ENERGY AUDIT - CASE STUDY 1

PLANT EQUIPMENT DETAILS

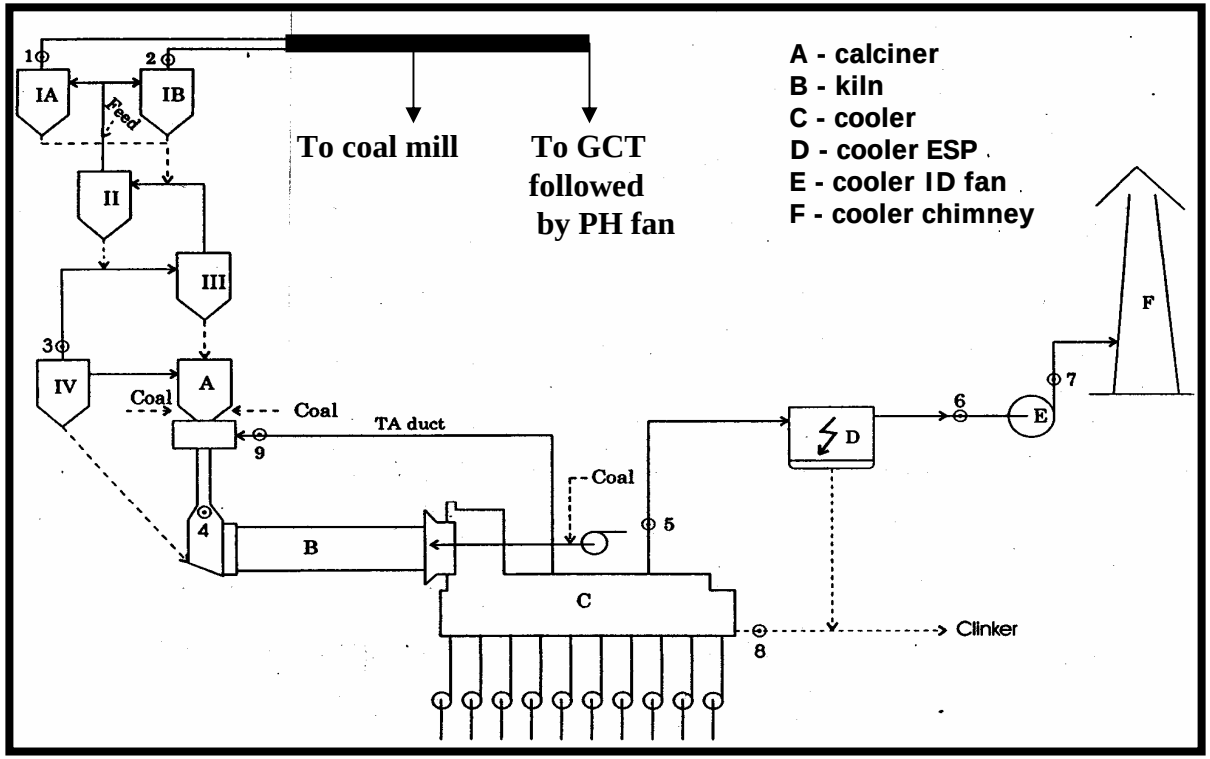
- ILC – type PC kiln , four stage PH , LP cyclones at top stage, grate cooler upgraded with stationary inlet grate
- Twin roller mills for raw material grinding , 2 fan system
- Vertical roller mill for coal grinding
- Two open circuit ball mills for cement grinding

ENERGY CONSUMPTION (reported)

Power consumption

S.No.	Section	kWh/t of cement
1	Crusher + ropeway	2.34
2	Raw mills	32.29
3	Kiln	21.07
4	Coal mill	6.98
5	Cement mills	29.45
6	Packing	1.77
7	Miscellaneous	4.62
	TOTAL	**98.52**

Heat consumption through fuel : 750 Kcal/kg cl



Sl No	Location	Temp °C	St. pr mmWG	O2 %	COppm	Volume m3/hr
1	Cyclone IA outlet	425	-765	1.6	2280	382699
2	Cyclone IB outlet	412	-735	1.7	1300	358935
3	Cyclone IV outlet	855	-265	0.2	1080	-
4	Kiln inlet	1030	-25	0.0	15000	-
5	Cooler takeoff	300-450	-45	-	-	626455
6	Clinker discharge	138	-	-	-	-
7	Tertiary air	727	-50	-	-	-

Measurements in Kiln section (before repairs)

HEAT BALANCE ON KILN
(before repairs)

Base Temperature 20 C
Clinker production 165.33 tph

HEAT INPUT	Kcal/ kg cl	HEAT OUTPUT	Kcal/ kg cl
Coal combustion	853.4	• Heat of reaction	406.7
Sensible heat		• PH exist gases – I A	119.4
• Coal	2.8	• PH exit gases – I B	110.5
• Air	12.8	• Dust in PH exit gases	20.5
• Kiln Feed	19.2	• Clinker leaving cooler	22.5
		• Cooler vent air	156.4
		• Evaporation of moisture	1.6
		• Incomplete combustion	8.6
		• Radiation and convection losses	42.0
TOTAL	888.2	TOTAL	888.2

KILN

ABNORMAL OPERATING CONDITIONS

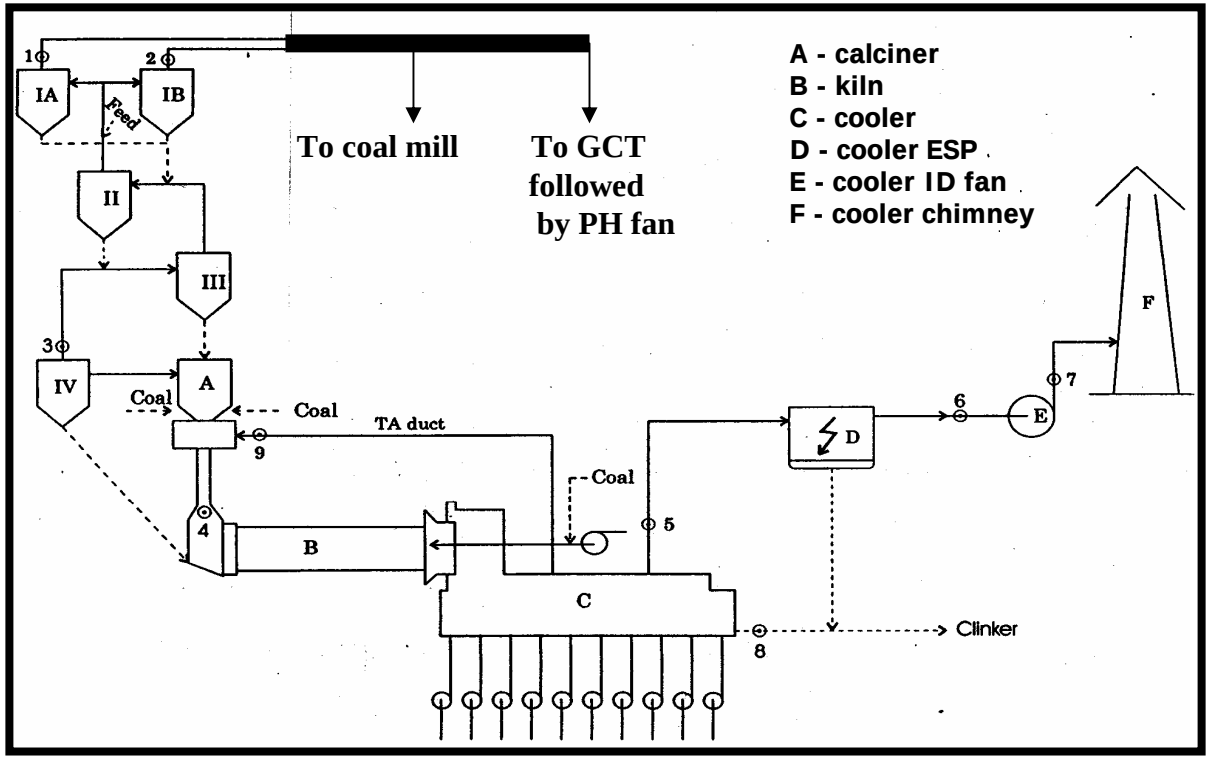
- **Preheater exhaust temperature of 425^{o}C and 412^{o}C at cyclone IA and IB respectively.**
- **High CO levels at kiln inlet, bottom cyclone outlet and top cyclone outlet**
- **Cooler exhaust air quantity of 1.77 Nm3/kg cl at a temperature of 300-450^{o}C**
- **Clinker discharge temperature of 138^{o}C**

KILN

REASONS FOR EXCESS HEAT LOSSES

- **Oxygen deficient conditions in kiln-precalciner-preheater circuit leading to prolonged combustion of coal and consequently high temperature of preheater exhaust gases.**

- **Leakages in the system particularly in the tertiary air line resulting in insufficient combustion air drawn into the kiln and precalciner & abnormal quantity and temperature of cooler exhaust air**



Sl No	Location	Temp °C	St. pr mmWG	O2 %	COppm	Volume m3/hr
1	Cyclone IA outlet	389	-775	2.0	560	344437
2	Cyclone IB outlet	395	-810	2.0	520	345810
3	Cyclone IV outlet	890	-350	0.8	260	-
4	Kiln inlet	1080	-30	1.6	-	-
5	Cooler takeoff	277	-30	-	-	472511
6	Clinkerdischarge	128	-	-	-	-
7	Tertiary air	804	-120	-	-	-

Measurements in Kiln section (after repairs)

HEAT BALANCE ON KILN
(after repairs)

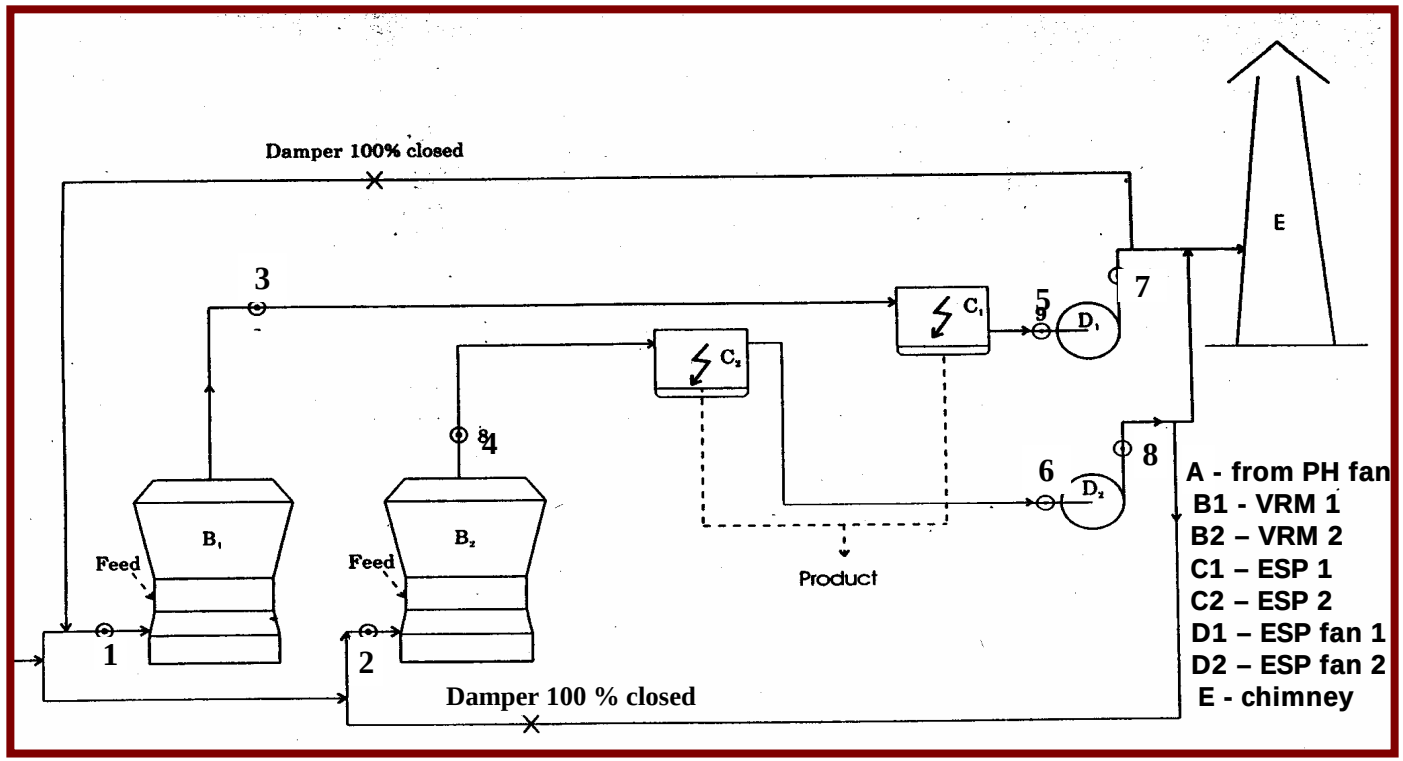
Base Temperature 20 C

Clinker production 172.0 tph

HEAT INPUT	Kcal/ kg cl	HEAT OUTPUT	Kcal/ kg cl
Coal combustion	763.6	•Heat of reaction	408.1
Sensible heat		•PH exist gases – I A	98.2
• *Coal*	2.5	•PH exit gases – I B	99.1
• *Air*	4.1	•Dust in PH exit gases	18.6
• *Kiln Feed*	19.4	•Clinker leaving cooler	20.5
		•Cooler vent air	108.0
		•Evaporation of moisture	1.6
		•Incomplete combustion	2.4
		•Radiation and convection losses	33.1
TOTAL	789.6	TOTAL	789.6

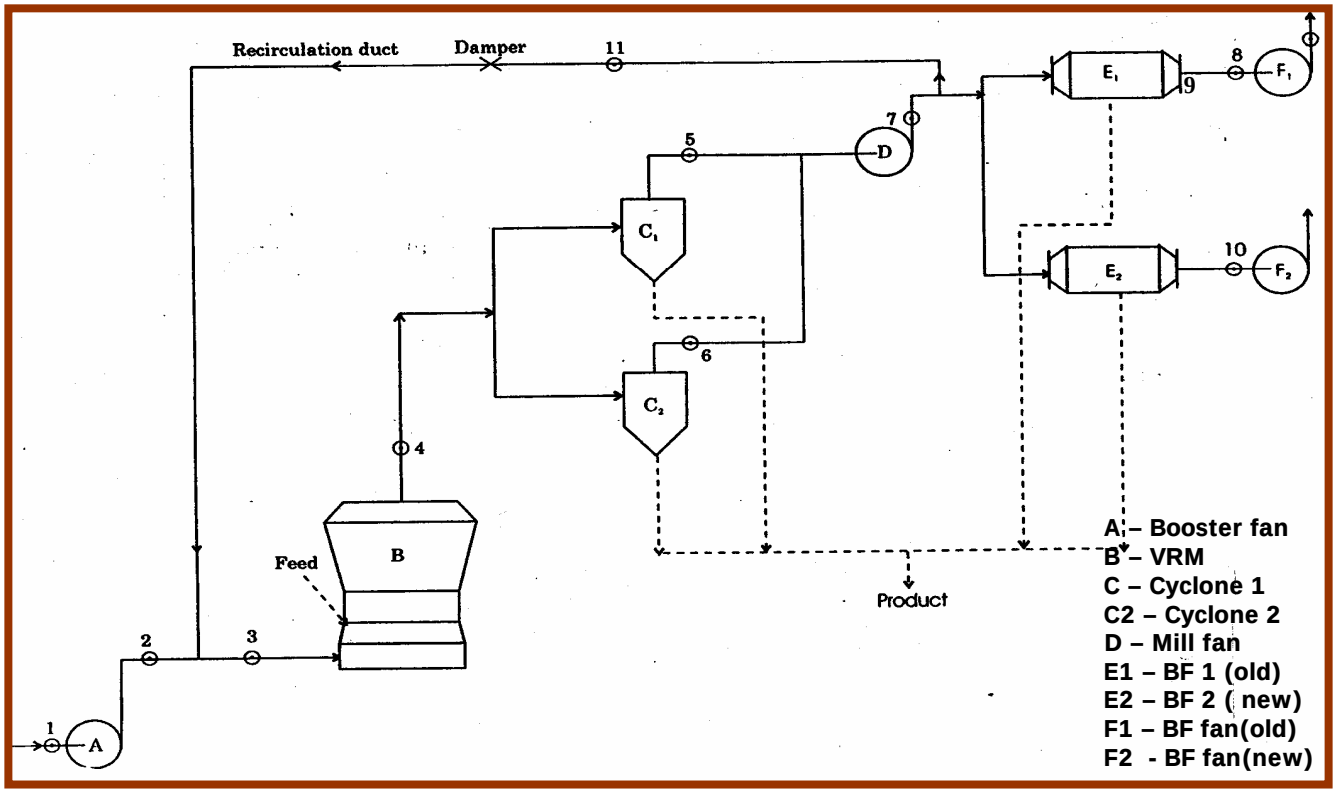
ENERGY SAVINGS

Potential thermal energy saving	Kcal / kg cl
♦ Repair of tertiary air duct and thereby ➢ Arrest leakages in tertiary air duct ➢ Draw required combustion air from cooler into kiln and calciner ➢ Reduce cooler exhaust air	100
♦ Optimisation of cooling air distribution in the different compartments of cooler to improve cooler thermal efficiency	20
Total	**120**
Achieved thermal energy saving	**105** (32475 t coal / annum)



Sl No	Location	Temp °C	St. pr mmWG	O2 %	Volume m3/hr
1	Mill 1 inlet	188	-25	4.4	-
2	Mill 2 inlet	192	- 40	5.1	-
3	Mill 1 outlet	90	- 875	10.7	-
4	Mill 2 outlet	95	- 935	8.8	-
5	ESP fan 1 inlet	94	- 865	11.1	341352
6	ESP fan 2 inlet	97	- 940	11.4	336960
7	ESP fan 1 outlet	107	- 30	11.0	-
8	ESP fan 2 outlet	103	- 30	11.7	-

Measurements in raw mill section



No	Location	Temp ° C	St pr mmWG	O2 %	Vo m3/hr
1	Booster fan inlet	396	-845	1.9	104580
2	Booster fan outlet	371	30	4.8	-
3	Mill inlet	287	- 120	5.6	-
4	Mill outlet	72	- 770	9.0	-
5	Cyclone outlet C1	71	- 875	9.9	-
6	Cyclone outlet C2	71	- 865	10.2	-
7	Mill fan outlet	82	- 20	10.7	84168
8	Bag filter fan (old) inlet	80	- 250	10.7	55908
9	Bag filter fan(old) outlet	-	-	11.2	-
10	Bag filter fan (new) inlet	71	- 280	12.4	16992
11	Recirculation	83	15	10.1	-

Measurements in coal mill section

MILLS

REASONS FOR EXCESS POWER CONSUMPTION

- **Leakages**
  - Mill 1 inlet to ESP fan 1 outlet : 66 %
  - Mill 2 inlet to ESP fan 2 outlet : 71 %
  - Mill inlet to mill fan outlet : 49.5 %
  - Across booster fan : 17.9 %
- **Inadequate gas quantity through raw mills**
- **Worn out liners in coal mill**

FAN EFFICIENCIES

S.No.	Fan location	Efficiency %
1	Raw mill 1 fan	68.4
2	Raw mill 2 fan	76.1
3	Preheater fan	64.5
4	Cooler ID fan	61.30
	Cooler fans	
5	Compartment 1	77.5
6	Compartment 2	47.3
7	Compartment 3	71.7
8	Compartment 4	73.00

FAN EFFICIENCIES

S.No.	Fan location	Efficiency %
9	Compartment 5	56.9
10	Compartment 6	79.2
11	Compartment 7	69.5
12	Compartment 8	78.0
13	Compartment 9	36.6
14	Compartment 10	67.8
15	Coal mill booster fan	61.1
16	Coal mill fan	57.8
17	Coal mill bag filter 1 (old)	78.4
18	Coal mill bag filter 2 (new)	64.9
19	Cement mill fan	30.4

REASONS FOR ENERGY LOSSES IN COMPRESSORS AND BLOWERS

- LOW VOLUMETRIC EFFICIENCY
- LEAKAGES
- IMPROPER SIZE AND PIPELINE ROUTING
- IMPROPER DISTRIBUTION OF COMPRESSED AIR FOR DUST COLLECTORS

ENERGY SAVINGS

Potential electrical energy saving	Kwh/tonne material	Kwh/tonne cement
Reduction in ESP-1 fan power consumption by arresting leakages in raw mill 1 circuit	0.75	1.05
Reduction in ESP-2 fan power consumption by arresting leakages in raw mill 2 circuit	0.82	1.15
Retrofitting raw mill 1 fan with high efficiency impeller	0.39	0.55
Replacement of preheater fan with high efficiency fan	1.50	1.44
Reduction in cooler ID fan power consumption due to reduction in vent air from 1.77 to 1.32 Nm3/kg cl	0.32	0.31
Installation of variable frequency drives for cooling fans 2 & 9	0.17	0.17
Reduction of leakages in coal mill circuit	4.52	0.81
Replacement of coal mill fan with high efficiency fan	2.00	0.36
Optimisation of compressed air utilisation		0.70
Reshuffling of motors and replacement of under loaded motors		0.20
TOTAL		**6.74**
Achieved electrical energy saving		**3.00**