Energy Loss Reduction through Improved Maintenance Practices ERTIMP

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Every maintenance activity results in energy consumption or loss.

Can this be reduced ?

- As per old thinking, it could probably be done marginally.
- But now a substantial reduction in energy consumption is possible with the advent of latest state of the art maintenance techniques including more advanced instruments, practices & even materials.
- All these help in curtailing ineffective maintenance practices adversely affecting energy consumption.

What Are the techniques?

- First & foremost practice which need to be adopted in any industry is to let the maintenance deptt take the responsibility to view the monthly energy bill alongwith the energy management rather than the practice adopted till 1980s of being viewed by Operations Manager or Facility Manager or the Accounts Manager.

- Although in Power Plants we recognize maintenance as an integral part of the production or generation process.

- But here also there is still no practice of making concerned maintenance deptt responsible for increased power consumption either due to ineffective maintenance or increased downtime for maintenance.

- In this context I always stress the need to involve the concerned Area Maintenance Engineer during the energy audit of any subsystem/equipment of the power plant or even while drawing the time bound action plan for implementation of different energy audit recommendations. This practice also helps make recommendations more acceptable to the management as the execution of recommendations becomes more smooth. Maintenance deptt also shares the responsibility & gain recognition for energy consumption reduction efforts.

- We also need to appreciate that Maintenance has a direct link to energy use effectiveness & need to view this as a major player in the effective reduction of energy loss either during the maintenance or due to the maintenance.
- At the time of establishing energy consumption reduction initiatives, we need to understand this direct relationship between the maintenance & energy effectiveness.
- The following equation indicates that reduction of energy loss dictates the validity and importance of the maintenance function:-

EI	**=**	**WO**	**+**	**EL**
Energy In		Work Out		Energy Losses

Maintenance Practices and Energy Consumption

But, first, how do we define maintnance

Maintenance is a business concerned with and dedicated to evaluation, assessment, calibration, adjustment, repair, overhaul and replacement of failed components in machinery, facilities, tools and mechanical & electrical systems.

Most of the equipments consume a basic level of energy, regardless of its function. This means that specific energy consumption is a function of load.

Thus high efficiency is achieved through 3 key elements

1. **Good energy efficient design** (which will be difficult to change without major rework).
2. **Effective maintenance** and
3. **Good load factor** (i.e. optimum use of machinery in energy management terms).

Objective task management

Good equipment design, in addition to being more energy efficient, reduces maintainability requirements significantly.

- A structured maintenance system also positively affect energy consumption.
- Energy consumption also needs to be considered as a function of equipment operation (running hours, loading etc.) in order to evaluate the enhanced maintenance strategy.

- Machinery that consumes energy independent of load condition (e.g. when idling) requires to reduce idling - either through automated controls or through streamlined planning.

- Studies performed have concluded that over 30% of total energy consumed by machine tools in a single shift was due to operation break times and non-productive times.

- Mechanical & Electrical equipment require sustained energy to produce work.

Energy Reduction Through Improved Maintenance Practices

Adopting the following 7 steps approach can help ensure success of ERTIMP program :-

1. Audit present state
2. Determine program goals
3. Build a MAP (Management Action Program) involving three major tasks
   - gap analysis of the present state vs the program goals
   - gain approval for a pilot program budget plan
   - construct a time bound MAP including milestones to achieve the goals developed
4. Roll out program in a pilot area
5. Advertise pilot program success
6. Roll out plant program
7. Monitor program success.

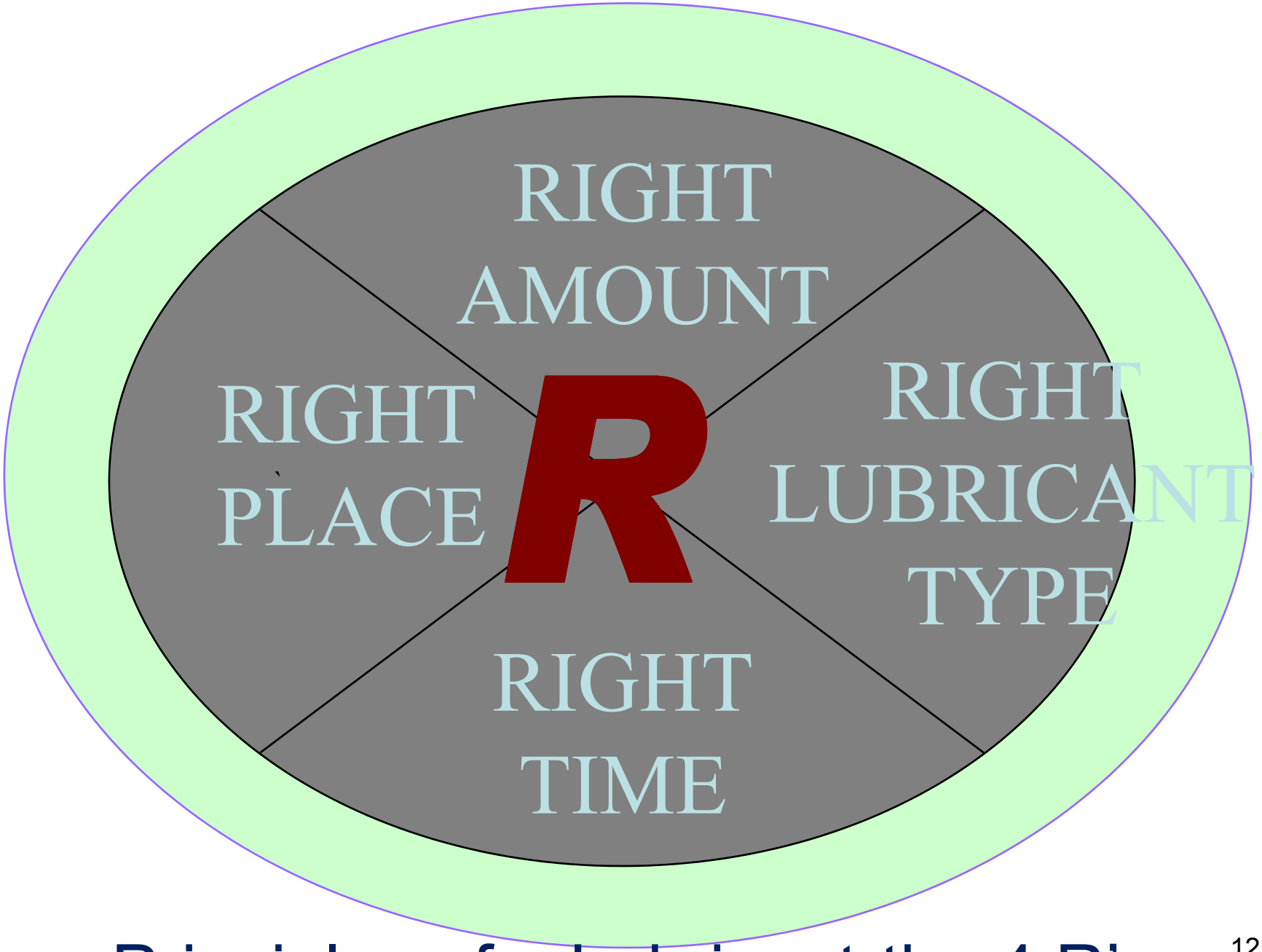
The 9 areas that affect the energy consumption and require the maintenance focus :-

1. Lubrication
2. Compressed air system
3. Electrical connectivity
4. Mechanical drive systems
5. Waste heat and cooling recovery
6. House keeping
7. P.M. Practices
8. Lighting
9. Steam systems

Lubrication

•A big amount of energy gets consumed/wasted to unlock the peaks and valleys of the roughness of the matting surfaces. Therefore lubrication becomes a must to over come or minimize this energy loss. The lubricant reduces

- •Friction
- •Wear
- •Temperature
- •Corrosion
- •Shock
- •Contamination
- •Energy requirement



Principles of a Lubricant-the 4 R's

Right Amount

- Lubricanat requirement is determined by considering the bearing area measurement, bearing design, bearing fit, machine speed and load, environmental conditions and lubricant type.

Right Time

- Mostly it is beneficial to deliver small amount of lubricant on a near-continual basis than to deliver a large amount of lubricant on a non-frequent basis

Selecting a Lubricant

1. Oil or grease

2. Mineral or synthetic

Energy savings

It is possible to secure more than 20% energy savings through effective lubrication which requires correct lubricant delivered at the correct time, place and quantity, although the amount of savings depends upon existing losses due to friction, wear, and ineffective lubricant delivery.

In addition to energy savings, the benefits due to reduced down time, reduced lubricant change outs and increased equipment life can also be achieved.

COMPRESSED AIR SYSTEMS

Energy Savings

Through maintenance:

Over 25% energy savings can be achieved by improving maintenance practices. The chart below is an indicator of potential savings due to maintenance

Check & Repair Action	Potential Savings
System air leaks	9.7%
System over pressure	2.3%
Filter maintenance	0.2%
Correct lubrication	4.8%
Reduced process air	5.0%

Electrical connections

Avoid Non specific maintenance instructions like “tighten all connections” or “ Replace all bushes and megger”. Unnecessary repeated tightening of same connection, leads to conductor failure producing an energy ground fault.

Use IR thermal imaging system and IR non contact thermometer which will help in determining ‘hot’ or ‘cold’ spots. The following table indicates different application of IR detectors for reducing energy consumptions.

Area	Problem
Electrical Connections	Unbalanced phases, loose connections (ground fault), poor insulation, degenerated fuses, worn brushes, broken or loose switch gear
Lighting	Ballast operations
Motors	Overloading, brushes, bearing failures
Power Transmission	Poor connections, broken insulators
Transformers	Housings, Windings

Poor electrical connectivity results in inefficient energy use, inefficient use of maintenance resources, and potential safety hazards.

Mechanical drive System

- Use laser alignment instead of manual to overcome mis-alignment between driver and driven parts.
- This technology helps to attain consistent and maximum alignment accuracy.
- This technology helps save 11% energy in addition to increasing the longevity of coupling, gears, bearing, etc. by 8 times.

Waste heat and cooling recovery

- Although not in the realm of maintenance activity a good maintenance practice can induct a heat recovery and cooling system, when conditions warrant.
- The excess heat produced during heating and /or cooling in the process, can be utilized gainfully for space heating, hot air curtains, pre heated process makeup air and for heating process or potable water.
- Even modern type VAR air-conditioning can also be attempted.

Housekeeping

- While good housekeep is necessary for safety, quality control, maintenance reduction, ease of maintenance and energy cost reduction, it is a key component of any Reliability Centered Maintenance (RCM) or Total Productive Maintenance (TPM)
- Clean electrical system avoids high current drawl, relays chattering, flashover, overheating and increased cabinet ambient temperature.
- Loss of efficiency in HVAC due to filter clogging is also a well known phenomena.
- Good housekeeping also reduces wear contamination, product contamination, component failure- all leading to higher energy consumptions.

P.M. Practices

- P.M., which accounts for 1/3rd the cost of reactive maintenance, is an act in which a maintenance function is performed in a structured manner to optimize the use of the maintained unit, thereby ensuring maximum availability, maximum efficiency and intrusive maintenance.
  Various interpretations of the "P.M." are :-
  1. **Preventive maintenance**. It includes lubrication, adjustment, calibration and house keeping but does not include overhauls (minor adjustments are included).

2. **Predictive Maintenance** is again a non-intrusive maintenance incorporating technology to assist in early detection of equipment deterioration and potential failure.
3. **Productive Maintenance** consists of basic non-intrusive maintenance condition checks performed by non-maintenance i.e. operation staff.
4. **Planned Maintenance** is intrusive maintenance performed in a planned manner before equipment failure has occurred when labor, tools, spare parts, consumables are at the ready.

This usually results from preventive, predictive and productive maintenance. Overhauls are the best examples of planned maintenance.

5. **Proactive Maintenance** consists of all maintenance, intrusive and non-intrusive, performed in a planned and non-reactive (to break down) manner.

6. **Profit Maintenance** is again all maintenance performed with the singular goal of eliminating unnecessary down time and throughput losses.

Industrial Lighting

- Maintenance, rarely responsible for the correct type of lighting, is responsible for the maintenance of existing lighting system.

Operating fundamentals

There are two basic methods for industrial lighting energy reduction

1. Change of lighting type and/or fixture

- high intensity discharge (HID) lights are up to 2.5 times more efficient than fluorescent lights
- incandescent bulbs operate in an inert gas allowing the current to flow through a fine tungsten wire which heats up giving light & heat.

- Fluorescent lights are 3 times more efficient than incandescent lights.
- Retrofitting polished & angled reflectors can further increase the lighting efficiency
- Lighting energy cost can be reduced by retrofitting new fluorescent light technology, efficient electronic ballasts, compact fluorescent lamps etc.

2. Lighting load reduction

Full lighting is not required in unoccupied areas. For safety reason minimal lighting can be adopted with infra red or ultrasonic motion detector connected to delighting circuit

Steam Systems

Energy Savings

Maintenance group can contribute energy savings in the steam system by

1. Leak detection and elimination promptly
2. Pipe insulation check (using an infra red thermal imaging or ultrasonic leak detection) & prompt repairs
3. Ensuring correct DM water through water treatment.