MULTIPLE WAYS OF ENERGY CONSERVATION & COST REDUCTION IN CEMENT INDUSTRY

S. Peddanna, Jt. President (E&I) and D.H. Thanki, General Manager (Process)
ERCOM Engineers Private Limited, New Delhi

1.0 INTRODUCTION
In cement plants, the energy cost forms about 35 to 45% of the total cost of production. Out of this, thermal energy constitutes around 70%, whereas electrical energy about 30%, which may vary from plant to plant and local conditions. Energy cost is a major factor in pricing of cement and thus the energy cost needs to be minimized to the extent possible to ensure the profitable operations. The energy input to the cement plant includes both thermal and electrical energy and cost of these two forms of energy needs to be controlled.

There are two ways of controlling the energy cost. One way is to save the thermal energy consumption by multiple ways such as optimization of the Pyro process, homogenized raw material, fuel quality and alternative cheaper fuels to reduce the energy cost and the other way is to save the electrical energy consumption by optimization of all process operations, blended cements consuming less clinker per ton of cement, employing cheaper sources of energy such as waste heat recovery power generation, captive thermal power plants, solar power (to a limited extent) wherever feasible, etc to reduce the energy cost. Improvement of energy efficiency reduces the emission of carbon dioxide from fossil fuel and electricity use and also reduces the cost of producing the cement. Cement manufacturers are forced to implement energy saving measures and also look for cheaper energy sources to ensure profitable operations.

2.0 THERMAL ENERGY CONSUMPTION AND SAVING APPROACHES
The share of energy consumed in a cement clinker kiln plant is around 60 to 70% of the overall energy consumed in the process of cement production as a whole. The residual around 30 to 40% is the share of electrical energy. Thermal energy costs represent a considerable proportion of the total production cost (up to about 30% of the total production cost). Recently ERCOM for one of their clients had also successfully reduced the specific thermal and electrical energy consumption during Operation & Maintenance assignment, by various process optimisations as given below.

- Specific thermal energy consumption, Kcal/kg clinker (2 Kilns) : 803 to 788
- Specific electrical energy consumption, kWh/t cement : 120 to 114

01. Optimization of preheating system for kiln feed in pre-heater system
The specific fuel energy consumption increases with the increase of excess air, false air at the kiln inlet and in the pre-heater, dust load of kiln exit gas, kiln gas by pass ratio, if any, inconsistent homogenized kiln feed, fluctuation in fuel quality. False air at the kiln inlet can be minimized by replacing the seals. Improved process control will also help to improve the product quality and grindability, e.g. reactivity and hardness of the produced clinker, which may lead to more efficient clinker grinding. Kiln optimization systems can be employed to reduce energy consumption apart from increasing the production and refractory life.

02. Increasing the number of preheater stages
Typical values by adding sixth stage are given below:

<table>
<thead>
<tr>
<th>Preheater stage</th>
<th>Unit</th>
<th>5 stage</th>
<th>6 stage</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific heat consumption</td>
<td>Kcal/kg clinker</td>
<td>760</td>
<td>740</td>
<td>Saving of 20 Kcal/kg clinker</td>
</tr>
<tr>
<td>Specific Fan power consumption</td>
<td>kWh/t clinker</td>
<td>8.86</td>
<td>9.58</td>
<td>Increase of fan power by 0.72 kWh/t clinker</td>
</tr>
</tbody>
</table>
03. Optimization of preheating system for air in clinker cooler system
Reducing the primary air into the rotary kiln burner as much as possible and increasing the quantity of air heated in the Cooler as secondary and tertiary air lowers thermal energy consumption and also lowers NOX emission. The general aim is to achieve an efficiency of the cooler approximately more than 70%.

04. Reducing the wall heat losses in rotary kiln, pre-heater and Cooler
The heat loss through the shell of the kiln can be reduced by selecting the type of refractory having lower thermal conductivity (high insulation brick). It can also be decreased by uniform and stable coating inside the rotary kiln.

05. Homogenised raw materials
ERCOM had carried out the checking of the blending efficiency of Silo and recommended the ways to improve the same during the technical audit / process optimization study for one of their clients. Accordingly the deviation in the kiln feed parameter was minimized and pyro process got stabilized due to which clinker quality improved and reduced the specific heat consumption by 3-5 Kcal/kg clinker.

06. Selection of type of fuel
For one of our clients, after assessing the process parameters, raw material and fuel type, we recommended to change the source of coal from high ash content to low ash content and due to which specific heat consumption of both the kilns with the same raw mix design reduced by 12-15 Kcal/kg clinker and kiln operation got stabilised which improved the clinker quality in terms of C3S (from 47-49 to 53) which further impacted the cement grinding output and reduction in specific power consumption.

07. Recovery of heat from exhaust gases
The overall efficiency of the kiln system can be improved by recovering some of the heat loss from kiln exhaust gas and Cooler exhaust air after meeting the raw material drying requirement. The recovered heat energy can then be used for electricity generation by a waste heat boiler, steam turbine and generator.

08. Alternate cheaper fuels to reduce thermal energy cost
For the same fuel consumption, the specific fuel energy costs have been reduced still further by using cheaper fuels such as pet coke and secondary fuels. The saving in cost of fuel with pet coke use is working out to about US $39 per ton of white clinker for one of our overseas client.

3.0 ELECTRICAL ENERGY CONSUMPTION AND SAVING APPROACHES
Electrical energy costs represent a considerable proportion of the total production cost (upto about 15 to 20% of the total production cost). Most of the electrical energy is spent in grinding mills.

01. Optimization of ball mill operation for raw material, coal and clinker grinding
Recently for one of our clients, we have successfully achieved the saving in specific power consumption of 2.9-4.2 kWh/t in cement grinding mills by changing the clinker quality in terms of C3S (48 to 53) and changing the grinding media pattern on the basis of feed size analysis, circuit sample analysis and axial sampling analysis without changing any liners. One of our clients was operating the clinker grinding ball mill for grinding wet slag and when they switched back to OPC grinding, the mill output got reduced and specific power consumption increased. ERCOM was given the assignment to improve the output for OPC and reduce the specific power consumption. ERCOM recommended to change the grinding media pattern due to which OPC output increased from 44-47 tph to 54 tph and the specific power consumption was reduced by 4-6 kWh/t cement without changing any liners.
02. **Blended Cement**
The use of blended cements is a particularly attractive efficiency option since the inter grinding of clinker with other additives not only allows for a reduction in the energy used (and carbon emissions) in clinker production,

03. **High efficiency motors**
Efficiency of low voltage motors are not high due to higher currents involved. Now, low voltage motors of higher efficiency as per IE2 and IE3 are also available with payback period of about 1 to 2 years.

04. **Variable speed motors for fan applications**
From ERCOM we have recommended to one of our customers to provide variable speed drives for balance process fans of raw mills, kilns and cement mills, which will save about 4 kwh/ton of cement. Variable speed motors can also be used for compressors to save energy by about 15 to 35% of full load power and by running at lower speeds.

05. **Voltage imbalance**
A voltage unbalance causes a current unbalance, which will result in torque pulsations, increased vibration and mechanical stress, increased losses, and motor overheating, which can reduce the life of a motor’s winding insulation. Motor losses increase rapidly when voltage imbalance exceeds 1%.

06. **Lighting loads**
If the existing lights are replaced with energy efficient LED lamps, available today, the power saved will be about 1.5 kwh/T. of cement as recommended to one of our customers. Payback period of LED lights is about 1 to 2 years.

07. **Air conditioner loads**
The old air conditioners can be replaced by latest energy efficient air conditioners with variable speed drives, which will save up to about 2 units/ton of cement, as recommended to one of our customers.

08. **Cheaper sources of Electrical energy alternatives**

i. **Waste heat recovery system from preheater and cooler exit gases for power generation**
ERCOM had implemented a WHR project to one of its customer abroad, which is producing about 29 MW, out of which 18-19 MW power is from kilns and 10-11 MW from gas turbine exhaust.

ii. **Installation of captive thermal power generation based on coal**
As the grid power is costlier in the range of 6 to 9 Rs per kwh, the cement plant profitability and growth are not viable. Hence alternative captive thermal power generation plant with cost of generation in the range of 3 to 5 Rs per kwh is established inside the cement plant premises to restore profitability.

4.0 **POTENTIAL AREAS FOR ENERGY SAVING AND COST REDUCTION**
Apart from the above energy saving possible applications for both thermal and electrical energy, other potential areas for energy saving and cost reduction are discussed in detail in the main paper.

5.0 **CONCLUSION**
Substantial potential for energy efficiency improvement exists in the cement industry and in individual plants. Persistent efforts are being made to continue for improving energy efficiency and reducing the energy cost for the cement industry for survival and growth.

For all cement plants with varying types of cement machinery, energy saving options for both thermal and electrical energy are available for implementation as discussed above.

Internationally, the cement industry is moving towards the use of alternative secondary fuels, waste heat recovery systems and captive power generation apart from energy saving measures already being implemented. The efforts to improve energy efficiency minimize greenhouse gas generation, contributing to mitigate the environmental problems associated with cement production.