National Program

on

Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India

Jamnagar Brass Cluster

Detailed Energy Audit Report
Metal Alloys Corporation

Submitted to

Submitted by

InsPIRE Network for Environment

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Abbreviations

APFC	Automatic Power Factor Controller
BEE	Bureau of Energy Efficiency
CT	Cooling Tower
CO	Carbon Mono-oxide
CO_2	Carbon Di-oxide
FRPB	Fiber Reinforced Plastic Blades
GEF	Global Environment Facility
HP	Horse Power
Kcal	Kilo Calories
Kg	Kilogram
kVA	Kilo Volt Ampere
kVAR	Kilo Volt Ampere Rating
kW	Kilo Watts
kWh	Kilo Watt Hour
LPG	Liquefied Petroleum Gas
MDC	Maximum Demand Controller
MSME	Ministry of Micro Small and Medium Enterprises
PF	Power Factor
Ppm	Parts per Million
SEB	State Electricity Board
SEC	Specific Energy Consumption
SME	Small and Medium Enterprise
UNIDO	United Nations Industrial Development Organization
VFD	Variable Frequency Drive

About the Project

The project titled "Promoting Energy Efficiency and Renewable Energy in Selected MSME clusters in India" supported by Global Environment Facility (GEF), United Nations Industrial Development Organization (UNIDO), and Bureau of Energy Efficiency (BEE) aims to bring down the energy consumption in Jamnagar Brass cluster located in Jamnagar (Gujarat) by supporting them to adopt Energy Efficient and Renewable Energy practices. There are more than 4,000 Small and Medium Enterprise (SME) brass units operating in the various industrial pockets of the district. InsPIRE Network for Environment, New Delhi has been appointed as the executing agency to carry out the activities in the cluster.

The activities to be conducted under the proposed energy efficiency study in Jamnagar Brass Cluster include following:

- Conducting Pre-activity Workshop
- Comprehensive energy audit in 6 Brass units
- Discussion with 3 cluster experts and 2 equipment suppliers to develop best operation practice document for 5 key technologies
- Enumeration of common regularly monitorable parameter at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same
- Identification of set of energy auditing instruments that should be used for carrying out periodic energy audits in the units
- Conducting 3 post energy audit technical workshops for knowledge dissemination

As part of the activities conducted under the energy efficiency study in Jamnagar Brass cluster, detailed energy audits in 6 Brass units in Jamnagar was conducted in the month of July'2015.

Executive Summary

Name of SME unit : M/s Metal Alloys Corporation

Location of the SME unit : Plot No. 6/7, Village- Lakhabaval, Post- Khodiyar Colony, Jamnagar, Gujarat

Based on the measurements carried out and data collected during field visit in the month of July'2015 and analysis of the data, process wise scope for energy efficiency improvement are identified and relevant recommendations are made. The proposed energy saving measures along with the annual savings, investment required and the simple payback period is given the Table 1 below:

Table 1: *Cost Economic Analysis*

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback period (Year / months)
1	Avoiding overfilling of metals in the Induction Furnace	87,278	Nil	Immediate
2	Avoiding super heating of metals in the Induction Furnace	22,968	Nil	Immediate
3	Laddle Preheating	45,936	Nil	Immediate
4	Installation of timers in Cooling Tower (CT) fan system	9,416	17,000	1 year 10 months
5	Replacing conventional blades of cooling tower fans with energy efficient Fiber Reinforced Plastic Blades (FRPB)	8,560	40,000	4 years 8 months
6	Installation of Air Fuel Controllers	263,424	30,000	3 months
7	Installation of waste heat recovery system (recuperators)	240,000	150,000	7 months
8	Replace conventional ceiling fan with Energy Efficient (BLDC) Ceiling fan	60,888	198,000	3 Years 1 month
9	Replace 55W florescent tube light with T-8 (20W) LED light	27,776	20,800	9 months
10	Replace 70W CFL with 35 W rocket LED lamp	45,830	678,047	1 Year 6 months
11	Replace 65W CFL with 35 W rocket LED lamp	160,406	203,412	1 Year 4 months
12	Replace 27W CFL with 15 W rocket LED lamp	20,415	46,991	2 Years 4 months
13	Replace 150W halogen street light with 60W LED street light	39,715	32,880	10 month
14	Replace 500W metal halide light with 60W LED street light	113,088	258,024	2 Years 4 months
	Total	**1145,700**	**1675,154**	

▸ Electrical Panels:

The unit has contract demand of 800 kVA. The unit has installed one transformer of capacity 2000 kVA, of Nanda Enterprise make. This reduces the supply voltage from 11 kV to 440 V. The unit has also installed automatic power factor controller to maintain power factor close to unity. There is no Maximum Demand Controller (MDC) installed in the unit although the unit has exceeded its contracted value in May 2015. It is therefore suggested to install Maximum Demand Controllers to keep the demand below the contracted value.

- **LPG Fired Reheating Furnace:**

The Liquefied Petroleum Gas (LPG) fired reheating furnace being used in the unit was measured to have lower efficiency in the range of 28%. Based on the information collected, it is suggested to use air preheater as A/F ratio controller to improve the efficiency. Some of the thermocouples being used for temperature measurement were not operational and decision regarding completeness of heating was being made based on the operator's judgement. It is suggested to install proper temperature measurement device at proper locations.

- **Installation of energy efficient pumps, lightings and ceiling fans:**

The unit has installed conventional designed lightings and ceiling fans in their factory premises which are presently consuming a significant amount of energy. Replacement of these fixtures with energy efficient equivalent will lead to significant savings in terms of energy consumption of the unit.

Introduction

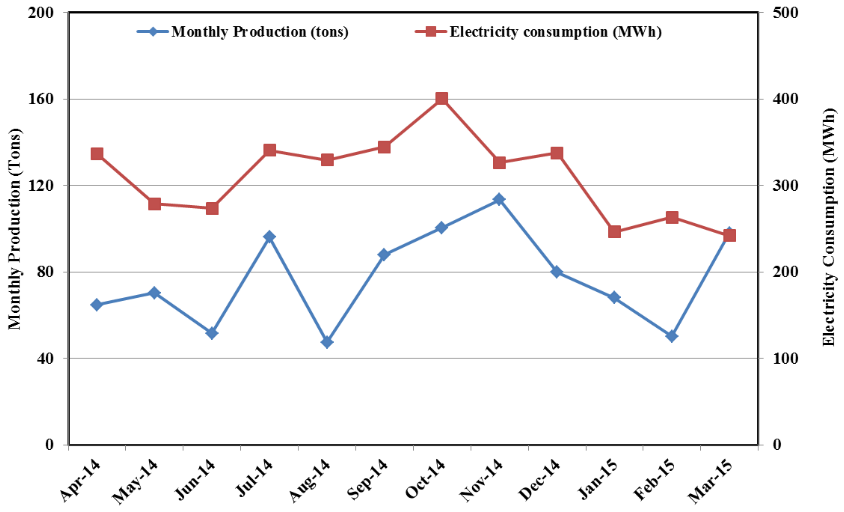
1.1 ABOUT THE UNIT

Metal Alloys Corporation is an ISO 9001:2008 certified company and is engaged in manufacturing of Copper and Copper Alloys Cast, Extruded and Drawn products, viz. Billets/Ingots, Mother Shells, Tubes/Pipes, Hollow/Solid Rods, Sections, Profiles, etc. The production range of the unit is given in Table 1.1.

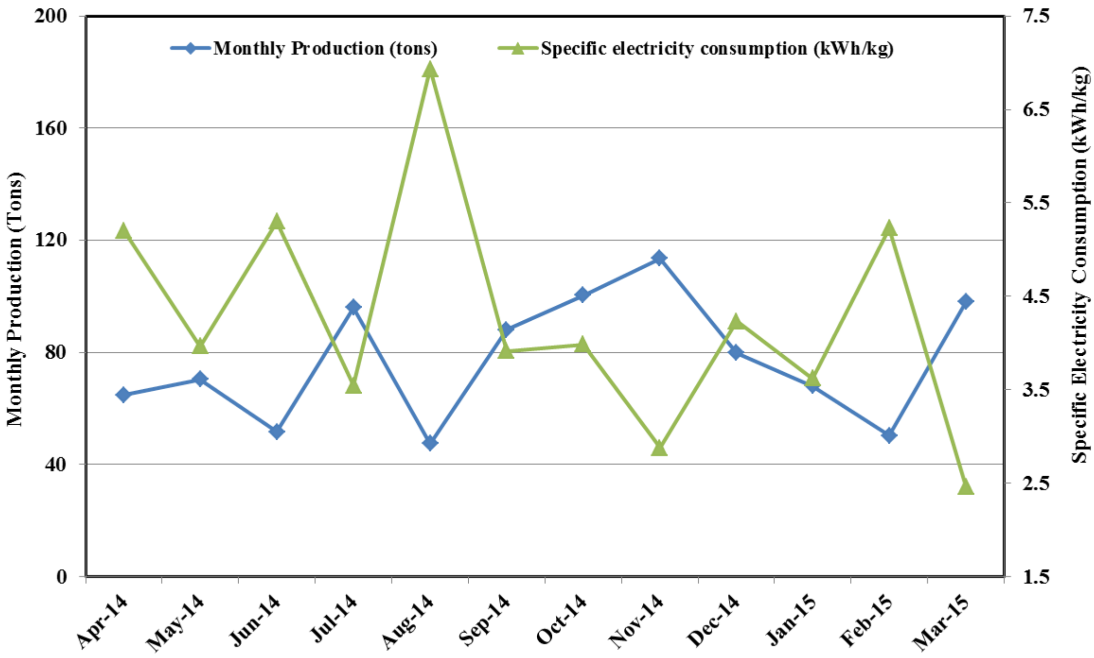
Table 1.1 ***Production Range***

Production range : TUBES / RODS / HEX / SQUARE / FLAT / PROFILE / HOLLOWS	
Tubes	6.35 mm to 110 mm
Round Rods	6 mm to 250 mm
Hex	5 mm to 60 mm
Square	4 mm to 60 mm
Flat	5 mm Min Thickness and 120 mm Max Width
Profile	As per Customer Drawing
Hollow Rods	Min Bore size 20 mm and Max OD 130 mm

The monthly production of the Unit is around 250 MT. The Unit uses electricity supply from State Electricity Boards (SEBs) for various process and utility applications in the premises and LPG for billet reheating furnace. Figure 1.1 depicts monthly electricity consumption vis-à-vis total monthly production of the unit for last one year.



(a) - Monthly variation of production and electricity consumption



(b) – Monthly variation of production and specific electricity consumption

Figure 1.1: ***Electricity consumption and production details***

Inference: It can be observed from the above figures that the monthly energy consumption is directly proportional to the production for a month. However, specific energy consumption is inversely proportional to the production. Lower the productivity of the plant, higher is the specific electricity consumption. This implies that lower productivity means lower utilization of the equipment thus leading to higher downtime and high specific energy consumption.

However, as observed in Figure a and b above, anomalies in direct relationship between production and electricity consumption can be observed in certain months like August 2014 and November 2014. For the month of August 2014, the unit has a low production and a high energy consumption and reverse in the month of November 2014, wherein the unit has a high production with low energy consumption. These anomalies can be related to reasons such as lower productivity due to low demand, idle running of machines, higher rate of rejections, lower utilization and high peak hour operations.

Major electricity consumption is required by electrical induction furnace for scrap melting operation. Unit uses LPG for re-heating furnace for carrying out heating of billets.

The monthly LPG consumption in the Unit is around 7,034 kgs. According to the assessment of the energy consumption data collected, the specific thermal energy consumption and specific electrical energy consumption is 0.09 kg and 4.01 kWh per kg of product respectively. The total specific energy consumption (in kCal) is 4530.44 kCal per kg of product. Details of annual electrical and thermal energy consumption and specific energy consumption details in Metal Alloys Corporation are presented in Table 1.2.

Table 1.2: ***Details of M/s Metal Alloys Corporation***

SN	Parameter	Value	Unit
1	Name and address of unit	Metal Alloys Corporation, Plot No. 6/7, Village- Lakhabaval, Post- Khodiyar Colony, Jamnagar, Gujarat	
2	Contact person	Mr. Rajiv Mehta, Mobile: +91-9328105171	
3	Manufacturing product	Copper and Copper Alloys Cast, Billets/Ingots, Mother Shells, Tubes/Pipes, Hollow/Solid Rods, Sections, Profiles	
4	Production	3,000 MT per annum	
	Energy utilization		
5	Average monthly electrical energy consumption	310,014	kWh per month
6	Average monthly thermal (LPG) energy consumption	7,034	kg per month
7	Average thermal specific energy consumption	0.09	kg of LPG /kg of product
		1081.84	kCal/kg of product
8	Electrical specific energy consumption	4.01	kWh/kg of product
		3448.6	kCal/kg of product
9	Specific energy consumption	4,530.44	kCal/kg of product
10	Electrical energy cost	30.87	Rs/kg of product
11	Thermal energy cost	5.04	Rs/kg of product
12	Total energy cost	35.91	Rs/kg of product

Note:

Specific gross calorific value of LPG is considered as 11900 kCal/kg

Thermal equivalent for one unit of electricity is 860 kCal/kWh.

Cost of LPG= Rs. 56 per kg (from LPG bills)

Cost of Electricity = Rs. 7.7 per unit (average cost calculated from electricity bills provided by units)

Figure 1.2 provides annual energy mix for both electrical and thermal energy on cost (in Rs.) as well as kCal basis. It can be observed that the share of electrical energy is high as compared to thermal energy as LPG is mainly used in reheating furnace for heating of billets.

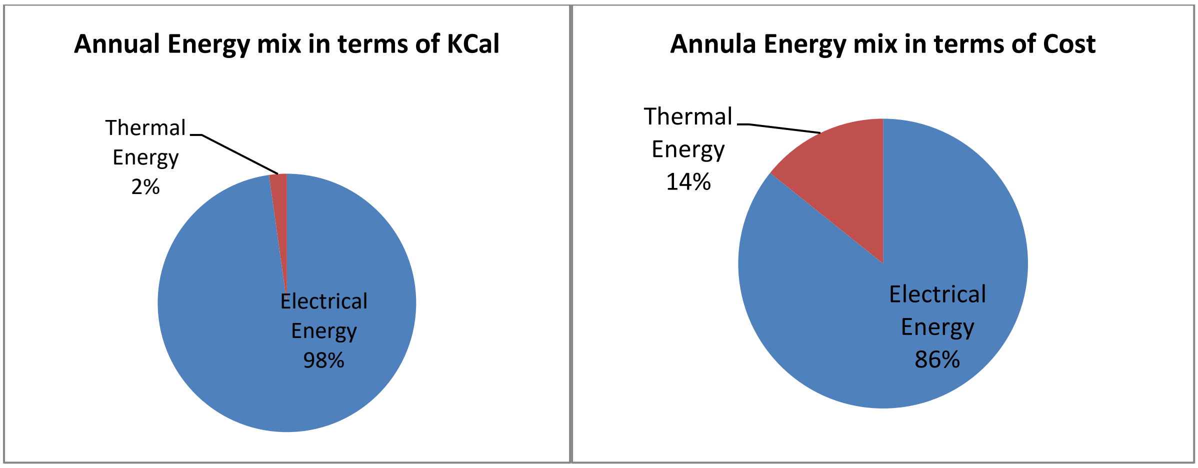


Figure 1.2: ***Annual Energy Mix for Electrical and Thermal Energy***

1.2 ENERGY AUDIT METHODOLOGY

The primary objective of the energy audit was to study prevailing energy consumption pattern and to identify scope for energy efficiency improvement through technical intervention as well as inclusion of best operation practices. Figure1.3 depicts the flow chart of activities being adopted for detailed energy audit study.

The activities for the current project started with organization of a pre-activity workshop attended by local unit owners, representatives from UNIDO. During the workshop, project objectives along with support required from the units were also discussed. After this workshop, six units for further consideration of energy audit studies were selected by the local association.

After selection of units, preliminary information relating to the energy consumption by the units was collected in a structured questionnaire. The intent of this preliminary data collection was mainly to get preliminary details about the units to make the energy audit process more effective. A copy of the same questionnaire is attached as ***Annexure 1***. Thereafter, field visit to selected industries was carried on a mutually decided dates. During energy audits, detailed data related to specific fuel consumption, various losses, operation practices being followed at the units were measured and collected. Further the gathered data is analyzed to assess prevailing energy consumption of each unit. Further, based on the observation as well as data analysis recommendations related to energy conservation opportunities are also made. List of measuring instruments used during detailed energy audit are summarized in Table 1.2.

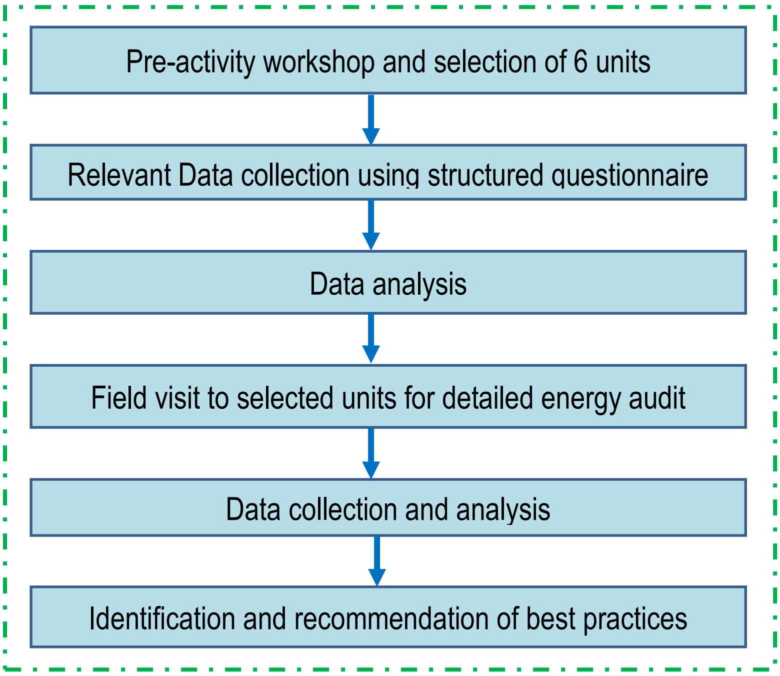


Figure 1.3: ***Flowchart depicting sequence of activities followed for carrying out detailed energy audit***

Table 1.3: ***List of instruments used during energy audit***

SN	Name of Instrument	Make / Model
1	Three Phase Power Quality Analyzer	Fluke/434/UNI
2	Single Phase Power Quality Analyzer	Fluke/43B
3	Ultrasonic Water Flow Meter	GE Panametrics/PT878
4	Rotating Vane Anemometer	Prova Ltd., Taiwan/AVM -05
5	Lux Meter	Metravi/1332
6	Portable Non-contact Infrared Thermometer	Raytek, USA/ST 80
7	Flue Gas Analyzer	Kan May, KM 900

Present Process, Observations and Proposed Technology

2.1 PRODUCTION PROCESS OF PLANT

Metal Alloys Corporation is involved in the production of Copper and Copper Alloys Cast, Billets/Ingots, Mother Shells, Tubes/Pipes, Hollow/Solid Rods, Sections, Profiles etc. The process flow chart being followed in the unit is shown in Figure 2.1. The detailed description of each step along with the type of energy input and details related to critical parameters are provided in subsequent paragraphs.

- **Raw Material Sorting and Scrap Pressing:**

The raw material received in the unit is first subjected to manual sorting based on their composition. After sorting, low density raw material are compressed in a hydraulic press. This scrap pressing is carried out only for selected raw materials and therefore machine is not operated regularly.

- **Metal Melting:**

The sorted as well as compressed scrap material is subjected to melting in the induction furnace. Based on the final product requirement, raw material composition in the induction furnace is decided. Scrap material is heated to around 1050^{0}C. The process requires electrical energy input for induction furnace as well as for pumps and motors used in the cooling circuit of induction furnace. The critical parameters to be observed in this process are composition of the molten metal as well as its temperature.

- **Metal Pouring:**

The molten metal in the induction furnace is poured directly in the dies after checking it's temperature and material composition. The unit has installed dies connected in series having the required cavity of the billet to be produced. Water is circulated in the outer shell of the dies to facilitate cooling of the poured material. Molten metal is poured from the top and after some time bottom lid is opened to remove the hot billets from the dies. This hot billet is then left for natural cooling and used for subsequent phase of operations.

- **Billet Cutting and Heating in LPG Fired Furnace:**

The billets are cut into smaller pieces based on the final product requirement using a bend saw machine. The billet cut pieces are then subjected to heating in a LPG fired furnace before extrusion process. The material is heated up to a temperature of 750^{0}C. This heating process requires electrical energy in the form of blower and thermal energy supplied through LPG burning. The detailed description of this is further provided in the subsequent section of the report.

- **Extrusion Press:**

In this process hot cut billet from re-heating furnace is squeezed in the extrusion press to produce long rods of required dimensions. The required shape and size is achieved by forcing the hot cut billets to pass through dies. These dies are also heated before passing material from these. So this essentially a size reduction step in which hot cut billets of larger diameter is converted into long rods of small diameter. The temperature of the hot cut billet is very critical to this extrusion process. If the material (hot cut billet) being put in extrusion press has lower temperature, then the electrical energy required by the press will be more. This process also results in material loss due to the removal of upper surface of the hot cut billet pieces.

- **Final Processing of Brass Rods:**

After hot drawing in the extrusion press, the brass rods are kept in open for 3 to 4 hours to facilitate natural cooling. The brass rods then goes through series of machining operations including pointing, acid washing/ pickling, drawing, cutting, straightening annealing and railing. The machining process is job specific and varies from one product to another. Major energy used in all these processes is electrical energy. Pointing process is carried out to make end of the brass rod suitable for subsequent operation. Acid wash of the brass rods is carried out mainly to remove surface impurities. Thereafter, material is subjected to cold drawing. This process would bring uniformity in the rod size throughout its length. After drawing, material is subjected to cutting to size the rods in required sizes. Finally, rods are subjected to straightening operation to make the rods straights. The materials are then subjected to annealing to make brass look better and last longer. In railing operation, brass rods are passed through rollers to make these straight as well as improve the surface finish. Finally the material is dispatched after proper inspection. The details of the electrical motors being used in these operations are summarized in the Table 2.1. Further Figure 2.2 to 2.11 provides pictorial depiction of the production process being followed in the Unit.

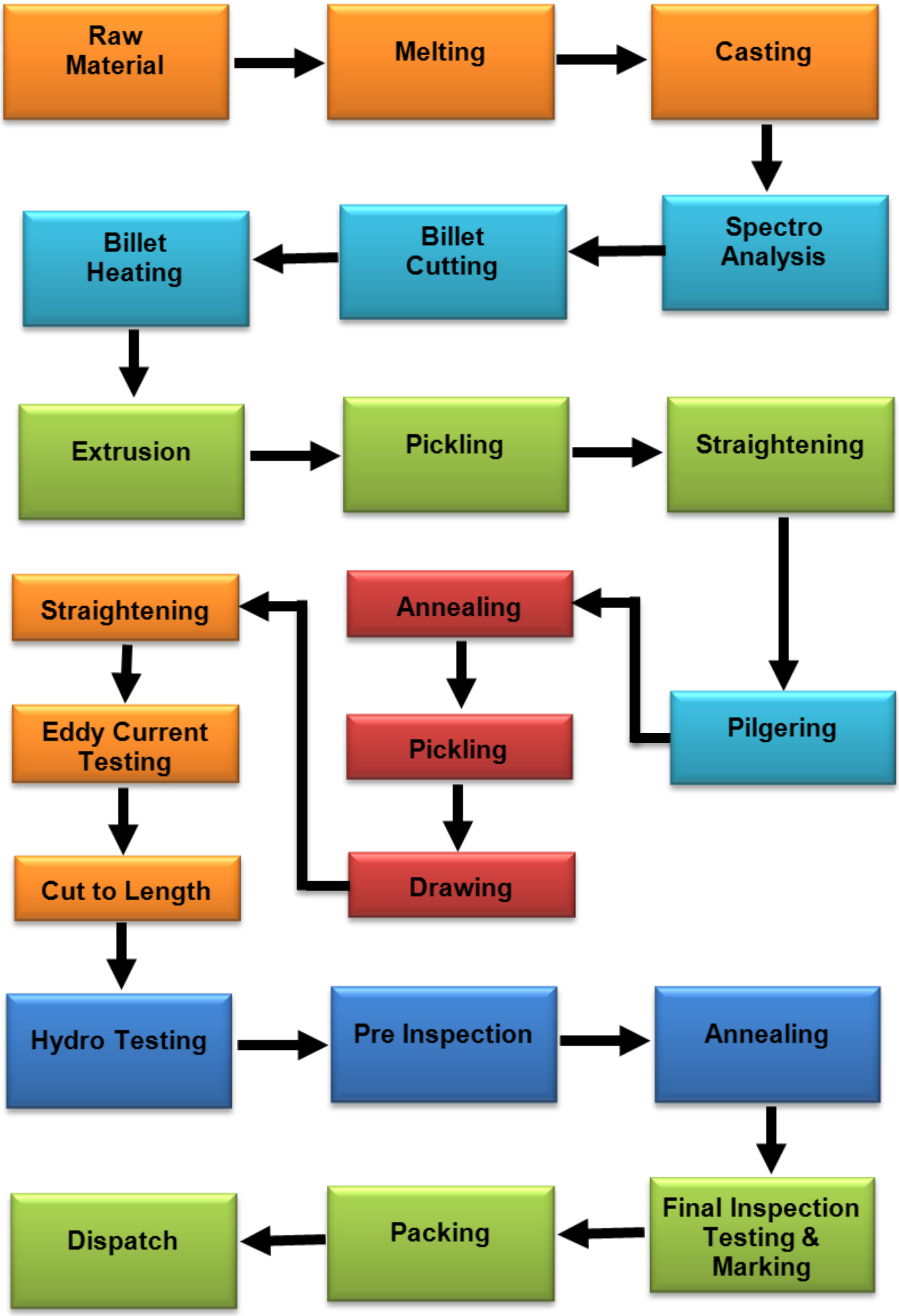


Figure 2.1: *Process flow diagram*

Pictorial Representation of Production Process

Figure 2.2: ***Scrap material and scrap pressing machine being used***

Figure 2.3: ***Feeding of scrap material in the induction furnace***

Figure 2.4: ***Melting of scrap material in the induction furnace***

Figure 2.5: ***Pouring of molten metal***

Figure 2.6: ***Billet produced after cooling***

Figure 2.7: ***Cut pieces of billets***

Figure 2.8: ***Reheating furnace for heating of billet pieces***

Figure 2.9: ***Feeding of billet piece into the reheating furnace***

Figure 2.10: ***Drawing of heated material in extrusion machine***

Figure 2.11: ***Machines being installed***

2.2 PRESENT TECHNOLOGIES ADOPTED

The unit mainly uses electrical energy for carrying out its operations. In addition, LPG is also used in billet re-heating furnace. Induction furnace is the most electricity consuming equipment. In addition, the Unit has installed extrusion press and annealing furnace. Table 2.1 below summarizes the process wise installed capacity in the unit. Further details about these machines are provided in ***Annexure 2***.

Table 2.1: *Process wise installed capacity of different equipment*

SN	Process	Number	Energy Source	Rated Consumption
1	Induction Furnace	2	Electricity	350 kW x 2, Crucible Capacity (1 ton)
2	Cutting Machines	2	Electricity	Total 34.5 HP
3	Gas reheating furnace	1	Electricity (Blower), Thermal (LPG)	Blower (10 HP), Conveyor belt (5 HP)
4	Hydraulic press	5	Electricity	200 HP (5 Nos) and 20.5 HP
5	Lathe Machines	8	Electricity	Total 28.5 HP
6	Pointing Machines	2	Electricity	27 HP
7	Pigger Mill	1	Electricity	256.5 HP
8	Straightening	1	Electricity	15 HP
9	Nitrogen Plant	1	Electricity	130 HP
10	Annealing Furnace	3	Electricity	170 kW and 12.5 HP, 210 kW and 12.5 HP, 180 kW and 8 HP
11	Draw Machine	5	Electricity	34.2 HP (2), 53.7 HP (2), 107.7 HP (1), 17.5 HP (1)
12	Pointing Machine	1	Electricity	28.55 HP

2.3 DETAILED ENERGY AUDIT

During the field visit to the unit detailed measurement of the following equipment were carried out. Following sections provides present observations and recommendations for each equipment to improve energy efficiency.

2.3.1 Electrical Panels

▶ Present System and Observations:

The unit has contract demand of 800 kVA. The unit has installed one transformer of capacity 2,000 kVA, Nanda Enterprise make. The complete specification of the transformer is given in Table 2.2. This reduces the input grid supply voltage from 11 kV to 440 V. The unit has installed three Automatic Power Factor Controller (APFC) panels of 600 kVAR, 100 kVAR and 210 kVAR capacity, to maintain power factor close to unity. Maximum demand controller is not installed while it has been observed from the electricity bills that the unit has exceeded its contracted value in May 2015.

Furthermore, due to APFC installation the power factor of the unit was observed to be on the higher side (close to unity). The specification of the APFC Panel is given in Table 2.3.

Table 2.2: ***Transformer Specification***

Make	Nanda Enterprise
Capacity	2,000 kVA
Voltage ratio	11,000 / 433 Volt
Volume of oil	2,000 liters
Mass	6250 kg

Table 2.3: ***Capacitor Bank Details***

APFC Panel-1	600 kVAR
APFC Panel-2	100 kVAR
APFC Panel-3	210 kVAR

2.3.2 LPG Fired Billet Reheating Furnace

- **Present System:**

The unit has installed LPG fired billet re-heating furnace to bake the cut billets piece at temperature of around 750°C. The furnace has got set of LPG burners located at both the sides of the furnace. LPG fuel is supplied through burner nozzles and air for combustion is supplied using motor driven blower. Cut billet pieces are placed from the charging door of the billet reheating furnace, whereas, the hot billets are taken out from the other side of the reheating furnace or discharge door. The details of the furnace specifications and the schematic drawing are given in Table 2.4 and Figure 2.12.

Table 2.4: ***Furnace specifications***

LPG fired Billet Heating Furnace Dimensions	1.7 m x 1.14 m x 3.5 m
Fuel type input	LPG
Blower motor rating	10 HP
Conveyor Motor rating	5 HP
Fuel consumption	13.3 kg/hr
Hours of operation per day	21 hours

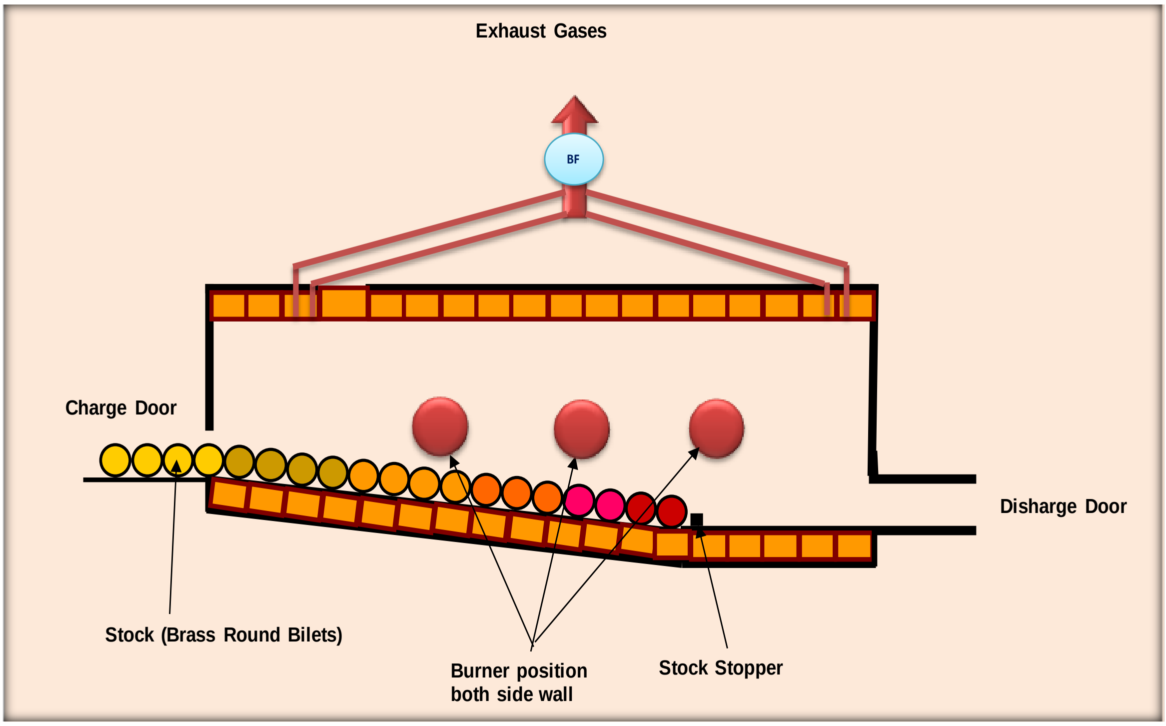


Figure 2.12: *Schematic diagram of the billet reheating furnace*

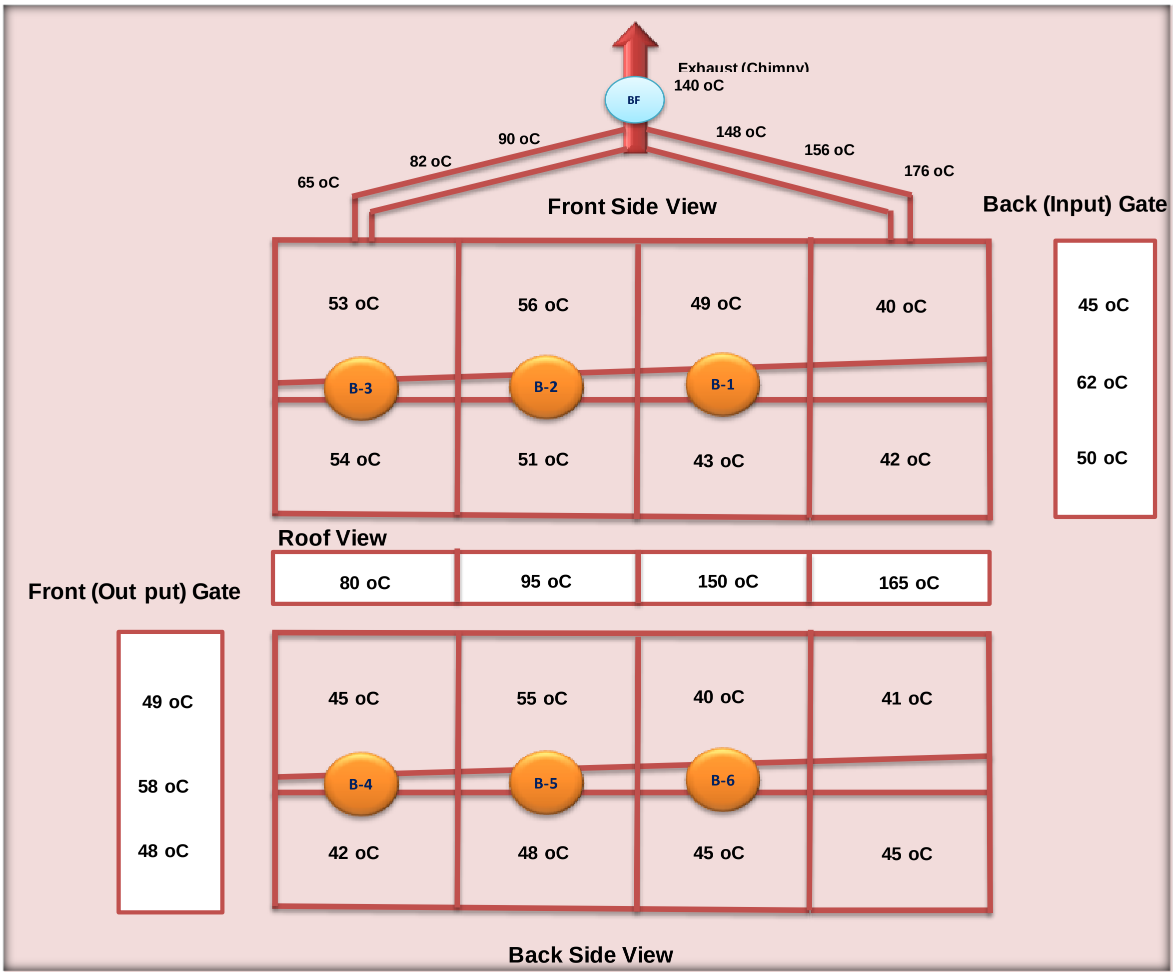
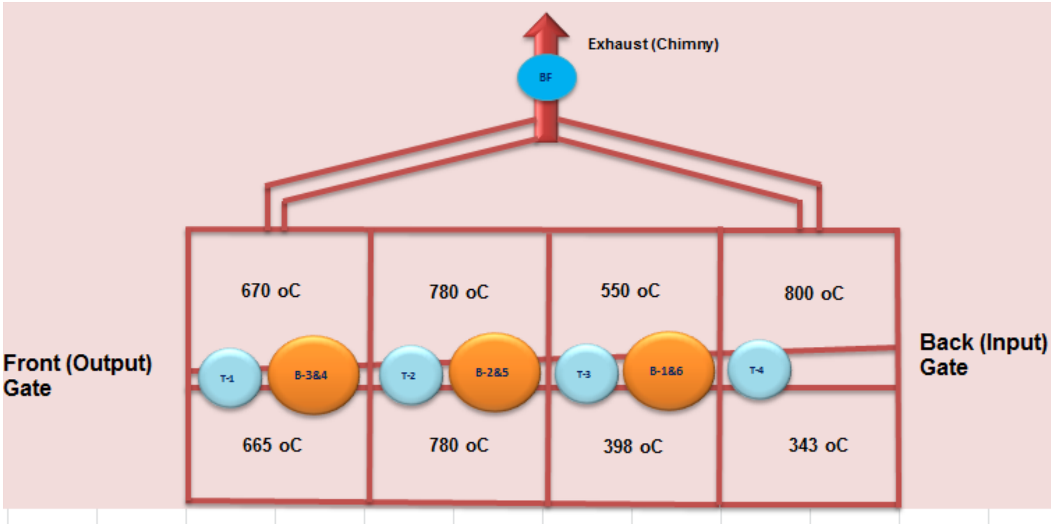


Figure 2.13: *Surface Temperature Profiling of Existing Reheating Furnace*



B indicates as Burners
T indicates as Thermocouple

Figure 2.14: ***Inside Temperature in the reheating furnace***

During field visit to the unit, reheating furnace performance assessment was carried out. Data related to fuel consumption, time of operation, furnace temperature, exhaust (flue gas composition & temperature) was measured. The data related to one complete charge was measured and collected. Based on the measurement and field visit, following observations are made.

- There were thermocouples installed in different zones to measure temperature inside the furnace. They have set maximum and minimum temperature limit for each zone, these are controlled automatically by either stopping or starting fuel supply to the burners. However, the air flow corresponding to the fuel flow is not maintained as the systems do not have any automatic air control system installed. In addition, the ID fan in the plant was not in operation. Under the scenario, air flow was higher than recommended due to which O_2% in the flue gas is higher.
- It was found that some of the thermocouple installed for temperature measurement inside the furnace was not functioning.
- Exhaust flue gas temperature was found to be around 140°C. There is no provision of exhaust heat recovery. The flue gas analysis/measurement is given in Table 2.5 below.
- O_2 and CO_2 in exhaust gas indicate around 200% of excess air
- LPG fuel consumption was found to be around 13.2 liters per hour. Efficiency of the furnace is calculated at 23.19%. The detailed efficiency calculation is attached as ***Annexure 2.***
- High temperature was observed on both sides of the furnace near the burner
- Insulation was found to be broken on some of the places of the furnace

Table 2.5: ***Flue Gas Analyzer Measurement Reading***

Exhaust Temp (°C)	CO_2 (%)	O_2 (%)	CO (ppm)
140	5.3	14.7	24

- **Recommendations:**

1. **Maintain Air-fuel ratio**: The furnace temperature is controlled by only controlling fuel input and not the air input. This increases the air flow inside the furnace and losses heat. It becomes difficult to maintain air fuel ratio, it is suggested to install automatic air-fuel ratio to have complete combustion and enhance the furnace efficiency.
2. **Online temperature measurement**: It is suggested to check the working of the thermocouples installed at appropriate locations. This would help in heating the material to the required temperature without causing any judgmental error.
3. **Installation of waste heat recovery system (recuperator):** The temperature of flue gas was measured to be around 524^{0}C which is being discharged to the atmosphere. It is suggested to use a suitable design waste heat recovery system (recuperator) in the exit flue duct to pre-heat the air being used for combustion using the waste exhaust heat to improve overall efficiency of the furnace.

The cost economic analysis of the above suggested measures are compiled in Table 2.6. It can be observed that all the measures suggested towards energy efficiency improvements of furnaces have good payback period of less than 6 months.

Table 2.6: *Cost Economic Analysis – Reheating Furnace*

SN	Energy Efficient Measure	Estimated Fuel savings (Liters/year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year)
1	Installation of Air-fuel ratio controller	9,408	263,424	30,000	3 months
2	Installation of waste heat recovery system (recuperator)	6,000	240,000	150,000	7 months

2.3.3 Induction Furnace:

- **Present System and Observations:**

The present operational practice of the induction furnace (350 kW with crucible capacity 1 ton) was studied in detail and an analysis of the same is carried out. It was observed that the total melt time is 1.30 hours, and the total pouring time is 13 minutes and the temperature achieved is 1086^{0}C. Total input scrap material was around 954 kgs, and metal output was 944 kgs, generating burning loss is 1%. Heel metal around 10~15% is kept in the furnace. Separate energy meter is installed to the induction furnace to record the electrical energy consumed per charge. Figure 2.15 provides pictorial representation of installed furnace.

Figure 2.15: ***Heating of material in induction melting furnace***

▶ Recommendations:

- Best Practice #1 (Material Log Book): Maintain log records of type and quantity of scrap material being used and electricity consumed for every charge (See ***Annexure 4***).
- Best Practice #2 (Furnace Loading & Operation): Level of molten metal should not exceed the level of induction furnace coil (See ***Annexure 5***).
- As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy.
- Holding of furnace should be avoided by proper planning in advance for sample analysis / testing and make available moulds.
- Heel metal should be avoided.
- During checking of metal composition (or sample testing) and pouring of molten metal in moulds, power supply to the induction furnace should be reduced to around 25% of the full capacity.
- For cooling of the Induction furnace cooling circuit and cooling tower is used. It is suggested to install timers in the cooling tower fan system and also replace the conventional cooling tower fan blades with fibre reinforced plastic blades which leads to sufficient energy saving owing to the better aerodynamic shape of its blades

The cost economic analysis of the above suggested measures are compiled in Table 2.7. It can be observed that all the measures suggested towards energy efficiency improvements of furnaces have good energy saving with less payback period

Table 2.7: ***Cost Economic Analysis – Induction Furnace***

SN	Energy Efficient Measure	Estimated Fuel savings (kWh/year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years / months)
1	Avoiding overfilling of metals in the Induction Furnace	11,637	87,278	Nil	Immediate
2	Avoiding super heating of metals in the Induction Furnace	3,062	22,968	Nil	Immediate
3	Installation of timers in cooling	1,256	9,416	17,000	1 year 9 months

SN	Energy Efficient Measure	Estimated Fuel savings (kWh/year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years / months)
	tower fan system				
4	Installation of energy efficient fiber reinforced plastic blades	1,141	8,560	40,000	4 years 8 months
	Total	**17,096**	**128,222**	**57,000**	

2.3.4. Installation of Energy Efficient Lightings

▶ Present System:

The unit has installed conventional lighting systems in the factory premises, comprising of florescent tube lights, compact florescent lamps and halogen lights. The unit has 32 nos. of florescent tube lights of 40 W each, 49 nos. of compact florescent lamps of 27 W each, 132 nos. of compact florescent lamps of 70 W each, 9 nos. of sodium lights of 150 W each and 12 nos. of halogen lights of 500 W each.

▶ Observations:

During the plant visit, a study was carried out to find out the energy saving potential from replacement of existing plant lightings with energy efficient equipment and fixtures. Detailed compilations of energy consumed by the different lighting fixtures were carried out and compared vis-à-vis to the use of energy efficient lightings. In order to find out the capacity required for the new fixtures, existing lux level was checked and desired capacity of replaced energy efficient lighting based on the existing lux level was determined.

▶ Recommendations:

Based on the observation made at site and detailed analysis of the existing system, it is suggested to replace the existing lighting with energy efficient pumps, lightings and ceiling fans. The table below summarizes the list of equipment and fixtures to be replaced with energy efficient equipment and fixtures:

Table 2.8: ***Replacement of conventional lightings***

Existing system	Equivalent Propose system
27W compact florescent lamp - 49 Nos.	15 W rocket LED lamp – 49 Nos.
70W compact florescent lamp - 132 Nos	35W rocket LED lamp – 132 Nos
65W compact florescent lamp - 44 Nos	35W rocket LED lamp – 44 Nos
40W florescent tube light – 32 Nos.	T-8 (20W) LED light – 32 Nos.
150W sodium light – 09 Nos	60W LED street light – 09 Nos
500W halogen light – 12 Nos	150 W LED light – 12 Nos

The estimated annual savings, estimated investment and simple pay-back for replacement of existing lightings with energy efficient equivalent is summarized below:

Table 2.9: ***Cost-benefit analysis – installation of energy efficient ceiling fan***

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback period (Year / months)
1	Replace conventional ceiling fan with Energy Efficient (BLDC) Ceiling fan	60,888	198,000	3 Years 1 month

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback period (Year / months)
2	Replace 55W florescent tube light with T-8 (20W) LED light	27,776	20,800	9 months
3	Replace 70W CFL with 35 W rocket LED lamp	45,830	678,047	1 Year 6 months
4	Replace 65W CFL with 35 W rocket LED lamp	160,406	203,412	1 Year 4 months
5	Replace 27W CFL with 15 W rocket LED lamp	20,415	46,991	2 Years 4 months
6	Replace 150W halogen street light with 60W LED street light	39,715	32,880	10 month
7	Replace 500W metal halide light with 60W LED street light	113,088	258,024	2 Years 4 months

2.3.5 Exploring Opportunity for Renewable Energy Usage

During field visit, opportunities of using renewable energy applications were explored. However, based on the higher temperature requirement in the operation process possibility of using solar thermal technology for thermal applications may not be applicable. Further, there was also constrained related to the area. Finally, during discussion with unit owner, possibility of using renewable energy was ruled out due to lesser anticipated savings against the cost and operational complexity associated with renewable energy interventions.

Questionnaire*

Energy Audit – Questionnaire Form

"Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India – Jamnagar Brass Unit"

Name of the MSME unit:	Metal Alloys Corporation
Address:	Plot No 647, Lakha Baval P.O. Khodiyar Colony Jamnagar 361000
Ph. No:	0288-2889251, 2889252. M. 09924443396
Name of the respondent	Y. K Tripathi
Designation:	G.M.

1. **Year of Establishment:** ____________
2. **Type of Products:** a) Brass pipe
   b) Copper Pipe
   c) Cop.Ni Pipe
3. **Installed Capacity:** 3000 M.T. PA
4. **Operating hrs per day :** 24 Hrs.
5. **Connected Load:** 800 KVA **(kVA or kW please specify)**
6. **Supply Voltage:**__________ **Volt**
7. **Annual Energy Consumption/ Production:**

Financial Year (April to March)	2012/13	2013/14	2014/15
Coke consumed (kg) –	–	–	–
Cost of coke (in Rs.) –	–	–	–
Electrical units consumed (In kWh)	33,18,370	34,81,730	3720,171
Electricity charges (in Rs.)	2,23,33,414	2,38,38,433	2,65,27,175
LDO/HSD/ FO consumption (L) LPG kg	71430	78,770	84410
Fuel Cost (in Rs.) LPG	40,60,641	51,13,409	4757145
Production (Kg)	1003438	1035934	9928559

8. Source and Calorific Value of Fuels:

Fuel	Source	Calorific Value (kCal)
Coke (Kg)	—	
HSD (L)	—	
LDO (L)	—	
FO (L)	—	
LPG	Super gas Porbund	

Fuel	Source
Electricity (kWh)	GEB.

9. Monthly Energy Consumption and Production Data:

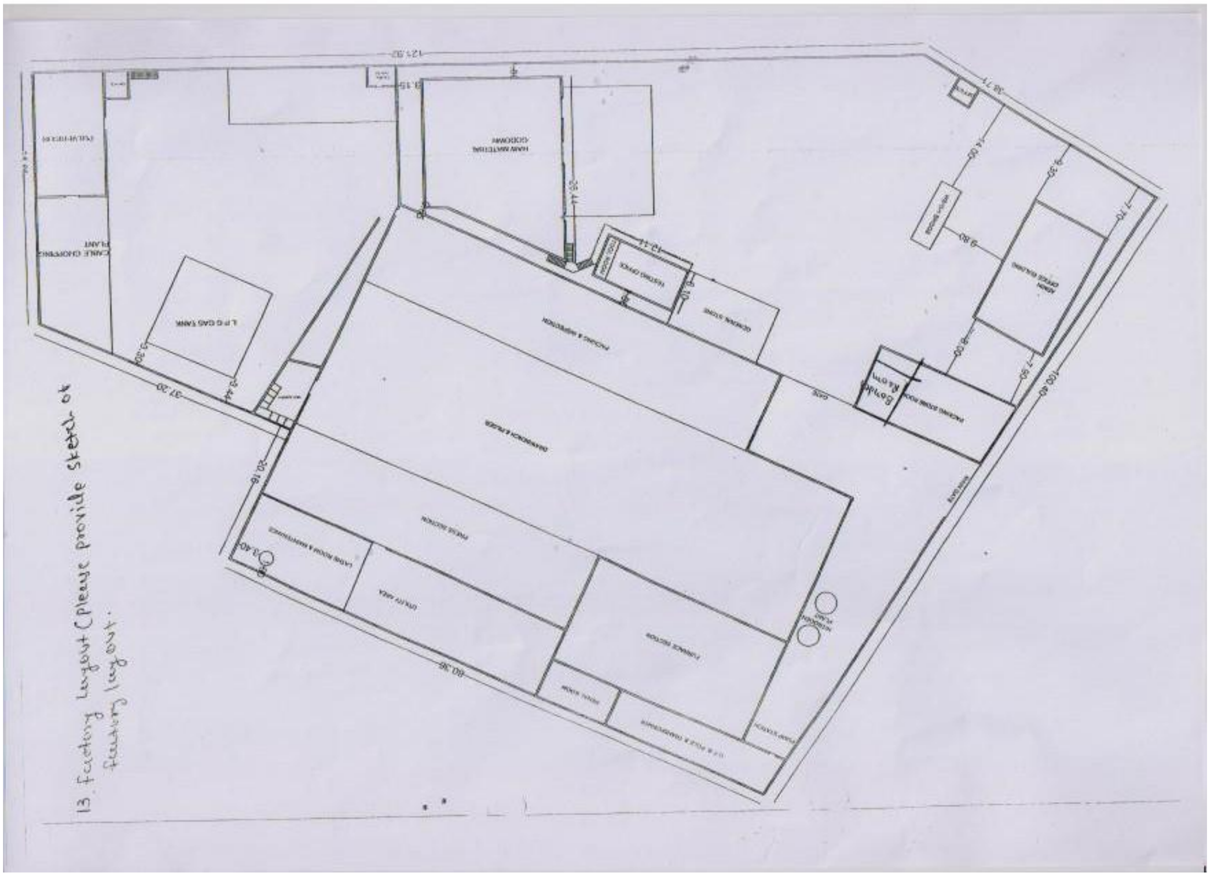
Month	Production (Kg)	Coke consumption (Kg)	Electricity consumption (kWH) Actual demand ↓	HSD/LDO /FO (L) LPG kgs	Any other fuel (specify units)
April, 14	64818	—	813 336,840	6000	
May, 14	70374	—	785 278840	6000	
June, 14	51637	—	691 273,570	6000	
July, 14	96078	—	776 360,801	6000	
August, 14	47484	—	835 329,290	6000	
September, 14	88059	—	797 344700	14700	
October, 14	100450	—	981 400,370	5910	
November, 14	113447	—	901 326,460	7120	
December, 14	79826	—	680 337,780	6000	
January, 15	68006	—	725 246,390	6000	
February, 15	50310	—	752 263,200	6680	
March, 15	98070	—	778 241930	8000	
	928559		37,20,171		

10. Duration of electricity supply: 24 Hours/ day

11. Cost variables per Kg of Production: 2014-15

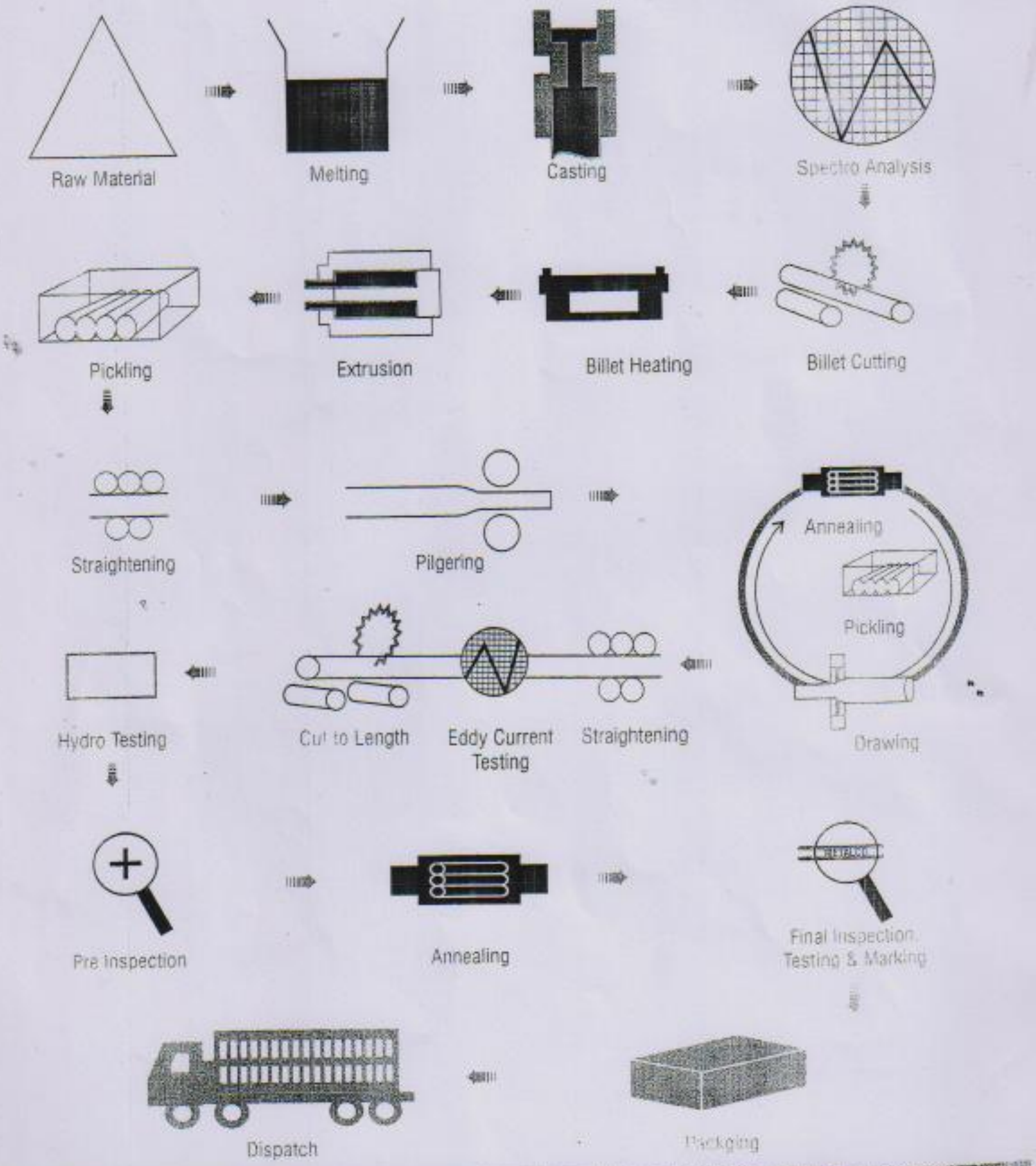
Cost Variable	Cost/ kg of production
Electricity Cost 2,62,74,160	25/55
Coke Cost —	—
Fuel Cost (LDO/HSD/FO) etc. LPG	00/77
Labour Cost	18/76
Material Cost	354/82
Other Cost	43/99
Total Production Cost	443/89

SN	Equipment	Energy source	Make/ Supplier	Year of Installation	Technical Specification/ capacity	Use	Comments
	Furnace (1) " (2) Oxiliary	330 KW 220 K.W [illegible] KW	pioneer Furnace pvt ltd	2005/06	1 TON 2 TON	R.M.	
	Extrusion press	650 KW	Siddhee Enterprise	2005/06	~~1250 MT~~ 15 MT/day	Ext. press	
	Billet Heater	18 K.W	Combustion Equip. Indust	2005/06	1 TON/Hr		
	pump House	18 KW	[illegible]	2005/06			
	pillger Mill	100 KW	Nuhas Oman LLC	2005/06	7 ~~[illegible]~~ MT/day		
	[illegible]	[illegible] KW	Parth Equipment	2005/06 2006/07	125 MT/month		
	Annealing	230 KW 160 KW 160 KW	Combustion Equip. Indust	200[illegible]/06	~~28~~ MT/day 15 MT/day 10 MT/day		
	[illegible]	~~[illegible]~~ 625 KVA 160 KVA	Sudhir Gensets	[illegible]			


13. Factory Layout (please provide sketch of factory layout.

Copper & Copper Alloys

Process flow chart...



METALCO

LOD LIST					
Furance Section lod					
Furnace-1	330 kw				
Furnace-2	220 kw				
Oxlaury	22 kw				
Extrusion Section					
Extrusion Press	650 kw				
Billet Furnace Section					
Billet Heater	18 kw				
Water Curcullar System					
Pump House	35 kw				
Pillger Section					
Pillger Mill	100 kw				
Draw Bench Section					
Draw Bench	220 kw				
Annealing Section					
Annealing	160 kw				
Grand Total Kw	1755 Kw				

Annexure 2:

Furnace Efficiency Calculations

Parameter	Unit	Value
Total weight of cut billets heated	kg	570
Specific heat of Brass	kCal/kg ^{0}C	0.09
Fuel Consumption per hour	kg/hr	13.2
Calorific Value	kCal/kg	11,900
Initial temperature cut billets	^{0}C	40
Final temperature cut billets	^{0}C	750
Total Input Energy	kCal	157080
Total Output heat	kCal	36423
Furnace Efficiency	%	23.19%

Annexure 3:

Load Details in the Unit

SN	Equipment	Energy Source	Make/ Supplier	Nos. of Installations	Technical Specification/Capacity
1	Induction Furnace	Electric		1	300 kg (Crucible)
2	Induction Furnace Pump Motor	Electric		1	1 HP
3	Induction Furnace Pump Motor	Electric		1	0.5 HP
4	Induction Furnace Pump Motor	Electric		1	0.5 HP
5	Extrusion Press	Electric	Kirloskar	1	50 HP
	Reheating furnace	Thermal (LPG)			
6	Pointing Machine	Electric		1	0.5 HP
7	Drawing Machine	Electric		1	3 HP
8	Straitening Machine	Electric		1	1 HP
9	Cutting Machine	Electric	Kirloskar	2	0.5 HP (each)
10	Cutting Machine	Electric	Kirloskar	9	1 HP (each)
11	Cutting Machine	Electric	Kirloskar	1	10 HP
12	Pressing Machine	Electric		2	0.5 HP (each)
13	Forging Machine	Electric		1	7 HP
14	Forging Machine	Electric		1	5 HP
15	Threading Machine	Electric		4	2 HP (each)
16	Threading Machine	Electric		3	1 HP (each)
17	Drilling Machine	Electric		2	1 HP (each)
18	Grinding Machine	Electric		3	0.5 HP (each)
19	Grinding Machine	Electric		1	1 HP
20	Turning Machine	Electric		4	2 HP (each)
21	Turning Machine	Electric		3	1 HP (each)
22	Surface Smoothing Machine	Electric		2	0.5 HP (each)
23	Slotting Machine	Electric		1	1 HP
24	DG Set	Electric	Kirloskar	1	7.5 kVA
25	Capacitor Bank	Electric		5	3 kVAR (each)
26	Capacitor Bank	Electric		1	10 kVAR

Material Log Book – Induction Furnace

Furnace ID:	……………………………	**Date**	…………………	**Charge Number**	………..	**Material Type**	…………………

Time Details

Melting		**Holding**		**Pouring**	
Start Time (A)	………..	Start Time (D)	………	Start Time (G)	………
End Time (B)	………..	End Time (E)	………	End Time (H)	………
Total time (C) = (B) – (A)	………..	Total time (F) = (D) – (C)	………	Total time (I) = (F) – (E)	………

Temperature Details

Melting Temperature (^{0}C)	……………………
Tapping Temperature (^{0}C)	……………………
Pouring Temperature (^{0}C) at start of pouring	……………………
Pouring Temperature (^{0}C) at end of pouring	……………………

Electricity Consumption (kWh)

Initial Reading (J)	……………………..
Final Reading (K)	……………………..
Total Electricity consumption (L) = (K)-(J)	……………………..

Material Input

SN	**Material Type**	**Quantity (kg)**
1	……………………………………	……………..
2	……………………………………	……………..
3	……………………………………	……………..
4	……………………………………	……………..
5	……………………………………	……………..
6	……………………………………	……………..
7	……………………………………	……………..
Total Input Material (M)		……………..
Total Material Output (N)		……………..
Material Lost (O) = (M) – (N)		……………..
Specific Electricity consumption (kWh/tons) (P) = (L) * 1000/ (M)		……………..

Remarks: Please capture any other information related to operation like reason for furnace holding, higher time taken for furnace holding etc…

Best Operating Practice

Following are the best practices to be followed for efficient operation of induction furnaces

- Maintain log records of type and quantity of scrap material being used and electricity consumed for every charge
- Loading of scrap material should always be done till the induction furnace coil height.
- As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy.
- Holding of furnace should be avoided by proper planning of moulds / shells in advance.
- Heel metal in the induction furnace should be avoided.
- During pouring and scrap composition measurement, power supply to the induction furnace should be reduced to around 25% of the full capacity.