DETAILED PROJECT REPORT
ON
USE OF LOW THERMAL MASS CAR IN TUNNEL KILN











ENERGY IS LIFE
BEE
CONSERVE IT

Bureau of Energy Efficiency

Prepared By

Energy
Environment
let's conserve

Reviewed By

ISTSL

USE OF LOW THERMAL MASS CARS IN TUNNEL KILN

MORBI CERAMIC CLUSTER

BEE, 2010

Detailed Project Report on Use of Low Thermal Mass Cars in Tunnel Kiln Ceramic SME Cluster, Morbi, Gujarat (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **MRV/CRM/LMC/10**

For more information

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan
R. K. Puram, New Delhi – 110066

Telephone +91-11-26179699
Fax +91-11-26178352
Websites: www.bee-india.nic.in
Email: jsood@beenet.in/ pktiwari@beenet.in

Acknowledgement

We sincerely appreciate the efforts of industry, energy auditors, equipment manufacturers, technology providers, consultants and other experts in the area of energy conservation for joining hands with Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India for preparing the Detailed Project Report (DPR) under BEE SME Program in SMEs clusters. We appreciate the support of suppliers/vendors for providing the adoptable energy efficient equipments/technical details to the SMEs.

We have received very encouraging feedback for the BEE SME Program in various SME Clusters. Therefore, it was decided to bring out the DPR for the benefits of SMEs. We sincerely thank the officials of BEE, Executing Agencies and ISTSL for all the support and cooperation extended for preparation of the DPR. We gracefully acknowledge the diligent efforts and commitments of all those who have contributed in preparation of the DPR.

Contents

List of Annexure

List of Tables

List of Figures

List of abbreviations

BEE	Bureau of Energy Efficiency
SME	Small and Medium Enterprises
DPR	Detailed Project Report
GHG	Green House Gases
CDM	Clean Development Mechanism
DSCR	Debt Service Coverage Ratio
NPV	Net Present Value
IRR	Internal Rate of Return
ROI	Return on Investment
SCM	Standard Cubic Meter
MT	Metric Tonne
LTM	Low Thermal Mass
LSP	Local Service Provider

EXECUTIVE SUMMARY

SEE-Tech Solution Pvt. Ltd. is executing BEE-SME program in Morbi Ceramic Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Morbi ceramic cluster is one of the largest ceramic clusters in India; accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient measures / technologies, so as to facilitate maximum replication in other ceramic clusters in India.

The weight reduction of the kiln cars gives the significant amount of energy savings in tunnel kiln. Low thermal mass materials (LTM) are now being used for kiln car construction, which reduces the weight of the kiln car considerably

Project implementation will lead to reduction in Natural Gas consumption by 50,076 SCM per year however; this intervention will not have any effect on the existing consumption pattern of electricity.

The total investment, debt equity ratio for financing the project, monetary savings, Internal rate of return (IRR), Net present value (NPV),Debt service coverage ratio (DSCR) Return on investment (ROI) etc for implementing energy efficient boiler is furnished in Table below

Financial indicator of proposed technology

S.No	*Particular*	*Unit*	*Value*
1	Project cost	₹ (in Lakh)	21.96
2	Natural Gas saving	SCM/year	50,076
3	Monetary benefit	₹ (in Lakh)	7.51
4	Debit equity ratio	Ratio	3:1
5	Simple payback period	years	2.92
6	NPV	₹ (in Lakh)	1.18
7	IRR	%	11.98
8	ROI	%	25.37
9	DSCR	Ratio	1.42
10	Procurement and Implementation time	Weeks	4

The projected profitability and cash flow statements indicate that the project implementation will be financially viable and technically feasible.

ABOUT BEE-SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Morbi Ceramic Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up gradation through studies and pilot projects in these SMEs clusters.

***Major activities in the BEE-SME program are furnished below*:**

Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting of energy efficiency projects in the clusters.

Implementation of energy efficiency measures

To implement the technology up gradation projects in clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion

1 INTRODUCTION

1.1 Brief Introduction about Cluster

Morbi SME Cluster is one of the largest ceramic clusters in India and mainly famous for manufacturing of ceramic tiles. Over 70% of total ceramic tiles product comes from Morbi cluster. The nearest airport is at Rajkot, which is 67 km from Morbi by road. Morbi could also be reached from Ahmadabad by Railway as well as by road which is about 184 km.

There are approximately 479 ceramic units in this cluster which are engaged in manufacturing of Wall Tiles, Vitrified Tiles, Floor Tiles, Sanitary wares, Roofing Tiles and others product. There are around 50 more ceramic units coming up in Morbi.

Majority of the cluster units are of integrated type, where the raw material is processed in-house to the final product. Majority of the units in the cluster are dependent on local / run of the mill technologies which is supplied by local service provider. Table 1.1 shows the total energy consumption scenario at Morbi cluster.

Table 1.1 Details of annual energy consumption scenario at Morbi ceramic cluster

S. No	*Type of Fuel*	*Unit*	*Value*	*% Contribution*
1	Electricity	GWh /year	1,200	8.23
2	Natural Gas	SCM/year	660,000,000	46.32
3	Charcoal	Tonne/year	165,000	8.55
4	Lignite	Tonne/year	1,320,000	36.84
5	Diesel	Liter/year	800,000	0.06

Energy usages pattern

Average monthly electricity consumption in ceramic industry ranges from 1 lakh to 2 lakh kWh depending on the size of the industry. In thermal energy, solid fuel such as lignite, charcoal, Indonesian coal, briquette, etc are used in spray dryer and Natural Gas is used in kiln in all industries except few of them. Solid fuel consumption in spray dryer ranges from 80 to 160 kg/MT of production. Natural Gas consumption in kiln varies from 1.01 to 1.4 SCM/m^2 of tiles produced.

Classification of Units

The ceramic units can be categorized into four types based on product manufacture

- Floor Tiles unit

- Vitrified Tiles unit
- Sanitary Wares unit
- Wall Tiles unit

Production wise unit breakup

Morbi ceramic cluster can be breakup into three categories viz. small, medium and large scale unit. Table 1.2 shows that production wise breakup of Morbi cluster.

Table 1.2 Production wise unit breakups

Type of product	*No. of Units.*				*Production (m^2/day or MT[1]/day)*			
Scale of Unit	*Small*	*Medium*	*Large*	*Total*	*Small*	*Medium*	*Large*	*Total*
Wall Tiles	43	100	35	178	2,500	3,500	7,500	13,500
Floor Tiles	8	38	6	52	3,000	4,000	7,000	14,000
Vitrified Tiles		22	4	26		5,760	11,520	17,280
Sanitary Wares	10	24	9	43	4	8	14	26

Products Manufactured

Different types of products manufactured in Morbi cluster are as shown in Table 1.3 below:

Table 1.3 Product manufactured

S. No	*Type of Product*	*% share*	*Units*
1	Wall Tiles	37	178
2	Vitrified Tiles	8	36
3	Floor Tiles	11	52
4	Sanitary Wares	9	43
5	Spray Dryer Mud Manufacturing Units	8	40
6	Roofing Tiles (seasonal operation)	25	120
7	Third Firing Manufacturing (Producing pictures on tiles)	37	10
Total			479

[1] *Sanitary ware product measured in MT*

Production process of manufacturing of sanitary ware

Only difference between manufacturing process of tiles and sanitary wares is the moulding process. In case of sanitary wares, manual moulding is carried out whereas in case of tiles hydraulic press is used to form the biscuits.

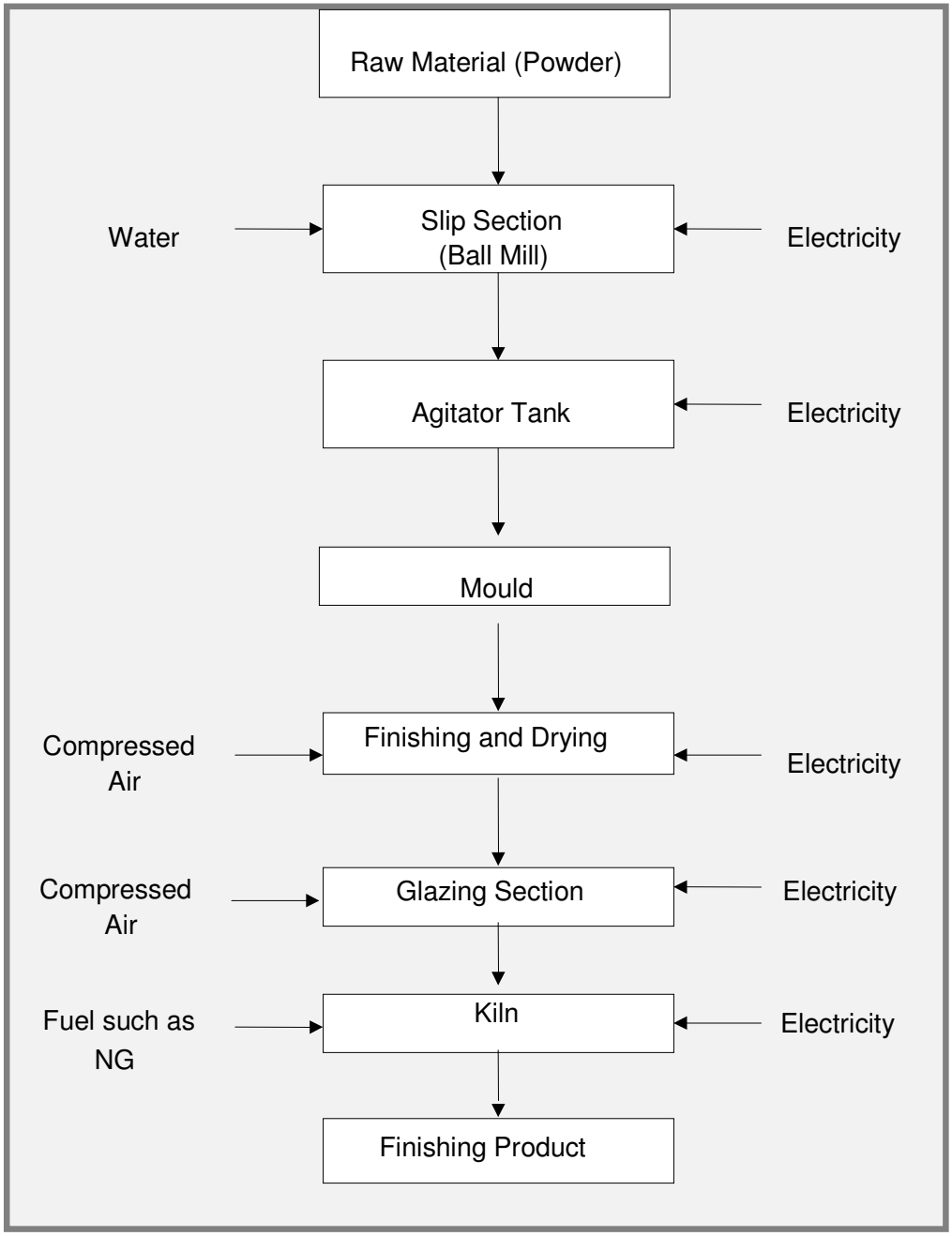


Figure 1.1 Process flow diagram of sanitary ware

Wet Grinding

Raw materials such as clay, feldspar, quartz, calcite etc. are mixed with water in a proper proportion and are grinded in a ball mill to make a homogeneous mixture. Ball Mill is a batch type of process. After completion of one batch of ball mill, slurry is taken in to the underground tanks fitted with agitator motor in each tank to maintain the uniformity of mixture.

Moulding

The slip (slurry) is poured into the moulds by a hand held hose. The slip is pumped through a hydraulic pump into the mould.

Drying

The cast wares are then dried in natural environment with the help of ceiling fans.

Glazing

The dried wares are then glazed in spray glazing booths, where compressed air is used for spray glazing.

Firing

The glazed wares are then fired in the kilns up to a temperature of 1200 ^{o}C where the Natural Gas is used as a fuel. The output from the kiln is inspected before packaging and dispatch.

1.2 Energy performance in existing situation

1.2.1 Average production

Annual production in terms of m^2 per year is taken in case of tiles and MT per year for sanitary wares is given in the following Table 1.4 below:

Table 1.4 Annual productions from a typical unit

Type of product	*No. of Units.*				*Production (m^2/day or MT/day)*			
Scale of Unit	*Small*	*Medium*	*Large*	*Total*	*Small*	*Medium*	*Large*	*Total*
Wall Tiles	43	100	35	178	2,500	3,500	7,500	13,500
Floor Tiles	8	38	6	52	3,000	4,000	7,000	14,000
Vitrified Tiles	-	22	4	26	-	5,760	11,520	17,280
Sanitary Wares	10	24	9	43	4	8	14	26

1.2.2 Fuel consumption

Energy consumption both electrical and thermal by a typical ceramic industry for different types of products is given in Table 1.5 below:

Table 1.5 Annual energy consumption

Energy	*Electricity (GWh per year)*			*Natural Gas (SCM per year)*			*Solid Fuel [lignite] (Tonne per year)*		
Scale of Unit	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*
Wall Tiles	0.9	1.5	2.4	750,000	1,050,000	2,250,000	2,400	2,880	3,600
Floor Tiles	0.9	1.5	2.4	900,000	1,200,000	2,100,000	3,600	4,200	4,800
Vitrified Tiles	NA[2]	6.0	2.4	NA	2,700,000	6,000,000	NA	6,000	9,000
Sanitary Wares	0.24	0.45	0.9	120,000	240,000	420,000	NA	NA	NA

1.2.3 Specific Energy Consumption

Specific energy consumption both electrical and thermal energy per m^2 or MT of production for each type of ceramic industry is given in Table 1.6 below:

Table 1.6 Specific energy consumption of different ceramic unit

Energy	*Electricity (kWh/m^2) or (kWh/MT)*			*Natural Gas (SCM/m^2) or (SCM/MT)*			*Solid Fuel [lignite] (kg/m^2)*		
Scale of Unit	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Wall Tiles	1.20	1.43	1.07	1.00	1.00	1.00	3.20	2.74	1.60
Floor Tiles	1.00	1.25	1.14	1.00	1.00	1.00	4.00	3.50	2.29
Vitrified Tiles	NA	3.47	3.47	NA	1.56	1.74	NA	3.47	2.60
Sanitary Wares	200.00	187.50	214.29	100.00	100.00	100.00	NA	NA	NA

[2] *Not Applicable*

1.3 Proposed technology/equipment

1.3.1 Description of technology/ equipment

Sanitary ware industry uses the open flame tunnel kiln to fire the products. The open flame tunnel kiln is a continuous type kiln, wherein the raw product is fed at one side and on the other side the finished product is taken out. The raw product undergoes firing and cooling cycles, as it moves from the front end to the back end of the kiln. The material movement through the tunnel kiln is by kiln cars, run on rails. The kiln cars are like train bogies designed to hold the products. Natural gas is used as a fuel in tunnel kiln. The kiln cars are constructed with refractory and insulating bricks. Due to high thermal mass, kiln cars consume considerable amount of heat energy supplied to the kiln.

1.3.2 Role in process

Tunnel kiln is used for final baking of the sanitary ware products to get the finish product. Natural Gas is used as a fuel in tunnel kiln. Sanitary ware products are fired upto a temperature of about 1210 ^{o}C in the tunnel kiln. It removes the moisture present in the product and also improves the strength of the products by baking at higher temperature.

1.4 Benchmarking for existing specific energy consumption

Energy consumption in Tunnel kiln would depend on following mentioned things

- Baking temperature which depends on the product to be dried
- Operational & maintenance practices
- Type of fuel and its calorific value
- Quantity of product to be baked

Energy use and technology audit studies were conducted in various units of Morbi ceramic cluster, the baseline energy consumption of present tunnel kiln and the performance of the same is carried out and attached in Annexure 1.

1.4.1 Design and operating parameters specification

In tunnel kiln, one of the requirement is that the product should be heated upto a temperature of about 1210 ^{o}C. Electrical and thermal energy consumption in tunnel kiln for different plant capacities are given in Table 1.7.

Table 1.7 Fuel Consumption in tunnel kiln for different plant capacities

Plant Capacity Nags/day (Pieces/day)	*Unit*	*2000 (27 MT/day)*	*1000 (13.5 MT/day)*
Electricity Consumption	MWh/year	142.44	118.310
Natural Gas Consumption	SCM/year	841216	578431

1.4.2 Operating efficiency analysis

Operating efficiency of tunnel kilns is found to be in the range of 19% to 26% varies from unit to unit. Detailed parameters and calculations used for operating efficiency evaluation of tunnel kiln efficiency are given in the Annexure 1.

1.4.3 Specific Energy consumption

In tunnel kiln, electrical energy is utilized for running the blowers. Specific energy consumption for both electrical energy and thermal energy for different capacities of tunnel kiln are given in Table 1.8 below.

Table 1.8 Specific Energy Consumption

Plant Capacity Nags/day (Pieces/day)	*Unit*	*2000 (27 MT/day)*	*1000 (13.5 MT/day)*
Electricity Energy	kWh/MT	15	24
Thermal Energy	SCM/MT	96	133

1.5 Barriers in adoption of proposed technology

1.5.1 Technological Barrier

An expert in implementation of this project is easily available at Morbi. So there is no issue of availability of supplier for this technology. Even the raw material suppliers of low thermal mass are easily available in Gujarat.

1.5.2 Financial Barrier

Availing finance is not the major issue. Among the SMEs, larger units, if convinced, are capable of either financing it themselves or get the finance from their banks. The smaller units will require competitive loan and other support to raise the loan. However, as most of them have been able to expand their setup and grow, there is readiness to spend for energy efficient

technologies which will have good returns. Energy Efficiency Financing Schemes such as SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

1.5.3 Skilled manpower

In Morbi ceramic cluster, the availability of skilled manpower is one of the limitations due to more number of ceramic units as compared to the availability of skilled manpower. One local technical persons available at Morbi takes care of about 5-10 ceramic units. For major equipments of ceramic units like kiln, Polishing Machine etc maintenance or the repair work of these equipments will be taken by the equipment suppliers itself even the suppliers like Sacmi, KEDA, Modena etc depute one of their representatives staying at Morbi for the maintenance work. Local technical person of Morbi takes care. As not many experts/skilled persons are available in the cluster, one expert takes care of all maintenance & operational problems of about 5 - 10 industries.

1.5.4 Other barrier (If any)

On discussion with the plant person during our audit, many of them agree with the possible saving measures but they demand demonstration of same energy saving technologies in some other plant and then they have readiness to follow.

2. PROPOSED TECHNOLOGY

2.1 Detailed description of technology

2.1.1 Description of technology

The weight reduction of the kiln cars gives the significant amount of energy savings in tunnel kiln. Low thermal mass materials (LTM) are now being used for kiln car construction, which reduces the weight of the kiln car considerably.

Weight of car furniture was reduced from 465 kg per car to 358 kg per car (23 percent weight reduction).

2.1.2 Equipment specification

The following modifications were made to reduce the weight of the kiln cars:

- Replacement of refractory bricks with the hollow ceramic coated pipes at the supporting pillars for holding the racks
- Introduction of ceramic fiber blankets at the base of the car instead of refractory brick base
- Use of cordierite (hollow) blocks to hold the raw wares instead of solid refractory mass

2.1.3 Suitability over existing equipment

The implementation of this project will be done in phases so as to minimize the production loss. This was mainly due to limited availability of kiln cars. The plant team would not face any major problems during the implementation of this project.

This technology has been selected for the following reasons:

- In sanitary ware unit, major energy is consumed in tunnel kiln only.
- It reduces the fuel consumption in tunnel kiln.
- It increases the capacity of kiln car for holding the raw products of sanitary ware.
- It results in reduction of GHG emissions.

2.1.4 Superiority over existing equipment

The use of low thermal mass materials (cordierite etc.) in kiln cars reduces the weight of the kiln car. The other advantages of low thermal mass materials are fuel conservation, increased capacity and longer service life. The incidental advantages due to LTM materials are less thermal shock resistance, ease to assemble and a good mechanical strength.

2.1.5 Availability of equipment

This is one of the well known concepts in use at Morbi. An expert for implementation of this

technology is already available. Many of the suppliers have also taken initiative for creating awareness about this technology among the unit owners.

2.1.6 Source of Technology

This technology is already in use in some sanitary ware unit where the operating temperature is same. They also got the results of reduction in fuel consumption and the technology is running successfully.

2.1.7 Technical specification of equipment

Technical specification of proposed technology is shown in Annexure 7.

2.1.8 Terms and conditions in sales of equipment

Service provider takes the guarantee for proper design and performance of the proposed system. The entire material cost shall be either born by client or by vendor which depends on the client.

2.1.9 Process down time during implementation

The implementation of this project was done in phases; so as to minimize the production loss. This was mainly due to limited availability of kiln cars. The plant team did not face any major problem during the implementation of this project. The time taken for the implementation was one month.

2.2 Life cycle assessment and risks analysis

Life cycle of this system is about 8-10 years depends upon its maintenance and material used for fabrication of duct and piping design.

The factors which causes the delay in implementation of this technology are as follows

- Lack of initiative of the unit owner
- Unreadiness for change in the existing system.

2.3 Suitable Unit for Implementation of proposed technology

At Morbi, there are total 43 sanitary ware units. Nearly 80 % of the sanitary ware units are having the production capacity of about 800 to 1000 pieces per day i.e. 10 to 14 MT per day. Therefore, the size of identified technology we have considered here for the plant production capacity is about 1000 pieces per day. Total no. of cars pass through the tunnel kiln is about 50 per day.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel saving

Replacement of heavy refractory material of the kiln car by low thermal mass material leads to a saving of about 8.67 % on total fuel consumption in tunnel kiln. Hence implementation of this project will give a saving of 50,076 SCM/year in Natural gas consumption in tunnel kiln which will save ₹ 7.51 lakh per annum. Detailed fuel saving calculation is given in Annexure-3.

3.1.2 Electricity saving

The electricity consumption is increased due to installation of blowers with 5 hp motors in the proposed technology but this electricity consumption is negligible with the thermal consumption.

3.1.3 Improvement in product quality

Product quality achieved would be same as the present quality. It does not have any impact in improving the quality of the product.

3.1.4 Increase in production

The proposed technology leads to the increase in production due to increase in car product holding capacity and energy saving due to reduction in car weight.

3.1.5 Reduction in raw material

Raw material consumption is same even after the implementation of proposed technology.

3.1.6 Reduction in other losses

This project reduces the heat gains by the kiln car due to reduction in weight of car.

3.2 Monetary benefits

Annual monetary savings due to implementation of new technology is ₹ 7.51 lakh per year. Energy & monetary benefit analysis of new technology after implementation in tunnel kiln are shown in Table 3.1 below.

Table 3.1 Energy and monetary benefit due to project implementation

S.No	Parameter	Unit	Value
1	Present Natural Gas consumption for heating of car structure	SCM/ day	680
2	Operational hours	hours/day	24

S.No	Parameter	Unit	Value
3	Operational days	days/year	321
4	Natural Gas consumption after implementation of LM Car	SCM/ day	524
5	Saving of Natural Gas	SCM/ day	156
6	Cost of Natural Gas	₹ per SCM	15
7	Monetary saving	₹ lakh	7.51

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

No change in improvement in working environment in the plant.

3.3.2 Improvement in workers skill

Not contributing to any improvement in skill sets of workers. They only get the knowledge on how savings in fuel consumption will be achieved by reducing the weight of LM car.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no significant impact in effluent generation due to implementation of the project.

3.4.2 Reduction in GHG emission

Implementation of this technology will results in reduction in CO_2 emissions due to reduction in overall fuel consumption. Implementation of this project will result in saving of 50, 076 SCM per year which leads to 103 tCO_2 emission reduction per year from one unit. Similarly, there are 43 sanitary ware units in Morbi ceramic cluster, if all units will implement this project then total CO_2 emission reduction will be approximately 4,429 tCO_2 per year. This will also help in getting the carbon credit benefit through Clean Development Mechanism (CDM) project.

3.4.3 Reduction in other emissions like SO_X

Sulphur is not present in Natural Gas; hence there is no impact on SO_X emissions.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of technology implementation

4.1.1 Material cost

Material required for fabrication of proposed technology would cost about ₹ 20 lakh which includes the design and fabrication.

4.1.2 Erection, commissioning and other misc. cost

Erection & commissioning cost is ₹ 1.00 lakh which includes the piping, instrumentation, labour work etc and ₹ 0.43 lakh for misc. cost.

Table 4.1 Details of proposed equipment installation cost

S.No	*Particular*	*Unit*	*Cost*
1	Erection & Commissioning cost	₹ (in lakh)	1.00
2	Interest during implementation	₹ (in lakh)	0.53
3	Other misc. cost	₹ (in lakh)	0.43
4	Total cost	₹ (in lakh)	1.96

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25 % of the total project cost which is ₹ 5.49 lakh.

4.2.2 Loan amount.

Remaining 75 % cost of the proposed project will be taken from the bank which is ₹ 16.47 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI's rate of interest for energy efficient projects. The loan tenure is 5 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 Financial indicators

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 6 years. The

financials have been worked out on the basis of certain reasonable assumptions, which are outlined below.

The project is expected to achieve monetary savings of ₹ 7.51 lakh per annum.

- The Operation and Maintenance cost is estimated at 4% of cost of total project with 3% increase in every year as escalations.
- Interest on term loan is estimated at 10 %.
- Depreciation is provided as per the rates provided in the companies act.

Based on the above assumptions, profitability and cash flow statements have been prepared and calculated in Annexure-4.

4.3.2 Simple payback period

The total project cost of the proposed technology is ₹ 21.96 lakh and monetary savings due to reduction in Natural Gas consumption is ₹ 7.51 lakh hence, the simple payback period works out to be 2.92 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10 % works out to be ₹ 1.18 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 11.98%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 25.37%.

Table 4.2 Financial indicators of proposed technology/equipment

S.No.	*Particular*	*Unit*	*Value*
1	Simple payback period	year	2.92
2	NPV	₹ (in lakh)	1.18
3	IRR	%	11.98
4	ROI	%	25.37

4.4 Sensitivity analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like when there is an increase in fuel savings or decrease in fuel savings. For the purpose of sensitive analysis, two following scenarios has been considered

- Optimistic scenario (Increase in fuel savings by 5%)
- Pessimistic scenario (Decrease in fuel savings by 5%)

In each scenario, other inputs are assumed as a constant. The financial indicators in each of the above situation are indicated along with standard indicators

Table 4.3 Sensitivity analysis in different scenario

Scenario	*Fuel Saving, (SCM per year)*	*IRR (%age)*	*NPV (₹ in lakh)*	*ROI (%age)*	*DSCR ratio*
Pessimistic	47572	9.97	-0.02	24.05	1.35
Realistic	50076	11.98	1.18	25.37	1.42
Optimistic	52579	13.96	2.38	26.46	1.50

4.5 Procurement and implementation schedule

Table 4.4 Procurement and implementation schedule

S. No.	*Activities*	*Weeks*			
		1	*2*	*3*	*4*
1	Designing				
2	Raw material Purchasing & preparation				
3	Dismantling of the existing system				
4	Fabrication				

Annexure

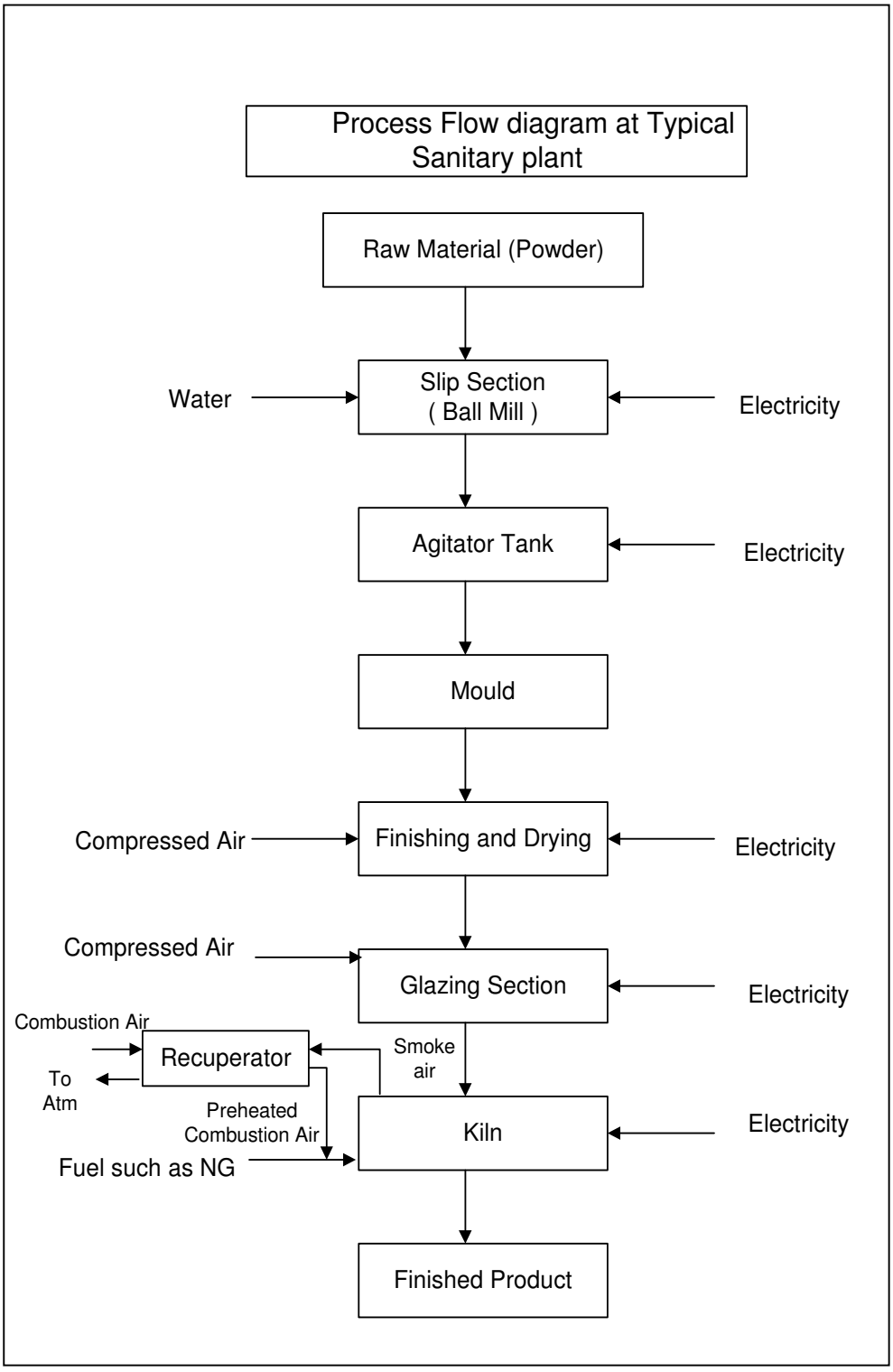
Annexure 1 Energy audit data used for baseline establishment

Efficiency of tunnel kiln can be calculated as follows:

Input Data

S. No.	*Parameter*	*Unit*	*Value*
1	Natural Gas Consumption	SCM/day	1800
2	Production from kiln	Pieces/day	1000
3	Production from kiln	MT/day	13.5
4	Weight of one Piece going to kiln	kg	14
5	Weight of one Piece coming out from kiln	kg	13.5
6	Kiln Cycle time	hr	14
7	Highest heating temperature in firing zone	^{o}C	1210
8	Inlet temperature of Tunnel Kiln	^{o}C	40
9	Heat required to heat the product	kCal/day	3,001,050
10	Heat supplied by fuel	kCal/day	15,840,000
11	Efficiency of kiln	%	18.95

Annexure 2 Process flow diagram



Annexure 3 Detailed equipment assessment report

S.No	Particular	Unit	Existing Technology	Proposed Technology
1	Weight of one high thermal mass kiln car	kg	465	358
2	Natural gas consumption LM Car	SCM/day	680	524
3	Working day in a year	days	321	321
4	Gross calorific value of Natural Gas	kCal/SCM	8800	8800
5	Specific heat of combustion air	kCal/kg^{0}C	0.22	0.22
6	Heat gain by combustion LM Car	kCal/ day	59,84,550	46,07,460
7	No. of cars/day	No.	50	50
8	Natural Gas saving in LM Car	SCM/year		50,076
9	Saving in Natural Gas consumption in LM Car	SCM/day		156
10	Saving in Natural Gas consumption in Tunnel kiln	%age		8.67
11	Firing temperature of Tunnel Kiln	^{o}C		1210
12	Inlet Temperature of material in Tunnel Kiln	^{o}C		40
13	Cost of Natural Gas	₹ SCM		15
14	Monetary saving	₹ (in lakh)		7.51

Annexure 4 Detailed financial analysis of proposed technology

Assumption

Name of the Technology	***LTM Car***		
Rated Capacity	***13.5 MT/day***		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	NA	NA	Installed Capacity
No of working days	Days	321	No of working days
No of Shifts per day	Shifts	3	No of Shifts per day
Capacity Utilization Factor	%		Capacity Utilization Factor
Proposed Investment			
Plant & Machinery	₹ (in lakh)	20.00	Feasibility Study
Erection & Commissioning	On Plant & Equip	1.00	Feasibility Study
Investment without IDC	₹ (in lakh)	21.00	Feasibility Study
Interest during Implementation	₹ (in lakh)	0.53	Feasibility Study
Other Cost (Misc.)	₹ (in lakh)	0.43	Feasibility Study
Total cost	₹ (in lakh)	21.96	
Financing pattern			
Own Funds (Equity)	₹ (in lakh)	5.49	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	16.47	Assumed
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4.00%	Feasibility Study
Annual Escalation	%age	3.00%	Feasibility Study
Estimation of Revenue			
Gas savings	SCM	50076	
Cost	Per SCM	15	
St. line Depn.	%age	5.28%	Indian Companies Act
IT Depreciation	%age	80.00%	Income Tax Rules
Income Tax	%age	33.99%	Income Tax

Estimation of term loan

₹ (in lakh)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	16.47	1.20	15.27	1.49
2	15.27	2.40	12.87	1.42
3	12.87	3.00	9.87	1.15
4	9.87	3.60	6.27	0.82
5	6.27	4.20	2.07	0.44
6	2.07	2.07	0.00	0.06
		16.47		

WDV Depreciation

₹ (in lakh)

Particulars / years	1	2	3	4	5
Plant and Machinery					
Cost	21.96	4.39	0.88	0.18	0.04
Depreciation	17.56	3.51	0.70	0.14	0.03
WDV	4.39	0.88	0.18	0.04	0.01

Projected Profitability

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	Total
Revenue through Savings							
Fuel savings	7.51	7.51	7.51	7.51	7.51	7.51	45.07
Total Revenue (A)	7.51	7.51	7.51	7.51	7.51	7.51	45.07
Expenses							
O & M Expenses	0.88	0.90	0.93	0.96	0.99	1.02	5.68
Total Expenses (B)	0.88	0.90	0.93	0.96	0.99	1.02	5.68
PBDIT (A)-(B)	6.63	6.61	6.58	6.55	6.52	6.49	39.39
Interest	1.49	1.42	1.15	0.82	0.44	0.06	5.37
PBDT	5.15	5.19	5.43	5.73	6.09	6.44	34.02
Depreciation	3.05	3.05	3.05	3.05	3.05	3.05	18.32
PBT	2.09	2.14	2.38	2.68	3.03	3.38	15.69
Income tax	-	0.57	1.61	1.90	2.06	2.19	8.32
Profit after tax (PAT)	2.09	1.57	0.77	0.78	0.97	1.19	7.37

Computation of Tax

₹ (in lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*
Profit before tax	2.09	2.14	2.38	2.68	3.03	3.38
Add: Book depreciation	3.05	3.05	3.05	3.05	3.05	3.05
Less: WDV depreciation	17.56	3.51	0.70	0.14	0.03	-
Taxable profit	(12.42)	1.68	4.73	5.59	6.06	6.44
Income Tax	-	0.57	1.61	1.90	2.06	2.19

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*
Liabilities						
Share Capital (D)	5.49	5.49	5.49	5.49	5.49	5.49
Reserves & Surplus (E)	2.09	3.66	4.43	5.20	6.18	7.37
Term Loans (F)	15.27	12.87	9.87	6.27	2.07	0.00
Total Liabilities (D)+(E)+(F)	22.85	22.01	19.78	16.96	13.73	12.86

Assets

Gross Fixed Assets	21.96	21.96	21.96	21.96	21.96	21.96
Less Accm. depreciation	3.05	6.11	9.16	12.22	15.27	18.32
Net Fixed Assets	18.90	15.85	12.79	9.74	6.69	3.63
Cash & Bank Balance	3.95	6.17	6.99	7.22	7.05	9.22
Total Assets	22.85	22.01	19.78	16.96	13.73	12.86
Net Worth	7.58	9.15	9.92	10.69	11.67	12.86
Debt Equity Ratio	2.01	1.41	1.00	0.59	0.18	0.00

Projected Cash Flow

₹ (in lakh)

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Sources							
Share Capital	5.49	-	-	-			
Term Loan	16.47	-	-	-			
Profit After tax		2.09	1.57	0.77	0.78	0.97	1.19
Depreciation		3.05	3.05	3.05	3.05	3.05	3.05
Total Sources	21.96	5.15	4.62	3.82	3.83	4.03	4.25
Application							

Particulars / Years	***0***	***1***	***2***	***3***	***4***	***5***	***6***
Capital Expenditure	21.96						
Repayment Of Loan	-	1.20	2.40	3.00	3.60	4.20	2.07
Total Application	21.96	1.20	2.40	3.00	3.60	4.20	2.07
Net Surplus	-	3.95	2.22	0.82	0.23	(0.17)	2.18
Add: Opening Balance	-	-	3.95	6.17	6.99	7.22	7.05
Closing Balance	-	3.95	6.17	6.99	7.22	7.05	9.22

IRR

₹ (in lakh)

Particulars / months	***0***	***1***	***2***	***3***			
Profit after Tax		2.09	1.57	0.77	0.78	0.97	1.19
Depreciation		3.05	3.05	3.05	3.05	3.05	3.05
Interest on Term Loan		1.49	1.42	1.15	0.82	0.44	0.06
Salvage / Realisable value				0.15			
Cash outflow	(21.96)	-	-	-	-	-	-
Net Cash flow	(21.96)		6.04	4.97	4.65	4.46	4.31
IRR	11.98%						

NPV	1.18

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***
Variable Expenses						
Oper. & Mainten-ance Exp (75%)	0.66	0.68	0.70	0.72	0.74	0.76
Sub Total(G)	0.66	0.68	0.70	0.72	0.74	0.76
Fixed Expenses						
Oper. & Mainten-ance Exp (25%)	0.22	0.23	0.23	0.24	0.25	0.25
Interest on Term Loan	1.49	1.42	1.15	0.82	0.44	0.06
Depreciation *(H)*	3.05	3.05	3.05	3.05	3.05	3.05
Sub Total (I)	4.76	4.70	4.44	4.12	3.74	3.37
Sales (J)	7.51	7.51	7.51	7.51	7.51	7.51
Contribution (K)	6.85	6.83	6.81	6.79	6.77	6.75

Break Even Point (L= G/I)	69.46%	68.75%	65.13%	60.61%	55.20%	49.88%
Cash Break Even {(I)-(H)}	24.90%	24.05%	20.30%	15.65%	10.09%	4.62%
Break Even Sales (J)*(L)	5.22	5.16	4.89	4.55	4.15	374.67%

Return on Investment

₹ (in lakh)

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***Total***
Net Profit Before Taxes	2.09	2.14	2.38	2.68	3.03	3.38	15.69
Net Worth	7.58	9.15	9.92	10.69	11.67	12.86	61.86
							25.37%

Debt Service Coverage Ratio

₹ (in lakh)

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***Total***
Cash Inflow							
Profit after Tax	2.09	1.57	0.77	0.78	0.97	1.19	7.37
Depreciation	3.05	3.05	3.05	3.05	3.05	3.05	18.32
Interest on Term Loan	1.49	1.42	1.15	0.82	0.44	0.06	5.37
Total (M)	6.63	6.04	4.97	4.65	4.46	4.31	31.06

DEBT

Interest on Term Loan	1.49	1.42	1.15	0.82	0.44	0.06	5.37
Repayment of Term Loan	1.20	2.40	3.00	3.60	4.20	2.07	16.47
Total (N)	2.69	3.82	4.15	4.42	4.64	2.13	21.84
Average DSCR				1.42			

Annexure 5 Procurement and implementation schedule

S. No.	*Activities*	*Weeks*			
		1	*2*	*3*	*4*
1	Designing				
2	Raw material Purchasing & preparation				
3	Dismantling of the existing system				
4	Fabrication				

Annexure 6 Details of technology service providers

S.No.	*Technology*	*Name of Service Provider*	*Address*	*Contact Person and No.*
1	Tunnel kiln fabricator	N. G. Parmar	Near Shyam Hotel, Lapar, Morbi	Mr. NanjiBhai – 0982b Lakdhirpur Road,5777279
2	Tunnel kiln fabricator	Perfect Mechanical Systems	8 – A National Highway , Lakdhirpur Road, opp. Sahib ceramic unit Morbi	Mr. Jayeshbhai - 09825230692

Annexure 7 Technical specification/Quotations for proposed technology

Technical Specifications:

Vendors providing services in this field are not ready to provide quotation along with design and costing. They all are telling that they will directly tell the cost to the interested clients after visiting their site and operating parameters and don't want to write any commitment. This is because of the following reason.

The cost of this project is divided into the cost of material purchase and the labour and consultancy charges. Many of the unit owners at Morbi hire only the labour and consultancy charges whereas the material cost was beared by them.

Therefore, we ask the LSP at least give the letter that you are working in this field and ready to provide services for implementation of the identified projects in tunnel kiln in sanitary wares then they give this letter which is attached as given below.

J.P. DAVE

Specialist for :- Low thermal, Mass Insulation, Ceramic Kiln.
Mobile : 98256 28879, Phone : (O)

8/Shakti Chambers. N.H. 8-A, MORBI (Guj.) India, Pin Code 363642.

Ref. :

Date : 21/04/2010.

To
See-Tech. solution P.LTD.
NAGPUR.

Res. Sir,
We are service provider in Tunnel kiln JOBS for CERAMICS Industries in following Conserv Technologies.

- Fabrication of Tunnel kiln JOBS.
- Ceramic kiln Brick work and Low themal mass insulation.
- Comb. equipamentls & machineries. (waste heat recovery)

Note:- JOB work charges we offer on visit partey site all variables.

J.P. DAVE

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

SEE-Tech Solutions Pvt. Ltd
11/5, MIDC, Infotech Park,
Near VRCE Telephone Exchange,
South Ambazari Road,
Nagpur – 440022
Website: www.letsconserve.org

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
Website: www.techsmall.com