

DETAILED PROJECT REPORT ON ENERGY EFFICIENT GAS FIRED REHEATING FURNACE (1200 kg/hr) (JAMNAGAR BRASS CLUSTER)



Bureau of Energy Efficiency

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ENERGY EFFICIENT GAS FIRED REHEATING FURNACE
(1200 kg/hr)

(JAMNAGAR BRASS CLUSTER)

BEE, 2010

***Detailed Project Report on Energy Efficient Gas Fired Reheating Furnace
(1200 kg/hr)***

Brass SME Cluster, Jamnagar, Gujarat (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **JAM/BRS/EGF/11**

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List of Abbreviations

MT	Metric Tonne
kWh	kilo Watt Hour
Gol	Government Of India
MoMSME	Ministry of Micro Small and Medium Enterprises
GHG	Green House Gas
BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
O&M	Operational & Maintenance
NPV	Net Present Values
ROI	Return on Investment
IRR	Internal Rate Of Return
DSCR	Debt Service Coverage Ratio
PBT	Profit Before Tax
PAT	Profit After Tax
ID	Induced Draft
FD	Forced Draft
DBT	Dry Bulb Temperature
SIDBI	Small Industries Development Bank of India

EXECUTIVE SUMMARY

Winrock International India is executing BEE-SME program in Jamnagar Brass Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Jamnagar is known as the brass city of India, it has been an important industrial centre since long for brass related parts. All the units in Jamnagar Brass cluster had been operating in traditional conditions and most of equipments/utilities using in cluster were procured from the local suppliers. They are making the equipments on their traditional expertise, which had remained unchanged over the years. Hence this cluster was chosen for energy efficiency improvements by implementing energy efficient technologies, so as to facilitate maximum replication in other brass clusters in India.

Major energy sources being used in manufacturing of Brass parts in Jamnagar Brass cluster are electricity and fuels such as Coal, Furnace Oil and Liquid petroleum gas. This depends on application of technology, process requirement, availability, and economic and safety point of view. The two forms of energy being used in manufacturing of Brass parts in typical Brass unit are electrical energy and thermal energy. Electrical energy is being used in melting of Brass in induction furnaces, operation of electrical utilities and thermal energy is being used in Brass melting operation.

Function of the reheating furnace in brass industries is reheating of raw material. During energy use and technology audit studies in various brass industry in Jamnagar brass cluster, it was observed that most of the brass units are using inefficient oil fired reheating furnace for reheating the brass billets and it is found that the efficiencies of existing reheating furnace is low.

Implementation of proposed energy efficient Gas fired reheating furnace equipped with waste heat recovery system having efficiency more than existing furnace would save energy and replace total 88872 litre of oil consumption per year.

This DPR highlights the details of the study conducted for assessing the potential for replacement of conventional oil fired reheating furnace by new energy efficient gas fired reheating furnace, possible energy 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, sensitivity analysis for three different scenarios 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:

Sr. No.	Particular	Unit	Value
1	Project cost	₹(in Lakh)	15.20
2	Furnace oil consumption in base case	litre/year	88872
3	Gas consumption in proposed case	Nm ³ /year	62400
4	Monetary benefit due to fuel change	₹(in Lakh)	9.74
5	Debit equity ratio	Ratio	3:1
6	Simple payback period	years	1.56
7	NPV	₹(in Lakh)	20.77
8	IRR	%	45.99
9	ROI	%	27.25
10	DSCR	Ratio	2.65
11	Process down time	Days	7
12	CO ₂ reduction	Tons/year	154

The projected profitability and cash flow statements indicate that the proposed project implementation i.e. energy efficient gas fired reheating furnace with existing oil fired reheating furnace 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. Jamnagar 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

Jamnagar, known as the brass city of India, has been an important industrial centre since long for brass related parts. Jamnagar is inhabited by a various types of brass related work units which include Brass foundry; Brass parts manufacturing, Electroplating and Extrusion units. There are about 3500 brass related units alone in Jamnagar. Majority of these Brass units in Jamnagar are in operation since last 20 years. All these units are located in pockets of Shankartekri, MP Shah Udyognagar, Patel colony and Dared areas.

Jamnagar Brass cluster like many other clusters was in dire-straits with regard to the energy efficiency and conservation. In almost all units, whether big or small, there had been no conscious effort to take up energy conservation and energy efficiency measures as a part of day to day operations. Many a times, the small scale entrepreneur was not even aware of measures that could bring down the percentage energy cost, which automatically brings down the manufacturing cost. Some of the bigger units had experimented with few parameters to improve energy efficiency in the units, but the results and outcome was confined to them only. All the units in Jamnagar Brass cluster had been operating in traditional conditions and most of equipments/utilities using in cluster were procured from the local suppliers. They are making the equipments on their traditional expertise, which had remained unchanged over the years.

Till now there has been very little focus on energy conservation activities in the units. Also, there have been no concrete external interventions as well to help the small units come out of their shell and rise up to the necessary energy efficiency benchmarks. The raw material requirement of the Jamnagar Brass cluster is met mainly from the following three sources:

- ❖ Old brass, copper and bronze utensils
- ❖ Imported brass scrap and honey
- ❖ Brass scrap from ship breaking yard

Apart from the Brass scrap; copper, zinc, led, other metal alloys and clay etc are also used as raw material depends on the final product requirement

Majority of the raw material requirement in Jamnagar Brass cluster is met through imports. The countries from which it is imported are USA, Singapore, Gulf and European countries. The imported raw material is available mainly in three forms i.e. Honey scrap, Dross of brass & Pale in the form of strips.

1.1.1 Existing production process

The production process mentioned in the below chart is almost similar to most of brass part manufacturing units in the Jamnagar brass cluster. However, depending on the final product, quality of final product manufacturing unit and raw material properties, stated process flow is altered to suit the requirement of industry.

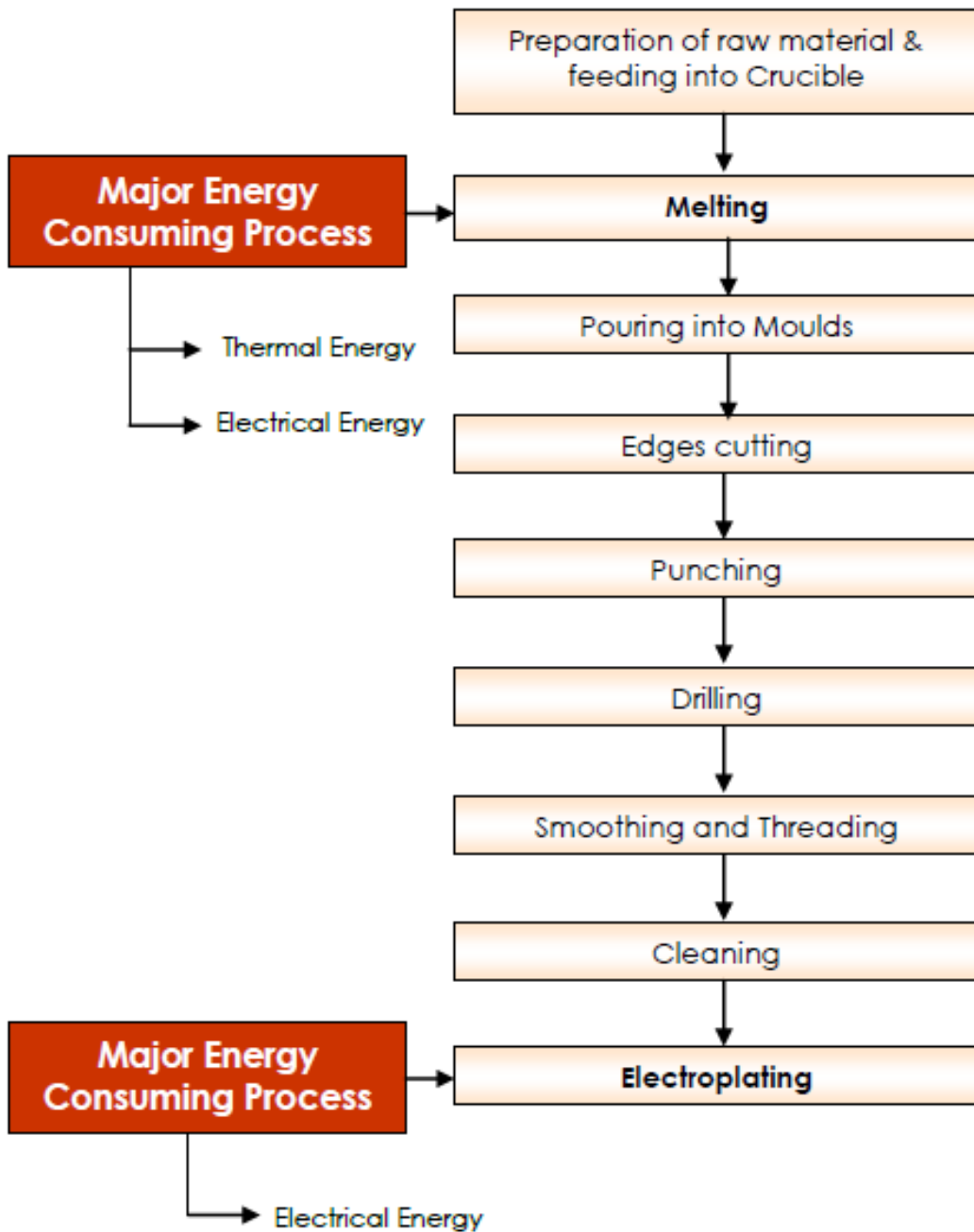


Figure 1.1: Process flow chart

1.2 Energy Performance in Jamnagar Brass Cluster

Major energy sources being used in manufacturing of Brass parts in Jamnagar Brass cluster are electricity and fuels such as Coal, Furnace Oil and Liquid petroleum gas. This depends on application of technology, process requirement, availability, and economic and safety point of view. The two forms of energy being used in manufacturing of Brass parts in typical Brass unit are electrical energy and thermal energy. Electrical energy is being used in melting of Brass in induction furnaces, operation of electrical utilities and thermal energy is being used in Brass melting operation.

Energy consumption (thermal energy & electrical energy) in Brass unit depends on type of unit and final product manufacturing in unit. Annual electrical energy and thermal energy consumption in typical Brass foundry, Extrusion unit, Machining and Electroplating unit is presented in below bar chart

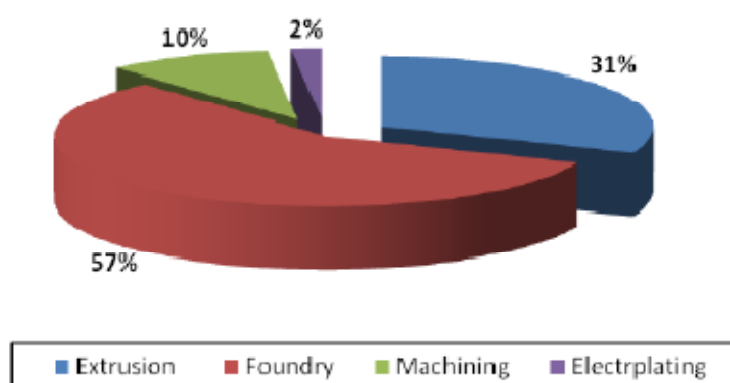


Figure 1.2: Percentage of energy consumption in different type of unit

1.2.1 Specific energy consumption

Specific electrical and thermal energy consumption in brass unit is varying on the final product manufactured in that unit. Specific energy consumption specific energy cost in different brass unit is shown in Table 1.1 & Table 1.2 below:

Table 1.1 Specific energy consumption in various brass units

S.No.	Type of units	Unit	Value
1	Brass foundry unit	kCal/kg of brass rod	1013-1057
2	Brass extrusion unit	kCal/kg of brass rod	1037-1186
3	Brass machining unit	kCal/kg of final product	473.04
4	Brass electroplating	kCal/kg of final product	875.21

Table 1.2 Specific energy cost in various brass units

S.No.	Type of units	Unit	Value
1	Brass foundry unit	₹/kg of brass rod	3.17-3.02
2	Brass extrusion unit	₹/kg of brass rod	5.64-5.194
3	Brass machining unit	₹/kg of final product	3.24
4	Brass electroplating unit	₹/kg of final product	5.99

1.3 Identification of existing technology/ equipment

1.3.1 Description of equipment

During energy use and technology audit studies in various brass industry in Jamnagar brass cluster, it was observed that most of the brass units are using inefficient reheating furnace for reheating the brass billets and it is found that the efficiencies of existing reheating furnace is low. Performances of various reheating furnaces in Jamnagar Brass units are evaluated and analyze the quantum of various losses in Reheating furnace were analyzed.



Figure1.3 Conventional oil fired furnace operations

From energy use and technology gap audit studies in various brass industries in Jamnagar brass cluster, below mentioned things are identified:

- Energy efficiency improvement opportunities
- Environment and safety improvement of workers

- Design flaws in the conventional oil fired reheating furnace
- Operational & maintenance practices in conventional reheating furnace

1.3.2 Technical gap in conventional oil fired reheating furnace

Technology gaps/design flaws in conventional oil fired reheating furnace system are identified and described below in detail

➤ **Air-Fuel Ratios:**

From energy use and technology studies it was observed that, air fuel ratio is not proper maintained. This reduces the furnace efficiency by 3-5%.

➤ **Location of Chimney:**

In majority of industries, chimney is located at centre of reheating furnaces; this causes the poor heat transfer between flue gasses and charge; this automatically leads to poor heat transfer efficiency between flue gas and reheating material.

➤ **Waste Heat Recovery System:**

This is the one of the area where major amount of heat energy is lost; in majority of the units is not installed waste heat recovery system to recover the heat from flue gasses. In a few cases it was observed that efficiency of existing waste heat recovery system is poor. Around 35% of heat input energy to reheating furnace is lost in the flue gasses.

➤ **Preheating of Charge and Combustion Air:**

In majority of the systems it was observed that, there is no system to preheat the charge and air.

➤ **Insulating Material:**

Furnace lining of the existing furnace was done with the locally available firebricks. The firebricks with low alumina content tend to get worn out in a short duration. Also, the insulation required for plugging heat loss through the furnace was usually done with locally available red bricks, which do not serve the purpose of insulation.

➤ **Burner:**

Majority of units are using locally fabricated burners for the combustion of fuel oil. These burners were either a far copy of a properly designed burner or sometimes substandard and locally designed. Many a times, oil could be seen leaking from the burner joints. Same types of burners were used for a large range of fuel flow rates.

➤ **Selection and Size of Blower System:**

A proper capacity blower is necessary for combustion air to be delivered at correct pressure and in appropriate volume. The existing blowers in the majority of the units are either locally fabricated without any proper design parameters or are under/over- sized without any consideration for correct air pressure.

➤ **Inadequate Sizing of Heating and Pumping Unit:**

In majority of the units it was observed that heating and pumping system are not designed properly. This is mainly due to lack of awareness about the standard oil temperature and pressure at the combustion stage and the benefits thereof.

1.3.3 Specification of existing furnace

Detailed specification of existing oil fired reheating furnace is furnished in Table 1.3 below:

Table 1.3 Specification of existing furnace

S. No	Details	Units	Value
1	Capacity	TPH	1.2
2	Fuel used	----	Furnace oil
3	Operational hours	Hrs/year	2000
4	Furnace depth	Inches	240
5	Furnace width	Inches	24
6	Furnace height	Inches	36

1.3.4 Role in the process

Function of the reheating furnace in brass industries is to reheat the raw material. Reheating is one of the major energy and time consuming process in the overall manufacturing process in brass industry. Apart from the energy and time, final product quality will also depend on time and temperature of reheating of raw material.

1.3.5 Need for up gradation of existing equipment

From the above sections it is clear that reheating cost is one of the major costs in the overall brass manufacturing process, in typical brass manufacturing industry, which comes out to be ₹ 1.036 per kg. This is approximately 20% of overall energy cost i.e. ₹ 5.2 - 5.6 per kg.

The efficiency of the existing installed conventional reheating furnace is 18.73 % only. Existing reheating furnaces being used in majority of the industries are of very primitive design; have poor preheating of charge, they do not have waste heat recovery system and poor heat transfer efficiency between hot flue gasses & billets. All these things will lead to increase in energy consumption in reheating furnace.

Advantages of replacing the conventional furnace with Energy Efficient furnace are:

- Improved product quality
- Saving in reheating time - it automatically leads to energy savings
- Improved working environment
- Productivity improvements

1.4 Baseline energy consumption of existing equipment

Energy consumption in oil fired reheating furnace would depend on below mentioned things:

- Design of furnace
- Burner design and position
- Poor heat transfer efficiency

Energy use and technology audit studies were conducted in various units of Jamnagar brass cluster to establish the baseline energy consumption of oil fired reheating furnace and the reports of same are attached in Annexure – 1.

1.4.1 Design and operating parameters

Major operating parameters to improve performance of furnace are:

- Preheating of charge and combustion air
- Insulating material.
- Selection and size of blower system.
- Inadequate sizing of heating and pumping unit.
- Burner design

1.4.2 Specific fuel consumption

Fuel consumption of typical oil fired reheating furnace of adequate capacity is around 37.03 litre/tonne of production. Performance of existing oil fired reheating furnace was evaluated and same is presented in Annexure 1.

1.4.3 Energy audit methodology

Predefined methodology was adopted to evaluate the performance of oil fired reheating furnace, same was furnished below:

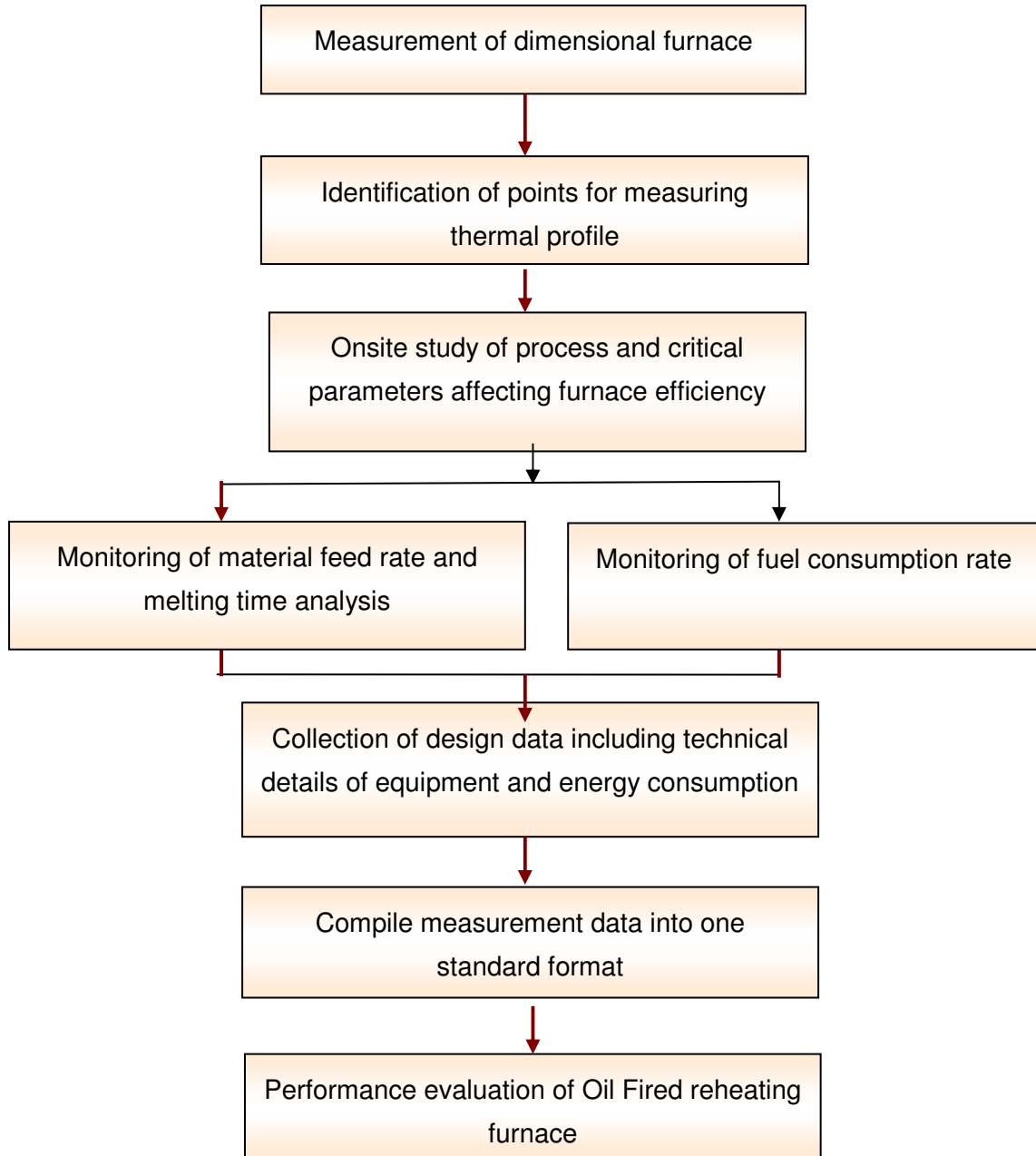


Figure1.4: Energy audit methodology

1.5 Barriers in adoption of proposed technology/equipment

The processes to do with technology and innovations in SMEs are different from those that take place the large firm context. Technology in the SME sector has an increasingly complex or combinative character, most of the SMEs units in cluster are regarded for their labour intensive and the capability work with local resources. In the past, SME entrepreneurs are

stressed less emphasis on technology due to cut the initial cost of plant /machinery. Major barriers in the up gradation of technology in the cluster are non availability of technology; distrust on technology supplier, lack of information about energy efficiency among small and medium enterprises still persists, preventing increased adoption of efficient technologies and non availability of skilled manpower and cost of new technologies. Details of the other barriers in the implementation of energy efficient technologies/equipments in the Jamnagar Brass cluster are presented in below sections.

1.5.1 Technological Barrier

As majority of the entrepreneurs in cluster are not aware of the energy losses in the plant, there may be a strong feeling that the energy efficiency initiatives in manufacturing facility can have a cascading effect of failure in critical production areas directly or indirectly connected if the intended performance of the replaced / retrofitted equipment falls below design values.

There is a strong feeling in the Brass unit entrepreneurs that, energy efficiency initiatives are difficult and they do not wish to take the risks such as business interruption due to production loss vis-a-vis the drive to save energy. These can however be overcome by motivating them to attend the awareness programs and use the detailed report on the benefits of the measures identified and cost benefit analysis. Further, sourcing of expertise on maintenance service provider or training by the equipment supplier will definitely overcome the barriers.

1.5.2 Financial Barrier

Significant amount of investment is not commonly seen in most of Jamnagar Brass industries. Further, from the business perspective for any industry owner, it is more viable, assured and convenient to invest on project expansion for improving the production capacity, rather than make piecemeal investment in retrofit and replace options for energy savings. Investment returns on large capacity addition or technology adoption shows up prominently in terms of savings and helps in benchmarking operations. Further, there is a strong feeling among the industry owners that, energy conservation initiatives of replacement and retrofit nature is not a common practice as it involves large capital investment against low returns. In view of this, and given the limited financial strength of entrepreneurs from Brass units in Jamnagar, they would not take the risks to invest in energy efficiency measures.

1.5.3 Skilled manpower

Skilled workers are locally available to run the machines available in Jamnagar. However, there is hardly any engineer employed in these enterprises and the production process remains traditional. This is one of the lacunae of the Jamnagar Brass Parts cluster.

Specialized training with local service providers for better operation and maintenance of equipments, importance of the energy and its use will create awareness among workforce. These programs should be organized with equipment suppliers.

2 EQUIPMENT OPTION FOR ENERGY EFFICIENCY IMPROVEMENT

2.1 Description of proposed equipment

Proposed energy efficient gas fired reheating furnace equipped with waste heat recovery system. Use of scientifically designed burners equipped with air fuel ratio controller to improve reheating furnace efficiency. Insulated and designed efficiently to minimize losses. Due to all above mentioned modifications, saving in reheating time can be achieved with improved product quality and improved efficiency of the system.



Figure2.1: Energy efficient gas fired reheating furnace

2.1.1 Comparison of conventional with new reheating furnace

Technical, economic, Environmental, safety aspects of conventional reheating furnace and energy efficient gas fired furnace are compared on life cycle of equipment, same is presented in Table 2.1 below:

Table 2.1 Comparison of conventional equipment and proposed equipment

S. No	Parameters	Conventional oil fired reheating furnace	Energy efficient gas fired reheating furnace
1	Fuel consumption	High	low
2	Environment pollution	High	Low
3	Safety of workers	Poor	Good
4	Maintenance	High	Low
5	Operational cost	High	Low
6	Availability of local service providers	Yes	Yes
7	Waste heat recovery system	Not installed	Installed
8	Insulation	Poor	Good
9	Temperature gauges	Not installed	Installed

From the above table it is clear that Energy efficient gas fired reheating furnace has significant advantages in Energy, Environmental, Economic & safety aspects. It is technically justifiable to install energy efficient gas fired reheating furnace in place of conventional oil fired reheating furnace.

2.1.2 Suitability over existing system

The proposed equipment is completely replaced the existing system and suitable with the existing process.

2.1.4 Technical specifications

Specification for energy efficient gas fired reheating furnace varies from industry to industry and can be provided to vendor as per the need. A general specification of new furnace is furnished in Table 2.2 below:

Table 2.2 Technical specifications

S. No	Details	Units	Value
1	Name of Equipment	NA	Energy Efficient Gas Fired Reheating furnace
2	Model	NA	---
3	Capacity	kg/hr	1200
4	Blower motor	HP	2
5	Width of furnace	Inch	24
6	Height of furnace	Inch	36
7	Depth of Furnace	Inch	240

2.1.5 Superiority over existing system

Energy efficient gas fired reheating furnaces are available with waste heat recovery and equipped with designed burners with air fuel ratio control to improve reheating furnace efficiency.

2.1.6 Availability of proposed equipment

The technology identified for implementation is available locally and are indigenously produced. The technology/ equipments will be procured from local equipment suppliers. The proposed equipment is locally manufactured by well known vendor in Jamnagar brass cluster for making energy efficiency equipments in cluster.

The equipment identified is available in the State of Gujarat (Jamnagar) and implemented successfully in few units in the cluster. The investment required for implementation of the identified measures has good financial returns and the proposed measure is technically and financially viable.

2.1.7 Equipment providers

Technology/service provider selected for implementation of the proposed energy efficiency project has long years of experience in implementation of energy efficiency projects. This technology/service provider is having in house R&D team to develop the new technologies / equipments, which are energy efficient & eco friendly. Recommended supplier having the trust in cluster on products developed by them. Details of equipment suppliers are furnished in Annexure 7.

2.1.8 Terms and conditions in sales of Energy efficient reheating furnace

The technology/ service provider are providing performance guarantee for the products supplied and warranty for a period of one year for any manufacturing defects. The terms of sales from the proposed supplier is presented in the table below:

Terms and conditions for sale of Gas fired energy efficient gas fired reheating furnace is furnished in table below:

Table 2.3 Term and condition for supply of equipment

Delivery	Delivery of the billet reheating furnace will take 6 to 8 weeks from the date of purchase order along with necessary advances.
Payment	40% advance along with purchase order and balance towards our performa invoice before delivery of the goods.
Cancellation	You shall not cancel the order once placed in any matter. In case of cancellation of the order placed, the advance amount will not be returned in any condition.
Taxes	Will be charged extra as applicable at the time of dispatches.
C. Excise	Will be charged extra as applicable at the time of dispatches.

2.2 Process down time during implementation

The process down time for implementing the replacement of conventional furnace with energy efficient furnace will take one week. The implementation can be taken up during weekly holiday, or other holidays, so that the process down time can be reduced.

2.3 Suitable unit for proposed equipment

The studies on energy use and technology audit revealed that the proposed energy efficient reheating furnace is suitable for the unit having production capacity is 1200 kg/hr.

3 ECONOMIC BENEFITS OF NEW EQUIPMENT

Energy use and technology audit studies were conducted in various units of the Jamnagar brass cluster to evaluate the performance of existing furnace, technical gaps in existing furnace and analyzed energy, economic, environmental and social advantages of energy efficient reheating furnace over conventional reheating furnace.

3.1 Energy & monetary benefits

3.1.1 Fuel Saving

Energy use and technology audit studies revealed that reheat operation in reheating furnaces depends on the design of the reheating furnace, type and position of burners. Analysis was carried out on conventional reheating furnace and specific fuel consumption was found out to be 37.03 litre/tonne, whereas, specific gas consumption with proposed energy efficient gas fired reheating furnace is 26 Nm³/tonne. Total annual production capacity is 2400 tons hence, total oil consumption would be 88872 litre per year which will be replaced by gas and total gas consumption would be 62400 Nm³ per year.

3.1.2 Electricity saving

Project implementation will not save electricity while its implementation will increase electricity consumption of about 3000 kWh per year.

3.1.2 Monetary benefit

Annual monetary savings due to implementation of energy efficient reheating furnace is about ₹ 9.74 lakh per annum. Details of monetary saving and fuel saving calculation are furnished at Annexure 3.

3.2 Environmental benefits

3.2.1 Reduction in fuel consumption

Most of units in the cluster are using oil for oil fired reheating furnace; by implementing the proposed energy efficient gas fired reheating furnace in place of conventional furnace will eliminate oil consumption.

3.2.2 GHG emission reductions

Specific energy consumption of proposed energy efficient gas fired reheating furnace is less than conventional furnace; it automatically leads to reduction of GHGs emissions by implementing proposed energy efficiency reheating furnace in place of conventional furnace. Reduction of GHGs emissions leads to improved environment and better compliance with environmental regulations.

3.2.2 CDMability of the project

The proposed project saves about 88,872 litres of oil per year for one furnace. This roughly corresponds to 281 tonnes of CO₂ emission reduction and the use of natural gas will generate 127 tonnes of CO₂ (62400 Nm³ of gas consumption per year). The net CO₂ emission reduction will be around 154 tonnes or 154 CERs. Considering, at the cluster level 200 units apply this technology then the total savings would be about 30,800 CERs per annum which can be a suitably sized small scale CDM project.

3.3 Social benefits

3.3.1 Impact on working environment

Replacement of conventional furnaces with energy efficient gas fired furnaces will reduce furnace skin temperature, closed combustion chamber & temperature control of gas fired reheating furnaces, all those things will improve the working condition & safety of workers near to furnace.

3.3.2 Impact on manpower skills

Proposed energy efficient gas fired reheating furnace components were procured from other companies and also generate employment during installation and commissioning. As training will be provided by equipment suppliers will improve the technical skills of manpower required for operation of the equipment.

3.3.3 Impact on wages/emoluments

The awareness among the technologies and training retained during implementation of the project will lead to increase the wages of the employees indirectly, as it improves the technical skills of the workforce during operation and maintenance of equipments. Further, the remuneration will improve in the market or in other companies for the work force.

3.4 Other benefits (If any)

3.4.1 Productivity improvements

Due to improved design of gas fired reheating furnace will improve melting temperature; this automatically reduces melting time of brass. It was observed that reheating is one of major time consuming area, reduction in cycle time and specific fuel consumption in brass manufacturing unit will improve productivity of the units in Jamnagar brass cluster.

3.4.2 Quality improvements

Most of the brass manufactured in Jamnagar brass industries is temperature sensitive. As already discussed in above chapters that inbuilt design of automatic temperature control

system in energy efficient gas fired reheating furnace will control temperature of material inside the furnace, this automatically improves quality of material.

3.4.3 Easy operation& maintenance

Operation and maintenance of new energy efficient gas fired reheating furnace is easy and economical.

4 ECONOMICS & IMPLEMENTATION OF NEW SYSTEM

4.1 Cost of project implementation

4.1.1 Equipment cost

Technical and financial quotations of proposed energy efficient gas fired reheating furnace are collected from reputed vendors. Cost of furnace having production capacity of 1200 kg/hr is ₹ 13.50 lakh as per the quotation provided at Annexure 8.

4.1.2 Other cost

Erection & commissioning cost is ₹ 1.35 lakh only. Details of project cost are furnished in Table 4.1 below:

Table 4.1 Details of proposed equipment installation cost

Sr. No.	Particular	Unit	Value
1	Equipment cost	₹ (in Lakh)	13.50
2	Erection & Commissioning cost	₹ (in Lakh)	1.70
3	Other misc. cost	₹ (in Lakh)	0.00
4	Total cost	₹ (in Lakh)	15.20

4.2 Arrangement of funds

Proposed financing for the replacement of conventional furnace with energy efficient furnace is made considering a debt equity ratio of 3:1, which is normally allowed by financial institutions for financing energy efficiency projects. On the basis of debt equity ratio of 3:1 the promoter's contribution works out to 25% of the project cost and the balance would be term loan from the Bank / FIs.

4.2.1 Entrepreneurs contribution

Total cost (Equipment and erection & commissioning) of project works out to be ₹ 15.20 lakh. Out of which entrepreneur's contribution is 25%, which work out to be ₹ 3.80 lakh.

4.2.2 Loan amount

75% of the project cost would be available as term loan from the banks/financial institutions, which works out to be ₹ 11.40 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 8 years, being period, with in which the entire term loan would be repaid. The financials have been worked out on the basis of certain realistic assumptions, which are outlined below

- The project is expected to achieve monetary savings of ₹ 9.74 lakh per annum.
- The operational and Maintenance cost is estimated at 4% of cost of fixed assets with 5% increase every year to take care of escalations.
- The erection and commissioning charges is estimated at 10% of the total project cost for the plant and machinery
- Interest on term loan is estimated at 10%. The tenure of the loan is considered 5 years and repayment starts after 6 months from the first date of disbursement of loan in 60 monthly installments.
- Depreciation is provided as per the rates provided in the companies Act.
- Income tax provision is made as per IT Act 1961.
- Based on the above assumptions, profitability and cash flow statements have been prepared.

4.3.2 Simple payback period

Simple payback period of replacing conventional furnace with energy efficient furnace is 1.56 year.

4.3.3 Net Present Value (NPV)

The Net present value of the investment on project is at @10.00% interest works out to ₹ 20.77 lakh.

4.3.4 Internal rate of return (IRR)

After tax Internal Rate of Return of the project is works out to be 45.99%. 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 27.25%.

Details of all the financial parameters for the replacement of conventional furnace with energy efficient furnace are presented in Table 4.2 below:

Table 4.2 Financial parameters of energy efficient furnace

S. No	Parameter	Unit	Value
1	Simple payback period	Years	1.56
2	NPV	₹ in lakh	20.77
3	IRR	%age	45.99
4	ROI	%age	27.25
5	DSCR	Ratio	2.65

4.4 Sensitivity analysis

In different situation fuel saving may increase or decrease on the basis of this scenarios a sensitivity analysis in realistic, pessimistic and optimistic scenario has been carried out which is as under

- Fuel saving increased by 5%
- Fuel saving decreased by 5%

Table 4.3 Sensitivity analysis

Particulars	IRR	NPV	ROI	DSCR
Normal	45.99%	20.77	27.25%	2.65
5% increase in fuel savings	49.03%	22.66	27.41%	2.79
5% decrease in fuel savings	42.93 %	18.88	27.07%	2.51

Assuming all provision and resource input would remain same during sensitivity analysis

4.5 Procurement and implementation schedule

Total time required for implementation of proposed project is about 13 weeks from the date of financial closure. Detailed procurement and implementation schedules are furnished at Annexure 6.

ANNEXURE**Annexure-1 Energy audit reports of conventional reheating furnace****Energy audit report of reheating furnace report at Unit-1:**

Reheating Furnace is the one of the major energy consuming equipments in production process of Brass in Unit-1. Detailed Performance assessment of the reheating furnace at Unit-1 is presented in the tables below.

Efficiency of reheating furnace was evaluated by two methods:

- Direct method
- Indirect method

Both these methods require measuring of a number of operational parameters of the reheating furnace. The indirect method has an advantage over the simpler direct method that various heat losses from reheating furnace can be quantified and accounted. However, efficiency is calculated using both the methods and the results are presented along with the measured data in the following Tables below.

Data collected at unit 1 during reheating furnace operation.

S. No.	Parameter	Unit	Value
1	Total material fed	kg	661
2	Total fuel fed	Ltrs	25
3	Flue gas temperature	Deg C	423
4	O ₂ / excess air	% age	14.18

Direct Method

The above data have been used to calculate the efficiency of reheating furnace in table below. The following table presents the efficiency calculation by direct method.

Efficiency calculations using direct method

Parameters	Units	Value
Mass of material during study	Kg	661
Temperature of inlet billet	Deg C	80
Temperature of outlet billet	Deg C	821
Temperature difference	Deg C	741
Specific heat of material	kCal/kg-deg C	0.09
Heat contained in material	kCal	44082.09
Total fuel supplied	Litres	25

Parameters	Units	Value
Specific gravity of fuel	---	0.88
Calorific value of fuel	kCal/kg	9800
Total heat input to furnace	kCal	215600
Furnace efficiency	% age	20.44

The above table shows the reheating furnace efficiency, as obtained by direct method is 20.44%.

Indirect Method

Major heat losses encountered in the operation of reheating furnace are computed and provided in table below. The reheating furnace thermal efficiency is evaluated by indirect method, where in the efficiency is arrived at by subtracting the total heat losses from 100%.

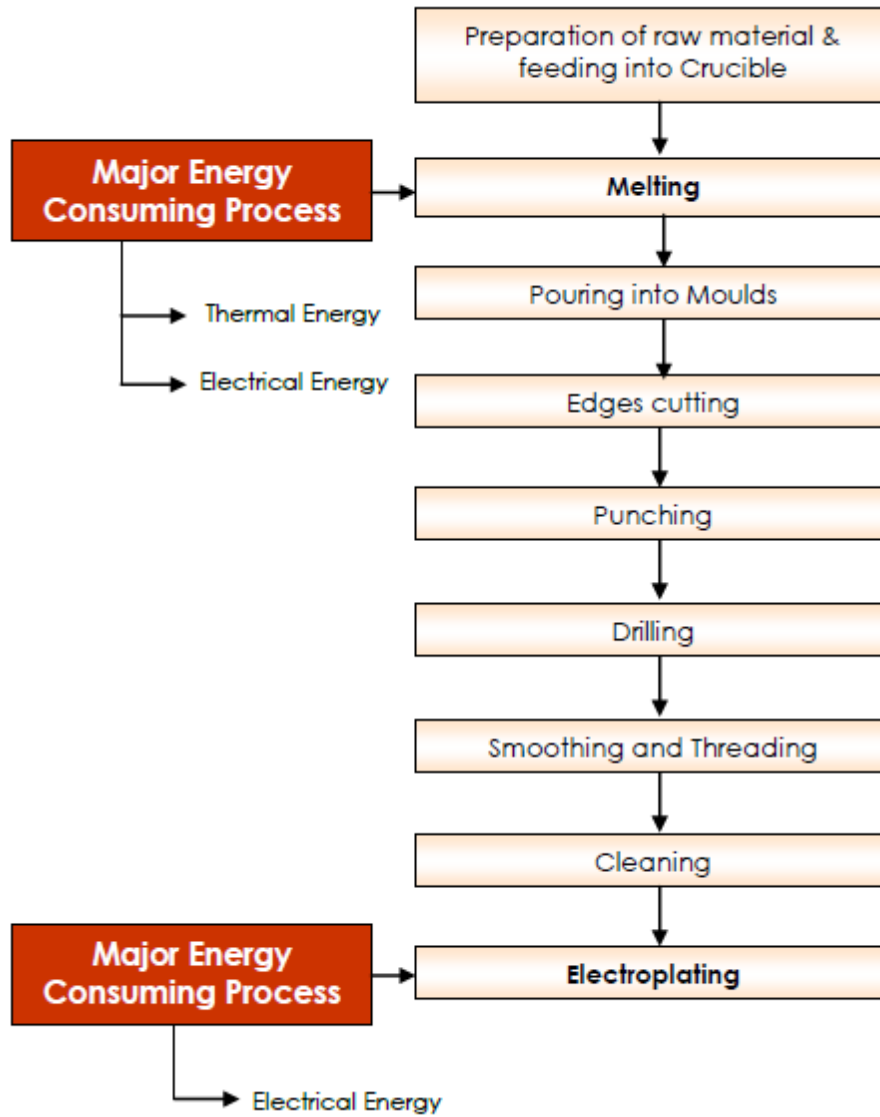
Energy efficiency using indirect method

S. No	Parameters	Units	Value
1	Measured O ₂ in flue gas	% age	14.18
2	Measured CO in flue gas	ppm	158
3	Excess air used for combustion	% age	207.92
4	Total air used for combustion	kgs of air	41.38
5	Heat loss due to dry flue gas	% age	43.90
6	Heat losses due to moisture in air	% age	0.23
7	Heat loss due to hydrogen in fuel	% age	29.38
8	Heat loss due to moisture in air	% age	0.15
9	Heat loss due to CO formation	% age	0.09
10	Heat loss due to radiation	%	7.88
11	Total losses	%	81.63
12	Reheating furnace efficiency- Indirect method	%	18.73

The above table shows the reheating furnace efficiency, as obtained by indirect method is 18.73%.

Annexure 2 Process flow diagram

Process flow diagram of typical brass unit is same even after implementation of proposed furnace



Annexure-3 Detail technical assessment report

Brass manufacturing units in unorganized sector has these characteristics; low engineering, limited technology innovation, poor R&D base, low level of human resource on knowledge of technology and operational skill etc. This sector also faces deficiencies such as the lack of access to technology, technology sharing, lack of strong organizational structure, professional attitude etc.

Majority of Brass units in Jamnagar Brass cluster are using low end technologies in their processes and utilities. The performance of those processes/equipments is poor as compared to the technologies available in the market. There are various technological gaps which were identified in units as under:

- Lack awareness on the technologies available
- Lack of awareness on quantum of energy loss and its monetary benefit
- Lack of awareness among the workforce etc.

There is a tremendous need for this industry to modernize/upgrade its technology and adopt energy efficient technologies in some of the areas. Further, as per the discussions made with the some of the progressive managements, they are interested in improve the efficiency their units by replacing the conventional technology with energy efficient technologies in market.

The various factors which influence the management towards implementation energy efficiency and energy conservation projects in brass unit in Jamnagar Brass Cluster are:

- Energy efficiency and energy conservation is a low cost investment option which reduces energy consumption
- Low capital investment
- The energy efficiency improvement will enhance the plant management to be competitive in local and global markets by reducing production cost
- To conserve depleting fossil fuels
- The energy efficiency and conservation reduces GHG emissions because of low carbon dioxide and particulate emissions
- Energy efficiency and conservation is a viable strategy to meet future energy needs of the expanding plans in the industry

- The energy efficiency and conservation places no financial and administrative burden as no separate manpower is required and only training of operation and maintenance of the technologies adopted is envisaged

S. No.	Parameter	Units	Value
1	Efficiency of existing reheating furnace	% age	18.73
2	Specific fuel consumption of conventional reheating furnace	liters/tonne	37.03
3	Efficiency of energy efficient reheating furnace	% age	29.00
4	Specific fuel (Gas) consumption of energy efficient gas fired reheating furnace	Nm ³ /tonne	26
5	Specific fuel cost (Oil) in existing furnace @ ₹ 28 /liter	₹/tons	1036.84
6	Specific fuel cost (gas) in proposed furnace @ ₹ 24 /Nm ³	₹/ tons	624
7	Savings in specific fuel cost	₹/ tons	412
8	Annual production capacity	tonne	2400
9	Total oil consumption in base case	Liter/year	88872
10	Total gas consumption in proposed case	Nm ³ /year	62400
11	Total connected load	HP/kW	2/1.492
12	Annual electricity consumption cost @ ₹ 5/kWh	₹in lakh	0.15
13	Total annual monetary saving due to fuel change	₹ in lakh	9.74
14	Implementation cost	₹ in lakh	15.20
15	Simple payback period	years	1.56

Annexure-5 Detailed cash flow evaluations

Name of the Technology	Gas fired Reheating Furnace		
Rated Capacity	1200 kg		
Details	Unit	Value	Basis
Installed Capacity	Kg/hr	1200	
Total annual operating hours	hrs	2000	
Total production	Tons	2400	
Proposed Investment			
Cost of plant & Machinery	₹(in lakh)	13.85	Feasibility Study
Erection & Commissioning (10% of plant machinery)	₹(in lakh)	1.35	Feasibility Study
Total Investment	₹(in lakh)	15.20	Feasibility Study
Financing pattern			
Own Funds (Internal Accruals)	₹(in lakh)	3.80	Feasibility Study
Loan Funds (Term Loan)	₹(in lakh)	11.40	Feasibility Study
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10.00	SIDBI Lending rate
Estimation of Costs			
O& M Costs	%(on Plant & Equip)	4.00	Feasibility Study
Annual Escalation	%	5.00	Feasibility Study
Estimation of Revenue			
Fuel savings	₹/Tonne	412	-
Annual production	Tonne/Annum	2400	-
Electricity consumption	kWh/Year	3000	-
Cost	₹/kWh	5	-
St. line Depreciation	%	5.28	Indian Companies Act
IT Depreciation	%	80.00	Income Tax Rules
Income Tax	%	33.99	Income Tax Act 2008-09

Estimation of Interest on term loan

₹(in lakh)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	11.40	0.90	10.50	1.32
2	10.50	1.80	8.70	0.97
3	8.70	2.16	6.54	0.77
4	6.54	2.40	4.14	0.54
5	4.14	2.64	1.50	0.30
6	1.50	1.50	0.00	0.04
		11.40		

WDV Depreciation

₹(in lakh)

Particulars / years	1	2
Plant and Machinery		
Cost	15.20	3.04
Depreciation	12.16	2.43
WDV	3.04	0.61

Projected Profitability

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	Total
Revenue through Savings									
Fuel savings	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	77.90
Total Revenue (A)	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	77.90
Expenses									
O & M Expenses	0.61	0.64	0.67	0.70	0.74	0.78	0.81	0.86	5.81
Total Expenses (B)	0.61	0.64	0.67	0.70	0.74	0.78	0.81	0.86	5.81
PBDIT (A)-(B)	9.13	9.10	9.07	9.03	9.00	8.96	8.92	8.88	72.10
Interest	1.32	0.97	0.77	0.54	0.30	0.04	-	-	3.94
PBDT	7.81	8.13	8.30	8.49	8.70	8.92	8.92	8.88	68.16
Depreciation	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	6.42
PBT	7.01	7.33	7.49	7.69	7.90	8.11	8.12	8.08	61.74
Income tax	-	1.94	2.82	2.89	2.96	3.03	3.03	3.02	19.68
Profit after tax (PAT)	7.01	5.39	4.67	4.80	4.94	5.08	5.09	5.06	42.05

Computation of Tax

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	7.01	7.33	7.49	7.69	7.90	8.11	8.12	8.08
Add: Book depreciation	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Less: WDV depreciation	12.16	2.43	-	-	-	-	-	-
Taxable profit	(4.35)	5.70	8.30	8.49	8.70	8.92	8.92	8.88
Income Tax	-	1.94	2.82	2.89	2.96	3.03	3.03	3.02

Projected Balance Sheet

Particulars / Years	1	2	3	4	5	6	7	8	
Liabilities									
Share Capital (D)	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	
Reserves & Surplus (E)	7.01	12.40	17.08	21.88	26.82	31.90	36.99	42.05	
Term Loans (F)	10.50	8.70	6.54	4.14	1.50	0.00	0.00	0.00	
TOTAL LIABILITIES (D)+(E)+(F)	21.31	24.90	27.42	29.82	32.12	35.70	40.79	45.85	
Assets									
Gross Fixed Assets	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	
Less Accm. depreciation	0.80	1.61	2.41	3.21	4.01	4.82	5.62	6.42	
Net Fixed Assets	14.40	13.59	12.79	11.99	11.19	10.38	9.58	8.78	
Cash & Bank Balance	6.91	11.31	14.63	17.83	20.93	25.32	31.21	37.07	
TOTAL ASSETS	21.31	24.90	27.42	29.82	32.12	35.70	40.79	45.85	
Net Worth	10.81	16.20	20.88	25.68	30.62	35.70	40.79	45.85	
Debt Equity Ratio	2.76	2.29	1.72	1.09	0.39	0.00	0.00	0.00	

Projected Cash Flow:

₹ (in lakh)

Particulars / Years	0	1	2	3	4	5	6	7	8
Sources									
Share Capital	3.80	-	-	-	-	-	-	-	-
Term Loan	11.40								
Profit After tax		7.01	5.39	4.67	4.80	4.94	5.08	5.09	5.06
Depreciation		0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Total Sources	15.20	7.81	6.19	5.48	5.60	5.74	5.89	5.89	5.86
Application									
Capital Expenditure	15.20								
Repayment Of Loan	-	0.90	1.80	2.16	2.40	2.64	1.50	-	-
Total Application	15.20	0.90	1.80	2.16	2.40	2.64	1.50	-	-
Net Surplus	-	6.91	4.39	3.32	3.20	3.10	4.39	5.89	5.86
Add: Opening Balance	-	-	6.91	11.31	14.63	17.83	20.93	25.32	31.21
Closing Balance	-	6.91	11.31	14.63	17.83	20.93	25.32	31.21	37.07

IRR

₹ (in lakh)

Particulars / months	0	1	2	3	4	5	6	7	8
Profit after Tax		7.01	5.39	4.67	4.80	4.94	5.08	5.09	5.06
Depreciation		0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Interest on Term Loan		1.32	0.97	0.77	0.54	0.30	0.04	-	-
Cash outflow	(15.20)	-	-	-	-	-	-	-	-
Net Cash flow	(15.20)	9.13	7.16	6.25	6.15	6.04	5.93	5.89	5.86
IRR	45.99%								

NPV

20.77

Break Even Point

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.46	0.48	0.50	0.53	0.55	0.58	0.61	0.64
Sub Total (G)	0.46	0.48	0.50	0.53	0.55	0.58	0.61	0.64
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.15	0.16	0.17	0.18	0.18	0.19	0.20	0.21
Interest on Term Loan	1.32	0.97	0.77	0.54	0.30	0.04	0.00	0.00
Depreciation (H)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Sub Total (I)	2.27	1.93	1.74	1.52	1.28	1.04	1.01	1.02
Sales (J)	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
Contribution (K)	9.28	9.26	9.24	9.21	9.18	9.16	9.13	9.10
Break Even Point (L= G/I)	24.45%	20.85%	18.86%	16.54%	13.99%	11.37%	11.03%	11.17%
Cash Break Even {(I)-(H)}	15.81%	12.18%	10.17%	7.82%	5.25%	2.61%	2.23%	2.35%
Break Even Sales (J)*(L)	2.38	2.03	1.84	1.61	1.36	1.11	1.07	1.09

Return on Investment

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	7.01	7.33	7.49	7.69	7.90	8.11	8.12	8.08	61.74
Net Worth	10.81	16.20	20.88	25.68	30.62	35.70	40.79	45.85	226.54
									27.25%

Debt Service Coverage Ratio

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	7.01	5.39	4.67	4.80	4.94	5.08	5.09	5.06	31.90
Depreciation	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	4.82
Interest on Term Loan	1.32	0.97	0.77	0.54	0.30	0.04	0.00	0.00	3.94
Total (M)	9.13	7.16	6.25	6.15	6.04	5.93	5.89	5.86	40.66

DEBT

Interest on Term Loan	1.32	0.97	0.77	0.54	0.30	0.04	0.00	0.00	3.94
Repayment of Term Loan	0.90	1.80	2.16	2.40	2.64	1.50	0.00	0.00	11.40
Total (N)	2.22	2.77	2.93	2.94	2.94	1.54	0.00	0.00	15.34
Average DSCR (M/N)	2.65								

Annexure-6 Details of procurement and implementation plan

Procurement and implementation schedule of energy efficient gas fired reheating furnace are presented below.

Activity	Weeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Energy data reconfirmation	■												
Technical discussion & finalization	■	■											
Collection of vendor quotes			■										
Order placement				■									
Material receipt				■	■	■	■	■	■				
Installation & Commissioning										■			
Measurement of savings											■	■	
Certification of savings													■

Annexure-7 Details of equipment and service providers

Name of company	Micro Hydraulic
Advanced Heating Systems	207, Vandaman Complex 8, Facilty Center, Mayapuri Phase-II, New Delhi 110064, Phone no. : 91-011-28112315, 32914872 +91-09810520120 Email : services@advance-systems.in , sales@advance-systems.in

Annexure 8 Quotations of energy efficient reheating furnace



Date: 1ST MARCH, 2011

Ref: - Sales/ 11

M/S WINROCK INTERNATIONAL INDIA

788 UDYOG VIHAR PHASE V,

GURGAON

CONTACT 4303809, 9899748347

SPECIFICATIONS FOR BILLET RE-HEATING FURNACE

WIDTH	:	600 MM
HEIGHT	:	900 MM
DEPTH	:	6000 MM
MAX. TEMPERATURE	:	1200° C
OPRATING TEMP.	:	500° C TO 1000° C
NO OF ZONES	:	1 NO.
NO. OF BURNERS	:	1 NO. DUEL BLOCK BURUNER WITH HEIGH/LOW FIRING SYSTEM
FUEL TO BE USED	:	LPG/NG.
NOS. OF AIR BLOWERS	:	1 NO WITH 2 H.P. MOTOR
BILLET MOVEMENT	:	GRAVITY MOVEMENT ON A SET OF RAILS.
DOORS	:	1 NO VERTICAL RISE AND FALL TYPE.
SERVICE DOOR	:	2 NSO.
DISCHARGE DOOR	:	1 NO
THERMAL INSULATION ROOF	:	230 MM THICK CERAMIC FIBER LINING OF SUITABLE GRADES.
THERMAL INSULATION SIDES & BOTTOM	:	115 MM FIRE BRICKS
CHIMNEY	:	230 MM INSULATION BRICKS
CONTROL	:	DOWN DRAFT CHIMNEY WITH DAMPER
TEMPERATURE CONTROL	:	AUTOMATIC AT ANY PRE-SET TEMPERATURE.
FABRICATION	:	THICK MS PLATES DUELY REINFORCED WITH STEEL SECTIONS.
PRICE	:	RS. 13,50,000/- EACH

FOR ADVANCE HEATING SYSTEMS

KAMAL POPLI



Manufacturers of : Furnaces, Ovens, Control Panels & Industrial Machines.

OFFICE : 207, VARDHMAN COMPLEX, 8 FACILITY CENTRE, MAYA PURI, PH-II, NEW DELHI-64 TELE / FAX : 91-11-28112315

GENERAL TERMS & CONDITIONS

PRICES

Prices quoted by us are ex-our works, Delhi.

PAYMENT

40% value of the order will be payable as advance along with the order and balance 100% value of consignment along with full value of taxes, duties and any other levies as applicable at the time of dispatch will be payable against the Performa invoice prior to dispatch.

PACKING & FORWARDING

The charges shall be extra at actual.

INSURANCE

If desired by the customer we can cover the goods to be dispatched against transit insurance at an additional charge of 1% of the insured value.

TAXES & DUTIES

Central / State Government Sales Tax, Octroi and /or other statutory levies as applicable at the time of delivery will be charged extra and to be borne by the client. At present Central sales tax is 2% against form 'C'.

DELIVERY

Within 60 days of receipt of P.O. along with advance.

EXCLUSIONS

Our services do not include any civil engineering works, cabling from main to panel or any other item not specifically mentioned in our offer.

For ADVANCE HEATING SYSTEMS

A handwritten signature in black ink, appearing to read "Kamal Popli", with a horizontal line underneath.

KAMAL POPLI



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