July 2018

DETAILED PROJECT REPORT
ON
REPLACEMENT OF COAL FIRED FURNACE WITH INDUCTION MELTING FURNACE

Ms Elite Enterprise –Jamnagar Brass Cluster

Submitted to

(Prepared under GEF-UNIDO-BEE Project)

Bureau of Energy Efficiency

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List of Abbreviations

AC	Alternate Current
ANSI	American National Standards Institute
BEE	Bureau of Energy Efficiency
DC	Direct Current
DPR	Detailed Project Report
EE	Energy Efficient
GEF	Global Environmental Facility
IRR	Internal Rate of Return
kW	Kilo Watt
LSP	Local Service Provider
MSME	Micro and Medium Scale Industries
NPV	Net Present Value
OEM	Original Equipment Manufacturer
PGVCL	Paschim Gujarat Vij Company Ltd
TOE	Tonnes of Oil Equivalent
UNIDO	United Nation Development Organization
IGBT	Insulated Gate Bipolar Transistor
KVAh	Klio. Volt Ampere Hrs.

ACKNOWLEDGEMENT

Confederation of Indian Industry (CII) would like to express its sincere thanks to United Nations Industrial Development Organization (UNIDO), Global Environment Facility (GEF) and Bureau of Energy Efficiency (BEE) for the role played by them in guiding and steering this prominent assignment - "Capacity Building of Local Service Providers in Jamnagar Brass Cluster"
CII would also like to give special gratitude to Jamnagar Brass Factory Owners' Association for supporting CII for carrying out this project at Jamnagar Brass Cluster and for their constant support and coordination throughout the activity.

CII is grateful to Mr. Milind Deore, Director, Bureau of Energy Efficiency, Mr. Sanjay Shrestha, Industrial Development Officer, Industrial Energy Efficiency Unit, Energy and Climate Branch, UNIDO, Mr. Suresh Kennit, National Project Coordinator, UNIDO, Mr. Niranjan Rao Deevela, National Technology Coordinator, UNIDO and Mr. Samir Patel, UNIDO, Cluster Leader, Jamnagar-Brass Cluster for their support and guidance during the project.

Last but not least we are thankful to Elite Enterprise, especially Mr. Devraj Bhai, Director for showing keen interest in the implementation of this technology and providing their wholehearted support and cooperation for the preparation of this Detailed Project Report.

We would take this opportunity to express our appreciation to the Original Equipment Suppliers and Local Service Providers for their support in giving valuable inputs and ideas for the completion of the Detailed Project Report.

We would also like to mention that the valuable efforts being taken and the enthusiasm displayed towards energy conservation by the Jamnagar Brass Cluster is appreciable and admirable.

1. EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, in collaboration with United Nations Industrial Development Organization (UNIDO) is executing a Global Environment Facility (GEF) funded national project "Promoting energy efficiency and renewable energy in selected MSME clusters in India". The overall aim of the project is to develop and promote a market environment for introducing energy efficiency and enhanced use of renewable energy technologies in process applications in 12 selected energy-intensive MSME clusters across 5 sectors in India (with expansion to more clusters later). This will enable improvement in the productivity and competitiveness of units, as well as reduce overall carbon emissions and improve the local environment.

Key activities involved in the project are as follows:

- **LSP MAPPING:** Detailed Mapping of LSPs in the cluster.
- **TECHNOLOGY FEASIBILITY STUDIES:** Preparation of 10 bankable DPRs.
- **TRAINING MATERIALS:** Development of 5 customized training material based on mapping
- **TRAINING PROGRAM:** Conduct 4 training programs in the cluster for the capacity building of local service providers.
- **LSP's AS LOCAL DISTRIBUTORS:** Mapping of LSPs and OEMs so that LSPs can become local dealers for major OEMs.

1.1 Brief Unit Profile

Table 1: Unit Details

Particulars	Details
Name of Plant	Elite Enterprise
Name(s) of the Plant Head	Mr. Devraj Bhai
Contact person	Mr. Mannish Kanz
Constitution	Private Company
MSME Classification	Small
Address:	Plot no:-4/B, Ashapura Ind. Estate, GIDC Phase 1,Shankar Tekri, Udyonagar, Jamnagar
Industry-sector	Manufacturing

1.2 Proposed EE Measure

During the plant visit it was observed that the plant was operating with pit type coal fired melting furnace and has a scope of replacing it with energy efficient IGBT based induction melting furnace. After discussion with the plant team and technology supplier, it was proposed to replace

the old furnace at Elite Enterprises. The expected reduction in specific cost is Rs. 1071/Tonne, which will lead to a saving of Rs. 5.67 lakhs per annum as per the current melting production of 530Tonne/Year. The details of the proposed EE measure is given in below:

Table 2: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings, (TOE)	Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	Annual GHG reduction (T CO_2)
1	**Replacement of coal fired furnace with induction melting furnace**	30.71	5.67	20.30	43	13.7

1.3 Means of Finance

The details of means of finance for the proposed EE measure is as under:

Table 3; Project Finance

Sl. No.	Particulars	Unit	Value
i	**Total Investment (Incl. of Tax)**	Rs. Lakh	20.30
ii	**Means of Finance**	Self / Bank Finance	Self
Iii	**IRR**	%	42
Iv	**NPV at 70 % Debt**	Rs. Lakh	19.5

2. INTRODUCTION ABOUT ELITE ENTERPPRISE

2.1 Unit Profile

Elite Enterprise is mainly involved in casting of building hardware like brass door handles, brass door knobs, brass gate hooks, brass kitchen hardware and sanitary parts. It is a micro industry produce located at Plot no:-4/B, Ashapura Ind. Estate, GIDC Phase 1, Shankar Tekri, Udyonagar, Jamnagar and registered with Jamnagar Factory Owners Association.

Table 4: Unit Profile

Particulars	Details
Name of Plant	Elite Enterprise
Name(s) of the Plant Head	Mr. Devraj Bhai
Contact person	Mr. Mannish Kanz
Contact Mail Id	finebrassindustries001@gmail.com
Contact No	+91 9998381727
Constitution	Private Company
MSME Classification	SME
No. of years in operation	5 Years
No of operating hrs./day	8 hrs.
No of operating days/year	312 Days
Address:	Plot no:-4/B, Ashapura Ind. Estate, GIDC Phase 1,Shankar Tekri, Udyonagar, Jamnagar
Industry-sector	Manufacturing
Type of Products manufactured	Brass door handles, Brass door knobs, Brass gate hooks, Brass Kitchen Hardware and Sanitary parts

2.2 Production Details

The various products casted in Elite Enterprise manufacturing Brass door handles, Brass door knobs, Brass gate hooks, Brass Kitchen Hardware & Sanitary parts and had an average finished product output of 39.86 Tonne per month[1].

The graph below shows the average Brass produced during last 9 months:

[1] Finished brass goods

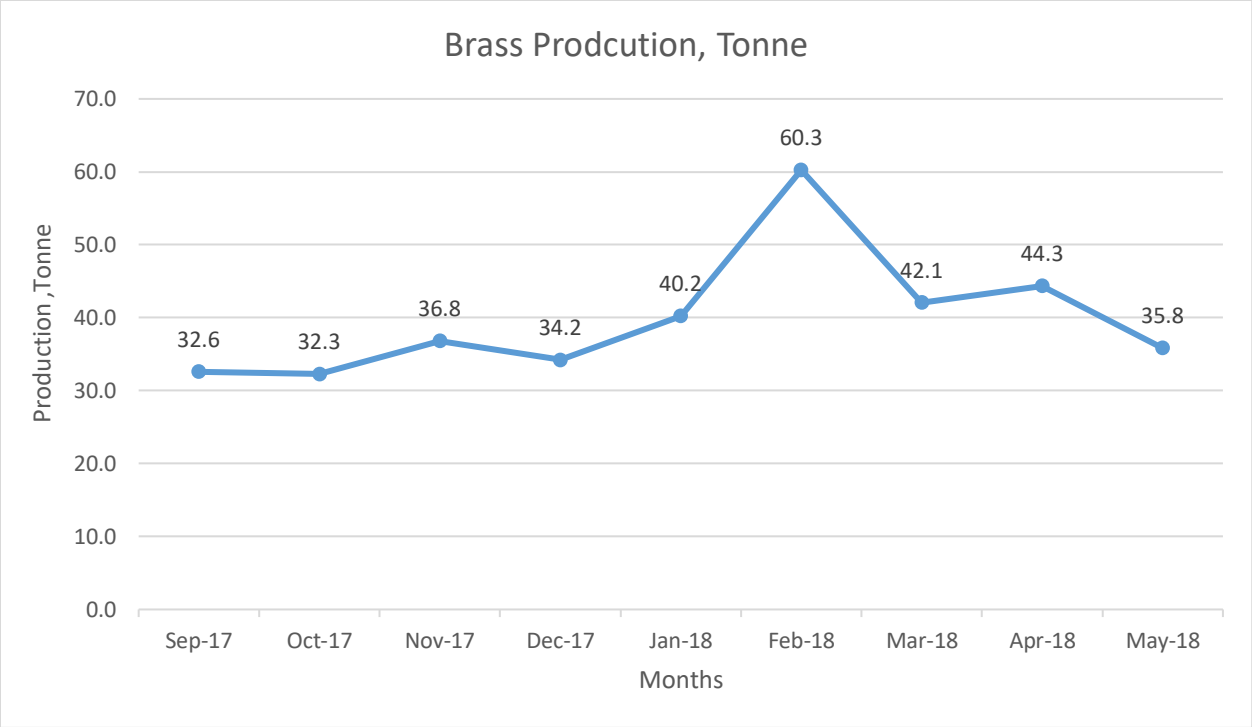


Figure 1: Production Details

2.3 Typical Brass Production Flow Diagram in Jamnagar

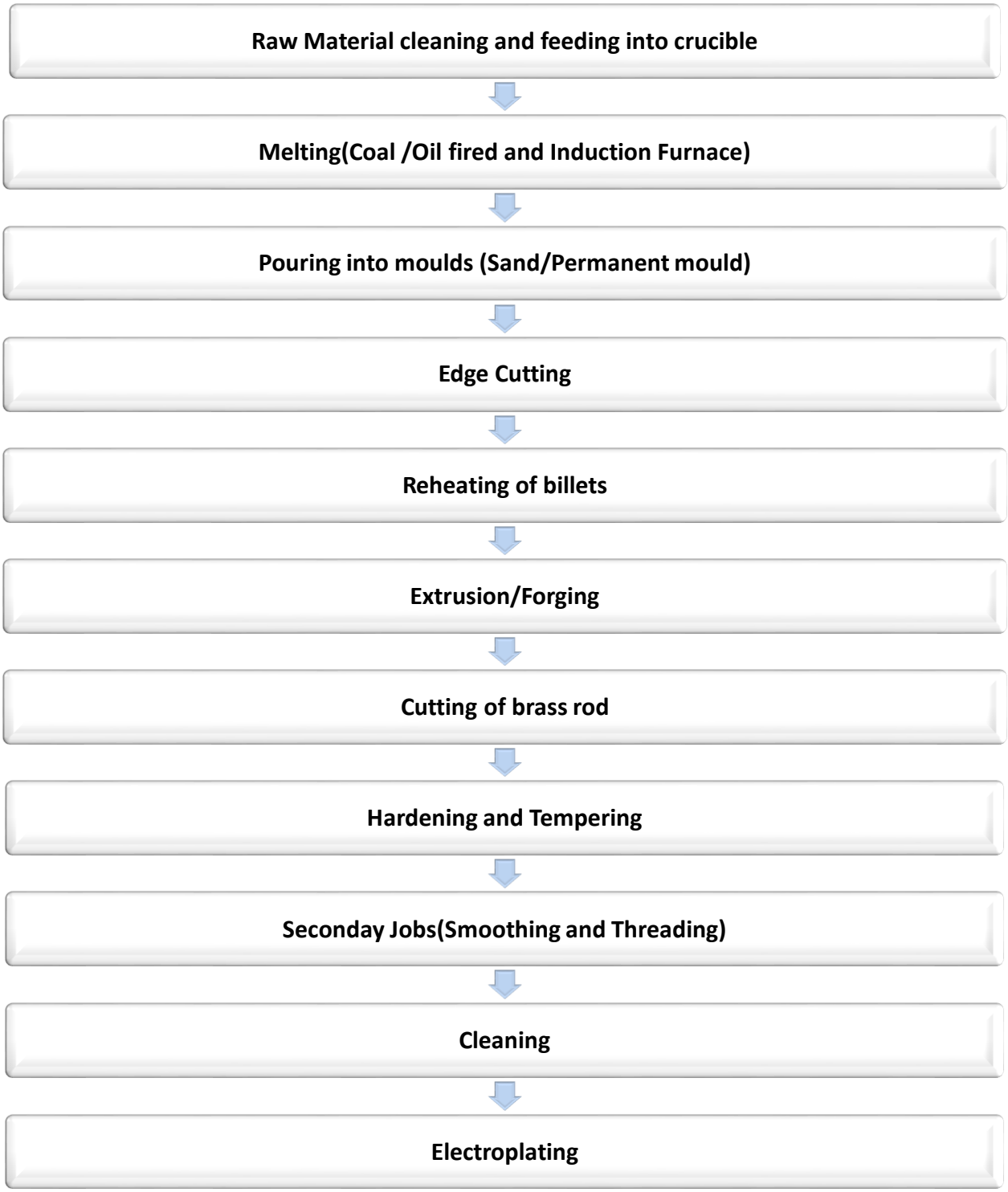


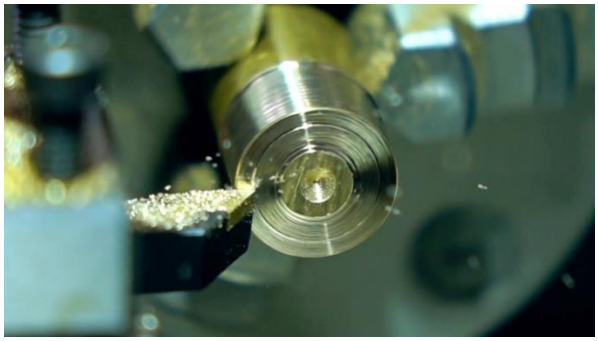
Figure 2: Typical Process Flow Chart

The production process mentioned in the above chart is almost similar to most of brass part manufacturing units in the cluster. However, depending on the final product, quality of final product and raw material properties, some of the stated process flow is altered to suit the requirement of industry. The major processes taking place at a typical Brass industry includes:

Melting: After separating the impurities form the brass scrap, the first step in making most of the products is melting the scarp in small furnace ranging from 100kg to 2000kg. Typically in Jamnagar pit type coal fired and induction melting furnaces are mainly used

Casting: After melting the next step involves casting molten brass in permanent mould or sand mould, depending upon the final product of the company. Sand moulding usually involves the preparing the consolidated sand mould around a pattern held within a supporting metal frame and removing the pattern to leave the mould cavity with cores. The liquid brass is poured into the cavity and allowed to solidify and when it does, the product is taken out of the mould cavity, trimmed and made to shape.

Machining: It is a broad term used to describe removal of material from a workpiece to get the desired shape and size of the material for further use. Machining is one of the key specialty of the products manufactured in Jamnagar clusters. Most of the plants are using traditional machines for grinding, grooving and other secondary jobs along with latest generation CNC machines for some specific jobs.



Electroplating: Is the process that is coating metals through reaction of the electrical conductive and chemical organics. The basic electroplating process consists of a plating bath filled with water containing a small amount of acid or alkali added to improve its conductivity.

- An anode (positive electrode) - either the plating metal or an inert electrode; this is expended as the process goes on and replenished periodically

- A cathode (negative electrode) - the item to be plated; these can be either hung inside the bath or placed in a barrel, which is rotated slowly to make the plating material deposited evenly

Usually, the bath is contained in metal container, lined with acid/alkali resistant membrane e.g. PVC sheet to make it insulated from electric circuit. The application of direct electric current across the bath solution causes the migration of positively charged particles (anions) towards the negative electrode (cathode) and negatively charged particles (cations) towards the positive electrodes (anode).

2.4 Energy Profile

Both electricity and thermal energy are used for carrying out various activities in plant like melting, machining, operation of utilities etc. The following fuels are used in the plant:

Table 5: Type of fuel used

Type of fuel/Energy used	Unit	Tariff	GCV
Electricity	Rs./kWh	**7.8**	-
Coal	Rs/kg	**28**	6500

The table below shows the average monthly energy consumption of the plant along with the average production of the finished goods during the last nine months:

Table 6: Energy Consumption and Finished product Details

Month	Electricity Consumption (kWh)	Total Electricity Bill , Rs.(Lakhs)	Total Coal Consumption, (Tonnes)	Total Fuel Bill, Rs.(Lakhs)	Final Product, (Tonnes)[2]
Sep-17	5352	0.42	5.07	1.42	32.60
Oct-17	5162	0.40	5.02	1.41	32.30
Nov-17	4330	0.35	5.73	1.60	36.82
Dec-17	4587	0.36	5.33	1.49	34.24
Jan-18	6252	0.48	6.26	1.75	40.22
Feb-18	5968	0.45	9.37	2.62	60.25
Mar-18	5571	0.43	6.55	1.83	42.10

[2] Average annual final product output of the plant was approximately 9.7% less than the melting production due to processing losses of brass alloy at different stages such as casting and machining, etc.

Apr-18	5627	0.51	6.90	1.93	44.35
May-18	5245	0.49	5.58	1.56	35.85

The major form of energy used in the plant is electricity which is imported from PGVCL grid supply at 415kV. Apart from electricity, furnace oil is the major source of thermal energy in the plant. Electricity accounts for 20% of the total fuel cost and rest 80% thermal cost in the plant. Based on the data collected from the plant, the graph below shows the variation of energy/fuel cost over the last 9 months. Electricity cost was Rs. 0.43 Lakhs/month whereas the average thermal energy cost was Rs 1.74 Lakhs/month.

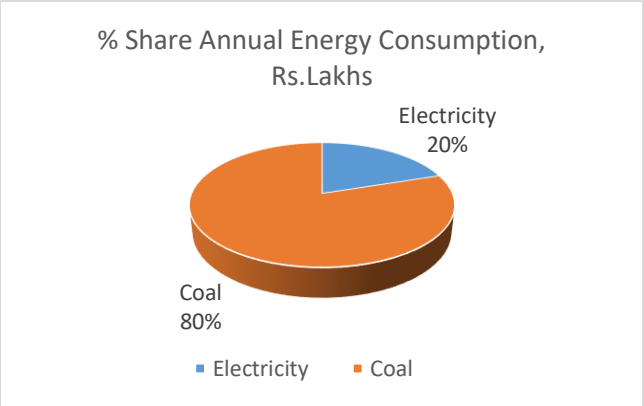


Figure 3: Annual percentage share of fuel cost

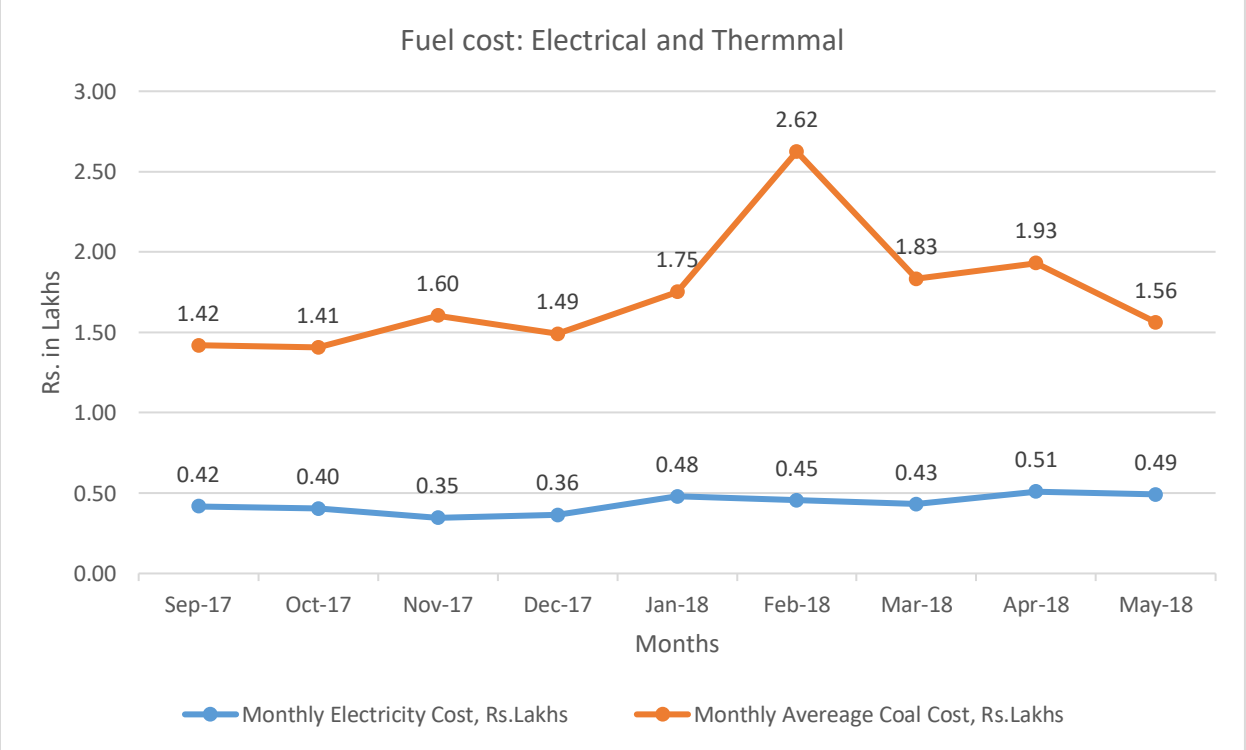


Figure 4: Energy Cost- Fuel & Electricity

3. PROPOSED EE MEASURE – REPLACEMENT OF COAL FIRED FURNACE WITH INDUCTION MELTING FURNACE

3.1 Present System

During the feasibility study, it was found that units involved in the casting of building components is using coal fired pit type melting furnace to melt brass scrap, which is subsequently used in for pouring into different molds to obtain various shapes. It is evident that melting of Brass scrap is one of the major energy and time-consuming process in the entire process in brass industry. Apart from the energy and time, final product quality will depend on time and temperature of raw material melt.

Plant was using coal fired pit type melting furnace of 300kg, and the operation of the furnace depends on customer requirement and runs in a 5-batch operation in a day. The furnace operator decide melting time on the basis molten brass color and practical experience and normally it was varying in Elite Enterprise from 119 to 121 minutes. Existing furnace has drawback like high burning loss, high fuel cost, and poor quality of final products, unhealthy plant's atmosphere, non-controllable fuel, unsafe operation and high carbon emission.

The following key reasons were contributing for the lower efficiencies

- Poor design of the furnaces
- Lack of awareness and information of the losses in the use of a coal fired furnace
- Due to lack of technical knowledge and expertise
- Lack of leadership to take up the energy efficiency projects in the plant

3.2 Observation and Analysis

The specific power consumption of the furnace was estimated based on the data measured/collected during the field visit in the unit. Furnace operation was observed for 5 bathes and coal consumption & melt production was taken. The unit was charging approximate 100% brass scrap (approximately 60% and 40% Zinc) in a batch. The average melting per batch has been estimated to be 331 kg per batch which has an average coal consumption 47kg.It was also observed that plant was taking more yield from than its rated capacity.

The detailed observed parameters for the 4 batches are given below:

Table 7: Operating Parameters for different cycles

Parameters	Batch 1	Batch 2	Batch 3	Batch 4
Coal Consumption, kg	45.9	46.2	49.3	45.2

Liquid Metal Yield, kg	330.0	325.0	340.0	330.0
Time, Minutes	119.0	121.0	121.0	120.0
SEC(kg Coal/Tonne)	139.0	142.0	145.0	137.0

3.3 Recommendation

An induction furnace is an electrical furnace in which the heat is applied by induction heating of metal and the main advantage of the induction furnace that it is a clean, energy-efficient and well-controllable melting process compared to other means of melting. Induction furnace capacities range from less than one kilogram to one hundred tonnes capacity and are used to melt Iron and Steel, Copper, Aluminum, Brass and other precious metals. The loss of valuable alloying elements are less in the induction furnace since there is no arc or combustion used and the temperature of the liquid can be controlled precisely. The operating frequencies range from utility frequency (50 Hz) to 750 kHz or higher, usually depending on the material being melted, the capacity (volume) of the furnace and the melting speed required. Generally the smaller the volume of the melts, the higher the frequency of the furnace used; this is due to the skin depth which is a measure of the distance an alternating current can penetrate beneath the surface of a conductor. For the same conductivity, the higher frequencies have a shallow skin depth - that is less penetration into the melt. Lower frequencies can generate stirring or turbulence in the metal. Power supplies range from 10 kW to 15 MW, with melt sizes of 20 kg to 30 tonne of metal respectively.

The typical specific power consumption of induction furnace for brass is given below.

- Medium frequency induction furnace for (hand pouring)- 380 – 400units / tonne[3]

Hence there is a good potential to save energy by installing medium frequency induction furnace.

Benefits of Installing Induction Melting Furnace

- Low melting cost
- Higher production
- Low rejection rates
- Better quality (malleability)
- Cheaper scrap material can be used
- Less pollution i.e. environment friendly
- Less burning loss

The design specifications of the new IGBT type 100kW induction furnace are given below:

Table 8: Design Details of the new Furnace

Description	Rating
Rated Power, kW	100
Total Input, kVA	106
Input PF	0.98

[3] SEC Nos. given by technology supplier

Input Voltage, Volts	415
Output Frequency, Hz	1000
Output Voltage, Volts	1050
Pouring Temperature for Brass, °C	1175
Nominal Capacity of furnace, Kg	300
Melting Rate for Brass at Pouring Temperature, kg/hr	293

3.4 Suppliers Details

Table 9: Supplier Detail

Equipment Detail	IGBT Induction Furnace
Supplier Name -1	Electrotherm India
Address	Survey No. 72, Village, Palodia, Taluka, Kalol, Dist. Gandhinagar - 382 115 Gujarat, India.
Contact Person	Kalpesh Chavda
Email Id	kalpesh.chavda@electrotherm.com
Supplier Name -2	Inductotherm India
Address	Plot no. SM-6, Road no. 11, Sanand-II Industrial Estate, BOL Village, Sanand, Ahmedabad - 382170
Contact Person	Nishant Singh
Email Id	nsingh@inductothermindia.com
Supplier Name -3	Indo Power Furnace Pvt Ltd
Address	No. 56/ A - 4, Phase - 1,G. I. D. C., Vatva, Ahmedabad - 382445, Gujarat, India
Contact Person	Nandlal Pate
Email Id	indopowerfurnace@gmail.com

3.5 Savings

Installation of IGBT based induction furnace in place of coal furnace will increase the electrical consumption and completely replace coal. The average specific coal consumption was found out to be 140.8Kg/tonne, whereas specific electrical energy consumption with proposed energy IGBT based melting furnace would be 390 kWh/tonne. The total average annual production was 530tonnes hence; total coal consumption in base case would be 74,597.5kg per year which will be replaced by electrical unit consumption and total unit's consumption would be 2,06,700kWh per year which will lead to an annual saving of 30.71 TOE/year and 13.7Ton/year CO_2 equivalent reduction. After replacing the furnace, the burning losses in the furnace will also come down marginally, which will lead to marginal reduction in the raw material consumption in the furnace.

Detailed savings calculations is given in below table

Table 10: Savings Calculation

Parameters	Units	Existing System	Proposed System
No of Heat Cycles in a day		5	
Average annual Operating days		320	
Average Production per batch	kg	331	
Average Current Production	Tonne/Year	530	-
Unit Price of Coal	Rs./kg	28	-
Unit Price of Electricity	Rs./kVAh		7.8
Average Specific coal Consumption	Kg/Tonne	140.8	-
Expected Electricity Consumption(Hand Pouring)	kVAh/Tonne		390
Blower energy consumption	kVAh/Tonne	22	-
Specific Energy Cost of Melting	Rs/Tonne	4113	3042
Reduction in Specific Energy Cost	Rs/Tonne	1071	-
Annual Monetary Savings	Rs. Lakhs/Year	5.67	
Investment	Rs. Lakhs/Year	20.30	
Simple Payback period	Months	42.9	
TOE Savings		30.71	
CO2 Reduction	Tonne/Year	13.7	

4. FINANCIAL ANALYSIS

4.1 Project Cost

Table 11: Project Cost

Parameter	Amount in Rs Lakhs
Installation of new IGBT type induction furnace with all new auxiliary and Hydraulic tilting crucible	17.20
GST @18%	3.096
Total Project Cost	20.30[4]

4.2 Assumptions for Financial Analysis

- Cost of Debt (Interest rate) taken as 12%
- Yearly increase in fuel cost by 2% for cash flow analysis
- Depreciation method: Reducing balance method
- Depreciation rate: 40% [5]
- Life cycle of the project is taken as 7 years
- Three different Capital Structure considered
    - CS1 – 70:30 Debt Equity Ratio
    - CS2 – 50:50 Debt Equity Ratio
    - CS3 – 100 % Equity
- Return on equity is taken as 15 %
- Operation and Maintenance Cost taken as 5% of Initial investment
- For calculating weighted average cost of capital, the corporate tax rate is assumed as 30 %

4.3 Cash Flow Analysis

Table 12: Cash flow of the project

Cash flow for the project		1	2	3	4	5	6	7
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Required Investment	20.3							
Energy Savings		5.7	5.8	5.9	6.0	6.1	6.3	6.4
O&M Cost		-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

[4] Plant is going with branded manufacture for furnace and auxiliaries, so initial cost is high in comparison to local suppliers

[5] https://www.incometaxindia.gov.in/charts%20%20tables/depreciation%20rates.htm

Depreciation		8.1	4.9	2.92	1.8	1.1	0.6	0.4
Net Cash Flow	-20.3	12.8	9.6	7.8	6.8	6.2	5.9	5.8

The table below shows the WACC at various capital structure assumed for the financial analysis

Table 13: Capital Structure

Capital Structure			
Particulars	CS 1	CS 2	CS 3
Debt	70	50	0
Cost of Debt	0.12	0.12	0.12
Tax 30%	0.3	0.3	0.3
Equity	30	50	100
Sum of debt& Equity	100	100	100
Cost of Equity	0.15	0.15	0.15
WACC	10.38	11.7	15

Table 14: NPV Calculation

NPV Calculation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	NPV
NPV at CS 1 (70:30)	-20.3	11.6	7.9	5.8	4.6	3.8	3.3	2.9	19.5
NPV at CS 2 (50:50)	-20.3	11.4	7.7	5.6	4.3	3.6	3.0	2.7	18.1
NPV at CS 3 (100% Equity)	-20.3	11.1	7.3	5.1	3.9	3.1	2.5	2.2	14.9

4.4 Sensitivity Analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations such as

- Change in energy savings
- Change in operating hours
- Change in interest rate

The sensitivity analysis will help to estimate the impact of key project indicators on attractiveness of the project, thereby helping to understand the financial viability.

Table 15: Sensitivity analysis: based on energy savings

Sensitivity analysis: based on energy savings			
	at 100% Savings	at 75% Savings	at 50% Savings
IRR	42%	34%	22%
NPV at CS 1 (D70:E30)	19.46	13.85	6.07
NPV at CS2 (D50:E50)	18.05	11.19	4.16

NPV at CS3 (D0:E100)	14.89	10.03	3.33

Table 16: Sensitivity analysis: change in operating hrs.

Sensitivity analysis: based on operating hours			
	at 100% Operating hours	at 90% Operating hours	at 80% Operating hours
IRR	42%	38%	34%
NPV at CS 1 (D70:E30)	19.5	16.6	13.7
NPV at CS2 (D50:E50)	18.1	15.3	12.5
NPV at CS3 (D0:E100)	14.9	12.4	9.9

Table 17: Sensitivity analysis: change in interest rate

Sensitivity analysis: change in interest rate						
	at 9.5% Interest rate	at 10.05% Interest rate	at 11% Interest rate	at 12% Interest Rate	at 12.5% Interest Rate	at 13% Interest Rate
NPV (70:30)	20.85	20.29	20.01	19.46	19.19	18.93

5. ENERGY EFFICIENCY FINANCING IN MSMEs

Financing plays a key role in facilitating procurement and implementation of energy efficient technologies and products in any industry. Government has given EE financing in MSMEs top priority since the sector contributes significantly towards India's economic growth. However, existing financing options are not sufficient to meet the financing requirement in the sector due to the large size of the sector. MSMEs using various financing schemes for technological up-gradation are still very less, as most of them use their own capital fund rather than making use of external financing models. Although financing models were very successful in some clusters, the scale-up of such activities is rather slow. This slow pace in implementation of energy efficiency financing in MSMEs is due to the various sector specific challenges in the sector.

Some of the key barriers to finance EE projects in the sector are:-

- Lack of available capital for investment as EE interventions being small may not get financed through FIs as they do not qualify as term loans
- Lack of clarity on financing schemes- repayment mechanism and complex procedural requirements
- Lack of availability of financing model that cater to the particular requirement of the MSME
- Lack of awareness among MSMEs with respect to benefits of implementing EE technologies
- FIs consider MSMEs as a high risk category due to low credit flow to this sector. This is due to several factors such as poor book-keeping practices, weak balance sheets, poor credit history and smaller sizes of MSME loans.
- Collateral based lending, advocated by FIs, restricts MSMEs from availing loans
- No formal M&V procedure available to estimate the savings achieved by implementing EE measure
- Risks associated with repayment of loans which include technical, commercial and performance risks

5.1 FI Schemes in Gujarat

Table 18: FI schemes in Gujarat

Sl.No	Name of Scheme	Purpose	Financial Details	Contact Address
1	**SIDBI Make in India Soft Loan Fund for Micro, Small & Medium Enterprises (SMILE)**	• The focus of the scheme is on technology upgradation which helps in reducing the impacts from process and operations as the reduction in resource consumption and productivity improvements are major outcome of technology upgradation • The program aims to bridge the gap by providing financial support to the companies.	• Rate of interest is according to credit rating • Interest rates for soft loans are from (8.90 % to 8.95 % pa) and term loans are in the range of (9.45% to 9.60% pa) • Min loan amount: Rs 25 Lakhs • Term Loan: 75% of the project cost as debt	Mr.Chandra Kant SIDBI, NO.1-2-3/4, Shreeji Patel Colony, Jamnagar-361008. Contact no : 0288 275 3954 Mail id : chandrakant@sidbi.in
2	**4E scheme (End to End Energy Efficiency Financing scheme)**	• The 4E scheme promoted by SIDBI aims to assist the industries in implementation of energy efficiency and renewable energy projects. • The scheme addresses all aspects of energy efficiency in a company from assessment and identification of energy efficiency interventions to facilitating implementation by providing technical and financial support	• Interest rate - 2.5% below market interest rate • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 150 Lakhs • 90% of the project cost as debt	Mr.Chandra Kant SIDBI, NO.1-2-3/4, Shreeji Patel Colony, Jamnagar-361008. Contact no : 0288 275 3954 Mail id : chandrakant@sidbi.in

3	**Partial Risk Sharing Facility for Energy Efficiency project (PRSF)**	• The partial risk sharing facility aims at transforming the energy efficiency market in India and promotion of Energy Service Contracting Model for the Energy Efficiency. • The scheme address barrier related to the financing aspects for energy efficiency	• Term Loan: 12%-15% • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 15 Cr • Total Project funding of – USD 43 million • Risk Sharing facility component of USD 37 million to be managed by SIDBI • Technical assistance component of USD 6 billion to be managed by SIDBI and EESL	Mr Chandra Kant SIDBI, NO.1-2-3/4, Shreeji Patel Colony, Jamnagar-361008. Contact no : 0288 275 3954 Mail id : chandrakant@sidbi.in
4	**Bank of Baroda's Scheme for Financing Energy Efficiency Projects**	All these Schemes from various banks (SBI, Bank of Baroda, and Canara Bank) have their focus towards technology upgradation. Technology upgradation can lead to improvement in energy, productivity, and lower emission from the MSME company. As technology upgradation could be capital intensive most of the	• Loans of up to 75% of the total project cost, subject to maximum of Rs. 1 crore, will be provided. (Minimum amount of loan Rs. 5 Lakhs • Collateral will be required for all loans. An interest rate of bank base rate + 4% will be applicable, to be paid back over a period of 5 years.	Bank of Baroda Saru Section Road,Swastik Society,Park colony,Jamnagar,Gujarat,361008 Contact no : 0288 266 0779 Mail Id : Jamnag@bankofbaroda.com
5	**Canara Bank's Loan scheme for Energy Savings for SMEs**		• The scheme covers up to 90% of project costs of up to INR 1 million (EUR 13,000). • Max. loan: INR 10 million (EUR 130,000) • Security: collateral free up to INR 5 million (EUR 65,000), beyond INR 5 million collateral required as determined by the bank • Margin: 10% of project costs	Canara Bank, 1st Floor,New Super Market,Bedi Road,Jamnagar,Gujarat,361001 Ph no: 0288 267 6597

6	**SBI's Project Uptech for Energy Efficiency**	schemes from banking institutions aim at bridging the gaps for access to finance for MSME sector	• SBI identifies industrial clusters with potential for quick technology upgradation and a supporting environment. Based on studies in interested units, technology upgradation is undertaken if the same in viable. • With a ceiling of INR 1 lakh, an amount equal to that invested by the unit is provided under this loan. There is a start-up period of 3 years, with a repayment period of 5-7 years, at zero interest.	SBI Regional Office Junagadh Jamnagar Highway, Maheswari Nagar, Opp Anupam Cinema Hall, Kadiawad, Jamnagar, Gujarat 361001. Ph no : 0288 2554026 Mail id : sbi.01816@sbi.co.in
7	**Solar Roof Top Financing Scheme IREDA**	The loan scheme is applicable to grid interactive, rooftop solar PV plants for industries, institutions and commercial establishments. Financing can be accessed for single or aggregated investments.	• Interest rate: 9.9% - 10.75% • Max. repayment time: 9 years • Minimum promoter's contribution: 30% • The applicant's minimum capacity needs to be 1MW	IREDA Camp Office 603, Atlanta Towers Near Panchvati Circle, Gulabi Tekra Ahmedabad Ph No : 9811889805 Email Id : ashokyadav@ireda.in

6. ENVIRONMENTAL AND SOCIAL BENEFIT

6.1 Environmental Benefit

A resource-efficient business demonstrates a responsibility towards the environment. Energy and the environment are so closely linked, that, in addition to saving energy and reducing utility expenses, there are additional and often unreported benefits from conserving energy, saving natural resources being an important benefit.

Energy efficiency plays a major role, even where company output is increased, energy efficiency improvements can contribute significantly in most cases to reducing the negative impact of energy consumption per unit of output. Any increase in pollutant emissions will thus be minimized. Significant environmental benefits gained by adopting energy efficient technologies and processes may include lowering the demand for natural resources, reducing the emission of air pollutants, improving water quality, reducing the accumulation of solid waste and also reducing climate change impacts. Improving energy conservation at the facility can improve the facility's overall efficiency, which leads to a cleaner environment.

Reduction in Pollution Parameters

The proposed energy efficiency measure of installing energy efficient induction furnace will result in reduction of 30.71TOE per annum. The proposed EE measure will result in decrease of CO_2 emissions by 13.7 TCO_2 annually, thus resulting in reduced GHG effect.

6.2 Social Benefit

Work Environment

The Factories Act, 1948 covers various aspects relating to working environment maintenance and improvement. The good maintenance practices, technology up gradation, efficient use of energy and resource conservation not only contribute to energy and pollutant reduction but also contributes in ensuring safe and clean working environment to the employees of the organization. Many units have also been doing review of safety process and have provided access to safe working environment to the workers. Basic facilities such as first aid kit, PPE gears and many others have been made available

Skill Improvement

Implementing energy efficiency measures requires mix of people and skills. It involves upskilling workers at all levels from the shop floor to the board room to understand how companies manage their energy use—and to identify, evaluate and implement opportunities to improve energy performance. As the project involved identifying energy saving projects, implementing and verifying the savings, the unit have understood how to estimate energy savings with respect

to energy saving proposals and also energy wastage have been identified. The activity has been successful in bringing the awareness among workers on energy wastage reduction, technology up gradation possible, etc. Each new technology implemented in a brass units will create an impact on the entire cluster as each unit can replicate the new technology and promote the concept of energy efficiency and renewable energy in entire Cluster and thus reduce the overall energy consumption of the cluster as a whole. Technical skills of persons will be definitely improved as the training provided by the OEMS' on latest technology will create awareness among the employees on new trends happening in market. The training also helps in improving the operational and maintenance skills of manpower required for efficient operation of the equipment.

7. CONCLUSION

Energy efficiency is an instrument to address the issue of energy crisis and also be employed as a cost effective means to attain sustainability and business. Cost of energy is considered as a vital component for industries and warrant judicious use of energy. Amid spiraling power cost energy efficiency assumes at most importance for the sector to remain competitive.

The GEF, UNIDO and BEE project through its various engagements is able to demonstrate energy efficiency potential in Jamnagar Brass cluster. The project is able to promote the concept of energy efficiency and renewable energy in brass cluster through various capacity building programs for local service providers, technology feasibility studies in brass units, training programs on EE/RE technologies and also helped in penetrating new /latest technologies into the cluster.

The DPR on replacing the existing old coal fired furnace with EE IGBT based induction furnace is prepared after the OEM came to the unit and also did a detailed feasibility study. This measure will significantly reduce the dependency on coal which will result in an annual energy savings of 30.71TOE per year with 13.7 TCO_2 reduction annually.

The following table gives the overall summary of the savings achieved:-

Table 19: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings, (TOE)	Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	Annual GHG reduction (T CO_2)
1	**Replacement of coal fired furnace with induction melting furnace**	30.71	5.67	20.30	43	13.7

The summary of financial analysis given in the below table clearly indicates that implementation of this project is economically and financially viable with an attractive payback period. So it is recommended to install new IGBT based induction furnace.

Table 20: Financial Analysis

Sl. No.	Particulars	Unit	Value
i	**Total Investment (Incl. of Tax)**	Rs. Lakh	20.30
ii	**Means of Finance**	Self / Bank Finance	Self
Iii	**IRR**	%	42
Iv	**NPV at 70 % Debt**	Rs. Lakh	19.5

7.1 Replication Potential

Most of the small scale units in Jamnagar brass cluster are using basic design furnace pit type coal fired melting furnace and has huge replication potential. The implementation of this project will inspire other units to take up similar energy efficiency initiatives which eventually will lower the bottom line and increase the top line therefore the margin increases. Secondly, the very clear specifications on vendor and the cost base is already available which makes it easy for other units in the Jamnagar Brass cluster to access the technology and gives them a very good idea about the cost and benefits associated with the projects. Overall, the holistic approach adopted by the project will be extremely useful in achieving the goal of improving EE in the cluster.

8. ANNEXURE

8.1 Financial Quotation

Elite Enterprise, Jamnagar

Dear Sir,

This has reference to the discussions Mr. Kalpesh Chavda had with you regarding your requirement of induction melting furnaces for your foundry. We thank you very much for your interest in Electrotherm foundry melt shop solutions.

Established in 1983, Electrotherm has supplied over 3300 induction furnaces in over 36 countries for a wide ranging applications in iron, steel and non-ferrous induction melting. The state of the art manufacturing facility in Ahmedabad, supported by the full-fledged R & D centres in Ahmedabad and Coimbatore can provide optimum solutions for all induction melt shop requirements.

With a network of over 32 sales and service centres spread across India, Electrotherm sales and service personnel will always be at your service for prompt assistance when required.

Based on your requirement, we are sending our offer no: **ET/I/ABD/SQ/20692/17-18** for

- **One 100 kW / 1000 Hz Quick-Melt "IG-nite"- Series Solid State Power Supply Unit with one 300 Kg ET-Alumin-SL Induction Melting Furnace.**

The offer consists of quotations, technical specifications, scope of supply and terms and conditions.

We trust that you will find the above offer in line with your requirement. If you need any further information/details, please feel free to contact us.

With a copy of this offer we are advising our regional office to get in touch with you for techno-commercial discussion.

Thanking you,

Yours faithfully,
for ELECTROTHERM (INDIA) LIMITED

SUNDAR SWAMI (HEAD - FOUNDRY FURNACE DIVISION)
(M) 9879204104 E-mail: sundar.swami@electrotherm.com

Copy to:

Mr. Kalpesh Chavda (M) 9825150066 E-mail: Kalpesh.chavda@electrotherm.com

Page: 2 **Proposal No: ET/I/ABD/SQ/20692/17-18** **Date: January 19, 2018**

Elite Enterprise, Jamnagar

E/CS/MK/QF04 Rev.00

OFFER FOR 100 KW / 300 KG MEDIUM FREQUENCY INDUCTION FURNACE

Sr. No.	Description	Qty.	Price (₹ in Lacs)
1	100 kW "IG-nite"- Series Solid State Power Supply Unit with DM Water Circulating Unit.	1 No.	11.80
2	300 Kg ET-Alumin-SL Melting Furnace with Hydraulic Tilting Arrangement, Bus bar, Water Cooled Cables, etc	1 No.	5.40
3	Hydraulic Power Pack	1 No.	
	Total Ex- works Price for above: ₹ 17.20 Lacs (RUPEES SEVENTEEN LACS TWENTY THOUSAND ONLY)		

Please refer to our standard terms and conditions attached with this offer for price basis and commercial terms.

for ELECTROTHERM (INDIA) LIMITED

SUNDAR SWAMI
HEAD - FOUNDRY FURNACE DIVISION

Page: 3 **Proposal No: ET/I/ABD/SQ/20692/17-18** **Date: January 19, 2018**

TECHNICAL SPECIFICATION OF "IG-nite" SERIES

MEDIUM FREQUENCY INDUCTION MELTING FURNACE

Sr. No.	Description	Rating
1.	Rated Power (KW)	100
2.	Total Input KVA	106
3.	Input PF	0.98
4.	Input Voltage (Volts)	415
5.	Output Frequency (Hz)	1000
6.	Output Voltage (Volts)	1050
7.	Pouring Temperature (°C)	1175
8.	Nominal Capacity of furnace in Kg for Brass	300
9.*	Melting Rate for Brass at Pouring Temperature (Kg/Hr)	293

Notes:

- Melt rate specified is on charge weight with best charging practices and best melting operations excluding all non-productive time. (When furnace is not doing any melting operation like - initial charging, pouring, superheating, holding for chemical analysis or de-slagging.).
- The scrap should be cleaned, sized and dense, yield should be better than 99%. Slag consumes nearly double the power than consumed by scrap
- Furnace lining should be in hot condition after second heat of lining with recommended lining thickness. Water temperature of coil should be as specified.
- There should be rated voltage available in the input of power supply. Power drops if the input supply drops below 99%. Power factor mentioned is at full load.
- There should not be any stoppages during heat while trial run.
- The charging and slag removal should be uniform and without any noticed delay.
- Chemical composition of the metal considered is Plain Carbon Steel / Mild Steel maximum temperature considered is as given in above table.
- Defined melt rate is with standard length of our bus bars and water cooled cables.
- Melt rate may vary ±3%.

FEATURES AND ADVANTAGES OF "IG-nite" SYSTEM

➢ **Features**

- 7" touch screen HMI.
- Up to 10 years Storage facility of data like KWh consumed, daily/shift wise production report, tripping log ETC.
- Automatic Sintering facility with different sintering pattern.
- IGBT inverter having latest innovative and efficient technology.
- Short-circuit-proof power circuit to work at any load condition.
- FPGA based fully digital control with colour touch screen operator interface.
- Near unity power factor (> 0.98) at any power level and any metal level.
- Constant output within specified range of input voltage variation.
- Exceptionally stable electronic control circuit.
- User programmable auto-sintering cycle.
- User settable dual power limits and frequency to meet most industrial requirements.
- Energy monitoring and data logging system.
- Maintenance-friendly design.
- Global connectivity.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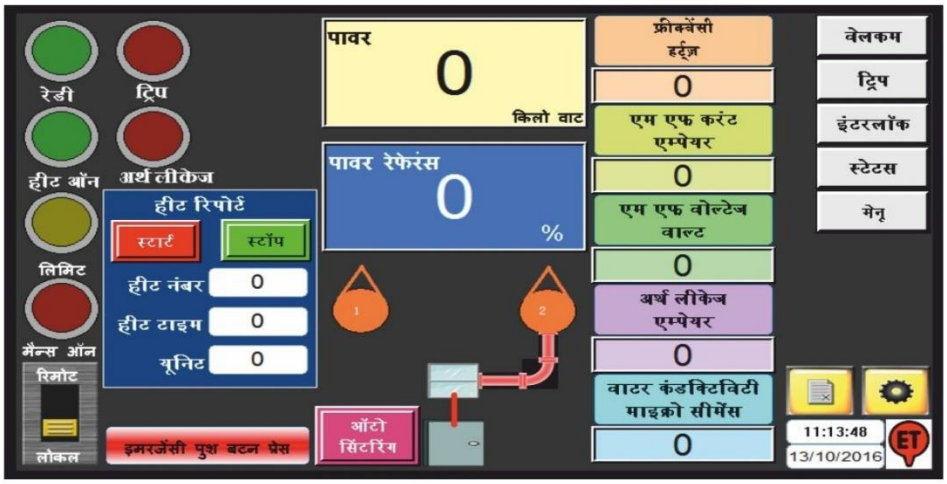
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➢ Advantages of Digitalization

- Generation of specific reports for ease of maintenance and fault diagnosis. Data storage facility through USB drive in csv file format, which can be further opened in MS-Excel.
- Minute-wise logging of electrical parameters like power, MF voltage, coil frequency etc. for over 2 years for further trending and analysis.
- Customized production report like heat number, heat time, electricity consumed etc.
- Alarm history with time and date.
- Continuous monitoring of water conductivity with preset alarms and tripping at two levels.
- Earth leakage protection with adjustable leakage current level.
- Setting of electrical parameters like power, voltage, current from HMI.
- Highly user friendly system with provision for language selection in HMI.
- Multi-level password protection system.
- Globally accessible equipment through Ethernet connectivity.

SCOPE OF SUPPLY FOR INDUCTION FURNACE

SOLID STATE POWER SUPPLY UNIT

Solid State Power Supply Unit conditions the incoming power suitable to operate induction furnace. The incoming three-phase supply at 50 Hz is converted into DC using a three phase full bridge rectifier. The DC supply is converted to single phase AC at required frequency using single phase thyristorized current source (parallel) inverter. The Power Supply Unit consists of fast acting semiconductor grade backup HRC fuses, IGBT based controlled unit to control the power to the furnace, DC smoothing reactor, single phase thyristorized bridge inverter, control electronics with necessary feed-back elements and power supply, protection circuits, a set of fault indicating lamps, meters, push buttons, interconnecting busbars, flow monitoring switch and conductivity meter for monitoring conductivity of de-ionized water. All these components are fitted into a dust proof MS cubicle.

CAPACITORS

Medium Frequency water cooled capacitors are used to form a tank circuit with the furnace coil. This presents unity power factor load to the inverter. The electrical connections to the main busbars are provided by water cooled tubes to ensure proper cooling at the joint. Temperature sensors are used to ensure the appropriate water cooling of capacitor bank. Colour coded PVC braided pipes are used for inlet and outlet water connection.

D. C. REACTOR

Electrotherm's iron core DC Reactor substantially reduces the rate of rise of fault current and allows front-end thyristorized convertor to stop current flow within 6 - 8 milliseconds. This protection is faster than any other circuit breaking device with minimum risk of fuse blowing and thyristor failures.

DM WATER CIRCULATION SYSTEM

Components of solid state power supply unit, medium frequency capacitors and interconnecting busbars are cooled by water. De-ionized water is used for cooling various components in a closed loop. The de-ionized water circulation system consists of water storage tank, non-ferrous pump, plate type heat-exchanger, a mixed bed resin cartridge and inter-connecting pipelines. The conductivity of de-ionized water is continuously monitored. In case it exceeds the pre-set level, the PSU unit is stopped. Occasional make-up of the de-ionized water is required. A plate type heat exchanger which is easy to maintain is used to cool de-ionized water. The plates of the heat exchanger are made out of stainless steel grade 316 for better corrosion resistance.

HYDRAULIC SYSTEM

This system consists of a Hydraulic power pack, hydraulic cylinders, interconnecting pipelines and direction control valves. Hydraulic cylinders are used for tilting the furnace. Required pressure and flow for tilting the furnace is generated by this hydraulic power pack, which consists of motor, pump, pressure relief valves, filters and adequate capacity oil tank. Hydraulic power pack is connected to the cylinders by seamless hydraulic pipes through a direction control valve. Furnace tilting is controlled by the operator, using a direction control valve.

MELTING FURNACE

ET-Alumin-SL Furnaces have an energy efficient coil to perform under typical harsh melt shop environment.

The coil is made of rectangular cross section electrolytic grade copper. The gap between two turns of the coil is maintained using spacers. The coils are electrically insulated by a special resin based coating. The coil is firmly secured to insulating bars, equally spaced around the coil periphery. These bars provide mechanical strength against deformation during maintenance and normal operation.

INTER CONNECTING BUS BARS & FLEXIBLE WATER COOLED CABLES

Inter connecting bus bars between capacitors and coil carry large reactive currents. Adequately rated EC copper bus bars with tinning at the contact points are used to keep the losses to minimum. Flexible cables are used to feed power to the furnace coil. The cables carry the same current as that of the bus bars and are water cooled. Rubber hoses of the flexible cables are carbon free and are provided with braiding for preventing puncture due to accidental metal splashes.

Note: The Photographs shown in the proposal are only indicative. Actual product's design, feature and colour may vary from those visible in the photographs.

ITEMS NOT INCLUDED IN OUR SCOPE OF SUPPLY

1. The required power supply at 415 V, 3 phase, 50 Hz for the Furnace auxiliary load like pumps, motors, cooling towers, interconnecting cables, starter, switch gears, etc.

2. Water cooling system consisting of pumps, cooling tower, pipe line and valves.

3. All civil engineering works including furnace platform, foundation drains, ducting, doors, windows, lighting, etc.

4. Ramming tools and other foundry materials, refractory lining material, hydraulic oil and other consumables, material handling equipment as required (crane etc).

5. Earthing connection to the equipment as per the requirement.

6. Necessary tools, handling equipments, utilities, skilled and unskilled workers necessary for erection and commissioning of the equipment.

7. All other work / items / equipments / tackles which are not specifically mentioned but are required for installation and operation of the furnace.

8. All necessary approval from the local authorities for the erection, testing, commissioning and operation of the furnace and auxiliary equipment.

9. Measuring instruments

A. Cathode Ray Oscilloscope (1 No.):		'Scientific Make', model no. HM-203, Dual Channel with line trigger facility, 30 MHz.
B. Probes	:	10:1 (2 Nos.) 1:1 (2 Nos.)
C. Digital Multi-meter	:	3 ½ digit, Measuring Facilities AC & DC Voltage – 1000 V AC currents – 10 Amp.