Energy conservation measures in the engineering sector

SIDBI
भारतीय लघु उद्योग विकास बैंक
SMALL INDUSTRIES DEVELOPMENT BANK OF INDIA

DFID Department for International Development

Wi WINROCK INTERNATIONAL INDIA

Department for International Development

DFID is a department of the British Government responsible for Britain's contribution towards international efforts to eliminate poverty. DFID works in partnership with governments of developing countries for poverty alleviation and supports long term programs to help tackle the underlying causes of poverty. DFID recognizes that the development of Micro, Small and Medium Enterprises (MSMEs) is key to creating jobs and income in India. DFID is supporting the development of the MSME sector in India through the MSME Financing and Development project (MSMEFDP).

MSME Financing and Development Project

SIDBI is implementing a multi agency / multi activity project (MSMEFDP) for MSMEs. While SIDBI has been assigned the responsibility of implementing the project, the Department of Financial Services, Ministry of Finance, Government of India is the nodal agency for the same. The World Bank, Department for International Development (DFID) UK, KfW Germany and GTZ Germany are the international partners in the project.

Winrock International India

WII is a not-for-profit organization registered under the Societies Registration Act. WII works in four principal program areas – Energy & Environment, Natural Resources Management, Climate Change and Outreach. WII is affiliated to the US based Winrock International, a global not–for–profit organization. In all areas, WII works towards achieving its mission to "develop and implement solutions that balance the need for food, income and environmental quality".

Winrock International India has been accorded recognition as a Scientific and Industrial Research Organization (SIRO) by the Department of Scientific & Industrial Research (DSIR), Ministry of Science & Technology, Government of India, under the Scheme on Recognition of Scientific and Industrial Research Organizations (SIROs)-1988.

Disclaimer

This booklet is an initiative of Small Industries Development Bank of India (SIDBI) under the MSME Financing and Development Project and funded by Department for International Development (DFID), UK. The views expressed here are not necessarily those of DFID/SIDBI. While every effort has been made to avoid any mistakes or omissions, SIDBI would not be in any way liable to any person / institution by reason of any mistake/ omission in the publication. The graphs, tables and other analyses of data that are carried in various parts of this publication have been drawn from a variety of resources, both primary and secondary.

Published by: Winrock International India, 788, Udyog Vihar, Phase V, Gurgaon - 122 001, Haryana; Tel: +91-124-430 3868; Fax: +91-124-430 3862; Website: www.winrockindia.org

For further details contact:

Project Management Division, SIDBI, Videocon Tower, Ground Floor, E-1, Rani Jhansi Road, Jhandewalan Extension, New Delhi - 110055, Phone - 91-11-23682473-76

ENERGY IS LIFE ऊर्जा कार्यकुशलता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)
CONSERVE IT

vt; ekFkqj] ih,p-Mh
egkfun'kd
Ajay Mathur, Ph. D
Director General

MESSAGE

The contribution of Micro, Small and Medium Enterprises (MSMEs) has been significant in India's economic development. Due to its contribution towards employment and balanced regional development, it is imperative to take measures to strengthen this vital sector.

With increased competition and the ongoing economic slowdown, adopting innovative practices which can manage the bottom line are a necessity for enhanced competitiveness and profitability. Energy efficiency enhancement is a powerful bottom line management intervention for the MSME sector, as it reduces energy consumption while maintaining current levels of productivity and quality – in other words, producing the same goods or services while using less energy.

The Bureau of Energy Efficiency (BEE) has a number of programs to facilitate delivery mechanisms for energy efficiency in all sectors in the country. In the MSME units, local service providers, technology vendors and banks collaborate in the implementation of energy efficiency interventions on a sustainable for-profit basis. To enable this business model, BEE and SIDBI have signed a Memorandum of Understanding to partner and create a shelf of energy efficiency projects for 25 MSME clusters across India.

This booklet contains wide-ranging tips on housekeeping for energy saving practices, at the shop-floor level in the engineering sector. I am delighted by this practical knowledge product and congratulate SIDBI on their continued and innovative efforts in disseminating knowledge in this important area.

I am confident that these simple housekeeping measures, identified best practices, and cost saving tools will help in raising awareness, reducing energy bills, and minimizing waste and will go a long way in contributing to increased competitiveness of the entire MSME sector.

(Ajay Mathur)

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of Self and Nation
चौथा तल, सेवा भवन, आर० के० पुरम, नई दिल्ली-110 066
4th Floor, Sewa Bhawan, R.K. Puram, New Delhi - 110066
टेली/Tel. : 26178316 (सीधा/Direct) 26179699 (5 Lines) फैक्स/Fax : 91 (11) 26178328
ई-मेल/E-Mail : dg-bee@nic.in वेबसाईट/Web-Site : www.bee-india.nic.in

FOREWORD

The Micro, Small and Medium Enterprises (MSMEs) sector has, over the years, emerged as an important vehicle for the economic growth of India. The sector's contribution to the Indian economy has been immense, providing the second largest source of employment, 45% of the industrial manufacturing output and 35% of the country's exports. Through its sheer size and potential, MSMEs play a vital role towards coordinated balanced regional development and inclusive growth of the country. It is noteworthy that this sector has also proved to be innovative, adaptable and resilient throughout different phases of economic cycles.

Small Industries Development Bank of India (SIDBI), being the principal financial institution for MSMEs, is committed towards holistic growth of the MSME sector by making it strong, vibrant and globally competitive. We recognize energy efficiency as an effective tool to promote competitiveness of the MSME sector. SIDBI and the Bureau of Energy Efficiency (BEE) are cooperating to promote energy efficiency in MSME clusters. SIDBI has also tied up a line of credit with the Japan International Cooperation Agency (JICA) to finance energy saving projects at concessional terms.

In our endeavor towards creating widespread awareness on the necessity and urgency of energy saving measures in the MSME sector, we are bringing out this booklet which is an attempt to disseminate information on simple, cost-effective solutions in engineering enterprises. The booklet presents measures that guide adoption of energy efficiency and greener practices to help MSMEs cut costs and attain higher competitiveness. This publication is the second in the series; the first being energy saving measures in the fruit and vegetable processing sector published in association with The Energy and Resources Institute (TERI).

I am confident that this booklet will be a valuable resource for MSMEs in the engineering sector in reshaping their manufacturing process by adopting energy efficiency measures and technologies.

I wish the entire MSME fraternity the very best for success in all their endeavors.

RM Malla,
Chairman and Managing Director,
SIDBI

Introduction

The engineering sector plays an important role in manufacturing. If all production processes are considered together, the role of engineering comes in after primary processes such as foundry operations, forging, rolling etc.

Engineering, as an industry in India, has a large operating scale; the capacity of engineering companies may vary from units which have just a couple of simple machine tools and a small tool room, to large establishments with dedicated and sophisticated processing lines for each component. A typical MSME engineering unit has several machine tools for general operations such as turning, milling, and grinding and a few specialized machine tools for particular operations. The machining operations are supported by small tool rooms and equipments such as welding and material handling machines, lifters, etc. In addition, to run the entire set-up, utility equipments (or utilities) are needed, which include hydraulic systems, compressed air and pneumatic systems, electrical systems (distribution, demand management and utilization), electric/oil fired furnaces for melting/heat treatment, diesel generator sets and so on. Specialized utilities, for example, steam boilers, and refrigeration systems are found in engineering units with specialized process applications. Electricity is used to run most of the equipments, specially the machine tools and utilities, while fuel oil is burnt in furnaces to provide the remaining energy. In a typical engineering unit, the following items consume the maximum energy/resources:

- Machine tools operation – conventional and CNC
- Metal casting/reheating
- Electroplating
- Compressed air systems, and
- Electrical systems

Adopting and following Best Operating Practices (BOPs) would result in:

- Savings of energy, resources and money
- Reduce the chances of reworking and thereby, costs
- Productivity increase
- Lead to better quality
- Continuous improvement
- Increase in safety of operations

Energy Saving in Machine Tools

Machining is the most important operation in all engineering units. The use of conventional versus CNC machine tools depends on the nature of the product and the scale of operations. Motors, drives and pumps are driven by electricity. If machine tools are properly operated and maintained, specific energy consumption will decrease, tool and machine life will increase and productivity will go up. Some important practices that will help to operate and maintain machine tools properly and save energy are listed below.

- Lubricate and adjust machine tools before operation. Improper lubrication and loose fasteners can cause excessive/uneven motor loading and inefficient operation.
- Check the foundation for correct leveling before installing any machine. Install mobile machine tools or new machine tools on even ground after proper leveling.
- Do not use the guide ways on machine tool beds as tables for other tools.
- Keep the guide ways free of grit and dirt. If the lubricant has particles (grit and dirt), the movement of the carriage assembly will use more power.
- Make sure there are no metal chips in the gear mechanism. Check the lead screw, gears and worms frequently. Do not run the machine

with open gearboxes. Dust and grit will collect on the greasy surface and not allow proper lubrication. Poor lubrication may increase the loading on the motor by as much as 5%.

- Use the right kind of cutting tools for a particular operation. There are different tools for turning, facing, parting, etc. Use tools specially designed for operations like knurling, end cutting, thread-cutting and so on. Do not use one single tool for many operations, otherwise the tool and product may be damaged. Figure 1 shows various cutting tools and associated correct machining operations.

It is seen that each tool's geometry is specific for one cutting operation. Different tool bits and inserts are available which have specialized cutting geometry for optimizing cutting performance and other parameters like chip generation, chip removal and clearances.

Depth of cut is the distance that the tool bit moves into the work. It is measured in thousandths of an inch or in millimeters. Feed is the distance the tool bit advances along the work for each revolution of the spindle. Feed is measured in inches or millimeters per revolution. Optimum machining practice is to use a depth of cut up to five times the rate of feed. For example, for rough turning stainless steel, using a feed of 0.02 inch per revolution and a depth of cut of 0.10 inch would reduce the diameter by 0.20 inch. Deep cutting and faster feed rates will increase the motor loading and heat up the work piece, produce smoke and a loud chatter noise. Keep the depth of cut and feed rate low for fine machining.

- The benefits of using cutting fluids or metal working fluids (MWF) are:
  - o Tools will not have to be sharpened frequently
  - o Grinding frequency will reduce
  - o Equivalent cutting can be carried out with fewer repetitions
  - o Will help to remove chips or swarf (an accumulation of fine metal and abrasive particles) easily from the cutting zone

Optimum machining practice is to use a depth of cut up to five times the rate of feed

Use proper cutting tools for metal cutting operations

Use recommended MWF to reduce tool regrinding frequency

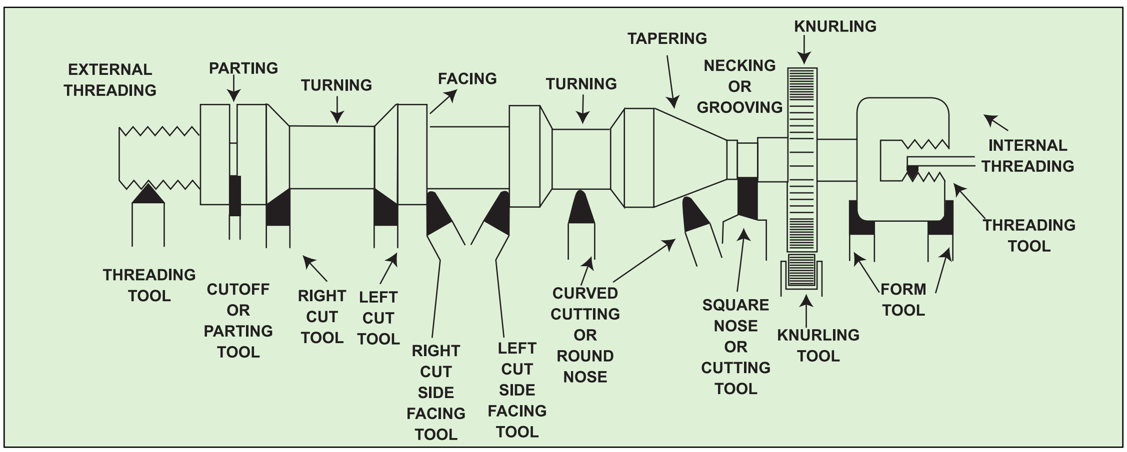
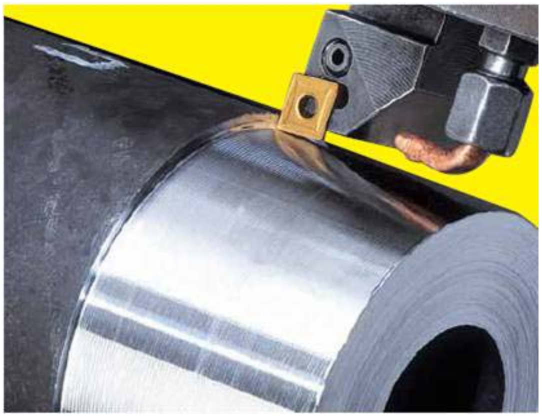


Figure 1: Correct cutting tool selection for different cutting operations

- o Improved tool life and better surface finish on the metal. This is because lubrication reduces friction between the cutting tool and the machining parts.
- Will stop the circulation of MWF when there is no machining operation going on. This will save energy being used by the pump and also minimize the mist effect of MWF and improve the working conditions.
- Routine and simple maintenance of machine tools prevents frequent breakdowns and ensures proper operating conditions. Perform these checks before the start of every shift, it takes only a few minutes to complete.
  - o Clean the chips from the chip pan
  - o Check hydraulic oil level in the main hydraulic tank and top up if required
  - o Check the lubricating oil level in the guide ways and lubricating oil tank and top up if required
  - o Check the coolant levels in the coolant sump and top up if required
- Preventive maintenance of machine tools must be conducted regularly. This will help to keep the machine tool in good working condition. If preventive maintenance is not carried out, an entire batch of products may have to be rejected due to malfunction of the machine tool. Preventive maintenance should cover the following checks:
  - o Alignment check between spindle, carriage assembly and other components to ensure accuracy of cut.
  - o Draining of coolant and replacing with fresh coolant made in proper proportions as instructed by the manufacturer.
  - o Calibration of gauges and instruments, if thought to be necessary.



All the measures mentioned above for getting the most efficient operation from machine tools in an engineering unit have been summarized in Table 1.

Table1: Efficient operation of machine tools

Dos	Don'ts
1. Lubricate machine guide ways, gear boxes and hydraulic systems properly.	1. Don't leave gearbox and other lubricated parts uncovered.
2. Change the lubricant frequently if working in dusty conditions.	2. Don't use a quality lower than High Speed Steel for metal working.
3. Ensure optimum cutting speed, depth of cut and feed rate for proper machining, surface finish and tool life.	3. Don't run the machine at very high speeds in extreme cold conditions.
4. Use a light feed on slender and small work pieces to avoid damage.	4. Don't use MWF with black appearance. Change MWF when concentration changes, as per manufacturer's guidelines.

Energy Saving in Metal Casting / Reheating

In metal casting, the metal is heated several degrees above its melting point and then poured into moulds. Metal casting is only a small part of the entire engineering process, but it consumes a lot of energy and forms a large part of the overall energy cost. Melting and casting processes are employed by foundries, on a large scale. Foundries usually install large cupola or induction melting furnaces for metal casting. The smaller engineering units install either crucible furnaces for non-ferrous melting (brass, copper, aluminium, etc.) or small capacity induction furnaces. Table 2 compares typical efficiency levels for commonly used melting furnaces.

Melt losses are a measure of the difference in metal quantity before and after the melting process. The loss can occur for many reasons but the most important one is oxidation of metal. Factory owners try to reduce melt losses because the cost of metal is usually several times higher than the fuel cost. Metal casting and reheating processes can be made more efficient by:

- Minimizing the temperature of exhaust gases from the furnace. The temperature of exhaust gases can be lowered by increasing the length of the preheating zone of the furnace.
- Reducing the charging time to ensure maximum capacity utilization and faster mass flow rate.
- Reducing the holding time to ensure minimum fuel/electricity consumption while holding (non-productive operation). This will also improve the life of the refractory lining

Excess air levels and flue gas temperatures are two important parameters on which kiln efficiency depends

Loss of even one drop of oil every second wastes over 4000 litres of fuel a year

A 22^{0}C reduction in the flue gas temperature can reduce the fuel consumption by 1%

It is better to install more burners with smaller firing capacities instead of a few burners with a larger firing capacity

Table 2: Energy and material losses in different kinds of furnaces

Melting Furnace	Common Use	Melt Loss (%)	Thermal Efficiency (%)
Cupola	Iron	3-12	40-50
Electric Arc	Steel	5-8	35-45
Electric Reverberatory	Aluminum	1-2	59-76
	Zinc	2-3	59-76
Gas Crucible	Aluminum	4-6	7-19
	Magnesium	4-6	7-19
Gas Reverberatory	Aluminum	3-5	30-45
	Zinc	4-7	32-40
Gas Stack Melter	Aluminum	1-2	40-45
Induction	Aluminum	0.75-1.25	59-76
	Copper-Base	2-3	50-70
	Magnesium	2-3	59-76
	Iron	1-2	50-70
	Steel	2-3%	50-70

in induction furnaces.

- Planning and scheduling the furnace operation, especially for batch melting furnaces, such that the number of cold starts is minimized. Each cold start consumes 10 – 20% more energy than regular furnace running and also reduces the life of the refractory.
- Optimizing excess air in the furnace. Excess air (that is, more than the stoichiometric amount) is needed in a furnace to allow complete mixing of air and fuel and maximizing combustion efficiency. However, if too much excess air is added, the furnace temperature will go down, and more fuel will be needed. Too little excess air will lead to incomplete fuel combustion, formation of soot and scale. Excess air in the furnace should be optimized in the following ways:
  - o Controlling the entry of air through furnace openings.
  - o Maintaining proper air pressure.
  - o Monitoring the levels of excess air using a combustion analyzer.
  - o Regulating the supply of air through the blower according to the rate of fuel supply.
  - o Turn off combustion air supply with cut off in fuel supply regulated by thermostat. Both combustion air and fuel supply should be interlinked with the auto cut operation of thermostat. This helps in increasing the restart time of fuel supply at ON signal from thermostat.

Table 3 shows the optimum levels of excess air for different fuel and furnace types

- Fuels should be bought only from authentic sources because adulterated or impure fuels can damage the burner and pumping units, decrease combustion efficiency and result in higher costs. Fuel quality should always be monitored by verifying fuel test reports.

Table 3: Recommended excess air for different fuels

Fuel	Type of Furnace or Burners	Excess Air (% by wt)
Pulverised coal	Completely water-cooled furnace for slag-tap or dry-ash removal	15-20
	Partially water-cooled furnace for dry-ash removal	15-40
Coal	Spreader stoker	30-60
	Water-cooler vibrating-grate stokers	30-60
	Chain-grate and traveling-grate stokers	15-50
	Underfeed stoker	20-50
Fuel oil	Oil burners	15-20
	Multi-fuel burners and flat-flame	20-30
Natural gas	High pressure burner	5-7
Wood	Dutch over (10-23% through grates) and Hofft type	20-25

- Fuel should be stored according to the guidelines for that particular fuel. For liquid and gaseous fuels, leakages in storage and supply lines are wasteful and can be dangerous. The supply lines and the storage should be checked for leakages/blockages once in a week.
- Never allow the burner flame to directly touch the material or the refractory. Direct touching will increase scale losses, reduce the refractory lining's life and cause inefficient heating. Also, flames from different burners should not touch each other inside the heating chamber of the furnace.
- Use digital temperature indicators and automatic controllers in place of human monitoring. This will reduce the chances of the material overheating and also prevent energy/material loss.

- Heat loss occurs through furnace openings in the following ways:
  - o Direct radiation loss
  - o Leakage of hot combustion gases
  - o Infiltration of cold air

  To minimize such losses, any furnace openings caused by normal wear should be immediately sealed and material flow gates covered with proper curtains.
- In heat treatment furnaces, use proper digital temperature indicators so that the furnace gates do not have to be opened to check the temperature.
- Follow the specified heating treatment cycle for material while using bogey type heat treatment furnaces. Use thermostat based controls to maintain the required temperature.
- Load the material in optimum sizes in batch type furnaces. This will ensure that there is no obstruction to the flow of hot gases, flame path and the exhaust port.
- In crucible furnaces, place the stock near the furnace opening for preheating.

The measures mentioned above, for operating the furnaces most efficiently in an engineering unit, have been summarized in Table 4.

Energy Saving in Electroplating

Electroplating is an important production step in almost all engineering units which involves production of finished goods. The electroplating process involves dipping the semi-finished products into various baths of metallic salts, to coat a metallic layer on the semi finished product surface. Such metallic baths are placed in series and are separated by one or more rinse water tanks between every two metallic bath tanks. Rinse water tanks are to remove the chemicals from the previous metallic bath and prevent mixing of chemicals into the next metallic bath. Therefore, considerable amount of water is required to be pumped into these rinse tanks to keep the process chemically stable.

The following parameters are required to be monitored in the electroplating section of an engineering unit to make the process more efficient.

Table 4: Efficient operation of furnaces and combustion systems

Dos	Don'ts
1. Always maintain proper air – fuel ratio. Use combustion analyzers to find air – fuel ratio.	1. Don't estimate the furnace temperature.
2. Clean burner nozzles to remove deposits once a month.	2. Don't leave air supply open while fuel supply is closed.
3. Plan production to avoid furnace cold starts.	3. Don't open furnace gates unnecessarily.
4. Use the correct/recommended frequency in induction furnaces for the alloys being melted. This will ensure faster mixing of additives and reduce cycle time.	4. Don't use liquid fuel without proper heating and pumping.
5. Always use calibrated digital meters for reading temperature and pressure. Manual estimation may be incorrect.	5. Don't use adulterated fuel.
6. Seal unnecessary furnace openings and leakages.	

Reduce amount of water used for rinsing

The amount of water required for the rinsing process plays an important role in determining the efficiency of rinsing. Minimizing rinse water requirement will not only conserve water, but also save the energy required to pump and treat waste rinse water before disposal. It also reduces the quantity of costlier metallic salts which are wasted as unrecoverable salts from the rinse water.

The rinsing process can be made more effective and economical by adoption of the following practices:

Proper design of electroplating line and rinse tanks

- Rinse tanks should have proper agitation of water. Agitation can be created by using pressurized water inlet nozzles on the bottom edge of the rinse tank.
- The water inlet pipe should be located to create turbulent flow close to the products' surface.

Figure 2 shows the sketch of a rinse tank which includes the above mentioned design parameters.

Installing staged rinsing techniques

- Multi stage rinsing with water conservation: Multi stage rinsing involves the use of two or more rinse tanks with a water flow arrangement such that the least concentrated (effluent) waste water from the final stage of rinsing is directly used in the preceding. The final effluent with highest concentration appears only in the first stage of rinsing. Figure 3 shows that the water requirement for the later rinsing stages is gradually reduced.

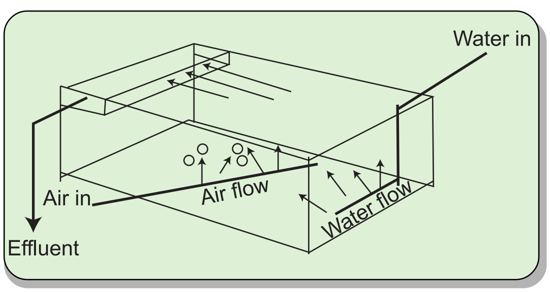


Figure 2: Schematics of an efficient rinse tank design

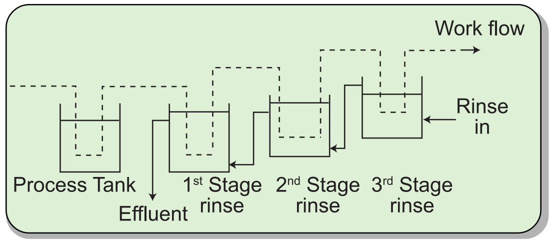


Figure 3: Schematics of counter flow rinsing

Minimise bath drag out

Spray rinsing with drag out reduction

Whenever the hangers carrying the items to be electroplated are taken out from the metallic bath, a considerable quantity of bath solution also comes out of the tank on the surface of articles and the hangers. Such outflow of the chemical bath from the process tank is called drag out. Drag out quantity also depends on the shape and form of articles under process. Reducing the quantity of drag out not only saves the excess water required to rinse off such chemi-

The rinse tank size should be just enough to hold the products on hangers. A large size rinse tank requires excess water and more metallic salt.

Use of counter flow rinsing saves both water and energy

Techniques like spray rinse and drain board reduce drag-out considerably cals, but also saves the precious and costly metallic salts from flowing out of the process tank.

Use of spray rinse, as outlined in Figure 4 can save a large quantity of drag out from the process tank by the immediate return of the entire drag out back into the process tank. Pressurized water is sprayed using suitable sized nozzles. Care must be taken in spraying the correct quantity of water so as to prevent dilution of the bath in the process tank.

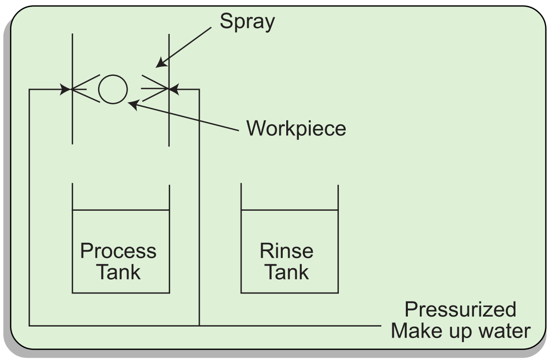


Figure 4: Spray rinse method for reducing drag out in electroplating

Use of simple drain boards between two tanks in electroplating line

One very simple and effective way to reduce drag out from process tanks is to keep the electroplating section free of spills. Use inclined drain boards between every two process tanks. As outlined in Figure 5, flat boards can be placed between two tanks, inclined at an angle such that the drag out flows back into the process tank.

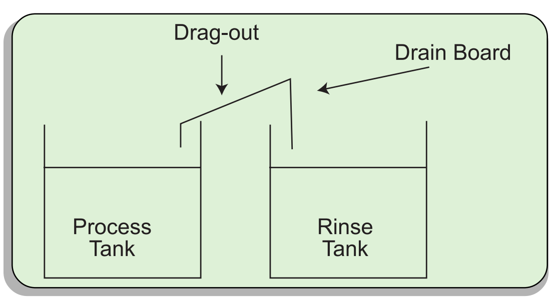


Figure 5: Drain board method for reducing drag out in electroplating

Energy Saving in Compressed Air System

Air compressors are used in engineering units to supply compressed air to pneumatic equipment and machine tools. Air compression consumes a lot of energy. From Figure 6, it is clear that only 10 – 30% of input energy to the compressor reaches the point of end-use and the balance 90 – 70% of input energy gets wasted in the form of friction and noise.

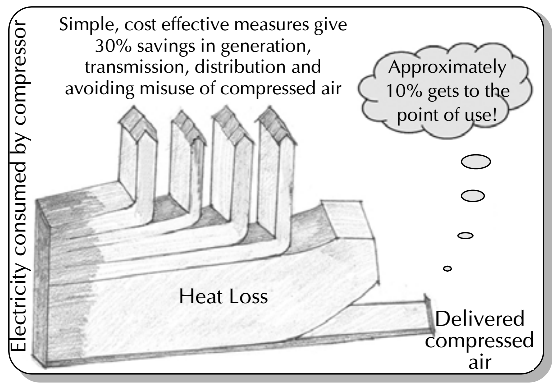


Figure 6: Sankey's diagram for energy utilization in compressors

Energy savings of up to 30% can be realized in a compressed air system by adopting regular simple maintenance measures. Some practices that will optimize air compression are listed below.

- The location of air compressors and the quality of air drawn by the compressors will have a significant influence on the amount of energy consumed. The following points should be taken into consideration while deciding the location of compressors or combined compressed air systems.
  - o Locate the compressor away from heat sources such as kilns, dryers and other items of equipment that radiate heat. Table

5 shows the power savings with decrease in inlet air temperature.

- o The compressor should be located such that it draws cool ambient air from outside because the temperature of the air inside the compressor room is high. While extending the air intake from the outside of building, minimize excess pressure drop in the suction line, by selecting a duct of large diameter with the smallest number of bends.
- o The compressor should be placed where there is no particulate matter. Do not place the compressor near spray coating booths, sawing machines, the buffing section, etc.

- Any moisture in the inlet air to the compressor will affect its performance adversely. The compressor should be placed away from equipment which may add moisture to the atmosphere, for example, rinsing lines, cooling towers, dryer exhaust, etc. If the compressed air is moist, the components of the compressed air system will corrode. Also, the specific power consumption will increase.
- Choose the pressure setting in the compressed air system very carefully. Judge/assess the requirement of different compressed air users before connecting them to common compressed air grid. This is the most important criterion for optimizing the efficiency of the compressed air system.

Table 5: Relative power savings by decreasing intake air temperature

Inlet temp. (°C)	Relative air delivery (%)	Power Saved (%)
10.0	102.0	+1.4
15.5	100	Nil
21.1	98.1	-1.3
26.6	96.3	-2.5
32.2	94.1	-4.0
37.7	92.8	-5.0
43.3	91.2	-5.8

- Segregate users of compressed air on the basis of the pressure required for proper operation. Set up two or more compressed air grids if needed, with each having the air pressure set according to the requirement of equipment in that particular grid. A single compressed air network will always have delivery pressure set equal to the requirement of the equipment that demands the highest pressure. This is not desirable.
- Some items of equipment in the grid require air at low pressures. Do not use valves to reduce the pressure in the compressed air grid, because it wastes the energy that is consumed in building up the excess pressure. Compressed air pressure must be set at the point of generation.

The unit adopted the best operating practices for compressor operation. The following steps were taken to reduce the power consumption in generating compressed air.

- When monitored, it was found that the bubbler equipment was run for only 4 – 5 hours in a week. Most of the compressed air was consumed by other low pressure equipments.
- The compressor's pressure was reset to 5.5 kg/cm^2 for operation when the bubbler was in use.
- Optimizing the compressor loading and unloading pressure and segregating high and low pressure loads in the compressed air grid, can lead to significant energy savings without any major investments.
- Minimize the pressure drop in the line between the point of generation and the point of use. Excess pressure drop can result from the following:
    - o Inadequate pipe size

- o Choked filter elements
- o Improperly sized couplings and hoses

All these lead to significant energy losses. Table 6 shows typical energy wastage on account of pressure drop created by smaller pipe diameter.

Table 6: Typical energy wastage due to smaller pipe diameter for 170 m^3/h (100 cfm flow)

Pipe Nominal Bore (mm)	Pressure drop (kg/cm^2) per 100 meters of pipe length	Equivalent power losses (kW)
40	1.84	9.5
50	0.66	3.4
65	0.22	1.2
80	0.04	0.2
100	0.02	0.1

In industrial practice, the typical acceptable pressure drop is 0.3 bar in the mains header at the farthest point, and 0.5 bar in the distribution system.

- Clean the air intake filters regularly so that clean air can enter the compressor and permit a low pressure drop across the filters.
- It has been observed that Free Air Discharge (FAD) by compressors increases by as much as 12.5% in some cases by simply cleaning the air intake filters.
- Maintain the proper level of tension in the belt in compressors connected by belt drives. Improper belt tension, loose or vibrating belts can cause an increase in power consumption of the prime mover by as much as 6%.
- Put the right kind of compressor to use. This is specially important in a compressed air network consisting of several compressors of the same or different sizes, capacity, operational efficiency, etc. The following points should be noted while deciding the operating pattern of compressors.
  - o If all compressors are similar, adjust the pressure setting of the compressors so that only one compressor handles the load variation. The others should operate with full load, to the extent possible.
  - o If compressors are of different sizes, the pressure switch should be set such that only the smallest compressor is allowed to modulate (vary in flow rate) according to the demand compressed air
- Avoid air leaks and associated energy losses. Conduct leakage tests regularly (once in a month) to remove air leaks in the compressed air system. The following Table 7 shows the loss in FAD through orifices of different sizes in a compressed air grid.

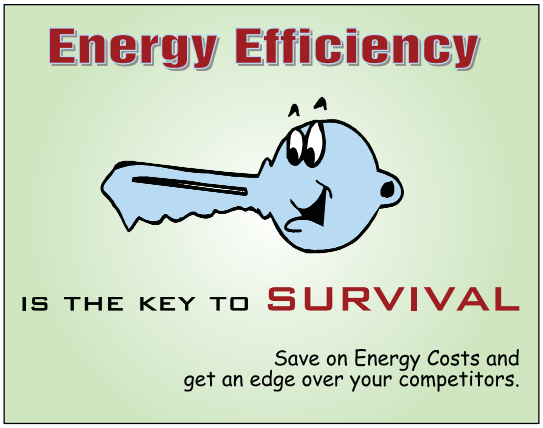
Every 4°C rise in inlet air temperature results in an increase in energy consumption by 1%, to achieve an equivalent output

Increase in air discharge pressure by 1 kg/cm^2 above the desired value will result in input power by about 4–5%

Clean the air intake filters and conduct leakage test atleast once in a month

Table 7: Discharge of air (m^3/minute) through orifice (orifice constant C_d = 1.0)

Air Pressure (Bar)	Orifice size in mm						
	0.5	1	2	3	5	10	12.5
0.5	0.06	0.22	0.92	2.1	5.7	22.8	35.5
1.0	0.08	0.33	1.33	3.0	8.4	33.6	52.5
2.5	0.14	0.58	2.33	5.5	14.6	58.6	91.4
5.0	0.25	0.97	3.92	8.8	24.4	97.5	152.0
7.0	0.33	1.31	5.19	11.6	32.5	129.0	202.0



Figures 7 & 8 shows examples of badly choked filters.

Figure 7 & 8: Choked filters of compressors

- The measures mentioned above for best operating practices for efficient operation of compressors in engineering units are summarized in Table 8.

Energy Saving in Electrical Distribution System

The electrical system is an integral part of all engineering units. An efficient electrical distribution system together with demand management can reduce the electricity bill significantly. Adopt the following practices in order to maintain an efficient electrical distribution system.

- Stagger the non-critical load according to the electricity tariff to reduce the energy bill. The benefits of load sharing are shown in Table 9.

Table 9: Benefits of Load Staggering

Load to be shifted to night shift (10 PM - 6 AM)	10 kW
Assumed working hours per shift	8 hours
Monthly power consumption (30 days/month)	2400 kWh
Electrical cost for night shift operations (@ Rs 3/kWh during 10 PM - 6 AM)	Rs 7200
Electrical cost for general shift operations (@Rs 4.5/kWh)	Rs 10,800
Savings per month	Rs 3,600
Annual savings	Rs 43,200

Table 8: Summary of best operating practices for efficient operation of compressors in engineering units

Dos	Don'ts
• Keep compressors suction in ambient air away from heat and moisture sources	• Don't install different pressure loads on the same compressed air grid.
• Check the filters for proper cleaning and minimum pressure drop across it	• Don't leave compressed air leaks unattended.
• Use proper size piping for distribution of compressed air	• Don't fail to conduct leakage test once a month.
• Use direct coupling for same motor and machine rpm	

- Maintain a high power factor, which will lead to reduced demand, better voltage, high system efficiency as well as rebates from the electricity supplying company. The power factor can be improved by installing capacitors in the electrical system.
- Any shortfall in power factor, from the desired value, can be made up by the use of capacitor banks. The following Table 10 shows the value of capacitance required per kilowatt to improve the power factor.
- Transformers are normally designed to operate at maximum efficiency between loadings of 32% and 35% of their full capacity. If the load on the transformer increases beyond 80% of the designed capacity, it is better to buy a new or bigger transformer to prevent a sharp rise in transformer losses.
- Control the maximum demand by tripping non-critical loads through a demand controller. This will avoid the penalty levied when the usage is greater than the sanctioned load.
- Balance the system voltage to reduce the distribution losses in the system. For every 1% increase in voltage imbalance, the efficiency of the motors decreases by 1%.

Energy Saving in Electrical Utilities – Motors and DG Sets

Electrical motors are the principal source of motive power in any engineering unit. Machine tools, auxiliary equipment and other utilities come equipped with one or more electric motors. A machine tool can have several electric motors other than the main spindle motor. These are used for allied operations. Motors are generally efficient, but their efficiency and performance depends on the motor load. Figure 9 shows the variation in efficiency and power factor vis-à-vis the total load, for a typical motor.

Since there are many motors in an engineering unit, it is very important to maintain them and adopt proper operating practices. These practices will save a significant amount of en-

Table 10: Multipliers to determine capacitor KVAR required for power factor correction

Original Power Factor	*Desired Power Factor*															
	0.85	**0.86**	**0.87**	**0.88**	**0.89**	**0.90**	**0.91**	**0.92**	**0.93**	**0.94**	**0.95**	**0.96**	**0.97**	**0.98**	**0.99**	**1.00**
0.85	**0.86**	**0.87**	**0.88**	**0.89**	**0.90**	**0.91**	**0.92**	**0.93**	**0.94**	**0.95**	**0.96**	**0.97**	**0.98**	**0.99**	**1.00**	
0.85	0.00	0.03	0.05	0.08	0.11	0.14	0.16	0.19	0.23	0.26	0.29	0.33	0.37	0.42	0.48	0.62
0.86		0.00	0.26	0.53	0.08	0.11	0.34	0.17	0.20	0.23	0.26	0.30	0.34	0.39	0.45	0.59
0.87			0.00	0.03	0.06	0.08	0.11	0.34	0.17	0.20	0.24	0.28	0.32	0.36	0.42	0.57
0.88				0.00	0.03	0.06	0.08	0.11	0.15	0.18	0.21	0.25	0.29	0.34	0.40	0.54
0.89					0.00	0.03	0.06	0.09	0.12	0.15	0.18	0.22	0.26	0.31	0.37	0.51
0.90						0.00	0.03	0.06	0.09	0.12	0.16	0.17	0.23	0.28	0.34	0.48
0.91							0.00	0.03	0.06	0.09	0.13	0.16	0.21	0.25	0.31	0.46
0.92								0.00	0.03	0.06	0.10	0.13	0.18	0.22	0.28	0.43
0.93									0.00	0.03	0.07	0.10	0.14	0.17	0.25	0.40
0.94										0.00	0.04	0.07	0.11	0.16	0.22	0.36
0.95											0.00	0.03	0.08	0.13	0.19	0.33
0.96												0.00	0.04	0.09	0.15	0.29
0.97													0.00	0.05	0.11	0.25
0.98														0.00	0.06	0.20
0.99															0.00	0.14
1.00																0.00

Required capacity rating (KVAR) = load (kW) x multiplication factor

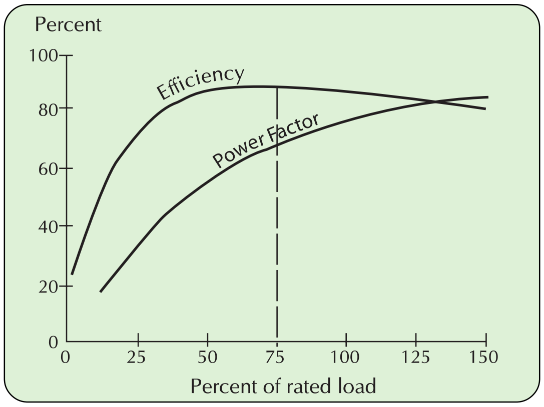


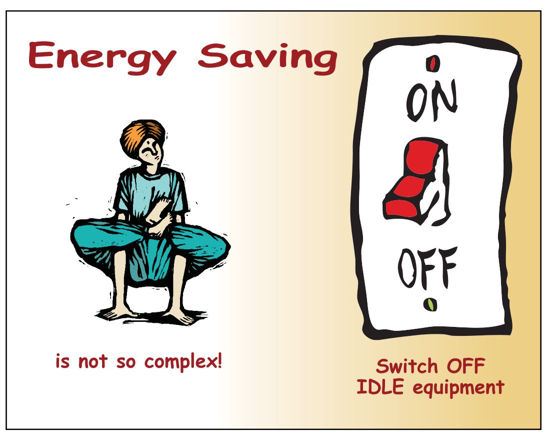
Figure 9: Variation of motor efficiency and power factor with percentage load on motor

ergy. A list of such practices and measures is presented below.

- Always use motors sized according to the requirement of the load. It is a good practice to operate motors between 75 -100 % of their full load rating.
- Oversized motors result in energy losses through decrease in efficiency and power factor. Oversized motors should be replaced with motors of appropriate rating.
- When replacing motors, always buy energy-efficient motors instead of conventional motors. The cost of energy consumed by a conventional motor during its life is far greater than the incremental cost of the energy efficient motor.
- If a motor is continuously running below 45% of its designed load, it is better to reconfigure the motor delta to star connection or install a delta star converter. This measure will give energy savings of up to 10%.
- A properly balanced voltage supply is essential for a motor to reach its rated performance. An unbalanced three-phase voltage affects a motor's current, speed, torque, and temperature rise. Equal loads on all three phases of the electric service help assure a voltage balance while minimizing voltage losses.
- Regular maintenance helps to minimize friction losses, heat losses, and extends a motor's life. The motor should be lubricated and cleaned periodically.
- Motors should be rewound only by a qualified person. This will minimize losses in the rewound motor.
- Motors frequently drive variable loads such as pumps, hydraulic systems and fans. It is appropriate to use a variable speed drive (VSD) with such motors.
- Check motors for over-heating and abnormal noises/sounds and sparking and ensure proper bedding of brushes.
- Tighten belts and pulleys to eliminate transmission losses.
- Install capacitors across motors of high rating to reduce the distribution losses.

Apart from electric motors, diesel generator (DG) sets are also installed in a majority of engineering units, as a source of back up power. Tips to monitor/improve the performance of DG sets are highlighted below

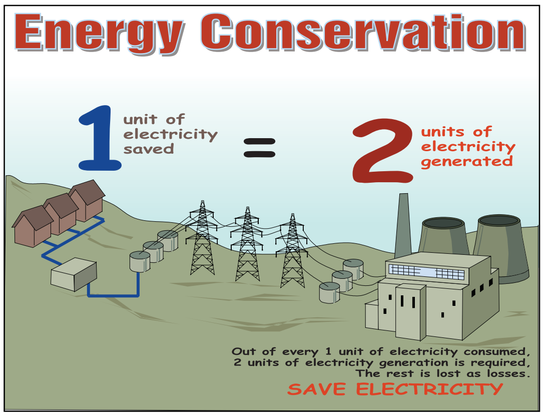
- The performance of the generator set is monitored in terms of the SEGR (Specific Energy Generation Ratio), which is the ratio of units of electricity generated (in kWh) per unit of



Life cost of a motor is often over 100 times the purchase cost

Every time a motor is rewound, its efficiency drops by 2%

Every 10^{0}C drop in inlet air temperature will lead to a 2% saving in fuel costs



diesel consumption (in liters).

- Conduct regular SEGR trials to monitor the performance of the generator. Contact the manufacturer for overhauling if the operating value of SEGR is less than 80% of the designed value, at optimum load.
- The SEGR value drops significantly at a loading of below 60%. Try to optimally load the DG sets.
- Ensure that the air intake to the generator is cool and free from dust. Warm air can seriously decrease the generator's performance on account of reduction in volumetric efficiency.
- Clean the air filters regularly.
- Unbalanced loads on A.C. generators lead to an unbalanced set of voltages and additional heating in the generator. Hence, the load on A.C. generators should be balanced as far as possible.
- DG sets require regular and periodic maintenance for efficient running. Carry out maintenance once in a month covering the following points.
  - o Check the level and appearance of lubricant oil. Top up or change the lubricant oil periodically as per the manufacturer's guidelines.
  - o Clean the radiator fans and heat exchanger.
  - o Check the belt condition. Loose or damaged belts will lead to high coolant temperatures.
  - o Optimize the operating frequency of the generator.

Conclusion

It can be seen from Table 15 above that significant energy savings are realizable in the engineering sector by adopting Best Operating Practices and implementing simple housekeeping measures. Various energy intensive sections and processes in any typical engineering unit, which require focused attention for regular upkeep and maintenance for efficient operation, are Machine tools, Metal casting/reheating, Electroplating and plant utilities.

In general, adoption of the following measures in a variety of engineering units would result in higher energy efficiency, lower operating costs and increased profit and equipment life.

- Optimum machining practice is to use a depth of cut up to five times the rate of feed
- Use proper cutting tools for metal cutting operations
- Use recommended MWF to reduce tool regrinding frequency
- Excess air levels and flue gas temperatures are two important parameters on which kiln efficiency depends

.........................State Electricity Distribution Co. Ltd.

ELECTRICITY BILL FOR THE MONTH OF May-2008 Page 1 of 1

RASTAPETH CIRCLE .... B'GARDEN DIVN ....

No. 170019031210 Alias: .... DTC

Customer Name: ABC

Address: XYZ AREA

Village: .... Pin Code: ....

Connected Load (KW) 183.00 Sanctioned Load (KW) 183.00 Supply at: HT

Contract Demand (KVA) 156.00 Sanctioned Demand (KVA) 156.00 Prev. Highest (Mth) NOV

Recorded MD (KVA) 78.00 Meter No. .... Bill Demand (KVA) 117

Date of Connection 09-10-2006 Tariff 56 HT-IN Elec. Duty **60 PART F ASC %**

BILL DATE: 04-06-2008 DUE DATE: 18-06-2008

Last receipt No./Date: PU00804103/13-05-2008

Last Month Payment : 95,170.00

DG Set (KVA) : .00

Scale/ Sector : Small Scale/Private Sector

Activity :

Seasonal :

Load Shed Ind INDUST

Express Feeder Flag: No

Feeder Voltage (KV): 11.0

Reading	Date	KWH	KVAH	RKVAH (LAG)	KW (MD)	KVA (MD)
Current	26-05-2008	184039.000	199889.000	63519.000	0.000	40.045
Previous	26-0-2008	177818.000	192770.000	60748.000		
Difference		6221.000	7119.000	2771.000		
Multiplying factor		2.0000	2.0000	2.0000	2.0000	2.0000
Consumption		12442.000	14238.000	5542.000	0.000	80.090
LT. metering		0.000	0.000	0.000	0.000	0.000
Adjustment		0.000	0.000	0.000		
Assessed consumption		0.000	0.000	0.000		0.000
Total Consumption		12442.000	14238.000	5542.000	0.000	80.000

Billed Demand (KVA) 30 @Rs. 300 Assessed P.F. 0.87 Billed P.F. 0.87 L.F. 13

Consumption Type	Units	Rate	Charges Rs.	E.D. On (Rs.)		Amount Rs.
Industrial	12,442	3.4	42302	59,732.98	6	3583.98
Residential	0	2.6	0.00		12	
Commercial	0	4.6	0.00		13	

Zone	Units	Demand	Charges
A Zone	9,740	80.00	-8,279.00
B Zone	1,780	79.00	0.00
C Zone	416	12.00	332.80
D Zone	506	61.00	556.60

Cr. Adj. Rs. 835 of type PROMPT PAYMENT DISCOUNT Cr.
Adj. Rs. 20406 of type interest on Security Deposit ASC Units:
0 Benchmark Consump: 1822 Period from 200711 to 200804

Arrears = Rs. -20.404.70

Interest = Rs. 0.00

FAC2 @ 9 p/u Units: 12442, Amount: 1119.78, ASC@ 536 p/u, Units: 0, Amount: 0; IASC @p/u, Units: 0, Amount: 0

Current time one wise tariffs
Zone A - Rs. 3/KWh (10 PM - 6 AM) Zone B - Rs. 3.85/KWh (6 AM - 9 AM) & (12 PM - 6 PM)
Zone C - Rs. 4.65/KWh (9 AM - 12 PM) Zone B - Rs. 4.95/KWh (6 PM - 10 PM)

	Amount in Rs.	Amount in Rs.
Demand Charges	23,700.00	
Addl. Supply Charges + IASC	.00	
Energy charges	42,302.00	
TOD Tariff EC	-7,389.60	
FAC @p/u + FAC2	1,119.78	
Electricity Duty	3,583.98	
Other Charges	0.00	
Tax On Sale @ Ps./U 4	497.68	
P.F. Penal Charges/P.F. Incentives	2,389.32	
Charges for Excess Demand	0.00	
Reliab Charge@42 p/u	5,225.64	
Debit Bill Adjustments	0.00	
TOTAL/CURRENT BILL		71,429.60
Interest on Arrears Upto 31/05/2008	0.00	
Arrears Payable + S.D. Arr.	-20,404.70	
Total Bill Amount (rounded) Rs.		51,020.00
Delayed payment charges Rs.		1,428.59
Amount payable after 18-06-2008 (Rounded) Rs.		52,450.00

Amount Rounded to Nearest Rs. (10/-)

Security Deposit Head Rs. 4,39,750.00 Addl. S.D. Demanded Rs. 0.00 S.D. Arrears Rs. 0.00

E&O.E. And Subject To Conditions overleaf

FIFTY ONE THOUSAND TWENTY ONLY

**** BILL AMOUNT ACCPTABLE Rs. IF PAID ON OR BEFORE 10-06-2008

**** PROMP DISCOUNT Rs. IF PAID ON OR BEFORE 10-06-2008

APR-08	MAR-08	FEB-08	JAN-08	DEC-08	NOV-07
18,214	19,608	15,916	17,298	15,514	22,772

Chief Engineer (Commercial)

Observe difference between recorded MD and billing MD, if difference is high for overall year change the contract demand as per requirement.

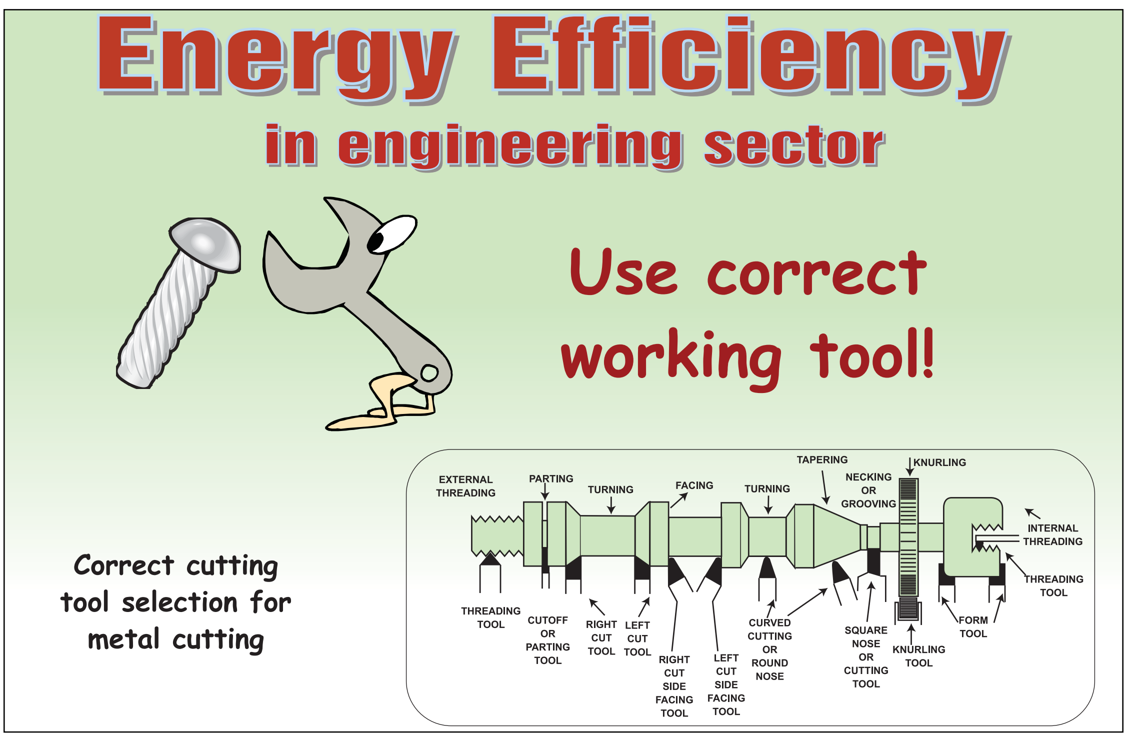
Maintain PF Above 0.9 to avoid PF Penalty

For maximum benefit, Energy Consumption should be maximum in off peak hours 10 pm - 6 am

Avoid penalty for low Power Factor by installing capacitors

Table 15: Energy conservation potential in different sections of an engineering unit

Section where Best Operating Practices can be adopted	Energy conservation potential in the section (%)	Remarks
Machine Tools	3 – 5	Proper lubrication, maintenance, production scheduling.
Metal Casting and Re-heating furnaces	5 – 10	Maintaining air to fuel ratio, sealing furnace openings and cracks, reducing holding time by improving production cycle.
Electroplating	2 – 3	Reducing drag out, reducing evaporation and use of counter flow rinsing.
Compressed air system	6 – 10	Regular upkeeping of compressors, proper location, suitable pipe sizing, regular leakage tests.
Electrical Distribution system	0.5 – 1.0	Adequate sizing of transformer, proper loading, capacitors at load ends, segregation of loads, optimizing contract and maximizing demand.
Electrical Utilities – DG Sets and Motors	2 - 3	Maintain good health of process motors, avoid rewinding of motors, use adequate capacitors, proper location of DG set, regular cleaning of filters.



- Loss of even one drop of oil every second wastes over 4000 litres of fuel a year
- A 22^{0}C reduction in the flue gas temperature can reduce the fuel consumption by 1%
- It is better to install more burners with smaller firing capacities instead of a few burners with a larger firing capacity
- The rinse tank size should be just enough to hold the products on hangers. A large size rinse tank requires excess water and more metallic salts.
- Techniques like spray rinse and drain board reduce drag-out considerably
- Every 4^{0}C rise in inlet air temperature results in an increase in energy consumption by 1%, to achieve an equivalent output
- Increase in air discharge pressure by 1 kg/cm^2 above the desired value will result in input power by about 4–5%
- Clean the air intake filters and conduct leakage test at least once in a month
- Every time a motor is rewound, its efficiency drops by 2%
- Every 10^{0}C drop in inlet air temperature will lead to a 2% saving in fuel costs
- Use BEE star rated equipment (minimum 3 star) for considerable energy saving.

Energy Audit

What is energy audit?

Energy audits indicate the ways in which different forms of energy are being used and quantify energy use according to discrete functions. An energy audit does not provide the final answer to the problem; it identifies where the potential for improvement lies, and therefore, where energy management efforts must be directed. Energy audit is broadly classified as preliminary energy audit and detailed energy audit, as explained below.

Preliminary energy audit

In a preliminary energy audit, the entire audit exercise can be divided into three steps. Step one identifies the quantity and cost of the various energy forms used in the plant. Step two identifies energy consumption at the department/process level. Step three relates energy input to production (output), thereby highlighting energy wastage in major equipment/processes. In a preliminary energy audit study, one basically relies on the data supplied by the unit or panel readings from meters installed in the industry.

Detailed energy audit

A detailed energy audit goes much beyond the quantitative estimates of energy savings and cost savings. It is generally preceded by a plant visit, which is also called a scoping study or preliminary energy audit, wherein the scope of the audit assignment is discussed in detail with the plant personnel. The study involves detailed mass and energy balance of major energy consuming equipments. The system efficiencies are evaluated and measures are identified for improving the end-use energy efficiency. The study proposes specific projects/feasibility studies for major retrofitting/replacement proposals, providing a cost-benefit analysis of the recommended measures. The duration of the audit is a function of the size and complexity of the plant, the areas to be covered under the study, and so on.

Winrock International India sincerely acknowledges the industries for the cooperation and the support extended during the conduction of Energy Conservation Studies at their premises.

- Anand Metals
- Magnus Steels Pvt Ltd
- Manoj Enterprises
- High Tech Industries
- Punjab Metallics Pvt Ltd
- Rubicon Steels
- Super Steels
- Shivalik Steels
- Kohistan Alloys
- P K Industries
- Mohali Industries Association, Mohali

Government Fiscal Incentives for MSME Sectors

The Ministry of Micro, Small and Medium Enterprises (MoMSME) provides support to activities in MSME units. The schemes that are eligible for the engineering industry are given below.

1. Credit Linked Capital Subsidy Scheme (CLCSS)

Under this scheme, the Ministry of MSME is providing subsidy to upgrade technology (Machinery/ Plant equipments). Subsidy limit per unit is Rs. 15 Lakh or 15% of investment in eligible Machinery / Plant equipments whichever is lower. For more details of the scheme visit www.laghu-udyog.com/schemes/sccredit.htm

2. Credit Guarantee Fund Trust for MSE

This scheme will cover both term loan and working capital facility upto Rs. 100 Lakh. Under this scheme, loan will be sanctioned without any collateral security or third party guarantee. For more details of the scheme visit www.cgtmse.in/

3. Market Development Assistance Scheme

To encourage MSME entrepreneurs to tap overseas market potential and represent India in the overseas market, Government of India is reimbursing 75% of air fare by economy class and 50% space rental charges of stalls for exhibition of their products in the overseas trade fairs / exhibitions. For more details of the scheme visit www.fisme.org.in/MDA%20Faq.doc

4. Quality Upgradation/Environment Management Scheme

Under this scheme charges would be reimbursed for acquiring ISO-9000/ISO-14001/HACCP certifications to the extent of 75% of the expenditure (maximum to Rs. 75,000/- in each case). For more details of the various schemes visit http://msme.gov.in/

5. SIDBI Financing Scheme for Energy Saving Project in MSME Sector

To improve the energy efficiency levels in various MSME sectors, SIDBI is providing loans to eligible projects under JICA line of credit at a nominal rate of interest of 9.5-10% p.a. For more details of the list of eligible projects under this line of credit visit: www.sidbi.in

MSMEs and Green House Gases (GHG) Reduction Benefits

- Implementation of energy efficiency projects leads to reduction in emission of Green House Gases, leading to earning of revenue through carbon credits. The mode of operation for this benefit scheme is under Clean Development Mechanism (CDM). Therefore, also called CDM benefits.
- Generally, for MSMEs, it does not make economic sense to apply for carbon credits individually. This is because the number of credits generated would not be sufficient to even meet the transaction cost associated with the various steps of the CDM cycle.
- To tackle this there are 2 options that MSMEs can make use of, i.e, bundling and Program of Activities (PoA)
- Bundling of CDM projects is an option that has been available for a few years now. Under this option, a number of similar projects can be put together as a single CDM project and submitted for registration to the United Nations Framework Convention on Climate Change (UNFCCC). The transaction costs are reduced in this case.
- PoA is a very new concept wherein a single organization/agency is the organizing entity and it claims the carbon credits and further distributes it amongst the individual units based on the agreement. This is also useful if the technology intervention, i.e, energy efficient measures, fuel switch, etc. are carried out in a phased manner with some units doing it first and the others following suit later. A single umbrella PoA is created that has a life of 28 years. Within this PoA, several CDM project activities can be added without any additional cost. The life of these project activities within the PoA is as much as 21 years.
- MSMEs can make use of forward trading mechanisms where organizations can help them bear the transaction cost upfront and then buy the carbon credits later at a slightly discounted price.

SIDBI Financing Scheme for Energy Saving Projects in MSME Sector Under JICA Line of Credit

The Japan International Cooperation Agency (JICA) has extended a line of credit to SIDBI for financing Energy Saving projects in Micro, Small and Medium Enterprises (MSMEs). This project is expected to encourage MSME units to undertake energy saving investments in plant and machinery to reduce energy consumption, enhance energy efficiency, reduce CO_2 emissions, and improve the profitability of units in the long run.

Eligible Sub Projects / Energy Saving Equipment List Under JICA Line of Credit:

- Acquisition (including lease and rental) of energy saving equipments, including installing, remodeling and upgrading of those existing.
- Replacement of obsolete equipments and/or introduction of additional equipments which would improve performance.
- Equipments / Machinery that meet energy performance standards /Acts.
- Introduction of equipments that utilize alternative energy sources such as natural gas, renewable energy etc., instead of fossil fuels such as oil and coal etc.
- Clean Development Mechanism (CDM) projects at cluster level that involve change in process and technologies as a whole, duly supported by technical consultancy, will be eligible for coverage.

Eligibility criteria for units (Direct assistance)

- Existing units should have satisfactory track record of past performance and sound financial position.
- Projects will be screened as per Energy Saving List, which is available on the SIDBI website.
- Units should have minimum investment grade rating of SIDBI.
- Projects which may result in negative environmental and social impacts are also not eligible under this scheme.

Financial parameters

The financial parameters for appraising the project are:

Parameter	Norms
Minimum assistance	Rs. 10 lakh
Minimum promoters contribution	25% for existing units; 33% for new units
Interest rate	The project expenditure eligible for coverage under the Line will carry the following rate of interest: • Fixed rate: 9.5 to 10% per annum based on rating • Floating rate: 9.75 to 10.5% per annum based on rating
Upfront fee	Non-refundable upfront fee of 1% of sanctioned loan plus applicable service tax
Repayment period	Need based. Normally the repayment period does not extend beyond seven years. However, a longer repayment period of more than seven years can be considered under the line, if necessary

For further details, please contact the nearest SIDBI branch office or refer to the SIDBI website **www.sidbi.in**

Small Industries Development Bank of India (SIDBI)

Small Industries Development Bank of India (SIDBI) was set up under an Act of Parliament viz. Small Industries Development Bank of India Act, 1989 and commenced its operations from April 02, 1990 for financing, promotion and development of Industries in the Micro, Small and Medium Enterprises (MSME) sector and to coordinate the functions of other institutions engaged in similar activities.

Mission

"To empower the Micro, Small and Medium Enterprises (MSME) sector with a view to contribute to the process of economic growth, employment generation and balanced regional development."

SIDBI has been supporting the MSME sector with various innovative schemes and has brought special products for addressing the requirements in the areas of cleaner production measures and energy efficiency, with the support of various multilateral agencies.

Direct Finance Schemes of SIDBI

- **Term Loan Assistance** – For setting up of new projects and for technology upgradation, diversification, expansion, etc., of existing MSMEs, for service sector entities & infrastructure development & upgradation.
- Various other schemes e.g. Working Capital, Inland Letter of Credit, Guarantee Scheme, Equity Support, Vendor Development Scheme & Bill Discounting Facility, Credit Linked Capital Subsidy Scheme etc.

SIDBI has a country wide network of 100 branches to service the MSME sector efficiently.

Eastern Zone
Bhubaneswar
Bhubaneswar MFB
Dhanbad
Durgapur
Jamshedpur
Kolkata
Kolkata MFB
Patna
Ranchi
Rourkela

Northern Zone
Alwar
Baddi
Chandigarh
Faridabad
Ghaziabad
Greater Noida
Gurgaon
Jaipur
Jammu
Jalandhar
Janakpuri
Jodhpur
Ludhiana
Kishnagarh
Kundli
New Delhi
Noida
Okhla
Shimla
Udaipur

Southern Zone
Ambattur
Balanagar
Bengaluru
Bengaluru MFB
Belgaum
Bellari
Chennai
Chennai MFB
Coimbatore
Erode
Hosur
Hubli
Hyderabad
Hyderabad MFB
Kochi
Kozhikode
Mangalore
Nellore
Peenya
Puducherry
Rajahmundry
Tirupur
Trichy
Vishakhapatnam
Vijayawada

Western Zone
Ahmedabad
Ahmednagar
Andheri
Ankleshwar
Aurangabad
Baroda
Chinchwad
Gandhidham
Jamnagar
Kolhapur
Mumbai Bandra Kurla Complex
Mumbai Metropolitan RBBO
Nagpur
Nashik
Panaji
Pune
Rajkot
Surat
Thane
Vapi
Vatva
Waluj

Central Zone
Agra
Aligarh
Bareilly
Bhopal
Bilaspur
Dehradun
Indore
Kanpur
Lucknow MFB
Lucknow RBBO
Raipur
Roorkee
Rudrapur
Varanasi

Guwahati Region
Agartala
Aizawal
Dimapur
Gangtok
Imphal
Itanagar
Shillong
Guwahati
Guwahati MFB

MFB – Micro Finance Branch
RBBO – Retail Business Branch Office

For further details please contact the nearest SIDBI branch
Toll free number: 1800226753. Website: www.smefdp.net, www.sidbi.in

SIDBI has also set up the following subsidiary / associate organizations for the development of MSME sector.

SIDBI Venture Capital Ltd (SVCL)	www.sidbiventure.co.in
Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE)	www.cgtmse.in
SME Rating Agency of India Ltd (SMERA)	www.smera.in
Indian SME Technology Services Ltd (ISTSL)	www.techsmall.com
Indian SME Asset Reconstruction Company Ltd (ISARC)	www.isarc.in