Sustainable Energy Solutions in Reinforcing Cement Manufacturing with Energy Efficiency

Anamika singh, Yogesh sharma, Shammi noor

1. Bureau of Energy efficiency,
Ministry of Power, 4th Floor Sewa Bhawan, R.K. Puram New Delhi-110066 India
2. KHD Humboldt Wedag
A-36, Mohan Co-operative Industrial Estate, New Delhi - 110 044, India
3. Bureau of Energy efficiency,
Ministry of Power, 4th Floor Sewa Bhawan, R.K. Puram New Delhi-110066 India

1. asingh@beenet.in, 2. yogesh.sharma@khd.com, 3. snnor@beenet.in

Abstract:
Concerns about global Climate and sustainable energy are perhaps among the most inevitable and fanatical issues of the present time. To tackle concerns arising from high energy consumption and its adverse environmental impact, in recent years has caused manufacturers to establish energy management cell and policymakers to formulate policies. These Policies are required to be firmly held, in order to meet the urgency of finding the ways of limiting green house gases (GHG) emissions, Particularly CO$_2$ generated from the combustion, Coal predominantly required for production. Cement production has been one of the most energy intensive industries in the world and the escalated cost of manufacturing because of the prices of fuels, policy Norms and raw material have resulted in a focused approach for significant reduction in specific energy consumption levels in cement plants. Effective planning to improve energy efficiency, retrofitting of energy efficient equipment/systems, technology upgradation, process optimization, appropriate maintenance and management, energy monitoring through energy audits are the various measures found by manufacturers and policy makers to reduce the specific energy consumption levels in cement plants. The readers of this paper will savour the flavor of energy auditing and identified technological opportunities in order to decrease energy consumption of the relevant factories and improved production process. This study also highlights a variety of ways formulated in set of policies with statutory compliances, guidelines and technologies to reduce specific consumption and the various measures for conserving energy in cement plants. Relevant standards planned by government that can provide significant potentials, are discussed too.

Key words: Cement, Manufacturing, Energy consumption, Energy efficiency, Process optimization

I. INTRODUCTION

Indian cement industry witnessed an unprecedented growth as a sequel to government’s liberalization policy initiated n the form of partial decontrol in 1982, subsequently culminating in total decontrol in 1989. India has progressed from being the world’s eighth largest cement producer in 1979-80 to being the second largest producer at present. However, this huge growth in cement production has exacted a heavy price in the form of massive energy utilization. Cement manufacturing comprises of various sub processes—Raw meal grinding, Preheating, Precalcining, Clinkerization and Grinding. Energy is consumed in each of these sub processes. Thermal energy constitutes 80 to 90 percent of the total energy, while the remaining is electrical energy. Portion of the energy consumed is thermal energy (80-90%) and the rest is electrical. The clinkerization sub process consumes the largest share of thermal energy while the cement grinding mills consumes the highest electrical energy. Among the energy intensive industries in India, cement industry happens to be highly energy-intensive with the second highest share in fuel consumption (15.60%), after Iron and Steel (18.10%), mostly in the form of coal utilization. Its expansion could not have been achieved without a substantial increase in energy input, especially in the form of coal combustion [1, 2, 3].

There are 139 large cement plants and over 365 mini cement plants in India, with currently 42 players in the industry. The Indian cement industry is the second largest producer of cement in the world after China’s. In 2011, the installed capacity of Indian cement Industry was 244.4 Million Tonnes (Mt), while cement production was 174.29 Mt. The final energy consumed by the Indian cement industry was 607 Peta Joules (PJ) in 2007. This accounted for 9% of the total energy consumed by the industrial sector. [2, 3]. With concerns towards contributing environmental cleanliness, cement industry consumes hazardous wastes like fly Ash and slag in the world today. Some of the plants have thermal and electrical Specific Energy Consumptions comparable to the
best cement plants in the world resulting in low emission intensities as well. For instance in 2005, the average thermal Specific Energy Consumption (SEC) of a cement plant was 734 kCal/kg clinker, while the average electrical SEC was 89 kWh/t cement. The ratio of total energy consumption to cement production gives a measure of the SEC. However, the thermal SEC of the best plant in India was 663 kCal/kg clinker, while the best electrical SEC of an Indian cement plant was 63 kWh/t cement. These are comparable to the best figures of 650 kCal/kg clinker and 65 kWh/t cement in a developed country like Japan.

Cement Industry produces several varieties of cement such as Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PFC), Portland Blast Furnace Slag Cement (PBFS), Oil Well Cement, Rapid Hardening Portland Cement, Sulphate Resisting Portland Cement, White Cement, produced strictly as per the Bureau of Indian Standards (BIS). It also exports Cement/Clinker to around 30 countries across the globe and earns precious foreign exchange. According to Ministry of Commerce & Industry data for November 2012 cement production registered a negative growth of (-) 0.2 per cent in November 2012 against its 17.0 per cent growth in November 2011. The cumulative growth of cement production was 6.7 per cent during April- November 2012-13 compared to its 4.8 per cent growth during the same period of 2011-12. Considering that the industry is one of core sector of the Indian economy as it is a backbone of many others industry such as infrastructure and transport and many more. The financial downturn, coupled with fuel shortage has led to an increase in fuel price consequently affected the growth and performance targets of the Industry. Additionally, fluctuating demand profiles of specific product types, high transportation costs impact the cement sector as a whole. In this environment, Government of India Under its National Action plan of Climate change Launched Perform achieve and trade (PAT) mechanism on 1st April 2012 for most energy intensive industries. The threshold limit of 30000 Tonnes of Oil equivalent (Toe) has been defined in PAT for cement sector, and 85 nos. of designated consumers have been identified from various States. The key goal of the PAT scheme is to mandate specific energy efficiency improvements for the most energy intensive industries like Thermal Power plants, Aluminium, Cement, Chlor-alkali, Fertilizer, Iron & Steel, Pulp & Paper, and Textiles. National energy saving targets specified under PAT for the period of (2012-15) are provided in Fig 1.[2,3,4,8,9]

II. TECHNOLOGICAL ADVANCEMENTS AND DEVELOPMENT ENERGY CONSERVATION MEASURES

Technology up-gradation and modernization and is a continuous process and it is equally true for the cement industry as for any other growing industry which results in increased capacity, energy savings and reduced cost of production of cement. There are numerous changes that have occurred during last two decades in the process technologies providers and equipment manufacturers such as KHd Humboldt wedag, Fls Smidth, Thyssen Krup and proved to be outstanding in their own area of expertise.

Source: Bureau of Energy Efficiency (PAT notification)
Fig : 1 National Energy Savings Targets under PAT(%) 2012-2015
Pressure comminution with Roller Press is one of the most efficient combinations in the area of cement grinding which claims high production upgrade of 40 to 300% with 2 to 6 kWh/t energy saving against tube mill. Roller Presses with Stud-lining require least maintenance costs complementing with a COMFLEX arrangement. Which gives trouble free operation for highest capacities of CO₂ reduction and money saving with latest Roller Presses and process understanding? Some results of the equipment are tabulated in Table 2.

Coal and electricity are the main sources of fuel for cement manufacturing. The total cost of energy accounts for about 40% of the total manufacturing cost in some of the cement plants cost of fuel is almost 15%–20% of the total production costs. The specific thermal energy consumption and electrical energy consumption for state-of-the-art cement plants are as low as 658 kcal/kg of clinker and 67 kWh/ton of cement, respectively.

Various energy audit studies have estimated that about 5% energy saving is possible in both thermal energy consumption and electrical energy consumption in cement plants through the adoption of various energy conservation measures. Various technologies and measures listed in Table 3 can reduce the energy intensity of the various process stages of cement production. Plants are setting targets not only for overall energy consumption levels, but also for section wise energy consumption through operational control and optimization using process optimization, load management and operational improvement and replacement of equipments to energy efficient equipments, the associated typical specific fuel and electricity savings, the simple payback period which result in significant amount of savings. They generally involve marginal financial investment and yet found to have produced encouraging results in energy saving. These aspects have been accorded high priority by the plants. The different aspects explored in this direction by the plants are given in Table 3 which provides a list of number of these technologies and practices by process stage.

However, there are other options that the industry could adopt to conserve natural resources. Alternate Fuels and Raw Materials (AFR) such as coating residue, industrial lime and lime sludge, gypsum from gas desulphurization are promising options. Rigorous research and experimentation needs to be pursued to establish the standards and rates at which AFRs could be blended. Also, fuels such as refuse derived fuel, rice husk, wood chips, tyre waste etc. could redress the shortage of coal (used in the burner adjoining the kiln).

Economic analysis of energy efficiency interventions has also been performed. Investments for different types of energy efficient interventions along with the corresponding annual savings were used to calculate the payback, net present value and internal rate of return. A list of Energy Efficient Technologies and measures, Estimated specific fuel savings GJ/t cement, Estimated electricity savings(KWh/t cement ) and Payback period is discussed in table no 3[3,4,5,6,8,10]
Table 3 List of number of Energy Efficient technologies and practices by process stage

<table>
<thead>
<tr>
<th>S:No</th>
<th>Energy Efficient Technologies and measures.</th>
<th>Estimated specific fuel savings GJ/t cement</th>
<th>Estimated electricity savings(KWh/t cement)</th>
<th>Pay back period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raw materials preparation</td>
<td>-</td>
<td>1.5-3.9</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>Raw meal (slurry) blending and homogenizing systems.</td>
<td>-</td>
<td>1.5-3.9</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>Raw meal process control- vertical mill</td>
<td>-</td>
<td>0.8-1.0</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Switch from pneumatic to efficient mechanical transport systems.</td>
<td>-</td>
<td>3.2</td>
<td>&gt;10</td>
</tr>
<tr>
<td>5</td>
<td>Replace ball mills with high efficiency vertical roller mill</td>
<td>-</td>
<td>10.2-11.9</td>
<td>&gt;10</td>
</tr>
<tr>
<td>6</td>
<td>High efficiency classifiers/seperators</td>
<td>-</td>
<td>4.3-5.8</td>
<td>&gt;10</td>
</tr>
<tr>
<td>7</td>
<td>Kiln shell heat loss reduction</td>
<td>-</td>
<td>0.8-3.2</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Optimization of heat recovery/upgrade clinker grate cooler</td>
<td>0.06-0.12</td>
<td>-1.8-0.0</td>
<td>1-2</td>
</tr>
<tr>
<td>9</td>
<td>Energy management and process control systems</td>
<td>0.1-0.2</td>
<td>1.2-2.6</td>
<td>1-3</td>
</tr>
<tr>
<td>10</td>
<td>Heat recovery for power generation (cogeneration)</td>
<td>-</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>Conversion of long dry kiln to multi-stage preheater</td>
<td>0.36-0.73</td>
<td>-</td>
<td>&gt;10</td>
</tr>
<tr>
<td>12</td>
<td>Low-pressure drop cyclones for suspension preheaters</td>
<td></td>
<td>0.5-3.5</td>
<td>0.01-0.04</td>
</tr>
</tbody>
</table>

### III. SCENARIOS OF FUTURE ENERGY TRENDS

If we flip through the pages of cement history cement production in India grew at an average annual rate of 8.1% between 1981 and 2003, and 9.1% during the tenth five year plan (2002-2007) According to the data published by the Department of Industrial policy and Promotion (DIPP). The cement and gypsum products sector has attracted foreign direct investments. (FDI) worth US$ 2,625.90 million. Between April 2000 to November 2012. According to ‘Indian Cement Industry. Forecast to 2012, it is also anticipated that in the coming years, majors players of the industry are looking forward to continue enhance their production figure to reach 303 MMT in 2013-14 with a outpaced compound annual growth rate (CAGR) of around 12 per cent.[7,11,15,14]
Sustainable Energy Solutions in Reinforcing Cement Manufacturing with Energy Efficiency

The Indian cement industry has grown rapidly over the past few decades and there have been significant improvements in new cement kilns and associated production equipment. The challenge for the Indian cement industry is to modernize or phase out the older, inefficient plants while acquiring the best possible cement production technology as production inevitably expands in the coming decades. Cement plays a vital role in infrastructure development, especially in a developing country like India. The industry also provides direct and indirect employment to people. Also, the industry has tremendous potential for development vides Policies of Government of India, Energy efficient technologies and large sources of limestone found all over the country.

The Policy-related recommendations for the improvement of the industry includes establishment of a dedicated “energy management cell” within a cement company and a full-time energy manager with monitoring, training, and auditing responsibilities, Promotion of blended cements through incentives to manufacturers for producing blended cements. Following conclusions can be drawn from this study:

- It has been found that cement manufacturing is an energy intensive process consuming about 12–15% of total energy consumption of a country.
- Pyro-processing found to be consuming major share of the total energy (i.e. 93–99% in some cases) use.
- Among the different sections, grinding consumes about 60% of total energy consumption in a cement industry. Significant can be made in this section to reduce heat loss or recycle heat.
- It was also observed that coal is the major source of energy for few selected countries. Therefore, fuel substitution can be considered as an alternative option to reduce environmental pollution.
- Use of alternative fuels or waste heat recovery could be a good solution. However, challenges associated with the use of alternative fuels must be overcome. This could be a potential area for future research and development.
- It has been identified that sizeable amount of energy can be saved and emission can be reduced in raw materials preparation, clinker production, finish grinding, general areas, products and feedstock changes applying different energy savings measures.
- VRM, high pressure grinding rolls or horizontal/ring roller mill can be considered viable options due to the simplicity of the systems along with low specific energy consumption.
- It was found that raw meal process control for vertical mills in dry process can reduce SEC by 6% with a payback period of about 1 year.
- Use of an adjustable speed drive for kiln fan for clinker making found to be saved about 30% of energy consumption with a payback period of about 2–3 years. Upgrading a pre-heater in clinker is also found to be saved energy consumption by 11–14%.

REFERENCES


Fig. 2. Annual cement capacity in production in India from 1990-2012
Source: Jaypee Cements


