CHAPTER XI
The Cement manufacturing, being highly energy intensive process, has been engaged with energy saving / efficient measures including elimination of wastes and recovery of waste energy and has achieved remarkable improvements through various technological innovations. The energy cost which accounts upto 50% of the cement production costs has encouraged the Indian Cement Industry to adopt the technological advance taking place elsewhere in the World. The main thrust areas for reducing the energy component have been better efficiencies in grinding process, high heat recuperating systems, improved refractories and utilisation of agricultural and industrial wastes.

Some of the recent technological developments in cement industry include new crushing and grinding systems, precalcinators, high efficiency coolers, improved burner and refractories, environment control equipment etc.
The technological developments in Indian cement plants has been very fast during and after eighties and most of the technological upgraded systems and aiming at reduction in energy consumption apart from offering the advantage of higher throughputs. Besides, a lot of awareness is being created for the past few years to improve the productivity through Total Productivity Management (TPM), Energy Management System (EMS), Total Quality Management (TQM), etc. It has helped in reducing the cost of cement manufacture through optimising various factors involved in cement manufacture and enabled to produce the competitive quality of cement in the market. Keeping in view the larger capacity plants operating else where in the world with upgraded technology, the Indian Cement Industry has still to go a long way in achieving lower energy consumption levels, higher throughputs and lower costs.

(a) OPTIMUM PLANT CAPACITY:

The growth of Indian Cement Industry till the pre-80’s was quite slow. The post-decontrol era after 1982 saw a significant improvement in capacity and production. The
installed capacity at the end of 1994-95 was of the order of 82.69 million tonnes per annum (including 5.7 MTPA from mini and White Cement Plants). It would be interesting to note that while during the past decade, world cement production increased by about 50%, certain countries like India, Taiwan, Malaysia, Korea and Indonesia have doubled their production, and China and Thailand have even tripled their production during the same period.

In the year 1950, there were only 33 kilns out of which 32 were based on wet process and only one based on semi-dry process. The Indian Cement Industry, continued to have a major share of production through the inefficient wet process till the late 70’s and changed the technology scenario to the more efficient large size plants with dry process thereafter. Presently there are 177 kilns comprising 60 wet process, 109 dry process and 8 based on semi-dry process as per statement given below:

Presently in terms of installed capacity the share of wet process is only 9% whereas dry process accounts for 89% and 2% cover other process. In terms of production, the
The utilisation of installed capacity in Indian Cement Industry has witnessed variations ranging from 70 to 88%. During the year 1996-97 the Industry's (Large Plants) capacity utilisation was 96.25% whereas in 1995-96 the utilisation was 86.76%. Amongst processwise capacity utilisation, wet process plants had an average capacity utilisation of 56.61% only during 1996-97 as against 73.32% for semi-dry and 82.56% for dry process plants and 96.53% for others.
Among the various types of cement produced, OPC (Grade 33, 43, and 53), PPC and PBFS comprises a major proportion. During 1996-97 production of OPC was 70%, PPC 19% and PBFS 10% and other varieties accounted for about 1% of the total cement production.

(b) CONVERSION FROM WET PROCESS TO DRY PROCESS:

The dry process of manufacture has proved to be quite successful in India and in the post-1973 period. Out of the nine plants which commenced production, five employed the dry process of manufacture. The present trend is not only to install dry process plants but also to convert the existing wet process into dry process ones, wherever it is possible. The latest development in the dry process technology is the design of a plant with multi-stage cyclone type suspension pre-heater. Fuel consumption in this type of process is as low.
In addition to the above, there are two significant advantages in the dry process, one, the relatively low lime element when compared to the wet process, and two, the less dependence on coal and thus on railways both of which have contributed towards increasing the under-utilisation of capacity in the Industry in some of the recent years.

**Wet Process Plants**

These plants contribute very little to national production and are totally outdated. The layout of many wet process plants is congested and does not enable retrofitting of modern energy-efficient upstream and downstream. The process of modernisation in the existing wet process is not found feasible due to the adverse economics and poor internal generation of investible funds. The wet process plants, therefore, have a very low level of technology in respect of overall unit operations.

For encouraging the industry to go for early conversion of the remaining wet process plants into dry process plants,
it is necessary that a special package be considered consisting of various concessions including fiscal, such as frozen power tariff, excise duty rebate, sales tax holiday, custom duty relief on essential imported equipment as a part of technology transfer, and easy concessional lending.

Dry Process/Semi-Dry Process Plants Built Before 1980

There are a number of technology gaps to be bridged to bring them closer to desirable efficiency level. All the innovation and modernisation adopted in the latest group of plants have to be added to these, which include system upgradation and necessary hardware, energy conservation systems, process control devices and quality assurance techniques.
Though earlier wet process was preferred in India, primarily from quality consideration of the product, dry process is now preferred because of lower fuel consumption (25% to 35% less than in the wet process) and lower requirements of water. Most of the new plants are of dry process. The capital costs for both dry and wet processes are almost the same. Conversion of the existing wet process plants to dry process depends on various parameters of existing equipment in the Plant, bearing capacity of civil foundations, possibility of retaining much of the existing equipment after conversion, availability of space, life of the existing equipment and distance from coalfields. Conversion of existing wet process plants to dry process could cost around Rs.1500/- to 2000/- per tonne of installed capacity depending upon the factors cited earlier. Panyam Cements converted its 300 TPD wet process kiln to 600 TPD dry process involving an expenditure of Rs.300 Lakhs. Conversions with such a low capital costs are not possible. The units employing beneficiation and making use of sludge from fertiliser plants cannot be converted to dry process for
obvious reasons. Conversion of existing wet process units to a dry process should thus be coupled with expansion of existing capacities to make them economically viable by taking advantage of higher retention prices allowed on expanded capacities.

The advent of one million tonne and above capacity dry process cement plants has brought into focus automatic kiln control systems based on expert and fuzzy systems. Expert Systems have also found applications in automatic control of closed circuit ball mills. Refractory safety and management is generally taken care of by continuous scanning of shell temperatures by using kiln shell promoters. As a corollary to automation, quality is also maintained by continuous monitoring of the raw mix composition with the help of X-ray Analyzer and Automatic Proportioning of Components of Raw Mix. New type of on-line bulk material analyzers have also been developed based on Prompt Gamma-ray Neutron Activation Analysis (PGNAA) for giving maximum control over raw mix for superior cement products. The analyzer quickly and reliably analyses the entire flow-on-line producing real time results in a minute.
(d) PRE-CALCINER TECHNOLOGY

Pre-calciner Technology is regarded as the most significant development in Cement Industry in the last two decades. The pre-calciner, as the name suggests calcines raw materials, partly or completely, depending on the design of the pre-calciner before the raw materials enter the kiln proper. It ensures that endothermic reaction of calcination of cement raw materials requiring the highest heat input in the entire cement clinkering process takes place outside the rotary kiln, thus reducing heat load in the kiln. It also makes it possible to supply a more uniform feed to cement kiln. Refractory consumption is also expected to be low if precalciner is used. Because of pre-calcining, sizes of the rotary kilns can be reduced for a given throughput. This particular aspect has relevance to the Indian Scene. A large number of existing cement plants are either old or operated with uneconomic capacities and processes. These Plants could be expanded by introducing suitable pre-calciner and providing balancing facilities, thus raising capacities with a relatively lower capital investment.
Pre-calciner technology has to be imported though attempts are now being made to develop know-how in the country. It has been suggested that among the technologies available, fluidised bed type pre-calciner is considered to be the most suitable for Indian Plants which are using pulversied coal as fuel. During 1971-75, Japan converted a total capacity (dry process SP kilns) of 66 Lakh Tonnes TPA to 94 Lakh Tonnes by addition of such pre-calciners, along with those of 17,250 TPD capacity of Wet Process Plants to 35,400 TPD capacities, based on dry process with pre-calciners. The capital investment required for conversion of dry SP kilns and wet process to dry-pre-calciner process were estimated at nearly one-third of the capital required for installation of new plants. The operating costs are also expected to be reduced significantly. Even for new plants of 1,200 TPD capacity a system with pre-calciner included could realise a saving of about Rs.60 Lakhs mainly because of decrease in kiln size, not withstanding additional capital cost incurred on pre-calciner compared to a system without pre-calciner. There is thus a good case of converting most of the existing wet process plants and dry SP kilns to dry-pre-calciner processes, if the existing balancing facilitates permit such conversions. ACC Limited has imported Mitsubishi Fludised System pre-calciners. KCP Limited has also import French Technology.
The Cement Research Institute of India recently designed a pre-calciner for a kiln (300 TPD) capacity of a cement plant in the South. It is expected that the throughput of this kiln would increase by 30% after installation of the pre-calciner.

In the late sixties and early seventies, the economic size of a plant was considered to be of 600 TPD Capacity. The optimum economic size was later raised to 1,200 TPD capacity. The Cement Manufacturers' Association, in response to a question by the Tariff Commission (1974), stated that "Keeping in View the National Employment Policy and Economies of Scale, a unit with a single kiln of 1,200 TPD be regarded as an Economic Unit", but it would be advisable to have two kilns of 600 TPD instead of one kiln of 1,200 TPD in view of the special conditions that exist in the country such as transport difficulties for raw materials and irregular power supply so that at least one kiln could be operated continuously. The DGTD in reply to the above question by the Tariff commission, stated that "until recently a cement plant of two lakh tonnes per annum capacity used to be considered as of economic size. However, the present trend is towards putting up of plants of capacity of four lakh tonnes per annum".
In response to the questionnaire sent by the NCAER to the cement manufacturers, bulk of replies received favoured a plant size of 1,200 TPD now and 2,000 TPD for the late eighties. Keeping all other variables constant, it is beyond doubt that the cost of production will be lower in case of larger sized plants. The limitation in going for 2,000 TPD plants at present is in regard to transport, namely, shifting plant machinery, especially kilns, from manufacturers to plant sites. In reply to the questionnaire sent by the NCAER, the Cement machinery manufacturers, expressed their capability to build 2,000 TPD capacity plant without any difficulty. Impact of precalciner technology (discussed in the following pages) will reduce the sizes of kilns, thereby solving the transportation problems for relatively larger size plants. Availability of adequate limestone reserves nearby is another problem in selecting larger sized plants.

The consensus in industry on the economic size of the unit at present is thus of 5,000 TPD capacity now, and it was 2,000 TPD in late eighties, when other technological inventions like precalciner technology were not incorporated in the manufacture of cement machinery and transport facilities which improved.
The introduction of precalcination technology in the plants built in the '80's has, in addition, entailed many other state-of-art sub-systems upstream and downstream of the clinkering unit. Some of the specific technological features of these plants are large-size single-stage crushers, pre-blending beds for limestone, vertical mill for raw material and coal grinding, large capacity continuous blending silo, 5/6-stage preheater with precalcinator, high-efficiency multi-channel kiln burner, closed-circuit cement grinding mills, high pressure roll press, variable speed slip recovery systems, variable frequency AC Motors, etc.

These plants have a high degree of instrumentation and centralised plant operation through PLC's/computer from the central control room. Specific computerised software package like raw mix control, process control and optimisation, refractory management system, energy management system, etc. have been adopted by some of the plants for the optimisation of production, reducing energy consumption, besides improving the quality of product.
These plants have been able to achieve substantial improvements in energy consumption levels by using advanced technology. The fuel consumption is in the range of 750-800 Kcal/Kg Clinker and Power Consumption is about 95-120 KWh/tonne of cement.

Processes

The development of pre-calcination technology in the mid '70's in Japan and its introduction in the Indian Cement Industry in the '80's marked the beginning of an era of large capacity kilns.

The plants presently under construction have been designed for a heat consumption of 700-725 Kcal/Kg Clinker and a power consumption of about 90-100 KWh/t Cement. These Plants incorporating advanced technology in almost all sub-systems are of international standards.

Presently 85% of the Cement Production is being contributed by more energy efficient dry process plants.
The use of pre-calcinator technology has enabled utilisation of high as coals with lower calorific value, as well as of various agricultural and industrial combustible wastes. Systems have been developed to use more difficult fuels like lignite. Calciners designed with longer retention time can also take coarsely ground fuels thereby saving in grinding cost. Almost all the new kiln installations are now coming up with precalininator. Precalcinators have been used to obtain 2-2.5 times higher production from the same kiln.

The introduction of high efficiency and low pressure drop cyclones has led to increase in the conventional 4-stage cyclone preheaters to 5-stage and even 6-stage cyclone preheaters with improved thermal efficiency and marginal increase in the pressure drop. Waste gases are now almost totally used in drying raw material and coal. With the latest development of controlled flow grate clinker cooler system, increase in cooler heat recuperation efficiency, decrease in clinker exit temperature and reduced maintenance costs are being achieved. The limitations of the conventional straight pipe burner have been overcome by highly flexible multi-channel burner. The multi-channel
burner enables easy and sensitive flame shape adjustment as well as gives rise to entrainment of secondary air. High Alumina refractory bricks which were mostly used by the Cement Plants in the past are now replaced by direct bonded magnesite-chrome bricks, periclase-spinel bricks, light weight high strength insulating bricks and monolithic refractories. The aluminum zirconium-silicate bricks with coating repellent properties are also in now use with the new improved refractory bricks, it is possible to increase refractory life and reduce radiation losses.

(e) UTILISATION OF WASTE MATERIAL

It has been found that the utilisation of slag, an industrial waste from the steel mills can effectively be used in large quantities for cement manufacture. Clinker is not required to be used for the manufacture of this cement, avoiding a long and expensive list of various machineries and raw materials up to the clinkering stage. Granulated slag which is a major raw material for this cement is ground with calcined gypsum and hydrated lime.
On Commercial scale, these materials could be easily ground in suitable ball mill up to the required fineness of 4,000 cm/gram. For calcination of limestone and gypsum a small down draft dome type kiln would be most suitable. Its cost of construction will also be low and the flue gases may be economically used for drying the granulated slag by passing them through a series of hot chambers. The powdered gypsum can be pressed in the form of bricks, using some binding agent, dried, in the hot chamber and burnt in the down draft kiln.

Phosphorous Slag

Phosphorous slag is another waste material receiving attention now. When Phosphorous is produced by the electric furnace method at temperature of 1,200 - 1,400 °C from calcium phosphate, slag consisting of CaO and SiO₂ is produced. Granulated phosphorous slag could be used in producing phosphorous slag cement. This slag is softer than granulated blast furnace slag. Experiments conducted by the Central Building Research Institute showed that phosphorous slag can be added up to 25% to Portland Cement.
Phospho-Gypsum

Gypsum is a by-product in the production of phosphoric acid from phosphate rock by the wet process in fertiliser plants. It can be used in place of natural gypsum in cement production. Currently 1.3 million tonnes per annum of phospho-gypsum is available and additional 1.8 million tonnes per annum are expected to be available from the plants under implementation. ACC Limited have plans to use phosphogypsum for a few of its cement plants located near fertiliser plants producing phospho-gypsum as a by-product. The phospho-gypsum needs purification before it is used in production of the cement.

Super Sulphated Cement

Super Sulphated Cement can be produced by grinding slag (about 80%), gypsum (10%) and hydrated lime (about 10%). Clinker is not required for this cement. It was estimated that the capital cost of plants producing super sulphated cement would be only one-fourth of the conventional OPC
Plants. This cement has greater resistance to sulphates, seawater, oil and fats and diluted acids, and is suitable for mass concrete jobs, marine works and concrete construction in sulphate-bearing soils. These plants could be a smaller scale of about 50 to 100 tonnes per day production. The main drawback of this type of cement is its hygroscopic nature. Precautions should be taken in packing and storing. The conventional jute bags cannot be used for packing this cement. This type of cement has thus limited scope and plants can only be planned very near consuming centres to reduce the time interval between production and consumption, so that it would not have time to absorb moisture in the atmosphere.

FLY ASH

With the introduction of electrostatic precipitators in the Thermal Power Projects for generation of electricity, the availability of fly-ash pozzolana is in plenty all over the country. This material which otherwise is a pollution hazard and a problem for Thermal Power Projects is an excellent
Pozzolanic material for replacement of part of the cement (Bureau of Indian Standards permits replacement up to 25%). This replacement can be done either by grinding clinker along with flyash or by the blending the fly-ash with OPC.

In view of the good quality of flyash available from modern thermal power plants and availability of high quality clinker due to advanced technologies available to the cement plants, it is observed that the quality of PPC being produced by some of the plants at present is quite good and is having compressive strength values much in excess of the values specified for 53 grade OPC.

For the concrete of structures which has to face aggressive waters containing chlorides and sulphates, the fly-ash based PPC provides improved resistance than normal OPC. This note covers the durability aspects of concrete made with fly-ash based PPC for marine structures, foundations and super-structure in polluted corrosive atmosphere and also the additional compressive strength advantage fly ash based PPC has.
Fly-ash a waste product from modern thermal power house. It is a pollution hazard and its disposal is a problem for the thermal power houses. With the use of flyash based PPC, we will be able to convert this industrial caste product into value added product i.e. PPC which is in national interest and is environment friendly.

It is estimated that the volume of various industrial, agricultural and urban wastes produced annually in India are:

- Industrial including Mining Wastes: 250 Million Tonnes
- Agricultural Wastes: 500 Million Tonnes
- Rural and Urban Wastes: 1900 Million Tonnes

Use of fly ash and slag should be further encouraged, Portland Slag Cement have provision for use of slags other than blast furnace slag, which should be taken advantage of.

Another problem common to Indian Cement Industry is use of high ash coal for cement manufacture. Its variable ash content results in increasing coal consumption, thus leading to the problem of ash absorption in clinker.
A list of various industrial wastes which can be used for cement and their availability in India is given below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Waste</th>
<th>Source</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Million Tonnes Per Annum</td>
</tr>
<tr>
<td>1</td>
<td>Fly ash</td>
<td>Thermal Power Station</td>
<td>36.0</td>
</tr>
<tr>
<td>2</td>
<td>Blast furnace Slag</td>
<td>Steel Plants</td>
<td>7.8</td>
</tr>
<tr>
<td>3</td>
<td>Lime Sludge</td>
<td>Paper, Sugar, Fertilizer acetylene, chromium industry.</td>
<td>6.0</td>
</tr>
<tr>
<td>4</td>
<td>Phospho-gypsum, Fluoro-gypsum</td>
<td>Fertilizer Plants</td>
<td>5.5</td>
</tr>
<tr>
<td>5</td>
<td>Red Mud</td>
<td>Aluminium Plants</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>Ferro-alloys, metallurgical slags</td>
<td>Smelters</td>
<td>10.0</td>
</tr>
<tr>
<td>7</td>
<td>Silica dust</td>
<td>-</td>
<td>Small Quantity</td>
</tr>
<tr>
<td>8</td>
<td>Kiln dust</td>
<td>Cement Plants</td>
<td>5.0</td>
</tr>
<tr>
<td>9</td>
<td>Rice husk</td>
<td>Rice Mills</td>
<td>40.0</td>
</tr>
</tbody>
</table>

Source: NCB
(f) ELECTRONIC PACKER - A NEW SYSTEM

1. INTRODUCTION

As we are well aware, cement be classified as inexpensive material, therefore cost of packing, loading and despatching should be minimized. It is also important that the correct amount of cement is filled in each bag, i.e. accuracy is very essential.

In recent years, there have been many developments in the cement packing equipment. Earlier we had stationery packing machines, then we had rotary type but mechanically operated packing machines. And latest entrant to packaging field is electronically operated rotary packing machine.

2. PACKING PLANT

In the conventional system, the storage of cement is provided by the flat-bottom high capacity silo.
supported direct on the natural soil. This solution may lead to a saving of up to 30 percent in capital cost as compared with the elevated silo. The packing plant is set up in a separate building beside or close to the storage silo. The cement is supplied to the packing machine via the silo discharge device, bucket elevator, vibrating screen and feed bin. Spillage and dust collected in the filter are returned to the feed bin and to the bucket elevator respectively.

It is very important to have continuous availability of cement for filling into sacks. Therefore, the capacity of the conveying and handling devices is much higher than that of the packer. It is moreover advisable to install before each packer a screen to intercept foreign bodies. Experience has shown that a mesh size 10 x 20 is appropriate for the purpose though 4 x 4 mm is also used. This ensures that any larger objects that happen to be present in the cement and are liable to cause trouble in the packing machine are eliminated. It is very important to have good level indicators and bag filter installations.
3. PACKING MACHINES

The electronic packers can be broadly divided into two types viz.,

(a) Impeller type filling system and
(b) Fluidised filling system

(a) Impeller type filling system

In this type each spout of the packing machine is connected with a motorised impeller which regulates flow of cement from spout to the bag. This implies that we have to have a drive arrangement for each spout of the packer, over and above the Main drive required to rotate the tank; hence power consumption in this type of packer is very high.

(b) Fluidised Filling System

In this type of filling, the complete packer bottom is injected with high pressure air through
sintered bronze plates. This results in fluidising of cement and the cement flows out of the packer tank into the bags attached to the spouts. The cement quality to be filled is regulated by a slide gate placed between the spout and packer. Thus when the required quantity of cement is filled in the bag this gate closes, stopping further flow of cement into the bag.

Since no motorised arrangement is required for each spout the power consumption will be limited to the main drive and additional compressed air required for fluidising. It has been found that total power consumption in this type of packer is much less than that of impeller type.
INTRODUCTION

If it is true that a cement plant wants to optimize raw mix control, then it is possible to approach closer to this goal via the technique of high analytical frequency. The QCX/On Stream module (part of the FLS Automation QCX/System) address this requirement by means of the integration of a suitable robust analytical device. This device employs a proven optimization software program, such as the FLS Automation QCX/Proportioner.

The result is a means of moving the laboratory to the process point, reducing time otherwise used for sample transport. Sample material is analyzed without processing or preparation, further reducing time and sample variance. Benefits realized from this frequency of sampling and analyses include better kiln feed, more uniform refractory coating, lower power consumption, and better cement quality. These benefits are partially attributed to the QCX/OnStream method of lowcost tighter quality control.
Incorporating the latest in reliable and roughest equipment technology has enabled FLS Automation to integrate XRF systems operations in a complex of quality management and process control normally otherwise acquired via laboratory instrumentation.

When FLS Automation originally developed QCX (Quality Control through Computer and X-Ray), the system was based upon a dedicated X-ray quality control system. The application was designed around a production laboratory that provided chemical quality data 24 hours/day. Today's QCX system incorporates a design that applies all laboratory functions using LIMS (Laboratory Information Management System) technology for quality control.

Inherent in any system that is to be part of the heart of the plant process is the foreknowledge that the requirements for sampling and data management will vary considerably from one plant to another. This is largely a measure of the type and availability of the raw materials, the degree of heterogeneity of these materials, the condition
and vintage of production machinery, and, overriding all of the latter, the quality assurance needs as defined by management.

Key to this idea is simplicity of operation and avoidance of human intervention for purposes of maintenance or other intervention. This is reflected in the design of the system componentry, which is based on the premise that raw mix control can be optimized by high frequency of analysis to which feeder set points can be adjusted according to analytical results. The advent of robust, compact, microprocessor-based analytical devices has allowed the incorporation of lowcost, high reliability, modular systems adequate to these needs.

One variable which has confounded most attempts at rigorous, reliable and accurate analysis has been the nearly insurmountable task of achieving true and error-free sampling. If it is assumed that it is next to impossible to achieve a 100 percent statistically correct sampling of powder materials, then any technique that can reduce sampling error will lead to better total accuracy and precision obtained with the analytical device employed.
The system that resulted from this design automatically analyzes samples taken every 2-5 minutes in a milieu where the sample bias is reduced. This technique advance the possibility of eliminating sampling uncertainty. That is, the greater this factor can be reduced, the closer the measure of the actual instrumentation can be said to approach the true value of what is being analyzed. The higher the frequency of this type of measurement, the closer the technique approaches true real-time analysis. In the end, if these several and separate goals can be met, data acquired and retrieved becomes more useful in achieving quality control, and the more dynamic the process control becomes.

ON-STREAM TECHNIQUES

On-stream / on-line / in-line / in-stream analytical techniques are employed in process instrumentation and automation primarily to monitor changes as they occur. Reaction to information indicating an out-of-target situation has the greatest benefit when the time between occurrence and correction is reduced to an absolute minimum. Thus, the maximum benefit occurs when the residence time from sample to analytical result to corrective action is at minimum. In the end, the goal is to provide the means for achieving a constant condition status-reaction continuum.
It is now possible to accomplish the above by using a low-energy X-ray tube for targeting the most important cement-specific light elements. So-called TEEDXRF (tube excited EDXRF) allows continuous rapid analysis (less than five minutes total elapsed time) for all four, or even five cement-specific key Oxides (CaO, SiO₂, Al₂O₃, FeO, and MgO). Most notably the technique is essentially free from sample preparation and solves questions of sample presentation.

The fully integrated version includes a serial connection to the laboratory X-ray system (such as QCX Laboratory), and setpoints for the inner loop are automatically calculated based on the QCX/Proportioner and average sample values. Analytical values can be automatically logged and stored.

RESULTS OF OPERATIONAL EXPERIENCE AT AN INSTALLED PLANT

Quarry Optimization is where the process for consistent chemistry really begins. Any reliable monitoring and control system that can accomplish this end reduces material heterogeneity far upstream in the plant process. The QCX/OnStream takes advantages of the optimized quarry through the other modules in the system and moderates the feed chemistry.
POLLUTION CONTROL BY ESP

INTRODUCTION

The Cement industry in India has undergone a phenomenal growth in the past two decades. The overall installed capacity of the cement plants has now reached about 60 million tonnes and this is expected to pick up once again the next decade. This is because the overall per capita consumption of cement in India is lower compared to that of other countries.

The process of cement manufacturing has contributed significantly to the air pollution level within and outside the premises of the cement plant. Large quantities of pulverised material being handled contribute to the air pollution problem mainly through stack emissions from kilns, mills, clinker cooler etc. The overall pollution created by the cement plants on global level are of less significance. The local problems are more important.
Specific norms and standards have been evolved for pollution control by many countries including India. In many countries, the pollution control act is more stringent than in India. The dust emission levels have been restricted to less than 50 mg/Nm³ in some of the countries, where in India the emission limits are in the range of 100-400 mg/Nm³ depending on the size, status and the location of the plant. The government has issued strict guidelines requiring the industries to obtain no objection certificate from the respective state pollution control boards before an industrial licence is converted into a Letter of Intent. It is also possible that more stringent emission limits may be favoured in view of the awareness of both the government and the public about pollution hazards.

**DUST SOURCES**

In the cement plant dust is generated at all stages of production from quarry to packing of the cement. The dust sources can be generally classified into "point sources" and "diffuse sources". Dust control at point source is of major importance in this paper as control of dust emission from
diffuse sources are dealt separately. Of the point sources, the major dust is produced in the kilns, mills and grate cooler which are all vented through chimneys.

EXPERIENCE OF FLAKT IN THE CEMENT INDUSTRY

Flakt India probably has the widest experience that any Company can boast of in the field of air pollution control for the cement industry. Nearly 100 installations of ESPs and over 200 installations of Bag Filters in the Cement Industry alone speak volumes on the experience of Flakt in the Cement Industry.

ESP s in the Cement Industry

ESP s are predominantly used in the cement industry for collection of dust from cement kiln, cement mill and coal/lignite mills. A new area for installation of ESP in the Clinker cooler for which so long only multiclones were used to meet the pollution control demand.
Flakt India started with the first installation of ESP for a cement kiln way back in the late sixties. Since then cement production in India has gone through tremendous change. With the installation of more ESPs in India, the design philosophy has been upgraded to suit typical Indian conditions. Major emphasis is placed on improving dust collection efficiency and high availability of the equipment. In view of the rising cost of production, power saving aspects are also given due importance in the design of all the air pollution control equipment like the EPIC Controllers for ESPs and the energy efficient pulsing system for bag filters.

Recent Developments in the Design of ESP

ESPs in the beginning were charged with conventional TR sets for dust collection in all the processes. It was felt that a better method of charging of the ESP will improve overall performance. Years of research and development combined with test programmes of numerous ESP installations have culminated in the development of two distinct pulsing concepts for Flakt ESP namely,

- Semipulse Concept
- Multipulse Concept
The semipulse concept has been employed in many of the Flakit ESPs for various processes including cement. The use of multipulse concept is prevalent in the power industry. Of late, it has also found its way into the cement industry and a few ESPs with multipulse concept are being installed in India.