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Cement Quality Enhancement with Multi Channel Burner in Kiln-Department

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ABSTRACT: This paper deals about the quality improvement of cement in Kiln- Department. In order to greater quality of cement, Coin burner is replaced with Multi Channel burner. The replacement of existing coin burner with multi channel burner result in increased clinker quality. It is observed that the flame geometry is improved with new burner. Also there is enhanced nodulization and improved strength. Hence a thorough investigation was done on the problem quality improvement is carried out. This dissertation work reports the successful completion and implementation of the same.

Keywords: TPH, Coin burner, Multi Channel burner, Nodulizatio, Life of the refractory lining of Kiln.etc

I. INTRODUCTION

Cement, first developed in the early 19^{th} century, and today stands as the second biggest consumer product in the world, just after water. Cement is an artificial hydraulic binder, which binds the particles of sand and aggregates together.

The Invention of Cement was way back in the year 1817 and is considered to be the starting point for the revival of the construction industry. It was early in the 1800's that Louis Vicat a young, 22-year old civil engineer conducted work on the hydraulicity of the "lime-volcanic ash" mixture. This binder, which had been used since Roman time, remained the only material known to set in contact with water.

In France, the first cement plant was opened in 1846 in Boulogne-sur-Mer, yet the very first cement was produced in Poully, in Burgundy.

II. CEMENT MANUFACTURIN STEPS

(i) Mining
(ii) Drilling
(iii) Blasting
(iv) Loading And Transportation
(v) Crushing And Conveying
(vi) Secondary Breaking
(vii) Sub Grade Material Handling
(viii) Cinkeriztion (Kiln)
(ix) Cement Grinding
(x) Packing And Dispatch

III. PROCESS IN KILN (CINKERIZTION)

It is combined process made of Pre-heating, Calcining, Burning and cooling operation. Rotary Kiln is the main equipment for clinkeriztion.

The ACC Wadi Cement plant consisting of Kiln (Size 4.8 Mts. Dia x 74.0 Mts. Length) from ABL with 3000 TPD.

After blending and homogenization process, the raw meal is conveyed to the Preheater through SFM system (solid flow meter system is for weighing and feeding the raw meal) and bucket elevator/air lift from Silo. Kiln feed is fed into the Cyclone duct. Preheating and Calcination takes place in various stages of Cyclones due to heat transfer.

Fine Coal is fired from Kiln outlet and through a Burner pipe. The hot gases generated due to fine coal firing are taken out by ESP Fan through Preheater and ESP.

Heat transfer takes place in Preheater as Kiln feed moves downward and flue gases move upwards causing co-current flow in gas ducts. Kiln feed after preheating (around 90% calcined material) enters at Kiln inlet. Then such decarbonized material will flow to the burning zone due to the inclination and rotation of the kiln in the direction of the hot zone (burning zone). The temperature of the burning zone is maintained at about 1400deg C for proper clinkerization. After this stage the material is known as CLINKER. This clinker gets cooled in the cooling zone, where it cools down from 1250deg C to 100deg C temperature by cold incoming air from the cooling fans connected to the cooler. Finally clinker will be conveyed to the stockyard by DPC (Deep Pan Conveyor).

A. Coin Burner and problem

FORMULATION: The existing "COIN" burner in Kiln-3 having single channel and mixing chamber in which hot air is taken from cooler at 300deg C. In this existing burner there is a hot air fan that is subjected to high temperature and wear because of clinker dust.

Reliability of fan is not good, because of these conditions; it requires frequent buildups and replacement of bearings etc. The oil-firing burner for initial light up is additional by the side of main burner, which requires fixing and removal at every Kiln light up. Adjustment of flame momentum is difficult on “COIN” burner.

Experimental Observations

The following are problems faced due to the use of “COIN” burner.

1. Flame geometry is poor.
2. Poor clinker quality and strength.
3. Restricted layout because of additional hot air fan, and associated ducts.
4. Poor operational flexibility.
5. Time taken for overall maintenance is more and hence maintenance cost is more.
6. Manpower is being engaged for this work.

Considering all the above problems it has been decided to replace existing “COIN” burner by “MULTI CHANNEL FLAME” burner.

B. Multi Channel Flame Burner

The Multi channel burner is used for burning coal dust or for combined burning of coal dust and fuel oil and/or fuel gas.

In the case of combined firing, the burner must be used in conjunction with an oil lance and/or gas lance for introducing and atomizing the fuel.

Only a part of the airflow required for the combustion process, i.e., the primary air, is injected through the burner. Normally, the primary airflow will constitute 7-10% of Lmin (the minimum airflow for combustion). To this should be added the conveying air which is injected together with the coal dust.

The primary air is injected at a pressure of up to 250 mbr, resulting in a maximum injection rate of approx.200-210 m/s

CONSTRUCTION AND OPERATING PRINCIPLE

The burner which is suspended from a carriage (07) is fed with primary air from the primary air fan (14). A special cooling air fan (13) assures cooling of the burner in the event of power failure.

The burner is suspended from the supporting beam (22), which in turn is welded to the supporting pipe (21). The supporting pipe has an air intake for admitting the external primary airflow, referred to as axial air. Referring appendices I, II,III and IV.

In the centerline of the burner there is a central duct (33) and, dependent upon the specific application, this duct may have a protective tube for the oil or gas burner set as well as for an ignition gas burner. Externally, the duct is equipped with a wear-resistant Densit lining in the zone in which the admission of coal dust takes place. Also, fitted at the inlet end is a pipe connection (26) with a ball valve (17) and hose (16) for feeding cooling air from the primary air fan (14). At the outlet end the duct features a nozzle plate(41) with holes for cooling air.

A coal pipe (34), radial air pipe (35) and a burner pipe, in the mentioned order, are fitted concentrically around the central duct (33).

The coal pipe (34) is centered around the central duct (33) by means of guide fins. At the outlet end, the duct (30) is provided with a machined, cylindrical nozzle (27). At the inlet end, the duct is fixed via a flanged joint to the coal inlet (25). The coal inlet, which is internally lined with a wear-resistant Densit lining is designed so that the inlet extends into the coal pipe on the front section. Also, the coal duct is connected via expansion joint (44) to the radial air pipe (35). The radial air pipe (35) extends through the supporting pipe (21), being connected to the latter by means of a flanged joint. Radial air (~swirl air) is admitted through pipe connection (22).

Burner pipe (20) is, via a flanged joint, bolted to supporting pipe (21). At the outlet end, the pipe is provided with a conical air nozzle (40). The swirler unit (29) which is fixed by welding inside the burner pipe (20) also features a number of inclined vanes (28) to subject the airflow to swirling action. The swirler unit is also equipped with a turned bushing and a number of spring-loaded means (30) for centering the coal nozzle (27).

Externally, the burner pipe (20) as well as the air nozzle (40) are equipped with a refractory lining (19).

Conveying air and coal dust are fed via hose (08) and coal inlet (25) to the coal pipe (34) through which it is injected into the kiln. Immediately after its discharge from the nozzle, the coal dust is mixed with the primary airflow, which is injected through the conical air nozzle (40).

Normally, the injection rate of the primary air will be much higher than the rate at which coal dust is injected. As a result, there will be an acceleration of the coal dust flow. At the same time, hot secondary air is drawn into the coal flow, assuring the ignition of the coal.

The primary air is supplied by the fan (14) via coupling flange for air (04) and expansion joint (05) to the air distribution pipe (06), where the airflow is distributed into, respectively, axial air and swirl air. The axial air flows via the damper (36) and burner pipe (20) through to the conical air nozzle (40) while the swirl air flows through the damper (37) and the radial air pipe (35) on to the swirler unit (29). The inclined vanes in the swirler unit subject the airflow to swirling action before it is again mixed with the axial air. The total primary airflow is then discharged through the air nozzle (40).

In the event of power failure or if the primary air pressure is too low, the emergency cooling fan (13) will be started automatically, with simultaneous opening of the butterfly valve (12). The coal pipe (34) and coal inlet (25) are suspended jointly from the supporting beam (23) via the movable suspension (24) to allow it to be displaced in the longitudinal direction. It will thus be possible to adjust the annular area in the air nozzle (40). Adjustment is done by means of the spindle gear unit (38). The adjustment unit (38) consists of a spindle gear unit with worm gearing and a hand wheel (45). The unit can be maintained in the selected position by means of lock nut (46). The position of the coal pipe, and thus of the area of the air nozzle, is indicated on the scale (49). During operation, the temperature of the burner pipe (20) will be increased, causing it to expand more than the internal pipes. The scale (49) is designed so that automatic compensation for this longitudinal expansion will take place. The scale is mounted on a lever (39), which is fixed to the coal inlet (25). The pointer (50) is fixed to a lever (48), which is mounted in a guide way on the outer side of the radial air pipe (35) to allow displacement in the axial direction. The lever is in contact with the swirler unit (29), against which it is pressed by means of the spring (51). When, subject to thermal impacts, an expansion of the burner pipe (20) occurs in the longitudinal direction, the swirler unit (29) and the lever (48) will follow the pipe. Readings of the longitudinal expansion can be obtained on scale (47), and the opening of the air nozzle is indicated on the scale (49).

C. Operation

SHAPE OF FLAME, ADJUSTMENT OPTIONS

The flame shape can be adjusted by altering the primary air set points. See schematic diagram, Appendix VI. The controlling parameters for the flame characteristics flame are:

1. Primary air momentum (volume and injection rate)
2. Primary air swirl (rotation)

A low momentum will yield a relatively long, wide and smooth flame. Conversely, a high momentum will yield a relatively short, thin and hard flame.

Swirling action will generate a recirculation zone, which will yield a faster rate of ignition of the fuel. A shorter and more stable flame is generated.

PRIMARY AIR MOMENTUM

The primary air momentum [%m/s] is defined as the primary air percentage multiplied by the injection rate of the primary air. It can be determined as follows, see Appendices VI, VII and VIII:

3. Read off the primary airflow on flow meter (58) and the primary air pressure on pressure gauge (55).
4. Determine the primary air percentage, i.e. the primary airflow expressed as a percentage of the combustion air volume, which is theoretically required. In normal circumstances (at a low altitude above the sea, approx. 20deg C ambient temperature), the percentage of the primary airflow appears from the diagrams, Appendix VII.
5. Read off the momentum/injection rate on the diagram, Appendix VIII.

Experience has shown that a good steady flame can be obtained with a primary air momentum of 1400-1600% m/s. The optimum setting must be determined on a trial-and-error basis.

Two methods can be used to determine the primary air volume and the rate of injection:

1. By adjusting the fan damper or the guide vane (57) in special cases the adjustment is done by varying the speed of the fan. This can be done from the control room.
2. By changing the area of the air nozzle. This is done manually by means of the adjustment unit (38).

The two methods of adjustment will alter the primary airflow rate as well as the injection rate, and thus the momentum. Advantageously, the pressure, and thus the injection rate, should always be kept as high as possible. The primary airflow rate will then be reduced to maximum extent, resulting in optimum operating efficiency. However, to allow for cooling of the burner pipe, the primary airflow rate should not be lower than 3-4percent.

PRIMARY AIR SWIRL

Before the primary air leaves the nozzle (40), it can be subjected to swirling action by directing some of the air (~swirl air) via the racial air pipe through the inclined vanes in the swirler unit (29). The intensity of swirling can be adjusted by opening the damper (37) to some extent.

LIGHTING-UP

Always check the following prior to lighting-up:

- The position of the burner in the kiln.
- That all flexible connections are intact and properly connected.
- The oxygen meter of kiln has been cut in and that full functionality is ensured.

Use the following procedure for lighting up a cold-state kiln:

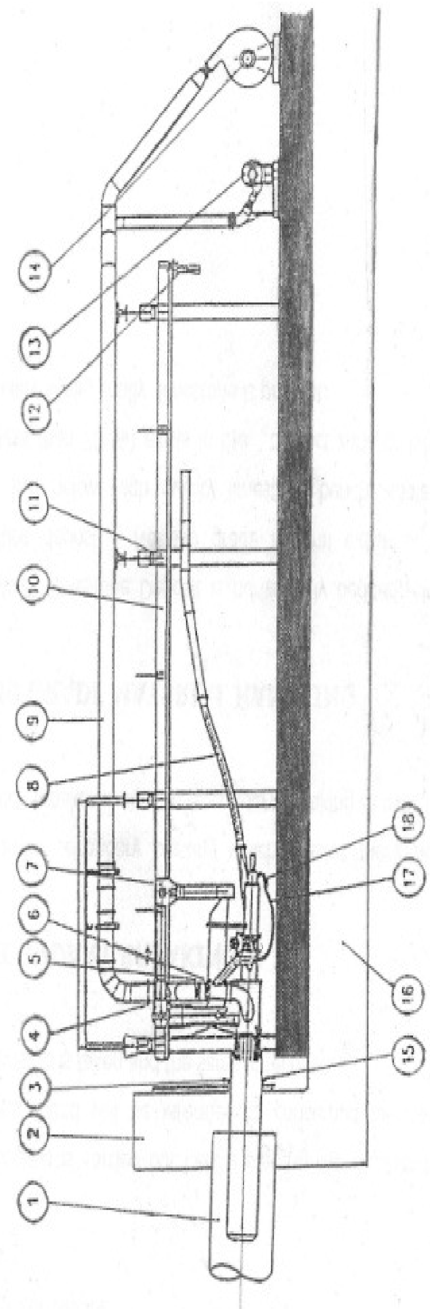
1. Restrict the area of air nozzle (40) to a minimum.
2. Open dampers (36) AND (37) to full extent.
3. Start the primary air fan (14) with closed damper or guide vane.
4. Start the ignition gas burner or use alternative approach to generate an open flame in front of the burner tip.
5. Start the oil or gas burner
6. Watch the flame. If the flame extends upwards towards the ceiling, the primary airflow must be increased by opening the primary air damper slightly. However, an excessive increase of the primary airflow must be avoided since this will disturb the stability of the flame.
7. After the flame has stabilized, the ignition gas burner can be extinguished. At the same time, the ignition gas burner must be slightly retracted.
8. The primary air volume can be increased gradually as the kiln temperature is raised. The primary airflow must always be high enough to prevent flame impingement against the lining. The opening of damper (37) for swirl air can be simultaneously reduced to 0-50%. The optimum setting must be determined on a trial-and error basis.
9. When the kiln is hot, coal firing can be started. Gradually as the coal flame is stabilized, i.e. with a lining temperature at around 800degC, the oil burner can be stopped.

REGULATION DURING OPERATION

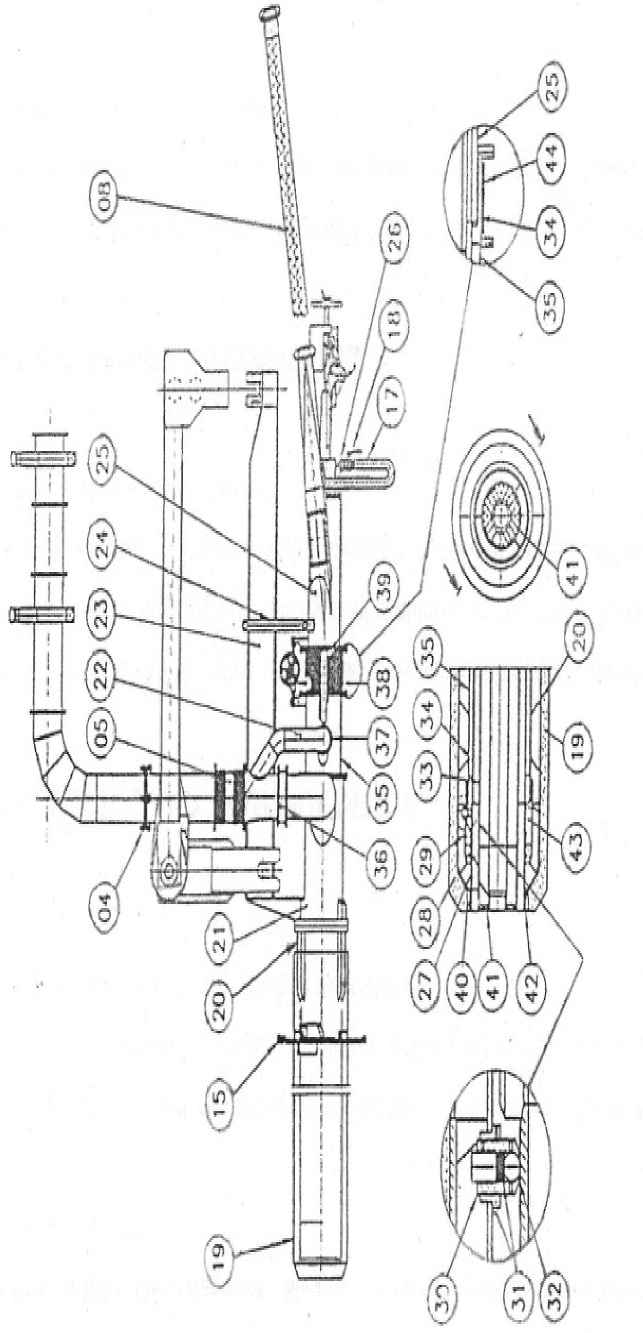
Once the kiln is in normal operation, the flame should be monitored very closely. Impingement of the flame against the lining must never occur since this may have a disruptive effect on the coating, which in turn may entail a too high kiln shell temperature and a reduced life span of the lining. If the height of flame is too high and too close to the kiln shell, the position of the burner should be adjusted to move the flame down towards the kiln charge

The primary air momentum and swirl must be adjusted to make the flame hard and stable. For firing with normal coal with a medium content of volatiles, the initial setting of the burner must be as follows:

- Damper (36) for axial air : 100% open
- Damper (37) for swirl air : 20% open
- Primary air pressure : 230-250 mbar
- Momentum (opening of nozzle (40)): 1400%m/s



When burning coal with a higher content of volatiles (lignite, etc.) is used for firing, the momentum can be reduced. Conversely, a higher momentum may be necessary when burning pet coke or anthracite coal, which has a low content of volatiles.



The above settings are provisional. A final setting can only be made subject to close monitoring of the flame. Damper (36) for axial air should normally be kept wide open all the time. To ensure cooling of the burner, it should never be closed more than 50%.

TERMINATION OF FIRING

Stop the fuel supply for oil burner and coal dosage equipment, respectively.

The primary air fan must not be stopped until scavenging of the oil burner has been carried out.

If the kiln is in a hot state, the primary air fan must not be stopped until sufficient cooling of the kiln and cooler has been ensured. If this is not possible, the emergency cooling fan must be started or the burner must be moved back.

IV. OBSERVATIONS

Burner is closely monitored for 15 Days for following parameters.

A. CLINKER QUALITY (ANEXURE-1)

Clinker samples were collected and analyzed for chemical analysis & strength. Results are enclosed in annexure. Results indicate that there is increase in strengths.

B. FLAME GEOMETRY (ANEXURE-2)

The flame momentum at various burner adjustments are observed & optimized. During all adjustments the shell temperatures were closely monitored

C. POWER CONSUMPTION (ANEXURE-3)

Power consumption with this burner is compared with earlier one, there is an increase in power consumption by 35kw. After replacement of P.D.Blower by new one there will be net increase in power consumption by 15kw.

D. SHELL TEMPERATURE (ANEXURE-4).

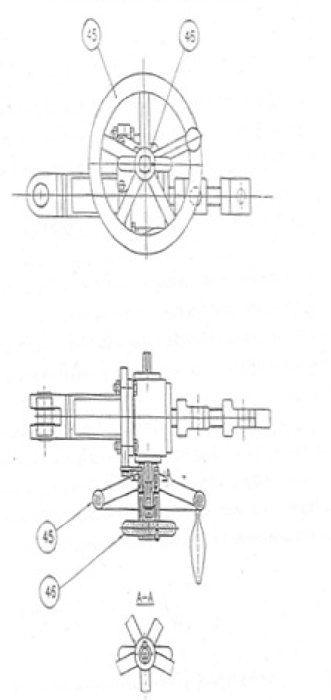
Shell temperatures in the burning zone area were continuously observed and found normal. -Refer annexure,

E. BURNER POSITIONING.

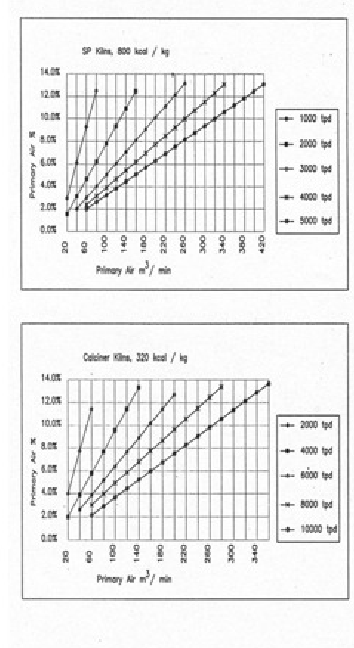
F. RELIABILITY & MAINTAINABILITY

- In existing burner there is a hot air fan, which is subjected to high temperature & wear because of clinker dust. Reliability of fan is not good, because of these conditions, it requires frequent buildups & replacement of bearings etc. This fan is eliminated after installing new burner.
- The oil-firing burner for initial light up is concentric to the new burner where as in existing burner it was additional by the side of main burner, which requires fixing and removal at every kiln light up. This activity also avoided after installation of new burner.
- Adjustment in flame momentum is possible as compare to earlier burner with least efforts through gearboxes.

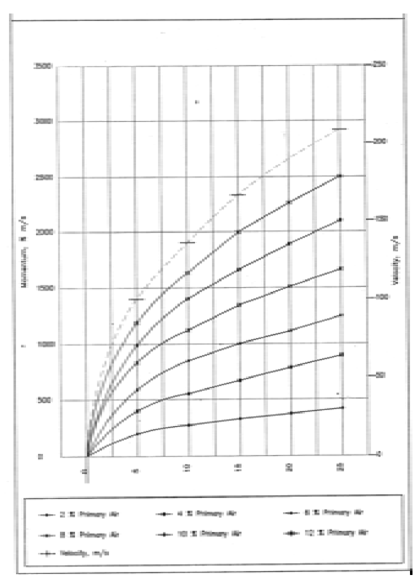
APPENDIX – III
ADJUSTMENT UNIT



APPENDIX - IV
PRIMARY AIR PERCENTAGE



APPENDIX – V
PRIMARY AIR MOMENTUM



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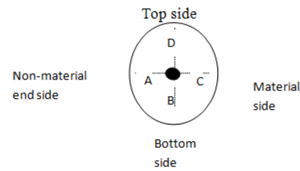

A-2250mm B-2180mm C-2080mm D-2180mm

F. RELIABILITY & MAINTAINABILITY

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-The oil-firing burner for initial light up is concentric to the new burner where as in existing burner it was additional by the side of main burner, which requires fixing and removal at every kiln light up. This activity also avoided after installation of new burner.

- Adjustment in flame momentum is possible as compare to earlier burner with least efforts through gearboxes.

ANNEXURE – 1
CLINKER QUALITY ANALYSIS

BEFORE

Samples	CaO	F/CaO	1 Day	3 Days	7 Days	28 Days
1	64.8	1.6	28	42	50	60 Mpa
2	66.2	2.7	25	40	47	58
3	66.2	2.0	23	41	47	60
4	64.8	2.0	30	42	55	62
5	65.6	1.8	28	43	53	56
6	65.0	2.0	24	37	46	60
7	65.2	2.2	21	40	46	60
8	65.2	1.8	24	39	47	62
9	65.4	2.0	25	37	47	64
10	65.4	1.9	24	38	46	58
11	65.4	1.9	22	39	47	60
Avg	**63.47**	**1.68**	**21.24**	**33.61**	**48.27**	**60**

AFTER

Samples	CaO	F/CaO	1 Day	3 Days	7 Days	28 Days
1	64.4	2.8	26	41	48	64 MPa
2	66.4	2.2	28	37	48	65
3	66.4	1.8	24	41	50	64
4	66.2	2.2	28	38	49	62
5	66.2	1.7	23	41	52	62
6	64.8	1.8	19	47	54	62
7	65.0	1.7	28	38	53	62
8	66.2	1.7	28	37	47	63
9	66.0	1.9	28	37	47	64
10	66.0	1.9	28	39	47	62
11	66.0	1.9	20	41	52	62
Avg	**65.78**	**1.96**	**25.45**	**39.72**	**49.72**	**62.90**

FLAME MOMENTUM				
		KILN FEED	260TPH	
COAL - FIRING RATE	TPH	11.5		
CV OF COAL	KCAL/KG	4300		
HEAT RELEASE	MKCAL/HR	49.5		
THEORETICAL AIR REQD	SM3/HR	52417		
AXIAL AIR				
NOZZLE POSITION	mm	20		
PRESSURE	mmWC	3500		
VELOCITY	m/sec	237		
AXIAL AREA	SQ.M	0.005376		
AXIAL AIR FLOW	SM3/HR	4155		
AXIAL AIR AS% OF TH.AIR	%	7.9		
AXIAL FLAME MOMENTUM	%.m/sec	1876		
RADIAL AIR				
NOZZLE POSITION	mm	-5		
PRESSURE	mmWC	800		
VELOCITY	m/sec	113		
RADIAL AREA	SQ.M	0.002		
RADIAL AIR FLOW	SM3/HR	739		
RADIAL AIR AS% OF TH.AIR	%	1.4		
RADIAL FLAME MOMENTUM	%.m/sec	159		
STABILISING AIR				
PRESSURE	MmWC	180		
VELOCITY	m/sec	54		
STABLISING AREA	SQ.M	0.0009		
STABILISING AIR FLOW	SM3/HR	165		
AIR AS% OF TH.AIR	%	0.3		
ST.AIR FLAME MOMENTUM	%.m/sec	17		
COAL CONVEYING AIR				
CONVEY AIR FLOW	SM3/HR	2434		
NOZZLE AREA	SQ.M	0.0187		
CONVEY AIR VELOCITY	m/sec	40		
AIR AS% OF TH.AIR	%	4.6		
CONV.AIRFLAME MOMENTUM	%.m/sec	185		
TOTAL FLAME MOMENTUM	%.m/sec	**2237**		
PRIMARY AIR	SM3/HR	5059	9.65	%
CONVEY AIR	SM3/HR	2434	4.64	%
TOTAL AIR THROUGH BURNER	M3/HR	7492	14.29	%

POWER CONSUMPTION		
EXSISTING BURNER		
Hot air fan		
	Rated power	150kw
	Running power	90kw
GRK(Coal conveying) Blower		
	Rated power	55kw
	Running power	35kw
Total power required		125kw
NEW BURNER		
Primary air blower		
	Rated power	132kw
	Running power	120kw
Coal conveying blower		
	Rated power	75kw
	Running power	40kw
Total power required		160kw
Difference in power		**35kw**

ANNEXURE - 3

KILN SHELL TEMPERATURE AT VARIOUS BURNER ADJUSTMENTS			
KILN POSITION FROM OUTLET	TEMP DEG.C	TEMP DEG.C	TEMP DEG.C
13.3MTR	214	177	260
12.55MTR	146	220	263
14.5MTR	186	199	259
1.45MTR	22	191	256
18.4MTR	186	229	241
20.35MTR	193	174	209
22.3MTR	132	210	171
24.25MTR	114	204	200
25.7MTR	136	189	180
27.65MTR	93	167	159
29.6MTR	100	164	190
30.8MTR	195	201	190
32.5MTR	189	213	211
	Axial:300mmWG	Axial:3400mmWG	Axial:3200mmWG
	Radial:500mmWG	Radial:700mmWG	Radial:600mmWG
	Stabilising:250mmWG	Stabilising:200mmWG	Stabilising:200mmWG

V. RESULT

Advantages of Multi Channel Flame Burner over Coin Burner

1. Improved flame geometry.
2. Enhanced nodulization and hence improved strength
3. Improved layout because of removal of hot air fan and associated ducts.
4. Eliminating unreliable equipment.
5. Oil firing burner for initial light up is concentrate
6. Increase in operational flexibility
7. Low maintenance cost.
8. Increased refractory life

By replacing coin burner with multi channel flame burner, the flame geometry can be controlled easily. The clinker quality and strength is increased. The time for over all maintenance is less and hence there is low maintenance cost. Also, as the lime percentage increases in the clinker, the grinding capacity also increases. Hence there is reduction in power consumption in grinding process.

SAVINGS

Even though there is increase in power consumption by 35kw using new burner, it results in the reduction of power consumption in cement grinding by 5kwh/T.

That is earlier specific power consumption of cement grinding is 45kw, after burner installation it is reduced to 40kwh/T. Also, there is quality enhancement and cement strength increases by 3 percent.

And the life of the refractory lining in the Kiln-3 is increased by 2 months. Hence the low maintenance cost.

Therefore, Power in Grinding Mill = 5kwh/T x24hrs x 30days x Rs 4.5

= Rs 16,200/month.

VI. CONCLUSION

The analysis carried out in Kiln-3" has resulted in increase in overall production of cement and also resulted in saving of the power, money and time.

Replacement of coin burner with multi channel flame burner improved the efficiency of production. The power consumption has reduced by 5kwh/T of the cement grinding mill. That result in the m0onthly saving of Rs 16,200/month.

Also the production capacity of plant increased by 2 months, as the life of refractory lines increased in Kiln.

The use of multi channel burner enhanced the clinker quality thereby increasing 3 percent in cement strength.

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