TIPS FOR ENERGY SAVING IN INDUSTRIAL EQUIPMENTS

The industrial sector alone accounts for about 50% of the commercial energy. It uses both, the thermal and electrical energy in various equipments like boilers, compressors, furnaces, diesel generating engines, motors, pumps, refrigeration etc. Here are tips for energy saving through these equipments.

Electrical Energy – General

The industrial sector consumes about 33 per cent of the total electrical energy consumed in the country.

Tips for electrical energy saving:

- Improve power factor by installing capacitors to reduce KVA demand charges and also line losses within plant.

- Improvement of power factor from 0.85 to 0.96 will give 11.5% reduction of peak KVA and 21.6% reduction in peak losses. This corresponds to 14.5% reduction in average losses for a load factor of 0.8.

- Avoid repeated rewinding of motors. Observations show that rewound motors practically have an efficiency loss of upto 5%. This is mainly due to increase in no load losses. Hence use such rewound motors on low duty cycle applications only.

- Use of variable frequency drives, slip power recovery systems and fluid couplings for variable speed applications such as fans, pumps etc. helps in minimizing consumption.

Compressed air:

Compressed air is used in almost all types of industries and accounts for a major share of Electricity used in some of the plants. It is utilized for a variety of end uses such as pneumatic tools and equipment, instrumentation, conveying, etc. and is preferred in Industries because of its convenience and safety. Normally, the compressed air factor is an overlooked area in most of the industries, though it is a costly source of power, about 7 to 10 times the cost of electricity. Given this economics, better maintenance practices and elimination of wastage would help in improving the performance of compressed air systems.

Tips for energy saving:

- Compressed air is very energy intensive. Only 5% of electrical energy is converted to useful energy. Use of compressed air for cleaning is rarely justified.

- Ensure low temperature of inlet air. Increase in inlet air temperature by 3°C increases power consumption by 1%.

- It should be examined whether air at lower pressure can be used in the process. Reduction in discharge pressure by 10% saves energy consumption upto 5%.
- A leakage from a ½" diameter hole from a compressed air line working at a pressure of 7kg/cm^2 can drain almost Rs. 2500 per day.
- Air output of compressors per unit of electricity input must be measured at regular intervals. Efficiency of compressors tends to deteriorate with time.

Cooling towers:

A cooling tower is a specialized heat exchanger in which two fluids (air and water) are brought into direct contact with each other to effect the transfer of heat. In a spray filled towers, this is accomplished by spraying a flowing mass of water into a rain - like pattern, through which an upward moving mass flow of cool air is induced by the action of a fan. There are two basic types of cooling towers, direct (or open) and indirect (or closed).

Tips for energy saving:

- Replacement of inefficient aluminum or fabricated steel fans by moulded FRP fans with aerofoil designs results in electricity savings in the range of 15-40%.

- A study on a typical 20 ft. diameter fan revealed that replacing wooden blade drift eliminators with newly developed cellular PVC drift eliminators reduces the drift losses from 0.01-0.02% with a fan power energy saving of 10%.

- Install automatic **on-off** switching of cooling tower fans and save upto 40% on electricity costs.

- Use of PVC fills in place of wooden bars results in a saving in pumping power of upto 20%.

Electric motors:

The electric motors are used to provide motive power to equipment such as compressors, pumps, blowers, etc. It is important that the industrial users define their need accurately to enable proper selection of a motor for a particular application. Of the total electricity consumed in the industrial sector, electric motors account for approximately 70%.

The motors are classified under DC (direct current), AC (alternating current) synchronous, and AC induction (squirrel cage or wound rotor type) types. The AC induction is additionally distinguished as single or polyphase. Most of the power consumed by motors in the industry is accounted for by polyphase (three-phase) AC induction motors. Of the three-phase induction motors, the squirrel cage motor is most popularly used because of its relatively low capital and maintenance costs, and rugged design.

Tips for energy saving:

- The motors should be energy efficient.
- Convert delta to star connection for lightly loaded motors.
- Install soft start-cum-energy saver for lightly loaded motors.
- In case of centrifugal-blower pump, install variable voltage frequency (VVVF) drives for speed control of motors.
- Install multi speed motor.
- Optimize operating voltage level of motor for lightly loaded motors
- Replace eddy current controls with variable frequency drives for varying speed driven equipment?
- Provide interlock for electric motor to avoid idle running
- Replace motor generating sets with thyristor drives.
- Avoid frequent rewinding of motors. Greater the number of rewind, lesser the efficiency.
- Carry out preventive maintenance and condition monitoring schedule regularly.

Advantages of Energy Efficient Motors

- Reduced operating costs
- Less heat losses
- Extended winding lifespan
- Extended lubricating grease service life
- Lower noise levels than other motors
- Reduced energy costs. The higher purchase price investment pays off.
- Reduce emission of CO2 and NOx greenhouse gasses from power stations for positive environmental effect.

Lighting:

A lumen is the measurement of light output from a lamp, often called a tube or a bulb. All lamps are rated in lumens. For example, a 100-W incandescent lamp produces about 1750 lumens. The distribution of light on a horizontal surface is called its illumination, which is measured in foot-candles or lux. A foot-candle of illumination is a lumen of light distributed over one-square-foot (0.09 m^2) area. Another lighting term is efficacy, which is the ratio of light output from a lamp to the electric power it consumes and is measured in LPW (lumens per watt).

Lighting uses can be divided into three categories: ambient, task, and accent. Ambient lighting provides security and safety, as well as general illumination for performing daily activities. The goal of task lighting is to provide enough illumination so that tasks can be completed accurately. The idea here is not to illuminate the entire area. Accent lighting illuminates walls to blend more closely with naturally bright areas like ceilings and windows.

Tips for energy saving:

- Use of electronic ballast in place of conventional choke saves energy upto 20%.
- Use of CFL lamp in place of GLS lamp can save energy upto 70%.
- Clean the lamps and fixtures regularly. Illumination levels fall by 20-30% due to collection of dust.
- Use of 36W tube light instead of 40 W tube light saves electricity by 8 to 10%.
- Use of sodium vapour lamps for area lighting in place of mercury vapour lamps saves electricity upto 40%.

Pumps:

Most of the industrial processes in and out of plants involve transportation of fluids and the pump is the only mechanical means available to facilitate this transportation. Work has to be done by a prime mover in order to enable the pump to discharge its functions, because the pump is incapable of transporting the fluid on its own. The prime mover can either be an electric motor, a diesel engine, on a steam/gas turbine. All prime movers consume energy, either in the form of electric power or precious petroleum products like diesel, oil or gas, to impart working capacity to the pump.

Tips for energy saving:

- Select a pump of the right capacity in accordance with the requirement. Improper selection of pumps can lead to large wastage of energy. A pump with 85% efficiency at rated flow may have only 65% efficiency at half the flow.

- Matching of the motor with the appropriate-sized pump.

- Use of throttling valves instead of variable speed drives to change flow of fluids is a wasteful practice. Throttling can cause wastage of power to the tune of 50 to 60%.
- It is advisable to use a number of pumps in series and parallel to cope with variations in operating conditions by switching on or off pumps rather than running one large pump with partial load.

- Void valves in the pipe line throttle wastes energy. A positive displacement pump with variable speed drive is recommended.

- Proper installation of the pump system, including shaft alignment, coupling of motor and pump is a must. Drive transmission between pumps and motors is very important. Loose belts can cause energy loss upto 15-20%.

- Modern synthetic flat belts in place of conventional V-belts can save 5% to 10% of energy.
- Properly organized maintenance is very important. Efficiency of worn out pumps can drop by 10-15% unless maintained properly.

Refrigeration and Air-Conditioning:

Refrigeration is the process of removing heat at a low temperature level and rejecting it at a relatively higher temperature level. Refrigeration is accomplished by various methods, such as the vapour compression system, absorption system, and steam jet refrigeration cycle. The most commonly used systems are the vapour compression and absorption systems. Further, even out of above two, the vapour compression system is more widely used.

The items required for the make-up of a complete refrigeration and air-conditioning system are refrigerating equipment, fans, pumps, cooling towers, filters, air-handling units, and ducting. Depending upon the process, all or some of the items mentioned may be required.

Tips for energy saving:

- Close doors and windows while running the air conditioning. Don't use a whole house fan or window fan while the air conditioner is on, but do use a ceiling fan.

- Use of double doors, automatic door closers, air curtains, double glazed windows, polyester sun films etc. reduces heat ingress and air-conditioning load of buildings.

- Maintain condensers for proper heat exchange. A 5°C decrease in evaporator temperature increases the specific power consumption by 15%.

- Utilization of air-conditioned/refrigerated space should be examined and efforts made to reduce cooling load as far as possible.
- Utilize waste heat of excess steam or flue gases to change over from gas compression systems to absorption chilling systems and save energy costs in the range of 50-70%.

- The compressor of the central air conditioner should be located in a cool, shaded place outside.

- Specific power consumption of compressors should be measured at regular intervals. The most efficient compressors to be used for continuous duty and others on standby.

- The air conditioning unit must be inspected; cleaned and tuned by a professional every two to three years to keeps it going longer and to using less electricity. If the refrigerant needs to be recharged, make sure it is done correctly. If it is overcharged, it would reduce operating efficiency and could damage the unit. If it is undercharged it would also use energy less efficiently.

- The duct system should be properly sealed. This could save 10 per cent to 15 per cent of the electricity into air conditioner.

Thermal Energy – General

The coal, lignite and petroleum products like diesel furnace oil, LPG, natural gas are the sources of thermal energy and their savings is very imperative as coal and lignite deposits are depleting year after year, petroleum products are eating away foreign exchange.

Tips for energy saving:

- Undertake regular energy audits.
- Plug all oil leakage as leakage of one drop of oil per second amounts to a loss of over 2000 liters/year.
- Filter oil in stages. Impurities in oil affect combustion.
- Pre-heat oil. For proper combustion, oil should be at right viscosity at the burner tip. Provide adequate Pre-heat capacity.
- Incomplete combustion leads to wastage of fuel. Observe the color of smoke emitted from chimney. Black smoke indicates improper combustion and fuel wastage. White smoke indicates excess air and hence loss of heat. Hazy brown smoke indicates proper combustion.
- Use of low air pressure "film burners" helps save oil upto 15% in furnaces.
- The maintenance in plant should follow the "zero leak" philosophy, particularly in the areas of steam and utilities so that loss of energy could be totally eliminated.

Boilers:

Boilers are used in various industrial units to convey heat for different process applications. Steam is commonly used as the heating medium mainly due to two reasons: one -it is generated from water which is usually available; and two-it is able to store a large quantity of heat at a temperature which can be conveniently used. Various types of fuels, namely; coal, oil, gas, biomass, etc. are used for steam generation in boilers depending on the availability of fuel and cost economics prevailing in the plant. Some of the boilers even use waste (generally low calorific value fuels) as fuel. For example, paper industries use black liquor generated within the plant as fuel.

Boilers can be categorized into different types depending on water/flue gas passage in the boiler, fuel usage, and pressure generation. The types of boilers vary with respect to the requirement of the plant. Whatever may be the type of boiler used, the motive of the industry should be to generate the required quantity and quality of steam at minimum possible costs. This can only be achieved by reducing the various avoidable heat losses occurring within the boiler system, thus improving the efficiency of the same. Different boilers will have different efficiency levels depending on the fuel type as shown in the table on next page.

Tips for energy saving:

- All possible attention- should be paid to control excess air by monitoring oxygen level in flue gas and also by visual inspection of flame color.

- Remove soot deposits when flue gas temperature rises 40°C above the normal. A coating of 3mm thick soot on the heat transfer surface can cause an increase in fuel consumption of as much as 2.5%.

- Soot blowers can always be maintained in perfect working condition so that their regular and periodic use does not suffer.

- Recover heat from steam condensate. For every 6°C rise in boiler feed water temperature through condensate return, there is 1% saving in fuel.

- Improve boiler efficiency. Boilers should be monitored for flue gas losses, radiation losses, incomplete combustion, blow down losses, excess air etc. Proper control can decrease the consumption upto 20%.

- Use only treated water in boilers. A scale formation of 1 mm thickness on the waterside increases fuel consumption by 5-8%.

- Stop steam leakage. Steam leakage from a 3 mm-diameter hole on a pipeline carrying steam at 7kg/cm^2 would waste 32 kl of fuel oil per year amounting to a loss of Rs. 3 lakh.
- Maintain steam pipe insulation. It has been estimated that a bare steam pipe, 150 mm in diameter and 100m in length, carrying saturated steam at 8kg/cm^2 would waste 25 kl of furnace oil in a year amounting to an annual loss of Rs. 2.5 lakh.

Thermal efficiency levels

Boiler type	Variations
Manually-fired	40-60
Stoker-fired	65-70
Coal-fired	55-60
Oil and gas - fired up to 20 tonnes/hour	70-80
Above 20 tonnes/hour	80-85
Fluidized-bed combustion	75-80
Waste-heat	55-75
Pulverized-fuel-fired	80-85

Diesel generating sets:

With the gap between the demand and supply of electric power widening, the role of diesel generating sets in the Indian industry cannot be overemphasized. Depending on the type of industry, its sitting, and the magnitude of the connected load, DG sets are employed in various modes like: the standby mode to meet a part or the full requirement of the plant in case of power failures; the peak-load mode to meet the requirement during peak demand, thereby reducing the maximum demand; the base-load mode, where a part or whole of the plant's requirement is met on a continuous basis; and the total energy mode, where it not only supplies the total power required but also meets the heating and cooling requirements of the plant by utilizing the waste heat from the DG set exhaust in an integrated system.

Tips for energy saving:

- Maintain diesel engines regularly.
- A poorly maintained injection pump increases fuel consumption by 4gm/kWh.
- A faulty nozzle increases fuel consumption by 2gm/kWh.
- Blocked filters increase fuel consumption by 2gm/kWh.
- A continuously running DG set can generate 0.5 ton/hr of steam at 10 to 12 bars from the residual heat of the engine exhaust per MW of the generator capacity.
- Measure fuel consumption per KWH of electricity generated regularly. Take corrective action in case this shows a rising trend.

Furnace - Tips for energy saving:

- Recover and utilize waste heat from furnace flue gases for preheating of combustion air. Every 21°C rise in combustion air temperature results in 1% fuel oil savings.
- Control excess air in furnaces. A 10% drop in excess air amounts to 1% saving of fuel in furnaces. For an annual consumption of 3000 KL of furnace oil means a saving of Rs 3 lakhs, (cost of furnace oil-Rs. 10 per liter).

- Reduce heat losses through furnace openings. Observations show that a furnace operating at a temperature of 1000°C having an open door (1500mm × 750mm) results in a fuel loss of 10 lit/hr. For a 4000 hrs furnace operation, this translates into a loss of approx. Rs. 4 lakhs per year.

- Improve insulation if the surface temperature exceeds 20°C above ambient. Studies have revealed that heat loss form a furnace wall 115mm thick at 650°C amounting to 2650 kcal/m2/hr can be cut down to 850 kcal/m2hr by using 65 mm thick insulation on the 115 mm wall.