Cleaner Production in Ceramic Sector

A strategy for Pollution Prevention

Prepared by:

Gujarat Cleaner Production Centre

(Established by Industries & Mines Department, Government of Gujarat)

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Optimization of Combustion Efficiency: Kilns and Dryers

Firing is the most cost intensive part in any ceramic industry, whether it may be using oil or natural gas. Slightest deviation from the scientific technique may consume more fuel than theoretically required. It is crucially required to optimize the Combustion air – Fuel ratio. Deviation from stoichiometric combination of air and fuel may affect in two ways –

1. Less air than required: It may lead to incomplete combustion of fuel and thereby generation of Carbon Monoxide (CO), a potentially harmful gas

2. More air than required: It may lead to over utilization of fuel, as more oxygen attracts more fuel in combustion chamber, increasing the fuel consumption.

A few kilns were studied using a portable Flue Gas cum Combustion Efficiency Analyser and the results obtained were quite surprising, and after the analysis, the precautionary measures to be undertaken and expected results were even more surprising.

Combustion Efficiency Indicator:

1. As a rule, the most efficient and cost-effective use of fuel takes place when CO_2 concentration in the exhaust is maximized. Theoretically, this occurs when there is just enough O_2 in the supply air to react with all the carbon in the fuel.

2. The absence of any O_2 in the flue gas directly indicates deficient combustion air while presence indicates excess air. Ideally, the O_2 level shall be maintained 2 % to 6 %, CO_2 level shall be maintained 8 % to 11 %, CO level shall be maintained 80 ppm - 100 ppm and excess air shall be maintained 5 % to 7 % (high pressure burner) for natural gas.

3. Carbon monoxide (CO) is a sensitive indicator of incomplete combustion; its levels should range from 0 to 400 ppm by volume. The presence of a large amount of CO in flue gas is a certain indicator of deficient air.

The same can be maintained by regular monitoring of flue gas sample with the help of a portable flue gas analyser or by installing O_2 sensor at the furnace exhaust for flue gases and a modulating motorized damper or RPM of combustion air blower through VFD for combustion air control. The sensor will provide constant feedback of O_2% to the damper / VFD which will in turn regulate the flow of combustion air to maintain the combustion efficiency at optimum level of 80 - 90% (Achievable combustion efficiency).

Case Study – 1	Wall and Floor Tiles manufacturing industry with roller kilns and horizontal and vertical roller dryers (Fuel: Natural Gas)
Implementing the technology	Flue gas exhaust at the kilns & dryers was monitored. The flue gas analysis for the kilns & dryers were carried out at the exhaust of individual kilns.Four kilns and three dryers were subjected to the exercise. The measured parameters are shown in tables below:

Table 1: Floor Tiles Plant Kiln 1

Parameter	Unit	Initial	Reduced Combustion Air
Net Temperature	^{0}C	168	160
O_2	%	15	12.7
CO	Ppm	107	120
Combustion Efficiency	%	71.6	76.6
CO_2	%	3.5	4.7
Flue Gas Temperature	^{0}C	198	194
Ambient Temperature	^{0}C	30.2	33.8
Excess Air	%	231	164
Pressure	mbar	0.08	0.40

Table 2: Floor Tiles Plant Kiln 2

Parameter	Unit	Initial	Reduced Combustion Air
Net Temperature	^{0}C	226	204

O_2	%	17.2	14.5
CO	ppm	79	180
Combustion Efficiency	%	50.2	68.2
CO_2	%	2.0	3.6
Flue Gas Temperature	^0C	255	237
Ambient Temperature	^0C	29.5	33
Excess Air	%	480.5	221.5
Pressure	mbar	0.07	0.37

Table 3: Wall Tiles Plant Biscuit Kiln

Parameter	Unit	Initial	Dilution Blower Off
Net Temperature	^0C	246	260
O_2	%	17.1	16.7
CO	ppm	29	32
Combustion Efficiency	%	46.7	49.5
CO_2	%	2.1	2.4
Flue Gas Temperature	^0C	279	274
Ambient Temperature	^0C	32.6	32.6
Excess Air	%	464.8	397.6
Pressure	mbar	0.29	0.28

Table 4: Wall Tiles Plant Glost Kiln

Parameter	Unit	Initial
Net Temperature	^0C	150
O_2	%	15.3
CO	ppm	86
Combustion Efficiency	%	72.3
CO_2	%	3.2
Flue Gas Temperature	^0C	181
Ambient Temperature	^0C	82.4
Excess Air	%	273.2
Pressure	mbar	0.22

Table 5: Horizontal Dryer 1

Parameter	Unit	Initial	Reduced Combustion Air
Net Temperature	^{0}C	88	88
O_2	%	19.9	19.7
CO	ppm	22	24
Combustion Efficiency	%	37.9	44.7
CO_2	%	0.6	0.7
Flue Gas Temperature	^{0}C	119	120
Ambient Temperature	^{0}C	30.7	31
Excess Air	%	1990	1642
Pressure	mbar	0.04	0.05

Table 6: Horizontal Dryer 2

Parameter	Unit	Initial
Net Temperature	^{0}C	144
O_2	%	19.2
CO	ppm	1
Combustion Efficiency	%	38.4
CO_2	%	1.0
Flue Gas Temperature	^{0}C	177
Ambient Temperature	^{0}C	33.1
Excess Air	%	1061
Pressure	mbar	0.29

Table 7: Vertical Dryer

Parameter	Unit	Initial
Net Temperature	^{0}C	127
O_2	%	17.9
CO	ppm	37
Combustion Efficiency	%	62.7
CO_2	%	1.7
Flue Gas Temperature	^{0}C	161

Ambient Temperature	^{0}C	34.3
Excess Air	%	620.6
Pressure	mbar	0.06

Recommendations:

It was suggested to control the combustion air through reducing the RPM of combustion air blower by 1-2 Hertz at a time by monitoring required temperature within kiln and set the appropriate frequency and monitoring the required O_2 percentage in flue gas to optimize the air fuel ratio and thus combustion efficiency at the kiln.

Excessive draft allows increased volume of air into the furnace. The large amount of flue gas moves quickly through the furnace, allowing less time for heat transfer to the material side. The result is that the exit temperature decreases with increase in heat quantity along with larger volume of flue gas leaving the stack contributes to higher heat loss.

Benefits	
Environmental	• Per Day reduction in the gas consumption: 500 SCM. Per Year reduction in gas consumption: 1,82,500 SCM. • Per Day reduction in Greenhouse Gas (CO_2) emission: 0.94 MT Per Year Reduction in Greenhouse Gas (CO_2) emission: 341.82 MT
Economical	Investment: **NIL** Savings: **Rs. 53,50,000/-** per annum Payback period: **Immediate**

Case Study – 2	Low Tension Ceramic Insulators manufacturing industry having tunnel kiln (Fuel: Natural Gas)

Implementing the technology

Flue gas exhaust at the tunnel kiln was monitored. %O_2 in flue gas varies from 5.1% to 15.6%.

Parameter	Unit	Exhaust (Flue Gas)		Firing Zone
O2	%	14.1	12.0	20.3
CO	ppm	1266	1137	20
Combustion Efficiency	%	45.2	57.5	O2> 20%
CO2	%	3.01	5.0	O2> 20%
Excess Air	%	344.6	137.5	O2> 20%
Pressure	mbar	0.05	0.08	0.24

The Carbon Monoxide (CO) level is alarmingly high. The reason is **No Proper Mixing of Combustion air and the fuel**, most possibly due to **Not Cleaning** the burners for **8 – 10 years** and possible damage to the burner tip.

The same can be maintained by regular monitoring of flue gas sample with the help of a portable flue gas analyzer or by installing O_2sensor at the furnace exhaust for flue gases and a modulating motorized damper for combustion air control.

Recommendations:

It is suggested to control the combustion air through reducing the RPM of combustion air blower by 1-2 Hertz at a time by monitoring required temperature within kiln and set the appropriate frequency and monitoring the required O_2 percentage in flue gas to optimize the air fuel ratio and thus combustion efficiency at the kiln.

The proper control of air to fuel ratio can result in combustion efficiency more than 75 % with old burners as well. Thus increase in 15% combustion efficiency will result in saving of approximately 85,540 SCM gas per annum.

Benefit	
Environmental	• Per Day reduction in the gas consumption: 234 SCM. Per Year reduction in gas consumption: 85,540 SCM. • Per Day reduction in GHG (CO_2) emission: 489 Kg Per Year Reduction in GHG (CO_2) emission: 160 MT
Economical	Investment: **Rs. 20,000/-** (For VFD) Annual Savings: **Rs. 16,25,000/-** per annum Payback Period: **Immediate**

<table>
<tr><td>Case Study – 3</td><td>Low Tension Ceramic Insulators manufacturing industry having tunnel kiln (Fuel: Natural Gas)</td></tr>
<tr><td>Implementing the technology</td><td>Flue gas exhaust at the tunnel kiln furnace was monitored. %O_2 in flue gas varies from 5.1% to 15.6%.
Flue gas temperature also varies from169°C to 200°C.% O2 in flue gases should be between 2 – 6%.
<table><tr><th>Parameters</th><th>At Kiln Exhaust</th><th>At Firing Zone</th></tr><tr><td>O2 (%)</td><td>17.3</td><td>10.2</td></tr><tr><td>CO (ppm)</td><td>131</td><td>65</td></tr><tr><td>CO2 (%)</td><td>2.4</td><td>6.1</td></tr><tr><td>Efficiency (%)</td><td>67.5</td><td>64.1</td></tr><tr><td>Excess Air (%)</td><td>364.3</td><td>95.3</td></tr><tr><td>Pressure (mbar)</td><td>0.12</td><td>0.20</td></tr></table>
Recommendations:
It is suggested to control the combustion air through reducing the RPM of combustion air blower by 1-2 Hertz at a time by monitoring required temperature within kiln and set the appropriate frequency and monitoring the required O_2 percentage in flue gas to optimize the air fuel ratio and thus combustion efficiency at the kiln.

The proper control of air to fuel ratio can result in combustion efficiency more than 75 % with old burners as well. Thus increase in 10 % combustion efficiency will result in saving of approximately 12,971 SCM gas per annum.</td></tr>
<tr><td colspan="2">Benefits</td></tr>
<tr><td>Environmental</td><td>• Per Day reduction in the gas consumption: 35.5 SCM.
Per Year reduction in gas consumption: 12,971 SCM.

• Per Day reduction in Greenhouse Gas (CO_2) emission: 65 Kg
Per Year Reduction in Greenhouse Gas (CO_2) emission: 24.3 MT</td></tr>
<tr><td>Economical</td><td>Investment: NIL
Annual Savings: Rs. 4,21,000/- per annum
Payback Period: Immediate</td></tr>
</table>

Case Study – 4	Tableware manufacturing industry having tunnel kiln (Fuel: Natural Gas)
Implementing the technology	Flue gas exhaust at the tunnel kiln furnace & decoration kiln was monitored. % O_2 in flue gas is more than 11 % in tunnel kiln and more 9 % in decoration kiln. % O_2 in flue gases should be between 2 – 6%. The same can be maintained by regular monitoring of flue gas sample with the help of a portable flue gas analyzer or by installing O_2sensor at the furnace exhaust for flue gases and a modulating motorized damper or RPM of combustion air blower through VFD for combustion air control. The sensor will provide constant feedback of O_2% to the damper / VFD which will in turn regulate the flow of combustion air to maintain the combustion efficiency at optimum level of 80 - 90% (Achievable combustion efficiency).

Table: Flue Gas Monitoring Parameters at Tunnel Kiln

Parameter	Unit	At Kiln Exhaust	Firing Zone
Net Temperature	0C	215	482
O2	%	14.2	11.9
CO	ppm	11	53
Combustion Efficiency	%	69	55.2
CO2	%	3.9	5.2
Flue Gas Temperature	0C	233	507
Ambient Temperature	0C	20.6	25
Excess Air	%	198.5	127.1
Pressure	mbar	0.06	0.29

Table: Flue Gas Monitoring Parameters at Decoration Kiln

Parameter	Unit	Firing Zone
Net Temperature	0C	502
O2	%	10
CO	ppm	0
Combustion Efficiency	%	57.3
CO2	%	6.0
Flue Gas Temperature	0C	534
Ambient Temperature	0C	29.5
Excess Air	%	100.9
Pressure	mbar	0.02

It is suggested to control the combustion air through reducing the RPM of combustion air blower by 1-2 Hertz at a time by monitoring required temperature within kiln and set the appropriate frequency and monitoring the required O_2 percentage in flue gas to optimize the air fuel ratio and thus combustion efficiency at the kiln.

The proper control of air to fuel ratio can result in combustion efficiency more than 75 % with old burners as well. Thus increase in 10% combustion efficiency will result in saving of approximately **19,782** SCM gas per annum.

Benefit	
Environmental	• Per Day reduction in the gas consumption: 54.15 SCM. Per Year reduction in gas consumption: 19,782 SCM. • Per Day reduction in GHG (CO_2) emission: 113 Kg Per Year Reduction in GHG (CO_2) emission: 41,344 Kg
Economical	Investment: **Rs. 20,000/-** (For VFD) Savings: **Rs. 6,33,000/-** per annum Payback Period: **Immediate**

Case Study – 5	Low tension porcelain ware and industrial and technical ceramics manufacturing industry having tunnel kiln (Fuel: Natural Gas)
Implementing the technology	Flue gas exhaust at the tunnel kiln was monitored. $\%O_2$ in flue gas was more than 12%.Flue gas temperature at exhaust of the kiln (at charging end) was also at 378^0C. $\%O_2$ in flue gases should be between 2 – 6%. The same can be maintained by regular monitoring of flue gas sample with the help of a portable flue gas analyzer or by installing O_2sensor at the furnace exhaust for flue gases and a modulating motorized damper or RPM of combustion air blower through VFD for combustion air control. The sensor will provide constant feedback of O_2% to the damper / VFD which will in turn regulate the flow of combustion air to maintain the combustion efficiency at optimum level of 80 - 90% (Achievable combustion efficiency). Table: Flue Gas Monitoring Parameters at Kiln It is suggested to control the combustion air through reducing the RPM of combustion air blower by 1-2 Hertz at a time by monitoring required temperature within kiln and set the appropriate frequency and monitoring the required O_2 percentage in flue gas to optimize the

Parameter	Unit	Firing Zone
O2	%	14.3
CO	ppm	0
Combustion Efficiency	%	45
CO2	%	3.9
Excess Air	%	124.8
Pressure	mbar	0.11

	air fuel ratio and thus combustion efficiency at the kiln. The proper control of air to fuel ratio can result in combustion efficiency more than 75 % with old burners as well. Thus increase in 30 % combustion efficiency will result in saving of approximately **1,03,543** SCM gas per annum.
Benefit	
Environmental	• Per Day reduction in the gas consumption: 284 SCM. Per Year reduction in gas consumption: 1,03,543 SCM. • Per Day reduction in Greenhouse Gas (CO_2) emission: 594 Kg Per Year Reduction in Greenhouse Gas (CO_2) emission: 2,16,404 Kg
Economical	Investment: **Rs. 20,000/-** (For VFD) Annual Savings: **Rs. 44,52,000/-** per annum Payback Period: **Immediate**

Optimization of Combustion Efficiency of Spray Dryer Furnace

The spray dryer is a device mainly used in wall and floor tiles manufacturing industries as far as ceramic sector is concerned. Its main application is in formation of required size granules from the wet slip. Care must be taken that the density of the slip fed to the spray dryer must always remain the same to obtain the same size of granules, as varying density of feed forms granules of varying sizes.

The evaporation of the moisture present in slip is removed by hot gases, generated by combustion of fuels, say natural gas or coal. In either of the cases, combustion efficiency always remains the key component of economy, more importantly in the case of coal. Coal may contain high amount of moisture and may be with less calorific values. Hence it becomes necessary to optimize the combustion efficiency of coal.

3 nos. of furnaces were selected for studying the furnace efficiencies. All of them were coal fired, forming hot gases, passed through cyclone for filtering out the solid particles and then to the spray dryers for formation of granules. The results of the study are as follows.

Case Study – 1	Walls and Floor Tiles Manufacturing Industry, having three spray dryers with fluidized bed coal fired furnaces (Fuel: Coal)
Implementing the technology	Plant is operating 3 nos. of spray dryers for material processing for which hot flue gases are being generated through respective fluidised bed furnaces with coal as fuel. The operating parameters of the furnaces are mentioned in following table:

Table: Furnace Operating Parameters

Parameters	SD – 1	SD – 2	SD – 3
Set Temperature Value (^{0}C)	600	575	610
Fuel Feeder Motor Frequency (Hz) – Auto	10-23	10-16	8-30

FD Fan Motor Frequency (Hz) – Fixed	41.6	36.5	38

As it is evident that the frequency of fuel feeding is varying as per temperature requirement but the supply air and draft control is constant thus affecting the combustion efficiency of the furnaces resulting in excess fuel consumption. Thus, the flue gas analysis for the furnaces were carried out at the exhaust of individual furnaces, the measured parameters are shown in table below:

Table: Flue Gas Monitoring Parameters at Furnaces

Parameter	Unit	SACMI	SAKA	BORA
Net Temperature	^{0}C	592	560	495
O_2	%	13.6	O_2> 20%	O_2> 20%
CO	ppm	58	O_2> 20%	O_2> 20%
Combustion Efficiency	%	38	O_2> 20%	O_2> 20%
CO_2	%	6.1	O_2> 20%	O_2> 20%
Flue Gas Temperature	^{0}C	619	592	525
Ambient Temperature	^{0}C	26.4	33.1	30
Excess Air	%	216.6	O_2> 20%	O_2> 20%
Pressure	mbar	0.09	0.06	0.07

Recommendations:

- Thus, it is recommended to operate the furnaces at optimum efficiency by controlling (manual/auto) air fuel ratio so that to get maximum combustion efficiency.
- The fluidised bed furnaces are known for generating maximum combustion efficiency in principal more than 80 %, thus plant should target to achieve the same, initially by manual adjustment through frequency adjustment and monitoring oxygen percentage in flue gases and then putting the drives in auto with online O_2 sensor in exhaust and feedback to supply air.
- Although caution needs to be considered with setting of

	minimum air requirement for bed generation within furnace, if the required bed height is not achieved after reduction in air supply and there is still less combustion efficiency achieved, then the design of furnace needs to be modified accordingly.
Benefits	
Environmental	• Per Day reduction in the Coal consumption: 14.5 Tons • Per Year reduction in Coal consumption: 5,289 Tons For the sub-bituminous coal: • Per Day reduction in Greenhouse Gas (CO_2) emission: 40 Tons • Per Year Reduction in Greenhouse Gas (CO_2) emission: 14,545 Tons
Economical	Investment: **Rs. 75,00,000/-** (O_2 Sensors for 3 furnaces) Savings: **Rs. 2,38,00,000/-** per annum Payback period: **4 months**

Case Study – 2	Removing the moisture contents of coal using solar drying
Implementing the technology	A wall and floor tiles industry uses spray dryers for the formation of granules. The hot gases to the spray dryers are supplied by the combustion of 'sub-bituminous' coal in box furnaces. It was found during the field visit that the coal had moisture of 30% – 35%, (varying according to seasons). Most of the time, the coal had moisture more than 35%. There was no facility for preheating of coal. The coal storage area was open to environment which led to increase in the moisture especially in winter and monsoon seasons. • *The moisture content of the coal is a serious issue as far as the combustion efficiency is concerned.* • *The average annual consumption of coal of the industry happens to be 20,307 MT. With 30% moisture in coal at average, the water content in the coal would be 6,100 MT.* • *It means that the industry has to use energy equivalent to 1870 MT of coal annually just to evaporate the moisture from that coal itself.* • *Also, the purpose of the hot gases are to take up the moisture of the slip in*

the spray dryer, however, the hot gases themselves are moist, hence they also decreases the efficiency of Spray Drying operation.

- *Ultimately, it invites an extra expense of Rs. 85 Lacs annually to the industry, excluding the efficiency loss of spray drying.*

Also the loss due to wind flow is significant. There was a huge hole in the back side wall of the yard, leading to the loss of coal by wind, also generating air borne particles, polluting the air.



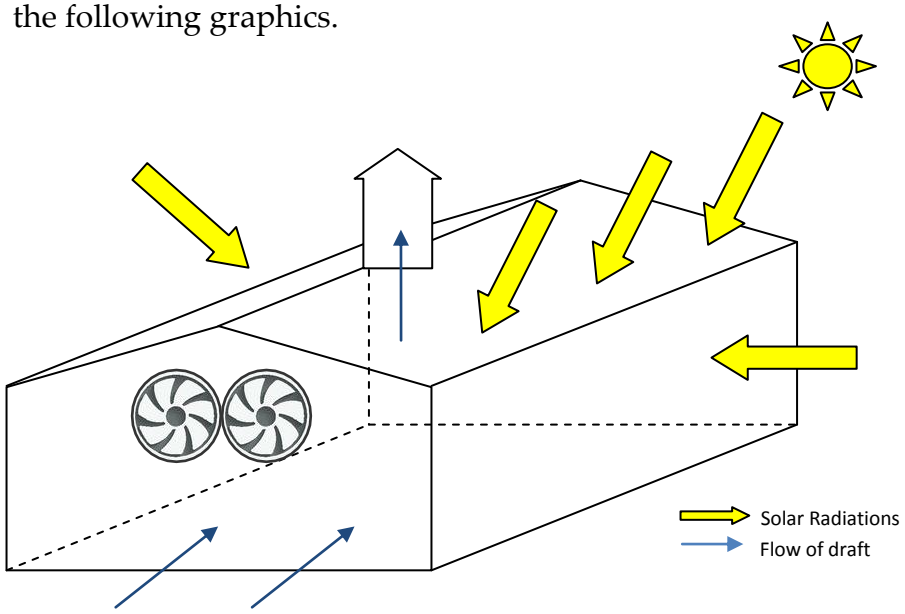

Recommendations

- The most appropriate suggestible option for removal of moisture from coal, without using any type of fuel for heat generation, is by 'Solar Drying', by an application of Solar Glass House along with a Churning machine for regular and even mixing of newer and older coal.

- India is a subtropical country. The average incidence of solar radiations on earth on an average sunny day in subtropical areas like India is around 800 – 1000 W/M^2 (especially in regions like Gujarat, which falls on 'Tropic of Cancer'

- The energy obtained from the Sun in form of radiations can be

utilized for drying purpose. The space allotted for coal storage can be modified in the form of Solar Glass House by building a storage yard made up of High Emissivity Tempered Glass as depicted in the following graphics.



- The arrangement contains, as shown in the graphics, a tempered glass house with a churning machine inside to evenly distribute the coal in a layer of fixed thickness. Fans are arranged at the inlet side of the drying area to provide draft to the moist air. An exhaust chimney is provided for creating a suction draft inside the drying area.

The drying principle is based on four factors:

1. **Temperature:** It is directly proportional with the rate of drying. More the temperature of drying area, rapid will be the drying. Here, sufficient temperature will be available due to the combined effect created by the plastic sheets and solar radiations.

2. **Air draft velocity:** It is also directly proportional with the rate of drying. More the velocity of wind/drying air, faster will be the drying. In this case, it will be provided using small fans from inlet side of drying area.

3. **Moisture:** It is inversely proportional with the rate of drying. In this case, we have to decrease the moisture from 30% to 5%

4. **Surface area:** More the surface area of contact between the object and the air, faster will be the drying. This will be done by the churning machine by evenly spreading the coal on ground. A typical churning machine is shown here.

The working of this operation can be explained as below.

- The Glass House creates a Greenhouse Effect inside the drying chamber, which absorbs solar radiations inside the chamber but allows only partial radiations to reflect out in atmosphere, hence increasing the temperature inside the chamber.

- The increased temperature heats up the inside air, which is naturally drafted upwards. The fans regulate the draft direction and velocity. The hot air has more absorption capacity than the cold air; hence it absorbs the moisture of coal and moves outside the chamber through the small chimney provided at the top, creating a suction pressure inside to draw the hot air. This continues the process ahead.

	• The objective of the dryer is to supply the coal with more heat than is available under ambient conditions, thereby increasing sufficiently the vapour pressure of the moisture held within the drying area and decreasing significantly the relative humidity of air and thereby increasing its moisture carrying capacity and ensuring sufficiently low equilibrium moisture content of coal.  
Benefit	
Environmental	Without using any type of combustion or heat utility, moisture of coal can be decreased from 30% to less than 5%. The dried coal gives a more efficient combustion than a moist coal, thereby leading to complete combustion of coal. The direct benefit to the environment would be – • *Decrease in annual requirement of coal by 1560 MT.* • *Reduction in emission of Green House Gas by 2500 MT.*
Economic	Investment: **Rs. 25 Lacs** (For setting up the glass house and churning machine) Savings: **Rs. 70 Lacs per annum** Payback Period: **5 months** Note: Industry may save initial capital investment by not installing the churning machine, however, it would then be much necessary to engage sufficient manpower to continuously rearrange and redistribute the coal evenly on the ground, so as to maximize the contact time between the coal and solar radiations.

It is also recommended to use the technique of Solar Glass House Drying in all kinds of industries, for drying any kind of material in fact any material whose moisture needs to be removed. This has dual advantage of drying faster and after removal of moisture, requiring less fuel to bake in firing stage.

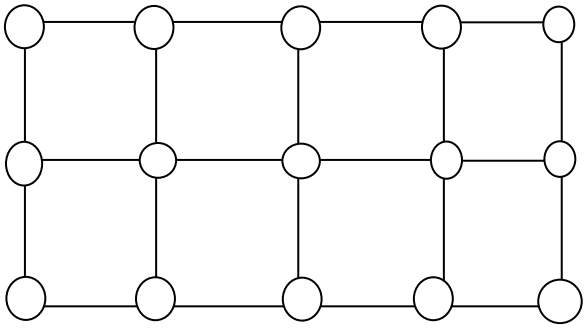
Modifying Kiln Cars for Efficient Use of Heat

(Low Thermal Mass)

The heavier the material on kiln car more will be the gas consumption of the kiln. The heavier the furniture material, more the heat is utilized to heat up the car, which is of no use. The only useful heat is what absorbed by the product loaded on the car.

Furniture of the car consists of the shelves for loading the moulded pieces, supports to withstand the shelves and refractory bricks platform to withstand the whole assembly. This kind of arrangement makes the kiln car very heavy, aiding to heat absorption and increase the gas consumption.

Case Study – 1	Modification in kiln car furniture by replacing **'Solid Cordierite Kiln Car Shelves (Saggers)'** with **'Extruded Batts'**, thereby reducing the weight of kiln car (Low Thermal Mass Kiln)
Implementing the technology	The diagrammatic representation of kiln car before modification at a porcelain ware industry is shown here.



The size of the kiln	104' (31.69 meters) approx.
Car capacity of kiln	27 Cars
Dimensions of the kiln car	(46" * 20" * 30") (L * W * H)
Cycle time	40 Min

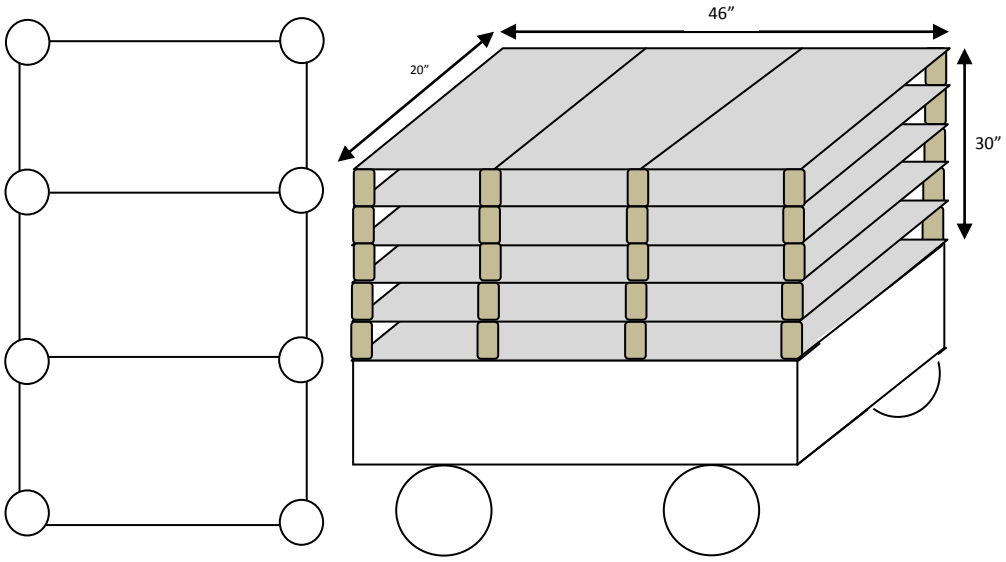
Material of car furniture	The shelves are made of Pressed Cordierite and the platform is made up of heavy refractory bricks with ceramic fibre as filling
Dimension of cordierite plates	11″ * 10″ * 1″ (280mm * 254 mm * 25mm)
Loaded product per kiln car	150 Kg
No. of layers of sagger per car	4 to 6 (depending upon size of product)
Gas consumption	287.35 SCM/Ton of product

A typical cordierite plate is shown here (For Symbolic reference only)

Recommendations:

As per the thumb rule, the gas consumption will be reduced dramatically by reducing the weight of the kiln car. The option to reduce the kiln car weight is by changing the design of shelves in the kiln car

It is highly recommended to replace the Solid Cordierite Shelves with light weight 'Extruded Cordierite Batts'. The structure can be visualized in the picture given below.

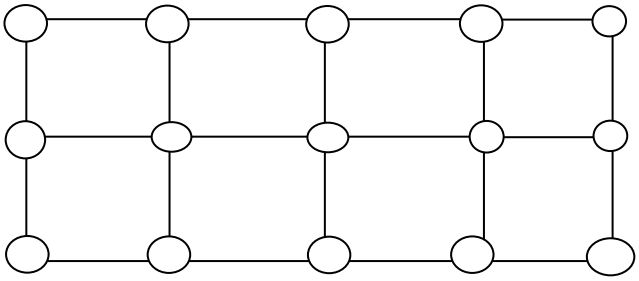
	The specific gravity of the extruded cordierite batts is 2.57 – 2.66 with better thermal efficiency and thermal shock resistance and proven to reduce the gas consumption than the solid cordierite plates. The only drawback associated with using such plates is that the thickness required for carrying heavy load is around 25 mm. However, it is still the better condition, because after deducting the internal hollow portion, the solid portion thickness still reduces to 12 mm. 
After CP	• Size of one shelve: 20″ * 15″ * 1″ (0.508 * 0.381 * 0.025 meter) • Volume of one shelve: 0.0048 m^3 • Density of one extruded batt: 2100 Kg/m^3 * 60% (as 40% space is hollow) • Weight of one extruded batt: (0.0048 * 2100 * 0.6) = 6.048 Kg • Each layer of car will contain 3 shelves of extruded batt • Each car may contain 5 layers of such batts • Total no. of batts per car: (5 * 3) = 15 (405 batts for 27 Cars) • Total weight of 15 batts: (15 * 6.05) = 90.72 Kg • Total weight of batts for 27 cars = 2450 Kg • Current weight of shelves on 27 cars 4082.4 Kg + Weight of product 3500 Kg = Total 7582 Kg • After modification, weight of shelves on 27 cars 2450 Kg + Weight

	of product 3500 Kg = Total 5950 Kg • Reduction in weight of cars: (7582 – 5950) = 1632 Kg • % Reduction in weight: 22% • % Reduction in Gas Consumption: 22% approx. • Savings in Gas Consumption per annum: 1,20,860 SCM
Benefit	
Environmental	• Per Day reduction in the gas consumption: 335.72 SCM. Per Year reduction in gas consumption: 1,20,860 SCM. • Per Day reduction in Greenhouse Gas (CO_2) emission: 0.63 MT Per Year Reduction in Greenhouse Gas (CO_2) emission: 226 MT
Economic	Investment: **Rs. 4,90,000/-** (for 405 batts @ Rs. 200/Kg of batt) Expected Savings: **Rs. 22,80,000/- per annum** Simple Payback Period: **3 Month**

Case Study – 2	Modification in kiln car furniture by replacing **'Solid Cordierite Kiln Car Shelves (Saggers)'** with **'Oxide Bonded Silicon Carbide (SiC) Shelve'**
Implementing the technology	• The kiln used at the industry is a tunnel kiln, made up of ceramic fibre walls with asbestos covering outside. • Capacity: **3300 Kg/day**. • Average fuel consumption: **475 SM^3/day**(144 SM^3/ton product) • Car capacity of kiln: **27 Cars** • Kiln Car Dimensions: **(46" * 23" * 30")** (Length * Width * Height)  • Cycle Time: **80 Minutes** • Total time inside kiln for a car: **37.5 Hours** • Average material loading per car: **165 Kg** **Before Cleaner Production:** • The platforms used to hold the moulded insulators were made up

of 'Cordierite'

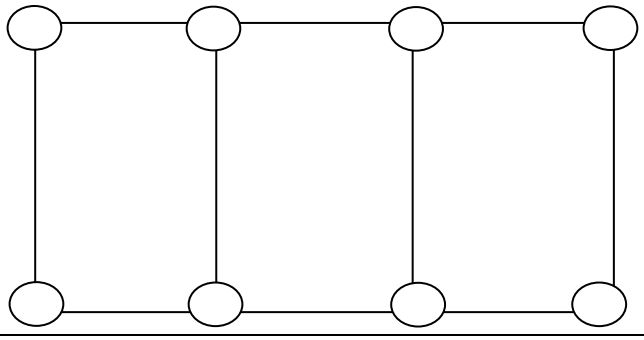
- Dimension of cordierite plates: 11"*11"* 1" (280mm * 280 mm * 25mm)
- Each layer of car contained 8 plates.
- The graphical design (Top View) of the kiln car is as shown here.



- With this structure, approximately 24 Kg of product could be loaded on one layer
- Each car contained approx5 layers of cordierite plates.
- Total weight of products loaded on car with above structure: (24 Kg * 5 layers) = 120 Kg approximately.
- As the car loading cycle time is 80 minutes,
  Per day car sent for baking: 18 cars
  Per day firing of products: 2160 Kg approximately
- Average gas consumption per day: 545 SM^3 / Day Approx.
  Gas consumption per ton of product: (545 SM^3 / 2160 Kg)
  = 252 SM^3 /MT

After Cleaner Production:

- The platforms used to hold the moulded insulators are made up of 'Oxide Bonded Silicon Carbide'
- Dimension of SiC plates: 15"* 22"* 0.6"
  (381mm * 560mm * 15mm)
- Each layer of car contained 3 plates.
- The graphical design (Top View) of the kiln car is as shown here.



<table>
<tr><td></td><td colspan="2">

- With this structure, approximately 30 Kg of product could be loaded on one layer
- Each car contained approx 6 layers of oxide bonded silicon carbide plates.

- Total weight of products loaded on car with above structure: (30 Kg * 6 layers) = 180 Kg approximately.

- As the car loading cycle time is 80 minutes,
  Per day car sent for baking: 18 cars
  Per day firing of products: 3240 Kg approximately
- Average gas consumption per day: 488 SM^3/Day approx.
  Gas consumption per ton of product: (488 SM^3 / 3240 Kg)
  = 150 SM^3 /MT

</td></tr>
<tr><td>Benefits</td><td colspan="2"></td></tr>
<tr><td>Environmental</td><td colspan="2">

Before CP:

- Per Day Consumption of fuel: 545.984 SM^3/Day

After CP:

- Per Day Consumption of fuel: 488.371 SM^3/Day
- Reduction in fuel consumption:
  = (545.984 – 488.371)= 57.61 SM^3/Day
  = 20739.72 SM^3/Year
  = Reduction in Green House Gas Emission = 43385 Kg CO_2.
- Percentage reduction of fuel consumption: 10.55%

</td></tr>
<tr><td rowspan="3">Economical</td><td>Before CP</td><td>After CP</td></tr>
<tr><td>

- Fuel expense per day
  = (Rs. 40/SM^3) * (545.984)
  = Rs. 21,839/Day

</td><td>

- Fuel expense per day
  = (Rs. 40/SM^3) * (488.371)
  = Rs. 19,534/Day
- Savings of Rs. 2,305/Day
  Rs. 69,150/Month

</td></tr>
<tr><td>

- Average Productivity per day: 2160 Kg

</td><td>

- Average Productivity per day: 3240 Kg
- Increase in productivity: 1080 Kg/Day
- % increase in productivity: 50%

</td></tr>
<tr><td colspan="2">Total Investment: Rs. 14,70,000/- (One time)
Total Savings: Rs. 8,29,800/-Per Annum
Payback Period: 21 Months</td></tr>
</table>

Case Study – 3	Tableware Industry – Replacing high weight HFK refractories with light weight low density **Ultralite™** filling material for kiln cars
Implementing the technology	**Before CP:** The original kiln car construction was constructed from Hot Face Kyanite (HFK) bricks, having a density of around 1100 kg/m^3. The cars measure almost 1 m^2 and the base has a depth of 180 mm.  **After CP:** The kiln cars were re-designed, incorporating a periphery wall around the perimeter of each car, and filling the void with Ultralite™, which has a density of just 75 kg/m^3. The construction was completed with load bearing cover slabs, placed on structural support posts. All 32 kiln cars were converted as part of this exercise. 

<table>
<tr><td colspan="3">Benefits</td></tr>
<tr><td>Environmental</td><td colspan="2">Before CP:
• Per Day Consumption of fuel: 889 SM³/Day
• Per Kg Consumption of fuel: 0.36 SM³/Kg of product

After CP:
• Per Day Consumption of fuel: 788 SM³/Day
• Per Kg Consumption of fuel: 0.32 SM³/Kg of product
• Reduction in fuel consumption:
= (889 – 788)= 101 SM³/Day
= 36865 SM³/Year
= Reduction in Green House Gas Emission = 77 MT.
• Percentage reduction of fuel consumption: 11.45%</td></tr>
<tr><td rowspan="2">Economical</td><td>Before CP
• Fuel expense per day
= (Rs. 28/SM³) * (889)
= Rs. 24,892/Day</td><td>After CP
• Fuel expense per day
= (Rs. 28/SM³) * (788)
= Rs. 22,064/Day
• Savings of Rs. 2,828 Per Day
Rs. 84,840 Per Month
Rs. 10,32,220 Per Annum</td></tr>
<tr><td colspan="2">Total Investment: Rs. 2,80,000/- (One time)
Total Savings: Rs. 10,32,220/- Per Annum
Payback Period: 4 Months</td></tr>
</table>

Case Study – 4	Table ware Industry: Modification in kiln car furniture by modifying the shape of cups and saucers holding shelves (Fuel: Natural Gas)
Implementing the technology	• The kiln used at the cup – saucers manufacturing industry is a tunnel kiln, made up of ceramic fibre walls. • Product Capacity: **2952 Kg/day.** • Average fuel consumption: **890 SM³/day** (301 SM³/ton product) • Car capacity of kiln: **24 Cars per day** • Kiln Car Dimensions: **(1700 * 1000 * 800) mm** (67″ * 39″ * 31.5″) • Kiln Length: 40.8 m (1606.3″) **Before Cleaner Production:** The industry has been using round shape cranks with three legs made up of solid cordierite material having diameter 5.5 inches for holding the saucers while firing in biscuit kiln. The crank is shown.

- No. of cranks per car: 792 Pieces per car
- Weight of each crank: 0.218 Kg (218 gm)
- Total weight of cranks per car: 173 Kg
- Total weight of cranks on 24 cars: 4152 Kg

Also, the industry uses Box type saggers to hold the cups, made up of solid cordierite material having dimensions:
(11" * 11" * 3.74") and weight 3 Kg.

- No. of box saggers per car: 48 Pieces per car
- Weight of each box sagger: 3 Kg
- Total weight of box saggers per car: 144 Kg
- Total weight of box saggers on 24 cars: 3456 Kg

This way, the total weight of the structure per car becomes:
(173 + 144) = 317 Kg. Adding to that, 123 Kg of product loaded per car, thus making total weight loaded on a car: **440 Kg**

After Cleaner Production:

It is suggested to replace the entire saucer holding cranks with small size stilts made up of high alumina. The diameter of the stilts being 2.36 inches (60 mm) and height being 0.6 inch (15 mm) and weight being **15 gm only.** The image of the stilt is shown here.

With this structure, the cumulative height of the stilt and saucer becomes 0.88 inch (25 mm), allowing 12 more saucers to be placed on a single stack. (432 saucers per car)

- No. of stilts per car: 792 + 432 = 1161 Pieces of stilts per car
- Weight of each stilt: 0.015 Kg (15 gm)
- Total weight of stilts per car: **17.5 Kg**
- Total weight of stilts on 24 cars: 418 Kg

Also, there is a scope of reducing weight of the cup holding box saggers by drilling 1 inch diameter holes in the bottom of all saggers, thereby reducing almost 20% of the total weight. The additional advantage would be improvised firing of cups. Hence, considering 20% reduction in weight of box saggers,

- No. of box saggers per car: 48 Pieces per car
- Weight of each box sagger: 2.4 Kg
- Total weight of box saggers per car: **115.2 Kg**
- Total weight of box saggers on 24 cars: 2765 Kg

This way, the total weight of the structure per car becomes: **(115.2 + 17.5) = 132.7 Kg.** Adding to that, **160 Kg of product** loaded per car, thus making total weight loaded on a car: **292 Kg**

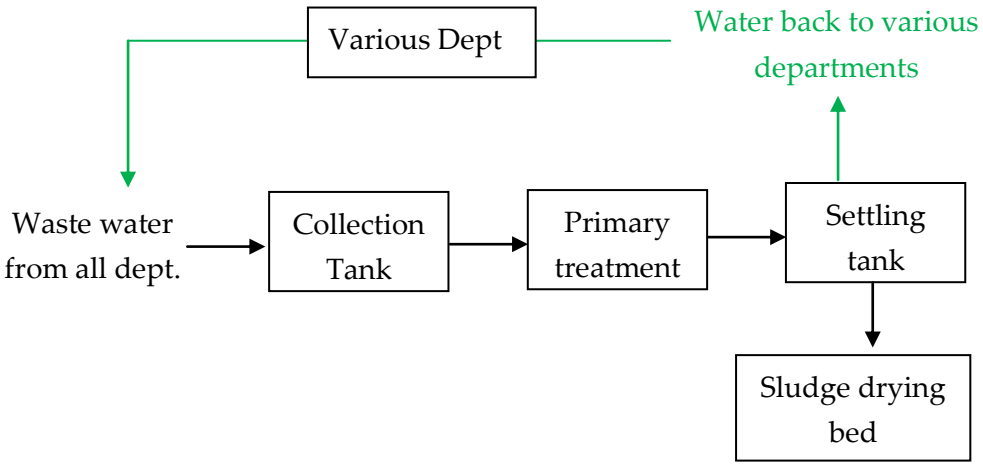
<table>
<tr><td></td><td colspan="2">This whole structure will reduce (440 – 292) = 148 Kg of weight per car, with an increased productivity due to addition of more space on the top of car.

Reduction in the weight of car = 148 Kg
% Reduction in the weight of a car = 33.6%</td></tr>
<tr><td>Benefits</td><td colspan="2"></td></tr>
<tr><td>Environmental</td><td colspan="2">Before CP:
• Per Day Consumption of fuel: 890 SM³/Day

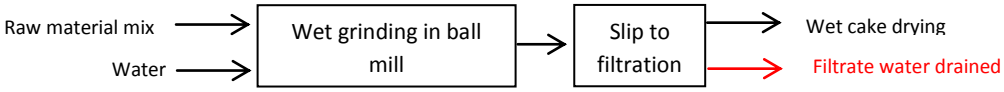
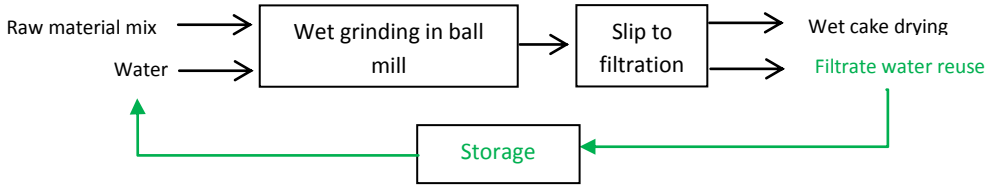
After CP:
• Reduction in fuel consumption: 33.6%
• Per Day Consumption of fuel: 590 SM³/Day
• Per Day savings of fuel: (890 – 590) = 300 SM³/Day
• Annual savings of fuel: 1,08,000 SM³/Day
• Reduction in Green House Gas Emission = 202 MT CO_2.</td></tr>
<tr><td rowspan="2">Economical</td><td>Before CP
• Fuel expense per day
= (Rs. 28/SM³) * (890)
= Rs. 24,920/Day</td><td>After CP
• Fuel expense per day
= (Rs. 28/SM³) * (590)
= Rs. 16,520/Day
• Savings:
Rs. 8,400/Day
Rs. 30,24,000 per annum</td></tr>
<tr><td colspan="2">Total Investment: Rs. 2,40,000/- (For purchasing stilts for 24 cars)
Total Savings: Rs. 30,24,000/- Per Annum
Payback Period: 1 Month</td></tr>
</table>

100% Reuse of Water & Sludge in the Process

(Zero Liquid Discharge)

Case Study – 1	Wall and Floor tile manufacturing industry, having a Waste Water treatment plant designed to reuse 100% of water back to the process in wet grinding	
Implementing the technology	Before: • The effluent generated in the plant was sent for treatment in the Effluent Treatment Plant and the waste water generated was not recycled/reused anywhere. After: • The waste water after the primary treatment of the effluent is pumped back into the plant for utilizing in the slip preparation (wet grinding) operation. Flow diagram of the Zero Discharge waste water recycle plant (ETP)  	
Benefits		
Environmental	Before: • High consumption of fresh water • Waste of water in the disposal of the effluent	After: • Conservation of fresh water by recycling of waste water back into the process, hence saving the same amount of

		fresh water • Zero discharge of liquid from the industry
Economical	Industry had to buy more amount of water from the GIDC water supply system.	Reduced amount of purchase for fresh water due to recycling **134.13 KL/Day** of waste water.

Observation	Low Tension Ceramic Insulators manufacturing industry
Implementing the technology	From the storage tank, the slip is sent to the press and frame filter for wet cake formation. The water removed from the slip in form of filtrate was drained out from the plant earlier, which was a major loss of water from the plant. Approximate quantity of water wasted: 7.48 KLD  **Recommendations:** All of the filtrate water can be reused in the process, at the wet grinding stage in ball mill. The industry has already implemented this option. The plant is a Zero Discharge Plant, all the water is reused in the process. 
Benefit	• Reduction in the cost of purchasing water from GIDC • Savings in the natural resource by reusing 100% water • Approximate reduction in the fresh water demand: 7.48 KLD

Case Study – 3	Low Tension Ceramic Insulators manufacturing industry
Implementing the technology	**Before CP:** The process waste water generated in the plant (from press and frame filter during formation of wet cake) was disposed off and was not recycled/reused anywhere.

	The waste water also contained processed raw material filtered from the press filter machine, which was also a considerable loss to the industry. **After CP:** Industry has built two waste water storing and settling tanks in which all the waste water from the press and filter section is stored. After settling of the solid particles/sludge, 100% of water from the tank is pumped back to the ball mill, in the wet grinding operation, leading to Zero discharge of water. Also, the sludge remained after the settling of solid particles, is removed from the tank regularly and is used along with the fresh raw material in wet grinding operation. 

Benefits		
Environmental	**Before CP:** • Wastage of water in the drainage • Wastage of solid material along with the drained water	**After CP:** • Recycle of 100% of waste water and sludge into the process, conserving **3 KL/Day** of water and **7 MT/month** of sludge.

Case Study – 4	Wall and Floor tile manufacturing industry, reusing 100% of sludge generated in wet grinding operation for tiles body
Implementing the technology	Before: • The effluent generated in the plant was sent for treatment in the Effluent Treatment Plant and the sludge generated after

the treatment was sent for disposal in TSDF. The sludge did not have much impurity, but the recyclable value of the sludge was not being considered.

After:

- The sludge generated after the treatment in ETP is stored open to environment for evaporation, and after drying, the sludge is reused in the manufacture of tile body as a raw material along with the fresh raw material.
- After taking this step, industry is now mixing the sludge formed from the ETP in small quantum to mix it with the raw material formation in the slip preparation stage.
- The wall and floor tiles are completely natural products with only physical operations involved in the manufacturing; hence the addition of small quantum of ETP sludge in the slip preparation for the tile body along with the virgin raw material does not alter the quality of the tile body.
- The sludge is wet grinded in the ball mill along with the raw materials.

<table>
<tr><td></td><td colspan="2">   </td></tr>
<tr><td>Benefits</td><td colspan="2"></td></tr>
<tr><td>Environmental</td><td>Before:
The sludge of ETP was sent to the TSDF for disposal, increasing the load of solid waste in the environment.
The major part of the sludge contained the waste glaze, containing chemicals used for glaze preparation, harmful for the environment as well as human health</td><td>After:
As the sludge is being recycled in the process, the load of solid waste disposal on the environment decreased considerably
Also leading to decreased health harms to the associated people
Savings in material: 385.5 MT per annum</td></tr>
<tr><td>Economical</td><td colspan="2">Before:
Considerable amount of the economy was lost in the sludge, as it contained processed raw material.
Company had to pay fees for the disposal to the TSDF
After:
Recycling of sludge leaded to decrease in the raw material consumption
Company had to pay Zero amount for the disposal of sludge</td></tr>
</table>

Options for Saving Electricity

Electricity is equally the important and costlier utility in any plant like the natural gas, coal and oil. There are many ways for saving electricity; some of them are very cheaper and some are a little costlier, but every expense made as a return of investment. Saving electricity does not only help the industry economically, but also helps reducing the Carbon Footprint from the environment. Following are some of the proven case studies.

Case Study –1	Power factor improvement to unity through installation of capacitors
Before CP	The source of outside power for the plant is from UGVCL (Uttar Gujarat Vij Company Ltd.) grid at 11 kV. The 11 kV supply is stepped down through common Discom transformer and supplied to the plant at 420 V. For the type of connection plant has UGVCL do not have clause for power factor penalty or rebate, but UGVCL charges Rs. 0.10 per kVArh which is recorded due to low power factor maintained within plant. The total amount paid to UGVCL against reactive power consumption by the plant during January 2015 to December 2015 was Rs. 32,190
After CP	Through power factor maintained near to unity, plant can reduce the reactive power consumption which will save additional charges in electricity bill. Power factor is improved by the installation ofcapacitors and replacement of the de-rated existing capacitors.
Benefit	
Economical	Investment: **Rs. 25,000/-** (for capacitors) Approx. Annual Savings: **Rs. 32,000/-** per annum Payback Period: **10 months**

Case Study – 2	Installation of Variable Frequency Drive (VFD) In Ball Mill Motor
Before CP	Plant is operating 5 nos. ball mills, with common connection to single 30 HP motor. The motor load test conducted while operating all 5 nos. ball mill simultaneously is shown in table below: Table: Electrical Parameters Measured at Ball Mill Motor (5 Ball Mills to single motor)

Parameter	O/P from the panel (to ball mill)			I/P to the panel	
	Reading 1	Reading 2	Reading 3	Reading 1	Reading 2
Voltage (V)	408	409	410	409	408
Ampere (A)	22.5	20.0	21.1	15.6	16.6
Power (kW)	9.71	6.90	8.35	6.10	7.27
Power Factor (Cos Ø)	0.61	0.49	0.56	0.55	0.62

The load survey conducted on the ball mill shows that the maximum loading on ball mill motor is 43%. The load variation recorded during normal operation of ball mill motor is 6.10 kW to 9.71 kW, while the rated capacity of motor is 22.4 kW.

The load survey during single ball mill operation is shown in table below:

Table: Electrical Parameters Measured at Ball Mill Motor (Individual Motor)

Parameter	Reading 1	Reading 2	Reading 3	Reading 4
Voltage (V)	417	416	417	417
Ampere (A)	7.03	6.95	7.00	7.20
Power (kW)	2.83	2.71	2.78	3.02
Power Factor (Cos Ø)	0.56	0.54	0.55	0.58

Thus even if less than 5 nos. ball mill(s) operate, the loading on motor will be less than 40 % and thus resulting in higher efficiency losses at motor.

Ball mill/Blunger is a batch grinding process. As per the process requirement the motor should run at full speed during the start of batch, however after a particular time the ball mill or Blunger can be rotated at less speed (RPM).

After CP

The speed of the motor can be reduced by installing variable frequency drive on Ball Mill/Blunger motor and operating speed can be programmed based on time.

This will result in reduction in electricity consumption to the tune of 15% saving in electricity consumption in ball mills and blunger.

Benefit	
Environmental	Reduction in the electricity consumption by 5500 units per year, ultimately reducing the carbon footprints to the environment.
Economical	Investment: Rs. **40,000/-** (for 40 HP VFD) Approx. Annual Savings: **Rs. 41,300/-** per annum Payback Period: **12 months**

Case Study – 3	Installation of Variable Frequency Drive (VFD) in Ball Mills – Porcelain ware manufacturing plant having a ball mill of 25 HP Motor
Before CP	Ball mill/Blunger is a batch grinding process. As per the process requirement the motor should run at full speed during the start of batch, however after a particular time the ball mill or Blunger can be rotated at less speed (RPM). The load survey conducted on the ball mill shows that the average loading on ball mill motor is 58.1 %. The load variation recorded during normal operation of ball mill motor is 8 kW to 16 kW.
After CP	The speed of the motor can be reduced by installing variable frequency drive on Ball Mill/Blunger motor and operating speed can be programmed based on time. This will result in reduction in electricity consumption to the tune of 15% saving in electricity consumption in ball mills and blunger. This concept is applicable to glaze preparation ball mill in glaze section also.
Benefit	
Environmental	Reduction in the electricity consumption by 4080 units per year, ultimately reducing the carbon footprints to the environment.
Economical	Investment: **Rs.35,000/-** (for 25 HP VFD) Approx. Annual Savings: **Rs. 30,600/-** per annum Payback Period: **14 months**

Case Study – 4	Optimize Power Consumption at Ball Mill Motor by Installing Timer Based ON-OFF Controller
Before CP	The ball mills are one of the major electricity consuming equipment, since the batch time for the material preparation varies from 5 to 6 hours; the plant is operating 5 nos. of ball mill and since the material processing require 5 hours operation for required material properties, the manual dependency on operator results in additional operation of ball mill motors.
After CP	In order to reduce unnecessary operation of ball mills, a simple programmable timer based ON-OFF controller will automatically switch OFF the motor of ball mill on completion of programmed time.
Benefits	
Environmental	Reduction in the electricity consumption by 4520 units per year, ultimately reducing the carbon footprints to the environment.
Economical	Investment: Rs. 25,000/- (for ON-OFF Timer) Approx. Annual Savings: Rs. 33,900/- per annum Payback Period: 9 months

Case Study – 5	Implementation of ON - OFF Controller (10 minutes ON and 5 minutes OFF) for Agitation Motors
Before CP	In agitation section, agitators are provided in underground tanks to maintain the uniformity of the slurry. These motors operate for about 24 hours in a day. Agitation in a necessary operation to maintain the quality of the slurry and not to let it settle down and deposit as dry, however, there is a scope to save energy in it.
After CP	Installation of automatically ON - OFF system on the agitator motors do not affect the uniformity (quality) of slurry but gives saving in electricity consumption in agitator motors. This system automatically switches ON agitator motors for about 10 minutes and then switches OFF for about 5 minutes. This means that in one hour agitator motors operate for about 40 minutes and remain switch off for about 20 minutes. This could result in approximately 30% saving in electricity consumption of agitator motors.
Benefit	
Environmental	Reduction in the electricity consumption by 1760 units per year, ultimately reducing the carbon footprints to the environment.

Economical	Investment: **Rs.8,000/-** (for timer based ON-OFF controller) Approx. Savings: **Rs. 13,200/-** per annum Payback Period: **8 months**

Case Study – 6	Avoid Compressed air usage for cleaning purposes from direct open hose pipe
Before CP	During the visit of all the industries, it was observed that compressed air was used for cleaning purposes at all workstations to clean the components with an open hose of 5 mm diameter and at 6 kg/cm²g pressure.
After CP	Usually, cleaning can be done at lower pressure (around 2-3 kg/cm²g). So, the first step would be to reduce the pressure and energy saving would be around 8% at drop of each bar for that hose if generated separately. From our past experience the company can save Rs. 21,000 per year (from one workplace) by installing compressed air saving gun.   The compressed air is a costly utility and the less critical purposes like cleaning can be achieved by installing air saver nozzles at the tip of these cleaning devices or shall be replaced with new one. The special design of these improved cleaning nozzles allows ambient air to get entrained in the path due to vacuum created by compressed air and delivers the air with similar velocity and thrust giving to desired cleaning effect. However, the amount of compressed air uses is only 20-25% which reduces the compressed air requirement and thus resulting in energy savings. In addition, these nozzles also reduce the noise level.

	Strong Recommendations for Efficient Working of Compressor: • The Compressor must be located in a cool and dry area. • Avoid moist air near the compressor area, as Hot and Moist air cannot be compressed efficiently and the equipment starts using more electricity day by day. • The heat generated from the compressor motor must be removed from the surrounding of the compressor in case of a closed room; however, it is NOT advised to install air cooler to cool the area, as cooled will aid the moisture in the air, which is not recommended.
Environmental	Reduction in the electricity consumption to generate the compressed air, with that, also reducing Noise Pollution of the surrounding, making the site easy to work
Economical	Investment: **3,000/-** per gun Annual Savings: **Rs. 21,000/-** per station Payback Period: **3 months**

Improvement in Kiln Insulation

Improvement in Kiln Insulation using PCPF Wall Blocks

Generally used insulation in ceramic industries is Ceramic Fiber. However, there are many drawbacks associated with it, such as –

- It shrinks on prolonged use at higher temperature
- Loses its insulation properties after 2 – 3 years, as it starts absorbing moisture
- It develops huge gaps in-between the insulation, adding to the heat losses
- The broken pieces of fiber fall on the product, damaging the product quality
- Kiln undergoes maintenance every now and then
- Most important of all, its non – precautionary use may lead to increased chances of diseases like cancer
- In European countries, there is legislation on using the ceramic fiber – it is considered as Category – 1 B Carcinogenic and needs to carry a Danger sign on its packing.

It is recommended to insulate the Kiln Walls using 'Pre-Cast Pre-Fired (PCPF) Hollow Wall Blocks. Its technical parameters are as follows.

As all the industries Steel, Cement, Non metal, petroleum, all engineering industries progressed in more and more sophisticated, their requirement for precision and durability increased. The need for better, stronger, stable at extreme conditions of pressure or temperature or abrasion material increased.

The conventional Pressed Refractory fired at high temperature were found wanting in such critical situation. Newer system of manufacturing, newer material stronger and fired at low temperature for the ease of Transportation and movement, far more stable were found. The unique ability to be formed in any shape you want, gave the designer a vastly improved area of working. These are pre cast, and pre fired to the precision required. The use of Hydraulic and Ceramic bonding simultaneous make these a unique material.

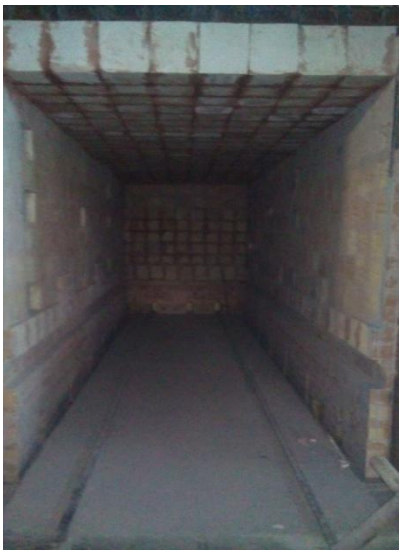
Historically, all the kilns were lined by pressed, standard sized bricks in all the cases in 9" or 12" series. So the wall thickness in all the kilns and furnaces were either 12-18 or 24 inches thick, irrespective of its requirement. Anything less than 9" long was not available and hence they will use only this. Material like The Ceramic Fibre, the ULTRALITE, the Vermiculite got discovered in the last ten to twenty years.

Using this complete knowledge now the wall thickness can be made much lighter keeping the hot face of say 4.5" instead of 9" and design such blocks with cavity which will hold much superior insulating material like ULTRALITE etc.

This reduces the weight of the wall drastically. Keeping the solid part as required gave this wall a lasting life - Far more than a complete wall of ceramic fibre wall. Some pictures are shown in the attached email. The comparison between a solid brick wall, ceramic fibre wall and PCPF wall block is given here to highlight the energy efficiency of these wall blocks.

The fact remains that the new blocks will give far more stability at high temperature while keeping the fuel efficiency improved.

1 M^3 Weight Comparison								
PCPF Block			Fiber			HFK		
Weight	1024 kg	(32 pcs)	Weight	250 kg	(11 pcs)	Weight	936 kg	(468 pcs)
Cost	80,000.00		Cost	8,800.00		Cost	32,760.00	
Per Kg Cost	78.125			35.20			35.00	



For More Details:

Gujarat Cleaner Production Centre

(Established by Industries & Mines Department, Government of Gujarat)

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