COST REDUCTON MEASURES IN A CEMENT PLANT

Cost reduction initiatives in cement plants are essential for maintaining competitiveness, profitability, and sustainability in a challenging market. By optimizing operational efficiency and minimizing expenses, cement plants can enhance profitability and financial resilience. Cost reduction measures also enable investments in technology, and environmental compliance, thereby ensure long-term viability. The improvement in operation efficiency results into reducing operation costs and helps mitigate risks associated with fluctuating market prices, regulatory changes, and economic uncertainties. By prioritizing cost reduction initiatives, cement plants can improve their ability to adapt to market dynamics and remain resilient in the face of evolving challenges, ultimately securing their position in the industry.

An elaboration of various cost reduction measures that can be implemented in a cement plant are mentioned as below:

1. Efficient System Design:

Cost reduction measures usually starts from the early stage, while conceiving the concept of system design. An efficient system design involves some key decisive factors which need to be incorporated while developing the technical concept. The decisions mostly focused on the investment cost, cost of operation and maintenance, optimised manpower, accessibility of energy resources (power and fuel) and Plant location from the prospective market. Some of the key criterions for selection, can be described as follows;

- System availability and reliability
- Ease of operation and maintenance
- Skilled manpower availability and subsequent support services
- Operating cost
- Investment cost

Further, Plant layout has significant impact on overall energy consumption of the plant. Hence, proper technical approach is of utmost importance while finalising plant concept. Some of the key areas can be mentioned, as below;

1. Use of natural contours of the plant
2. Less no. of transfer towers for belt conveyors
3. Using mechanical conveying instead of pneumatic conveying
4. Minimising ducting length to reduce pressure loss
5. Proximity of coal mill to Preheater building
6. Distributed compressor house instead of centralised compressor room
7. Positioning of the Load Centres to minimise the Cable Loss & having decentralised distribution system

The overall idea for an efficient system design is to select the most suitable option which justifies the afore-mentioned points and leads towards optimization of cost of operation.

2. Adaptation of Advanced Technologies:

Adapting the most advanced technologies in cement plants is essential for enhancing efficiency, reducing environmental impact, and maintaining competitiveness. Hence, selection of technologies is of prime importance and should be relevant to the particular situation.

Grinding Systems:

Selection of grinding technology should pertain to the following factors which influences the systems performance;

- Physical characteristics of the materials
- Moisture content
- Grindability of material
- Operational Cost related to maintenance
- Specific investments required

Grinding systems are energy intensive and consumed approximately 65-70% of the total power demand of cement manufacturing process. Hence, selection of proper technologies could be beneficial, to reduce the operation cost.

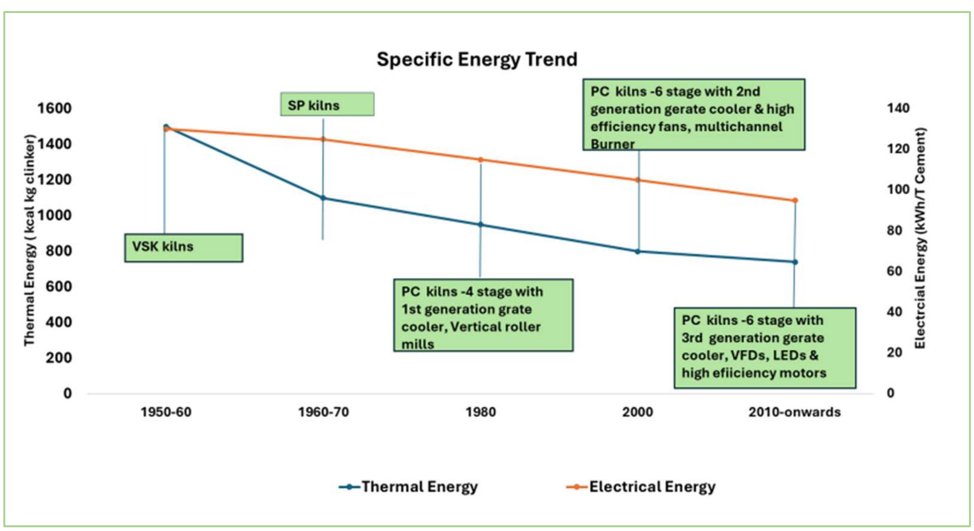
1. Vertical Roller Mills (VRM) are considered to be the most energy efficient system over the traditional Ball Mill, as its grinding efficiency is almost 30-40% higher than Ball Mill. No limitation in moisture content of the incoming material (can handle ~20%) and inclusion of an external recirculation system makes it more effective w.r.t. Ball Mill system.
2. High Pressure Grinding Rolls (HPGR) is also an efficient grinding system, similar to the VRM. This system can be used for pre-grinding, semi-finish and finish grinding, as well. Induction of HPGR with existing Ball Mill system in Clinker grinding, further reduces energy consumption and enhance productivity for cement mill application. Product quality is the key factor for HPGR systems as it ensures better PSD and minimum water demand for cement products. Present generation of HPGR systems are more energy efficient as compared to VRM, especially for Raw grinding.
3. High Efficiency Separators in grinding circuits are very effective towards particle size regulation, productivity enhancement and reduction in grinding power consumption, to the extent of ~15%. Introducing these Separators, reduce the chances of overgrinding and helps optimizing the Ball Mill charge, as well, in case of Clinker grinding.
4. In an operating Cement Ball Mill, introducing Improved Ball Mill Internals shall further improve the grinding efficiency, resulting into improved productivity and reduced power consumption. Improved high-chrome grinding media resulting into lower wear rate, controlled flow diaphragms and boltless liners are some of the key features, contributing towards significant cost reduction in the Clinker grinding section.
5. Studies comprising of various Grinding System's for Clinker grinding, comparison of specific power consumption at equal Throughput & Product Fineness, reveals the following as below.

Mill System	BM	HPGR as Pregrinder	VRM	HPGR in Semi-Finish Mode
SPC (kWh/t Cem)	38.2	29.7	21.8	20.8

Pyro-processing System:

Major technological developments over the past decade were focused more into thermal energy savings, effective AFR usage to reduce carbon footprint, and optimizing components of the Preheater system while making it more efficient for the WHR Boilers at Preheater and Cooler end. Below are some of the technological developments, aimed at reducing the cost of operation.

1. Advanced Precalcinator system
2. External combustor system for various AFR burning (for higher size materials)
3. Low primary air multi-channel burners
4. Improved Clinker Cooler technology with hot air recirculation
5. Improved refractory application in Kiln
6. Application of high efficiency process fans



3. Cost Reduction Thru' Process Optimization:

Optimizing the cement manufacturing processes involves maximizing efficiency, and productivity. Further, optimization leads towards reducing environmental impact through continuous improvement of raw material preparation, clinker production, and clinker grinding. Some examples of key optimisation measures are mentioned as below;

- The important tracking parameters like temperature, pressure, etc need to be maintained within the prescribe limit, for efficient system performance.
- System false air infiltration should be maintained as minimum as possible. For e.g., Pyro system efficient operation can be achieved if false air across the Preheater can be restricted below 7%. Every 1% reduction in False Air shall reduce the SHC by around 2-3 kcal/kg Clk.
- Optimization of the Kiln burner operation (effective ratio between axial and radial air) and its position inside the Kiln can result into desired flame shape and intensity, while maintaining the primary air quantity at minimum level
- Clinker Cooler operation should be optimized to achieve maximum heat recuperation, so as to lower the Sp. Heat Consumption. An effective balancing between Cooler grate speed and resulting Secondary Air and Tertiary Air temperature, is of prime importance. Further, with WHR installed, the balancing between effective heat utilization vs WHR generation also plays a major role, in defining the systems overall efficiency
- Maintaining optimum fineness of Cement leads to lower power consumption and enhanced production, as well. This can be determined by analysing the ongoing Cement quality and predicting the Cement Strength, through implementation of Prediction models (AI/ML based), where target for optimized Cement Fineness can be prescribed.
- Idle running of the equipment should be avoided, especially during Plant startup and stopping period, through implementation of sequential interlocking. Further, creating awareness among the operation team members shall have direct influence on reducing the cost of operating.

Periodic Audits need to be conducted to assess the System performance and its inefficiencies. The exercise should focus on the following;

- Optimizing the system throughput
- Optimizing specific energy consumption
- Prompt addressing of issues related mechanical, electrical and process
- Optimizing quality of final product
- Addressing issues related to environment

Optimization Thru' Data Analytics:

Optimizing Plant operation through implementation of Advanced Data Analytics, is showing an increasing trend, now a day. Various AI/ML models are being used to Predict / Forecast the key variables, which have significant impact on the Plant operational performance. These machine guided solutions help the Plant operation team to take proactive measures, which ensures sustainability of the ongoing processes.

To optimize the operation based on data analytics, AI/ML based Analytics models, developed by Holtec, gives additional advantage towards fulfilment of cost reduction initiatives.

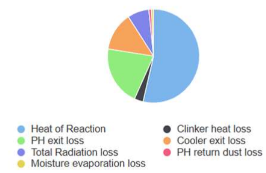
Online Heat Balance | Last Update On: 2024-04-05 21:14:52 | Auto Refresh

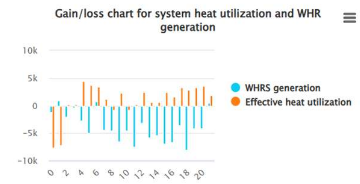
HEAT OUTPUT (KCAL/ KG CLINKER)	CURRENT	TODAY AVG	PREV DAY AVG	TARGET	ACTUAL TEMP	TARGET TEMP
Heat of Reaction	404	404	404	403		
Clinker heat loss	23.4	26.7	30.8	29	121.7	150
PH exit loss	155.4	155.3	150.8	156	317.2	310
Cooler exit loss	100.3	108.9	109.5	110	415.6	370
Total Radiation loss	57	57.1	55.4	48		
PH return dust loss	6.8	6.8	6.8	7		
Moisture evaporation loss	5.5	5.5	5.6	6		

HEAT INPUT (KCAL/ KG CLINKER)	CURRENT	TODAY AVG	PREV DAY AVG	TARGET	ACTUAL TEMP	TARGET TEMP
Sensible heat input	28.2	29.3	28.4	25		
Cooling air input	25.3	25.9	25.9	29	49.2	

PRODUCTION KPIs	CURRENT	TODAY AVG	PREV DAY AVG	TARGET
Specific heat consumption(kcal\kgcl)	698.8	709.1	708.6	700
Clinker production rate (TPH)	234.5	236.8	244.4	250
WHRS Generation(MW)	7.2	7	7	7

Gain/ loss WRT effective heat utilization (Today till now in INR):	-84,329
Gain/ loss WRT ref WHRS generation (Today till now in INR):	22,167
System heat utilization Vs WHRS generation (Today	-62,162

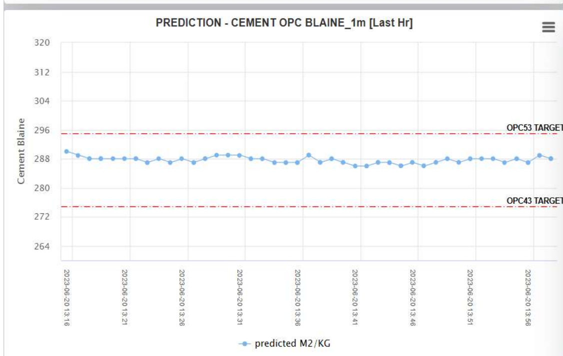


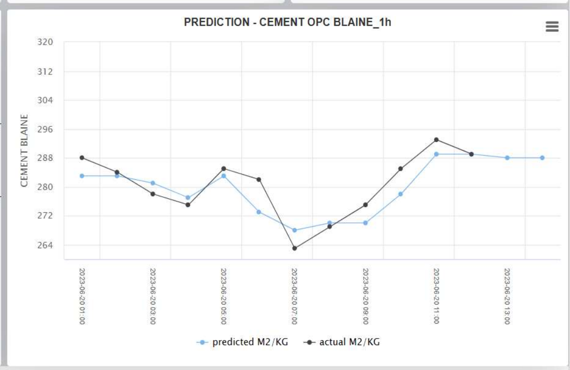


Real-Time Heat & Mass Balance with Effective Heat Utilization vs WHR Power Generation

Intelligent Report | Performance Review | Unit Operation | Data Analysis | Interventions | Collaboration | Help | Logout | ABC Plant : Mode=Test User: MVR

Prediction Model For Cement Blaine | Last Update On: 2023-06-20 13:59:36 | Auto Refresh





PREDICTED VS TARGET STRENGTH [2023-04-23]

	1 day Strength	28 Days Strength
Predicted Value	21.1	58.3
Target Value	21.0	56.0
Target Blaine	302	

Save To Database

SAVED RUN RECORDS OF [2023-04-23]

PRODUCT	1D TARGET STRENGTH	28D TARGET STRENGTH	IR	CaO	Na2O	SO3	BLAINE	+45 MICRON	1D PREDICTED STRENGTH	28D PREDICTED STRENGTH	TARGET BLAINE	RUN BY
opc53	20.00	58.00	1.66	63.29	0.16	2.16	298.00	12.80	20.90	58.80	0.00	

Cement Fineness and Cement Compressive Strength Prediction Models (AI/ML based)

Holtec proprietary Cement Fineness Prediction model and 28D Compressive Strength Prediction model helps in eliminating under or over quality product, before being sent to the market. An estimated savings of 2-3 % reduction in cost of production is envisaged.

4. Optimization of Raw Materials Cost:

Effective use of raw materials in cement plants involves optimizing the sourcing, handling, and processing to ensure uninterrupted production while minimizing the operation costs and environmental impact, as well. The following can be useful while considering the target to reduce the raw materials cost.

1. Usage of cost-effective correctives and additives, while keeping a close watch on their quality aspects and formulating a competitive, low cost raw mix design.
2. Using high MgO limestone in the clinkering process can impact the clinker quality, leading to expansion of cement. Hence, the same can be used in the clinker grinding process, as performance improver, limiting to max allowable as per standards.
3. Exploring usage of limestone with higher Alkali content, by balancing with high Sulphur, low-cost fuels results into decrease in raw materials cost or by adding small amount of Gypsum during the Milling stage.
4. Usage of alternate raw materials like Iron sludge, Red mud, Red ochre, LD Slag, Zinc Slag, etc are being used successfully in several plants, which proves to be cost effective, as well. Use of ARM's can reduce the raw materials cost to the tune of 0.05-0.07 USD/t of Clk.

Regular testing and analysis of raw materials is of high importance, to ensure compliance with the quality standards and subsequent optimization of the process parameters, shall lead to improved performance and competitiveness in the cement industry.

5. Usage of Alternative fuel :

Dispensing with fossil fuel & reduction of CO_2 emission is key concern of a cement manufacturing plant. Hence, optimization of fuels is crucial for environmental impact while maintaining the efficiency of the operation. Maximum utilisation of alternate fuels like Biomass, Carbon Black, Rice husk TDF, RDF, etc need to be proportioned effectively, to dispense with conventional fuels

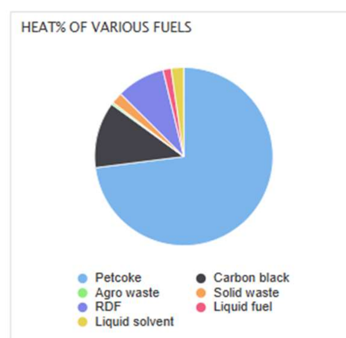
Holtec developed a Fuel mix Optimization model to optimize the fuel and securing the maximum possible TSR.

MOST OPTIMIZED OUTPUT	MT (Dry Basis)	HEAT (%)	MT (Wet Basis)
Petcoke	17.4	73.0	18.7
Carbon black	3.4	12.0	3.4
Agro waste	0.2	0.4	0.3
Solid waste	1.5	2.1	2.1
RDF	3.5	8.8	4.9
Liquid fuel	1.8	1.5	1.8
Liquid solvent	1.8	2.3	1.8
TSR without carbon black	8.8	15.0	
TSR with carbon black	12.2	27.0	
Total	29.6	100.0	

OPTIMIZED FUEL COST: 1,373.7 RS/T CLK

LIKELY MINOR OXIDES IN CLINKER

SO3	Na2O	K2O	cl	Excess_sulphur	ash absorption
1.41	0.22	0.53	0.04	816.86	0.89



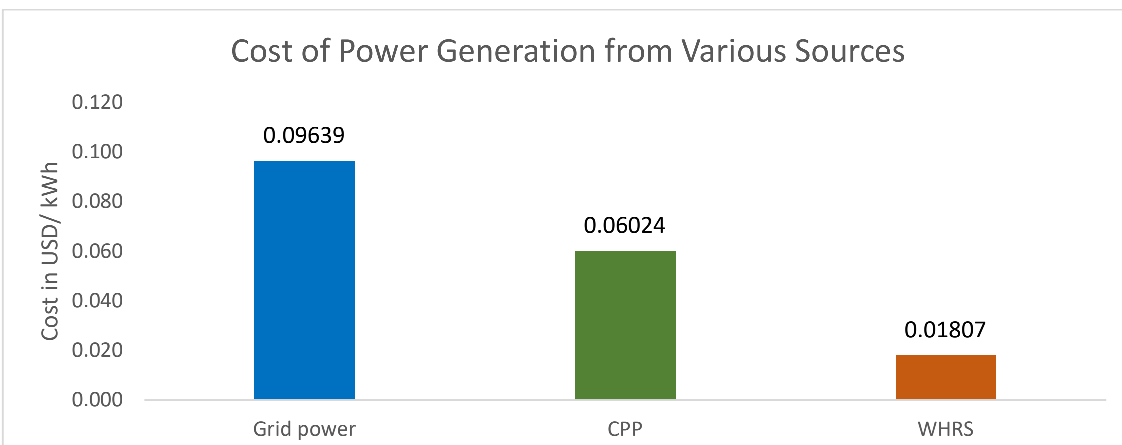
Fuel Mix Optimisation Model for Optimizing Specific Fuel Cost & Maximizing TSR

The following are some of the key areas which need to be focused while doing the fuel optimization exercise:

1. Too high Ash in solid fuels may lead to higher LSF target, thereby increasing heat consumption and cost of production, as well. Hence, optimization of fuel mix is essential to keep the Ash content, within an acceptable limit.
2. Fuels having high Sulphur content should either be avoided or need to be mixed with low Sulphur content fuels to maintain an optimized limit for the system to operate. In case of high Sulphur input, Alaklies need to be introduced to avoid unwanted jamming, buildups in Preheater system. Installation of gas Bypass system will further increase the Specific Heat Consumption, thereby increasing the cost of operation as well.
3. Volatile matter in the fuel is also to be checked before using, as it impacts the grinding energy consumption of the Coal Mill due to higher fineness of fine coal
4. While considering alternate fuels, higher moisture content materials should be avoided, even if their unit cost remains at lower end. Higher moisture leads to lower Net calorific value, thus resulting into higher fuel consumption and subsequently higher cost of production, as well.
5. Fuel burning should always be in an oxidising environment. Heat liberation from the fuel will be doubled as compared to incomplete combustion, in a reducing environment. Further, few mineralisers can be used like CaF_2, AlF_3, ZnO, etc., to reduce the overall thermal energy demand, thus saving the overall production cost. Studies suggest that by using mineralisers, specific heat consumption can be reduced to the tune of ~30 kcal/kg clk.

6. Installation of Waste Heat Recovery System:

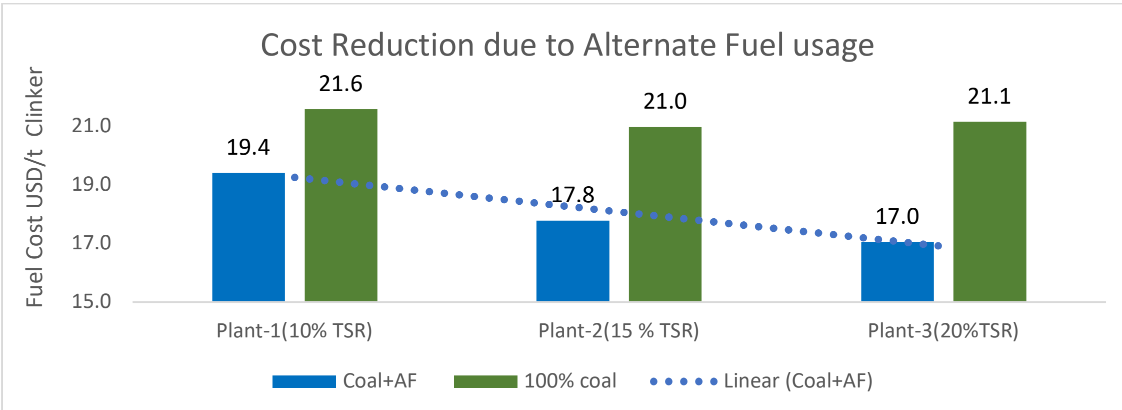
- Waste Heat Recovery (WHR) System in cement plants is instrumental in cost reduction by harnessing the excess heat liberated from the Pyro-process system, and used for power generation. This further helps in reducing the need for purchasing power from the Grid or reduction in usage of fossil fuels in own Captive Power Plant, as well.
- Based on Preheater Stages like 5 Stage or 6 Stage, and chosen technology of WHR System, power generation to the extent of 25-30% of the total System's demand, can be envisaged. This waste power generation can eventually drive the Pyro-process operation, thereby, reducing the Specific Power Consumption of the operation.
- In India, Power generation cost of WHR system is around USD 0.01807 /kWh as compared to USD 0.06025 /kWh for a captive power plant. The total WHR installed capacity in India is around 400 MW (up to PAT cycle II) against potential capacity of around 1200 MW, as obtained from recent studies.



Hence, it can be concluded that, enormous savings potential exists with each WHR plant installation, which will directly reduce the fossil fuel consumption and also reduce carbon footprint, as well. Further, implementation of waste heat recovery systems will improve overall energy efficiency, maximizes resource utilization, and enhances the competitiveness of cement plants while contributing to a more sustainable and economically viable operation, which could be one of the key factors towards cost reduction measures.

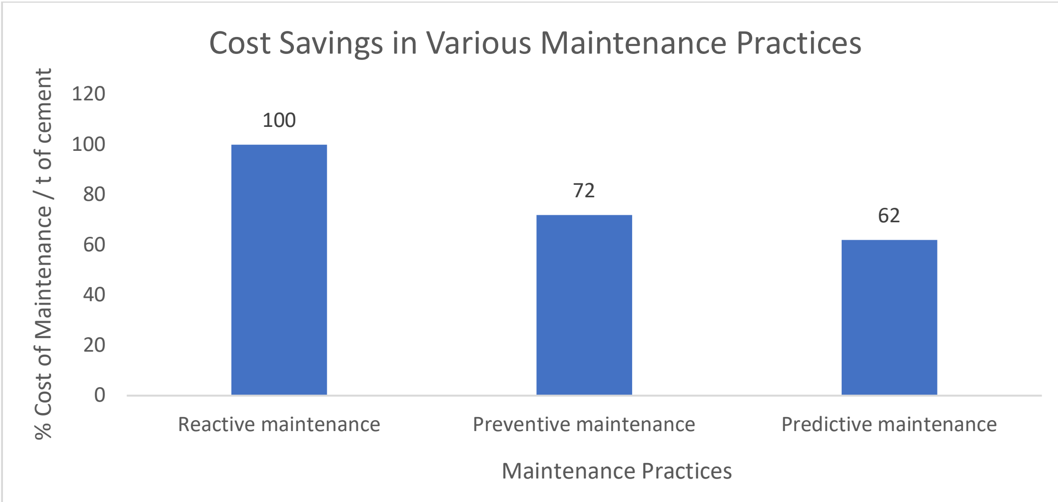
7. Usage of Alternate Fuels (AFR):

- The usage of alternate fuels in cement manufacturing involves supplanting conventional fuels with renewable or waste-derived alternatives. This includes biomass, municipal solid waste, tires, industrial by-products, etc.
- Co-processing these materials in cement kilns not only reduces reliance on finite resources but also mitigates greenhouse gas emissions by diverting waste from landfills.
- Careful selection, processing, and monitoring are crucial to ensure compliance with environmental regulations, maintain product quality, and optimize energy efficiency, contributing to a sustainable and circular approach to cement production while reducing overall environmental impact.



8. Improvement in Maintenance Practices:

- Maintenance practices in cement plants are vital for ensuring equipment reliability, minimizing downtime, and maximizing production efficiency. This includes preventive maintenance scheduling, regular inspections, and predictive maintenance techniques to anticipate and address potential failures.
- Predictive maintenance practices are slowly picking up momentum for managing assets which will significantly reduce the cost of piling up of inventory and reduced breakdowns by early detection of abnormality in the equipment.
- Implementing condition monitoring systems, lubrication management, and spare parts inventory optimization enhances equipment performance, as well.
- Additionally, establishing a comprehensive maintenance management system facilitates tracking maintenance activities, prioritizing tasks, and optimizing resource allocation.
- By maintaining equipment in optimal condition, cement plants can achieve higher productivity, extend equipment lifespan, and minimize operational costs while ensuring safety and environmental compliance.



9. Advanced Electrical and Automation Systems:

Implementation of advanced electrical and automation techniques further helps in reducing the Plant operation cost. Some of the key measures are mentioned as below;

- Use of higher efficiency motors
- Installation of capacitor banks to maintain higher Power Factor (above 0.99)
- Automatic control of Plant Illumination systems
- Incorporation of VFD's for all major Process Fans
- Advanced Kiln Scanner with Refractory condition monitoring
- Energy Management system
- Centralised DCS control system
- Lab & dispatch Control system

Conclusion:

Implementing effective cost reduction measures is vital for sustainable operations. By optimizing energy usage, enhancing raw material efficiency, and streamlining production processes, significant savings can be achieved. Investing in modern technology like AI-driven process controls and predictive maintenance systems can also minimize downtime and maintenance costs. Additionally, fostering a culture of waste reduction and continuous improvement among employees can lead to innovative solutions and further cost savings. Ultimately, these measures not only enhance profitability but also contribute to the overall competitiveness and long-term viability of the cement plant in a dynamic market environment.

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