# Capacity Enhancement and Energy Conservation in Cement Plant

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## ABSTRACT

The cement industry continues to remain in a stage where pressures are increasing to remain competitive by optimising operations and reducing cost of production. The specific cost of production, to some extent, can be lowered by way of the capacity enhancement leading to increased sales volume. Similarly, the variable cost of production can be reduced significantly by energy conservation.

The present paper focuses on the scope for capacity enhancement and energy conservation in the existing cement plant. This paper also discusses various options for capacity upgradation and energy conservation of an equipment or the plant, as a whole. A case study where in few options were exercised for the capacity upgradation in the existing cement plant has also been included in this paper.

## 1 INTRODUCTION

As the specific cost of capacity upgradation is significantly less than that for installing a green field cement plant, it becomes important that all the available potential for enhancing production is exploited from the existing plant and machinery. Likewise, the cost of energy is important to be conserved.

Savings in production cost and increased sales volume lead to improved profitability and which is the ultimate objective of operating business.

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## 2 METHODOLOGY

A typical methodology for capacity enhancement and energy conservation would include:

- Comprehensive study, covering the assessment of existing equipments and operating practices.

- Preparation of a feasibility report covering technical concept and financial calculations.

- Implementations of the technical concept.

For capacity enhancement and energy conservation, It is generally more advantageous to conduct a comprehensive plant operational audit study covering entire cement production process. This is due to the fact that all the unit operations are inter related. The study may be done either by some members of the plant team or by some external agency. The study incorporates the capacity enhancement in three categories viz. Without investment, Limited investment and Major investment, which may be decided on case to case basis.

## 3 CONCEPT

The whole idea of capacity enhancement is basically conceptualized from the assessment of potential available with the existing equipment or system.

Primarily, the maximum achievable capacity of the kiln is the critical criteria for deciding the enhanced capacity of the plant. Some important factors influencing the kiln capacity include:

- Specific volumetric loading in $tpd/m^3$

- Specific thermal loading in $Gcal/h/m^2$

- Kiln filling, %

For instance, many cement plants world over are operating their kilns with a specific volumetric loading of about 6.5 $tpd/m^3$ . Similarly, some cement plants suppliers recommend the specific thermal loading upto 5.5 $Gcal/h/m^2$. In order to maintain the kiln filling as per recommended norms, Operation of some kilns is being done successfully at a kiln speed upto 5.5 rpm.

Based on the above and other concepts some of the ideas for capacity upgradation and energy conservation in major unit operations of cement production process are as given in table below:

| Equipment | Improvement area |
|---|---|
| Kiln | • Conversion of a Wet/ Semi wet process kiln to dry process kiln<br>• Maintain kiln filling within the recommended norms. |
| Preheater and precalciner | • False air infiltration to be controlled.<br>• Conversion/ replacement of the conventional cyclones by low pressure, high efficiency cyclones.<br>• Installation of an additional cyclone in parallel to the existing top stage cyclone (s) to reduce the pressure drop.<br>• Enlargement of the riser ducts<br>• An additional preheater string can be installed in parallel with existing preheater string.<br>• Replacement of conventional insulation bricks by block insulation.<br>• Effective volume of the existing precalciner can be increased by:<br>➢ Increasing height/ diameter of the precalciner.<br>➢ Providing an extension duct.<br>➢ A balancing precalciner can be installed in series with the existing one. |
| Gas cooling | • Air aided water spray system may be replaced by high pressure water spray system.<br>• Considering the heat requirement for grinding, the GCT may be shifted from 'after the preheater fan' to 'before the preheater fan'.<br>• Gas cooling may be done in preheater downcomer duct. |

| Equipment | Improvement area |
| --- | --- |
| Clinker cooler | • Retrofitting of the static, high heat recuperation efficiency plates in the initial 7/ 8 rows of the first grate.<br>• Replacement of conventional grate plates by high efficiency grate plates.<br>• Internal water spray over clinker bed at the middle of cooler. |
| Process fans | • Retrofitting the high efficiency impeller.<br>• Increasing the impeller diameter by tipping.<br>• Installation of speed regulation devices in fixed speed fans.<br>• Removal of inlet dampers, wherever possible.<br>• Replacement of low efficiency fans by high efficiency fans.<br>• Installation of parallel fans. |
| Mills | • Optimisation of the existing ball mills by modifying the charge composition and quantity, arresting the false air entry, gas velocity optimisation, operating parameters stabilisation etc.<br>• Optimisation of vertical mills involving arresting the false air, nozzle velocity optimisation, optimisation of operating parameters, dam ring height adjustment, feed size reduction, etc.<br>• Replacement of conventional low efficiency separators by new generation high efficiency separators.<br>• Increasing the width of the existing tyre of the rollers.<br>• Installation of precrusher/ pregrinder with ball mills.<br>• Installation of energy efficient grinding systems like vertical roller mill, roller press in finish mode etc.<br>• Using the product of roller press from other production unit as a feed to the existing ball mill. |
| Material transport system | • Optimising the consumption of compressed/ pressure air.<br>• Replacement of the pneumatic transport by mechanical transport system like belt conveyor, bucket elevators etc.<br>• Modifying the transport rout to minimise the travel distance. |

| Equipment | Improvement area |
|---|---|
| Electrical systems | • Improving the power factor.<br>• Replacing the conventional motors by high efficiency motors.<br>• Optimising the lighting load.<br>• Control of plant illumination system by doing it in auto mode. |
| Environment control | • Replacement of multiclones by ESP/ bag filters.<br>• Installation of new fields in parallel/ series with the existing ESP.<br>• Replacement of glass bags by membrane type bags.<br>• Installation of additional chambers with the existing bag filters.<br>• Extension of GCT height. |
| General | • Minimising the idle run of equipment.<br>• Prevention of wastages like water, lubricants, compressed air etc.<br>• Installation of optimisaton packages like:<br>➢ Kiln optimisation system<br>➢ Refractory management system<br>➢ Integrated energy management system |
| Product diversification | • Blended cement like Portland pozzolana cement (PPC), Portland slag cement (PSC) etc. can be produced. |

Above proposals can be implemented depending on the following:

- Situation analysis
- Plant assessment
- Availability of space
- Down time requirement
- Marketing potential
- Financial gains like, net profit, payback period, internal rate of return (IRR) etc.

- Availability of funds

## 4 CASE STUDY

Holtec had carried out a plant operations audit in a dry process cement plant operating at a capacity of about 3,350 tpd clinker.

The important details of plant are as follows:

| | |
|---|---|
| Kiln | : Rotary kiln, 4.4m dia. x 68 m long |
| Preheater | : 5 stage with N- MFC system |
| Raw mill | : Vertical raw mill with dynamic classifier |
| Cement mill | : Ball mill, 2 chambers close circuit with dynamic separator |

The plant capacity enhancement are as follows:

**With minor investment:**

Initially, the plant capacity was enhanced to about 3,900 tpd clinker. The major activities carried out during this phase of capacity upgradation are as given below:

- Reduction of dam ring height by 10 mm in the vertical raw mill.
- Replacement of single flap by double flaps in raw mill inlet feeding chute.
- Replacement of pneumatic transport system by mechanical system having air slides and bucket elevators in kiln feed.
- Increasing the operating speed of kiln.
- Enlargement of smoke chamber.
- Installation of a 3rd cyclone in parallel to the existing twin cyclones at top stage of the preheater.
- Extension of the precalciner volume by increasing its height by 5 meters.
- Replacing the cold air at ambient temperature by preheated tertiary air in precalciner for oil firing.
- Optimising the speed of grates in the clinker cooler.
- Optimisation of grinding media charge in the ball mill for cement grinding.

- Reducing the pressure drop across the bag filter for cement mill venting.

As a result, the following improvements were achieved:

- Capacity of vertical raw mill increased from 275 tph to 295 tph.
- Kiln production increased from about 3,350 tpd clinker to 3,900 tpd clinker.
- Kiln primary air reduced from about 13.0% to 8%.
- Cement mill capacity increased from 175 tph to 185 tph.
- Specific power consumption reduced from 104 kWh/t cement to 98 kWh/t cement.
- Saving in specific heat consumption by 23 Kcal/ kg clinker i.e. From 754 Kcal/ kg clinker to 731 Kcal/ kg clinker.

**With major investment:**

In the second phase, the plant capacity is envisaged to increase from 3,900 tpd clinker to 5,100 tpd clinker**.**

- Installation of a new vertical raw mill of capacity 180 tph.
- Increasing the kiln speed to 4.8 rpm.
- Installation of a new suitably sized SLC type PC with 5 stage PH. Using the existing preheater as kiln string.
- Installation of a new GCT for PC string gas.
- Retrofitting the high efficiency, fixed plates in first 7/ 8 rows of cooler and extension of cooler area from 72 $m^2$ to 93 $m^2$.
- Installing a parallel field with the existing cooler ESP.
- Replacement of existing deep pan conveyor by a suitably designed conveyor for clinker transport from cooler exit to clinker silo.
- Installation of a pregrinder before the existing cement mill to enhance the system capacity from 185 tph to 280 tph.
- Providing parallel chamber with the existing raw mill/ kiln ESP.

With this phase of upgradation, the following are envisaged:

- Kiln capacity increased from 3,900 tpd clinker to 5,100 tpd clinker.

- Reduction in specific power consumption from 98 kWh/t to 94 kWh/ t.

- Specific fuel consumption is likely to reduce from 731 Kcal/ kg clinker to 723 Kcal/ kg clinker.

## 5 CONCLUSION

The capacity enhancement by upgradation and energy conservation in an existing cement plant help to reduce the specific cost of production. Capacity enhancement can be done by utilizing the available equipment to it's full potential and adding balancing equipment, wherever required. Energy conservation can be achieved by optimising the operation and installing energy efficient equipment.