Manual on Best Practices in Indian & International Cement Plants

World Class Energy Efficiency Initiative in Cement Industry

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FORE WORD

India is now the 2nd largest producer of cement in the world, next only to China. It is expected that the Indian Cement Industry will double its capacity within 10 years at an annual growth rate of 9 – 10%. The per capita consumption of cement, presently at 135 kg will grow to 175 kg within a period of next 5 years, but it will be still below the world average of 355 kg.

Apart from being the investors' paradise, the industry has also been technologically very advanced with the state-of-the-art plants and equipments installed and retrofitted periodically for not only capacity enhancement but also for energy conservation.

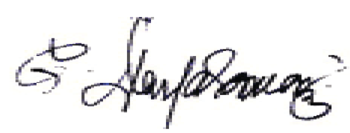
One of the most redeeming features of this technological growth is that India is now ready to take-off to "greening" cement plants with every new plant becoming a benchmark in overall equipment effectiveness, energy utilization, waste to wealth conversion, manpower optimization and world class quality assurances. And this trend is exponential both in spirit and content.

What makes such a rapid growth possible is the industry's readiness to try and absorb new technologies, share the experience with others in totally open and transparent ambience, and bank on enormous statistical and strategic information on global practices across the cement units.

For CII, it is a philosophy to put the practices as proof of preaching. We are constantly striving to institute a forum for sharing knowledge and skills across the industry for the best practices in operation and maintenance of the plants. While Cementech Conferences focus CII's objectives in deliberations, its publications of best practices will be a ready reckoner for many cement units to follow for achieving improved results.

And, I would hasten to add, this approach is a continuous exercise to be updated perhaps every year. This is what CII would try to achieve.

I am sure; this manual will receive an overwhelming response from the cross section of the industry.



(G. **Jayaraman**)
Kolkata
20.11.2006

EXECUTIVE SUMMARY

Indian cement industry is going through a phase of substantial growth, very high market demand and a much greater & promising future in the next few years.

The economic growth of India has been significant at around 6.5% mark and the target of growth rate is 8%.

Cement industry had always been a backbone for such economic growth. The need of the hour is two fold: capacity augmentation with the installation of latest energy efficient technologies and improving the performance of the existing cement plants by adopting energy efficient and environment friendly practices.

CII – Godrej GBC had taken up the initiative of facilitating the Indian cement industry achieve 'World Class Energy Efficiency' levels in cement manufacturing.

CII – Godrej GBC defines a 'World Class Energy Efficient' unit as:

- ❖ A trend setter in specific energy consumption norms – the lowest in the world
- ❖ A leader in implementing the latest technologies
- ❖ Has practically "nil" Energy Wastage
- ❖ Has adopted the Energy Scorecard
- ❖ Has made ENCON an "On-going activity" and incorporated it as a part of the management system

Essentially, a World Class Energy Efficient unit will be operating with the world's lowest specific energy consumption (electrical & thermal).

CII – Godrej GBC has taken the responsibility of overall execution of this project under the able guidance of an advisory group headed by **Mr G Jayaraman, Chairman Green Cementech 2006 and Executive President, Birla Cement Corporation.**

The six cement manufacturing companies participating in this World Class Energy Efficiency initiative of CII – Godrej GBC are:

1. Dalmia Cement Bharat Limited, Dalmiapuram
2. Madras Cements limited, Alathiyur
3. Maratha Cement Works (Gujarat Ambuja Cement Limited), Upparwahi
4. Shree Cement Limited, Beawar
5. Ultratech Cement Limited, Tadipatri
6. Vasavadatta Cement, Sedam

The following activities have been carried out in these six companies:

1. A Comprehensive training program on Energy efficiency
2. Detailed Energy Audit was carried out in all the six participating companies and areas for improvement have been identified. Several projects identified have been implemented and has resulted in significant energy saving.
3. Representatives from the participating cement plants visited each others' cement plants and an open and transparent information sharing was observed.
4. Visit to international cement plants in Germany, Belgium, Switzerland, United Kingdom and Japan was carried out. The mission is designed to focus on the following major areas of high relevance to Indian Cement Industry:
    i. Waste Fuel Utilization
    ii. Waste Heat Recovery opportunities
    iii. Energy Efficiency

Detailed observations and experiences of this mission are included as part of this manual.

This manual contains the following:

1. World class energy efficiency
2. Equipment and Energy Consumption details from participating companies
3. List of projects implemented in the participating companies in the last 3 years
4. Unique case studies implemented by the participating companies
5. Experiences and learning from the international mission to cement plants in Germany, Belgium, UK, Switzerland and Japan

The objective of the 'World Class Energy Efficiency' Initiative will be fulfilled only if the performance of all cement plants in the country improves and achieves world class standards.

We are sure that the Indian Cement plants will make use of this opportunity, improve their performance and move towards theWorld Class Energy Efficiency.

HOW TO USE THIS MANUAL

- The objective of this manual is to act as a catalyst to promote activities in Indian Cement Plants towards continuously improving the performance of individual units and achieving the World class Energy Efficiency.

- To set a clear goal for improving the performance and moving towards the world class standards, the best practices adopted in six Indian Cement plants have been included in this manual.

- These best practices may be considered for implementation after suitably fine tuning to meet the requirements of individual units.

- Apart from the best practices from Indian Cement plants, the details about the state of the art technologies from the International Cement Plants have also been included.

- Suitable latest technologies may be considered for implementation in existing and future Cement plants for achieving the world class energy efficiency. Further investigation and statutory requirements need to be verified for the suitability of these technologies for Indian Cement Plants.

- The collated best operating parameters and the best practices identified from various plants need not necessarily be the ultimate solution. It is possible to achieve even better energy efficiency and develop better operation and maintenance practices.

Therefore, Indian Cement Plants should view this manual positively and utilize the opportunity to improve the performance and to achieve World class Energy Efficiency.

BRIEF PROFILE OF INDIAN CEMENT INDUSTRY

Indian cement industry is going through a phase of substantial growth, very high market demand and a much greater & promising future in the next few years.

The economic growth of the country has been significant at around 6.5% mark and the target of growth rate is 8%.

In the first 5 years of this decade, 2000-01 to 2004-05, the cement output increased by 32.6 MTPA and the cement consumption rose by 30.6 MTPA. This is nearly a 25% raise in the last 5 years.

Exports of cement from the Indian manufacturers also increased from 2.4 MTPA to 4.1 MTPA. In the next two years, we would be seeing an addition of nearly 20 MTPA, predominantly to meet the demand of the local market.

At present, we have 56 cement corporations in India, with a total of 128 cement manufacturing units and a cement production capacity of about 155 MTPA.

In the recent years, Indian cement industry has seen the participation of several foreign players also. Some of the world cement majors such as Lafarge, Holcim, Heidelberg and Italcementi have marked their presence in the Indian markets.

Technological Developments in Indian Cement Industry

Indian cement industry has been a fore-runner as far as energy efficiency in the cement manufacturing process is concerned. Some of the Indian cement plants are operating with specific energy consumption numbers which are the best in the world.

The cost of energy had been the predominant driving factor for such advancements in energy efficiency. An average cement plant would be operating with energy cost being about 30 – 40% of the total manufacturing cost of cement. This is much higher compared to other western countries.

Energy Efficiency in Cement Industry

Substantial reduction has been observed over the last 10 years in the specific energy consumption figures for all cement plants. While the average in the year 1995 was about 112 kWh / ton of cement and 815 kCal / kg clinker, the present average stands at 82 kWh / ton of cement and 723 kCal / kg clinker. This indicates an average reduction in electrical energy consumption by 26.7% and thermal energy consumption by 11.3%. Probably, no other sector in the country would have recorded such a significant reduction in average specific energy consumption figures for all their plants across their country.

When one looks back at how cement industry has been able to achieve such a significant reduction in its specific energy consumption, there had been no external or government pressure. It had been driven by the tremendous competition in the open market and the need to sustain that fierce competition. It is also an excellent instance where several stakeholders like the cement manufacturers, cement machinery & equipment suppliers, consultants, etc, came together with concerted efforts to reduce the energy consumption in the Indian cement industry.

Another excellent practice in the cement industry had been the sharing of knowledge among other units. The openness of information sharing, either at plant level or in seminars, conferences and workshops has resulted in significant information dissemination and benefit to all. Cement industry today, stands as an example for several other sectors of industry, leading the way in following the path of learning by sharing.

What should be the future target for the Indian cement industry?

After discussions with several stakeholders – cement manufacturers, equipment suppliers, consultants, etc. the committee felt that the future target for the Indian cement industry should be as under:

Future energy consumption targets for Indian cement industry

Electrical energy consumption : 56 – 62 kWh / Ton of OPC

Thermal Energy Consumption : 650 kCal / kg clinker

Break-up of electrical energy consumption

Area of activity	Electrical consumption (kWh / Ton of OPC)
Crushing	1.50
Raw mill	12.00 to 18.00
Kiln and Cooler	18.00
Coal mill	2.50
Cement mill	18.00
Packing	1.00
Miscellaneous	3.50
Total	**56 to 62 kWh / T of cement**

Break-up of thermal energy consumption

Parameter	Specific Fuel Consumption (kCal / kg Clinker)
Theoretical heat consumption	410
Pre-heater loss	105
Cooler loss (Clinker & Cooler vent gases)	90
Radiation loss	75
Heat input	(-) 30
Total	**650 kCal / kg Clinker**

WORLD CLASS ENERGY EFFICIENCY

Energy conservation practices have acquired top priority, in the present context of increasing energy prices, acute energy shortage and the ever-widening demand supply gap.

All industrial units have adopted several measures to optimize the energy costs. Significant reduction in power consumption and substantial reduction in cost has been achieved by these units.

On achieving significant reduction, some units reach complacence. The open mind to look forward to further avenues of improvement no longer exists.

The opposite of world class companies is not average or bad units - it is only the good units !

Some units, not succumbing to complacence, continue to strive and achieve excellence in energy management.

This document attempts to bring out the subtle differences between these units which have achieved excellence in energy management ("World Class" units) and the other units (the "Good" units which have stopped without exploring full potential.

The various characteristics and the differences between world class units and good units are elaborated below:

Good units Vs World Class Units

Bench marking & Trend setting

'Benchmarking' is the approach adopted by the good units. They try to identify the best unit in its class, and plan to match themselves their performance in line with the best unit identified.

World Class units follow "next" pracctices - not " best" practices !

With the benchmarking approach, at the best, the good units can reach a performance level only closer to the best units, leaving them at the second level only.

On the other hand, the world class units adopt an approach of 'trendsetting'. They start with a 'zero' base, look for innovative opportunities in each area of operation and implement them.

This approach facilitates the plant to look for the most efficient design / technology / operating practices without being bounded by the 'Benchmark'. World class plants thus are trendsetters and emerge as leaders in the field.

Information Sharing

Information sharing could be a major differentiator between the good units & best units

The information, either sourced within or obtained elsewhere, in good companies is shared only within the organization. It takes a long time for this information to percolate even to other group companies.

World Class companies, on the other hand, believe in information dissemination as quick as possible. The fact that the time lost due to delay in information transfer could result in a significant monetary (energy) loss is well appreciated.

Good Companies - Share information 'Within'. World Class companies - Extensive and quick sharing & dissemination of information

Some units like Philips, Birla Group and Coca Cola share best practices across their units worldwide at a very quick pace and ensure its implementation to achieve the benefits at the earliest.

Implementation of latest technologies

A good unit plays a very conservative & defensive role in implementing latest technologies.

Good units are comfortable with proven technologies and are risk averse. These units want successful case studies of this technology implemented elsewhere, before considering implementation.

Good Companies - look for proven technologies. World Class companies - look for pioneering technologies

A World Class unit, on the other hand, sees this situation as opportunity to be a pioneer.

They are willing and have the capacity to take this risk at all levels of the organization. Several rewards accompany this risk. They become the technology developer's first preference, and get the technology at a very low price. The technology developer also works hand-in-hand with the plant team in making the new technology successful.

Once the first few trials are successful, the technology supplier would then sell this to "good" units at a much higher price (than the best units) to recover the development costs of that technology and the subsidy offered to best units.

Ultimately, the good unit pays for the world class unit to get still "better" !!. This competitive advantage accumulates in the world class plants and the gap between the world class and good plants increases with time.

Energy wastage

Energy wastages in a good unit are minimal but will be visible to a trained eye.

Good Companies - leakages visible.
World Class companies - leakages not apparent

In a world class unit, these are not apparent. Further energy saving avenues need to be evolved after a detailed and exhaustive study.

EnCon Culture

Energy conservation activity in a good plant is driven by external factors. An increase in energy costs, cheaper imports, etc. generally drive the plant towards energy efficiency. The energy efficiency activities are therefore momentary and part of the management culture.

In a world class unit, it becomes a routine activity. Every top management is committed to energy conservation, but has different ways of expressing it and finally achieving benefits.

In a good plant, a good idea waits for funds; in a World Class Unit, funds await good ideas

In good units, it could be setting targets or fixing budgets.

In a best unit, it works based on resource allocation. The top management allocates resources to each department. This mode of operation has 2 benefits – it ensures faster implementation of energy saving projects once technically proven and drives people to identify newer avenues for utilizing the resources allocated.

Monitoring & energy scorecard

Good units as well as the best units have an excellent energy monitoring system.

Good units - Data Generation
World Class units - Energy Scorecard

In a good unit, it stops with data generation.

On the other hand, the World Class unit compiles this data in a presentable format (Energy Scorecard) which could be used as a tool to evaluate the performance of the individual. In some excellent units, the yearly performance appraisal of an individual or departments is based on the energy scorecard.

EnCon activity

In a good unit, the energy manager tries to identify and implement all the energy saving projects himself. This not only results in reduced number of projects but also results in longer gestation time.

A World Class unit has a facilitator in an Energy Manager. The energy conservation culture is well entrenched in the organization, that the operation & maintenance team approach the energy manager with projects. He engages experts with domain expertise to identify newer areas. This results in more number of projects identified & faster implementation.

Approach to EnCon

In a Good Plant, Energy conservation is seen as an isolated activity which involves reduction of operating costs.

World Class units have a holistic approach to Energy conservation. The Life cycle cost of implementing Energy Conservation is considered.

Good unit - 'EnCon' seen in isolation

World Class Unit - Holistic approach - Life cycle cost considered

Characteristics of World Class Energy Efficient Units

A World Class Energy Efficient unit:

- ❖ Is a trend setter in specific energy consumption norms – the lowest in the world
- ❖ Is a leader in implementing the latest technologies
- ❖ Has practically "nil" Energy Wastage
- ❖ Has adopted the Energy Scorecard
- ❖ Has made ENCON an "On-going activity" and incorporated as a part of the management system

Essentially, a World Class Energy Efficient unit will be operating with the world's lowest specific energy consumption (electrical & thermal).

World Class Energy Efficiency - Activities carried out so far ...

The World Class Energy Efficiency initiative of CII – Godrej GBC has evoked tremendous response in the Indian cement industry. The activities of World Class Energy Efficiency have been divided in three phases and six cement companies have evinced interest in availing the services of CII – Godrej GBC to facilitate their units to achieve world class energy efficient levels. The six companies participating in this initiative are:

1. Dalmia Cement Bharat Limited, Dalmiapuram
2. Madras Cements limited, Alathiyur
3. Maratha Cement Works (Gujarat Ambuja Cement Limited), Upparwahi
4. Shree Cement Limited, Beawar
5. Ultratech Cement Limited, Tadipatri
6. Vasavadatta Cement, Sedam

The following activities have been carried out in these six companies

1. A Comprehensive training program on Energy efficiency was carried out for the technical personnel in the plant team. The objective of the training program was to increase the awareness & capacity building of the technical staff, and also increase the involvement of the plant team in the project.

2. Detailed Energy Audit was carried out in all the six participating companies and areas for improvement have been identified. Several projects identified have been implemented and has resulted in significant energy saving. The comprehensive detailed energy audit in the plants was jointly conducted by the plant and CII energy teams. This approach led to identification of specific energy conservation projects and creating ownership for the projects identified. This has also facilitated quicker implementation of the projects.

3. Visit among the participating companies was carried out. Representatives from the participating cement plants visited each others' cement plants and an open and transparent information sharing was observed. The whole idea is to facilitate adoption of all best practices among these 6 units participating in this initiative.

4. Visit to international cement plants in Germany, Belgium, Switzerland, United Kingdom and Japan was carried out. The mission is designed to focus on the following major areas of high relevance to Indian Cement Industry:

   i. Waste Fuel Utilization

   ii. Waste Heat Recovery opportunities

   iii. Energy Efficiency

   Detailed observations and experiences of this mission are included as part of this manual.

BEST PRACTICES ADOPTED IN PARTICIPATING COMPANIES

DALMIA CEMENT BHARAT LIMITED, DALMIAPURAM

Introduction

It was in the year 1939, during the pre-independence era, the company started its cement unit as a venture towards Building up a self-reliant India with respect to one of the country's essential commodities / Core Sectors.

Of the four units so started, one was located at Dalmiapuram, which was later incorporated as **"DALMIA CEMENT (BHARAT) LIMITED"** (whilst two units got absorbed in Pakistan due to partition).

In 1939, a 250 Tons per day kiln was started by the Company to manufacture cement by Semi-dry process. The machinery was supplied by M/s. POLYSIUS, GERMANY. It is a tribute to the engineers of Dalmia Cement that this unit is still actively functioning at Dalmiapuram Works.

1949 – 1982

In 1949, a 500 TPD Wet Process Unax Kiln supplied by M/s. F.L.SMIDTH, Denmark was installed. Again in 1959, expansion was undertaken with the installation of another 500 TPD wet process Folax Kiln supplied by M/s. F.L.SMIDTH, Denmark. In 1982, a 200 TPD Vertical Shaft Kiln (First of its kind in India) was installed using fuel as Coal Slurry Process.

1983 – 1993

Indian cement industry witnessed Partial Decontrol in the year 1983 and full Decontrol in the year 1984.

In the year 1983, Captive Power Gensets supplied by M/s Wartsila were installed.

In the year 1984, Oil well cement production was started and in 1986 the prestigious API Monogram certification was received from American Petroleum Institute, USA.

With rising costs of fuel, major modernization programme was undertaken in line with policy of the Government of India to switch over from Wet Process to Dry Process. Consequently, a **1500 TPD** pre-calcinator kiln supplied by **M/s. Khd Humboldt Wedag AG, West Germany** was commissioned in 1987 and both the Wet Process kilns were stopped. This is a modern Dry Process Kiln First of its kind in TAMILNADU with Computerised Controls. The new plant includes Stacker Reclaimer and 'X' RAY Analyzer to ensure uniform quality.

In the year 1990, Dalmia installed state of the art Electronic Roto Packer - I with 8 spouts for packing cement.

In the year 1991, a new technology "Auto Kiln Control System" was introduced for smooth operation of Kiln. Also, in the year 1991, a Regional Training Centre sponsored by World Bank DANIDA is started at our Plant to cater to all South Indian Cement Plants. This is recognition of Dalmia as center for excellence for transfer of Technology.

In the year 1993, we have been awarded ISO 9002 certification for our Quality Management System (First cement company in South India) from BIS.

1994 – 2004

In the year 1994, state of the art Electronic Roto Packer-II (12 spout) for packing cement was installed.

In the year 1997, Cement grinding was modernized by introducing Vertical Roller Mill.

The Central control room has been upgraded with latest fuzzy logic controls for improved energy efficiency and productivity.

The Kiln Cooler was upgraded with the latest IKN technology for improved thermal efficiency.

A substantial expansion project was completed in 2002 with upgradation of KHD Kiln, enhancing the capacity to 3300 TPD, by installing energy efficient low pressure cyclones and the Kiln Cooler with the latest CFG technology for improved thermal efficiency.

In the year 2004, we have received ISO 14001 certification for our Environmental Management System from BIS.

2005 Onwards

A major capacity expansion project is commissioned during the year 2006 to enhance the total cement capacity by putting up a most modern & energy efficient 3800 TPD Plant.

Also to meet the increased power requirement at optimum cost, a 27 MW Captive Thermal Power Plant is put up during the year 2005.

The major features of the New Cement Plant are listed below.

- Most Modern & Energy Efficient 3800 TPD Plant
- Consistent Quality with Bulk Solid Analyser , XRD Technologies
- Pollution Free with Bag Houses, Bag Filters and ESPs
- Covered Sheds for all Raw-Materials / Fuels
- Automatic Material Handling – Stacker & Reclaimers for all Raw-Materials & Fuels
- Latest Technology – Pipe Conveyors, Vertical Roller Mills, Belt Elevators
- Lowest Fuel Consumption – 705 Kcal/Kg of Clinker
- Lowest Power Consumption – 65 Units/Ton of Cement

First Credits to Dalmia Cements

- First to install **250 TPD Semi Dry Process kiln** in India.
- First to install **500 TPD Wet Process kiln** in India.
- First to install the unique Coal Slurry based **Vertical Shaft Kiln** Technology in the World.
- First to introduce the **Vertical Roller Mill** Technology **(for Lime Stone grinding)** in Indian Cement Industry thus saving valuable energy.

- First to install **Captive Power Generator** in India, which can run on Heavy Fuel Oil, thus saving scarce and valuable light distillates like Diesel.
- First to produce **OWC in India to API specification**. This unit is a Pioneer in manufacture of Oil Well Cement conforming to specifications of American Petroleum Institute.
- First Cement Plant in Tamil Nadu to venture into large **Wind Mill Farm**.
- First Cement Plant in South India to obtain the **ISO 9002 Quality System Certification** in 1993. Now switched over to IS:ISO 9001:2000 version.
- First Unit in India to go in for **Vertical Roller Mill for Cement grinding** in 1997.
- First to install **Modern Pre-calcinator Dry process Kiln** in this state in 1987.
- First to introduce **Auto Kiln Control System using Linkman** in India in 1992. (Now replaced by RAMCO System in the year 1999).
- This Unit is recognized by World Bank DANIDA, as Centre of Excellence for transfer of technology and sponsored a **Regional Training Centre at Dalmiapuram**, to cater to the needs of South Indian Cement Industries.
- This unit is one of the Leaders in the Production of **High Strength Special Cement required for Air strips** & for Manufacture of **Concrete Railway Sleepers**.

Plant Details

- Located 35 km away from Trichy on Chennai - Trichy chord Line
- Started operations in pre-independence era since 1939
- Present Capacity /Annum : 3.5 Million MT Cement
- Captive Power Generation : 12 MW(LSHS / Furnace Oil based Gensets)
- Wind Mill Power Generation :16.5 MW
- Captive Limestone Mines at FOUR different locations

Equipment Specification

Sl No	Equipment	Parameter	Line 1	Line 2	Line 3
1	Crusher	Make	FLS	L&T	L&T
		Type of crusher	Double swing hammer mill	Impact	Impact
		Installed Capacity (TPH)	150	400	1000
		Operating Capacity (TPH)	125	277	1000
		Drive rating (kW)	187*2	550	950
2	Raw mill	Make	Loesche	Loesche	Loesche
		Type of mill	VRM	VRM	VRM
		Installed Capacity (TPH)	50	190	320
		Operating Capacity (TPH)	47	200	370
		Type of separator		Dynamic	
		Drive rating (kW)	400	1100	2400
		Fan rating (kW)	400	2100	3300
		Product fineness (Residue)	2-3 % on 212 micron sieve		
3	Coal mill	Make	Polysius	KHD	Loesche
		Type of mill	Ball mill	Ball mill	VRM
		Installed Capacity (TPH)	2.2	22	33
		Operating Capacity (TPH)	2.2	26	38
		Type of separator	Static	Dynamic	Dynamic
		Drive rating (kW)	90	580	640
		Fan rating (kW)	30	240	1000
		Product fineness (Residue) on 90 micron sieve	16-18%	18-20 %	15%

4	Kiln	Make	Polysius	KHD/FLS	FLS
		Installed Capacity (TPD)	250	3000	3800
		Operating Capacity (TPD)	200	3250	4000
		Kiln dimensions	3.0 dia length 30 m	3.8 dia length 56 m	3.95 dia length 62 m
		No.of pre-heater stages	Lepol preheater	4	5
		Overall PH Pressure drop (At fan inlet)		560	560
		PH fan rating (kW)	250	1650	1450
5	Cooler	Make	Polysius	IKN/FLS	FLS
		Capacity	250	3000	3800
		No.of cooler fans	Not applicable	10	10
		Cooler Area		52.3	88.9
		Cooler vent fan rating		315	315
6	Cement mill	Make	FLS	Loesche	Loesche
		Type of mill	Ballmill	VRM	VRM
		Installed Capacity (TPH)	CM2 - 34 CM3- 53	OPC : 190	OPC : 305
		Operating Capacity (TPH)	CM2 - 24 CM3- 44	OPC : 200 PPC : 175	OPC : 285 PPC : 260
		Type of separator		Dynamic	
		Drive rating (kW)	CM2 - 970 CM3- 1492	3150	5400
		Fan rating (kW)	360	2100	2600
		Product fineness (Blaine)	OPC : 270-290 PPC : 350-360		

Specific Energy Consumption (Typical Average)

Sl No	Equipment	Parameter	Line 1	Line 2	Line 3
1	Crusher	Crusher Main Motor	205		197
		Crusher & Auxiliaries			
		Subtotal SEC upto crusher			
		1. kWh / Ton of Material	1.42		1.64
		2. kWh / Ton of Clinker	0.98		1.11
		3. kWh / Ton of Cement	0.76		0.86
2	Raw mill	Raw Mill Main Motor	302	905	1932
		Raw Mill Circulating Fan	353	1408	2124
		Separator	55	271	154
		Raw Mill Auxiliaries			
		kWh / Ton of Material	18.03	12.98	13.71
3	Coal mill	Coal Mill Main Drive	68	526	411
		Coal mill Vent fan		185	489
		Coal Mill Booster Fan		312	37
		Coal Mill Separator			835
		Coal Mill Auxiliaries			
		kWh / Ton of Material		61.4	49.3
4	Kiln	Kiln Main Drive	134	195	220
		PH Fan	NA	1022	799
		a. KS Fan		NA	NA
		b. CS Fan			
		ESP			
		a. ESP Fan	64	285	NA
		Bag House Fan	Not Applicable (NA)		302
		a. Bag House Fan			
		b. Reverse Air Fan			
		Cooler Fans	NA	478	729
		Cooler Vent Fan	NA	81	98
5	Up to clinkerisation	kWh / MT of clinker		22.41	19.88
		kWh / MT of clinker	65.5	54	52.1
6	Cement mill	Cement Mill Main drive	CM2 - 767 CM3- 1411	2583	4331
		Cement Mill Fan	219	1027	1815
		Separator	319.2	702	151
		Cement Mill Auxiliaries			960
		kWh / Ton of Material	38.28	23.2	27.22

7	Packing plant	Packing Plant & Auxiliaries kWh / Ton of Material	- -	- 1.5	- 1.4
8	Auxiliaries	Colony Water Pumping System			
9	Total	kWh / MT of clinker kWh / MT of OPC kWh / MT of Cement	65.5 81.5 75.7	54	52.1 76.1 71.3

Heat Balance (Typical Average)

Polysius Kiln heat balance (Line 1)

Heat input (in Kcal /Kg of clinker)		
		%
From kiln feed	**23.9**	**2.4**
From cooling air	**17.5**	**1.7**
From fuel	**970.9**	**95.7**
Coal dust sensible heat	**2.4**	**0.2**
Total heat input	**1014.7**	**100**
Heat output (in Kcal /Kg of clinker)		
Heat of formation	**405.4**	**40.0**
Kiln feed moisture evaporation	**149.1**	**14.7**
Heat through Kiln exhaust gas	**216.5**	**21.3**
Heat through dust from ESP	**0.9**	**0.1**
Heat through Clinker	**31.2**	**3.1**
Radiation & Convection heat loss	**211.6**	**20.9**
Total heat output	**1014.7**	**100.0**

KHD Kiln heat balance (Line 2)

Heat input (in Kcal /Kg of clinker)			
			%
From kiln feed	b1	**28.7**	**3.6**
From cooling air	b2	**20.6**	**2.6**
From fuel	b3	**744.5**	**93.5**
Coal dust sensible heat	b4	**2.4**	**0.3**
Total heat input	b1+b2+b3	**796.2**	**100**
Heat output (in Kcal /Kg of clinker)			
Heat of formation	c1	**414.6**	**52.1**
Kiln feed moisture evaporation	c2	**5.5**	**0.7**
Coal dust moisture evaporation		**1.2**	**0.1**
Heat through PH exhaust gas	c3	**206.6**	**26.0**
Heat through dust entrained in PH exhaust gas	c4	**12.0**	**1.5**
Heat through Cooler Vent air	c5	**79.7**	**10.0**
Heat through Clinker	c6	**18.5**	**2.3**
Radiation & Convection heat loss	c7	**52.0**	**6.5**
Cooler dedusting system heat loss		**6.0**	
Total heat output	**c1+..+c7**	**796.2**	**100.0**

FLS Kiln heat balance (Line 3)

Ref Temperature : Zero Degree			
Heat input (in Kcal /Kg of clinker)			
			%
From kiln feed	b1	**19.2**	**2.6**
From cooling air	b2	**22.8**	**3.1**
From fuel	b3	**700.6**	**94.1**
Coal dust sensible heat	b4	**2.2**	**0.3**
Total heat input	b1+b2+b3	**744.8**	**100**
Heat output (in Kcal /Kg of clinker)			
Heat of formation	c1	**410.0**	**55.0**
Kiln feed moisture evoparation	c2	**5.2**	**0.7**
Coal dust moisture evoparation		**1.0**	**0.1**
Heat through PH exhaust gas	c3	**158.4**	**21.3**
Heat through dust entrained in PH exhaust gas	c4	**5.1**	**0.7**
Heat through Cooler Vent air	c5	**91.1**	**12.2**
Heat through Clinker	c6	**24.1**	**3.2**
Radiation & Convection heat loss	c7	**49.8**	**6.7**
Total heat output	**c1+..+c7**	**744.8**	**100.0**

Case Study –1

COMPRESSORS OPTIMISATION SYSTEM

Introduction

Dalmia Cement (B) Ltd started cement production operations in 1939 at Dalmiapuram. Then, the capacity of this Polysius plant was 250 TPD clinker production. But today the capacity is 3250 TPD clinker production, with the upgradation of KHD line, commissioned in 1987. How ever, still the Old machinery of 1939 plant was run continuously.

Over these years, 39 compressors (Reciprocating as well as Screw type) of different makes with a total installed capacity of 20081m^3/h were installed to meet compressed air demand for various applications. The total installed drive power is 1908.5 KW.

Out of these, 20 compressors with total capacity 17,749 m^3/h and rated power of 1631 KW were in old plant (VRM-1, M.H, CVRM, PH and Polysius Line). It was decided to choose these sets of compressors for optimization in the old plant.

Compressors Energy Consumption

The Compressors at Old plant were installed near to each application, but connected / interconnected with all applications – literally - like a spider web. Almost any compressor's air can go to any application – resulting in un-optimized use of Air and consequent wastage of Energy.

To monitor the energy consumption, the plant team had installed energy meters for individual compressor in the old plant and recorded the energy consumed by each compressor on a daily basis. The total energy consumed by all compressors was approximately 2,41,000 units per month

From the preliminary study , it was understood that it is adequate to operate only 12 Screw compressors with total installed capacity of 9507 m^3/h (and power consumption of 1003.5 kW) in the old plant to meet the compressed air demand for all sections - VRM-1, CVRM, MH, PH and Polysius Line).

The rest of the compressors were stopped. It was observed that the continuous operation of these 12 Screw compressors was also not required indicating surplus capacity. There existed further scope for energy saving.

However, this optimization and consequent energy saving was possible if a supervisory monitoring and control system to operate all screw compressors was procured and installed.

Optimization System

EnergAir Automation system for Supply side Management and Control Air System for Demand side Management was installed on a turnkey project by Godrej & Boyce Mfg. Co. Ltd. The system was inspected and commissioned by Godrej & Boyce Mfg Co Ltd., during Dec 2003 – Jan 2004, at Dalmia Cement (Bharat) Ltd., Dalmiapuram.

Basically this system classified plant Air applications in Two Groups – one set of users that consumes compressed air at Steady rate (Process Applications) and the other that consumes at Cyclic pattern (Fluxo Pump Applications). Two headers were formed - one dedicated for each group.

Selected applications were provided with Pressure/Flow controllers – where application pressure can be set. All twelve screw compressors were connected to Central Controller – which can switch on and off each compressor depending on Demand.

All screw compressors supply air to process header at preset Pressure. From this header, process applications received air through Flow controller at lesser but steady pressure. The compressors are run to maintain header pressure within a set range.

The Demand side ControlAiR™ Systems are connected to 4 networks to meet the plant demand.

a) ControlAIR™ Model GE-20 (1000-SCFM) was connected at CVRM Mill application and brought on-line with the discharge set pressures at 62 psig (4.36 kg/cm^2).

b) ControlAIR™ Model GE-10 (500-SCFM) was connected at Packing Silos application and brought on-line, with the discharge set pressures at 30 psig (2.10 kg/cm^2).

c) ControlAIR™ Model GE-10 (500-SCFM) was connected at Ball Mill (O-sepa Bag Filter and Water Spray) application and brought on-line with the discharge set pressures at 71 psig (4.99 kg/cm^2).

d) ControlAIR™ Model GE-10 (500-SCFM) was connected at Polysius Kiln Shell Cooling application and brought on-line with the discharge set pressures at 30 psig (2.10 kg/cm^2).

The Supply side EnergAir SX Controller was connected to process header and brought on-line for control and automation for all the 12nos. of screw compressors with optimized pressure setting of 73 psig to 78 psig (Average 75 PSIG – 5.27 kg/cm^2).

The above commissioning was done in a staggered manner as and when the respective plant was made available.

Savings

- **Guaranteed Energy Savings = 15 %**
- **Actual Achieved Energy Savings based on observation for a week = 27 %**
- **Stoppage of 2-3 Compressors.**

With and without this system energy consumption readings were taken and the energy savings effected by the system was found to be 27% as below :

Measurement of Power Consumption and Energy Savings

Following readings were taken on M/s DALMIA CEMENT (BHARAT) LTD's energy meters in presence of their representatives for proving the energy savings.

WITHOUT System:

Average Daily Compressor Energy Consumption = 11,284 kWh / day

WITH System:
Average Daily Compressor Energy Consumption = 8,224 kWh / day

Difference of Energy Consumption between
"WITHOUT Control System" and "WITH Control System" = 11,284 – 8,224 kWh / day

Energy Savings with EnergAir & ControlAiR system = 3,060 kWh / day
% Energy Savings with EnergAir & ControlAiR system = 27.12%

This system will pay back within one year.

Conclusion

It is possible to optimize air utilization and save compressors energy consumption through suitable supervisory systems available in the market.

Case Study - 2

INSTALLATION OF DRY FLY ASH STORAGE AND HANDLING SYSTEM

Background

In order to meet the customer demand PPC production was increased to as high as 50 % of the total product volume. However achieving this level was difficult because of the following bottlenecks:

Dry Fly Ash Storage

- ❖ Higher moisture content of the wet fly ash (as high as 25%) requiring hot gas source for drying
- ❖ Limited availability of heat from cooler vent
- ❖ Total Heat requirement for drying wet fly ash was about 14 M kCal/hr whereas Cooler heat available is only 11 Mkcal /hr and thus requiring a paid heat of 3 M kCal /hr
- ❖ Jamming of conveyor chutes, mill feed chute because of high moisture content of wet fly ash
- ❖ Reduction in mill output due to the above reasons

Dry Fly Ash Pumping

Energy saving project

In order to avoid the above problem, trials were conducted by installing a small bin arrangement to feed 10 Tons of dry fly ash per hour to study the performance of the system with dry fly ash and to establish the benefits.

With the trials found to be successful and attractive, it was decided to go for dedicated system for utilizing dry fly ash for the production of PPC.

Dry fly ash storage and handling system:

One of the old raw meal silos was used for receipt and primary storage of the dry fly ash. Suitable unloading and pumping systems were installed to transport the dry fly ash from the tanker to the silo and from the silo to the intermediate pumping arrangement available at the mill house.

One intermediate storage cum feeding control bin of 60 Tons capacity was installed with solid flow meter and load cell arrangement to feed the dry fly ash as per the requirement in a controlled manner.

Suitable dust control systems were installed in the unloading, transportation circuit so that any associated dust nuisance is eliminated.

Benefits achieved:

The entire arrangement was made with an investment of **Rs 15 Lakhs**. The power saving is around 1.5 kWh/Mt of dry fly ash used and the requirement of Hot air Generator for the production of PPC has been eliminated resulting in a saving of 4128 MT of coal per annum.

The overall cost saving due to thermal energy and electrical energy will correspond to about **Rs 164 Lakhs per annum**.

Case Study - 3

PRESSURE DROP REDUCTION IN PREHEATER DOWN COMER DUCT BY INTRODUCING FLOW DIVERTING PLATES

Preheater down comer duct (as shown in the picture) was having a total length of 140 m from top stage cyclone to preheater fan. Though the gas velocity inside the duct was found to be at optimum level (19 m/sec) the pressure drop across the duct was high (130 mmwg against the calculated value of 50 mmwg)

Down Comer Duct

After analysis we found that the pressure drop was maximum near the two bends one at the top and the other at the bottom offering nearly 60% of the total pressure drop and the reason could be improper flow distribution resulting in high turbulence and hence pressure drop.

Gas Profile

Computational fluid Dynamic study was conducted and based on the same flow distribution plates were installed at both the bends (2 at the top bend and one at the bottom). This has smoothened the flow and resulted in **reduction in pressure drop by 33 mmwg.**

It has resulted in **energy saving of 63 kwh/hr** corresponding to **4.99 Lakh units per annum & cost saving of Rs 17.5 Lakhs per annum.**

The **investment** made was around **1.5 Lakhs** with an attractive **pay back period of less than a month.**

List of projects implemented by Dalmia Cement in last 3 years

Detail	Unit	Total
No of Encon projects	No	36
Total Investment made	RS Million	10.8
Electrical energy saved	Million units	4.8
	Rs in Million	18.2
Thermal energy saved	Tons of coal	14812
	Million Rs	25.2

Rs Million

Sl No	Project Detail	Investment	Total savings
1	Hot Gas ducting from PH fan discharge to VRM-I	1.09	5.0
2	Removal of Dampers in various plans	Nil	0.9
3	Low speed motor at Bag Filter Fan to minimize damper loss	0.015	0.167
4	Interconnecting Packing House cooling tower with CVRM cooling tower	0.1014	0.055
5	Low speed motor at CVRM Hopper bag filter fan	0.06	0.48
6	VRM-I Orifice meter removal	Nil	0.3
7	Kiln feed Raw meal ventilation system switched off as silo infeed is connected to this	Nil	0.182
8	HAG for Cement Grinding was stopped by using dry fly ash	Nil	7.74
9	Optimizing Pre-heater outlet O2 & Temperature	Nil	11.62
10	Removal of Polysius kiln ID fan inlet damper	Nil	0.05
11	Enlargement of recirculation duct in VRM-II	0.54	0.67

List of projects implemented by Dalmia Cement in last 3 years

Rs Million

Sl No	Project Detail	Investment	Total savings
12	Capacitor bank shifting to improve power factor	Nil	0.33
13	Speed reduction in 2 Nos. of Aux. Bag filter Fans	0.04	0.64
14	Lower feed size optimization for VRM-II	Nil	0.98
15	VRM-I ESP Fan Retrofit	0.6	0.93
16	IKN Fan II Retrofit	0.22	0.4
17	Dry Fly ash storage & handling system for CVRM	1.5	2.92
18	Installation of low pressure drop flow metering system in place of venturi in CVRM	0.42	1.11
19	VFD for three fans	3.05	1.4
20	Removal of one Air slide fan by modifying extraction circuit in Cement Silo	Nil	0.11
21	Low Nox modification at 6R.1	1.40	0.01
22	Putting Air slides in place of screw conveyors in Roto-II	Nil	0.09
23	Changing temperature setting of lub oil separator in DG set	Nil	0.28
24	Removal of venturi in KHD Coal Mill circuit	0.02	0.09
25	Avoiding idle run of conveyor belt in Roto-II	Nil	0.05
26	Compressor optimization with Godrej control system	1.5	1.3
27	Increasing dry fly ash feed for PPC with separate storage system	0.10	1.98
28	Avoiding idle running of belt conveyor in CVRM dump hopper	Nil	0.03
29	Energy efficient screw compressors in place of old piston compressor	0.06	0.04

List of projects implemented by Dalmia Cement in last 3 years

Rs Million

Sl No	Project Detail	Investment	Total savings
30	New energy efficient pump in place of old pump	0.01	0.02
31	Installation of car washer pump in place of high pressure pump for equipment maint.	0.003	0.003
32	In Roto-I, the Rotary feeder was replaced with pneumatic gate	0.03	0.04
33	Pressure drop reduction in PH down comer duct by introducing flow diverter plates	0.02	2.25
34	New Energy efficient impeller for cooler vent fan	0.01	0.86
35	Installation of correct size pump for identified PV systems	0.01	0.29
	TOTAL	**10.8**	**43.3**

MADRAS CEMENTS LIMITED, ALATHIYUR

Ramco Group

Under the stewardship and vision of the present chairman Sri P.R. Ramasubrahmaneya Rajha, the group has grown into a Rs 2000 Crores empire consisting of well diversified galaxy of stars and has become one of the most reputed business groups in India.

The group's business interests are :

- ❖ Cement
- ❖ Cotton yarn
- ❖ Software systems
- ❖ Fibre Cement products
- ❖ Wind Energy

Madras Cements Ltd.

Madras Cements Ltd is the flag ship company of Ramco Group. The main product of the company is Portland cement manufactured through the four advanced production facilities spread over South India.

The cement production capacity is 6 million tons per annum. The company is the sixth largest cement producer in the country and the second largest in South India. The main product is Ramco Supergrade which is a world class blended cement and one of the most popular cement brand in South India.

MCL also produces Ready Mix Concrete and Dry mortar products. In addition, the company also operates one of the largest wind farms in the country.

As on 31 March 2006, the company has made a turnover of Rs 1013 Crores and has a fixed assets base of Rs 1641 Crores. It has won many prestigious awards and is considered as one of the most energy efficient company in the country.

Madras Cements Ltd operates four ultramodern production facilities :

- R R Nagar, Tamil Nadu (1.2 MTPA)
- Jayanthipuram, Andra Pradesh (1.6 MTPA)
- Alathiyur, Tamil Nadu (3.0 MTPA)
- Mathod, Karnataka (0.2 MTPA)

The R R Nagar plant commenced operations in 1962 with 200 TPD. It commissioned the first 1200 TPD dry plant in 1976. A second Kiln with a Capacity of 650 TPD was added in the year 1993-94.

The Jayanthipuram Plant started the operations in 1988 with 2500 TPD and was upgraded to 3200 TPD in 1992. It is equipped with a modern computer based quality control system.

The Alathiyur plant Commenced operations in 1997 with 0.9 MTPA Capacity and was upgraded by 0.2 MTPA in 1999-2000. It started the Line-2 in 2000-01 with a capacity of 1.5 MTPA. Alathiyur is the first plant in India to go in for 100% Mining by Surface Miners. It has an enviro-friendly and energy Efficient MMD Crusher for Lime Stone Crushing Plant Operations

Highlights of MCL, Alathiyur

- A flagship company of RAMCO Group, having four Cement manufacturing units of Total capacity 6 MTPA.
- The plant at Alathiyur, Perambalur District was setup in two phases.
- Total Plant Capacity - 6600 TPD of Clinker.
- Manufacturer of Ordinary Portland Cement and Portland Pozzolana Cement as per Indian Standards and Ordinary Portland Cement as per British and Sri Lankan Standards.
- Coal based Power Plant 2 X 18 M.W
- ISO 9001, ISO 14001 & OHSAS 18001 Certified Company

Equipment specifications

Sl No	Equipment	Parameter	Line 1	Line 2
1	Crusher	Make	M/s.MMD Ltd, UK	M/s.MMD Ltd, UK
		Type of crusher	Roller	Roller
		Installed Capacity (TPH)	1000	300
		Operating Capacity (TPH)	900	250
		Drive rating (kW)	2x250	250
2	Raw mill	Make	Loesche LM 38.3	Loesche LM 38.3
		Type of mill	V.R.M	V.R.M
		Installed Capacity (TPH)	220	225
		Operating Capacity (TPH)	235	235
		Type of separator	LSKS 55	LSKS 55
		Drive rating (kW)	1750	1750
		Fan rating (kW)	1750	2200
		Product fineness (Residue)	90 MIC - 15 to 20%	90 MIC - 15 to 20%
3	Coal mill	Make	Loesche LM 20.2	Loesche LM 20.2
		Type of mill	V.R.M	V.R.M
		Installed Capacity (TPH)	23	23
		Operating Capacity (TPH)	25	27
		Type of separator	LKS 40 ZD	LKS 36 ZD
		Drive rating (kW)	400	400
		Fan rating (kW)	750	750
		Product fineness (Residue)	90 MIC - 25 to 30%	90 MIC - 25 to 30%
4	Kiln	Make	Fuller – USA	Fuller – USA
		Installed Capacity (TPD)	3000	3000
		Operating Capacity (TPD)	3300	3300
		Kiln dimensions	3.75 F m x 57 m long	3.75 F m x 57 m long
		No.of pre-heater stages	5	5
		Overall PH Pressure drop (At fan inlet, mmWg)	710	605
		PH fan rating (kW)	1750	1750

Sl No	Equipment	Parameter	Line 1	Line 2
5	Cooler	Make	Fuller CIS-CFG-RFT	SF Crossbar cooler
		Capacity	3300	3300
		No.of cooler fans	10	5
		Cooler Area	47.52	71.72
		Cooler vent fan rating	250 K.W	175 K.W
6	Cement mill	Make	Onada Kopel OK33.4	Loesche LM 56.2 +2C
		Type of mill	V.R.M	V.R.M
		Installed Capacity (TPH)	160	220
		Operating Capacity (TPH)	165	265
		Type of separator	OKS 70 C	LSKS 76 C
		Drive rating (kW)	2850	4000
		Fan rating (kW)	1750	2850
		Product fineness (Residue)	90 MIC-1.2 for PPC	90 MIC-1.2 for PPC
		Product fineness (Blaine)	3300 for PPC	3400 for PPC

Specific Electrical Energy Consumption (Typical Average)

Sl No	Equipment	Parameter	1
1	Crusher	Crusher Main Motor	0.32
		Crusher Auxiliaries	0.6
		Subtotal SEC	
		1. kWh / Ton of Material	0.9
		2. kWh / Ton of Clinker	1.29
		3. kWh / Ton of Cement	0.92
2	Raw mill	Raw Mill Main Motor	5.5
		Raw Mill Circulating Fan	5.95
		Separator, Baghouse fan	
		Raw Mill Auxiliaries	3.76

Sl No	Equipment	Parameter	1
3	Coal mill	Coal Mill Main Drive Coal mill Vent fan Coal Mill Booster Fan Coal Mill Separator Coal Mill Auxiliaries	0.85 1.6 0.19
4	Kiln	Kiln Main Drive PH Fan a. KS Fan b. CS Fan ESP a. ESP Fan b. Reverse Air Fan Cooler Fans Cooler Vent Fan	0.95 5.6 8.15
5	Up to clinkerisation	kWh / MT of clinker	47.0
6	Cement mill	Cement Mill Main drive Cement Mill Fan Separator Cement Mill Auxiliaries	12.9 6.1 3.0
7	Packing plant	Packing Plant & Auxiliaries	2.0
8		colony,workshop,AC,trafo lo Water Pumping System	2.25 1.2
9	Total	kWh / MT of clinker kWh / MT of OPC kWh / MT of Cement	47.0 70.18 59.92

Heat Balance (Typical Average)

Heat Balance		
Heat Output		
	(Kcal/Kgcl)	(%)
Heat of Reaction	412.2	56.6
Heat Loss with Kiln Exit Gases	159.9	21.9
Heat Loss with Kiln Dust	9.4	1.3
Heat Loss with Cooler Vent	81.3	11.2
Heat Loss with Clinker	19.1	2.6
Heat of Evaporation	9.2	1.3
Radiation Losses		
1) Kiln	19.2	2.6
2) Preheater	13.5	1.8
3) Cooler & Tad	5.0	0.7
Total Heat Output	728.7	100.0
Heat Input		
(Kcal/Kgcl)		(%)
Sensible Heat in Kiln Feed	22.9	3.1
Sensible Heat in Coal	1.9	0.3
Sensible Heat in Cooler Air	16.7	2.3
Sensible Heat in Primary & Conveying Air	0.5	0.1
Sensible Heat in False Air	1.0	0.1
Sensible Heat in Moisture	0.4	0.1
Specific Fuel Consumption	685.3	94.0
(By Difference)		
Total Heat Input	728.7	100.0

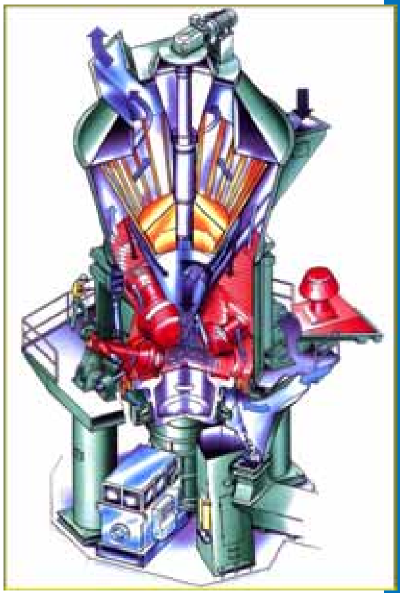
Case Study 1

OPTIMIZATION OF CEMENT MILL II

Background

Madras Cements Limited, Alathiyur has installed one of the biggest clinker grinding mill in the world. This mill is supplied by Loeshe, Germany. It is a vertical roller mill with a high efficiency separator.

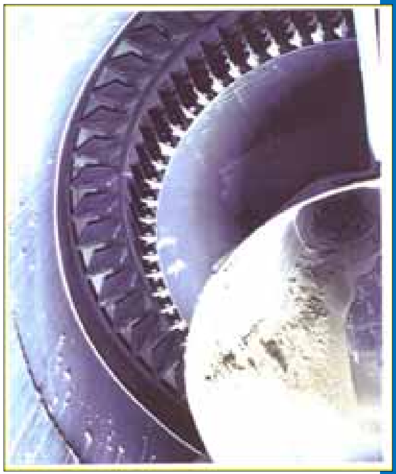
The description of the mill is as under:



Make	: M/s. Loesche, Germany
Mill size	: LM 56.2 + 2C
Fineness for PPC	: 3200 Blaines
Mill motor drive	: 4000 kW
Classifier type	: LSKS 85 C
Drive	: 160 kW

During the operation of the mill, the plant team had been exploring the options for increasing the capacity of the mill and reducing the specific energy consumption.

Energy saving projects



After evaluating the performance of the mill, the plant team carried out the following major modifications in the mill:

1. The width of the static flaps of the classifier in the vertical roller mill was modified
2. The high efficiency dynamic classifier Rotor diameter was altered.

Improvements

The following were the benefits recorded after carrying out the modifications:

Parameter	Units	Before Modification	After Modifications
Total Feed on dry	TPH	220	235
Mill inlet draft	mbar	-5 To -8	-5 To -8
Mill differential pressure	mbar	44 to 49	41 to 46
Mill inlet temperature	°C	121	125
Mill outlet temperature	°C	100	98
Air flow behind filter	m^3/hr	685000	660000
Power Consumption			
LM Motor	kW	3415	3200
Fan Motor	kW	1725	1520
Classifier Motor	kW	130	110
Auxiliaries			
Fan Speed	rpm	880	850
Sp. LM Power	kWh/t	15.52	13.62
Sp. Fan Motor	kWh/t	7.84	6.47
Sp. Aux. Power (mill & classifier)	kWh/t	0.59	0.46
Sp. Power total	kWh/t	**23.95**	**20.55**

Benefits

Implementing this in-house modification resulted in signficatnt energy saving of 3.4 kWh Ton of cement. This results in an annual energy saving of **Rs. 199.90 Lakhs.**

Case Study 2

OPTIMIZATION OF CEMENT MILL II

Background

Madras Cements Limited, Alathiyur has installed a vertical roller mill for raw material grinding in its cement manufacturing process. This mill is supplied by Loeshe, Germany. It is a vertical roller mill with a high efficiency separator.

The description of the mill is as under:

Make	: M/s. Loesche, Germany
Mill size	: LM 38.3
Mill motor drive	: 1750 kW

During the operation of the mill, the plant team had been exploring the options for increasing the capacity of the mill and reducing the specific energy consumption.

Energy saving projects

After evaluating the performance of the mill, the plant team carried out the following major modifications in the mill:

1. The classifier blades in the vertical roller mill were modified from flat surface to curved surface.
2. The configuration of the static blades was modified.

Carrying out these two modifications resulted in significant energy saving. The results are as tabulated below:

	Units	Before Modification	After Modification
Feed	TPH	235	240
Flow	m3/hr	315000	302000
Mill D.P	Mbar	77 to 83	71 to 75
Mill Power	KW	1135	1138
Fan Power	KW	1325	1195
Total	KW	2460	2333
	Kwh / t	10.47	9.72
Savings	Kwh / t of Material	**0.75**	

Benefits

Implementing this in-house modification resulted in significant energy saving of 0.75 kWh/ Ton of Material. This results in an annual energy saving of **Rs. 45.40 Lakhs.**

Case Study 3

OPTIMIZATION OF CEMENT MILL

Background

Madras Cements Limited, Alathiyur has installed a vertical roller mill supplied by OK with a high efficiency separator. The installed capacity of the mill is 165 TPH.

During the operation of the mill, the plant team had been exploring the options for reducing the specific energy consumption in the cement mill section.

One of the areas of improvement identified was the efficiency improvement in the cement mill fan. The cement mill fan was observed to the of lower operating efficiency. The oepraign efficiency was only about 63%.

Energy saving project

The cement mill fan casing and the impeller were retrofitted. The operating efficiency improved from 63.71% to about 71.70% resulting in energy saving of about 0.6 kWh / ton of cement. The results of this project are as tabulated below:

Parameters	Before modification	After Modification
Volume (Cu.m / hr)	312076	309000
Static Pressure (mm WC)	790	740
Fan Speed (rpm)	924	924
Power (kW)	1016	920
Production (TPH)	165	165
SEC of Fan (kWh / Ton of Cement)	6.2	5.6
Fan Efficiency (%)	63.71	71.70

Benefits

The benefits achieved by implementing this project are as under:

1. There is a reduction of fan power by 90 kW.
2. Specific power has also reduced by 0.6 units
3. The efficiency of the fan has improved from 63.71 % to 71.70 %

Case studies implemented in last 3 years

Sl No.	Title of Energy Saving project implemented	Year of Implem-entation	Annual Electrical Savings achieved		Annual thermal savings		Investments made
			Units Million	Rs Million	Tons of Coal or Oil	Rs Million	Rs Million
1	Cement MIll bag filter purging time increased.	03-04	0.015	0.0525	0	0	0
2	By pass duct installed for Cement mill booster fan from Cooler vent fan	03-04	0	0	1440	5.4	0.26
3	Nozzle ring modification and grit cone extension at Coal mill	03-04	0.5465	1.913	0	0	0.05
4	Air balancing and optimization at Coal mill	03-04	0.2049	0.717	0	0	0
5	Collecting air slide blower one number stopped at Cement mill	03-04	0.0012	0.0042	0	0	0
6	Classifer grit cone extension, flap adjustment and nozzle area modification at Line - II Cement mill	03-04	4.68	16.38	0	0	0.5
7	Armour ring and grit cone extension at Line- I Cement mill	03-04	0.594	2.079	0	0	0.15

Sl No.	Title of Energy Saving project implemented	Year of Implem-entation	Annual Electrical Savings achieved		Annual thermal savings		Investments made
			Units Million	Rs Million	Tons of Coal or Oil	Rs Million	Rs Million
8	Classifer sealing correction and deflector ring fixed at Raw Mill	03-04	0.2116	0.741	0	0	0.05
9	Armour ring angle modification and grit cone extension at Raw Mill	03-04	0.6348	2.222	0	0	0.1
10	Installation of seperate conveying and dozing system for alternative fuels.	03-04	1.656	5.796	0	0	0.2
11	Coal conveying line Optimization at Kiln -II	04-05	0.0792	0.277	0	0	0.02
12	Pre heater cyclone modification at Kiln - I	04-05	0.7425	2.599	0	0	1
13	Provided software interlock to stop the dedusting fan whenever feeding conveyor stops.	04-05	0.016	0.056	0	0	0
14	Provided dampers in the inlet of dust collector fans in packer to control the suction whenever the packer operates with single discharge	04-05	0.125	0.439	0	0	0
15	Changed 100 numbers of fittings from 80 watts HMPV lamp to 50 Watts MH lamp at packing plant.	04-05	0.0131	0.045	0	0	0.12
16	Godrej control air for compressed air system at flyash handling.	04-05	0.1353	0.4736	0	0	0.069

Sl No.	Title of Energy Saving project implemented	Year of Implem-entation	Annual Electrical Savings achieved		Annual thermal savings		Investments made
			Units Million	Rs Million	Tons of Coal or Oil	Rs Million	Rs Million
17	Modification of inlet box in Line - II Pre heater fan	04-05	0.18	0.63	0	0	0.07
18	Nozzle ring modification and grit cone extension at Coal mill	04-05	0.546	1.913	0	0	0.05
19	Classifer blades modified from flat to curved at both Raw Mills	04-05	1.296	4.536	0	0	1.5
20	Raw mill inlet duct modification at Line - I	04-05	0	0	784	2.89	0.05
21	2 x 18 M.W Coal based power plant to reduce the energy cost.	04-05	0	110	0	0	950
22	Replacement of high efficiency I.D fan at Line - I	05-06	0.432	1.512	0	0	1.6
23	Replacement of high efficiency Vent fan in Line - I	05-06	0.0594	0.2079	0	0	0.5
24	Introduction of Delta tube in Cement Mill – II	05-06	0.0749	0.2622	0	0	0.04
25	Installation of Power Boss for variable load applications such as conveyors and elevators so to reduce power	05-06	0.0168	0.0588	0	0	0.21
26	Stopped a bag filter fan in Kiln - II	05-06	0.075	0.2625	0	0	0.014
27	Optimization of extraction blowers	05-06	0.048	0.168	0	0	0.016

MARATHA CEMENT WORKS

(Gujarat Ambuja Cement Limited), Upparwahi

Introduction

Maratha Cements Works - a company promoted by **Gujarat Ambuja Cements Ltd. (GACL)** is operating a 2 million plant at Village Bhendvi / Upparwahi in District Chandrapur in the State of Maharashtra. This plant had obtained environmental clearance from Min. of Environment & Forests, Govt. of India in Year 2000 for the capacity of 2 Million MT of cement per annum with captive power plant (CPP) capacity of 45 MW. The plant has subsequently gone through modernization and achieved the consented capacity of 2.85 Million MT per annum.

Gujarat Ambuja Cements Limited (GACL), is recognized as one of the most progressive cement companies in India. The company has five cement plants with a total annual installed capacity of **13.80 Million MT.** Three cement kilns of 1.5 Million MT each are located at Kodinar in Gujarat. Cement plant of 2.0 Million MT at Darlaghat in Himachal Pradesh with a split location of grinding unit at Ropar, Punjab of 2.5 Million MT has been commissioned in 1995. The Company has another cement manufacturing facility of 1.8 Million MT at Rabariyawas in Rajasthan and amillion ton plant at Bhatapara, Chattisgarh state and the present plant in Maharashtra is operating at 2.85 Million MT.

Project Implementation

GACL's first plant was commissioned in 1985-86 within **22** months. The second plant was commissioned in 1993 in just **13** months time. To the best of our knowledge no other cement plant has been completed in such a short span of time. Moreover, the company enjoys recognition for high productivity, low power consumption, low fuel consumption, best pollution control and environmental preservation. These achievements put the company on the forefront in cement industry.

Bulk Cement Transportation By Sea Route

Almost the entire cement produced in India is bagged and transported by road and rail. Due to the fast development of the country, road and rail infrastructure are being overloaded and are experiencing heavy strain. This also results in deterioration in the quality of cement, delay in delivery, higher price on account of transportation and handling costs etc. GACL conducted a study to identify alternate mode of transport. It was observed that the developed countries, which are environmentally conscious, are transporting more than 90% cement in bulk. Moreover, they have been using waterways extensively for transporting cement. This challenge was accepted and GACL introduced the concept of bulk transportation through sea route for the first time in India. GACL established three bulk cement terminals at strategic locations at Kodinar and Surat in Gujarat and at Panvel, New Mumbai in Maharashtra. Concurrently, GACL have six specially designed ships, each having a capacity of 2500 tonnes, which were built, in the country to meet GACL's captive requirements. Based on performance of these ships and looking at the demand of furthering sea transportation of clinker and cement the Company has now an additional ship of 4000 tonnes.

Captive Ports And Ships

GACL has three captive ports and seven ships for captive cargo movement by sea. The port at Muldwarka is protected by about one kilometer long breakwater for round the year operations with facilities for berthing vessels upto 35000 DWT. GACL is the first and only company in India to have such facilities. This has enabled the company to export cement in bulk to the neighboring countries and states.

Corporate Philosophy

In a short span of GACL's existence, the company has become the numero uno performer in the cement industry through its innovative style of management and importance to total quality excellence. This has been achieved through team spirit of dedicated professionals from different disciplines of the organization and the "I can" philosophy, which encourages the personal mission of the individuals, rather than chasing fixed targets.

Equipment specifications

Sl No	Equipment	Parameter	1
1	Crusher	Make	L & T
		Type of crusher	Impact
		Installed Capacity (TPH)	1200
		Operating Capacity (TPH)	600-800
		Drive rating (kW)	1200
2	Raw mill	Make	Pfeiffer
		Type of mill	VRM
		Installed Capacity (TPH)	480
		Operating Capacity (TPH)	~ 600
		Type of separator	Dynamic
		Drive rating (kW)	5400
		Fan rating (kW)	4100
		Product fineness (Residue)	212 µ 3-4 % & 90 µ 22-24 %
3	Coal mill	Make	Pfeiffer
		Type of mill	VRM
		Installed Capacity (TPH)	60
		Operating Capacity (TPH)	67
		Type of separator	Dynamic
		Drive rating (kW)	800
		Fan rating (kW)	800
		Product fineness (Residue)	212 µ 1-2 % & 90 µ 14 -16 %
4	Kiln	Make	Polysius
		Installed Capacity (TPD)	6000
		Operating Capacity (TPD)	7800-8000
		Kiln dimensions	4.8 X 75
		No.of pre-heater stages	6
		Overall PH Pressure drop (At fan inlet)	~ 480
		PH fan rating (kW)	2800

Sl No	Equipment	Parameter	1
5	Cooler	Make Capacity No.of cooler fans Cooler Area Cooler vent fan rating (kW)	Polysius 6000 14 120 560
6	Cement mill	Make Type of mill Installed Capacity (TPH) Operating Capacity (TPH) Type of separator Drive rating (kW) Fan rating (kW) Product fineness (Residue) Product fineness (Blaine)	TKIL Ball mill 150 ~ 130 Sepol 2 X 2500 460 OPC:13-15% & PPC 9-10 % ON 45 µ OPC:3100 & PPC :4000

Specific Electrical Energy Consumption (Typical Average)

Sl No	Equipment	Parameter	1
1	Crusher	Crusher Main Motor Crusher Auxiliaries Subtotal SEC 1. kWh / Ton of Material 2. kWh / Ton of Clinker 3. kWh / Ton of Cement	0.43 0.58 1.05 1.52 1.47
2	Raw mill	Raw Mill Main Motor Raw Mill Circulating Fan Separator Raw Mill Auxiliaries	7.53 5.25 1.41

Sl No	Equipment	Parameter	1
3	Coal mill	Coal Mill Main Drive Coal mill Vent fan Coal Mill Booster Fan Coal Mill Separator Coal Mill Auxiliaries	10.74 10.73 6.31
4	Kiln	Kiln Main Drive PH Fan a. KS Fan b. CS Fan ESP a. ESP Fan Bag House Fan a. Bag House Fan b. Auxilliaries Cooler Fans Cooler Vent Fan	2.07 7.88 3.49 6.23 5.11 0.89
5	Up to clinkerisation	kWh / MT of clinker	55.03
6	Cement mill	Cement Mill Main drive Cement Mill Fan Separator Cement Mill Auxiliaries	33.5 2.67 4.56 40.73
7	Packing plant	Packing Plant & Auxiliaries	1.18
8	Auxiliaries	Colony Water Pumping System	2.2 0.4
9	Total	kWh / MT of clinker kWh / MT of OPC kWh / MT of Cement	53.12 94.05 82.84

Heat Balance (Typical Average)

Kiln Feed (TPH)	530.94		Clinker (TPH)		326.73
Heat Input					02-09-06
Content	Quantity (Nm3/ Kg cl)	Quantity (Kg/ Kg cl)	Temp (Deg C)	Sp Heat (kcal/ kg °C)	Sensible Heat (Kcal/ kg cl)
Coal combustion	-	0.126	-	4965	694.59
Kiln feed	-	1.625	76	0.21	25.94
Coal	-	0.126	70	0.29	2.56
Primary air	0.024	0.031	55	0.24	0.41
Coal conveying air	0.038	0.049	85	0.24	1
Cooling air	1.808	2.338	31	0.24	17.27
Inleaking air	0.012	0.016	31	0.24	0.12
TOTAL					741.89

Heat Output

Content	Quantity (Nm3/ kg cl)	Quantity (Kg/ Kg cl)	Temp (Deg C)	Sp Heat (kcal/ kg °C)	Sensible Heat (Kcal/ kg cl)
Preheater exhaust gases	1.44	2.012	311	0.24	150.18
Preheater exit dust	-	0.13	311	0.21	8.49
Cooler Exit air	1.00	1.3	324	0.24	101.09
Clinker discharge	-	1	137	0.19	26.03
Evaporation of moisture feed	-	0.004875	-	640	3.12
Shell losses					33.5
Heat of reaction					419.48
TOTAL					741.89

Cooler Heat Balance

kiln Feed	TPH	530.94	Clinker	TPH	326.73	
					Date:	02-09-06
Heat Input						
Content		Nm3/ kg cl	kg/ kg cl	Temp	Sp heat	Kcal/ kg cl
Clinker		-	1.00	1400.00	0.26	364.00
Cooling air		1.81	2.34	30.79	0.24	17.28
Total						381.28
Heat Output						
Content	kg cl	Nm3/ kg cl	kg/	Temp heat	Sp kg cl	Kcal/
Sec air		0.28	0.37	1060	0.26	101.97
Ter air		0.52	0.68	835	0.26	147.63
Cooler Exit		1.00	1.30	324	0.24	101.09
Clinker		1.00	-	137	0.19	26.03
Radiation						4.56
Total						381.28
Recuperation Efficiency					**65.46%**	
Cooler losses				**131.68**		

Case Study 1

RAW MILL FAN INLET BOX AND DAMPER MODIFICATION

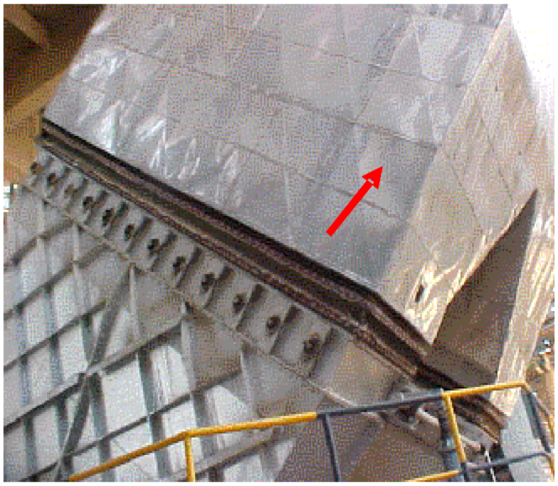
Background

Raw mill fan is one of the major energy consumers in a cement plant. At MCW, the power consumption of raw mill fan is about 5.25 kWh / ton. Energy conservation in raw mill fan is according a high priority and all possible efforts are taken to reduce the power consumption of this fan.

During the measurements carried out at the raw mill fan, it was observed that the raw mill fan inlet box velocity was about 47 – 51 m/s. The high velocity was attributed to the high pressure drop across the inlet box and the damper.

Energy saving proposal

An energy saving proposal was made by the in-house energy team to reduce the pressure drop to the extent of about 30 to 40 mm WC. Based on the suggestion and the proposal, the raw mill fan inlet box and the damper were modified.



The reduction in the pressure drop in the raw mill fan offers two benefits:

1. This can be utilized to reduce the power consumption of the raw mill fan for the same output from the raw mill or
2. The volumetric flow rate that would increase because of the lower pressure drop can be utilized to increase the mill throughput. Increasing the mill throughput will reduce the running hours of the raw mill thereby resulting in energy saving.

At MCW, the benefit of reducing the power consumption of the mill was chosen. The fan flow rate was marginally reduced and the mill pressure drop came down. The mill feed rate could be increased from 580 TPH to 625 TPH and the fan power was marginally reduced from 3150 kW to 3100 kW. The net benefit was significant – resulting in nearly 0.5 kWh / ton of material reduction in the power consumption.

The benefit by implementing this proposal is as under:

Description	Before Modification	After Modification
Mill feed rate,TPH	580	625
Fan flow rate, m3/hr	9,90,000	9,80,000
St.Pressure, mm wg	945	910
Fan power drawn,kW	3150	3100
Sp.Power (kW/Mat)	5.43	4.96

Benefits

The benefits by implementing this project were an annual energy saving of **Rs. 35.26 Lakhs** (reduction in energy consumption by 17.63 Lakh kWh / annum). This called for an investment of **Rs. 8.75 Lakhs** which had a simple payback period of **3 months** time.

Case Study 2

INCREASING THE COOLER ESP INLET DUCT DIAMETER

Background

MCW had been designed for cement manufacturing capacity of 6000 TPD. However, within the last few years of operation, the capacity of the plant has been increased from the design capacity of 6000 TPD to about 8500 TPD. This has resulted in proportional increase in the airflow rate across the cooler. Velocity in the cooler ESP duct has increased from the design value of 15 m/s at 6000 TPD to about 20 m/s at the present operating capacities.

Cooler gases are laden with clinker dust. Clinker dust, as all of us are aware, is extremely abrasive in nature. This increase in gas flow and velocity has created wear & tear problem in the cooler ESP duct. Increased gas flow velocities have resulted in significant increase in the pressure drop in the system also.

Energy saving project

Considering the increased production levels and corresponding increase in gas flow in the clinker cooler ESP duct, it was proposed to increase the duct diameter from the present value of 3600 mm to 4100 mm. This was anticipated considering the problem of wear & tear and to address the higher pressure drop in the duct.

This has resulted in energy saving, but more importantly, it has addressed the issue of wear & tear in the bends of the gas path.

The benefits are as tabulated below:

Description	Before Modification	After Modification
Clinker Production	8000	8000
Air flow rate, m3/hr	7,45,000	7,25,000
St.Pr Before ESP, mmwg	47	31
Power drawn, kW	305	270
Sp.power , kW/ton. of Mat	0.916	0.810

Benefits

The annual energy saving achieved by implementing this project was **Rs.5.30 Lakhs**. This required an investment of **Rs. 35.22 Lakhs** and had a simple payback period of **6 years.**

However, this project was implemented considering the wear & tear of the gas path. Subsequent to the implementation, the wear & tear has reduced substantially.

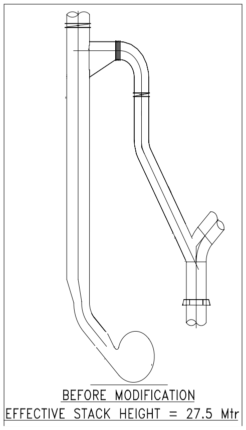
Case Study 3

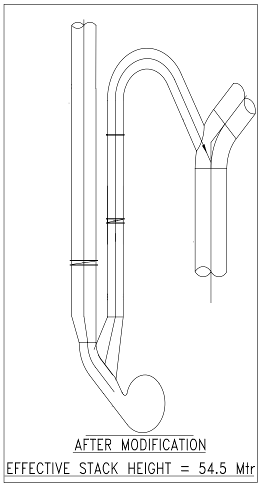
COAL MILL STACK AND RECIRCULATION DUCT MODIFICATION

Background

MCW had constantly been looking out for areas for reduction in energy consumption. One of the areas under focus was the utilization of the natural draft available from the tall stacks provided at MCW by design.

In the coal mill section, as per the original stack design and the recirculation duct layout, the damper was positioned in the middle of the stack to draw the recirculation air. The stack height is 62.50 m and the effective utilization of the natural draft was only with 27.50 m instead of the entire stack height of 62.50 m.





Energy saving project

During the duct audit carried out at MCW, this opportunity was explored to see the possibility of increasing the effective utilization of natural draft available. A proposal was made to shift the stack damper close to the fan outlet and to relocate the re-circulation damper to meet the coal mill requirement.

Once this proposal was approved, the implementation was completed and significant benefits were achieved.

The results are as tabulated below:

Description	Before Modification	After Modification
Stack height after Damper, m	27.50	54
Draft before stack damper	+177 mmwg	+120 mmwg
Draft after stack damper	-7 mmwg	-31 mmwg
Fan power drawn ,kW	714	700
Mill power drawn, kW	650	550

Benefits

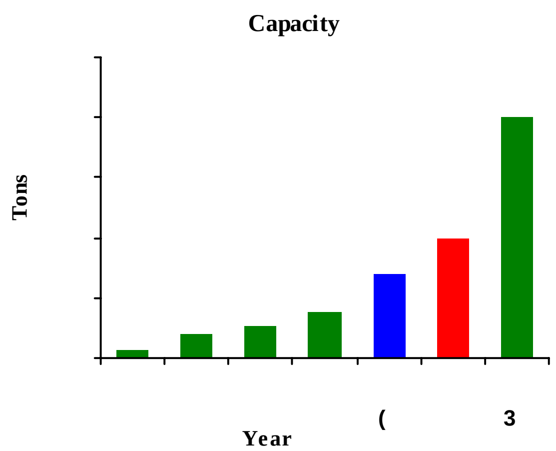
Implementing this proposal resulted in annual energy saving of **Rs. 1.41 Lakhs.** This called for an investment of **Rs. 2.23 Lakhs** and had a simple payback period of **19 months.**

List of All Significant Energy Conservation Projects implemented during 2003 – 04,05,06

Sl No:	Title of Energy Saving project implemented	Year of Implem-entation	Annual Electrical Savings achieved		Annual thermal savings		Investments made
			Units Million	Rs Million	Tons of Coal or Oil	Rs Million	Rs Million
1	Raw mill fan inlet box/ Damper modification	2005	1.763	3.52			0.88
2	Teritiary duct modification	2005			2500	4.5	2.6
3	Installation of duoplex burner for improving burining conditions	2005	0.18	0.35			4.4
4	Cooler ESP inlet duct modification	2005	0.27	0.53			
5	Cooler Take-off duct modification	2005			769	3.77	1.38

SHREE CEMENT LIMITED, BEAWAR

Shree cement is an energy conscious and environment friendly sustainable business origination. The present capacity of 3 MTPA makes it **the largest plant at a single location in Northern India. Under capacity enhancement programme, Green field project, of 1.2 MTPA capacities commissioned at Ras, Rajasthan. Three more projects are coming up (3*1.2MTPA).**



Under the chairmanship of Shri B.G. Bangur, the immense decision taking capability of Shri. H.M. Bangur (Managing Director) and the guidance of Shri. M.K.Singhi (Executive Director) and other directors, **Shree Cement is marching ahead with a vision of attaining 20 million ton capacity by year 2015.** The company is managed by qualified professionals with a broad vision who are committed to maintaining high standards of quality & leadership to serve the customers to their fullest satisfaction.

- In 2003, in order to become self sufficient in power, **Shree Cement installed its own 2x18 MW captive power plant in 2.8 hectares land to meet the entire power requirement of the plant** including its peak demand. The capacity of the plant **was further enhanced to 44 MW in year 2006**.

Productivity

It has a track record of over 100% capacity utilization in the eighteenth year of its existence. In 2005-2006 it registered its **highest ever production of 3.22 million tones with 116 % capacity utilization against industry average of 90 %.**

Energy Conservation

It consumed 118 kwh/ton of cement in 1985, which has come down to **73 kwh/ton of cement in 2005-06**, compared to industry average of 82kwh/ton of cement.

Sustainable Development Initiatives

The concept of sustainable development pre-empts a world order where it would be the only mode of progress. Taking a proactive stance, Shree joined a forum of International cement companies formed to help the industry make a transition to the sustainability ethos. Called the cement Sustainability Initiative (CSI), it has Shree as the first Indian Cement company joining it and partnering the World Business Council for Sustainable development (WBCSD), Switzerland, in its efforts. Sustainable development involves meeting commitments pertaining to climate protection, responsible use of fuels & materials, employee health and safety, emission reduction, local impact on land and community and reporting. Also joined Global Reporting Initiatives as a organizational stake holder in 2005.

Environment Protection Towards Sustainability

Adoption of environment management system **ISO 14001** and quality management system **ISO 9001**. Sustainability has been achieve by adopting innovative approaches that have resulted in reduction of CO2 emission, conservation of natural resources, improvement in ecology and profitability of company.

Clean Technology Initiatives

Incorporation of **Electro static air filter** in D.G. sets and compressors to improve efficiency & reduce fuel consumption, use of **clinker cooler waste gases** in 3 MW power plant, **zero disposal of wastes from Shree cement – Shree Power Plant**, replacement of blasting by **Eco friendly rock breakers in mines.** Shree has taken initiatives in formalizing the CDM projects.

Since inception **not a single day's production has been lost** because of environmental mishaps or non-compliance.

Research & Development

Shree R&D center one of the few in the cement industry is duly **recognized by Department of Scientific & Industrial Research, Govt. of India**. The R&D efforts are directed towards development of new product and process technologies, improvement of product performance and reduction in costs through use of alternate fuels and raw materials.

Environment friendly use of waste - **Utilization of pet coke** a refinery waste (first of its kind) resulted in reduced energy cost & increased profitability to the company. Now research is in progress to use waste drived fuels. Similarly use of flyash in cement manufacture has increased over the years.

Safety & Health

Certified with OHSAS-18001 the management system for Health & safety.

Good Corporate Citizenship

SCL is associated with rural & community development activities, health care, education, environment etc.SA-8000 certificate has been received in 2006.

People Philosophy

Institutionalized a suggestion scheme called **Jo Soche Woh Paave** to bring all members to main stream, created **leaders at every level** results in strong sense of emotional ownership, implemented recognition & reward scheme, **concepts of multi skilling** to optimize manpower enhance skill and to facilitate cross functional development, **small group activities** for energy conservation, to achieve **total prosperity** ASCENT groups have been formed,

Recognitions

- Recipient of :
  - Environment Award2003-04 by The Energy and Resource Institute
  - Energy Efficient Unit Award for the year 2003-04
  - Rajasthan Productivity Award 2003-04 consequently for 2nd year.
  - Second Best National Award for Quality Excellence for the year 2002-03.
  - Best Annual Report (2002-03) Award.
  - Excellent Energy Management Award 2002-03.
  - National Award for Best Thermal Energy Performance for U-2 2001-02&2002-03.
  - 6th Golden Peacock Environmental Management Award.

- 8th Golden Peacock Environmental Management Award 2005.
- National Award for Excellence in Energy Management 2006 by CII.
- National Vishwa Karma Award for implementation of innovative ideas for better productivity.
- Safety Award for longest accident free period.
- National Awards for Energy for five consecutive years from the Ministry of Power.
- Rajiv Gandhi National Quality Certificate Award for efforts & commitment to quality.
- Medallian Mines Award for best safety practices for last three years in continuity.

- Appointed **leader of cement sector task force** by Bureau of Energy Efficiency, Ministry of Power, Govt. of India.

Financial Highlights

Shree achieved the highest turnover of Rs 824.12 crore in 2005-06 an increase of over 13.98% over the previous period of 2003-04. The cost conscious measures also yielded handsome results in the form of increase in operating margin to Rs.225.18 crore in 2005-06 compared with Rs.173.92 crore in the previous period ending 31st March 2005. The net profit took a quantum fall of -36.68% at Rs. 18.40 crore for the year ending 31st March 2006 in comparison to Rs. 29.06 crore for the previous period ending 31st March, 2005.

Equipment Specifications

S.No	Equipment	Parameter	Unit I	Unit II
1	**Crusher**	Make	L & T Ltd.	L & T Ltd.
		Type of Crusher	Single Rotor Impactor	Single Rotor Impactor
		Installed Capacity (TPH)	Not in operation	800
		Operating Capacity (TPH)	Not in operation	500
		Drive Rating (kW)	500	950
2	**Raw Mill**	Make	FLS, Atox 37.5 MPS4750B	Peiffer Germany,
		Type of Mill	Vertical roller mill	Vertical roller mill
		Installed Capacity (TPH)	180	300
		Operating Capacity (TPH)	225	370
		Type of Separator	Dynamic RAR 3S	Dynamic
		Drive Rating (kW)	1600	2710
		Fan Rating (kW)	1110	2400
		Product Fineness (Residue)	At 90µ- 13-18 % At 90µ-15 to 18 %	At 212µ- 1.8-3.0 % At 212µ- 1.8to 3.0 %
3	**Coal Mill**	Make	FLS	FLS
		Type of Mill	Vertical Roller mill	Vertical Roller mill
		Installed Capacity (TPH) With Coal	25	38
		Operating Capacity (TPH) With petcoke	10	20
		Type of Separator	Dynamic RAKM236	Dynamic
		Drive Rating (kW)	300	500
		Fan Rating (kW)	220	585
		Product Fineness (Residue)	At 90µ-2.5 to 3.5	At 90µ- 2.6 to 3.8

4	**Kiln**	Make Installed Capacity (TPD) Operating Capacity (TPH) Kiln dimensions No. of preheater stages Overall PH pressure drop (At fan inlet) PH fan rating (kW)	L & T ,FLS 1800 3250 dia -3.95 m, length-56 m 4 60 mbar static. 1600	KHD 3700 4500 dia-4.4 m, lenth-60 m 6, double string 60 mbar- kiln string 85 mbar- pyro string 1.1600 2.770
5	**Cooler**	Make Capacity(TPH) No. of cooler fans Cooler Area (m^2) Cooler Vent fan Rating (kW)	FOLAX 1800 7 72 225	KHD 3700 10 92 365
6	**Cement**	Make Type of Mill Installed Capacity (TPH) Operating Capacity (TPH) Type of Separator Drive Rating (kW) Fan Rating (kW) Product Fineness (Residue) Product Fineness (Blaine) m^2 /Kg	FLS Two chamber close ckt 140 170 SEPAX 3930 640 6% on 90μ-(OPC) 5% on 90μ-(PPC 300 (OPC) 320 (PPC)	KHD Single chamber close ckt.Ball mill, Roller Press. However this material is also feed to Unit –I. 210 275 V & SKS Separator 2 * 2400 1110 6% on 90μ-(OPC) 5% on 90μ-(PPC) 300 (OPC) 320 (PPC)

Specific Energy consumption (Typical Average)

S.No	Equipment	Parameter	Unit-I	Unit-II
1	**Crusher**	1. kWh / Ton of Raw material 2. kWh / Ton of clinker 3. kWh / Ton of cement	1.60 2.23 1.9	1.56 2.15 1.47
2	**Raw Mill**	1. kWh / ton of Raw material 2. kWh / Ton of clinker 3. kWh / Ton of cement	16.88 25.22 21.5	15.25 22.73 15.55
3	**Coal Mill**	1. kWh / Ton of clinker 2. kWh / Ton of cement	7.2 6.14	5.69 3.89
4	**Kiln**	1. kWh / Ton of clinker 2. kWh / Ton of cement	30.49 25.99	27.7 18.95
5	**Up to Clinkerisation**	1. kWh / Ton of clinker 2. kWh / Ton of cement	**65.14** **55.53**	**58.27** **39.86**
6	**Cement**	kWh / Ton of cement	28.57	24.26
7	**Packing Plant**	kWh / Ton of cement	1.05	1.31
8	**Total**	1. kWh / MT of clinker 2. kWh / MT of cement	**65.14** **85.16**	**58.27** **65.44**

Case Study 1

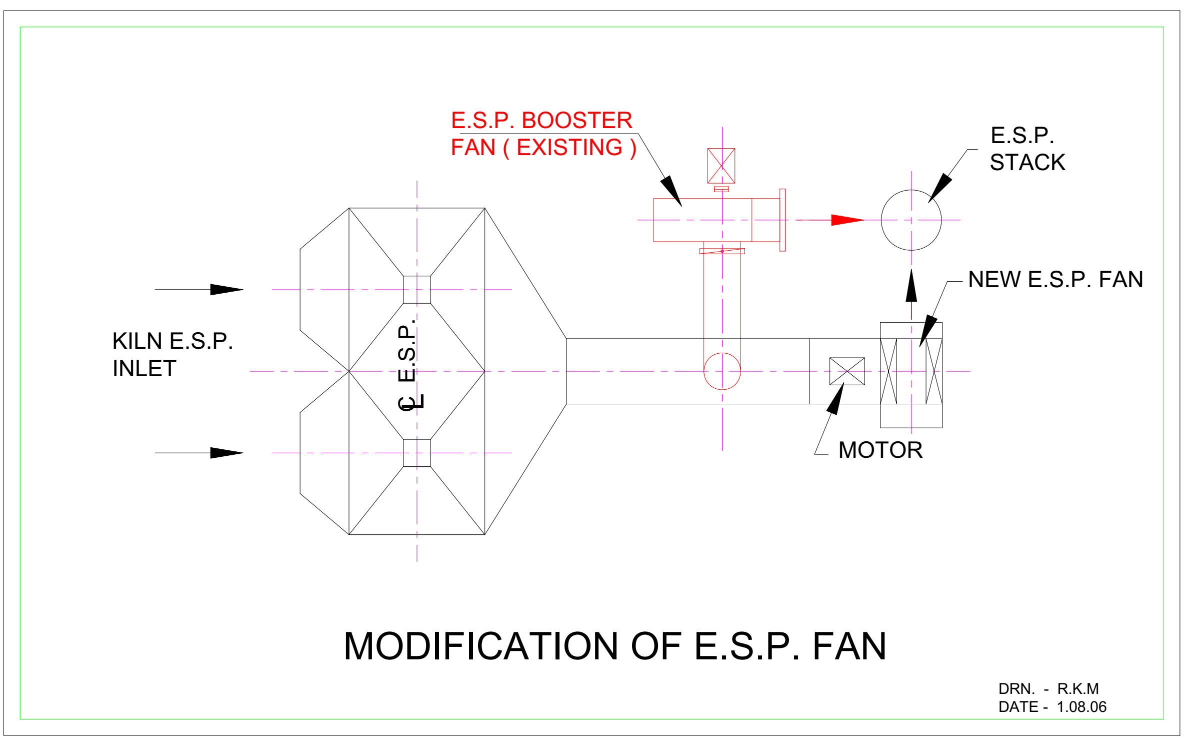
REPLACEMENT OF FAN BY THE ENERGY EFFICIENT FAN IN UNIT I

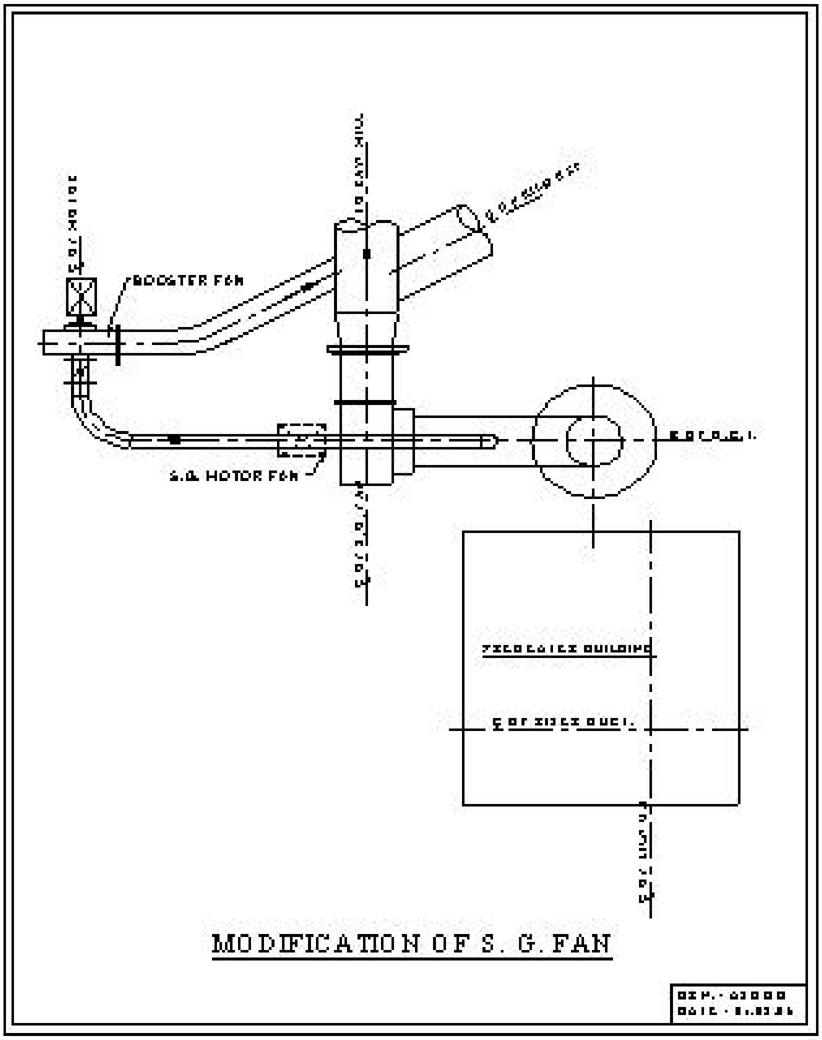
Background

M/s Shree Cement has always strived to improve its productivity through continuous adoption of latest technology and installation of energy efficient equipment. After Detailed energy audit SCL has decided to replace its smoke gas fan (SG fan -rated 1600 kW +Booster fan rated 640kW]) and ESP fan (ESP- rated 300 kW + PESP-rated 365 kW) with energy efficient fan. SG fan is modified with energy efficient single fan and removing booster fan. In another case ESP fan & PESP were replaced with an energy efficient ESP fan.

Status (Before and after modification):

Figure shown below after modification of the fans.





Description	Before	After	Saving
1. Power consumption by SG fan (kWh)	1736	1400	336
2. Power consumption by ESP fan (kWh)	441.1	288	156.1

Time frame for implementation: Project implemented in June 2006.

Major Suppliers were involved in implementing the project:

Overall cost economics:

Total power saving	=	492.1 kW / hr
Saving in kWh /Yr	=	3897432
Total amount saving (Rs per year)	=	Rs 17538444
	=	Rs 175.4 lac
Investment	=	Rs 110 lac.

Other benefits - environment, social,etc if any :

Green house gas emission is now major concern in the world. CO_2 is one of them. So adopting energy efficient project by SCL is not only saving energy but also reduce equivalent CO_2 emission.

Case Study 2

INSTALLATION OF TRIPLET CYCLONE IN UNIT II

Background

To further improve the efficiency of Pyro system, 3rd parallel cyclone (Triplet cyclone) was installed in the top stage of both strings to get relief from high pressure drop. Before installing triplet cyclone, the pressure drop across top stages of both strings were 130 and 135 mm WG (Kiln string & Pyro string respectively). After the modification, the pressure drop in the top stage cyclone was reduced by 35 mmWg in both the strings. The design and engineering support was provided by KHD and the fabrication was done at site with the help of Shree team.

Status (Previous and present)

Description	Before modification	After modification	saving
Pressure drop in kiln string mm WG	130	95	35
Pressure drop in kiln string mm WG	135	100	35

Time frame for implementation : Project has already implemented in 2006.

Major supplier involved : Engineering support from KHD-HW.

Overall Cost economics :

	Kiln String	Pyro String
Pressure drop saving (mm WG)	35	35
PH Fan Power saving, kW	32	45

Total Power saving	:	0.554 million / year
Total saving (Rs)	:	2.5 million /year
Cost of modification (Rs)	:	5.75 million

Other benefits

By reducing power consumption in other way reducing CO2 emission. By adopting this energy efficient project SCL reducing equivalent amount of CO2, therefore protecting environment.

Case Study 3

MODIFICATION IN CEMENT GRINDING SECTION

Background

Efficient operation and optimization studies at Shree Cement Ltd. in Cement Grinding sections have shown a significant effect on Power consumption, production and machine availability. The untiring efforts put in by the SCL team have resulted in the overall profitability of the plant which has also improved the performance of the product for better market captivity. The major optimization / modification jobs done in the cement mill circuit are:

1. Optimization of circulation factor in roller press circuit by increasing capacity of separator fan.
2. Close circuiting the tube mill for better quality & increase in production
3. Optimisation of grinding pressure of Roller Press
4. Optimisation of grinding efficiency in Roller Press
5. Optimisation of V-Separator guide vanes
6. Feeding two cement mills with single Roller Press

For optimization of any grinding circuit, it is important to study the history of the mill operation, mass flow and gas flow circuit, performance of the grinding system. A brief description of the modifications carried out in the cement grinding circuit is as follows:

Status (previous and present)

i) Adjustment of grinding pressure of Roller Press

One of the important factors which influence the performance of roller press grinding system is grinding force. The grinding Pressure is transferred from the hydraulic system via the floating roll to the material bed and absorbed in a stable, closed machine frame. The grinding pressure which has maintained at 90 bar was increased to 140 bar in steps. With this SCL was able to utilize maximum power of roller press i.e upto 1900 kW against the installed capacity of 2000 kW. This has improved the quantity and fineness of the mill feed. The effect of grinding pressures on Roller press performance is presented below:

Grinding Pressure, Bar	Roller Press, kW	Throughput, TPH	Mill I/L Blaine, m^2/kg
90	1250-1350	740-800	110
115-120	1350-1480	1000-1150	135
135-140	1700-1900	1200-1350	160

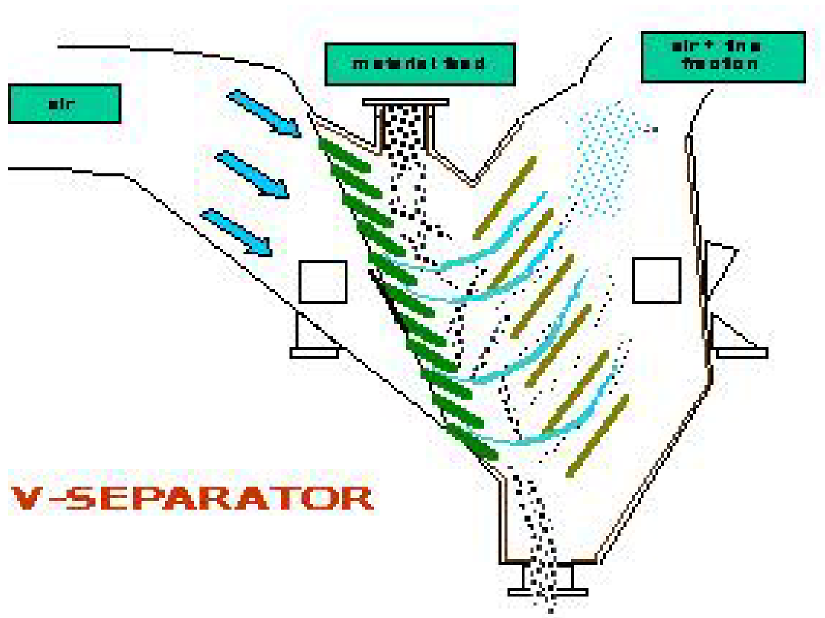
ii) Feeding to Roller Press

The efficiency of the Roller Press can be increased if the distribution of the feed samples is homogenous. SCL observed that the material distribution of feed samples to the Roller Press is heterogeneous. In order to take the advantage of increased grinding efficiency SCL has adjusted the feeding device to the Roller Press in order to check feed which ensured better distribution of material at feeding point resulting in better grinding efficiency.

iii) Optimization of V-Separator Vanes

The V-Separator is a purely static separator comprising of stepped grate for guiding feed material. Separation is achieved whilst feed material cascades down over the series of steps to a cross flow of air. The air extracts the fine fraction and transports it upward through a row of classifying channels.

In V-Separator SCL found at higher output some of the finer particles falls down which enters the roller press thereby reducing the efficiency. SCL team studied the process parameters and to overcome the problem SCL increased the velocity of the air. This was achieved by providing baffle plates in the entry of air passage and some dummy plates at the top most portion of the separator. Thus air flow in the V-Separator is maintained at higher velocity which prevented the dropping of finer particles at higher output.



iv) Feeding two Cement mills with Single Roller Press

Roller press in Cement mill is used for higher production, lower power consumption and better quality of cement due to better distribution of particle size. After thorough investigation SCL team explored the possibility to use the crushed material from KHD-HW roller press installed in cement mill –II to cement mill-I.

In this fresh feed is fed in to the roller press though a V Separator. The throughput from the Roller press is divided and a portion of roller press slabs are fed into the ball mill of cement mill circuit I while the remaining gets recirculated in cement mill circuit II. By means of this the grindability of the feed to cement mill I gets reduced so the ball mill can give increased output than installed. Moreover the product Blaine is also improved. The specific energy consumption of the combined circuit is also very satisfactory.

The roller press supplied by KHD-HW is working efficiently for the combined circuit which was installed for a single circuit.

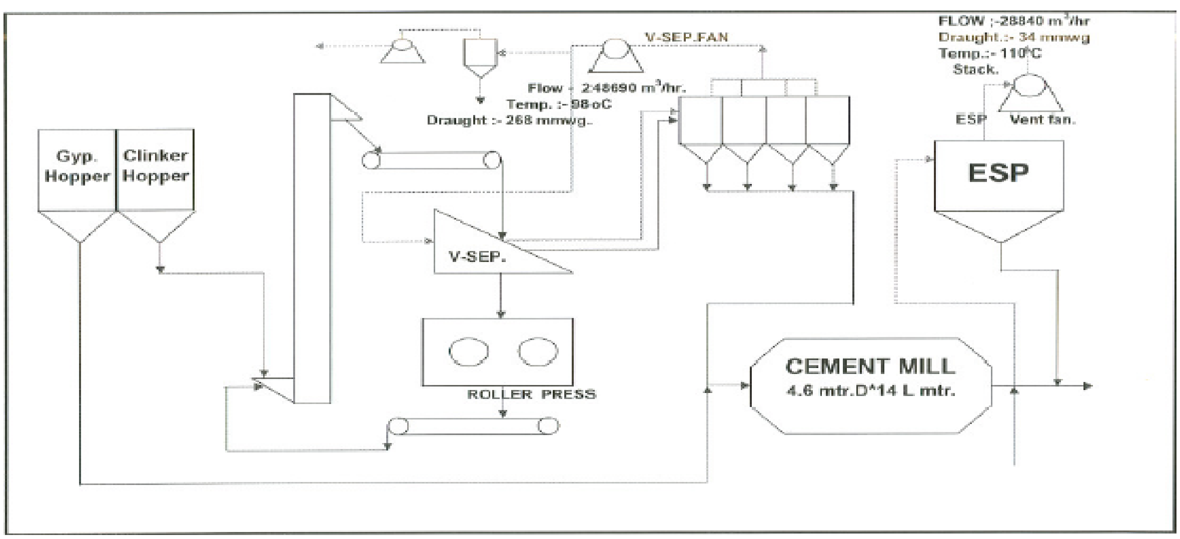
The results of operation are summarized below

Description	Before	After
Avg. Cement mill I, TPH	118	147
Avg. Cement mill II, TPH	213	211
Blaine in Cement mill I, m2/kg	320	340
Overall kWh/t in both mills	32.29	29.98

Saving in energy consumption : 2.31 kWh/t of cement
Increase in Output : 27 TPH
Yearly saving : Rs 2.74 Millions per annum

v) *Close circuiting of Cement mill*

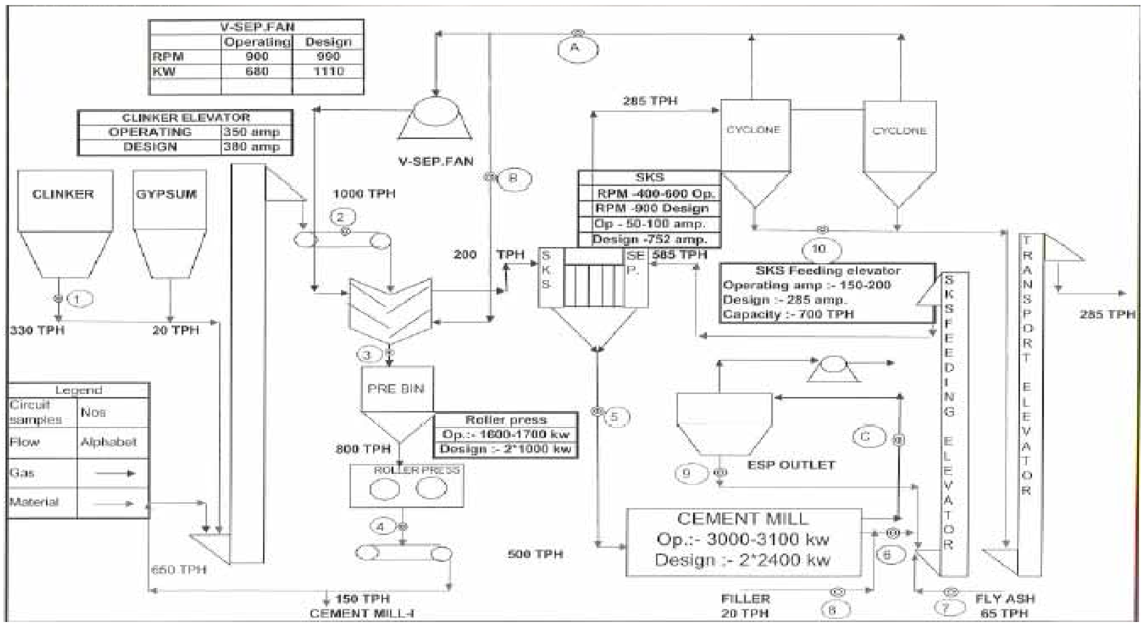
The cement mill was installed with Ball mill in open circuit in year 1997 The cement grinding circuit was installed as single chamber open circuit with V-Separator. Process Parameters of Cement Mil – II before Close Circuiting.



The fines classified from V-Separator are then introduced in the battery of four cyclones where solids are separated from air stream and then fed to ball mill. In order to increase the output and also at reasonable energy consumption, SCL was thought about of close circuiting the Ball mill.

Study was conducted jointly by KHD – HW and Shree Cement the feasibilities to increase the production and the performance of cement mill II which was running in open circuit and they suggested to modify by close circuiting the mill with SKS Separator in S-type circuit. By this, the fines classified from V-Separator are fed to SKS separator where fines are separated and rejects are fed to ball mill.

Process Parameters of Cement Mil – II after Close



Circuiting

This reduces the load on the ball mill and the mill discharge is recirculated to SKS separator which results in improved production with satisfactory energy consumption. This circuit was modified in the month of Feb 2006. The output increased more than the expected figure of 6% (16 TPH) as envisaged to above 7.5 % (20 TPH) over the present output.

Benefits

	Before	After
Capacity, TPH	255	275
Power, kWh/t cement	22.5	21.5

Increase in Capacity : 20 TPH

Decrease in Specific energy consumption : 1.0 kWh/t of cement

c) Time frame for implementation : Project already implemented in 2006.

d) Major Supplier involved : KHD -HW

e) Other benefit : By reducing power consumption in other way reducing CO2 emission. By adopting this energy efficient project SCL reducing equivalent amount of CO2. Therefore protecting environment.

Projects Implemented during 2003-04

Sl No	Title of project	Annual electrical savings		Investments Rs. Million
		Units Million	Rs Million	
1.	Modification of 1 cement mill	4.46	11.16	11.42
2.	Installation of Booster Fan for V-Separator for cement mill II	0.13	0.33	0.71

Projects implemented during 2004-05

Sl No	Title of project	Electrical savings		Thermal savings		Investment Rs. Million
		Units Million	Rs Million	Tons Coal	Rs Million	
1.	Installation of third cyclone Preheater unit II	0.6	1.2	2583	8.47	5.75
2.	Upgradation of cement mill- I					
3.	Installation of centrifugal Water pump in place of screw pump at Raw mill-II	0.03 3.35	0.06 6.67	0 0	0 0	0.1 9.9
4.	Conversion of motors Connections from Delta to Star	0.19	0.38	0	0	0.01

Projects implemented during 2005-06

Sl No	Title of Project	Electrical energy savings		Investment Rs Milion
		Units Million	Rs Million	
1.	Retrofitting of fans : Raw Mill-I, Coal Mill vent fan - II, Cement Mill Vent Fan-II	2	8.4	5.9
2.	Close Circuiting of Cement Mill	6.73	28.3	52.5
3.	Down comer ducts water spray system for kiln & Pyro strings Unit II	16.6	69.8	6.3
4.	High efficiency dust collector fans	0.3	1.2	2.2
5.	Upgradation of limestone handling system	0.2	0.9	9.5
6.	Energy saving from cooler fan by installing VFC drives	0.2	0.9	9.5
7.	Energy saving from cooler fan by installing VFC drives	0.95	3.99	2.45

ULTRATECH CEMENT LIMITED, TADIPATRI

UltraTech Cement Limited, a subsidiary of Grasim Industries Limited, a group company of Aditya Birla Group is a leading manufacturer of cement in India with installed capacity of about 17 Million Tonnes Per Annum (MTPA).

UltraTech's cement plants are located in Maharashtra (Awarpur), Chattisgarh (Hirmi), Gujarat (Kovaya) and **Andhra Pradesh (Tadpatri),** NCCL(Jafarabad) with grinding units at Orissa (Jharsuguda), TamilNadu (Arakkonam), West Bengal (Durgapur), Gujarat (Magdalla) and Maharashtra (Ratnagiri). It has three Bulk Cement Terminals, two in India and one in Sri Lanka. The two cement terminals in India are located at Navi Mumbai and Mangalore whereas the terminal in Sri Lanka is located at Colombo.

Aditya Birla Group Cement Business both Grasim & UltraTech put together having 10 integrated cement plants (18 kilns), 7 cement Grinding units, 7 ready mix plants, and 5 cement terminals(one Overseas).

Grasim Industries Installed capacity : 14.11 MTPA
UltraTech Industries installed capacity : 17.00 MTPA

Total : 31.11 MTPA

Grasim – UltraTech combine is one of the largest cement producer in India & 8th largest producer in the world. Grasim – UltraTech holds 21% of installed Indian capacity.

Group Vision

To be a premium global conglomerate with a clear focus on each business.

The Aditya Birla Group

The Aditya Birla Group is India's first truly multinational corporation. Global in vision, rooted in Indian values, the Group is driven by a performance ethic pegged on value creation for its multiple stakeholders. A US$ 8.3 billion conglomerate, with a market capitalization of

US$ 14 billion, it is anchored by an extraordinary force of 82,000 employees belonging to over 20 different nationalities. Over 22 per cent of its revenues flow from its operations across the world. The Group's products and services offer distinctive customer solutions. Its 72 state-of-the-art manufacturing units and sectoral services span India, Thailand, Indonesia, Malaysia, Philippines, Egypt, Canada, Australia & China.

A premium conglomerate, the Aditya Birla Group is a dominant player in all of the sectors in which it operates. Such as viscose staple fibre, non-ferrous metals, cement, viscose filament yarn, branded apparel, carbon black, chemicals, fertilisers, sponge iron, insulators and financial services.

Andhra Pradesh Cement Works (APCW)

To meet the southern market demand, UltraTech is operating 2.7 MTPA cement plant near Bhogasamudram village in Tadipatri Mandal in Anantapur district of Andhra Pradesh. This plant is referred to as Andhra Pradesh Cement Works (APCW). The Unit's turn over is around Rs. 500 crores and mostly cater to south Indian market mainly. It is ideally located as far as the market is concerned. It is, in fact, almost equidistant from three major cities in the south – Hyderabad, Bangalore and Chennai and will cover Karnataka, Tamil Nadu, Kerala and Goa in addition to Andhra Pradesh. APCW serves approx. 11% of south Indian market.

The finished product is sold through the Marketing department, which has wide dealer network. This Cement Plant has adopted many latest technologies during its installation:

- The Cement plant has been engineered with world leaders in cement Technology from FLSmidth, Denmark. Critical Machinery have been imported.
- L &T has supplied majority of the equipment. Cement plant is fully automated and is Centrally controlled by process Computers linked to the plant machinery.
- It has two raw mills having a roller diameter of 5 m. called Atox 50 mills, these are the two biggest mills in the country and first of its kind.
- It has a covered circular limestone store of 95-m dia with a stacker-reclaimer for feeding limestone to two raw mills simultaneously. This system with a storage capacity of about 45,000 m3 is the largest in the country, and one of the few limestone stacker-reclaimers of such huge storage capacity in the world.

- The RCC chimney at the plant is the tallest in the Indian cement industry of 142 meter height.
- The production unit and the packing plant have been located at different elevations. Plant is located at the hill top (351.5 m.MSL) and Packing plant & wagon tippler are Located at foot of hill (266.0 m.MSL).

The other state-of-the-art Equipment and facilities installed at APCW are:

- A large size single-stage limestone crusher with a maximum capacity of 1,300 tph
- Continuous storage-cum-blending controlled-flow raw meal silo of 22.4 m dia and 60 m height of capacity 30,000 tonnes for continuous feeding to the kiln with uniform and homogenised kiln feed.
- 8,000 tonnes per day kiln equipped with six-stage double-stream pre-heater cyclone system.
- The plant is equipped with vertical coal mill of capacity 71 TPH combining drying, grinding and classifying operations in one unit.
- Two clinker storage silos – one of 65 m dia with a capacity of 150,000 tonnes and the other of 40 m dia having 57,000 tonnes capacity.
- The two roller presses in APCW for grinding clinker provide an advantage with respect to specific power consumption and the seven cement storage silos each with a storage capacity of 6,000 tonnes help in dispatching different varieties of cement as per the market requirement.
- Six electronic packers are installed for packing cement in bags. Packing plant can load a full rake in one go as the wagon loading platform has a length of 650 m and is equipped with eight wagon loading machines each having three modules. Two rakes can be placed simultaneously one on either side of the platform. Also, facilities for simultaneous loading of cement bags into four trucks including trailers are available. The packing plant siding has nine railway lines for wagon shunting/parking for receiving coal and dispatching cement.
- In view of the anticipated power shortage in future, APCW is provided with
- two diesel generator sets of 23.74 MW (i.e., 2 x 11.87 MW) which is around
- 60% of total power requirement of the plant.

- APCW is ISO certified, ISO 9001:2000 for Quality Management system, ISO
- 14001:2004 for Environmental Management & OHSAS 18001 for Occupational Health & safety management system.

Awards & Recognitions

1. Best Management Award from Ministry of Labour, AP GOVT 2001-02
2. Appreciation Award from NSC for achieving OHSAS -18001 2001-02
3. Best rural development effort Award from FAPCCI 2001-02
4. FIMI environment Award for MINES 2002-03
5. "Energy Efficient Unit" Award by CII in National Award for Excellency in Energy Management DEC'2002
6. Excellence Award in Water Conservation & Pollution control by APPCB 2002-03
7. Exemplary Work in Energy Conservation in Medium Project Category organized by Petroleum Conservation & Research Association JAN'03
8. Innovation in SHE performance Award from CII 2004-05
9. "Energy Efficient Unit" Award by CII in National Award for
10. Excellency in Energy Management Aug'2004
11. Winner in Process Category in Ist National Energy Convention Organised by Andhra Pradesh Productivity Council Jul'2005
12. Best Management Award from Ministry of Labour, AP GOVT 2005-06
13. Excellence in Energy Efficiency in National Award for Excellence (04-05) in Energy Management organized by CII Oct'2005
14. Best Thermal Energy Performance First in for best Thermal energy (04-05) organized by NCCBM, New Delhi Nov'2005

15. "Water Efficient Unit" National Award for Water Management (05-06) organized by CII
16. "Best Innovative project for WHRU' in National Award for Excellence in Energy Management organized by CII Aug'2006
17. "Energy Efficient Unit" Award by CII in National Award for Excellency in Energy Management Aug'2006

Equipment Specifications

Sl No	Equipment	Parameter	1
1	Crusher	Make Type of crusher Installed Capacity (TPH) Operating Capacity (TPH) Drive rating (kW)	**HAZEMAG** **APPM 2022** **1200** **1300** **950**
2	Raw mill	Make Type of mill Installed Capacity (TPH) Operating Capacity (TPH) Type of separator Drive rating (kW) Fan rating (kW) Product fineness (Residue)	**FLS** **ATOX 50** **265** **325** **RAR 50** **4100** **3200** **20-23% ON 90 MICRON**
3	Coal mill	Make Type of mill Installed Capacity (TPH) Operating Capacity (TPH) Type of separator Drive rating (kW) Fan rating (kW) Product fineness (Residue)	**FLS** **ATOX 50** **70** **72** **RAKM 32.5** **950** **950** **14% ON 90 MICRON**
4	Kiln	Make Installed Capacity (TPD) Operating Capacity (TPD) Kiln dimensions No.of pre-heater stages Overall PH Pressure drop (At fan inlet) PH fan rating (kW)	**FLS** **6500** **8000** **75*4.75** **6** **650-700 for KS** **Fan** **700-750 for CS Fan** **2400 CS Fan** **1425 KS Fan**

Sl No	Equipment	Parameter	1
5	Cooler	Make	**FLS COOLAX**
		Capacity	**8000**
		No.of cooler fans	**16**
		Cooler Area	**141 SQ M**
		Cooler vent fan rating	**585**
6	Cement mill	Make	**FLS**
		Type of mill	**2*UMS 42*11**
		Installed Capacity (TPH)	**161**
		Operating Capacity (TPH)	**145**
		Type of separator	**SEPAX**
		Drive rating (kW)	**2*1425**
		Fan rating (kW)	**525**
		Product fineness (Residue)	
		Product fineness (Blaine) m^2/kg	**300-330**

Specific Energy Consumption (Typical Average)

Sl No	Equipment	Parameter	KWH/T.CEM
1	Crusher	Crusher Main Motor	**0.57**
		Crusher Auxiliaries	**0.55**
		Subtotal SEC	**1.12**
2	Raw mill (I+II)	Raw Mill Main Motor	**11.03**
		Raw Mill Circulating Fan	**7.23**
		Separator	**1.92**
		Raw Mill Auxiliaries	
		Subtotal	**20.27**
3	Coal mill	Coal Mill Main Drive	**1.04**
		Coal mill Vent fan	**1.26**
		Coal Mill Booster Fan	**0.48**
		Coal Mill Separator	
		Coal Mill Auxiliaries	
		Raw Coal transport	**0.23**
		Coal Stacker/reclaimer	**0.2**
		Subtotal	**3.21**
4	Kiln	Kiln Main Drive	**1.89**
		PH Fan	
		a. KS Fan	**3.39**
		b. CS Fan	**4.47**
		Coal Firing	**0.74**
		Kiln feed & Other Auxiliaries	**2.24**
		Bag House Fan	
		a. Bag House Fan	**2.49**
		b. Reverse Air Fan	
		Cooler Fans	**4.57**
		Cooler Vent Fan	**0.47**
		Subtotal	**20.26**

Specific Energy Consumption (Typical Average)

Sl No	Equipment	Parameter	KWH/T.CEM
5	Up to clinkerisation	kWh / MT of clinker	**54.24**
6	Cement mill	Cement Mill Main drive Cement Mill Fan Roller Press Cement Mill Auxiliaries Subtotal	**17.02** **3.67** **7.08** **5.75** **33.53**
7	Packing plant	Packing Plant & Auxiliaries	**0.98**
8	Auxiliaries	Colony Factory Lighting Transformer&dist losses Misc.loads CCR Water Pumping System	**0.7** **0.44** **0.79** **0.95** **0.26** **0.74**
8	Total	kWh / MT of clinker kWh / MT of Cement	**58.93** **83.67**

Heat Balance (Typical Average)

Heat input

Date	**07-10-06**
Clinker production(tph)	**8000**
	Heat(kcal/kg clink)
Heat in primary air	0.43625
Heat in cooler air	22.2
Heat in kiln coal conv air	0.181
Heat in PC coal conv air	0.279
Heat in Kiln feed	24.1
Heat of combustion of coal	**685.13**
Heat output	
	Heat(kcal/kg clink)
Heat in KS exit gases	53.8
Heat in CS exit gases	88
Heat in cooler vent air	106.77
Heat of formation of clinker	397.01
Heat in clinker leaving cooler	23
Heat in dust	9.55
Heat to evap of moisture	2.2
Radiation losses	52
Total	732.33

Case Study 1

BAG HOUSE FAN OUTLET DUCT BAFFLE PLATES MODIFICATION

Background

Ultratech Cement, Tadipatri operates with a Reverse Air Bag House (RABH) for duct collection in the kiln and raw mill section. The RABH fan was operating with Slip Power Recovery System (SPRS) for fan control during the normal operation of the plant. During the normal operation, the RABH fan speed is controlled and the normal speed of operation is between 70% and 90% of the full speed of the fan.

However during the light-up period of the kiln, the RABH fan was observed to operate at speed of 70% and with damper opening of only 5%. At this condition, the RABH fan outlet duct used to operate with heavy vibrations due to resonance.

To control the vibrations, 2 numbers of baffle plates of size 3 m x 1 m has been introduced in the system. After installing the baffle plates, the system resistance was observed to have increased in the duct and during the normal operation of the fan, it was observed to consume a significantly higher power consumption of about 1.5 kWh / Ton of clinker.

Energy saving project

To avoid the duct vibrations during the initial start up, SPRS limit was lowered to 67% from 70% earlier. At this lower speed, the damper opening was also increased from 5% to 15%. Due to this, the vibrations in the duct were also significantly reduced. Later, at the next available opportunity, the baffle plates were removed which has immensely reduced the system resistance.

Benefits

While the plant was started, the RABH fan was observed to operate with lower power consumption by about **2 kWh / Ton** of clinker.

This has resulted in reduction in power consumption by 620 kW / hr

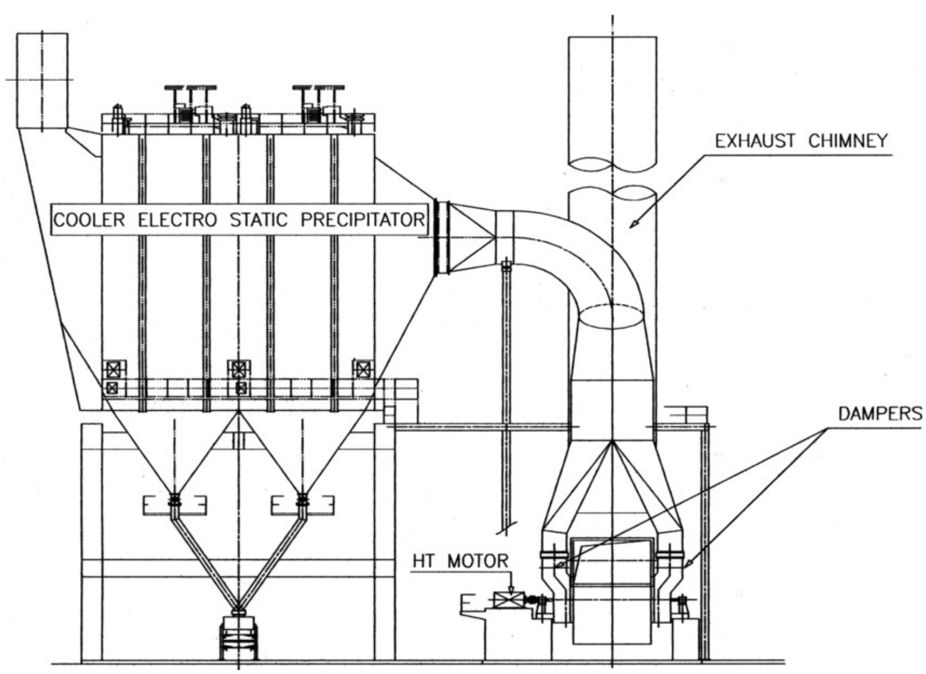
Case Study 2

OPTIMIZATION OF CLINKER COOLER ESP FAN

Background

The clinker cooler ESP fan was operating with Slip Power Recovery System (SPRS) for speed control. While the full speed of the fan is 475 rpm, the minimum speed of operation with SPRS control was 335 rpm. The further control of the clinker cooler ESP fan was controlled by a damper. The damper inlet pressure was measured to be -38 mm WC while the pressure after the damper was -48 mm WC. This resulted in 10 mm WC pressure drop across the damper.

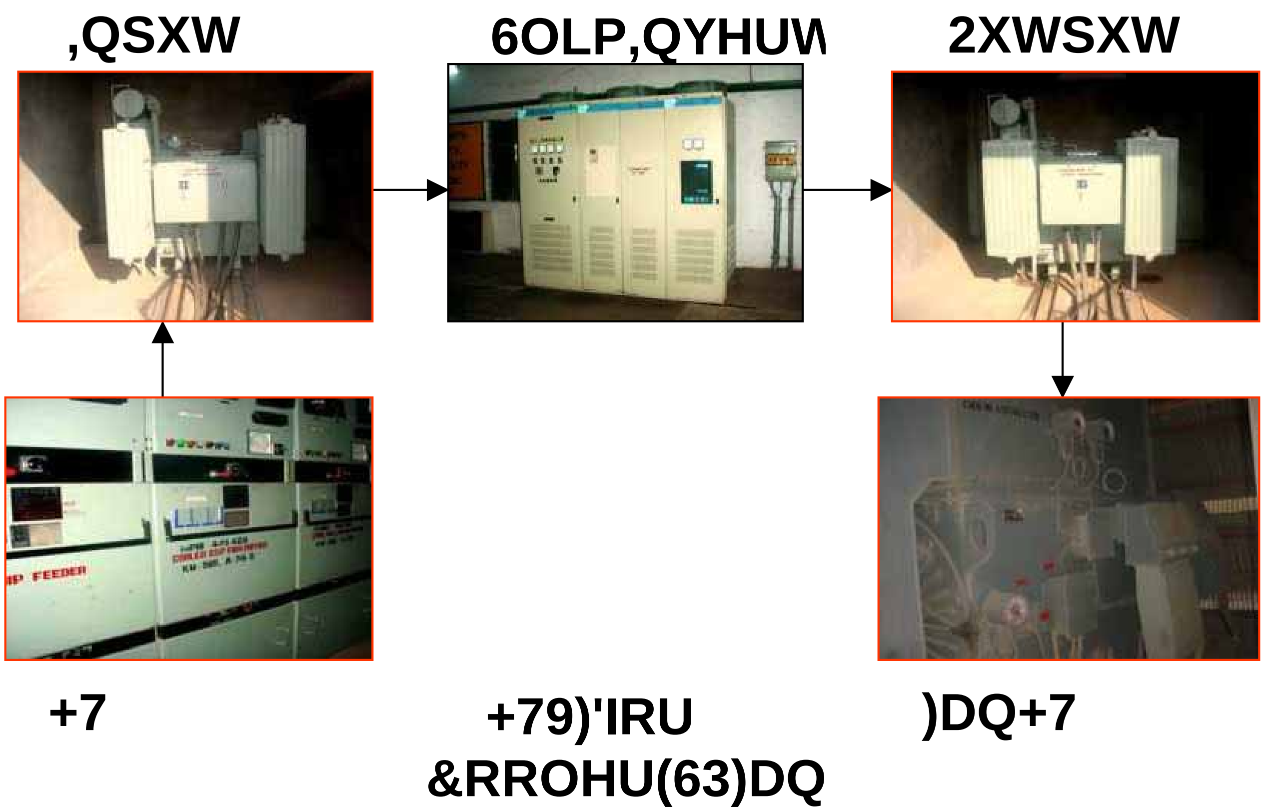
The power consumption of the clinker cooler ESP fan was 190 kW. After the SPRS recovery of 50 kW, the net power consumption of the clinker cooler ESP fan is 140 kW.



Energy saving project

To reduce the power consumption of the clinker cooler ESP fan, the plant team decided to install HT Variable Frequency Drive (VFD) to the fan. After commissioning the VFD, the clinker cooler ESP fan operates with 50% rated speed with 100% damper opening.

The damper loss has been minimized and the control of the fan had been on speed control.



Benefits

Implementing this energy saving project resulted in annual energy saving of **Rs. 12.0 Lakhs.** This called for an investment of **Rs. 35.0 Lakhs** and had a simple payback period of less than **3 years.**

Projects implemented in Ultratech cement, Tadipatri (2003-06)

Energy Saving Projects	**Saving, Rs. Lakhs**	**Investment, Rs. Lakhs**	**Payback, Months**
Improvement in Sepax fan	25	40	19
VFD			
Reverse air fan	24.8	9	4
Cooler fan -7 & 8	21.7	18.4	10
Peter silo JPF Fan	7.7	5.2	8
Raw meal feed RBC (R1J04 & R2J04)	6.2	1	2
Cement Mill ESP Fan (Z1P50 & Z2P50)	5.2	4.3	10
Kiln shell cooling fans 3	3.4	7.5	26
Dosimate filter fan ZIP15 & Z1P25	2	3.5	21
Raw mill main motors blower	1.6	3	23
Roller press dedusting fans	1.4	3.5	30
Z1P20 & Z2P20			
Packing plant compressor	1.3	4	37
CF silo aeration blower	0.9	1.2	16
Raw mill reject circuit dedusting	0.6	2.7	54
Fans (R1P95 & R2P95)			
CF silo JPF	0.5	1.5	36
Cooling Water Pump CCR A/C	0.2	1.5	90
Chilled Water Pump CCR A/C	0.2	1.2	72
Pressure drop reduction			
Modification in CS 3rd & 5th Cyclone Riser Duct Roof	12.4	10.6	10

Projects implemented in Ultratech cement, Tadipatri (2003-06)

Energy Saving Projects	Saving, Rs. Lakhs	Investment, Rs. Lakhs	Payback, Months
Installation of dedusting clone in Kiln string 2nd Cyclone	7.7	6.5	10
Increasing the kiln down comer duct dia from 2.5 mtr to 2.8 mtr	4.6	52	136
Compressed air system			
Installation of Godrej Optimiser for compressor	3.1	3.8	15
Merging of poking air with main compressor air grid to reduce unloading hours	9.1	0.7	1
Installation of new compressor for LS crusher	0.3	0	0
Provision of 2 bar compressed air line in place of 5 bar compressed air line for packing plant aeration	5.9	0.1	1
Providing individual SV for all spout aeration to stop air during OFF condition in Packer- 6	0.1	0.1	12
Interlock			
Reduction in packer idle running	1.9	0.1	1
Reduction in bulk cement loading idle running	0.4	0	0
LDO ring main pump stopping during HFO operation	0.7	0	0
Introducing time bound interlocks	8	0	0

Projects implemented in Ultratech cement, Tadipatri (2003-06)

Energy Saving Projects	Saving, Rs. Lakhs	Investment, Rs. Lakhs	Payback, Months
Fan optimisation			
Modification of Raw Mill Fan 1 & 2 Inlet Suction Box	18.6	11	7
Trimming of raw mill 1& 2 Fan Impeller by 70 mm	31	0.1	1
Widening of speed range of CS fan SPRS from 78% to 75%	10.8	0.1	1
Introducing energy saving mode of operation for cooler fans	5.3	0	
Voltage optimisation			
Voltage drop reduction in RM MCC 3.4 & MCC 3.3	0.2	0.2	12
Voltage reduction in PP Transformer	1.5	0	0
Voltage drop reduction CCR building MCC	0.4	0	0
Voltage optimization	8.5	0	0
Reduction in tap position of transformers at cement mill	4.7	0	0
Reduction in Voltage drop CM MCC-5.2	0.5	0	0
Switching off of one distribution transformer at raw mill	1.6	0	0
Electrical heating			
Provision of Heater in RM gear unit avoid the idle running	4.6	0	0
Switching off electric heat tracing system for HFO separator	0.3	0	0

Projects implemented in Ultratech cement, Tadipatri (2003-06)

Energy Saving Projects	Saving, Rs. Lakhs	Investment, Rs. Lakhs	Payback, Months
Removal of Rawmill hydraulic unit heating element	0.6	0	0
Belt conveyors			
Removal of counter weights from coal transport conveyors	0.4	0	0
Reduction in counter weight in RBC at LSC	1.5	0	0
Up gradation of drives			
Water pump from 30 kW to 45 kW to avoid the running of 75 kW pump when only Kiln & one CM is operating	1.6	0	0
Coal belt conveyor motor from 160kW to 200kW resulted in reduction of slag unloading Hours	1.5	0	0
Equipment elimination			
Bypass chute for bulk clinker loading reversible belt conveyor [U1U22]	0.6	0.2	4
Provision of coal crusher bypass chute for slag unloading to avoid running of coal crusher	1	0.1	1
Modification in the ducting for stopping of 2nos 30kw JPF Fans	2.8	0.1	1

VASAVADATTA CEMENT, SEDAM

A product of the prestigious **BK Birla Group** of Companies, Vasavadatta Cement stands for everything that is unique and above the ordinary. Builders over a short span of time have recognized our quality, strength and technology, which clearly has become a tradition, translating into relationships strong and cemented. Ours is an ISO 9001 Company, which goes on to prove the faith and trust Vasavadatta has built with our clientele and builders.

Vasavadatta Cement is a state-of-the-art Cement Plant of 2.45 MTPA located at Sedam in the state of Karnataka, India.

The products of Vasavadatta Cement are 43 grade Vasavadatta super, 53 grade Vasavadatta Gold and PPC Birla Shakti .

Line –1 of the cement plant was conceived in the year 1983 – 84 & Line-2 in the year 1997. Both plants supplied by world known M/s Krupp Polysius,Germany. Plant is based of Dry process Precalciner Technology.

In the year 2005-06, Vasavadatta cement had a Turnover of Rs. 517.94 crores.

Vasavadatta Cement is now in the process of installing 1.6 MPTA Line-III & total capacity will be plus 4.0 MPTA by Nov – 2006.

Vasavadatta Cement has got it's own two power generation stations of 15.7 MW & 9.5 MW capacities. Line – III of capacity 18.0 MW is under erection.

Cement being highly Energy Intensive Industry, Energy conservation has been a constant endeavor at Vasavadatta Cement by regular Energy Audits & Continuous monitoring of Energy Consumption.

Equipments specifications at Vasavadatta Cements

S.No.	Equipment	Parameter	Line-1	Line-2
1	**Crusher**	Make Type Installed Capacity Operating Capacity Drive Rating	Hazemag Impact type crusher 800 tph 800 tph 1000 Kw	
2	**Raw Mill**	Make Type Installed Capacity Operating Capacity Type of Separator Fan Rating Drive Rating Product Fineness	Polysius VRM 140 tph 145 tph Static 1200 kw 2000 kw 28-29 / 8.5 – 9.0	Polysius VRM+Ball Mill 210+50 tph 270 tph Dynamic 2000 kw 2850 kw 28.5 –29.5 / 8.5-9.5
3	**Coal Mill**	Make Type Installed Capacity Operating Capacity Type of Separator Fan Rating Drive Rating Product Fineness	Polysius VRM 19 tons 17 – 19 tons Static 215 kw 315 kw 14.5 / 0.8 Main 19.5 / 1.6 PC	Polysius VRM 26 tons 22 – 26 tons Dynamic 350 kw 400 kw 14.5 / 0.8 Main 19.5 / 1.6 PC
4	**Kiln**	Make Installed Capacity Operating Capacity Kiln Dimension No. of Pre heater Stages Overall pre heater pressure drop Pre heater fan rating	Polysius 1500 TPD' 2400 TPD L / D 56 / 3.8 05 500 mmWG 1200 kw	Polysius 2000 TPD 3500 TPD L / D 60 / 4.0 05 550 mmWG 1500 kw

Equipments specifications at Vasavadatta Cements

S.No.	Equipment	Parameter	Line-1	Line-2
5	**Cooler**	Make	Polysius IKN	Polysius IKN
		Capacity	43.89 tons/m2	53.07 tons/m2
		No. of cooling fans	07	08
		Cooler area	52 m2	65 m2
	fan rating	Cooler vent	132 kw	250 kw
6	**Cement Mill**	Make	Polysius	Polysius
		Type	Dubble chamber close circuit	Poly com with single chamber close circuit
		Installed Capacity	140 tph	190 tph
		Operating Capacity	150 tph	210 tph
		Type of Separator	Sepol	V – sep & Sepol Sep
		Drive Rating	2475 *2	2200 *1
		Product Finesse (Residue)	4 – 5 % on 90 Mic	1.9 – 2.0 on 90 Mic
		Product Finesse (Blane)	260 – 270	260 – 270

Specific Energy Consumption (Typical Average)

S.No.	Equipment	Parameter	Line-1	Line-2
1	Crusher	Crusher main motor	0.622	
		Crusher Auxiliary	0.321	
		Subtotal SEC	0.943	
		Kwh/ton of material	0.94	
		Kwh/ton of clinker	1.31	
		Kwh/ton of cement	1.26	
2	Raw Mill	Main motor	8.552	7.357
		ESP Fan	8.552	6.274
		Separator	-	0.171
		Ball Mill	-	4.011
		Mill Auxiliary	1.655	2.205
3	Coal Mill	Main Drive	12.308	11.256
		CA Fan	8.205	10.728
		Separator	-	0.528
		Mill Auxiliary	5.128	2.99
4	Kiln	Main Drive	1.333	1.857
		Pre Heater fan	8.095	7.143
		ESP	0.952	1.571
		Booster fan	0.667	0.643
		Cooler fans	3.233	2.429
		Cooler Vent fan	0.476	0.464
		Kiln auxiliary	3.810	6.000
5	**Up to Clinkerisation**	**Kwh / MT of clinker**	**52.62**	**55.70**

Specific Energy Consumption (Typical Average)

S.No.	Equipment	Parameter	Line-1	Line-2
6	Cement mill	Main drive	20.313	10.7000
		separator fan	1.625	0.800
				1.700
		Separator	0.750	0.650
		Roller Press-1	-	3.400
		Roller Press –2	-	3.165
		Mill Auxiliary	1.906	3.300
7	Packing plant Auxiliary	Packing plant & 1.141	1.531	
8	Auxiliaries	Colony	0.743	0.643
		Water pump system	0.794	0.893
9	**Total**	**Kwh/ton of clinker**	**52.62**	**55.70**
		Kwh / ton of OPC	**78.15**	**78.65**
		Kwh / ton of cement	**66.77**	**76.72**

Case Study 1

BODY MODIFICATION IN RAW MILL II

Background

Vasavadatta Cement, Sedam has installed a vertical roller mill and ball mill combination for its raw material grinding in cement manufacture. The equipment specifications of the raw mill section are as under:

Make	Polysius
Type	VRM+Ball Mill
Installed Capacity	210+50 tph
Operating Capacity	270 tph
Type of Separator	Dynamic
Fan Rating	2000 kw
Drive Rating	2850 kw
Product Fineness	28.5 –29.5 / 8.5-9.5

During the course of operation, it was observed that there was internal recirculation due to low velocity of air inside the mill.

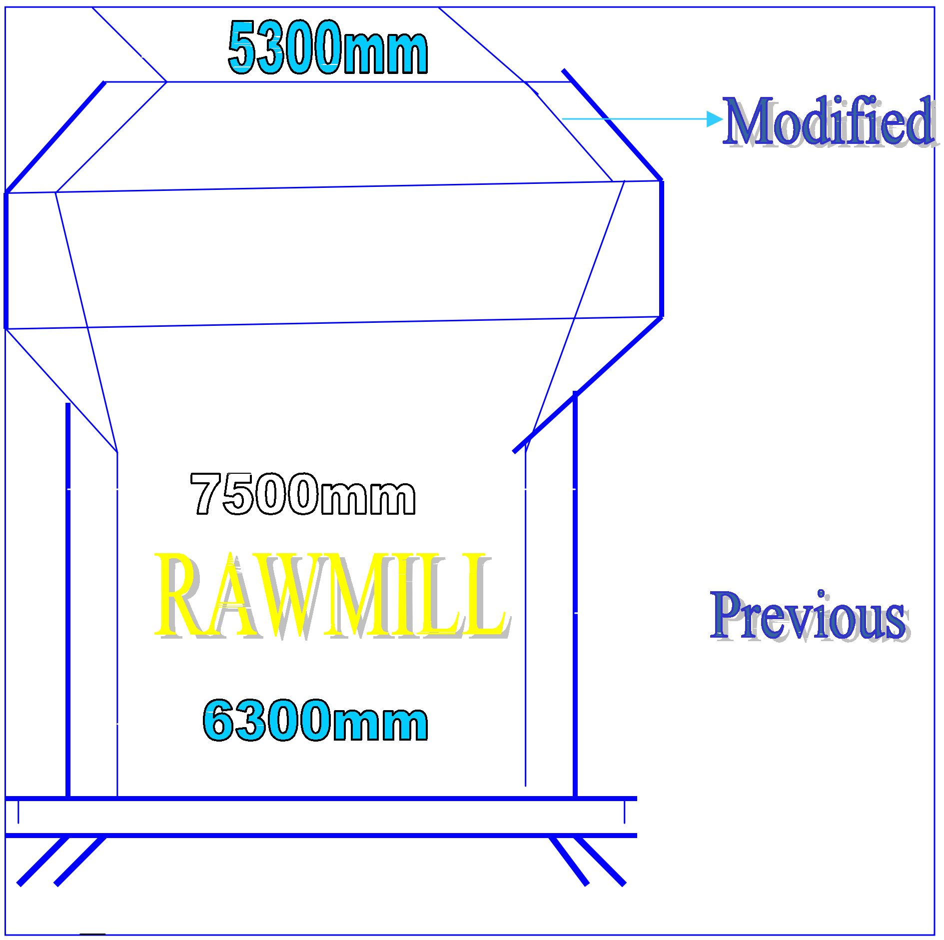
Energy saving project

The mill internal area was reduced. This has increased the velocity inside the mill. Increase of air velocity in the mill has resulted in reduced mill internal recirculation.

This has resulted in an increase in the mill output from 255 TPH to 275 TPH, an increase of 20 TPH. The power saving achieved by lowering the mill area had been observed in the ESP fan also. This was achieved by reducing the fan speed using a GRR. The energy saving achieved by this step was about 170 kW.

Benefits

The implementation of this project resulted in annual energy saving of **Rs. 52.17 Lakhs.** This called for an investment of **Rs. 9.37 Lakhs** which had a simple payback period of less than **3 months time.**



Case study 2

INTRODUCTION OF BALL MILL IN TANDEM WITH VRM IN LINE II

Background

Line 2 of Vasavadatta Cement was commissioned in the year 1997. After a few years of operation, as the capacity was increased on a continual basis, it was observed that the raw meal availability was a constraint for further increase in the kiln output.

An innovative idea of operating a Ball Mill in tandem with the existing Vertical Roller Mill was conceived by Vasavadatta Cement and implemented. As per the plant equipment supplier, M/s Krupp Polysius, this unique idea is the first of its kind in the world. After the successful implementation of this project, Vasavadatta Cement had several visitors from India and abroad to see the project implemented.

Why is this project unique?

- Hoppers and Weigh Feeders were not required
- Separate mill venting and de-dusting system were not required
- Additional Raw meal transport equipments was not required
- Reduction in VRM vent volume was achieved
- Reduction in dust emission was observed
- Stable VRM operation was achieved

Methodology

- ❖ Ball mill feed was taken from the reject cone of VRM Classifier through a variable speed screw conveyor.
- ❖ Ball Mill is vented through VRM
- ❖ Ball mill product is fed by bucket elevator to existing air slide below ESP conveying raw meal to Silo

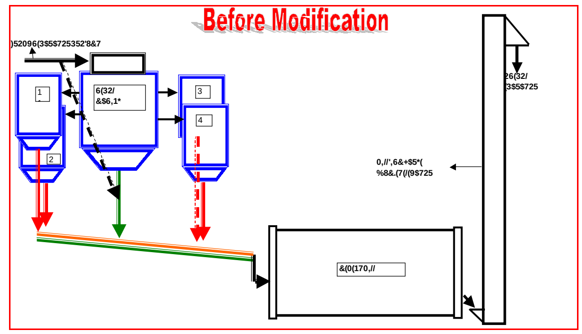
Results & Benefits

- ❖ Production increased by 55 TPH with very less investment of Rs. 417.16 Lakhs
- ❖ Dust loading in ESP is reduced
- ❖ VRM vent fan RPM is reduced
- ❖ Increase in clinker production resulting in lower Specific power consumption
- ❖ Total Saving Rs. 570 Lakhs/Annum

Case Study 3

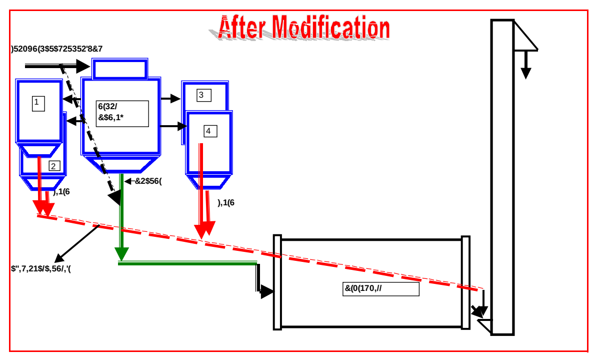
RE-ROUTING OF V-SEPARATOR CYCLONE MATERIAL TO THE MILL OUTLET

Background



In standard design of cement mills, the V – Separator reject material and the cyclone material is fed to the cement mill inlet.

However, in Vasavadatta Cement, in the pursuit of energy efficiency in cement mills, a complete review was carried out in the cement mill. It was observed during the study that the material which was going from the V – Separator cyclones to the mill inlet was very fine. This cyclone material was going to the mill along with the v – separator rejects. Circuit sample study indicates that the cyclone material was having specific surface area of 230 – 250 m^2/kg.



Energy saving project

After several discussions and observations, Vasavadatta Cement had diverted the cyclone material of the separator to the mill outlet leaving the coarse material from SEPOL casing to go to the cement mill inlet.

Benefits & results

1. This has resulted in improved "Grinding Efficiency" of the Mill
2. Mill output increased by 15 TPH
3. Specific Power consumption reduced by 0.5 kWh per ton of cement
4. Annual energy saving : 27.60 Lakhs per annum

List of projects implemented from 2003 to 2005

SL No.	Description	Investment	Savings / Annum
1.	Installation of belt bucket elevator for kiln feed in line-II	83.74	9.0
2.	Poldos-SC system for main firing in kiln-I	26.00	6.187
3.	Rawmill-II out let duct modification .	8.74	26.036
4.	Retrofitting of unit-II cooler fans (Three Fans)	10.5	31.887
5.	Line-II kiln inlet riser duct modification.	1.280	11.250
6.	Rawmill –II body modification	9.37	52.17
7.	Installation of high efficiency PA fan in line-II	1.95	9.754
8.	Installation of Secondary crusher	75.0	38.50
9.	Fuzzy expert system for cement mill-II	12.0	27.60

Projects with very less in house investments

SL No.	Description	Savings / annum
1.	Optimization of ESP fan air flow in cement mill-II .	3.64
2.	Modification of coal mill-II bagfilter inlet duct .	3.00
3.	VVVF drive for unit-I packers dust collector fans	1.486
4.	Optimization of separator fan air flow in cement mill-I	10.25

INTERNATIONAL BEST PRACTICES

International Best Practices - Plant Visit I

HEIDELBERG CEMENT, LENGFURT, GERMANY

Heidelberg Cement Group, with over 133 years of long association with cement manufacturing, having a production capacity of more than 82 MTPA from over 1500 locations in 50 countries, has carried out extensive activities in Waste Heat Recovery and Waste Fuel Utilization.

Heidelberg Cement, Lengfurt is one of the older plants in this group with a history of over 107 years. Cement production at Heidelberg Cement, Lengfurt started in the year 1899 and presently has a capacity of 1.0 MTPA.

The key features of Heidelberg Cement, Lengfurt include:

1. Alternate fuel – nearly 80% substitution

2. Organic Rankine cycle for waste heat recovery from clinker cooler

1. Alternate fuel usage

   Heidelberg Cement, Lengfurt utilizes a variety of waste in its cement plant. Some of the major wastes utilized are:

   a. Kiln inlet
      - Waste tyres

   b. Main firing
      - Waste oil
      - Animal meal
      - Pet coke
      - Solvents
      - Plastics

The calorific value and moisture content of some of the waste fuels utilized are as under:

Waste fuel	CV	Moisture
Coal	6450	5-10%
Waste oil	7200	-
Solvent	3500 – 8300	-
Animal meal	3800	10%
Plastics	4800	5-10%

Heidelberg Cement, Lengfurt plant utilizes a variety of secondary raw materials in cement manufacture. Some of the secondary raw materials used and its place of utilization are as under:

1. Paper Sludge

   Paper sludge is basically treated as a waste material for disposal. Paper sludge comes with nearly 50% of moisture content and has no significant heat value. At Lengfurt, paper sludge is disposed off in clinker cooler. Waste generators pay this cement plant to dispose off their waste.

2. Iron waste

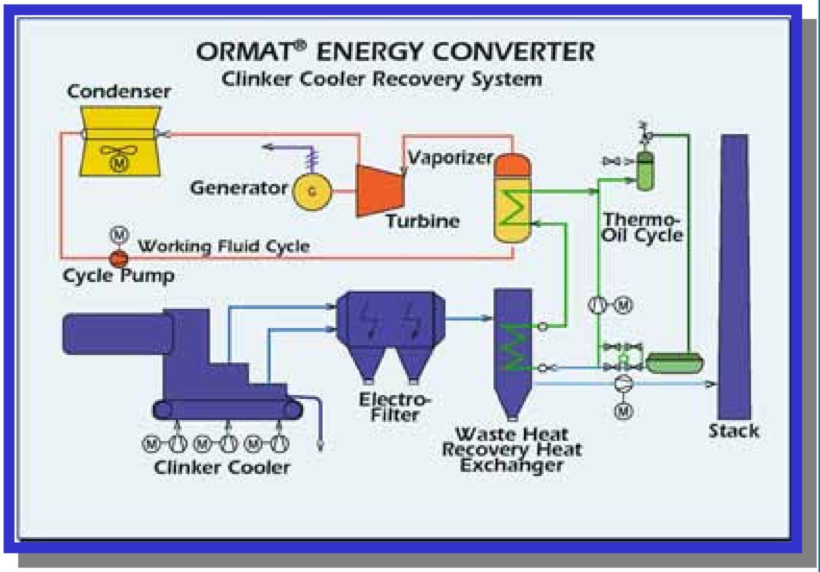
   Iron dust which is generated as waste from iron and steel plants is purchased by Lengfurt. This is to supplement the raw materials composition. Iron dust is preferred to iron ore because of its cost.

Emission Norms in Germany

- **SPM Emission levels : 20 mg/Nm³**
- **SPM with secondary fuel : 13 mg/Nm³**
- **SO_x Emission levels : 220 mg/Nm³**
- **NO_x Emission levels : 500 mg/Nm³**

3. Waste from photography industry

   Lengfurt plant receives waste from photography industry and disposes off in its cement process. This waste comes with 2 benefits – one, the waste generator pays this cement plant for its disposal. Second, with their experience in cement industry for several years, Lengfurt has observed that this waste material from Photography industry has been observed to act as an excellent DeNOX agent.



Waste heat recovery from clinker cooler

Hot gases from cooler vent fan had always been a source of waste heat recovery untapped. Of late, a few successful models have been introduced in the market. One of the most promising technologies for waste heat recovery from clinker cooler vent gases is the Organic Rankine Cycle.

Organic Rankine Cycle

The organic Rankine cycle employed in Heidelberg Cement, Lengfurt is a twin-working liquid model. After the electrostatic precipitator (ESP), a waste heat recovery heat exchanger is utilized to transfer the heat from clinker cooler hot gases to the thermo-oil cycle. The clinker cooler vent gases enter the heat exchanger at 275°C and leaves the heat exchanger at 120°C.

The heat from the thermo-oil cycle is transferred to the working fluid (Pentane) in a vaporizer. In this vaporizer, the working liquid is converted to vapour. This vapour is utilized to rotate a turbine. The spent vapour is cooled in an air-cooled condenser and the liquid is again fed back to the cycle to pick-up further heat from the vaporizer.

The installation of organic Rankine cycle at Heidelberg Cement, Lengfurt has been the first of its kind in the cement industry. For the cement production capacity of 1.0 MTPA at Lengfurt, the waste heat recovery based power generation is rated for a capacity of 1.5 MW. The net power export to the cement plant, after accounting for the auxiliary power consumption in the power house, is 1.3 MW.

This organic rankine cycle based heat recovery system was installed in the year 1999. The cost of installation for this entire waste heat recovery system was about Euro 4.0 Million. For the rated power generation capacity of 1.5 MW, this cost translates to Rs. 15.40 Crores / MW.

The installation of organic rankine cyale based heat recovery system at Heidelberg Cement, Lengfurt was supported by the Environment Ministry of Germany. The Ministry had funded about 40% of the investment in this project.

The clinker dust loading at Lengfurt is less than 10 mg/Nm^3. With this dust loading, there had been no failure in this waste heat recovery based power generation station in the last 7 years.

International Best Practices - Plant Visit II

HEIDELBERG CEMENT, LIXHE, BELGIUM

Known earlier as United Cement & Brick Factory with brand name of CBR, Heidelberg Cement, Lixhe was established in the year 1950. the present capacity of clinker and cement production is 1.4 MTPA and 1.6 MTPA respectively. Located in a very advantageous site, 20% of the cement dispatch is through canal & sea and the rest by road.

The price of cement at market is about Euro 60 – 65 / ton (Rs. 3600 – Rs. 3900 per ton) and the cost of limestone is about Euro 1.0 per ton. This cost of limestone also includes the cost of restoration of used quarry, which is about Euro 0.3 / ton.

Heidelberg Cement, Lixhe plant had been utilizing several alternative raw materials and waste fuel in its cement manufacture.

Some of the alternative raw materials used are iron oxide, sludges, slag and flyash.

Alternative fuel had been used in pre-calciner, kiln inlet and in the main firing. Majority of the waste material is processed and delivered at site by either the waste generator or an intermediary service provider. Majority of the waste again, comes to the cement plant with a price for its disposal. Some cement plants choose the kind of waste to dispose off depending on the cost of its disposal.

Some of the fuels used in the pre calciner are impregnated saw dust, textile pellets, shredded oil filters, polluted soil and other miscellaneous waste.

55% of heat energy requirement is met from firing secondary fuels

Whole tires and dewatered sludge is fired at the kiln inlet while saw dust, animal meal, liquid wastes and polluted water is utilized in the mail burner.

International Best Practices - Plant Visit III

CASTLE CEMENT, PADESWOOD, UNITED KINGDOM

Castle cement group comprises of 3 cement factories, 2 import terminals and 6 depots with a total cement manufacturing capacity of 3.3 MTPA. This meets about 25% of the cement demand of United Kingdom.

Castle Cement plant at Padeswood was established in the year 1949 and its new line underwent extensive upgradation in the year 2004 to a new dry process kiln. Maximum usage of existing infrastructure such as kilns, silos, etc were utilized to the fullest extent.

With the present employee strength of 110 employees at the production levels of 75000 T of clinker per employee, the present capacity of the new line is 0.82 MTPA of cement manufacture. The broad features of the new line are – dry process kiln with pre-calciner, 5 stage pre-heater and latest cross-bar clinker cooler. With the use of a very effective online analyzer, Castle Cement operates without a blending silo. To help the local electric utility manage the electrical load and demand in the vicinity, the cement mill control switch is located in the sub-station.

Apart from the conventional fuels such as coal, pet-coke and oil for startup, waste derived fuels (WDF) such as Cemfuel, Profuel, used tires and animal waste derived fuels (AWDF) such as bone meal and meat are fired in the cement manufacture.

Waste Derived Fuels

Cemfuel is a mature, tried and tested alternative fuel in UK. This comprises of industrial waste extracts such as methanol, ethanol and acetone. These chemicals are extracted during recycling of products such as printing ink, etc. Cemfuel is also observed to reduce NOx emissions and helps in alleviating global warming. With the use of Cemfuel extensively in cement industry, the use of high temperature incinerator establishment in UK has been eliminated.

Profuel is made from selected solid waste streams such as cellulose fibre, polypropylene, photographic film, paper and packaging wastes that cannot be recycled, low chlorine plastics and cut-off's from nappy and carpet manufacture to a pre-defined specification.

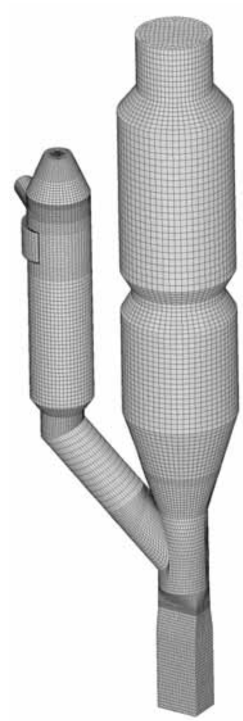
Used Tires generation is at the rate of about 37 million per year in Great Britain. All the waste tires are completely consumed in the country's cement industry. At Castle Cement, tires are both fed as whole tires at the kiln inlet or shreaded into chips and fired in Calciner. This waste not only comes with a significantly good calorific value but also with a good gate fee.

All the waste derived fuels such as Cemfuel, Profuel, Used tires and AWDF are processed either by the waste generator or service provider and is delivered to the cement plant at its doorstep. Each fuel comes with a cost for its disposal.

Computational Fluid Dynamics in Cement Industry

Computations fluid dynamics is an excellent tool to study the behavior of fluids in ducts and paths. Extensive adaptations of CFD are in vogue now and its use for energy efficiency and performance enhancement has been adopted by various industries. Cement industry, being extremely aware of the benefits of this study, has adopted CFD study in its performance optimization.

Castle Cement, Padeswood has also utilized CFD modeling to a large extent in its designing process. CFD study has been utilized to study the following:



- Devolatilisation of coal
- Char combustion and char fragmentation
- Gaseous phase reaction/combustion
- Mass, momentum, and energy exchange between gas and particle
- Alkalis formation with possible deposition in the system

This has resulted in significant benefits in energy consumption and performance optimization for Castle Cement.

International Best Practices - Plant Visit IV

HOLCIM CEMENT, SIGGENTHAL, SWITZERLAND

Holcim Cement, earlier known as Holderbank, was established in the year 1912. Holcim Cement today is the World's largest cement manufacturing group and Siggenthal manufacturing facility happens to be the first plant of Holcim Group.

Switzerland has 4 cement manufacturing factories with total cement production capacity of 2.5 MTPA. Holcim, Siggenthal, with cement manufacturing capacity of 0.75 MTPA, meets about 30% of cement demand in Switzerland.

Holcim Cement, Siggenthal operates with just about 105 employees for production of 0.75 MTPA. 90% of the cement dispatch is by bulk and only the balance 10% is dispatched in bags.

A variety of alternate fuels are used at Holcim Cement, Siggenthal. Use of waste tires as fuel has been a practice at Siggenthal for the past 25 years while the use of dried sewage sludge has been one of its recent used alternate fuels. The other alternate fuels include waste oils, solvents, saw dust, distillation residues, plastics, animal fats & meal, bone meal, etc.

Holcim Cement, Siggenthal with its wide experience and expertise, has studied the use of dried sewage sludge as alternate fuel and is now using it on a regular basis. When the moisture content in the dried sewage sluge was observed to exceed 10%, experience of Holcim, Siggenthal shows that the tendency of re-fermentation was very high. This was resulting in increase in temperature and thereby, increasing the chances of auto-combustion in storage. Today, when the firing of dried sewage sludge has been taken up on a regular basis, several precautions such as purging with nitrogen / carbon-dioxide and provision of explosion vents have been taken.

In the year 1998, when the mad-cow disease was prevalent in Switzerland, cement industry in the country came forward to help the Government dispose the animal meal from slaughter houses. Holcim Cement, Siggenthal plant played a key role in disposing the animal meal during that time.

Holcim Cement, Siggenthal has employed a 3-stage flue gas cleaning system.

1. Selective non-catalytic reaction
2. Electrostatic precipitator
3. Activated carbon filters

1. Selective non-catalytic reaction (SCNR)

Holcim cement, with their extensive research and observation, have seen a significant reduction in NOx levels when ammonia is injected in the riser duct. Ammonia reacts with NOx thereby lowering the emission of NOx in the flue gas stream.

In selective non-catalytic reaction, ammonia is injected in the riser duct. Hoclim Cement have identified a waste from a nearby chemical industry which contains 25% of ammonia concentration. This waste is delivered to Siggenthal doorstep free of charge. The waste is injected in the riser duct at a feed rate of about 1000 lph.

2. Electrostatic Precipitators (ESP)

As in any conventional cement manufacturing process, Hoclim Cement, Siggenthal also employs an ESP for removal of solid particulate matter in the flue gas path.

3. Activated Carbon Filter (ACF)

This is again a unique feature observed at Hoclim Cement, Siggenthal. It was observed that the coal utilized for firing has some heavy metal contents in it. These heavy metals were observed to be removed in the ESP and the ESP material was added in the cement mill. Thus, the heavy metals are captured and is disposed safely. The major problem observed was with the SOx emission levels. After detailed discussions amongst the Hoclim Technical team and with suppliers, an activated carbon filter (ACF) was introduced in the down stream flue gas path. This activated carbon filter comprises of two layers of activated carbon filter across which the flue gas is passed. Actvated carbon was found to adsorb the SOx content in the flue gas discharging clean gas to the atmosphere. This spent activated carbon was again fired in the kiln to utilize the carbon content.

This project is an excellent example of public support to encourage use of alternate fuels in cement plant. The entire project of ACF was funded by the city of Zurich to start sludge firing in the cement plant.

Waste heat recovery

Holcim Cement , Siggenthal plant has adopted waste heat recovery from clinker cooler exhaust gases for the benefit of the local community.

The clinker cooler vent gases coming out from the 2300 TPD kiln has a thermal power of about 10.8 MW of heat content. This heat is utilized to provide district heating system to the nearby villages. This service is being provided to the local community on chargeable basis. This entire system includes about 12.8 km of pipelines laid and caters to a heat load of about 5.0 MW. Provision for natural gas (NG) Supplementary firing to the extent of 20% of heat load is also provided to meet the requirement.

ETA Cooler

Holcim Cement, Siggenthal is also the host of the world's first installation of Claudius Peters' ETA clinker cooler. Some of the broad features of this unique cooler is as under:

- Walking floor arrangement for clinker transport
- A layer of Cold Clinker bed always at the bottom
- Static inlet with aerators
- Modular design, facilitates easy installation at lower downtime
- Roll crushers for clinker breaking at cooler outlet
- 8 cooler air fans to cool the clinker
- Air blasters provided to avoid conventional cooler problems
- Level radar to read the level on the fixed grate
    - Radar provided at Kiln hood

This cooler has been in operation at Holcim Cement, Siggenthal since 01 September 2004 and its first planned shutdown was carried out on 30 December 2005, after 12500 hours of successful operation. This cooler has a surface area of 45.5 square meters for a clinker loading of 2300 TPD. The coolers' availability in the last 18 months of operation had been 99.5% and the time lost in maintenance of this cooler was only 60 hours in this period.

International Best Practices - Plant Visit V

NIKKA SUMIEITO WASTE PROCESSING PLANT

As part of this mission to cement plants in Europe, UK & Japan, one of the waste processing plant in Japan was also visited.

This waste processing plant acts as a service provider between the waste generator and the user. This plant procures various types of waste from the industry and processes the waste at its premises. The processing includes mixing, blending and treating the waste to supply the waste fuel at a consistent quality and heat value to the end customer. The final blended oil is sold under the brand name 'Suramics' which has a calorific value of 4500 kCal / kg $\pm$ 200 kCal / kg.

Average usage of waste usage in Japan

- **400 kg/T of cement in 2005**

One of the major waste handled by this plant is the water-oil mixture which is a waste from the automobile industry. For correction of calorific value, reclaimed oil is purchased from the market and blended with this waste oil, if necessary. Whenever required, this blending would be to the tune of about 25 – 30%. However, no treatment is carried out to separate the water from the water-oil mixture.

Nikka Sumieito Waste processing plant handles a variety of waste and waste products and treats them for end use in cement industry. Some of the types of waste handled are as under:

- Old sludge
  - Tank sludge, spent activated clay, oil scum, car washing sludge, (mixture of sludge and waste oil), paint waste water sludge, printing ink waste, etc
- Sludge
  - Paper sludge, liquid waste water treatment sludge, neutralization processing sludge, etc

- Ashes
  - Coal ash, coke ash, heavy oil burned ash, chimney ash, incineration ash, etc.
- Soot & dust
  - Humidified or granulated EP ash, bug filter dust and cyclone dust, etc.
- Spent catalyst
  - Direct – indirect desulphurization catalyst, a catalytic –cracking catalyst, a silica type catalyst, and alumina type catalyst etc.
- Slag
  - Various slag, such as a blast furnace, a converter, an electric furnace, and Cupola furnace and waste molding sand etc.
- Animal and plants residual substance
  - Grain and coffee bean residue, etc
- Waste plastics
  - Ion exchange resin, crushed resin except halogen type
- Others
  - Toner powder, carbon powder, carbon black

This waste processing plant has also defined a few types of waste it would not handle. Some criteria for waste not handled are:

- Inflammable liquid of flash point lower than 210C Equivalent type-1
- Solidified paint
- Active waste
- Larger than 20 mm and over
- No permitted type, such as metal waste or wood waste
- Dusty waste
- Strong smelled waste

International Best Practices - Plant Visit VI

TAIHEIYO CEMENT CORPORATION, JAPAN

'Taiheiyo' in Japanese language stands for Pacific Rim. Befitting its name, Taiheiyo Cement Corporations activities are also focused in the Pacific Rim, in countries such as Japan, Korea, China, rest of Asia, North America, etc.

With a cement manufacturing capacity of 50.2 MTPA, Taiheiyo Cement Corporation today stands as the largest cement manufacturer in Japan and the 6^{th} largest cement producer in the world.

Taiheiyo Cement, Saitama Cement Plant

Saitama Cement Plant is a part of the Taiheiyo Cement Group with a design capacity of 1.8 MTPA. Production started in Saitama Cement Plant in the year 1955 and the cement market is close to the factory location.

Some of the unique features of Saitama Cement Plant are

1. Use of municipal solid waste – Applied kiln system
2. Waste fuel based power generation

1. Use of municipal solid waste – Applied kiln system

Saitama cement plant is located close to Hidaka City. Hidaka city, with a population of over 55000, the municipal solid waste generation from Hidaka city is about 15000 TPA. Earlier, the municipal solid waste from Hidaka city was disposed off by incineration. The local government and community faced problems due to dioxin emission which incineration. The emission levels were observed to be higher than the specified limits. For ensuring safe disposal of municipal solid waste, the local government approached cement industry to utilize the waste and dispose it off. MSW utilization and firing at Saitama cement plant started in the year 2002.

Applied kiln (AK) System

In the applied kiln system, Saitama cement plant feeds the incoming municipal waste into an unused kiln. A residence time of 3 days is allowed for the waste and the kiln is in rotation. Air is blown in the kiln during this operation. Aerobic digestion turns the organic content in waste into soil-like raw material. As the kiln rotates, mechanical breakdown takes place. Breaking down of the waste into finer particles is also observed to accelerate the aerobic digestion process.

The gases released as part of the aerobic digestion is fired in the main firing. The material, after a residence time and aerobic digestion for 3 days, is fed in the calciner or kiln inlet.

2. Waste fuel based power generation

In the construction industry in Japan, wood plays a significant proportion of construction material. As the buildings are brought down and renovated, a lot of wood is available for disposal. A subsidiary company of Taiheiyo Cement Corporation purchases the wood from the demolition companies, crushes them and supplies them to the cement plant for disposal. Saitama Cement plant has installed a 50 MW capacity power plant with biomass as fuel. 50% of the power generated is exported to the grid.

International Best Practices - Plant Visit VII

TAIHEIYO CEMENT, KUMAGAYA CEMENT PLANT

Kumagaya Cement Plant is a part of the Taiheiyo Cement Group with a design capacity of 2.1 MTPA. Operation in Kumagaya Cement Plant started in the year 1962 and Ordinary Portland Cement, High early strength cement and Blast furnace slag cement are the major cement types produced in this plant.

Some of the unique features of Kumagaya Cement Plant are

1. Alternate Raw Material Usage
2. Alternate Fuel Usage
3. Plastic Waste Processing System
4. Ash Processing system

1. Alternate raw material usage

Kumagaya cement plant has carried out lot of studies and activities to promote alternate raw material usage in its cement manufacturing process. Some of the waste materials used are:

- Slag from furnace
- Non ferrous slag
- Coal ash
- Sludge
- Fly ash of sewage disposal
- Sand for casting

2. Alternate fuel usage

Several waste fuel alternatives have been explored at Kumagaya cement plant. Some of the waste fuels commonly used are waste tires, waste oil, wood chips, plastic and pachinko machine waste.

The pachinko machine waste is one of the unique wastes handled by Kumagaya Cement plant. Pachinko is a very popular game in Japan. Several Pachinko game outlets are located all over the major cities and towns ad these machines are to be replaced once every 3 months. These pachinko machine wastes comprise of metal, wood and plastic. This practice of changing the pachinko machines every 3 months generates lot of waste materials.

3. Plastic waste processing system

Kumagaya cement plant has developed a processing system for pachinko machine waste. The various steps involved in the pachinko machine waste processing are:

- ❖ Primary crusher
- ❖ Secondary crusher
- ❖ Magnetic separator
  - ➢ Steel & plastics
- ❖ Double shaft screw type reducer
- ❖ Reducing and solidification
- ❖ Feed in kiln inlet

4. Ash processing system

The ash generated in various incinerators is now treated in Kumagaya cement plant. The ash processing system is a unique example of treating a waste material such as the incinerator ash and using the treated material in cement manufacture.

Some of the major processing steps in fly ash treatment and used water treatment are as under:

- Fly ash
  - Solution tank
  - Belt filter
  - Filter cake to kiln
- Used water
  - Neutralizing
  - Decanter
  - Precipitation
  - Sand filter
  - Mercury absorber
  - Filtrate tank
  - Sewage plant

International Best Practices - Plant Visit VIII

ICHIHARA ECOCEMENT PLANT

In Japan, the Municipal Solid Waste (MSW) was being disposed off in the incinerator. The treatment and disposal of MSW was the responsibility of the local municipality. With a total generation of MSW to the tune of about 51 MTPA, the ash generated after incineration in the incinerators was about 8.1 MTPA. This ash was earlier disposed as landfill. However, with the present cost of landfill being prohibitively expensive, the disposal of incinerator ash presents a major environmental issue to the municipality.

The local municipality of Ichihara prefecture then approached Taiheiyo Cement Corporation for the disposal of incinerator ash. Taiheiyo Cement Corporation, with its wide experience and expertise in cement industry, developed a unique design of cement manufacture to substitute the incinerator ash to the extent of about 49% in the raw material. With the support of the local municipality, EcoCement plant was sent up at Ichihara.

The broad features of Ecocement process are as under:

- Safe destruction of all toxic substances
- Extraction & enrichment of heavy metals
- Reduction of CO2 emissions
- No generation of secondary solid waste

Ecocement plant started its operation since April 2001 with a design cement production of 0.11 MTPA. The waste input of about 62000 TPA of incinerator ash and about 28000 TPA of other industrial waste is utilized for manufacture of cement. The fuel used is reclaimed oil – a waste oil from industrial consumers. Coal is not used in the cement manufacture.

The revenue model for Ecocement would be gate charge of incinerator ash and other industrial waste from the waste generators and from the cement sales in the market.

Ecocement is sold in the market at the same cost as the conventional cement.

After establishing the model and operation of Ecocement successfully for the last 4 to 5 years, Taiheiyo cement has installed another Ecocement plant in Japan. The investment for establishing the new cement plant was shared equally between the central government of Japan and Tokyo Santama Regional Association for Waste Disposal (TSARA). The cost of operation of this cement plant is also fully funded by TSARA for 20 years.

ACTION PLAN AND CONCLUSION

Action Plan

- The individual cement plants have to assess the present performance by comparing the data provided in this manual.
- Each unit should develop its own individual target for improving all the parameters.
- The target figure could be based on the collated best performance parameters.
- Set and achieve voluntary target of at least 5% reduction in specific energy consumption every year

Phase – 1

- The best practices and the performance improvement projects compiled in this manual may be considered for implementation after suitably fine tuning to match the individual plant requirements.
- Units can establish their present performance levels as Baseline and review all improvement activities against this Baseline.
- 'Green Cementech' will serve as a platform every year for information dissemination among all the Indian Cement Plants.

Phase – 2

- Each plant has some unique projects implemented against their name. Sharing such best practices during inter-plant visits would be the most cost effective way of improvement. Each visit to a good operating plant should fetch us ideas to save at least 1 kWh / ton of cement.

Phase – 3

- Indian Cement Plants have a few unique features to observe and implement from international cement plants in the areas of:
    - Waste fuel utilization
    - Waste heat recovery opportunities
    - Automation
- One such visit to Germany, Belgium, Switzerland, United Kingdom and Japan was organised in the year 2006 and has recieved a good response from the participants.
- Such experiences would give us a wider perspective on global operations of cement manufacturing and to adopt the best practices practiced therein.

CII - Godrej GBC will be glad to extend all possible assistants to units in all the three phases of action plan proposed.

For further details regarding the contents of this manual or any assistance in the action plan proposed, please contact :

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Conclusion

The objective of the project will be fulfilled only if the performance of all cement plants improves and achieves world class standards.

We are sure that the Indian Cement plants will make use of this opportunity, improve their performance and move towards the world class Energy Efficiency.