leakage quantity and avoidable loss of power due to air leakages.

   a) Leakage quantity (CMM) = \[ \frac{0.5}{0.5 + 0.5} \times 35 \]
      = \[ \frac{0.5}{1} \times 35 \]
      = 4.375 CMM

   b) Leakage per day = 6300 CM/day

   c) Specific power for compressed air generation = \[ \frac{188 kWh}{5 \times 60 \text{ CMH}} \]
      = 0.0895 kwh/m³

   d) Power lost due to leakages/day = 563.85 kWh
Pressure drop

Because of smaller pipe size, scaling in pipe, higher air velocity, etc.

Pressure drop (bar) = \( \frac{800 \times Q^2 \times 1}{d^{5.3} \times p} \)

\( Q \) = air flow – FAD (lit/sec)
\( L \) = length of pipe line (m)
\( d \) = inner diameter of pipe (mm)
\( p \) = compression ratio (bar absolute)

<table>
<thead>
<tr>
<th>Normal bore (mm)</th>
<th>Pressure drop per 100 metre (bar)</th>
<th>Eq. Power loss (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>1.8</td>
<td>9.5</td>
</tr>
<tr>
<td>50</td>
<td>0.65</td>
<td>3.4</td>
</tr>
<tr>
<td>65</td>
<td>0.22</td>
<td>1.2</td>
</tr>
<tr>
<td>80</td>
<td>0.04</td>
<td>0.2</td>
</tr>
<tr>
<td>100</td>
<td>0.02</td>
<td>0.1</td>
</tr>
</tbody>
</table>

- Pressure drop should not exceed 0.3 bar normally
- For larger plant, pressure drop should not exceed 0.5 bar
- Recommended compressed air velocity is 6-10 m/s
Good housekeeping – Compressed air

- Reduce pressure drop in pipeline
- Do not use underground piping
- Plug air leakages. Check the air leak periodically (once a month)
- Use minimum operating pressure. Increase of 1 kg/cm² air discharge pressure (above the desired) from the compressor would result in about 4-5% increase in input power. This will also increase compressed air leakage rates roughly by 10%
- Reduce inlet air temperature. Improve air quality of compressor room. Every 5°C rise in suction air temperature will increase power consumption by 2%.
- Conduct a periodical maintenance of intake (suction) filter. For every 250 mm WC pressure drop increase across at the suction path due to choked filters etc., the compressor power consumption increases by about 2 %
- If compressed air is required at 2 different pressures, it is better to have 2 compressors for catering to air requirement at different pressures than having one large compressor generating compressed air at higher pressure
Stop air leakages

Press Machine

Check the parts where air leaks
The potential for energy saving is high when installing inverter compressors. It is presumed that **22%** energy saving is possible by switching to inverter compressors (Fig. in the right). GA18.5 load factor = 72%; GA30 load factor: 74%
Improve air piping system: Piping from top

Bad example of piping connection
There is a possibility of drain flowing to the facility since this pipe is connected with the underside of the main piping.

Good example of piping connection
There is no risk of drain flowing to the facility as the pipe is connected with the upper-side of the main piping.
Fans & Blowers
## Fan Types and Efficiencies

<table>
<thead>
<tr>
<th>Fans</th>
<th>Peak Efficiency Range, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centrifugal</strong></td>
<td></td>
</tr>
<tr>
<td>Backward curved</td>
<td>79-83</td>
</tr>
<tr>
<td>Radial</td>
<td>69-75</td>
</tr>
<tr>
<td>Forward curved</td>
<td>60-65</td>
</tr>
<tr>
<td><strong>Axial fan</strong></td>
<td></td>
</tr>
<tr>
<td>Vane Axial</td>
<td>78-85</td>
</tr>
<tr>
<td>Tube Axial</td>
<td>67-72</td>
</tr>
<tr>
<td>Propeller</td>
<td>45-50</td>
</tr>
</tbody>
</table>
Case study: EE blowers

- Earlier – 375W centrifugal blower
- Now – 110W axial impeller blower
- Shop floor sound reduced
- Investment: Rs 60,000
- Energy savings: Rs 93,000
- Payback: 8 months
Fans Performance Assessment

- **Static pressure**
  - Potential energy put into the system by the fan

- **Velocity pressure**
  - Pressure arising from air flowing through the duct. This is used to calculate velocity

- **Total pressure**
  - Static pressure + velocity pressure
  - Total pressure remains constant unlike static and velocity pressure
Total pressure = Static pressure + Velocity pressure
\[ TP = SP + VP \]

A.
- Static pressure, in. wg
- Total pressure, in. wg
- Velocity pressure, in. wg

B.
- Supply fan
- Work \( W_{1-2} \)
- Return duct
- Supply duct
Velocity monitor
Thermal Anemometer
Calculation of stack velocity

\[
\text{Velocity} = C\sqrt{H} \times Ts
\]

Where,

c = a constant whose value is 0.1958
h = height of manometer displacement in meter
Ts = stack temperature in Kelvin
Fan efficiency and kW selection

Fan efficiency (%) = \( \frac{\text{Hydraulic power (kW)}}{\text{Measured power (kW)}} \times 100 \)

Hydraulic power (KW) = \( v \text{ (m/s)} \times P \text{ (kPa)} \)

For estimating kW of a new fan:
\( kW = \mu \times v \text{ (m/s)} \times P \text{ (kPa)} \)

\( \mu \)

P = Total pressure
kPa \times 4 = \text{ in WG}

For FD fan \( \mu = 0.65 \)
For ID fan \( \mu = 0.75 \)
Flow Control Strategies

- Normally, fan is designed for operating at constant speed
- Practically, there may be need for increase in flow or decrease in flow. Various strategies are
  - Damper controls
  - Pulley change
  - Inlet guide vanes,
  - Variable speed drives
  - Series and parallel operation
Inlet Guide Vanes

- Guide vanes changes the angle at which air is presented to the fan blades which in turn changes the fan characteristics.

- Guide vanes suitable for flow reduction from 100% flow to 80% flow. Below 80% flow, energy efficiency drops sharply.
Variable Speed Drives

- Provide infinite variations in speed control
- Fans laws are applicable: power input changes as the cube of the flow
- Economical for system with frequent flow variations
Energy Saving Opportunities

 Avoid unnecessary demand- excess air reduction, idle running, arresting leaks
 Match fan capacity to demand – downsizing, pulley change, VSD, impeller de-rating
 Reduce pressure drops – remove redundant drops, modify ducts with minimum bends
 Drive system- direct drive, V belt by Flat belt, two speed motors
 Replace with energy efficient fan, impeller
 Change to hollow FRP impeller
 Inlet guide vane in place of discharge damper control
Pumps & Pumping System
Centrifugal pump

- Invented in Europe in 1600’s
- Lot of new development in last 75 years
- Two parts
  - Rotary part – impeller
  - Stationary part – casting or volute
- Large pumps could efficiencies above 90%
- Smaller pumps (below 1 HP) have efficiencies around 50%
Pumps are designed for one specific condition. Usually efficiencies do not drop significantly +/- 20% of the best efficiency point.

The Head-Capacity curve should not be too steep (judged from the ratio of the head at shut off to that at the best efficiency point) for a good pump.
Composite characteristic curve

- Curves having a number of Head-Capacity curves for the same pump
- Single speed and several impeller diameters or
- One impeller diameter and several different speeds
Energy Audit Instruments used for Measurements

- Ultrasonic flow meter – Velocity and Water flow of pumps, headers and pipelines
- Portable clamp power analyser - Measurement of power parameters kW, pf, kVA, Hz, A and V
Performance assessment study

Pump head

Water flow rate

Pump motor input kW
Performance assessment study

Efficiency (%) = \frac{\text{Hydraulic power}}{\text{Pump shaft power}}

Whereas,

Hydraulic power (kW) = Q (m^3/s) \times \text{Total head (m)} \times \text{density (kg/m}^3) \times 9.81 \text{ (m/s}^2) / 1000

Pump input power (kW) = \text{Motor input kW} \times \text{efficiency of motor (%)
Calculation of Pump Efficiency

Flow (Q) : 110 m³/h
Head (H) : 50 m
Input Power to pump (P) : 20 kW
Application : Water
Operating temp : 23°C
Density : 1000 kg/m³ @ 23°C

Hydraulic kW is given by:
\[
\frac{Q \text{ in m}^3/\text{sec} \times \text{Total head in m} \times \text{density in kg/m}^3 \times g \text{ in m/s}^2}{1000}
\]

\[
\frac{(110/3600) \times 50 \times 1000 \times 9.81}{1000}
\]

: 14.98 kW

Pump efficiency is given by:
\[
\frac{\text{Hydraulic kW}}{\text{Input power to pump}}
\]

: 14.98 x 100/20
: 74.9%
Parallel and series operation of pumps

**Series (booster) operation**
A pump can take the discharge from another pump and boosts it to a higher pressure
✓ Head and HP are additive
✓ Capacity remains same

**Parallel operation**
Pumps taking suction from a common supply and discharging into a common header
✓ Flow and HP are additive
✓ Head remains same
Affinity Laws

Performance of a centrifugal pump can be varied by changing the impeller diameter or its rotational speed

- Capacity varies directly as the change in speed
- Head varies as the square of the change in speed
- Brake horsepower varies as the cube of the change in speed

Example:
A pump operating at 1750 RPM, delivers 210 LPM and 75 ft and requires 5.2 brake horsepower. What will happen if the speed is increased to 2000 RPM?
- Speed Ratio = 2000/1750 = 1.14
- Capacity 1.14 X 210 LPM = 240 LPM
- Head 1.14 X 1.14 X 75 = 97.5 ft
- BHP 1.14 X 1.14 X 1.14 X 5.2 = 7.72 BHP
BEE STAR RATING FOR PUMPS

- Only applicable for 3 phase pump sets from 1.1 kW (1.5 HP) to 15 kW (or 20 HP)
- Linked to the energy efficiency of the specific pump model above Bureau of Indian Standards (BIS) norm

<table>
<thead>
<tr>
<th>No. of Stars</th>
<th>Overall energy efficiency above BIS norm*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upto 5% higher</td>
</tr>
<tr>
<td>2</td>
<td>5 – 10 % higher</td>
</tr>
<tr>
<td>3</td>
<td>10 – 15 % higher</td>
</tr>
<tr>
<td>4</td>
<td>15 – 20 % higher</td>
</tr>
<tr>
<td>5</td>
<td>20 – 25 % higher</td>
</tr>
</tbody>
</table>

*Under test conditions when tested in accordance with relevant IS No., the actual energy consumption will depend on how the equipment is being used.
Avoid throttling

![Diagram showing pump curve at constant speed, system curves, operating points, and pump efficiency.]

- Static Head
- Operating Points
- Flow (m³/hr)
- Head Meters
- System Curves
- Pump Curve at Const. Speed
- Pump Efficiency 77%
- Partially closed valve
- Full open valve
- 500 m³/hr
- 300 m³/hr
- 300 m³/hr
- 70 m
- 50 m
- 42 m
- 42 m

- 70 m
- 50 m
- 42 m

- 50 m
Example for throttling operation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Part A</th>
<th>Part B</th>
<th>Part C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>m³/hr</td>
<td>500</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Head</td>
<td>M</td>
<td>50</td>
<td>70</td>
<td>42</td>
</tr>
<tr>
<td>Power</td>
<td>kW</td>
<td>83</td>
<td>74</td>
<td>45</td>
</tr>
<tr>
<td>Efficiency</td>
<td>%</td>
<td>82</td>
<td>77</td>
<td>77</td>
</tr>
</tbody>
</table>
| Remarks        |        | Existing pump | Throttling operation | • New small pump  
|                |        |        |        | • Trim impeller  
|                |        |        |        | • Use VFD     |
Energy conservation measures

- Conduct water balance to minimise water consumption.
- Avoid idle cooling water circulation in DG sets, compressors, refrigeration systems.
- In multiple pump operations, judiciously mix the operation of pumps and avoid throttling.
- Have booster pump for few areas of higher head.
- Replace old pumps by energy efficient pumps.
- In the case of over designed pump, provide variable speed drive, trim / replace impeller or replace with correct sized pump.
- Remove few stages in multi-stage pump with over designed head.
Cooling Tower
Cooling Tower: Types

- **Natural draft**
  - Large concrete chimneys
  - Generally used for water flow rates above 45,000 m³/hr
  - Utility power stations

- **Mechanical draft**
  - Large fans to force or suck air through circulated water.
  - The water falls downward over fill surfaces, which help increase the contact time between the water and the air, maximising heat transfer between the two.
  - Cooling rates of Mechanical draft towers depend upon their fan diameter and speed of operation
Induced draft counterflow water-fill tower

Induced draft counterflow tower with fill
Performance evaluation

Parameters to be measured

a) Dry bulb temperature
b) Wet bulb temperature
c) Water flow across cooling tower cell
d) Inlet water temperatures
e) Outlet water temperatures
f) TDS
Cooling Tower Performance

- **Hot water temperature (in)**
- **(In) to the tower**
- **(Out) from the tower**
- **Range**

- **Cold water temperature (out)**
- **Approach**

- **Wet-bulb temperature (in)**
Performance evaluation

- Range = d) – e)
- Approach = e) – b)
- Effectiveness = Range/(Range + Approach)

For better performance Range should be high and Approach low.
Cooling towers

- Maintain clean water, free of algae growth in the cooling tower basin.
- Control the operation of cooling tower fan based on leaving water temperatures. Switch off the cooling tower fan when loads are reduced or during night/colder months. This can be automated by installing a basin water temperature based controller for fan operation.
- Regularly clean the distribution nozzles in cooling tower to have uniform distribution of water.
- Consider installation of energy efficient FRP blades which consumes 15-20% less energy compared to cast iron/aluminium blades, with same airflow.
- Avoid idle operation of cooling tower and circulation of cooling water to an application which is not operating.
- Avoid buying an oversized cooling tower.
DG System
Energy balance of a DG set

Energy input 100%

- Exhaust 35-40%
- Cooling 15-20%
- Indicated horse power
  - Frictional and Other losses ~ 5%
  - Brake horse Power 40-45%
Operation and energy conservation

- **Loading**
  - Steady (avoid fluctuation, imbalance in phases, etc.)
  - Sufficient load on the engine
  - Avoid overloading
Performance of DG Sets

- Overall efficiency of a DG set is determined as specific energy generation ratio (SEGR)
- Units of electricity generated per litre of fuel oil
  - Separate fuel consumption measurement for each DG set
  - Separate arrangement for power generation measurement for each DG set
- To be compared with the design value
- Contact to supplier if the difference is significant
Energy Conservation in Diesel Generators

- The fuel consumption per unit of power generation is lowest if the DG set is loaded in a range of 60-80% of the design capacity, without fluctuation.

- The performance of the DG set can be evaluated in terms of specific energy generation ratio (SEGR) in terms of kWh/litre

- Carry out regular SEGR trials to monitor DG set performance. If the operating value of SEGR is less than 80% of the design value, it is time to contact manufacturer for overhauling.

- Air intake to the DG set should be cool and free from dust, preferably outside from the generator room.

- Regularly clean air filters to reduce the pressure drop across it.

- Consider the use of fuel oil additives in the DG set after carefully evaluating the results.

- In case of a base load operation, explore the possibility of waste heat recovery for hot water generation from the DG set’s exhaust.
Thank You

Contact details

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