CHITTOR CEMENT WORKS,

CHITTORGARH

BIRLA CORPORATION LIMITED

SUB: Response to comments received from UNFCCC on "Energy Efficiency Measures at Cement Production Plant" (UNFCCC Ref. No.: 1068)

Reasons for request:
"The PDD and monitoring plan, as appropriate, should transparently outline how the energy savings and emission reductions for each energy efficiency measure have been measured and/or calculated, and how the following sections of the methodology have been applied:
(a) Documenting the specifications of the equipment replaced
(b) Metering the energy use of the industrial facility, processes or the equipment affected by the project activity
(c) Calculating the energy savings using the metered energy obtained from subparagraph (b)".

Explanation:

The emission reduction has been calculated as per methodology and guidelines. The following algorithm has been followed to arrive at emission reduction.

Before the project activity, the specific energy consumption of each component of the project activity has been calculated based on meter reading of control volume, time of operation and clinker production.

The similar specific energy consumption has been arrived during post project activity. The monitoring of energy consumption and clinker production has been monitored accordingly.

Emission reduction figure is arrived based on every year's clinker production and difference of specific energy consumption for which algorithm is provided in PDD

The specification of the VFDs and new fans are reflected in kW, Voltage, Serial No and Range. These are finalized once for all and documented during validation visit. As estimations are done on the basis of actual measurements and not on rated capacity, it is not monitored each year. However, Maintenance record are kept and adjusted with operating hours that would be evidenced during verification visit.

The details of each measure are evidenced with the validator and included in PDD enclosure 3A & 3B. The calculation related to the measures as explained in the PDD page 6-8 are as follows respectively:

A. (April,00 to March,01)

Energy conservation Measures adopted at CCW

1. Project details : Provision of variable frequency drive in Raw mill vent fan.

Write-up :
Raw mill vent fan motor were drawing high power. It was observed that vent fan damper was only 40% open for the require flow. Since damper opening was less, there was high pressure loss across damper, resulting in higher power consumption. It was felt that power could be saved by keeping damper full open and reduction in fan RPM with installation of VFD. The fan was directly coupled with motor of 980 RPM. It was calculated that the desired flow can be achieved at about 840-850 RPM of fan with 100% damper opening. An exercise was done to determine the energy meter readings with existing motor along with flow measurements. It was felt that if variable frequency drive is installed there will be substantial saving in power at same flow.

Calculation :-
Flow measurement were done keeping 40% damper open at 980 RPM After this flow measurement done with 100% damper opened and reducing fan speed to 840 RPM. It was seen that flow remained same and power reduced.

Energy meter reading with VFD = 159 units/Hr.
Flow with DOL (direct on line) = 1593 m^3/min., damper = 40%,
Pressure = 274 mmWg
Fan RPM = 980

Monitoring Aspects :-
Flow & pressure measurement were monitored as follows ;

Energy meter reading after VFD = 103 units/Hr.
Flow with VFD = 1546 m^3/min., damper = 100%
Pressure = 271 mmWg
Fan RPM = 840

Saving = 56 units/Hr.
It can be observed that by reducing the fan RPM with help of VFD, at similar flow & pressure, there is saving of 56 units/Hr.

3.11.2000 to 31.03.2001 – Raw Mill R.Hrs. = 2279.75 ; Production = 471614 MT

$$\text{Saving KWH/T Clk} = 56 \text{ KWH/Hr.} \times \frac{2279.75 \text{ Hrs.}}{471614 \text{ MT raw meal}} \times \frac{1.52 \text{ MT raw meal}}{1 \text{ MT Clinker}}$$

= 0.41 KWH/T Clinker

Investment : Rs. 9.24 lacs

Date / Month of Implementation : 03.11.2000

Project life : 15 years

2. Project details : Provision of variable frequency drive in cooler fan 2R.

Write-up :
Cooler fan 2R motor were drawing high power. It was observed that vent fan damper was only 42% open for the require flow. Since damper opening was less, there was high pressure loss across damper, resulting in higher power consumption. It was felt that power could be saved by keeping damper full open and reduction in fan RPM with installation of VFD. The operating RPM was 1347 previously It was calculated that the desired flow can be achieved at about 1170-1180 RPM of fan with 100% damper opening. An exercise was done to determine the energy meter readings with existing motor along with flow measurements. It was felt that if variable frequency drive is installed there will be substantial saving in power at same flow.

Calculation :-
Flow measurement were done keeping 42% damper open and increasing fan speed. After this flow measurement done with 100% damper opened and reducing fan speed. It was seen that flow remained same and power reduced.

Flow with DOL (direct on line) = 410 m^3/min., damper = 42%, RPM = 1347
Energy meter reading with DOL = 64 units/Hr.

Monitoring Aspects :-
Flow & pressure measurement were monitored as follows ;

Flow with VFD = 398 m^3/min., damper = 100% RPM = 1180
Energy meter reading with VFD = 54 units/Hr.

Saving = 10 units/Hr.

It can be observed that at similar flow there is saving of 10 units/Hr. after installation of VFD

4.12.2000 to 31.03.2001 – Kiln R.Hrs. = 1788.92 ; Clinker Production = 228863 MT

$$\text{Saving KWH/T Clk} = 10 \text{ KWH/Hr.} \times \frac{1788.92 \text{ Hrs.}}{228863 \text{ MT clinker}}$$

= 0.078 KWH/T Clinker

Investment : Rs. 5.28 lacs

Date / Month of Implementation : 04.12.2000

Project life : 15 Years.

3. Project details : Modification of inlet duct of cooler fan V5A.

Write-up :

A study of V5A was carried out in house. This fan was supplied by M/s L&T along with piezometric flow measurement system. The system required one meter of straight duct at fan inlet. Considerable pressure drop was observed in the duct and therefore, modification of inlet duct was considered.

Calculation :-
It was estimated that there would be saving of 6.0 units/Hr., if inlet duct straight portion length was reduced from 1000 mm to 250 mm.

Fan RPM = 1700
Flow = 851 m^3/min.
Damper = 37 %
Power = 91 units/Hr.

Monitoring Aspects :-
The fan RPM, flow, damper & power were monitored as follows

Fan RPM = 1700
Flow = 862 m^3/min
Damper = 27 %
Power = 85 units/Hr.

Saving = 6.0 units/Hr.

29.9.2000 to 31.03.2001 – Kiln R.Hrs. = 3175.75 ; Clinker Production = 416086 MT

$$\text{Saving KWH/T Clk} = 6 \text{ KWH/Hr.} \times \frac{3175.75 \text{ Hrs.}}{416086 \text{ MT clinker}}$$

= 0.046 KWH/T Clinker

Investment : Rs. 0.10 lacs

Date / Month of Implementation : 29.09.2000

Project life : 15 Years.

B. (April, 01 to March,02)

B1. Energy conservation Measures adopted at CCW

4. Project details : Provision of variable frequency drive in cooler fan 2L.

Write-up :
Cooler fan 2L motor were drawing high power. It was observed that vent fan damper was only 47% open for the require flow. Since damper opening was less, there was high pressure loss across damper, resulting in higher power consumption. It was felt that power could be saved by keeping damper full open and reduction in fan RPM with installation of VFD. The operating RPM was 1440 previously It was calculated that the desired flow can be achieved at about 1040-1050 RPM of fan with 100% damper opening. An exercise was done to determine the energy meter readings with existing motor along with flow measurements. It was felt that if variable frequency drive is installed there will be substantial saving in power at same flow.

Calculation :-
Flow measurements were done keeping 47% damper open and increasing fan speed. After this flow measurement done with 100% damper opened and reducing fan speed. It was seen that flow remained same and power reduced.

Flow with DOL (direct on line) = 397 m^3/min. , damper = 47%,
RPM = 1440 ; Pressure = 574 mmWg

Energy meter reading with DOL = 83.66 units/Hr.

Monitoring Aspects :-
Flow & pressure measurement were monitored as follows
Flow with VFD = 397 m^3/min., damper = 100%
RPM = 1045 ; Pressure = 577 mmWg

Energy meter reading with VFD = 59.83 units/Hr.

Saving = 83.66 – 59.83 = 23.83 units/Hr.

It can be observed that at similar flow there is saving of 23.83 units/Hr. after installation of VFD.

05.11.2001 to 31.03.2002 – Kiln R.Hrs. = 2455.17 ; Clinker Production = 338585 MT

$$\text{Saving KWH/T Clk} = 23.83 \text{ KWH/Hr.} \times \frac{2455.17 \text{ Hrs.}}{338585 \text{ MT clinker}}$$

= 0.173 KWH/T Clinker

Investment : Rs. 4.90 lacs

Date / Month of Implementation : 05.11.2001

Project life : 15 Years.

5. Project details : Provision of variable frequency drive in cooler fan V5A.

Write-up :

Cooler fan V5A motor were drawing high power. It was observed that vent fan damper was only 46% open for the require flow. Since damper opening was less, there was high pressure loss across damper, resulting in higher power consumption. It was felt that power could be saved by keeping damper full open and reduction in fan RPM with installation of VFD. The operating RPM was 1490 previously. It was calculated that the desired flow can be achieved at about 1230-1240 RPM of fan with 100% damper opening. An exercise was done to determine the energy meter readings with existing motor along with flow measurements. It was felt that if variable frequency drive is installed there will be substantial saving in power at same flow.

Calculation :-
Flow measurement were done keeping 46% damper open and increasing fan speed. After this flow measurement done with 100% damper opened and reducing fan speed. It was seen that flow remained same and power reduced.

Flow with DOL (direct on line) = 863 m^3/min. , damper = 46%,
RPM = 1490 ; Pressure = 339 mmWg
Energy meter reading with DOL = 78.30 units/Hr.

Monitoring Aspects :-
Flow & pressure measurement were monitored as follows

Flow with VFD = 884 m^3/min., damper = 100%
RPM =1238 ; Pressure = 324 mmWg
Energy meter reading with VFD = 63.57 units/Hr.

Saving = 78.30 – 63.57 = 14.73 units/Hr.

It can be observed that at similar flow there is saving of 14.73 units/Hr. after installation of VFD.

05.11.2001 to 31.03.2002 – Kiln R.Hrs. = 2455.17 ; Clinker Production = 338585 MT

$$\text{Saving KWH/T Clk} = 14.73 \text{ KWH/Hr.} \times \frac{2455.17 \text{ Hrs.}}{338585 \text{ MT clinker}}$$

= 0.107 KWH/T Clinker

Investment : Rs. 4.90 lacs

Date / Month of Implementation : 05.11.2001

Project life : 15 Years.

6. Project details : Provision of variable frequency drive in cooler fan V5B.

Write-up :
Cooler fan V5B motor were drawing high power. It was observed that vent fan damper was only 46% open for the require flow. Since damper opening was less, there was high pressure loss across damper, resulting in higher power consumption. It was felt that power could be saved by keeping damper full open and reduction in fan RPM with installation of VFD. The operating RPM was 1470 previously It was calculated that the desired flow can be achieved at about 1320-1330 RPM of fan with 100% damper opening. An exercise was done to determine the energy meter readings with existing motor along with flow measurements. It was felt that if variable frequency drive is installed there will be substantial saving in power at same flow.

Calculation :-
Flow measurement were done keeping 46% damper open and increasing fan speed. After this flow measurement done with 100% damper opened and reducing fan speed. It was seen that flow remained same and power reduced.

Flow with DOL (direct on line) = 956 m^3/min., damper = 46%,
RPM = 1470 ; Pressure = 200 mmWg
Energy meter reading with DOL = 79.04 units/Hr.

Monitoring Aspects :-
Flow & pressure measurement were monitored as follows

Flow with VFD = 950 m^3/min., damper = 100%
RPM =1320 ; Pressure = 210 mmWg
Energy meter reading with VFD = 72.92 units/Hr.

Saving = 79.04-72.92 = 6.12 units/Hr.

It can be observed that at similar flow there is saving of 6.12 units/Hr. after installation of VFD.

05.11.2001 to 31.03.2002 – Kiln R.Hrs. = 2455.17 ; Clinker Production = 338585 MT

$$\text{Saving KWH/T Clk} = 6.12 \text{ KWH/Hr.} \times \frac{2455.17 \text{ Hrs.}}{338585 \text{ MT clinker}}$$

= 0.044 KWH/T Clinker

Investment : Rs. 4.90 lacs

Date / Month of Implementation : 05.11.2001

Project life : 15 Years.

B2. Energy conservation Measures adopted at BCW

7. Project detail : VFD for Raw Mill No.1 & 2 vent fans

Write-up :

Looking to the energy conservation scenario and with a view to save energy, which is a National Agenda, it was decided to see the feasibility of energy saving in Raw Mill No.1 & 2 vent fans. Hence, number of studies and energy measurements were carried out to establish expected savings. There was margin in both the fans, hence, VFD for both the fans was considered.

Calculation :

Before modification Raw Mill No.1 vent fan power = 33.81 Units / Hr.
- do - Raw Mill No.2 vent fan power = 33.92 Units / Hr.

Total = 67.73 Units / Hr.

After modification Raw Mill No.1 vent fan power = 23.62 Units / Hr.
- do - Raw Mill No.2 vent fan power = 23.57 Units / Hr.

Total = 47.19 Units / Hr.

Hence, saving (67.73 – 47.19) = 20.54 Units / Hr.

$$\text{Saving} = 20.54 \text{ KWH / Hr.} \times \frac{7443.93 \text{ (Avg. R. Hrs. of K1+K2)}}{622234 \text{ MT Clinker}}$$

= 0.25 KWH/T Clinker

Monitoring aspects :

Energy meter readings were taken before and after modification.

Investment : Rs. 7.10 Lacs

Date / Month of implementation : November, 2001

Projected Life : 15 years.

8. Project detail : VFD & replacement of Coal Mill No.1 BDC fan

Write-up :

Looking to the energy conservation scenario and with a view to save energy, which is a National Agenda, it was decided to see the feasibility of energy saving in Coal Mill No. 1 BDC fan. Hence, number of studies and energy measurements were carried out to establish expected savings of this fan.

Calculation :

Power consumption before modification	=	44.00 Units / Hr.
Power consumption after modification (when coal mill ran with coal only)	=	31.30 Units / Hr.
Saving	**=**	**12.70 Units / Hr.**

Saving in units / Ton clinker (Based on coal as fuel)

$$= \frac{12.7 \text{ Units / Hr.} \times 17 \text{ Hrs./day} \times \text{No. of days}}{2000 \text{ Tons clinker}}$$

= 0.11 Units / Ton Clinker

Monitoring aspects :

Portable electronic energy meter was connected to the Coal Mill NO.1 BDC fan motor and readings were taken before & after modification.

Investment : Rs. 6.57 Lacs

Date / Month of implementation : March, 2002

Projected Life : 15 years.

9. Project detail : Bucket Elevators for kiln feed of Kiln No.1 & 2

Write-up :

Looking to the energy conservation scenario and with a view to save energy, which is a National Agenda, it was decided to see the feasibility of energy saving in Kiln No.1 & 2 kiln feed air lift blowers. Hence, number of studies and energy measurements were done to establish expected savings. The layout permitted us to go for mechanical transport system in place of pneumatic transport system.

Calculation :

Power consumption before modification (with airlift) = 138 Units / Hr.
(Kiln feed airlift 1 & 2 = 69 units + 69 units)

Power consumption after modification = 52.25 Units / Hr.
(Bucker elevator 1 & 2 = 27.60 units + 24.65 units)

Saving in Elevator (138 – 52.25) = 85.75 Units / Hr.

Additional saving in Preheater fan :

Flow at preheater outlet with kiln feed = 189953 M^3 / Hr.
66 TPH (Air lift in circuit) at 330^OC

Flow at preheater outlet with kiln feed = 185380 M^3 / Hr.
66 TPH (Bucket elevator in circuit) at 350^OC

Flow decreased during Bucket elevator in circuit = 4573 M^3 / Hr.

Saving as per theoretical calculations :

$$\text{Fan power} = \frac{\text{Flow } (M^3 / \text{Sec.}) \times \text{Pressure (mmWg)} \times 0.745}{75 \times \eta}$$

$$= \frac{(52.75 - 51.49) \times 580 \times 0.745}{75 \times 0.80} = 9.07 \text{ Units / Hr.}$$

For both the kilns = 9.07 x 2 = **18.14 Units / Hr.**

Hence, Total saving (85.75 + 18.14) = 103.89 Units / Hr.

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Saving = 104 KWH / Hr. x $\frac{7443.93 \text{ (Avg. R. Hrs. of K1+K2)}}{622234 \text{ MT Clinker}}$

= 1.24 KWH/T Clinker

Monitoring aspects :

Portable electronic energy meter was installed in airlift blowers modification and in elevators after modification. Readings were taken.

Investment : Rs. 95.33 Lacs

Date / Month of implementation : March, 2002

Projected Life : 15 years.

C. (April, 2002-March, 2003)

C1. Energy conservation Measures adopted at CCW

10. Project details : Modification of pre heater cyclones, riser duct, down comer, Pre-heater fan, ESP fan & provision of Tertiary crusher of Raw mill in CCW.

Write-up :
CCW kiln was operating at 2800 TPD with conventional cyclones at pre heater. The technical study carried out along with M/s Holtec Consultants and Mr. E.H.Larsen of CemConsult Ltd. established that CCW kiln can be up-graded to 3300 TPD with major modifications in Pre-heater. Various option were studied and it was decided to change Pre-heater cyclones number 2, 3 & 5 to Low Pressure type, modify riser ducts, replace ESP & PH fans by high efficiency fans.
Raw mill was operating at approx. 200 TPH with input feed size 5% retained on +25 mm. It was felt that feed size could be further reduced to 5% on +10 mm, there would be increase in production along with power saving. A study was carried out by M/s Holtec Consultant and they recommended installation of Tertiary crusher for increasing the capacity of Raw mill. Modification of Raw Mill was clubbed along with pre heater modification.

Calculation :-
It was estimated that there would be saving of 2.0 KWH/T cement along with increasing production from 2800 to 3300. TPD.

PH fan flow = 7775 m^3/min.
PH fan RPM = 480
ESP fan flow = 7146 m^3/min.
ESP fan RPM = 699

It was estimated that there would be saving of 1.5 KWH/T cement along with increasing production from 200 to 230TPH, if tertiary crusher was installed.

Monitoring Aspects :-
Flow measurements an energy meter readings were taken of Pre-heater and ESP fans. A saving of 2.77 units/ton of clinker was achieved

PH fan flow = 8014 m^3/min.
PH fan RPM = 598
ESP fan flow = 6950 m^3/min.

Input feed size and TPH measurements were done and power saving achieved was calculated.

Total power saving = 3.41 units/ton.

Investment : Rs. 626 lacs

Date / Month of Implementation : Tertiary Crusher : 08.12.2000,
Preheater Modification : 01.02.2002

Project life : 20 Years.

11. Project details : Provision of 6 Nos. dip tubes in Raw mill section in CCW.

Write-up :

In house study was carried out in Raw mill section and it was felt that there may be some power saving and increase in O-Sepa separator efficiency by installation of dip tubes in multi cyclones.

Calculation :

It was estimated that there would be saving of approx. 4-5 units/Hr. along with increase in O-Sepa efficiency from 84 to 89%. Dust collection was done before & after multi cyclone. Multi cyclone efficiency before installation of dip tube = 83.55%. Power drawn = 690 units/Hr.

Monitoring Aspects :

Dust collection was done after installation of dip tubs. After installation of dip tube multi cyclone efficiency = 86.78 %. Power drawn = 686 units/Hr.

18.10.2002 to 31.03.2003 – Raw mill R.Hrs. = 1954.58 ; Raw meal Prod = 447568 MT

$$\text{Saving KWH/T Clk} = 4 \text{ KWH/Hr.} \times \frac{1954.58 \text{ Hrs.}}{447568 \text{ MT raw meal}} \times \frac{1.52 \text{ MT raw meal}}{1 \text{ MT clinker}}$$

= 0.026 KWH/T Clinker

Investment : Rs. 0.10 lac

Date / Month of Implementation : 18.10.2002

Project life : 15 Years.

C2. Energy conservation Measures adopted at BCW

12. Project detail : Bucket Elevators for raw meal transport from Raw Mill No.1 & 2 to homosilos.

Write-up :

Looking to the energy conservation scenario and with a view to save energy, which is a National Agenda, it was decided to see the feasibility of energy saving in raw meal transport from Raw Mill No.1 & 2. Hence, number of studies and energy measurements were done to establish expected savings. The layout permitted us to go for mechanical transport system in place of pneumatic.

Calculation :

Power consumption before modification (with Fluxo pump in circuit) = 271 Units / Hr.

Power consumption after modification (with tandem elevator system) = 46 Units / Hr.

Net saving = 226 Units / Hr.

Therefore, saving = 226 / 151 = 1.5 KWH/T raw meal

= 2.26 KWH / T Clinker

Saving KWH/T clinker =

$$226 \text{ KWH / Hr.} \times \frac{6574.25 \text{ (Avg. R. Hrs. of RM1\&2)}}{954841 \text{ MT Raw Meal}} \times 1.51 \text{MT Raw Meal/MT Clinker}$$

= **2.35 KWH/T Clinker**

Monitoring aspects :

Portable electronic energy meter was installed at raw mill compressor and readings taken and calculations done. Again portable energy meter was installed at Tandem elevator and readings were taken.

Investment : Rs. 61.81 Lacs

Date / Month of implementation : April, 2002

Projected Life : 15 years.

13. Project detail : VFD & replacement of Coal Mill No.2 BDC fan

Write-up :

Looking to the energy conservation scenario and with a view to save energy, which is a National Agenda, it was decided to see the feasibility of energy saving in Coal Mill No. 2 BDC fan. Hence, number of studies and energy measurements were carried out to establish expected savings of Coal Mill No.2 BDC fan.

Calculation :

Power consumption before modification	=	73.00 Units / Hr.
Flow at stack	=	14593 M^3 / Hr. at 68^{O}C
Power consumption after modification	=	51.50 Units / Hr.
Flow at stack	=	14624 M^3 / Hr. at 60^{O}C
Hence, saving (73.00 – 51.50)	=	21.50 Units / Hr.

$$\text{Saving KWH/T Clinker} = 226 \text{ KWH / Hr. x } \frac{6039 \text{ (R. Hrs. of KM2 of 2002-03)}}{634041 \text{ MT Clinker (2002-03)}}$$

$$= 0.21 \text{ KWH/T Clinker}$$

Monitoring aspects :

Portable electronic energy meter was connected to the Coal Mill No.2 BDC fan motor and readings were taken before and after modification.

Investment : Rs. 7.99 Lacs

Date / Month of implementation : June, 2002

Projected Life : 15 years.

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