National Program

on

Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India

Indore Foundry Cluster

Detailed Energy Audit Report
Mitasha Industries Ltd.

Submitted to

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InsPIRE Network for Environment

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Abbreviations

APFC	Automatic Power Factor Controller
BEE	Bureau of Energy Efficiency
BHEL	Bharat Heavy Electricals Ltd.
CI	Caste Iron
DB	Distribution Panel
FRPB	Fiber Reinforced Plastic Blades
GEF	Global Environment Facility
HP	Horse Power
kcal	Kilo Calories
kg	Kilogram
kVA	Kilo Volt Ampere
kW	Kilo Watts
kWh	Kilo Watt Hour
LT	Low Tension
MDC	Maximum Demand Controller
MCB	Miniature Circuit Breaker
MSME	Ministry of Micro Small and Medium Enterprises
PF	Power Factor
SEB	State Electricity Board
SEC	Specific Energy Consumption
SME	Small and Medium Enterprise
SG	Spheroidal Graphite
TOD	Time of Day
THD	Total Harmonic Distortion
UNIDO	United Nation's Industrial Development Organization
VFD	Variable Frequency Drive

About the Project

The project 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 Indore Foundry cluster located in Indore (Madhya Pradesh) by supporting them to adopt Energy Efficient and Renewable Energy practices. There are more than 20~25 Small and Medium Enterprise (SME) foundry 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 Indore Foundry Cluster include following:

- Conducting Pre-activity Workshop
- Comprehensive energy audit in 6 Foundry units
- Discussion with 3 cluster experts and 2 equipment suppliers to develop best operation practice document
- Development of Best Operating Practices Manual for top 5 technologies
- Identification of monitoring parameters and measuring instruments
- Conducting 3 post energy audit technical workshops for knowledge dissemination

As part of the activities conducted under the energy efficiency study in Indore Foundry cluster, detailed energy audits in 6 Foundry units in Indore was conducted in the month of June'2015.

Executive Summary

Name of SME unit : M/s Mitasha Industries Ltd.
Location of the SME unit : 65, Sector F, Sanwer Road, Indore-MP

Based on the measurements carried out and data collected during field visit in the month of June'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)
1	Laddle Preheating	35,424	Nil	NA
2	Avoiding over heating of metals in the Induction Furnace	35,424	Nil	NA
3	Installation of timers in Cooling Tower (CT) fan system	5,564	17,000	3.05
4	Replacing conventional blades of cooling tower fans with energy efficient Fiber Reinforced Plastic Blades (FRPB)	4280	15,000	3.5
5	Installation of capacitor banks across motors	235,222	10,000	0.05
7	Installation of Variable Frequency Drive (VFD) in Compressor	101,870	300,000	2.94

- **Electrical Panels:**

The unit has installed a single double tap transformer of 335 kVA which is used to cater to the electricity requirements of the loads of the unit including the electric furnace. It is suggested to install a separate transformer exclusively for the induction furnace to reduce the transformer dead losses. Electrical safety should be paid prime importance as presently it's been neglected. Cables to the main Low Tension (LT) distribution panel and to the loads points should be properly placed in cable trenches. It is suggested to properly place rubber (or insulating) mats on front for each of the electrical panels for safety reasons. There was no separate energy meter for induction furnace so electricity consumption measurement is not feasible. It is suggested to install separate energy meter for induction furnace. It is seen that in the main Distribution Board (DB) panel Miniature Circuit Breaker (MCB) one phase (B-Phase) is direct/bypassed which a dangerous practice. It should be immediate corrected and in future such practice should avoided.

- **Induction Furnace:**

Induction furnace is the most energy intensive equipment being used in the unit. The Unit has installed one electrical furnace of 175 kW supplied by Inductotherm (India) Pvt. Ltd. The crucible capacity of the furnace is 300 kgs. There were many deficiencies observed in the current operation practice like from 300 kgs crucible, melt of 430 kgs per charge was taken. This practice is not good for the energy saving aspect and material composition. Although, instrument for temperature measurement is available but there was no measurement being carried out. There was no data recording for electricity consumption in the furnace.

It is suggested to maintain log records of type and quantity of scrap material being used and electricity consumed for every charge. Level of molten metal should not exceed the level of induction furnace coil. Measurement of molten metal temperature is important and should be practiced by the operator. Heel metal should be avoided. During pouring and scrap composition measurement, it is suggested to reduce the power supply to the induction furnace to around 25% of the full capacity. It is suggested to avoid super heating of the metal/melt. The operator working on the induction furnace needs to be trained, so that he/she effectively utilizes the power for melting the metal. Laddle preheating is also suggested for energy saving.

- **Electric Motors:**

The unit has several motors of different size and capacity installed in different areas. Most of the motors are in the range of 5 to 7.5 HP and operated depending on requirements. It was observed that most of the motors are overloaded. Overloading can lead to overheating of the motors and may lead to its failure. It is recommended to replace these undersized motors with motors according to load requirement and they may be air-cooled. It is further suggested to install capacitor banks across motors having low power factor.

- **Compressor:**

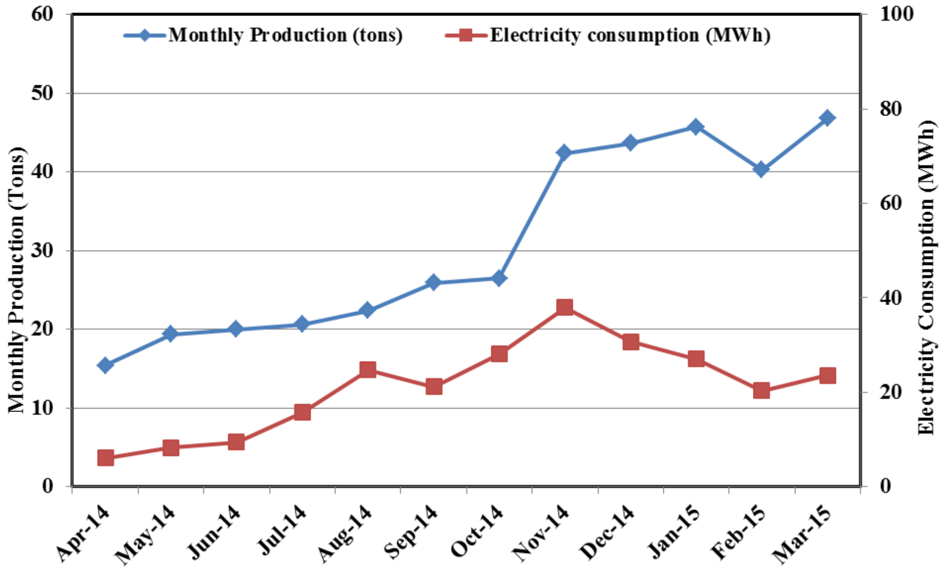
The unit has installed one 20 HP screw compressor to use compressed air in moulding section and fettling section. Based on the information collected, it is strongly recommended to carry out leakage trail fortnightly to assess the leakage level and necessary actions to be taken if any.

Introduction

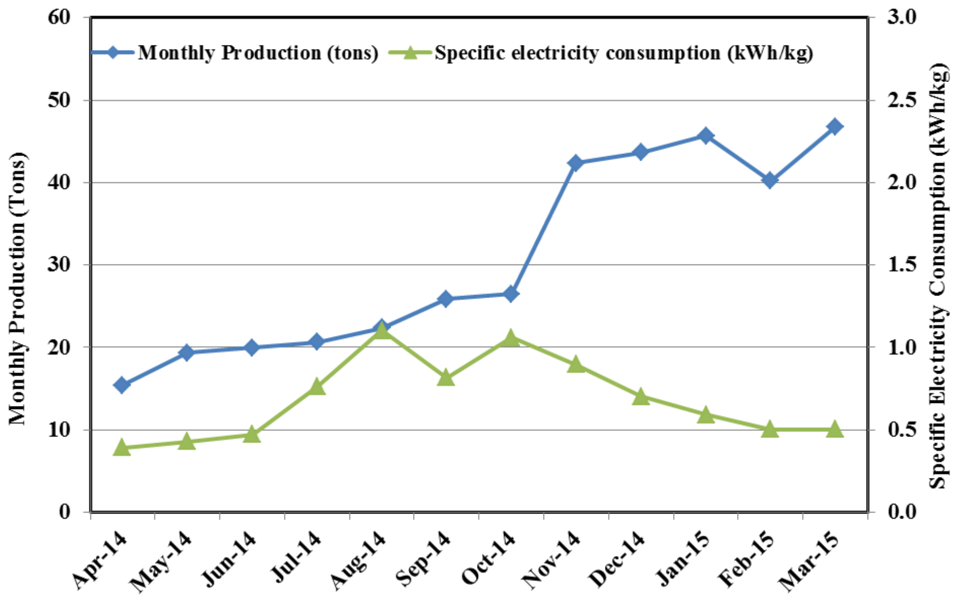
1.1 ABOUT THE UNIT

M/s Mitasha Industries Ltd. is engaged in manufacturing of different types of Cast Iron (CI) casting and Spheroidal Graphite (SG) Iron castings. Some of the key customers of the unit include Kirloskar Brothers, Jash Engineering, Avtech Ltd., Tata International, Bharat Heavy Electrical Ltd. (BHEL) Bhopal. The installed capacity of the unit is 1,500 MTA and contracted demand is 275 kVA. Further details of the unit are provided in Table 1.1

The production of the unit is approximately 31 tons per month. Electricity supplied by State Electricity Board (SEB) is the major source of energy being used by the Unit for carrying out operations. Average electricity consumption per month is around 21,000 kWh, and Specific Energy Consumption (SEC) is around 0.69 kWh per kg of the product produced. Major portion of electricity is consumed in melting, sand mixing, compressor and shot blast sections. 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 Fig a and b above, anomalies in direct relationship between production and electricity consumption can be observed in certain months like February 2015 and October 2014. For the month of February 2015, the unit has a low production and a high energy consumption and reverse in the month of October 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.

Table 1.1: ***Details of M/s Mitasha Industries Ltd.***

S. No	Parameter	Value	Unit
1	Name and address of unit	Mitasha Industries Ltd., 65, Sector F, Sanwer Road, Indore – 452010 (MP)	
2	Contact person	Mr. Aalok Singhi (CEO), Contact Number: 9826047592	
3	Manufacturing product	SG Iron Casting, Cast Iron Casting	
4	Monthly Production	31 tons	
	Energy utilization		
5	Average monthly electrical energy consumption	21,058	kWh per month
6	Electrical specific energy consumption	0.69	kWh/Kg of product
		593	kCal/kg of product
7	Specific energy consumption	593	kCal/kg of product
8	Electrical energy cost	5.12	Rs/Kg of product
9	Total energy cost	5.12	Rs/kg of product

Note:

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

Cost of Electricity = Rs. 7.5 per unit

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. Figure 1.2 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.

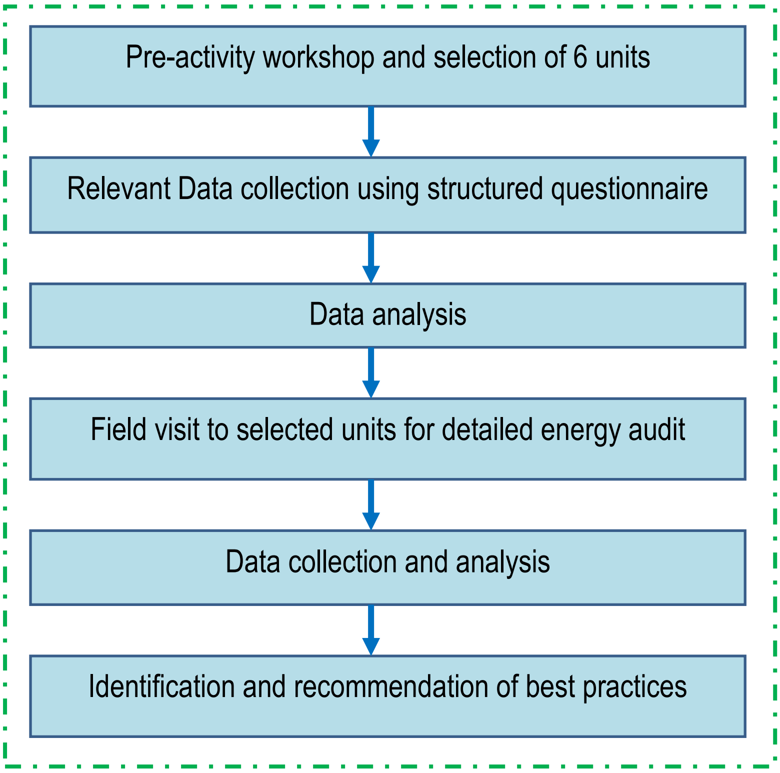


Figure 1.2: ***Flowchart depicting sequence of activities followed for carrying out detailed energy audit***

Table 1.2: ***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	Ultra Sonic 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

Foundries produce castings that are close to the final product shape. The simple process of casting involves pouring molten metal into moulds, with cores used to create hollow internal sections. After the metal has cooled sufficiently, the casting is separated from the mould and undergoes cleaning and finishing techniques as appropriate. The complete process of Cast Iron and SG Iron Casting as followed in the Unit is discussed in with the help of Flow Chart in Figure 2.1 and in the pictures (Fig 2.2 to Fig 2.19).

Casting production being followed in the unit can mainly be categorized into Core shop department, Moulding department, Melting department, Fettling department and Inspection department. The detailed description of each step along with the type of energy input and details related to critical parameters are provided in subsequent paragraphs.

Core Preparation:

The main purpose of using core in casting and moulding processes is to produce internal cavities and re-entrant angles. These cores are made of disposable material and are finally destroyed to get it out of the piece. Cores are placed into a mould cavity to form the interior surfaces of castings. The void space is filled with molten metal and eventually becomes the casting. In the unit sand core is being prepared using oil sand process in which sand is mixed with oil and placed in core box to obtain the desired shape. Thereafter, these sand cores are subjected to uniform baking at a temperature of around 280^{0}C for 5 hours in closed chambers. In the chamber around 20 kg of wood is fired and chamber is closed. Using this heat, sand cores are baked.

Moulding:

Moulding is nothing but the mould preparation activities for receiving molten metal. This process usually involves: (i) preparing the consolidated sand mould around a pattern held within a supporting metal frame, (ii) removing the pattern to leave the mould cavity with cores. The mould cavity contains the liquid metal and it acts as a negative of the desired product.

In moulding section, moulding sand from fettling section is returned to sand sieve to segregate the sand based on size. After this sand is send in muller where it is mixed with other binding agent, then the sand is send for moulding operation. The sand is periodically checked for its required properties using instruments available within the unit and the same is recycled back without using if not found suitable. Further details related to electrical energy consumption are summarized in table 2.1.

- **Melting:**

In this process, scrap material is melted using an electrical induction furnace. The raw material scrap to be melted in the induction furnace includes mixture of pig iron, swarf material (machining return material), and foundry return material. The unit has installed one induction furnace capacity 300 kgs per charge. The energy consumption details of the induction furnace along with observations are present in the later section. Once the material is melted and desired temperature is achieved, composition of molten metal is analyzed and accordingly if required, correction is made to make the required composition of molten metal. This process requires electrical energy input for induction furnace as well as for pumps and motors being 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 temperature of the molten material.

- **Metal Pouring:**

In this step, molten metal from induction furnace is poured into the moulds using laddle. After pouring, mould is left for natural cooling for around 1.5 hours.

- **Knockout:**

In this step, the mould containing solid metal is broken and sand is separated from the casting. The sand removed in this process is recycled back to hopper. The castings are further subjected to decoring operation where cores from inside of the castings are removed manually.

- **Fettling:**

This process includes shot blasting and grinding operations. Unit has installed two shot blasting machines in which surface finish of the casting products is improved. In the shot blast process, small sorts of 0.8 mm are thrown over the metal at high velocity. This process results into good surface finish of the metal. Castings received after shot blast operation are subjected to manual grinding to remove residues from the surface of the products.

- **Painting and Dispatch:**

Casting products received from grinding process are inspected for their accuracy and send for final painting and dispatch if found suitable. After painting casting products are subjected to 4 to 6 hours of drying. Finally the products are sent for dispatch.

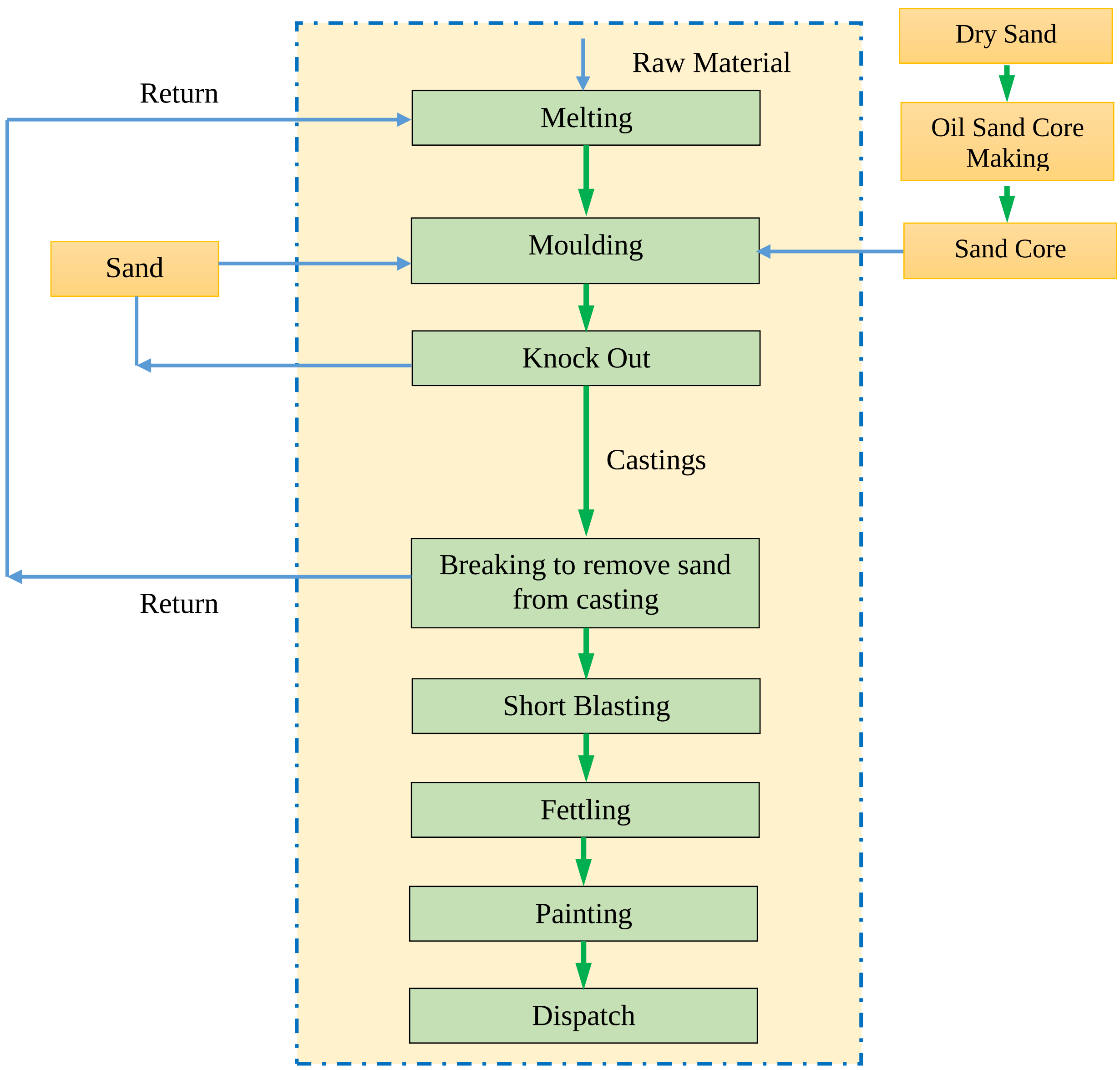


Figure 2.1: ***Process flow diagram at Mitasha Industries Ltd.***

Pictorial Representation of Production Process

Figure 2.2: ***Silica sand being used***

Figure 2.3: ***Sand core preperaed through oil core process***


Figure 2.4: ***Closed furnace for baking of sand cores***


Figure 2.5: ***Sand sieve for sieving the recycled sand***

Figure 2.6: ***Sand muller for preparation of moulding sand***


Figure 2.7: ***Sand moulding for preparation of mould***

Figure 2.8: ***Filling of moulding sand in pattern for preparation of mould***

Figure 2.9: ***Induction furnace panel installed***

Figure 2.10: ***Raw material being used in the induction furnace***

Figure 2.11: ***Raw water and soft water storage tank and heat exchanger being used in the cooling circuit***

Figure 2.12: ***Poking of material in the furnace***

Figure 2.13: ***Laddle for pouring of molten metal***

Figure 2.14: ***Pouring of metal from furnace to laddle***

Figure 2.15: ***Moulds left for cooling after pouring***

Figure 2.16: ***Castings after knockout***

Figure 2.17: ***Shot blast machine and casting ready for shot blast for operation***

Figure 2.18: ***Grinding of castings and finished products***

Figure 2.19: ***Final Products after painting***

2.2 PRESENT TECHNOLOGIES ADOPTED

The list of equipment's and appliances installed in the unit used for foundry process are as mentioned in table 2.1.

Table 2.1: *Process wise energy consumption information*

SN	Process	Number	Energy Source	Rated Consumption	Daily operation (in hours)	Days per month	Capacity	Remarks
1	Sand Muller	1	Electricity	5 HP	10 hrs	25	225 Kg per batch, Cycle time 5 mins	Sand quality to be tested for several parameters
2	Sand Sieve	1	Electricity	1.5 HP	10 hrs	25	5 tons per hour	-
3	Induction furnace	1	Electricity	175 kW	10 hrs	25	430 kg	Metal melting temperature is important around 1400^0C
4	Compressor	1	Electricity	15 kW	7 hrs	25	95.1 cfm (44.9 lps FAD)	Clean, cold and dry air inlet is important
5	Cooling Tower Pumps	1	Electricity	3 HP & 5 HP	12 hrs	25	110 LPM and 275 LPM	Cooled water
10	Shot Blasting	1	Electricity	7.5 HP	6 hrs	25	300 kg per table	Average time required around 7 min
11	Grinding	1	Electricity	5 HP & 2.2 kW	10 hrs	25	2 Tons per day	Final finish is important

2.3 DETAILED ENERGY AUDIT

Detailed measurements of the installed equipment were carried out to assess the operational efficiency. Following sections provides present observations and recommendations for each equipment's to enhance the overall energy efficiency of the system.

2.3.1 Electrical Panels:

- **Present System:**

The Unit has got contracted demand of 275 kVA. The Unit has installed a single double tap transformer of 335 kVA. The transformer is used to supply electricity to induction furnace as well as cater to electricity requirements of other loads within the unit. The unit has installed Automatic Power Factor Controller (APFC). The Unit did not install Maximum Demand Controller (MDC) as maximum contract demand was never touched. The single line diagram of the electrical system is given in figure 2.20 below.

Given below in the table 2.2 is the technical specification of distribution transformer installed in the unit.

Table 2.2: ***Transformer specifications***

Make	Specifications
Specification Reference	IS 1180 & 2026
kVA	335
Volts at No Load (Primary)	33000
Volts at No Load (Secondary)	433
Ampere (Primary)	5.86
Ampere (Secondary)	166.67
Phases (Primary)	3
Phases (Secondary)	3
Frequency (Hz)	50
Winding	Copper
Vector Group	Dy11
Year of Manufacture	2013
Type of Cooling	ON AN
Maximum Temperature Rise Top Oil/Winding (^{0}C)	45 / 55

Apart from regular consumption tariff, the SEB has time of day (TOD) tariff – a rebate of 7.5% is provided for operations between 10 pm to 6 am and a penalty of 15% is levied for electricity usage between 6 pm to 10 pm.

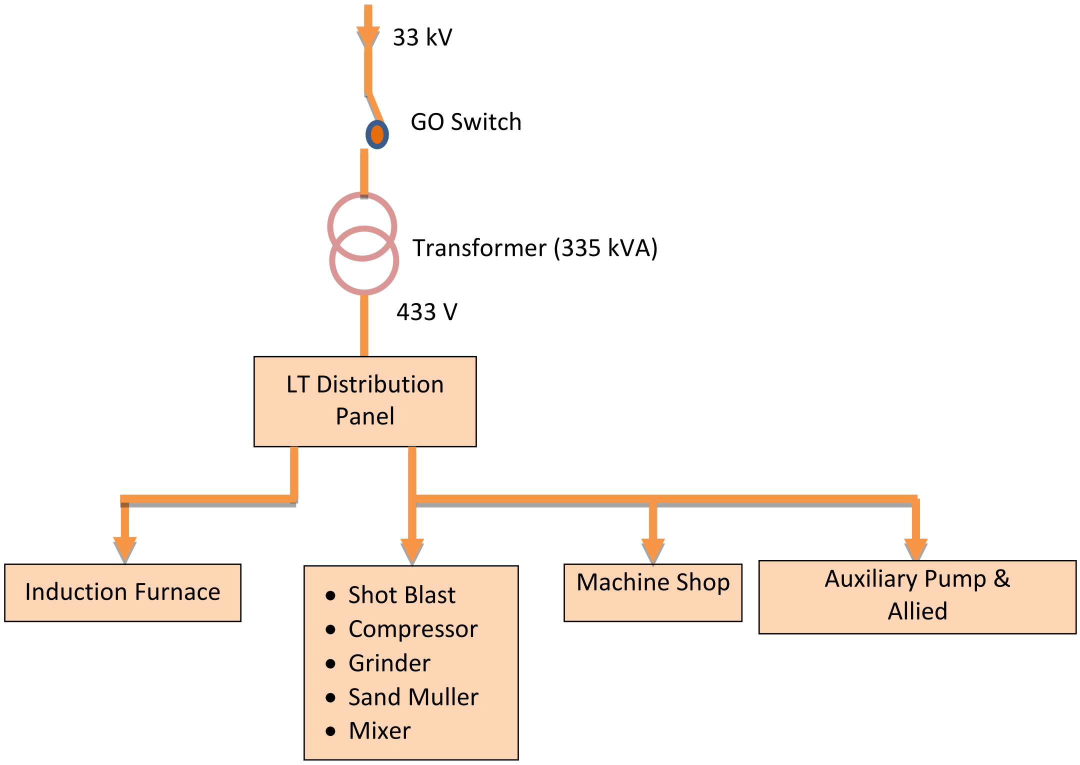


Figure 2.20: ***Single Line Diagram of Electrical Distribution System***

Figure 2.21: ***One phase (B- Phase) is direct/bypass***

Figure 2.22: ***Pictorial depiction of transformers and APFC Panel installed***

▶ Observations:

It was found that the induction furnace is operating for 8~10 hours per day. There is no provision to cut power from main incoming feeder (33 kV) when the furnace is not in operation. There was no separate energy meter installed in the furnace to measure or record the energy consumption. The Total Harmonic Distortion (THD) measured value was found to be around 1.5%. There's improper installation of LT distribution panel; no cable trenches and rubber mats for safety not in place. This badly maintained installation can be clearly seen via direct (by bypassing the MCB) connection of one phase (blue phase) of the MCB panel (See figure 2.21). The replacement of burnt MCB with new one was not there so it was directly connected bypassing the MCB, a dangerous, and risky situation.

▶ Recommendations:

It was observed that the transformer is not disconnected from the grid supply when the induction furnace is not in operation for a longer period. This results in energy loss as fixed (or no load) loss incurred in the distribution transformer. It is recommended to install an exclusive transformer for induction furnace and when the induction furnace is not in use for longer period, it should be disconnected from the grid supply to take benefit to cut down the transformer no-load loss (or dead loss).

Safety precautions in the electrical panels are not adopted. Cables connecting from transformer to main LT distribution panel and further to various loads points should be properly placed in cable trenches and not hanged around. Installation of insulated rubber mats should be provided on front of the LT distribution panels and other electrical panels to avoid electrical shocks. An exclusive energy meter for induction furnace may be installed to measure and record the electricity consumption of the induction furnace. An exclusive energy meter would benefit to assess and control the amount of energy used on per charge basis.

The direct or bypass connection at MCB in B - phase may be immediately changed with a new MCB and in future such practice should be avoided.

2.3.2 Induction Furnace:

- **Present System:**

The Unit has installed one induction furnace of 175 kW supplied by Inductotherm (India) Pvt. Ltd. The specifications of the furnace along with its pictorial depiction are provided in table 2.3 and figure 2.23. The crucible capacity of the furnace is 300 kgs. The melting time varies from 55 to 85 minutes depending upon the composition of the material to be melted. The unit mainly uses swarf (return from machining operation), pig iron and runner / risers return as raw material. The melting temperature achieved is around 1400^{0}C. Temperature of the molten metal is measured using pyrometer. Once melting of the scrap in crucible is achieved, small amount of silica is added to the molten metal which absorbs the slags present in scrap material and brings it on the top. This slag is removed from the top of the molten metal and the molten metal is ready for pouring. To avoid the heating of the coils being used in induction furnace, cooled water is continuously circulated through coils. Water in this cooling circuit operates even after shut down of furnace operation to remove the residual heat from the crucible. During energy audit, detailed study pertaining to performance assessment of induction furnace was carried out.

Table 2.3: ***Furnace specifications***

Model/Make	Inductotherm India Pvt. Ltd
Energy Input	Electricity, 175 kW
Crucible Capacity	300 kgs

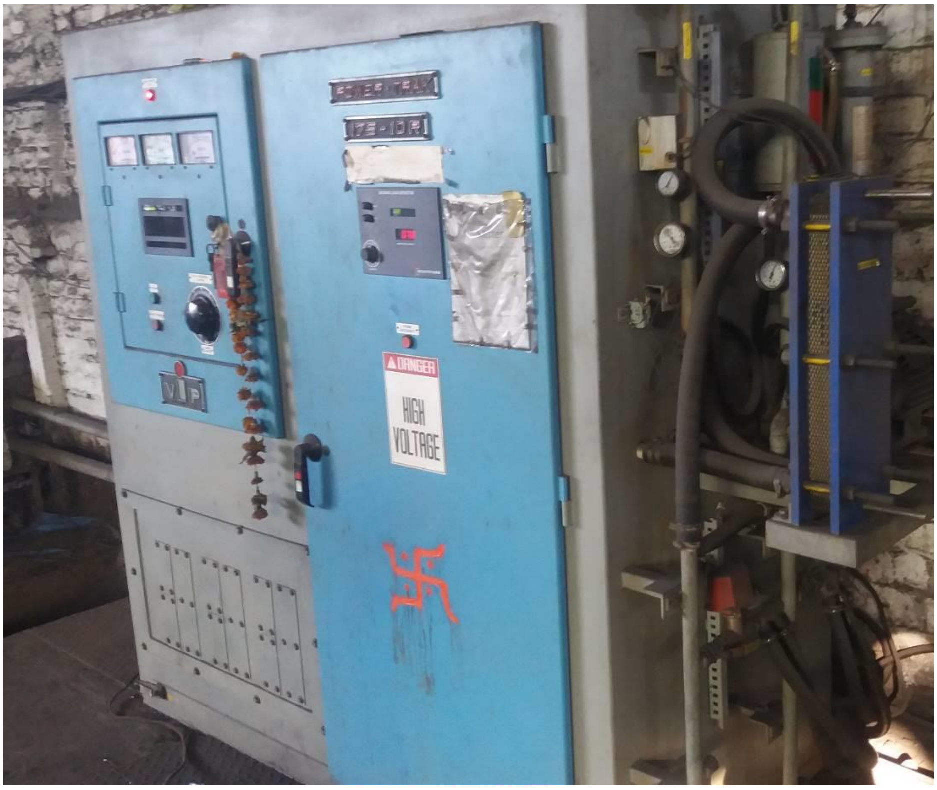


Figure 2.23: ***Induction furnace panel***

Observations:

During energy audit study complete measurement of one test charge in the induction furnace was carried out. During operation, crucible is filled with scrap material and heating is done. During the test audit only runners and risers (or foundry returns) along with some amount of scrap material was used for melting. The required temperature is attained within 55 to 65 minutes and around 22 minutes was taken to complete the pouring operation. Following are the key observations made during the operation;

- 300 kgs of scrap was loaded in the crucible (same as crucible capacity). After pouring the liquid metal in the moulds, practice of adding scrap in the crucible to the remaining liquid metal was found. Adding extra scrap in liquid metal is to increase the production of liquid metal. A total of 130 kgs of scrap was extra added to melt during the pouring operation. The overall melting time taken was 58 minutes and pouring time observed was around 22 minutes.
- Instrument to measure molten metal temperature is available with the Unit. However, the molten metal temperature is not measurement and decision regarding achievement of required temperature is made based on the operator's judgement. This is unreasonable decision to rely on operator's judgment instead of actual temperature measurement using instrument.
- There was no provision for measuring electricity consumption of the furnace and there was no data recording specifically for the furnace. On the first day of the visit, it was pointed out that without separate energy meter, it will not be possible to measure electricity consumed in induction furnace and Specific Energy Consumption (SEC) cannot be calculated. The Unit management could understand the seriousness of the issue and immediately order to install separate energy meter. However, during the period of conduct of the study, installation of the energy meter could not be possible. Henceforth, electricity consumption of the induction furnace could not be recorded. It is suggested to install separate energy meter for monitoring, recording and controlling the power consumption in induction furnace.
- The operator covers the furnace from top to avoid heat loss and achieve other benefits. Most of the time, furnace loading is done till crucible height only. One of the reasons for this is the smaller and consistent size of input raw material (refer figure 2.24).
- To remove heat from the furnace after furnace shut down, a graphite piece is placed inside the furnace (refer figure 2.25). This graphite piece absorbs heat from the furnace within 10-12 minutes. As a result of this, the furnace cools down quickly. A visual comparison of the same is presented in figure 2.26. It can be observed that inside surface of the furnace looks little blackish as compared to the laddle which looks red hot indicating higher temperature.

  Further, temperature inside the furnace was measured after 10 minutes of putting the graphite piece inside the furnace. The temperature on the top was 350^{0}C, at middle it was 450 – 480^{0}C and at the bottom it was 700^{0}C. This way of heat removal from the furnace reduces the duration of cooling water pump operation resulting into significant energy saving as most of these pumps operates for around 5 to 8 hours after switching off the induction furnace operation.

- The water evaporation loss in the cooling towers is high as the quality of water is very bad. There are lots of deposits over fins in the cooling tower. Therefore, water is not able to flow freely and it is sucked by the cooling tower fan.
- It is suggested to install timers in cooling tower fan system and also by replacing the conventional cooling tower fan blades with Fiber Reinforced Plastic Blades (FRPB) sufficient energy saving can be achieved owing to the better aerodynamic shape of its blades.

The cost economic analysis of the above suggested measures are compiled in Table 2.4. It can be observed that all the measures suggested towards energy efficiency improvements of furnaces have good energy saving without any investment.

Table 2.4: ***Cost Economic Analysis – Induction Furnace***

SN	Energy Efficient Measure	Estimated Energy Savings (kWh/year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year)
1	Laddle Pre-heating	4,723	35,424	Nil	NA
2	Avoiding over heating of metals in the Induction Furnace	4,723	35,424	Nil	NA
3	Installation of timers in cooling tower fan system	742	5,564	17,000	3.05
4	Replacing conventional blades of cooling tower fans with energy efficient fiber reinforced plastic blades	571	4,280	15,000	3.5

Figure 2.24: ***Induction furnace operation***

Figure 2.25: ***Graphite piece placed inside the crucible***

Figure 2.26: ***Visual comparison of inside surface of furnace and laddles***

- **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 2***).
- Best Practice #2 (Furnace Loading & Operation): Level of molten metal should not exceed the level of induction furnace coil (See ***Annexure 3***).
- As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy. Therefore, measurement of molten metal temperature becomes important and should be practiced by the operator.
- Heel metal 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.

2.3.3 Motor Loadings

▶ **Present System:**

In the present system there are different motors of different size and capacity installed in different areas of the foundry. Most of the motors are in the range of 5 to 20 HP and operated depending on requirements. The motor performance analysis was carried out on sample basis, selected based on the motor size and their operating hours. Motor loading measurements were carried out for motors installed in Short Blast (7.5 HP), Sand Muller (5 HP) and Cooling Tower Fan (5 HP).

▶ **Observations:**

The motor loading measurement for different motors (generally motors of high capacity and longer operating hours are chosen) were carried out. The results are summarized in Table 2.5. The loading of the motors varies from 90% to 130%.

Table 2.5: ***Measurements performed on the motors***

Equipment Section	Current (Amps)				Voltage (Volts)	PF	Actual Power (kW)	Rated Motor (HP)	Loading (%)
	R	Y	B	Average					
Shot Blast	12.1	13.9	12.6	12.9	401	0.68	5.59	7.5	108.61
Sand Muller	6.4	6.9	7.0	6.77	410	0.70	3.36	5.0	90.18
Raw Water Pump	9.9	9.3	8.9	9.37	410	0.73	4.86	5.0	130.18

▶ **Recommendations:**

The shot blast machine motor and raw water pump motor is overloaded by 9% and 30% respectively. The overloaded motors may cause overheating and rapturing the insulation to reduce the motor life. Air cooling the motor, using perhaps a fan, may help the situation. The overloaded motors may be replaced with appropriate size motors. The Power Factor (PF) across the motor terminals remains low around 0.68~0.73, this can be enhanced by using capacitor across at the motor terminals. The cost benefit analysis for the above recommendations is given below.

Table 2.6: ***Cost Economic Analysis – Motors***

SN	Energy Efficient Measure	Estimated Energy savings (kWh/Year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year)
2	Installation of capacitors across motors having low power factor	31,363	235,222	10,000	0.05

2.3.4 Compressor:

▶ **Present System:**

The Unit has installed one screw type air compressors of 20 HP (15 kW) capacity to meet compressed air demand in the unit. The compressed air is used in moulding section, and fettling section. The picture of the compressor installed in the system is given in Figure 2.27 and the single line diagram of the compressed air system is given in Figure 2.28

▶ Observations:

Measurement of electrical parameters was carried out to estimate the percentage loading of the compressors, the detailed specifications of which are provided in Table 2.7. Measurement/observations are summarized in Table 2.8. Compressor leakage test was performed and the leakage was found to be very less, mainly due to air usage in small and limited areas (only grinding and sand blast section located very close to compressor). The detailed calculation of the leakage trail is attached as ***Annexure 4***.

Figure 2.27: ***Compressor system***

Table 2.7: *Specifications of compressors*

Make	GA e 15 Atlas Capco
Year of Manufacturing	2013-G
Type	Screw
HP/kW	20/15
Tank Storage Capacity (Ltr)	2000
Maximum Final Pressure (Bar)	7.5
Free Air Delivery (L/S)	44.9
Upper Pressure Setting	7.0
Lower Pressure Setting	6.1

Table 2.8: ***Measurements performed on the compres***sor

Compressor Reference	Loading Condition	Current (Amps)	Voltage (Volts)	Actual Power (kW)	Rated Motor HP (kW)	Loading (%)
		Average				
Atlas Capco	Unload	8.33	410	4.44	20 (15)	27.61
	Load	28.33	409	18.67	20 (15)	124.42

Based on the measured data, it is observed that compressor motor is overloaded during loading (125%) i.e. when compressor motor is ON. Reduce the load immediately during loading conditions. During unloading when compressor motor is OFF, the loading is found to be 28%.

▶ Recommendations:

- It is recommended to carry out leakage trail every week or fortnightly to assess the leakage level and necessary actions to be taken if any.
- The compressor was overloaded (124.42%) during loading operation. It is suggested to revamp or upgrade the compressor, choosing instead to operate existing equipment in overload condition. VFD may be installed across compressor motor. Given below is the cost benefit for installation of VFD in compressor. It can be seen from the table that by using VFD in compressor energy saving upto 13,583 kWh/year can be achieved, which amounts to an energy saving of Rs 1.02 Lakhs /year.

Table 2.9: ***Cost Economic Analysis - Compressor***

SN	Energy Efficient Measure	Estimated Energy savings (kWh/Year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years)
1	Installation of VFD in Compressor	13,583	101,870	300,000	2.94

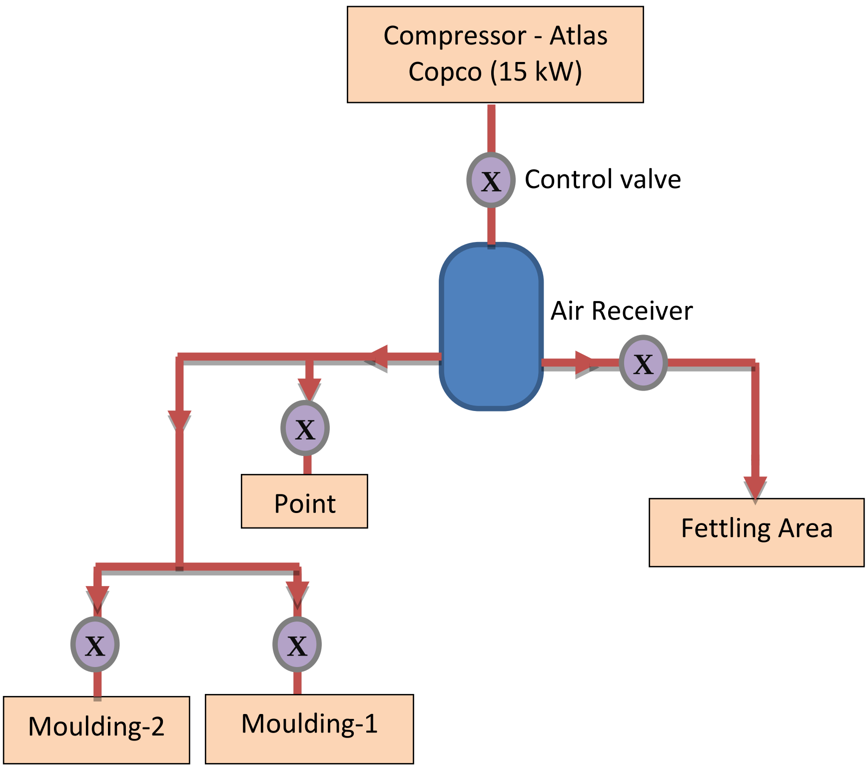


Figure 2.28: ***Single line diagram of compressed air System***

2.3.5 Exploring Opportunity for Renewable Energy Usage

During field visit, opportunities of using renewable energy applications were explored. Based on the process requirement observed in the unit, possibility of using solar thermal technology was explored. However, due to non-availability of area, this option was ruled out. Further, unit owner also rejected the idea of using renewable energy due to lesser anticipated savings against the cost and operational complexity associated with renewable energy interventions.

Annexure 1:

Questionnaire*

Energy Audit – Questionnaire Form

Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India – Indore Foundry Cluster"

Name of the MSME unit:	Mitasha Industries Ltd.
Address:	65, Sector F, Sanwer Road, Indore-MP
Ph. No:	
Name of the respondent	Aalok singhi
Designation:	CEO

1. **Year of Establishment: _____2013_____________**
2. **Type of Products: a) __S G iron Castings_______________**
   b) ___Cast Iron Castings_______________
   c) ___________________
3. **Installed Capacity: _______1500MTA____________**
4. **Operating hrs per day : _10________________**
5. **Connected Load: ____275______________ (kVA or kW please specify)**
6. **Supply Voltage:_440/460___________ Volt**
7. **Annual Energy Consumption/ Production:**

Financial Year (April to March)	2013	2014	2015
Coke consumed (tons)	8.35	68.620	1.837
Cost of coke (in Rs. Lakhs)	2.171	17.841	.477
Electrical units consumed (In kWh)	28.75	97.25	945.23
Electricity charges (In Rs. Lakhs)	1.35	2.35	27.96
LDO/HSD/ FO consumption (kL)	Nil	Nil	nil
Fuel Cost (In Rs. Lakhs)			
Production (Tones)	71.25	155.246	368.62

*Unit specific questionnaire were sent to units prior to the conduction of energy audits. Some portion of the questionnaire was not filled or left blank by the units, due to lack of understanding. However, data used for the energy audit calculations and reporting were subsequently collected during the physical visit of the energy audit team to the site.

8. **Source and Calorific Value of Fuels:**

Fuel	Source	Calorific Value (kCal)
Coke (Kg)	**BLA Coke Ltd**	**7000**
HSD (kL)		
LDO (kL)		
FO (kL)		

Fuel	Source
Electricity (kWh)	MPEB

9. **Monthly Energy Consumption and Production Data:**

Month	Production (Tons)	Coke consumption (Tons)	Electricity consumption (kWH)	HSD/LDO /FO (kL)	Any other fuel (specify units)
April, 14	15.387	0.477	6048	nil	
May, 14	19.32	Nil	8291	nil	
June, 14	19.956	Nil	9432	nil	
July, 14	20.622	Nil	15717	nil	
August, 14	22.358	Nil	24661	nil	
September, 14	25.865	Nil	21107	nil	
October, 14	26.454	Nil	28063	nil	
November, 14	42.341	Nil	37946	nil	
December, 14	43.654	Nil	30633	nil	
January, 15	45.698	Nil	27017	nil	
February, 15	40.207	Nil	20270	nil	
March, 15	46.758	Nil	23508	nil	

10. **Duration of electricity supply: _____12___Hours/ day**

11. **Cost variables per Ton of Production:**

Cost Variable	Cost/ ton of production
Electricity Cost	6375
Coke Cost	0
Fuel Cost (LDO/HSD/FO) etc.	
Labour Cost	4650
Material Cost	27800
Other Cost	1850
Total Production Cost	40675

12. Major Energy Consuming Equipment:

SN	Equipment	Energy source	Make/ Supplier	Year of Installation	Technical Specification	Use	Comments
1	Induction Furnace	MPEB	Inductotherm	2014	175 KW	Melting	
2	Air Compressor	MPEB	Atlas Copco	2014	15KW	Moulding/ Fettling	

13. Factory Layout (Please provide sketch of factory layout):

14. **Please provide detailed manufacturing process for each major products manufactured:**

We make Ductile Iron and cast iron castings.

Process Includes

1. Sand Screening
2. Sand Mulling
3. Mould Making
4. Core Making
5. Melting
6. Pouring
7. Fettling
8. Machining.

15. Any Energy Efficient Technology installed in the unit:

Technology	Specification	Cost	Year of Installation
DBC	27" DBC Cupola	13,50,000	2013

16. Any Energy Efficient Technology the management wants to implement in the unit:

Technology	Cost	Use
Open For every Technology		

17. Any factory expansion plan:

Yes

Annexure 2:

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…

Annexure 3:

Best Operating Practice-Induction Furnace

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.

Annexure 4:

Compressor Leakage Trial Format

(DATE) / (DAY) : (dd/mm/yyyy) / (day) …………………	
START TIME (hh:mm): …………	**END TIME (hh:mm): …………**
COMPRESSOR ID: ………………	**CAPACITY: ……… CFM**
PRESSURE SETING : Max - ……… bar; Min - ……… bar	**MOTOR: ………. kW**

S. NO.	**ON TIME**				**OFF TIME**			
	START TIME	**END TIME**	**AMPERE**	**ON TIME (MINS)**	**START TIME**	**END TIME**	**AMPERE**	**OFF TIME (MINS)**
(A)	**(B)**	**(C)**	**(D)**	**(E) = (C) - (B)**	**(F)**	**(G)**	**(H)**	**(I) = (G) - (F)**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
		Average				**Average**		

Percentage Leakage Calculation:

Total Cycle Time = (E) + (I)

Percentage Leakage = { (E) X 100 }/ { (E) + (I) }

Interpretation:

If percentage leakage is below 10% "Well Maintained System"

If percentage leakage is between 10 ~ 20% "Average Maintained System" - Requires leakage plugging

If percentage leakage is above 30% "Poorly Maintained System" - Requires immediate leakage plugging

NOTE :

1 : READING SHOULDBE TAKEN WITH BALL VALVES AT OPEN POSITION

2 : READING SHOULD BE CONSISTENT