Energy efficiency improvement in a cement industry in Sri Lanka

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This case study highlights the importance of an integrated approach to implement energy efficiency improvement measures in an industry, while pointing out the drawbacks of undertaking poorly coordinated sporadic activities. The discussion revolves around one of the energy improvement measures adopted in a cement mill, the introduction of a high efficiency clinker cooler. The case study is based on information and data gathered from different categories of personnel of an integrated cement mill in Sri Lanka.

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Introduction

In order to adopt energy-efficient improvement systems in any industry, it is vital to have an overall view of the entire production process such as: paying due attention to the design parameters, critical processes and equipment: energy and mass balance; product requirements; quality of existing energy sources and other energy options; compatibility of existing machines and equipment; skills available to acquire and adopt the technology, etc. More importantly, the economic viability of the proposal must be carefully analysed before selecting a particular energy efficiency measure for implementation. While looking for an energy-efficient technology, the industry must avoid costly and time consuming basic research and the inward looking attitude of self-sufficiency in everything. If a technology is available elsewhere and it is economically accessible, the industry should be willing to acquire it.

When external consultants are involved, they should provide firm commitment to their proposals. One way to guarantee the performance of the system up to its required efficiency and output level is to insist on some sort of financial commitment from consultants for project implementation or for profit sharing in lieu of consulting fees.

The anticipated economics or other forms of benefits such as improved productivity, higher product quality, and environmental gains may not be realized if the right organizational structure does not prevail at the plant level to facilitate different players within the enterprise contributing to the best of their abilities to achieve a common goal. The most important aspect is to ensure employee motivation at all levels

In many industrial establishments, Interdisciplinary interaction does not take place and hence, well-co-ordinated and cohesive actions are not taken for issues like adoption of energy efficiency improvements which require expertise from several fields. A case study is presented here, which highlights various issues related to the adoption of energy improvement measures in an integrated cement plant.

Table 1: General data of the factory

Designed capacity per line per day	660 metric tons
Current capacity per line per day	730 metric tons
Designed specific energy consumption	850 kcal per kg
Current specific energy consumption (1995)	985 kcal per kg
Number of employees	1140

Present status of the factory analysed

The plant under review was established in 1970 as a state-owned corporation and commenced production in 1973. In May 1993 the government of Sri Lanka decided to change its status to a private company with 100 per cent of the shares being held by the national treasury. Voluntary retirement was offered to employees to streamline its activities and, to solve the redundancy problem. Although the intention of the authorities concerned was to convert it to an independent and profitable entity, no significant change took place in the management structure or practices.

Later in January 1994, the company was fully privatized. Now it is a public-listed company with 10 per cent of the stake owned by the Sri Lankan government, with one government representative on the management board. One of the world's leading cement manufacturers recently bought 33 per cent of the shares, and thus became the controlling shareholder, while the remaining 57 per cent is owned by private shareholders.

In Sri Lanka, cement has become a near essential item and hence, this plant enjoys an oligopoly situation in view of its output and the quality demanded by the local construction industry. Due to the short supply and inferior quality of certain imported varieties, the cement business is a sellers' market. There is greater potential for growth and expansion of the plant, as it has privileged access to the source of the main raw material and the brand loyalty of end users.

Plant description

The cement mill has two parallel lines of production and employs the dry process with four-stage suspension preheating. It produces around 420,000 metric tons of Ordinary Portland Cement annually for the local market.

Figure 1 presents the process flow chart of the plant, highlighting unit operations where energy efficiency improvement attempts have been made. Table 1 gives the general data of the factory.

The plant is financial in a fairly healthy condition, with a net profit of around US$ 225,000 per month. It operate at almost 100 per cent above the breakeven point, and has an investment capacity of around US$ 2 million.

What went wrong

Since its inception until recently, maximizing production had been the major concern of the plant. Being the market leader, the plant was constantly under pressure from political circles to ensure maximum production to meet the demand of the construction industry. In the process, little attention was paid to energy efficiency and environmental aspects.

Prior to 1988, staff turnover was very high due mainly to the attractive remuneration opportunities available in the Middle East. There were frequent interruptions in production owing to labour unrest as a result of lack of motivation.

During this period, many unsuccessful attempts were made by the management to introduce innovative technological developments of some process equipments in an isolated manner without studying the plant as a whole or taking into account the design parameters. Top managers with no technical background had tried to introduce certain technological changes based on what they had learnt at seminars or seen during plant visits overseas.

An abortive attempt was made in the 1980s under the advice of some local consultants to introduce pre-calcination of the raw meal using a dual firing system. Most of the structural work had been completed, but as the project was a failure, it had to be dismantled. The reason for failure, according to the present management, was the unwillingness of local advisors to acquire the know-how from foreign sources. They were trying to re-invent the wheel by conducting basic research at the plant while technology was readily available elsewhere.

Another attempt was made to improve the performance of the waste (flue) gas fan in 1980. According to the present management, the output of the mill was increased from 650 to 730 tons per hour. However, this statement was countered by some others at the mill according to whom the fan improvement has led to problems in other parts of the process (for example, clinker cooler). Various unsuccessful attempts made at the mill for energy conservation are summarized in the Table 2.

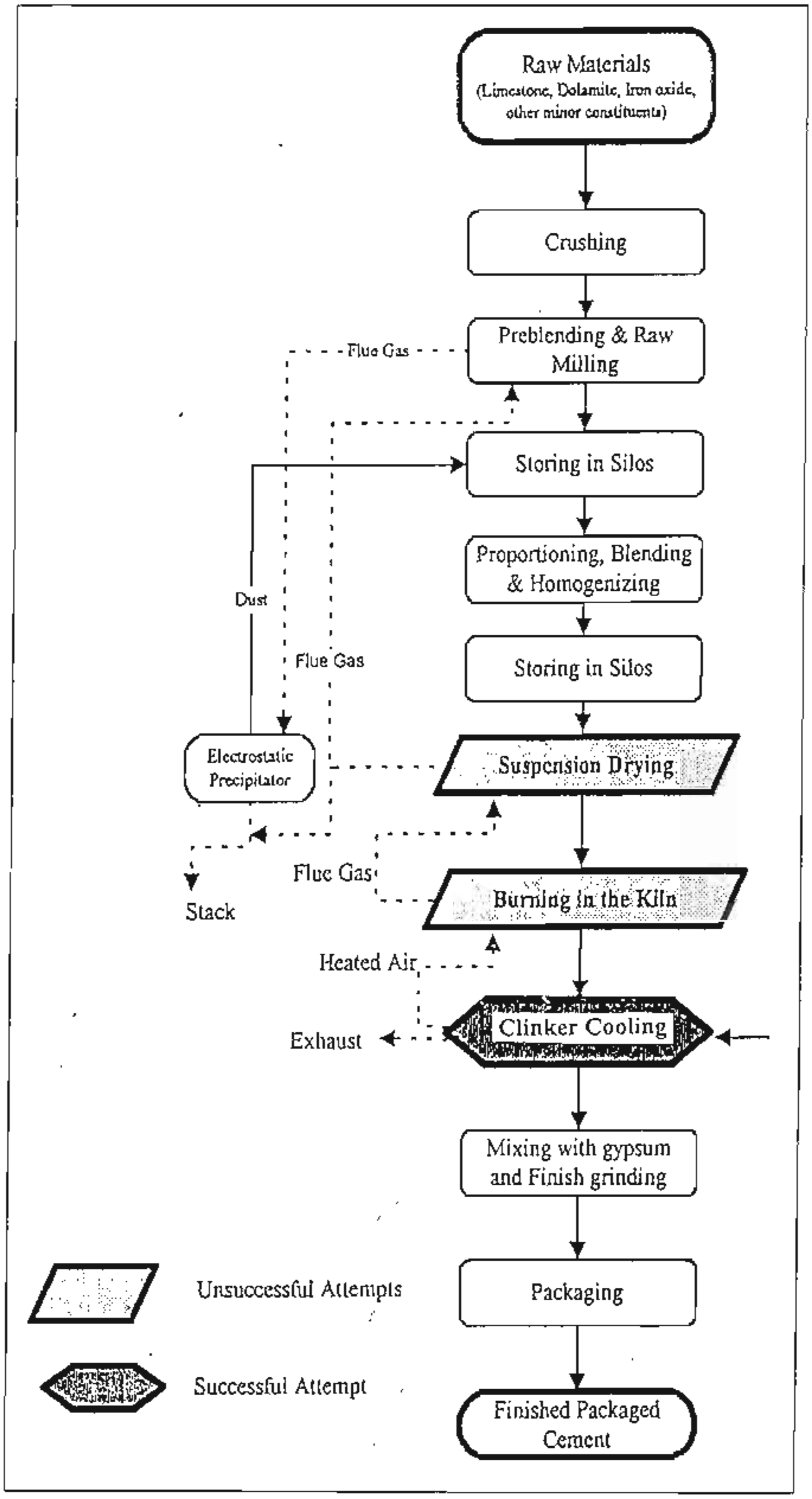
Significant difficulties were encountered in the maintenance of the plant due to the unavailability of spare parts as a result of the attempts to make everything in-house.

There were enough experienced local technical staff who could initiate energy-efficient projects. But they were handicapped by the many unsuccessful attempts made by various parties in the past to bring about improvements. As such, they were reluctant to take fresh initiatives.

How the situation was turned around

In the mid-1980s, the government managed to attract world renowned management companies specializing

Figure 1: Process flow chart of the cement plant



in the cement industry to upgrade the existing plant. A management contract was awarded to a British firm on a profit-sharing basis (20 per cent).

The first task of the overseas firm was to carry out a complete energy balance of the plant in order to identify all possible areas for energy efficiency improvements. Having done that, depending on the anticipated financial returns and making use of their past experience regarding the expected outcomes of various measures, a priority list was prepared. Some of the important options were listed, and these could be classified as improvement of energy, environment, production quality, etc.

- Introduction of energy-efficient clinker cooler system (Energy)
- Renovation of one of the electrostatic precipitators (Environment)
- Introduction of "R" type dust collector (horizontal multi-stage cyclone) at the entrance of the other electrostatic precipitators (Environment)
- Introduction of "Buffle Pots" to pneumatic conveyer lines (Maintenance)
- Introduction of an "Auto Weight Correction System" in the packing plant (Production)
- Kiln outlet air seal modification. (Energy and Environment)
- Introduction of a "Dust Shroud" at the above air seal (Energy and Environment)
- Diaphragm shifting of the cement mill (Production).

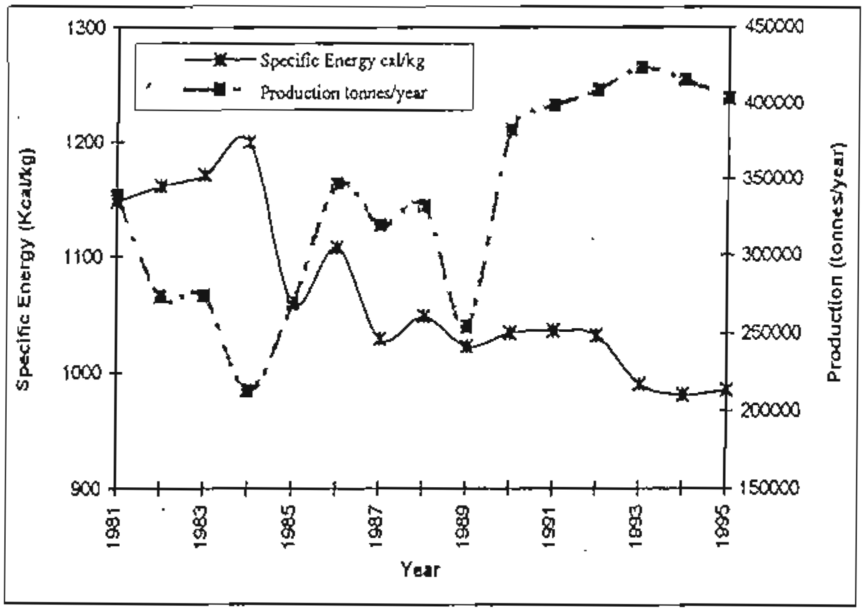
Although the ideas were initiated by the management consultants, the projects were formulated by a project team consisting of cement experts and the local technical staff. The project proposals were forwarded to the general manager at that time (an engineer by profession) for his perusal. Thereafter the board approval was obtained.

The consulting firm had all the resources at its disposal for implementing the projects. A well-established central consultancy unit was in operation at its headquarters in the United Kingdom to deal with all types of practical problems faced by the field staff.

Table 2: Unsuccessful energy conservation efforts made at the factory

Energy saving measures tried out	Result
• Precalcination (dual firing) Failed (Local design-Installation was completed. But could not operate due to operational problems)	
• Improvement of waste gas fan (Trial and error approach)	Partly successful
• Tertiary air duct improvement	Failed
• Coal conversion	Failed

Figure 2: Annual production and specific energy consumption



Making the decision for project implementation was not a difficult task as the project team was fully confident due to the encouragement, risk taking assurance and the accountability of the management consultant. As a result, the general fear of the local technical staff was completely eliminated and they actively participated in the energy improvement drive.

No well-documented financial feasibility report made by the project team could be traced. The need for evaluation was not felt at that time as the management consultants took the full responsibility for the project. They had a certain advantage in implementing the project as they had been exposed to similar problems in an identical plant in another country.

The plant management is now fully committed to the energy efficiency goal of the plant and constantly strives to reduce the specific energy consumption. As presented in Figure 2, a gradual decrease of the specific energy consumption, with increase in production capacity has been observed since 1984 and the company is targeting to achieve international standards/norms for cement industries. The electrical energy consumption has been reduced from 135 kWh/ton in the 1970s to 122 kWh/ton in 1996. Thermal energy consumption has been reduced from 1,214 to 985 kcal/kg of clinker during the same period. One of the main reasons for this is the increase in annual production and a higher plant utilization factor since 1990. A target is set to reach a figure of 900 kcal/kg. The company has adequate in-house facilities for monitoring the performance of various processes. Monthly analyses are carried out for all major process including the cooler modification.

Implementation of a specific energy-saving measure

This section describes one of the energy efficiency measures which has been successfully implemented at the cement mill as a result of the integrated approach. This represents a process modification (see Table 3 for details) adopted in mid-1988. This project was one among some 20 proposals made by the consulting firm after conducting a complete energy balance of the plant.

The energy balance revealed that the recuperation efficiency of the clinker cooler was only 44 per cent as against the international industry standard of 75 per cent. However, due to limitations such as space restrictions, requirement of heavy structural modifications, and long downtime of the plant, the company set a target of achieving an efficiency between 60 and 65 per cent.

The design for incorporating the modification was provided by the management consultants and the fabrication work was carried out by one of the engineering service companies in Sri Lanka with the supervision of the local engineering staff.

Adoption of this technology was expected to bring substantial benefits to the plant. Due to improved heat recovery at the cooler, around US$ 408,000 of savings were anticipated from reduction in fuel consumption in the kiln. Moreover, the quality of cement was expected to improve due to the formation of thermal cracks as a result of rapid cooling, leading to higher cement strength and enhancement of clinker grinding efficiency.

Cost-benefit analysis

The cost-benefit analysis is done on the basis of 28 tph (tons per hour)

Table 3: Clinker cooler modifications

The modification proposed consisted of:

- Increasing the height of clinker bed (by narrowing its width) in order to expand the resident time of the air stream.
- Installation of dwarf wall within first and second chamber for deep bed operation
- Introduction of a "flat bottom" to prevent air leaks from one chamber to another which enables better regulation of air pressure as desired in different chambers
- Installation of spillage gates to isolate drag chain fit from cooling air chambers
- Replacement of existing fans with ones having higher capacities

Table 4: Recuperation efficiency before and after improvements

Date of Measurement	Recuperation Efficiency (per cent)	Status
Cooler No. 1 (Target 60–65%)		
30.06.1988	48	Before implementation
15.09.1988	52	After implementation
Cooler No. 2 (Target 60–65%)		
07.01.1988	40	Before implementation.
18.05.1988	49	While implementing
17.08.1988	59	After Implementation

clinker handled per cooler. There are altogether two clinker coolers.

Total investment per cooler = US$ 100,000

Anticipated savings per month per cooler = US$ 17,000

Anticipated simple pay-back period = 6 months

Expectation vs. actual performance:

Actual savings per month per cooler = US$ 10,600

Actual simple pay-back period per cooler = 10 months

Though the expected recuperation efficiency of 60-65 per cent could not be achieved, what was actually realized was remarkable.

There was no problem of incompatibility with the existing technology when the energy-saving measures were introduced. The staff was competent and experienced to handle such projects with proper guidance. Other options such as re-commissioning of electrostatic precipitators (ESPs) were also evaluated. The management decided to opt for cooler modification as it was certain of achieving the financial returns. The project was financed from the annual operating budget of the plant.

A series of performance-related incentives have been introduced such as group production incentives, attendance incentives, etc. The annual salary increments are not automatic but are linked to employee performance and they can be anywhere between zero and double the previous salary. Other benefits for motivating the staff are provided, such as, professional training, selection of man of the month, recreational and sport facilities, annual trips, etc. Adequate medical facilities are made available to protect factory employees from dust and other occupational hazards.

Conclusions

The integrated approach is the best way of assuring the successful implementation of energy efficiency improvement projects. This approach advocates analysis of the entire process, in order to identify all possible areas which demand improvements and modification, and subsequently their prioritization according to the resources available, financial returns and others aspects important for plant operations. This case study highlighted the effectiveness of such an integrated approach. It was however noted in this factory that, the expected benefits could have been much higher than what was actually realized had the plant managed to overcome some of the drawbacks, namely:

The local executive staff is of the opinion that the benchmark set for the management contract was unfavourable to the plant as it was based on figures for the least profitable year.

Operator participation is not sought for such types of projects and discussions are always confined to those above the middle management level. Operators contribution is sought for operational activities only.

Certain technical personnel are not fully committed to the plant's evolution. Though the company accords high priority to human resources development at all levels, the results have not proved to be very effective. No specific career development paths have been identified for individuals. There is practically no opportunity for job enlargement for personnel at lower levels. No post-training evaluation is carried out to assess the effectiveness of the training provided.

The factory is quite isolated from other industries and professional bodies of the country, thus it has little access to vital information. There is neither an association for the cement industry nor a system of exchanging information among rival firms.

Acknowledgments

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WORKSHOP ON IMMUNODIAGNOSTICS

(Sponsored by Government of India-UNDP Umbrella Programme)

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Central Drug Research Institute, Lucknow, India

Developing and underdeveloped nations of the world are afflicted with a wide variety of diseases. These include parasitic, bacterial, viral and fungal infections. The emergence of AIDS has added new dimensions resulting in the aggravation of many of these and several other opportunistic infections. These diseases cause huge morbidity and mortality and also greatly affect the socioeconomic status. As a result huge amounts of funds are spent every year for their control and containment which greatly disturbs the national economics. Control and proper management of these diseases warrant their proper diagnosis.

Immunodiagnosis has emerged as an important field in medical sciences and is playing a major role in the diagnosis of the above diseases. In view of this, a six-day workshop will be organized at the Central Drug Research Institute, Lucknow, India. The workshop is being sponsored by the Government of India-UNDP-Umbrella Programme and will be held during November/December, 1998.

The workshop will comprise lectures by experts, practical demonstrations and bench training. The faculty of the workshop will comprise experts who have made original contributions is this field. The broad areas of practical training to be covered in the workshop include conventional immunodiagnostic procedures, viz., Enzyme Linked Immunosorbent Assay, Immunofluorescent and Immunoperoxidase techniques, Agglutination assays etc., Western blotting and the recent molecular techniques, viz., Polymerase Chain Reaction (PCR) and DNA probes.

It is intended to include up to a maximum of 30 participants in this workshop from developing countries. Interested participants should send their applications on the following proforma: Name of the application, educational qualification, research experience, nature of present assignment, facilities available in home institution, present and future research interests, recommendation of the Head of Institute indicating how the candidate proposes of use the training in his/her research programme. For further enquiries and other details please contact:

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