DETAILED PROJECT REPORT
ON
ENERGY EFFICIENT MELTING AND REHEATING FURNACE
(250 KG CAPACITY)
(BHUBANESHWAR BRASS CLUSTER)











Bureau of Energy Efficiency

Prepared By

Reviewed By

ENERGY EFFICIENT MELTING & RE-HEATING FURNCE
(250 KG)

BHUBANESHWAR BRASS CLUSTER

BEE, 2010

Detailed Project Report on Energy Efficient Melting Furnace (250 kg)

Brass SME Cluster, Bhubaneshwar, Orissa (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: ***BUB/BRS/CFM/12***

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See-Tech Solution Pvt. Ltd.

Nagpur

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BEE	Bureau of Energy Efficiency
MSME	Micro 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
WHR	Waste Heat Recovery
MT	Metric Tonne
MoMSME	Ministry of Micro Small and Medium Enterprises
SIDBI	Small Industries Development Bank of India

EXECUTIVE SUMMARY

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

Bhubaneshwar cluster is one of the biggest brass 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 brass clusters in India.

The main energy forms used in these cluster units are Hard Coke and Charcoal. Hard Coke is used in the melting furnace and Charcoal is used in the reheating furnace. In brass units, about 15% of energy is consumed in melting furnace and 84% is consumed in reheating furnace of total energy consumption cost.

Project implementation i.e. installation of energy efficient melting & reheating furnace of batch capacity 250 kg will lead to reduction in Hard Coke consumption by 22,171 kg per year and charcoal consumption by 44,720 kg per year.

This DPR highlights the details of the study conducted for assessing the potential for installation of energy efficient melting furnace & reheating furnace project, possible fuel saving, and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, and schedule of Project Implementation.

This bankable DPR also found eligible for subsidy scheme of MoMSME for “Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises” under “National Manufacturing and Competitiveness Programme”. The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

S.No	*Particular*	*Unit*	*Value*
1	Project cost	₹ (in Lakh)	9.28
2	Hard Coke saving	kg/year	22,171
3	Charcoal Saving	kg/year	44,720
4	Monetary benefit	₹ (in Lakh)	11.84
5	Debit equity ratio	Ratio	3:1

S.No	Particular	Unit	Value
6	Simple payback period	years	0.78
7	NPV	₹ (in Lakh)	33.96
8	IRR	% age	97.47
9	ROI	% age	29.70
10	DSCR	ratio	5.22
11	Process down time	Days	2
12	CO_2 emission reductions	MT/year	188

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

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Bhubaneshwar Brass 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*:**

Activity 1: 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.

Activity 2: 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

Activity 3: 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.

Activity 4: 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

Bhubaneshwar brass cluster is a household & age old business which is slowly diminishing and is restricted to certain tribes / communities. In short, they are artisians. These units are in operation since 35 -40 years. Since its an low value business and an family run business wherein all the family members are engaged hence very few avail the bank facilities, that too Gramin Bank. The general turnover of the brass units is approximately ₹ 3 Lakh to ₹ 7 Lakh.

In this cluster, brass units are located in 4 different villages named as Balakati, Pratap Sasan and Rathijema - these three villages are adjacent to each other at a distance of about 22 Kms from the old city of Bhubaneshwar while the fourth village Bainchua is around 8 Kms from the old city of Bhubaneshwar. This cluster is traditional and community based, can also be called as "Kutir-Udyog". Manufacturing activity in this cluster takes place at the backyard of the unit owner's house.

There are approximately 200 brass units in this cluster which are engaged in manufacturing of brass articles like Thali, Goddess Idol, Aasan, Bati, Bela, Ghara, Lota, Diya and others. These units have not registered under any; and identified by the names of the fore-fathers.

As there is neither association nor any organized form of the units, which are in this business, there is no one to hear their issues / problems and the brass units are gradually dying.

All these units are running in a single shift and there is no usage of any technology, neither any equipment which consumes energy to a greater extent is being used. The equipment which is being used is only for polishing of the end product.

Majority of the cluster units are of integrated type, where the raw material is processed in-house to the final product. Table 1.1 shows the total energy consumption scenario at Bhubaneshwar Brass cluster.

Table 1.1 Details of Annual Energy Consumption Scenario at Bhubaneshwar Brass Cluster

S. No	*Energy Type*	*Unit*	*Value*	*%age Contribution in Equivalent Energy Terms*
1	Electricity	kWh/year	15670	0.37
2	Hard Coke	MT/year	310	35.3
3	Charcoal	MT/year	359	64.4

Classification of Units

The brass units can be categorized into following three types based on product manufacture

S. No	Category	Products
1	A	Thali
2	B	Ghara, Lota, Diya, Bela etc
3	C	Handicrafts

Products Manufactured

Different types of products manufactured and their percentage share in Bhubaneshwar Brass cluster are as shown in Table 1.3 below.

Table 1.2 Product Manufactured

S. No	Type of Product	Category	%age share	Units (No.).
1	Thali	A	54	65
2	Different varieties of brass articles like Lota, Bati, Bela, diya etc.	B	38	45
3	Handicrafts	C	8	10
Total (No.)[1]				120

[1] – *Out of total 200 brass units only 120 brass units are in operation.*

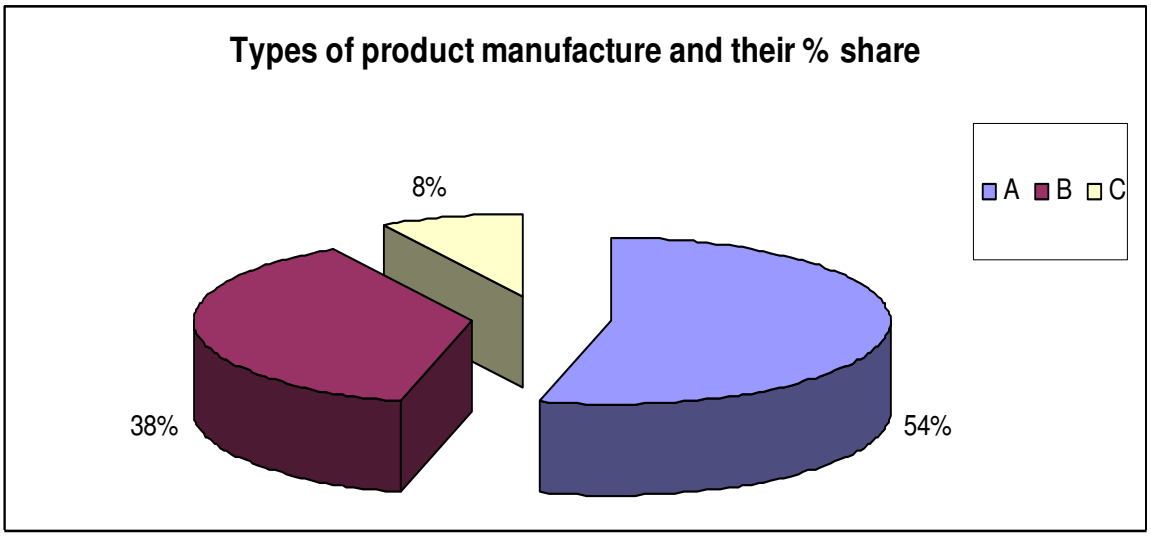


Figure 1.1: Different types products manufactured and their % age share

Figure 1.2: Photographs for Overview of Bhubaneshwar Brass Cluster

Production Process

Manufacturing process and technology that are in use in Bhubaneshwar Brass Cluster are as follows.

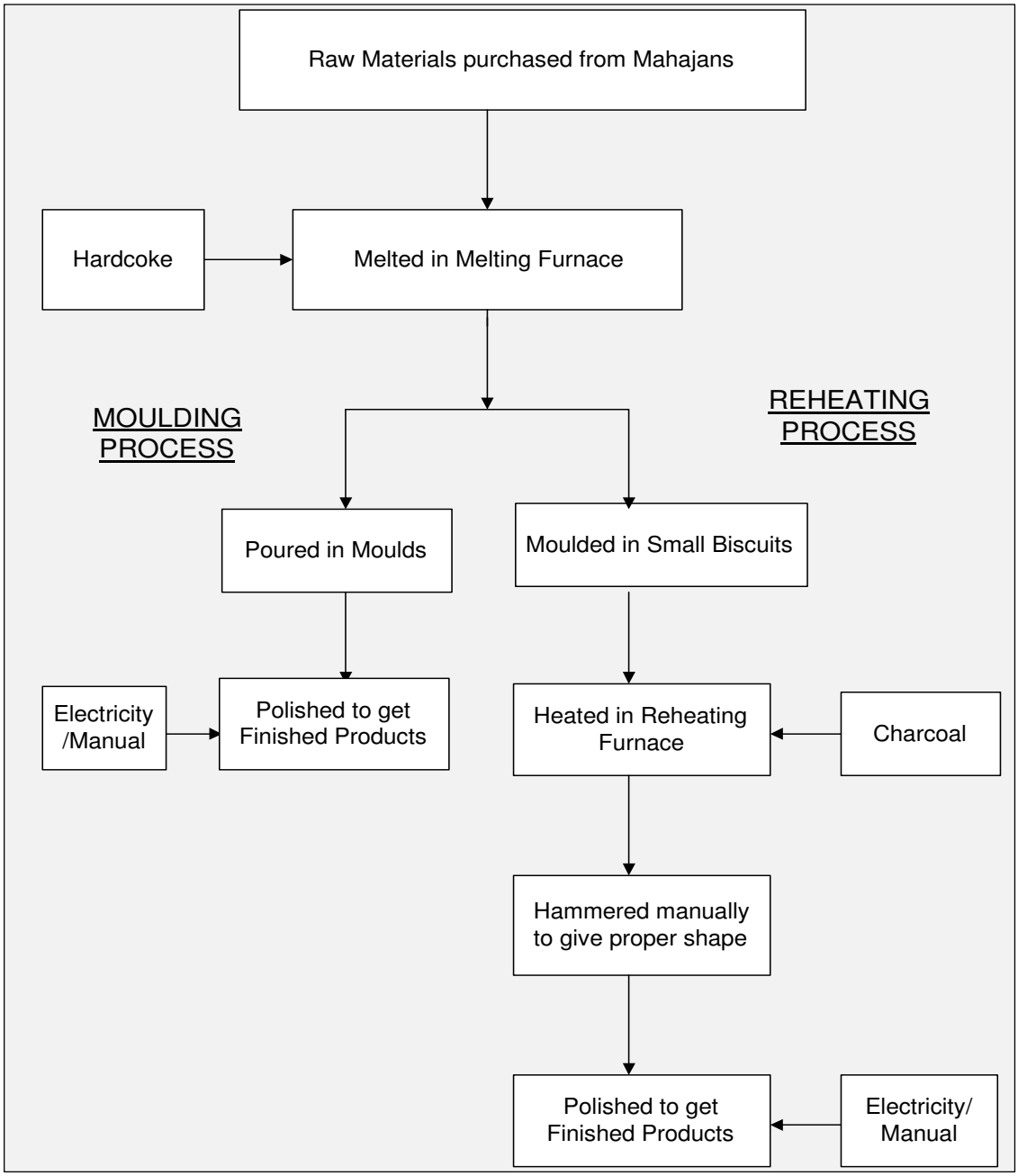


Figure 1.3 Process Flow Diagram of manufacturing of Brass Unit

Raw Materials

The raw material for production of brass articles are Copper and Zinc and sometimes scrap vessels of Brass or Copper and Zinc, both the materials are locally sourced or obtained from Mahajans (Raw material supplier). Fuel used in melting furnace is Hard coke and the fuel used in reheating furnace is Charcoal. Hard coke and Charcoal is obtained from local source at a comparatively much higher cost than available in the market.

Melting

The melting furnace is a unique and important requirement in the processing of manufacture of brass metal products. The Melting Furnace or Chulla is utilized for the melting of raw material i.e. Copper and Zinc, scrap vessels of Brass. This melting furnace is prepared by the unit owners as per their traditional process. Melting furnace heats the raw material to a temperature of about 950 ^{o}C. At this temperature, raw material melts. Furnace is about 40-70 cm wide and 15-60 cm deep. Basic metals are kept inside the crucible and process of heating is carried on. The source of thermal energy used for melting is Hard Coke. The melting process is a batch process; it takes time around 5 to 6 hours depending upon quantity of raw material under processing. Around 2 to 4 batches carried out in a week depending on the capacity of unit.

Moulding & Casting

The molten brass obtained from melting furnace is poured in suitable moulds i.e. Achhu for casting or moulding. The Achhu is prepared in different sizes shapes like thali, lota, bati, bela, ghara, diya etc keeping in view the quantity of the melted alloy is to be poured in it for different products. A small Koi called Dhal Koi is used for transporting the melted alloy from the Koi to pour into Achhu which is previously sterilized with Mobil oil. The molten alloy is allowed to remain sometime inside the Achhu to be cold. During the process of cooling, Tashu (rice head) is used after pouring the molten alloy. The rice head makes processing of cooling slow of the alloy. This cooled alloy is called Ghati. The moulds of lota, ghara, diya are available so molten material can be easily transformed into these shapes.

Re - Heating

The Reheating furnace is an open furnace build up on ground as per their traditional procedure. The furnace is built by just digging a hole of about 30-50 cm wide and 30-90 cm deep. Charcoal is used as a fuel in a reheating furnace. Temperature of about 800 ^{o}C is maintained inside the furnace.

Since in order to give the moulds a specific shape and size the moulded material are reheated in a Reheating Furnace and hammered, the moulded material are formed after moulding of melted

raw material from the melting furnace. This process requires more skill to give the ingot proper shape and size. For this different size of hammers, pincers, pathara (stone anvil), iron anvil etc. are required. This beating process also requires simultaneously heating and beating.

Beating

The heated billet from the reheating furnace is taken out through pincers at a temperature of about 800 ^{o}C and is then hammered in a sequential and known fashion. In case of formation of Thali and other products, the beating is carried out from left to right on the heated billet by a group of hammer men. The heating & beating is a simultaneous process in order to bring it to a desired shape. The process is carried out by holding the moulded material by craftsmen over stone anvil and is beated by the hammer men to form concave size. Next step is to increase the height of the product beyond its circumferential base. Under this process, a hammer man takes the leading part in hammering of the product. The products formed by this technique are like thali, ghara, diya etc.

Scrapping

After the process of beating the product scrapping is carried out by the artisans where if any portion of the body of the product unusually thick enough is removed. Thus scrapping is carried out for ensuring a uniformly thickness product and smoothness of product wherever required.

Polishing

The finished products after molding or manual finishing are polished for shining look and smoother surface. Machine used for polishing is either hand driven or electrically powered. This motor is connected to the main polishing part via pairs of flat belts. The finished products after polishing are sold to Mahajans.

1.2 Energy Performance in Existing Situation

1.2.1 Average Production

Annual production in typical unit in Bhubaneshwar brass cluster is given in Table 1.3 below:

Table 1.3 Annual production from a typical brass units

S. No	Type of Brass Unit	Production (kg/year)	
	Scale of Unit	Minimum	Maximum
1	A	1920	4836
2	B	1728	6144
3	C	360	7680

1.2.2 Energy Consumption

Energy consumption (both electrical and thermal) in a typical brass unit for different types of products is given in Table 1.4 below:

Table 1.4 Annual Energy Consumption

Type of Brass Unit	*Electricity (kWh per year)*		*Hard Coke (kg per year)*		*Charcoal (kg per year)*	
Scale of Unit	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
A	0	378	1920	6240	3840	5760
B	0	492	1200	4200	1920	5760
C	404	893	4320	6720	0	0

Note: *Minimum electricity consumption in most of the brass units is zero because they are operating the blowers and the polishing machines manually.*

1.2.3 Specific Energy Consumption

Specific energy consumption both electrical and thermal energy per kg of product for different types of brass products manufacturing units is given in Table 1.5 below:

Table 1.5 Specific Energy Consumption in different Brass units

Type of Brass Unit	*Electricity (kWh/kg of Production)*		*Hard Coke (kg/ kg of Production)*		*Charcoal (kWh/kg of Production)*	
Scale of Unit	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
A	0	0.12	0.56	1.79	0.8	1.78
B	0	0.15	0.23	1.4	0.8	1.67
C	0.10	1.12	0.88	2	0	0

Note: *Minimum electricity consumption in most of the brass units is zero because they are operating the blowers and the polishing machines manually.*

1.3 Proposed Equipment

1.3.1 Description of Equipment

In a brass unit, major energy consumption equipment is the melting & reheating process. Melting & reheating furnaces operating in this cluster are highly inefficient and fabricated according to their traditional methods. Melting Furnace is utilized for the melting of raw material i.e. Copper and Zinc, scrap vessels of Brass. In this furnace, temperature of around 950 ^{o}C is maintained. At this temperature, raw material melts. Furnace is about 40-70 cm wide and 15-60 cm deep. Basic metals are kept inside the crucible and process of heating is carried on. The source of thermal energy used in melting furnace is Hard Coke.

The Reheating furnace is an open furnace build up on ground for reheating of the moulded material in order to give the moulds a specific shape and size. The furnace is built by just digging a hole of about 30-50 cm wide and 30-90 cm deep. The moulded material is formed by pouring the melted brass material from the melting furnace in suitable moulds. The brass biscuits obtained after moulding are reheated and hammered to give the proper shape for final finishing. The biscuits moulds are reheated in a Reheating furnace at a temperature of about 800°C. The source of thermal energy used in reheating furnace is Charcoal.

The melting & reheating process is a batch process; it takes time around 5 to 6 hours per batch depending upon quantity of raw material under processing. Around 2 to 4 batches are carried out in a week depending on the capacity of unit. The efficiency of the furnaces in this cluster was observed less than 5 % in all the brass units.

All brass units at this cluster operate in a single shift. Melting & reheating furnaces operates alternatively for about 3 days in week. Implementation of energy saving project by combining 5 to 6 brass units is also possible which leads to less payback period for the proposed project.

1.3.2 Role in Process

Melting furnace is used for melting of the raw material so as to form the brass products of desired shapes by pouring the melted raw material in the desired shape moulds. Temperature of about 950 ^{o}C is maintained in the melting furnace. Mainly hard coke is used as a fuel in most of the brass units in Bhubaneshwar brass cluster.

In order to give the biscuit moulds a specific shape and size, the moulded material are reheated in a reheating furnace and hammered. Hammering process of the reheated mould requires more skill to give the proper shape to form the desired shape final product. The process of providing the shape to the reheated mould also depends on the reheating process of the biscuit mould

which can be achieve by reheating the biscuit moulds at a required temperature with a proper heating cycle time.

1.4 Benchmarking for Existing Specific Energy Consumption

Energy consumption in the furnaces would depend on the following mentioned parameters

- Type of fuel used and its calorific value
- Quantity of material to be handled
- Temperature maintained in the furnace
- Operational and maintenance practices

1.4.1 Operation Parameters details

Operating parameters means the total fuel consumption in the furnaces for about 5 to 6 brass units having a batch capacity of about 30 to 40 is considered in this DPR in order to estimate the feasibility study of the proposed project is given Table 1.6 below:

Table 1.6 Operating Parameters in a Brass unit

S. No.	*Particular*	*Unit*	*Value*
1	Capacity of Melting Furnace	kg	250
3	Hard Coke Consumption in melting furnace	kg/year	29,988
4	Charcoal Consumption in reheating furnace	kg/year	47,880
5	Production	kg/year	36,000
6	Melting Furnace Temperature	^{o}C	950
7	Reheating Furnace temperature	^{o}C	800

1.4.2 Operating Efficiency Analysis

Detailed operating efficiency calculation of the existing furnace is given in Annexure 1.

1.4.3 Specific Energy Consumption

Specific thermal energy consumption by combining a group of 5 to 6 brass units on annual basis is given in Table 1.7 below:

Table 1.7 Specific Energy Consumption in a Brass unit

Particulars	*Unit*	*Value*
Hard Coke consumption	kg/kg of Production	0.83
Charcoal Consumption	kg/kg of Production	1.33

1.5 Barriers in Adoption of Equipment

1.5.1 Technological Barrier

- It requires much time to convince the unit owners for implementation for the proposed project.
- Restrictions at this cluster to operate in a single shift by external source may also become a constraint.
- Basic educational level in this cluster is very poor. Most of the unit owners are themselves workers. The cluster is more of traditional handicraft then SME industrial cluster.
- No awareness or information about the new energy efficient technologies available in the market.
- Total dependence on local suppliers and limitation of working on labour rates.
- The unit owners do not have industrial culture/mindset even of MSME level.
- Actual working days per week is maximum 2 or 3 and that too one shift on that day.
- Units are too small in size.

1.5.2 Financial Barrier

- Implementation of the proposed project requires an investment of about ₹ 9.288 lakh which is a significant investment as far as this cluster is concern.
- The units owners are crafts-man work on labor rates work and earn for day to day living; their financial condition is very poor.
- Due to bare minimum margins, the unit owners are not able to make and investment.
- Due to less operating hours and seasonal dependency, payback period for implementation of the project increases if a single unit plans to implement the energy conservation projects.
- The unit owners in the cluster do not have any banking experience; they hardly have

anything to offer as collateral security.

1.5.3 Skilled Manpower

All the skills are limited to Crafts men's skills. Other than this there are no skills.

1.5.4 Other Barriers

- All the operations depend on Mahajans (Persons who are providing the raw material to the unit owners for converting to finished products. The unit owners are paid for labor charges for conversion. The margin for unit owners is very low). They have to operate their units based on orders from Mahajan.
- There are some associations (Samiti's) of these craftsmen; however policies or activities in these associations have not been able to raise their living/business.

2 PROPOSED EQUIPMENT

2.1 Detailed Description of Equipment

2.1.1 Description of Equipment

Here, we propose to install the new redesigned energy efficient melting & reheating furnaces of higher capacity of about 250 kg batch so that at a time 5 to 6 brass units can put their material for melting & reheating operation i.e. one common facility. This will decrease the investment required for the proposed project compared to if the units wish to separately implement this project for the same production. Proposed redesigned melting & reheating furnace will consist of furnace with recuperator where the waste heat of the flue gas will be utilized for preheating of combustion air which will further contribute to increase in efficiency of furnace. In the existing furnaces, the specific fuel consumption is very high and efficiency of furnace is found very low. Use of new redesigned furnaces with recuperator will improve the efficiency of furnace and decreases the specific fuel consumption. It will also lead to efficient fuel utilization. Exhaust flue gas temperature from the furnace entering to the recuperator at about 550 ^{o}C and by using such high temperature exhaust gas, combustion air can be pre heat upto 200 ^{o}C. Hence, efficiency upto 15% can be achieved by these new redesigns furnaces.

2.1.2 Equipment Specification

Detailed engineering drawing of the energy efficient melting & reheating furnaces, specifications of the other accessories required along with their dimensions is given in Annexure 4.

2.1.3 Suitability over Existing Equipment

Implementation of this technology requires the redesign of the melting & reheating furnaces. It includes the design of new structure for furnace along with the design of the waste heat recovery system i.e. recuperator, proper insulation and refractory of the furnace, along with the blower of very small capacity and adjustment of stoichiometric air to fuel ratio. Details are given in Annexure 4.

This project implementation is suitable because of the following reasons

- It will decrease the capital investment for the proposed project for the same production.
- It will increase the efficiency of the furnace.
- It will reduce the specific fuel consumption in the furnace.
- Reduces the operating energy cost in the melting & reheating process.
- It will reduce the flue gas loss due to installation of recuperator.

- It will also reduce the surface losses due to improved insulation.
- It reduces the GHG emissions.
- Also improves the operating practices in the process.

2.1.4 Superiority over Existing Equipment

Installation of new redesigned melting & reheating furnaces by replacement of the existing conventional designed furnace will reduce the fuel consumption as well as total energy cost for the same production.

2.1.5 Availability of Equipment

Melting & reheating furnaces of the proposed capacity is easily available with the well known furnace suppliers. Also the local furnace fabricators is available in this cluster who can fabricate the melting & reheating furnaces according to the drawings provided by the technical expert.

2.1.6 Source of Equipment

In Bhubaneshwar brass cluster, melting & reheating furnace is manufactured by own traditional methods which are highly inefficient. Efficiency of the melting & reheating furnaces at this cluster is found very less as compared to the efficiencies in the melting & reheating furnaces observed in other industries for the same capacities. The similar efficiencies can also be achieved in the melting & reheating furnaces at this cluster by installing the new melting & reheating furnace with waste heat recovery system and proper system thereby lead to reduction in fuel consumption in the furnaces for the same production.

2.1.7 Terms and Conditions in Sales of Equipment

Performance guarantee of one year of the melting & reheating furnaces will be provided by the vendor.

2.1.8 Process down Time during Implementation

Implementation of the new redesign energy efficient melting & reheating furnace is a completely new separate setup. Installation of the proposed equipment will not affect the present setup during the implementation phase. However after completion of the proposed equipment installation, it may require the shutdown period of 2 days.

2.2 Life Cycle Assessment

Life cycle assessment of the proposed equipment is about 15 years. Maintenance or replacement of the refractories will be required on a periodic basis i.e. after every 5 years.

2.3 Suitable Unit for Implementation of Proposed Equipment

For estimation of saving potential in hard coke consumption in a melting furnace and charcoal consumption in a reheating furnace, common facility for a batch capacity of about 250 kg is considered.

3 ECONOMIC BENEFITS FROM PROPOSED EQUIPMENT

3.1 Technical Benefits

3.1.1 Fuel Saving

Implementation of this proposed project as a common facility for a group of 5 to 6 units will save hard coke consumption in melting furnace and charcoal consumption in reheating furnace. Total hard coke and charcoal saving would be 22,171 kg and 44,720 kg per year respectively.

3.1.2 Electricity Saving

Implementation of this project will lead to increase in electricity consumption due to use of electrical blowers by replacing the present hand driven blowers. However, the cost of electricity consumption is very small as compared to the cost of fuel saving. The cost of electricity consumption will be about ₹ 11,118 per year @ ₹ 2.3/kWh.

3.1.3 Improvement in Product Quality

Product quality will be the same as in the present condition. However, this project will reduce the excess heating of the raw material due to installation of proper monitoring system thus saving in fuel consumption.

3.1.4 Increase in Production

Implementation of this project will definitely helps in increase in production due to reduction in furnace batch time at the present energy consumption cost in the furnace.

3.1.5 Reduction in Other Losses

This project will reduces the flue gas loss of the furnace by utilization of flue gas waste heat for preheating of combustion air with the help of recuperator.

3.2 Monetary Benefits

Total monetary benefit after implementation of this system as a common facility for a group of 5 to 6 units would be ₹ 11, 83,534 per year. Details of monetary saving calculation are given at Annexure 3.

3.3 Social Benefits

3.3.1 Improvement in Working Environment in the Plant

This project helps in reduction in the surrounding temperature around the melting & reheating furnaces. In the proposed equipment, process is carried out in a closed enclosure and proper insulation, due to which it will reduce the heat loss from the surface of the furnace. Thus it will

reduce the temperature of the room thereby providing the comfortable atmosphere to work for the workers. Due to its proper designed, it will further reduces the accidents which may happen due to manual handling as presently used practice.

3.3.2 Improvement in Workers Skill

Implementation of the energy efficient melting & reheating furnaces will results in improvement in workers skill set. Use of proper monitoring system provides the guidelines to the workers for the proper operation of the equipment in order to get the good quality final product in a lesser cycle time. They also learn about the new technologies employed in the melting & reheating furnaces which help in reduction in energy consumption cost.

3.4 Environmental Benefits

3.4.1 Reduction in GHG Emission

Installation of the new redesign energy efficient melting and reheating furnace will result in saving in hard coke consumption and charcoal consumption of about 22,171 kg and 44,720 kg per year in a single common facility for a batch capacity of about 250 kg. This will result in reduction of GHG emission reduction by 188 TCO_2 per year.

4 IMPLEMENTATION OF PROPOSED EQUIPMENT

4.1 Cost of Equipment Implementation

4.1.1 Equipments Cost

Cost of the proposed project is about ₹ 8.410 Lakh which includes the design and fabrication of the melting & reheating furnace along with their all other accessories like waste heat recovery system, blower, insulation and refractory etc and also includes the transportation cost and taxes as applicable.

Parameters	Unit	Value
Cost of melting furnace includes Furnace structure, Recuperator, Blower etc.	₹	2,45,000
Cost of reheating furnace includes Furnace structure, Recuperator, Blower etc.	₹	3,40,000
Service charges	₹	1,50,000
Vat	₹	73,125
Transportation Cost	₹.	32,906
Total equipment Cost	**₹**	**8.41**

4.1.2 Erection & Commissioning and other Miscellaneous Cost

Other cost includes erection & commissioning cost which includes piping cost, labor work etc and miscellaneous cost also. Details of project cost are furnished in Table 4.1 below:

Table 4.1 Details of Proposed Equipment Installation Cost

S. No	*Particular*	*Unit*	*Cost*
1	Equipment cost	₹	8.41
2	Erection & Commissioning Cost	₹	0.29
3	Contingency Value	₹	0.59
4	Total Capital Cost	₹	9.28

4.2 Arrangements of Funds

4.2.1 Entrepreneur's Contribution

Entrepreneur will contribute 25% of the total project cost which is ₹ 2.32 Lakh.

4.2.2 Loan Amount

Remaining 75% cost of the proposed project will be funded by the bank which is ₹ 6.96 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 moratorium period of 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 5 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below:

The project is expected to achieve monitory savings of ₹ 11.84 lakh per annum.

- The Repair and Maintenance cost is estimated at 5% of total cost 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-5.

4.3.2 Simple Payback Period

The total project cost of the proposed technology is ₹ 9.28 Lakh and monetary savings due to reduction in fuel consumption is ₹ 11.84 lakh hence, the simple payback period works out to be 0.78 year.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be ₹ 33.96 lakh.

4.3.4 Internal Rate of Return (IRR)

The after tax Internal Rate of Return of the project works out to be 97.47%. 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 29.70%.

Details of financial indicators are furnished in Table 4.2 below:

Table 4.2 Financial Indicators of Proposed Technology/Equipment

S. No.	Particular	Unit	Value
1	Simple payback period	Year	0.78
2	NPV	₹ (in Lakh)	33.96
3	IRR	% age	97.47
4	ROI	% age	29.70
5	DSCR	Ratio	5.22

4.4 Sensitivity Analysis in Realistic, Pessimistic and Optimistic Scenarios

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 have been considered.

- Pessimistic scenario (Decrease in hard coke as well as charcoal saving by 5%)
- Optimistic scenario (Increase in hard coke as well as charcoal saving 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 on Fuel Saving

Scenario	IRR (% age)	NPV (₹ in Lakh)	ROI (% age)	DSCR
Realistic	97.47	33.96	29.70	5.22
Pessimistic	92.72	31.82	29.49	5.05
Optimistic	102.02	36.03	29.88	5.57

4.5 Procurement and Implementation Schedule

Total time period required for implementation of this project required about 12 weeks in which only 2 days required for process breaks downs. Break up of procurement and implementation schedules are given in Annexure 6.

ANNEXURE

Annexure -1: Energy Audit Data Used for Baseline Establishment

Baseline for implementation of the proposed project can be considered is the specific fuel (Hard Coke) consumption in the melting furnace which depends on the efficiency of the furnace.

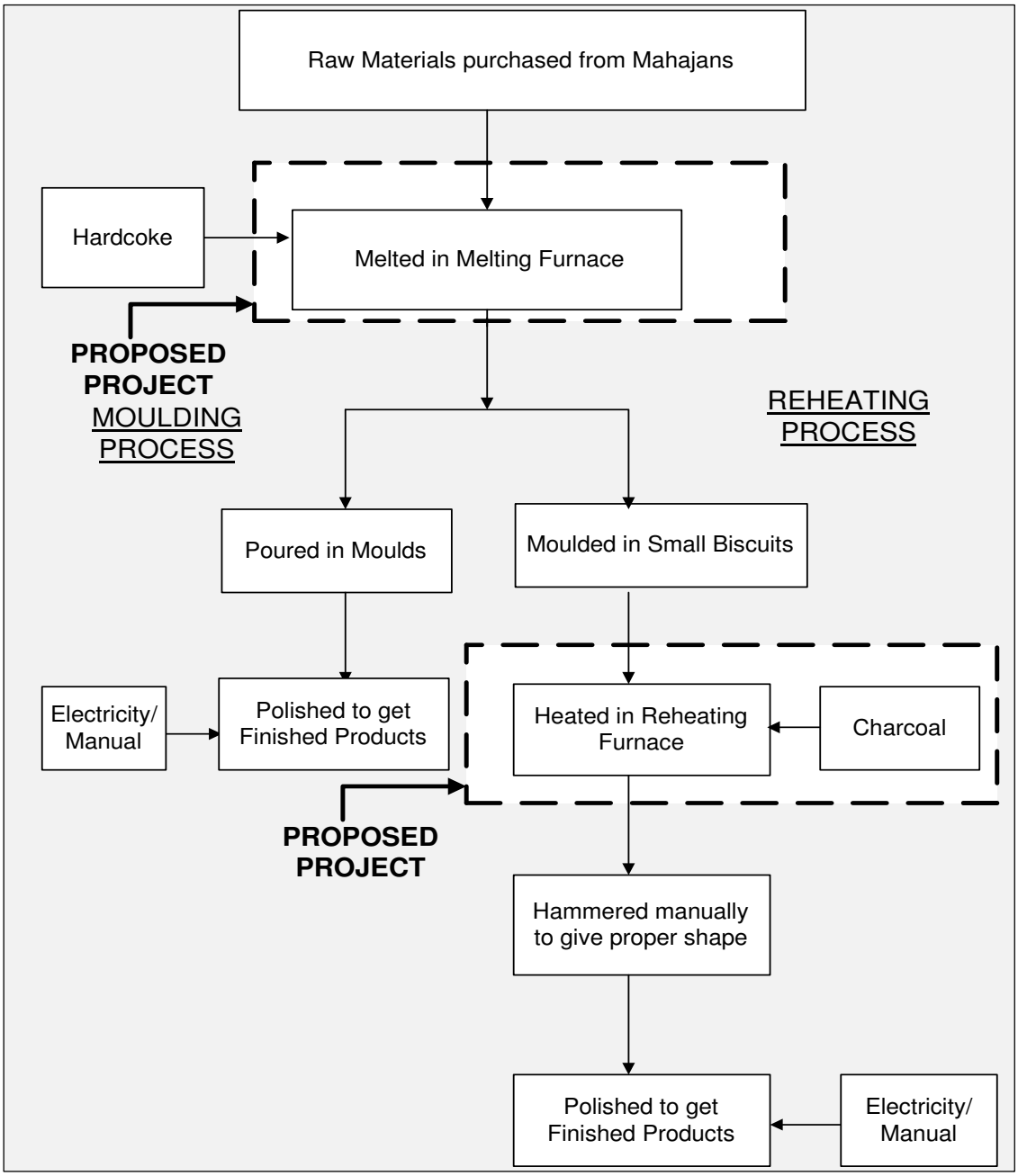
Efficiency calculation of the melting furnace is as follows:

S.No.	Particular	Unit	Value
1	Quantity of raw material feed per batch	kg	250
2	Melting temperature of Brass	^oC	950
3	Ambient Temperature	^oC	35
4	Specific heat of Brass	kCal/Kg ^oC	0.112
5	Latent heat of fusion of Brass	kCal/Kg	44
6	Calorific value of hard coke	kCal/kg	4500
7	Quantity of hard coke per batch	kg	208
8	Heat required for melting of one batch	kCal	36620
9	Heat Supplied by the fuel per batch	kCal	936000
10	Efficiency of the furnace	% age	3.91
11	Specific fuel consumption	kg of Hard Coke/ kg of raw material	0.83

Efficiency calculation of the Reheating furnace is as follows

S.No.	Particular	Unit	Value
1	Quantity of production per batch	kg	250
2	Furnace temperature	^oC	800
3	Ambient Temperature	^oC	35
4	Specific heat of Brass	kCal/Kg ^oC	0.112
5	Calorific value of Charcoal	kCal/kg	6500
6	Quantity of charcoal per batch	kg	333
7	Heat required for reheating of one batch	kCal	21420
8	Heat Supplied by the fuel per batch	kCal	2164500
9	Efficiency of the furnace	% age	0.99
10	Specific fuel consumption	kg of Charcoal/ kg of Production	1.33

Annexure -2: Process Flow Diagram

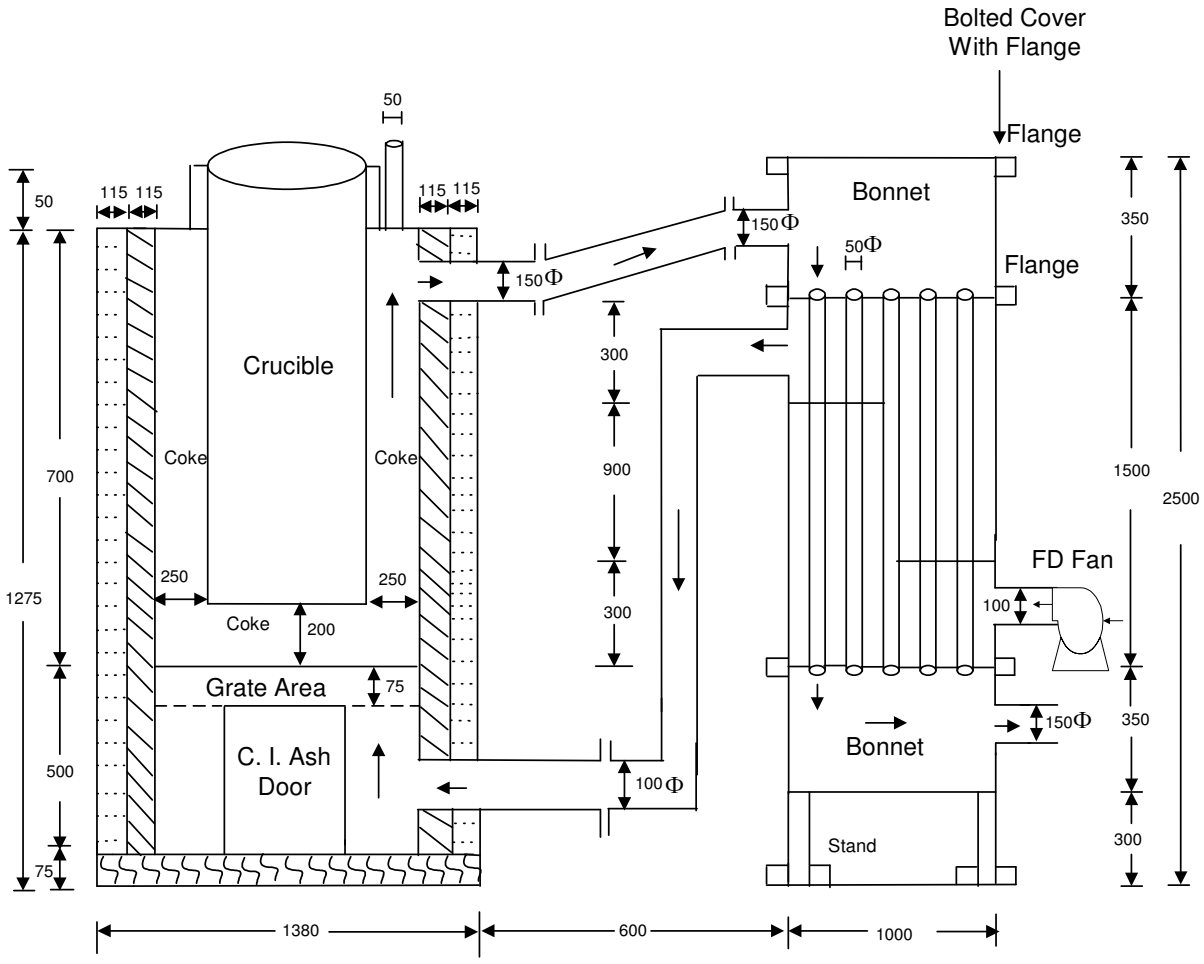


Annexure -3: Detailed Technology Assessment Report

S.No.	Particular	Unit	Melting Furnace		Reheating furnace	
			Present Situation	Proposed Situation	Present Situation	Proposed Situation
1	Type of Fuel Used	-	Hard Coke	Hard Coke	Charcoal	Charcoal
2	Fuel Consumption	Kg/year	29,988	7817	47,880	3160
3	Furnace temperature	°C	950	950	800	800
4	Furnace Efficiency	%age	3.91	15	0.99	15
5	Annual operational hours	Hours/year		432		864
6	Saving in Fuel consumption	kg/year		22,171		44,720
7	Rated Blower Power	kW		3.73		3.73
8	Electricity Consumption	kWh/year		1611		3223
9	Cost of Electricity	₹./kWh		2.3		2.3
10	Electricity cost	₹./year		3706		7412
11	Cost of Fuel	₹./kg		8.5		22.5
12	Saving in Fuel consumption Cost	₹./year		1,88,455		10,06,198
13	Monetary Saving	₹		1,84,748		9,98,786
14	Total saving of the project	₹				11,83,534

Annexure -4: Engineering drawing of the Proposed Equipment

250 KG Brass Melting Furnance Crucible Pot Type Coal Fired With Recruparator

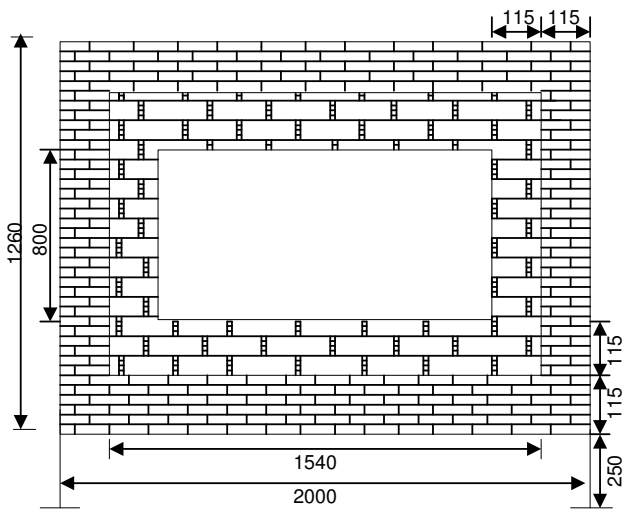


Crucible
Depth 550mm Thick
Diameter 420 OD
Diameter 370 ID
Bottom 295mm
Blower
Flow 1000 m^3 /hr
Pr 30 in WC
Power 5 HP

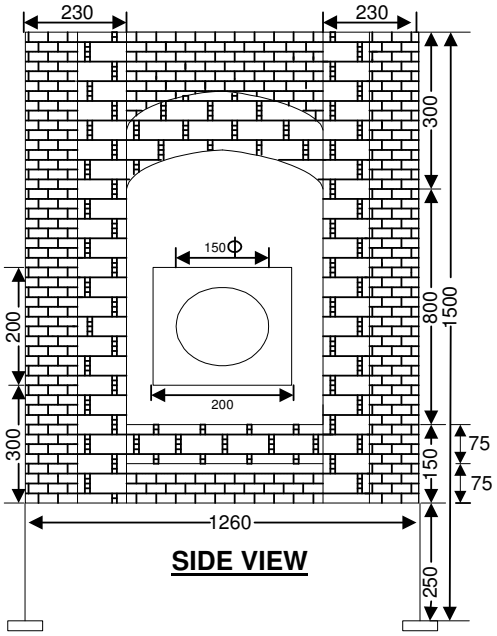
Recuparator
Pitch Ratio 105mm
SS 310
Tube OD 62Φ
Tube ID 50Φ
Area 20m^2
Noot Tubes 80 nos.

	50% Cupola Fire Brick
	Clod Face Insulation
	50% Al. Fire Brick

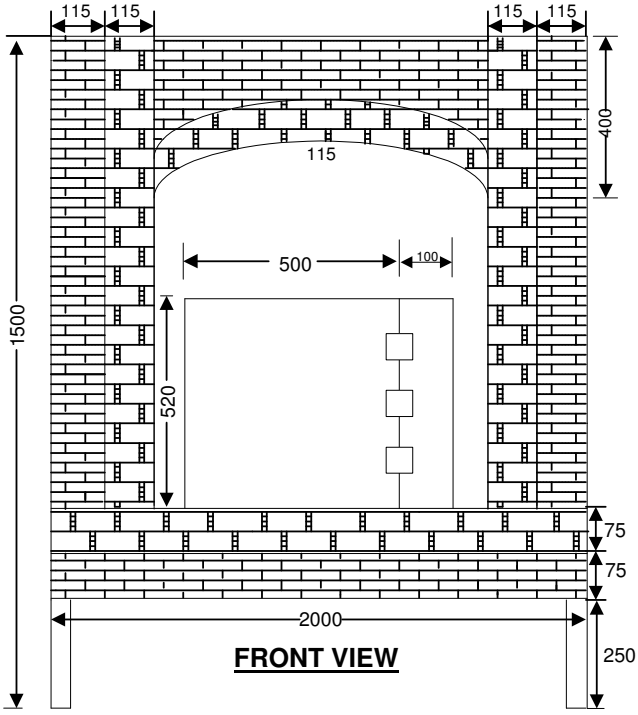
250 KG REHEATING FURNACE



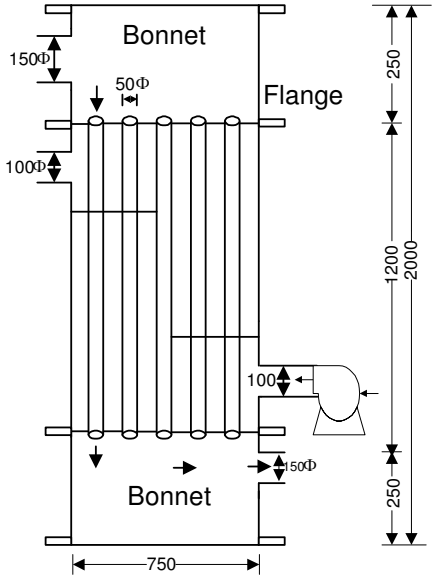
TOP VIEW



SIDE VIEW



FRONT VIEW



Blower Specifications
Flowrate-1000m3/hr
Pressure-39 in WG
Power-5 HP

Recuperator Specifications
Material-SS310
Tube OD-62Φ
Tube ID-50Φ
No. Of Tubes-80
Pitch-105mm

Drawing is not to scale,
All dimension are in mm

COLD FACE INSULATION

50% ALUMINA FIRE BRICK

Annexure – 5: Detailed Financial Analysis

Name of the Technology	***Melting & Re-heating Furnace***		
Rated Capacity	***250 Kg***		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	kg	250	
Proposed Investment			
Plant & Machinery	₹ (in lakh)	8.41	
Erection & Commissioning	₹ (in lakh)	0.29	
Investment without IDC	₹ (in lakh)	8.70	
Misc. Cost	₹ (in lakh)	0.58	
Total Investment	₹ (in lakh)	9.28	
Financing pattern			
Own Funds (Equity)	₹ (in lakh)	2.32	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	6.96	Feasibility Study
Loan Tenure	years	5.00	Assumed
Moratorium Period	Months	6.00	Assumed
Repayment Period	Months	66.00	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	5.00	Feasibility Study
Annual Escalation	%age	3.00	Feasibility Study
Estimation of Revenue			
Fuel savings(Melting furnace)	kg/Year	22171	
Cost	₹/ kg	8.5	
Fuel savings(Re-heating furnace)	kg/Year	44720	
Cost	₹/ kg	22.5	
Electricity consumption	kWh/Year	4834	
Cost of electricity	₹/ kWh	2.3	
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 Interest on Term Loan

(₹ in lakh)

Years	***Opening Balance***	***Repayment***	***Closing Balance***	***Interest***
1	6.96	0.90	6.06	0.79
2	6.06	1.20	4.86	0.55
3	4.86	1.32	3.54	0.43
4	3.54	1.44	2.10	0.29
5	2.10	1.68	0.42	0.14
6	0.42	0.42	0.00	0.01
		6.96		

WDV Depreciation

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	9.28	1.86
Depreciation	7.43	1.49
WDV	1.86	0.37

Projected Profitability

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Revenue through Savings								
Fuel savings	11.84	11.84	11.84	11.84	11.84	11.84	11.84	11.84
Total Revenue (A)	11.84	11.84	11.84	11.84	11.84	11.84	11.84	11.84
Expenses								
O & M Expenses	0.46	0.48	0.49	0.51	0.52	0.54	0.55	0.57
Total Expenses (B)	0.46	0.48	0.49	0.51	0.52	0.54	0.55	0.57
PBDIT (A)-(B)	11.37	11.36	11.34	11.33	11.31	11.30	11.28	11.26
Interest	0.80	0.58	0.46	0.32	0.18	0.02	0.00	0.00
PBDT	10.57	10.78	10.88	11.00	11.14	11.27	11.28	11.26
Depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
PBT	10.08	10.29	10.39	10.51	10.65	10.78	10.79	10.77
Income tax	1.07	3.16	3.70	3.74	3.79	3.83	3.83	3.83
Profit after tax (PAT)	9.01	7.13	6.69	6.77	6.86	6.95	6.96	6.95

Computation of Tax ***₹ (In lakh)***

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	10.08	10.29	10.39	10.51	10.65	10.78	10.79	10.77
Add: Book depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Less: WDV depreciation	7.43	1.49	0.00	0.00	-	-	-	-
Taxable profit	3.14	9.29	10.88	11.00	11.14	11.27	11.28	11.26
Income Tax	1.07	3.16	3.70	3.74	3.79	3.83	3.83	3.83

Projected Balance Sheet ***₹ (In lakh)***

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
Reserves & Surplus (E)	9.01	16.14	22.83	29.61	36.47	43.42	50.38	57.32
Term Loans (F)	6.36	5.16	3.87	2.46	0.84	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	17.70	23.62	29.03	34.39	39.63	45.74	52.70	59.65

Assets	1	2	3	4	5			
Gross Fixed Assets	9.28	9.28	9.28	9.28	9.28	9.28	9.28	9.28
Less: Accm. Depreciation	0.49	0.98	1.47	1.96	2.45	2.94	3.43	3.92
Net Fixed Assets	8.79	8.30	7.81	7.32	6.83	6.34	5.85	5.36
Cash & Bank Balance	8.90	15.32	21.21	27.07	32.80	39.40	46.85	54.28
TOTAL ASSETS	17.70	23.62	29.03	34.39	39.63	45.74	52.70	59.65
Net Worth	11.33	18.46	25.15	31.93	38.79	45.74	52.70	59.64
Dept equity ratio	2.74	2.22	1.67	1.06	0.36	0.00	0.00	0.00

Project cash flow ***₹ (In lakh)***

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sources									
Share Capital	2.32	-	-	-	-	-	-	-	-
Term Loan	6.96								
Profit After tax		9.01	7.13	6.69	6.77	6.86	6.95	6.96	6.95
Depreciation		0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Total Sources	9.28	9.50	7.62	7.18	7.26	7.35	7.44	7.45	7.44
Application									
Capital Expenditure	9.28								
Repayment of Loan	-	0.60	1.20	1.29	1.41	1.62	0.84	0.00	0.00
Total Application	9.28	0.60	1.20	1.29	1.41	1.62	0.84	0.00	0.00
Net Surplus	-	8.90	6.42	5.89	5.85	5.73	6.60	7.45	7.44
Add: Opening Balance	-	-	8.90	15.32	21.21	27.07	32.80	39.40	46.85
Closing Balance	-	8.90	15.32	21.21	27.07	32.80	39.40	46.85	54.28

Calculation of Internal Rate of Return

₹ (In lakh)

Particulars / months	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit after Tax		9.01	7.13	6.69	6.77	6.86	6.95	6.96	6.95
Depreciation		0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Interest on Term Loan		0.80	0.58	0.46	0.32	0.18	0.02	-	-
Salvage/Realizable value					-	-	-	-	-
Cash outflow	(9.28)	-	-	-	-	-	-	-	-
Net Cash flow	(9.28)	10.30	8.20	7.64	7.59	7.53	7.47	7.45	7.44
IRR	97.47%								

NPV	33.96

Break Even Point

₹ (In lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.35	0.36	0.37	0.38	0.39	0.40	0.42	0.43
Sub Total (G)	0.35	0.36	0.37	0.38	0.39	0.40	0.42	0.43
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.12	0.12	0.12	0.13	0.13	0.13	0.14	0.14
Interest on Term Loan	0.80	0.58	0.46	0.32	0.18	0.02	0.00	0.00
Depreciation *(H)*	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Sub Total (I)	1.41	1.19	1.07	0.94	0.80	0.65	0.63	0.63
Sales (J)	11.84	11.84	11.84	11.84	11.84	11.84	11.84	11.84
Contribution (K)	11.49	11.48	11.47	11.45	11.44	11.43	11.42	11.41
Break Even Point (L= G/I)	12.26%	10.38%	9.35%	8.22%	6.96%	5.68%	5.51%	5.55%
Cash Break Even {(I)-(H)}	7.99%	6.11%	5.07%	3.94%	2.67%	1.39%	1.21%	1.25%
BREAK EVEN SALES (J)*(L)	1.45	1.23	1.11	0.97	0.82	0.67	0.65	0.66

Return on Investment

₹ (In lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	10.08	10.29	10.39	10.51	10.65	10.78	10.79	10.77	84.27
Net Worth	11.33	18.46	25.15	31.93	38.79	45.74	52.70	59.64	283.74
									29.70%

Debt Service Coverage Ratio

₹ (In lakh)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Cash Inflow									
Profit after Tax	9.01	7.13	6.69	6.77	6.86	6.95	6.96	6.95	43.42
Depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	2.94
Interest on Term Loan	0.80	0.58	0.46	0.32	0.18	0.02	0.00	0.00	2.37
Total (M)	10.30	8.20	7.64	7.59	7.53	7.47	7.45	7.44	48.73

Debt

Interest on Term Loan	0.80	0.58	0.46	0.32	0.18	0.02	0.00	0.00	2.37
Repayment of Term Loan	0.60	1.20	1.29	1.41	1.62	0.84	0.00	0.00	6.96
Total (N)	1.40	1.78	1.75	1.73	1.80	0.86	0.00	0.00	9.33
	7.35	4.60	4.37	4.38	4.19	8.63	0.00	0.00	5.22
Average DSCR (M/N)	5.22								

Annexure -6: Details of Procurement and Implementation

S. No.	Activities	Weeks											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Design												
2	Civil Construction for foundation												
3	Procurement of Raw Material												
4	Fabrication												
5	Refractory Lining												
6	Insulation												
7	Erection and Commissioning												
8	Testing												
9	2 days breakdown period												

Annexure -7: Details of Technology Service Providers

S. No.	Technology	Name of Service Provider	Address	Contact Person and No.
1	Technical Expert	Yajna Fuel Services	B – 15, Dattaviahar Co – OperativeHousing Society, Ground Floor, Shivaji Nagar, B – Cabin,Thane (W) – 400602	Mr. Mukund Gharpure - 09969410594, 022 - 25424983
2	Fabricator	Standard Engineering Works	474/475, Palasuni, Rasulgarh , Bhubaneshwar - 751010	Harhpal Rajput - 093382224660
3	Fabricator	Biraja Steel Industries	Plot. No. 172, Sector A Zone A, Mancheswar Industrial Estate	Gaurang Mahalik - 09938677782
4	Technical Expert and Fabricator	Shri Sadguru Dev Engg. Services	A/4, New Veena Vihar, Datta Mandir Road, Dhanukar Wadi, Kandivali, Mumbai - 67	Mr. Ravi Patel - 09969378982

Annexure -8: Quotations for Proposed Technology

Yajna
FUEL SERVICES
Work Centre.: B-15, Dattavihar co-op Hsg.So., Gr. Floor, Shivaji Nagar, B- Cabin,
Thane (W) 400602. Tel.: 022- 2538 4681, Tel/Fax.: 2542 4983
e-mail.: yajnafuel@vsnl.net web site.: www.yajnafuelindia.com

Date: - 22 Sep 2010

To,
M/s.See-Tech Solution Pvt Ltd.
11/5, MIDC, Info Tech Park,
Near VRCE Telephone Exchange,
South Ambazari Road,
Nagpur – 440 022

Kind Attention: - Mr. Milind Chittawar

Subject: Budgetary offer for Melting Furnaces for different capacities

Dear Sir,

We thank you for your enquiry. Based on the discussions & data furnished by you, we are pleased to submit offer for the mentioned subject, as follows: -

1) Annexure I: Scope of Supply.
2) Annexure II: Quotation, Payment Terms & Exclusions

We hope you will find the details & information submitted in order and in line with your requirement. However if you have any quarries (Technical/Commercial), kindly feel free to call on us.

We assure you of our best services & hope to hear a favorable reply soon.

Thanking you,
Yours Faithfully,

For YAJNA FUEL SERVICES.

(Dr. M.G. Gharpure)

ANNEXURE I

Scope of work:

1. Preparation of site plan for furnace installation, estimation of Storage space, Chimney connection, firing orientation, Ducting to Chimney
2. Fabrication of furnace, Refractory lining, Insulation lining, Grate bar support fixation etc
4. Commissioning.
5. Performance testing and Economic Evaluation.

ANNEXURE II – PROJECT ESTIMATION & PROFESSIONAL CHARGES.

Sr. No.	Description	Total cost (Rs.)
1	Melting furnace with crucible type Hard Coke fired of capacity of about 30 Kg • Melting Furnace Fabrication plus refractory works • Recuperator • FD fan • Piping + ducts + insulation with aluminum cladding	Rs. 80,000/-
2	Melting furnace with crucible type Hard Coke fired of capacity of about 40 Kg • Melting Furnace Fabrication plus refractory works • Recuperator • FD fan • Piping + ducts + insulation with aluminum cladding	Rs.1,00,000/-
3	Melting furnace with crucible type Hard Coke fired of capacity of about 60 Kg • Melting Furnace Fabrication plus refractory works • Recuperator • FD fan • Piping + ducts + insulation with aluminum cladding	Rs. 1,20,000/-
4	Melting furnace with crucible type Hard Coke fired of capacity of about 100 Kg • Melting Furnace Fabrication plus refractory works • Recuperator • FD fan • Piping + ducts + insulation with aluminum cladding	Rs. 1,40,000/-
5	Melting furnace with crucible type Hard Coke fired of capacity of about 250 Kg • Melting Furnace Fabrication plus refractory works • Recuperator • FD fan • Piping + ducts + insulation with aluminum cladding	Rs. 2,45,000/-
6	Professional Charges for technical Consultancy work	Rs.25,000/- against each furnace

Payment Terms

20 % advance along with work order
30 % after providing the layout for furnace installation and start for fabrication
30 % after completion of fabrication
20 % after erection and commissioning

Exclusion: (Buyer's Scope)

1. Any damage to living or nonliving object.
2. Welding facility at site
3. Water required for castable.
4. Transportation/Freight.
5. Any instrumentation and control other than supplied with the furnace.
6. Start up fuel expense.
7. Expenses required for aesthetic.
8. Civil work & Electrical connections to all motors.
9. Any other item not included in scope of work.
10. Unloading/shifting of equipment at site.
11. Responsibility of any theft of material at site.

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