Energy conservation measures in the ceramics sector

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ENERGY IS LIFE ऊर्जा कार्यकुशलता ब्यूरो
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BUREAU OF ENERGY EFFICIENCY
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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 ceramic 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)

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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 ceramic 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 ceramic 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

CHAPTER 1

Introduction

The ceramic industry is an age old one that has evolved over the centuries from a potter's wheel to a modern industry with sophisticated controls. It is a fast-growing industry with a growth rate of 8%. The performance of the ceramic industry in India has remained quite impressive in the last two decades despite many challenges.

Morbi (Gujarat) is the heart of India's ceramic industry, producing more than 70% of the ceramic products. Ceramic units making pottery are also located in Khurja (Uttar Pradesh), while those making other pottery products are sited in Kerala and Jaipur (Rajasthan). Mostly, ceramic tiles, are produced by the Indian ceramic industry.

The demand for ceramic products has increased by 30% per annum, in the last few years. The present per capita consumption of ceramic tiles is around 0.5 sq m, which is very low compared to 2.0 sq m per person in countries such as Malaysia, Brazil and China.

The ceramic industry can be classified into two categories. The first category manufactures traditional or commodity ceramic products based on clay minerals, whereas, the second category is the advanced ceramics sector which produces products using pure inorganic materials essentially non clay based products. Most of the units in the Morbi cluster fall under the first category, manufacturing traditional ceramic products. The details are presented in Table 1.

Morbi is associated with the ceramic industry for the following reasons: availability of raw material (local clay suitable for ceramic products); availability of quartz, calcite/woolastonite, frits and glazes in Gujarat and in the neighboring state of Rajasthan. Labour is also easily available.

Table 1: List of ceramic products manufactured in Morbi

Sector	Subsector	Products
Traditional Ceramics	Ceramic tiles	Floor tiles, Wall tiles, Vitrified tiles, porcelein tiles
	Sanitary-ware	Sanitary ware, table ware
	Structural clay	Roofing tiles, bricks

There are about 400 ceramic manufacturing units in Morbi, most of which produce tiles, while a few make sanitary ware and structural clay products. All types of units work round the clock.

The production capacities of these units range between 1,500 and 2,500,000 tonnes per annum (TPA); however the average actual production lies between 100,000-500,000 TPA. Although, the largest portion of the products is sold in Indian markets, ceramics from Morbi are also exported. Production costs in Europe and the US are 25-30% higher than in Morbi.

Most units in Morbi use the roller kiln technology which is superior to the shuttle kiln technology used in the majority of ceramic units located elsewhere in India.

The cost of energy consumed in the ceramic industry may vary with the product being made, but it forms a significant fraction, i.e, 25-35% of the total manufacturing cost. Raw materials account for the next highest expense. With fuel prices and power tariffs on the rise, energy conservation will reduce operating costs substantially.

Electricity and heat are two forms of energy used in ceramic units. Electrical energy is used to drive motors and other electrical equipment. Thermal energy is used in the kiln and spray dryers. Natural gas or producer gases are also used to fire ceramic products. Apart from these two fuels, diesel is burnt in diesel generators (DG sets).

At one time, all the ceramic units in Morbi used producer gas to fire the ceramic products in the kilns. Today, 80% of the units have shifted to natural gas because it is energy efficient, cost effective and environmentally friendly. A few still use gasification plants, which burn coal to generate producer gas, while some use biowaste as a source of producer gas.

Most units in Morbi have been in operation for the last twelve years. Some ceramic industry entrepreneurs have conducted trials to increase the levels of energy efficiency and become world-class leaders.

Major energy consuming equipment installed in ceramic units are

- Kiln
- Press machine
- Ballmill/blunger
- Dryer
- Compressors
- Blowers
- Pumps

Process flow chart

In the ceramic industry the processes involved in the manufacture of ceramic products include raw material preparation, pressing, glazing, drying and firing. All the major processes and their outputs are shown in Figure 1.

The production process for different ceramic products is almost similar except for a few minor variations, as mentioned below:

- The raw ceramic tiles known as green tiles are produced at the pressing operation. Floor tiles are manufactured by baking of gray tiles, once. Wall tiles are manufactured by baking twice; in the first bake the tiles are made into biscuits. The biscuits are glazed with a design and colour and baked for the second time.

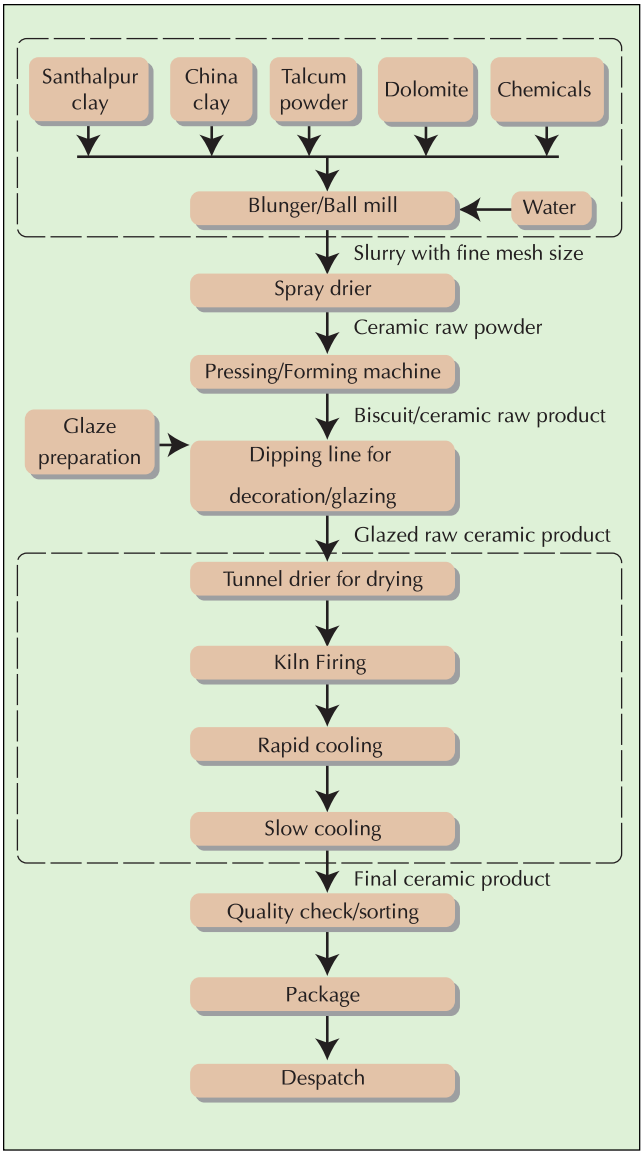


Figure 1: Process flow chart for the manufacture of a typical ceramic product

- Sanitary ware is first cast in a master mould, which is then glazed and baked in the tunnel kiln to produce the final product.

The energy consumption in different processes and utilities in a typical ceramic manufacturing unit is presented in Table 2.

Table 2: Energy consumption of different processes in ceramic products manufacturing

Process	% of total energy consumption
Raw material preparation	6
Spray drier	7
Press machine	5
Glazing machine	4
Kiln	60
Utilities	12
Miscellaneous	6

The typical specific energy (electrical and thermal) consumption (SEC) in ceramics production in India, China and Italy is presented in Table 3.

Table 3: SEC in ceramic manufacturing in India, China and Italy

Country	Electrical specific energy consumption (kWh/Tonne)	Thermal specific energy consumption (MKcal/Tonne)
India	210	1.34
China	259	1.05
Italy	139	1.16

It is clear from the table that the specific energy consumed in the manufacture of ceramic products in India is higher as compared to the world's best figures. This indicates the potential for improvement in energy efficiency.

CHAPTER 2

Energy Conservation Opportunities in the Ceramic Industry

If energy efficiency is to be achieved, the first step would be to understand how much energy is used and where it is being used in the different processes. The next step would be to identify how much of this energy is wasted.

In the ceramic industry, appreciable savings in energy, resources and money can be achieved by adopting Best Operating Practices (BOPs). These will also improve productivity and improve the safety at work. Such BOPs are detailed below:

Raw material processing

- Optimizing quantities of raw material used: Raw materials being natural products differ in composition from time to time and from place to place. Hence, by optimizing the quantities of raw materials used, the consumption of raw material and energy can be reduced. To do so, first decide the specifications of the final product and then calculate backwards to arrive at the quantity of raw material to be used.

Since the chemical properties of the natural raw material vary, it is essential to set standards for the procurement of raw material.

- Purchase the right materials; it will save the energy and costs that would otherwise be used to treat them in the factory.
- Raw material is transported to the processing areas by conveyors; do not operate the conveyor when there is no material to be transported.

- Fit time delay switches on all grinding and milling machines so that they are automatically switched off if no material is being processed.
- Avoid wastage while unloading from trucks/lorries; control spillages and contamination in the stock yard.

Ballmill/Blungers

The most important aspect of the entire tile-making process is the grinding of raw material. The composition and quality of grinding of the raw material determines the quality of the final product.

Run the ballmill at optimum speed to save energy and ensure proper mixing.

Check the size of the grinding medium every six months.

Don't blend the clay two or three days in advance.

The grinding of raw material is carried out by either ballmills or blungers. In this process most of the energy used to drive the ballmill blunger is in the form of electrical energy. The motor should thus be selected and used with care.

- Always operate the ballmill at its critical loading point. The material loading of the ballmill is a critical parameter in determining energy consumption. Energy consumption will increase if the ballmill is loaded below/above the critical loading point.

Don't use this size of pebbles *Use this size of pebbles*

- Mechanize the process to enable continuous feeding to the ballmill. This will reduce the ballmill's operating time and also that of its auxiliaries. The energy consumed overall will decrease.
- Use grinding media (pebbles) in three different sizes for better and efficient grinding of raw material.
- Check the mesh size of the slurry - when it reaches the required value, switch off ballmill/blunger.

Spray Drying

In a spray dryer the slurry is further dried and is converted into powder form. In this process, lignite is used as fuel.

- The particle size of the pulverized coal should be optimized and should be checked regularly.
- In the spray dryer operation, only 90% of the raw material slurry is converted into powder form, and the remaining is wasted because large clay lumps are formed. This happens because:
  - o Air circulation in the spray dryer is not proper.

Optimal excess air should be maintained in the combustion chamber for proper combustion.

Check and clean the nozzles regularly

Air circulation guides in the spray drier should be maintained properly

- Flow of slurry is improper. This happens mainly when the nozzles in the spray dryer are choked.

Forming/Press operation

- Maintain suitable pressure settings in the press machine. The amount of pressure to be applied depends upon the type of product being manufactured.
- Maintain correct press machine parameters to avoid wastage.
- Inspect the output from the press. This will ensure that defective material will not be dried or fired.

Maintain the moisture content at the required level in the powdered raw material, for proper pressing.

Operate press machine in off-peak hours (night), to benefit from time-of-use tariff.

Kiln drying

In this operation, moisture is removed from the raw tile surface by evaporation. The rate at which drying takes place depends on the temperature and moisture content of the raw ceramic product.

- Efforts should be made to find out the speed at which the air should strike the product.

The dryer should be insulated with heat insulation brick and ceramic wool to prevent structural heat losses

Glaze preparation

- Avoid spilling glaze materials at different stages of preparation.
- Glaze storage tanks should be covered to avoid dust falling on them.

Biscuit preparation

This is one of the processes in the manufacturing of wall tiles. After firing, the biscuit tiles are glazed.

- Biscuits should be carried safely to avoid breakage.
- Inspect the biscuit tiles and do not send defective ones for the second firing. This will save energy.

Kiln

In a kiln the raw ceramic article is converted to the finished product. The kiln consumes most of the thermal energy in the ceramic industry. Improving the energy efficiency of kilns is essential to reduce the manufacturing cost.

- Improve insulation in the kiln: Pay great attention to insulating the kiln walls. Good insulation takes care of both, thickness and material, reduces heat losses and also improves the quality of the product.
- If preheated air is used in the heating zone instead of ambient air, the fuel consumption will go down.

Figure 2 shows optimum firing cycle for a tunnel kiln for firing ceramic products.

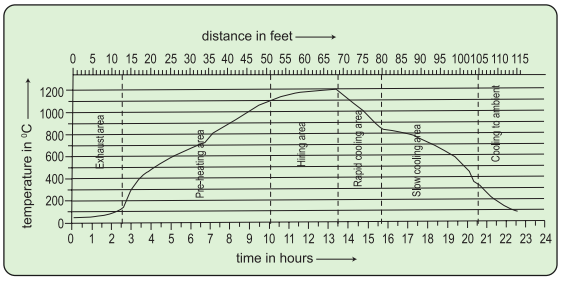


Figure 2: Optimum firing schedule for tunnel kiln

Air-to-fuel ratios in kiln

Maintain optimum levels of excess air levels in the kiln for proper combustion. Optimal excess air levels for different fuels and burners are presented in Table 4.

Table 4: Recommended excess air levels for different fuels and burners

Fuel	Type of Furnace or Burner	Excess Air (% by wt)
Pulverized 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

- Optimize the percentage of oxygen in the exhaust gas.
- Adjust the air-to-fuel ratio to the recommended value on all burners, to achieve energy savings.
- A 5% reduction in the level of excess air (recommended excess air percentage) increases kiln efficiency by 1%. Similarly, a 1% reduction of residual oxygen in the flue gas reduces fuel consumption by 1%.
- Analyse flue gas regularly using portable flue gas analysers. The parameters to be checked are O_2 (oxygen), CO (Carbon monoxide) and temperature. Adjust these parameters to the optimum values.
- Control air circulation in the kiln according to the fuel condition; maintain a correlation between air and fuel circulation. Servomotors of the air circulation system should be controlled according to the fuel condition.
- Maintain the required temperature in different zones of the kiln so as to follow the ideal firing schedule.
- Optimization of product loading: The raw ceramic products are stacked into kiln cars and then pushed into the kiln. The stacking pattern plays a vital role in the energy consumed by the kiln. Plan the loading so that the space between ceramic raw wares is minimized. This will save energy.
  - o Use material of a low thermal mass for constructing the kiln car. Use hollow ceramic coated pipes in the supporting pillars, instead of refractory bricks.
  - o Use ceramic fibre blankets at the base of the car instead of refractory base case.
- Use Cordierite blocks to hold the raw wares instead of a solid refractory mass.
- Maintain the pushing speed of the kiln car at optimum levels; this will contribute to energy savings.
- Periodically inspect, clean and adjust the burners in the kiln.
- Install kiln curtains to prevent heat losses on the entry and exit sides.

Heat recovery from the cooling zone of the kiln

- Air present in the rapid cooling zone is at a temperature of about 550^{0}C. This heat can be recovered by installing a recuperator system – a schematic is shown in Figure 3.
- The recuperator's heat exchange surface should be kept free of obstructions from the kiln structure. Complete circulation of hot gases around the heat exchanger surface is

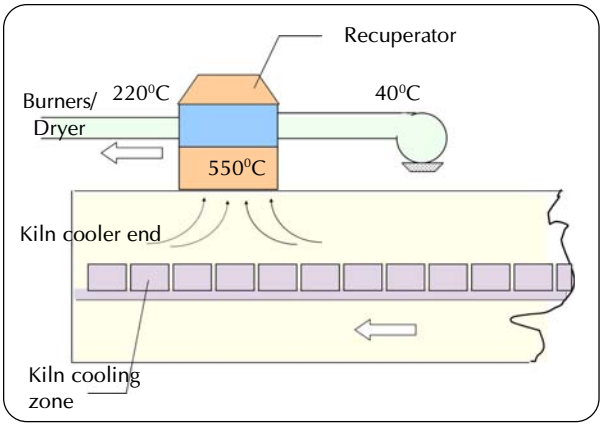


Figure 3: Recuperator system in Kiln

Every 20°C rise in combustion air temperature, will raise the thermal efficiency of the kiln by 1%.

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

Of the total amount of heat supplied to the kiln, a large amount of heat is absorbed in the kiln car

Do not obstruct the heat exchange surfaces of the recuperator.

necessary for effective heat recovery.

- Do not obstruct the heat exchange surfaces of the recuperator.
- Air from the recuperator system can be used in the burners as preheated combustion air or in the dryer where the ceramic products are dried.
- Using recuperator air in burners will result in greater energy savings as compared to its use in the dryer (this may also depend on industry).
- A 22°C reduction in the flue gas temperature can reduce the fuel consumption by 1%

CHAPTER 3

Energy Conservation Opportunities in Different Utilities

Electrical Distribution System

The electrical system is an integral part of the ceramic industry. An efficient electrical distribution system and demand management can reduce the electricity bill significantly. This section suggests ways to improve the efficiency of the distribution network.

- Stagger the non-critical load according to the electricity tariff to reduce the energy bill. The benefits of load staggering are shown in Table 5.

Table 5: 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 Annual savings	Rs 3,600 Rs 43,200

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. Table 6 illustrates the benefits of

Table 6: Cost benefit analysis of power factor improvement

Existing load of the unit (KW)	100
Existing power factor	0.9
Desired power factor	0.99
Existing demand (kVA)	111
Capacitor required (kVAr)	~35
New demand (kVA)	101
Reduction in maximum demand (kVA)	10
Monthly savings in demand charges @ Rs 300/kVA	3000
Cost of capacitors @ Rs 250/kVAr	8,750
Simple payback period	3 months

power factor improvements from the point of view of costs.

- Power factor should always be less than or equal to unity and never be leading, which may otherwise lead to motor burning. Use an automatic power factor relay for effective power factor management.
- Provide capacitors at the load end so as to benefit from reduced distribution losses (line losses, and cable loading).

The benefits of maintaining a high overall power factor in the industry are:

- o Reduction in maximum contract demand.
- o Better voltage at load end.
- o High system efficiency.
- o Rebate from electricity supply company.

- Any shortfall from the desired power factor can be met by connecting capacitors at the main panel or at the load. Table 7 shows the capacitance required per unit kilowatt to improve the power factor from the existing value to the desired value.
- Transformers are normally designed to operate at maximum efficiency between loadings of 32-35% 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 avoid a sharp

Table 7: 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

The maximum efficiency of a distribution transformer is at loads that are 32-35% of its full load capacity.

A 1% increase in unbalancing of voltages leads to a 1% reduction in motor efficiency.

Use an automatic power factor relay for effective power factor management

rise in transformer losses.

- Control the maximum demand by tripping non-critical loads through a demand controller. This will avoid penalties due to demand usage over that sanctioned.
- Balance the system voltage, to reduce distribution losses in the system.

Energy Savings in Compressed Air Systems

Air compressors are used in ceramic units to supply compressed air to pneumatic equipment and machine tools. Air compression consumes a lot of energy. From Figure 4 it is clear that only 10 – 30% of input energy to the compressor reaches the point of end-use and the balance 70 – 90% of input energy gets wasted in the form of friction and noise.

Energy savings of up to 30% can be realized in a compressed air system by 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 8 shows the relative power savings that result from a decrease in intake air temperature.

- 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 the building, minimize excess pressure drop in the suction line, by selecting a duct of large diameter with the smallest number of bends.

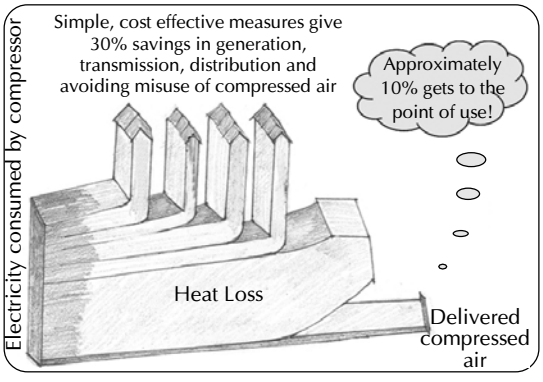


Figure 4: Sankey diagram for energy utilization in compressors

Table 8: Effect of intake air temperature on energy consumption

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

- 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 the common compressed air grid. This is the most important criterion for optimizing the efficiency of the compressed air system.
- Segregate users of compressed air on the basis of the pressure they require 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 which 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 would be consumed in building up the excess pressure. Compressed air pressure must be set at the point of generation.

The following steps were taken to reduce the power consumption in generating compressed air.

- 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 investment.
- The higher the compressed air pressure, the more expensive it is to provide the air.
- 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 9 shows typical energy wastage on account of pressure drop created by smaller pipe diameter.

Table 9: 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

.....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

	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 in Rs.

Amount Rounded to Nearest Rs. (10/-)

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)

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

(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 settings 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 of 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. Table 10 shows the loss in FAD, through orifices of different sizes, in a compressed air grid.

Table 10: 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

Table 11 shows best operating practices for efficient operation of compressors.

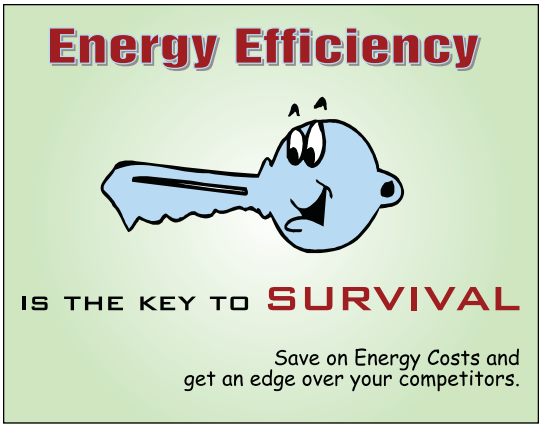
Every 4^0C rise in inlet air temperature results in an increase in energy consumption by 1%, to achieve an equivalent output.

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 a month.

Table 11: Summary of best operating practices for efficient operation of compressors

Dos	Don'ts
• Keep compressors suction in ambient air, away from heat sources 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 in a month.
• Use direct coupling for same motor and machine rpm.	



Energy Saving in Electrical Utilities–Motors and DG Sets

Electrical motors are the principal source of motive power in any ceramic 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 5 shows the variation in efficiency and power factor vis-à-vis the total load, for a typical motor.

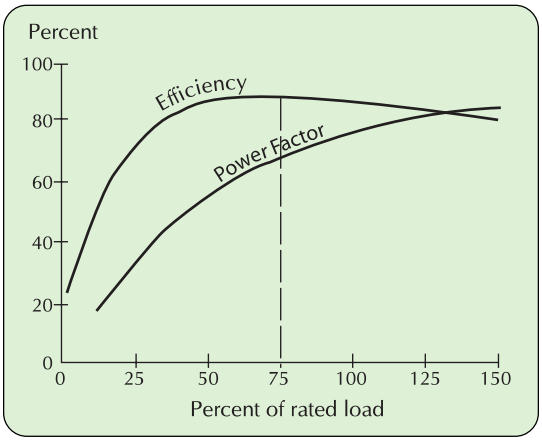


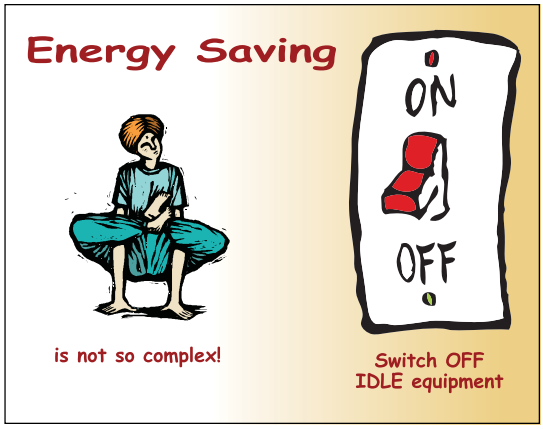
Figure 5: Variation of motor efficiency and power factor with percentage load on motor

Since there are many motors in a ceramic unit, it is very important to maintain them by adopting best operating practices as mentioned below.

- Always use motors sized according to the requirement of the load. It is good practice to operate motors between 75 -100 % of their full load rating because motors run most efficiently near their designed power rating.
- Oversized motors result in energy losses owing to a decrease in efficiency and power factor. Oversized motors can be identified by measuring the actual power drawn and comparing it with the rated power of the motor. Oversized motors should, therefore, be replaced with motors of appropriate rating. The energy and cost benefits resulting from replacing oversized motors are presented in Table 12.
- When replacing motors, always buy energy-efficient motors instead of conventional motors. The cost of energy consumed by a con-

Table 12: Benefits of proper sized motors

Parameter	Existing case	Proposed case
Rating (kW)	15	11
Shaft load (kW)	8.3	8.3
Loading of the motor (%)	55.3	75.5
Power factor	0.75	0.88
Motor efficiency (%)	84	86
Motor input power (kW)	9.88	9.65
Reduction in input power (kW)	–	0.23
Working hours per year	6000	6000
Annual electricity savings (kWh)	–	1380
Cost savings (@ Rs 4.5/kWh)	–	6210
Cost of new motors (Rs)	–	20,000
Simple payback period (years)	–	3.2



ventional 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 in assuring 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. In these applications, the motor's efficiency is often poor because it is operated at low loads. It is appropriate to use a variable speed drive (VSD) with the motor.
- Check motor for over-heating and abnormal noises/sounds, sparking and ensure proper bedding of brushes.
- Tighten belts and pulleys to eliminate transmission losses.
- Install capacitors across motors with a high rating to reduce the distribution losses.

Apart from electric motors, diesel generator (DG) sets are also installed in a majority of foundries, 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 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 a 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. When motors, for example, are fed with an unbalanced set of voltages, additional losses occur in the motors. 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 the following maintenance once in a month

- 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 Optimize the operating frequency of the generator.

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

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

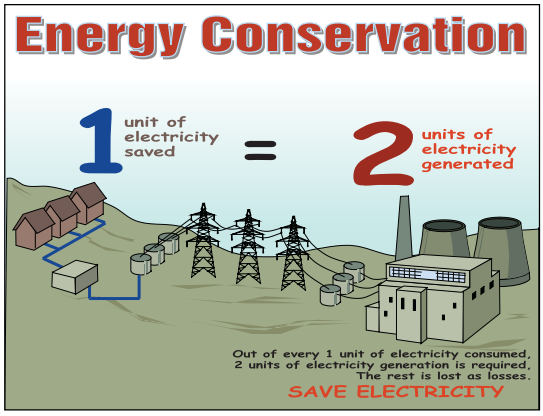
Every 10 ^{0}C drop in inlet air temperature will lead to a 2% saving in fuel costs.

Conclusion

It can be seen from Table 13 that significant energy savings are realizable in the ceramic sector by adopting Best Operating Practices and implementing simple housekeeping measures. Various energy intensive sections and processes in any typical ceramic unit, which require focussed 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 ceramic units would result in higher energy efficiency, lower operating costs and increased profit and equipment life.

- Check the size of the grinding medium (pebbles) every six months.
- Don't blend the clay two or three days in advance.
- Check and clean the nozzles of spray dryer regularly
- Air circulation guides in the spray drier should be maintained properly
- Operate press machine in off-peak hours (night), to benefit from time-of-use tariff.



- The dryer and the kiln should be insulated with heat insulation brick and ceramic wool to prevent structural heat losses
- Install recuperator in kiln rapid cooling zone. Every 20^{0}C rise in combustion air temperature will raise the thermal efficiency of the kiln by 1%.
- Use an automatic power factor relay for effective power factor management.
- Every 4^{0}C rise in inlet air temperature for air compressor results in an increase in energy consumption by 1% to achieve an equivalent output from compressor.
- Clean the air compressor filters and conduct leakage test at least once a month.
- Use BEE star rated equipment (minimum 3 star) for considerable energy saving.

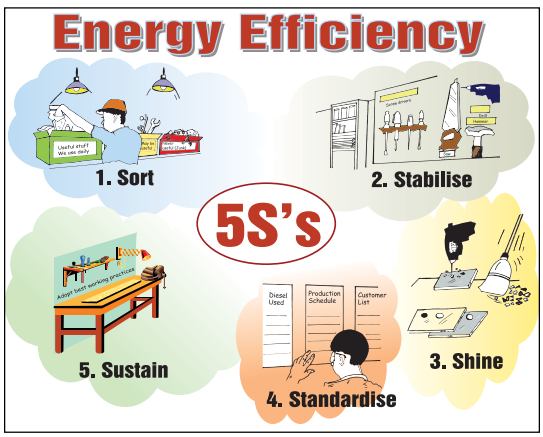
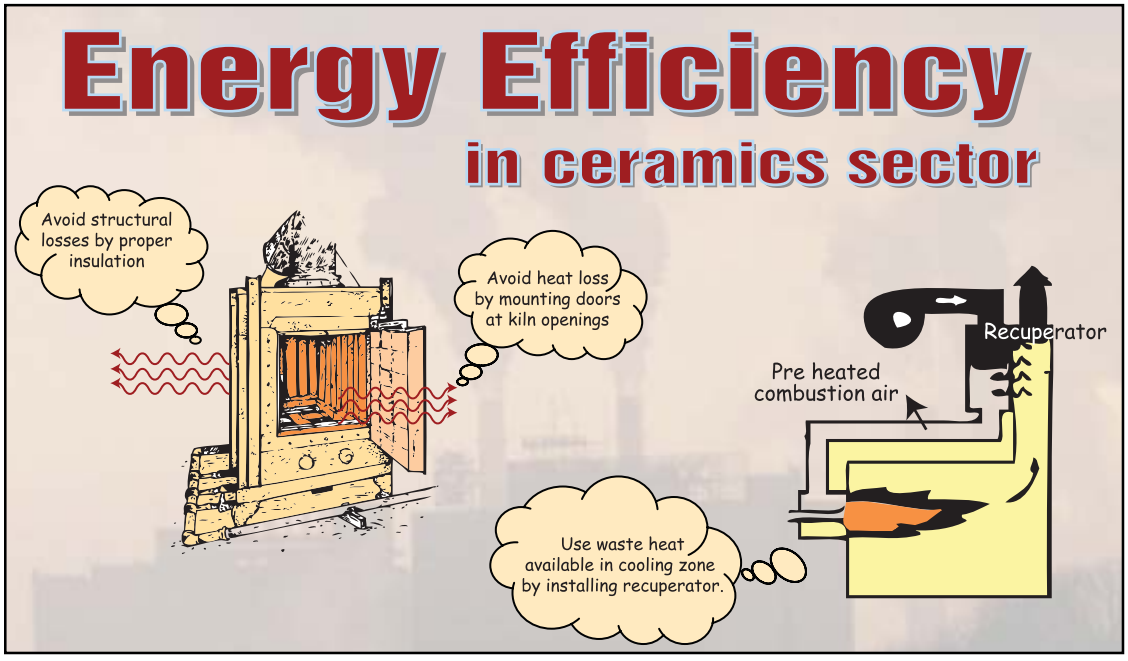


Table 13: Energy conservation potential in different sections of a ceramic industry

Section where Best Operating Practices can be adopted	Energy conservation potential in the section (%)	Remarks
Raw material processing	1-2	Operation of ballmill at critical load point, different sizes of grinding media.
Spray dryer	1.5-3	Size of pulverized coal, maintaining air to fuel ratio, cleaning of nozzles, proper circulation of air, maintenance of air circulation guides.
Kiln	5-10	Maintaining air to fuel ratio, sealing Kiln openings and cracks, waste heat recovery, maintaining proper insulation, cleaning of burners.
Compressed air system	1-2	Regular house keeping of compressors, proper location, suitable pipe sizing, regular leakage tests.
Electrical Distribution system	0.5 – 1	Operation of transformer at best efficiency point; installation of capacitors at major load ends; balanced voltage supply; optimizing contract maximum demand.
Electrical Utilities – DG Sets and Motors	2 - 3	Maintain good health of process motors; avoid rewinding of motors; Proper loading of motors; use of adequate capacitors at load end; proper location of DG set; regular cleaning of filters; maintenance as per schedule.



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 their cooperation and the support extended during the conduction of Energy Conservation Studies at their premises.

- Apple Tiles Pvt Ltd
- Matrix Ceramics
- Nubel Ceramics
- Omson Ceramics
- Orange Ceramics
- Venice Ceramics
- Senis Ceramics
- Arihant Ceramics
- Anchor Ceramics
- Vita Granito
- Morbi Dhuva Glazed Tiles Manufacturers' Association, Morbi

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 ceramic 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