BEE's National Program
on
Energy Efficiency and Technology Up-gradation in SMEs

Ludhiana Forging Cluster

Baseline Energy Audit Report
Radhe Mohan Forging (P) Ltd

Submitted to

Submitted by

InsPIRE Network for Environment

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About The Project

The project BEE's National Program on "Energy Efficiency and Technology Up gradation in SMEs - Ludhiana Forging Cluster" supported by Bureau of Energy Efficiency (BEE), Ministry of MSME and Ludhiana Auto Parts Manufacturers Association aims to bring down the energy demand of forging industries located at Ludhiana by supporting them to implement Energy Efficient Technologies in the SME units.

Executive Summary

1. Unit Details

Unit Name	:	**Radhe Mohan Forgings (P) Ltd.**
Address	:	E-589, Phase-VII, Focal Point, Ludhiana-10
Contact Person	:	Mr. Monoj Gupta (Cell No. 9417700006)
Products	:	Agriculture, Earthmoving, Auto Parts etc.
Production	:	10 TPD
DIC Number	:	**Applied for, will get within few days and send us**
Bank Details	:	Punjab National Bank; Branch: Cheema Chowk, Ludhiana; Account No: 3881008700003222
TAN / PAN No.	:	PAN: AADCR7936G
Contract demand	:	500 kVA

2. Existing Major Energy Consuming Technology

FO –Based re-heating technology

- Conventional Technology with higher losses
- Prevailing energy consumption 0.09 liters of FO per kg of the production

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Measures

- Replacement of FO fired re-heating furnace with one 300 kW induction re-heating furnace

Table 1: *Cost Economic Analysis*

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (Years)
Induction re-heating furnace (300 kW)	**61**	**1,440,000**	**2,500,000**	**1.7**
Total		**1,440,000**	**2,500,000**	

Introduction

1.1 ABOUT THE UNIT

M/s Radhe Mohan Forging (P) Ltd. was started in the year 2007 and is engaged in manufacturing of different types of agriculture forged products and earth moving parts as per the customer requirement. The manufacturing unit is located at E-589, Focal Point, Phase-7, Ludhiana – 141003, Punjab.

The raw material procured by the unit for agriculture forged components include EN8 and Mild Steel.

The daily production of the unit is around 10 tons per day. The unit utilizes primary energy, namely, Furnace Oil (FO) and Electricity supply from SEBs for various process and utility applications in premises. The monthly FO consumption of the unit is around 30000 liters and cost comes to around Rs. 12 Lakhs monthly (@ Rs. 40/ Liter). The monthly average electricity consumption of the unit is 12511 units resulting into total electricity bill of Rs. 1.12 lacs per month. The FO is purchased from local fuel supplier and electricity is purchased from Punjab State Power Corporation Limited. To manufacture the products, the unit has installed three FO based batch type re-heating furnace, forging press, trimming machine, grinding/ facing/ trimming lathes, shot blasting machine etc.

According to the assessment of the energy consumption data collected, the specific thermal energy consumption and specific electrical energy consumption is 0.12 L/kg (1224 kcal/kg) of product and 0.16 kWh/kg (137.18 kcal/kg) of product respectively.. Details of annual electrical and thermal energy consumption and specific energy consumption details in M/s Radhe Mohan Forging (P) Ltd is presented in table below:

Table 1.1: ***Details of M/s Radhe Mohan Forging (P) Ltd.***

SN	Parameter	Value	Unit
1	Name and address of unit	M/s Radhe Mohan Forging (P) Ltd., E-589, Phase-VII, Focal Point, Ludhiana - 141010	
2	Contact person	Mr. Munish Gupta	
3	Manufacturing product	Agriculture, Earthmoving, Auto Parts etc.	
4	Daily Production	10 TPD	
	Energy utilization		
5	Average monthly electrical energy consumption	39878	kWh per month
6	Average monthly thermal (FO) energy consumption	30000	Liters per month
7	Average thermal specific energy consumption	0.12	Liter /kg of product
		1224	kCal/kg of product
8	Electrical specific energy consumption	0.16	kWh/Kg of product
		137.18	kCal/kg of product
9	Specific energy consumption	1361.18	kCal/kg of product

SN	Parameter	Value	Unit
10	Electrical energy cost	1.20	Rs/Kg of product
11	Thermal energy cost	6	Rs/kg of product
12	Total energy cost	7.20	Rs/kg of product

Note:

^1: Specific gross calorific value of FO is considered as 10,200 kcal / liters

^2: Thermal equivalent for one unit of electricity is 860 kCal/kWh.

^3: The unit operates for 25 days a month (1 shift of 8 effective hours per day).

1.2 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at M/s Radhe Mohan Forging (P) Ltd. (refer Figure 1.1). The raw material in round or square shape is first cut into pieces of required sizes using shearing machines. After cutting, these pieces are heated in an oil fired re-heating furnace to a temperature of around 1200-1250 ^{0}C. These heated pieces are subjected to forging into the required shape using required shape dies. After forging, these pieces are subjected to trimming for removal of unwanted material from sides. Thereafter, the metal piece is naturally cooled for around 4 to 5 hrs. After cooling, grinding of the material is carried out using grinders. Finally these grinded pieces are put in shot blast machine to improve their surface finish. At last, material is dispatched after proper inspection.

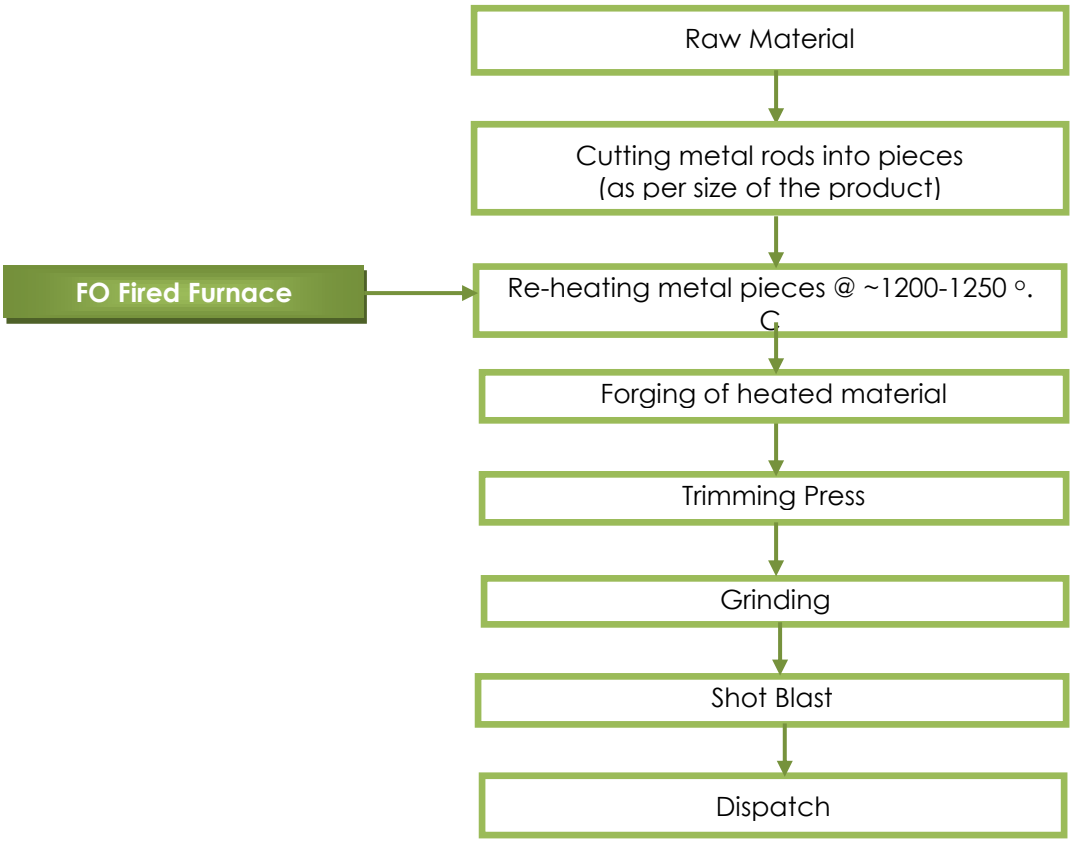

Figure 1.1: ***Process flow diagram***

Pictorial Description of the process being followed in the unit

Figure 1.2: ***Raw material being used in the unit***

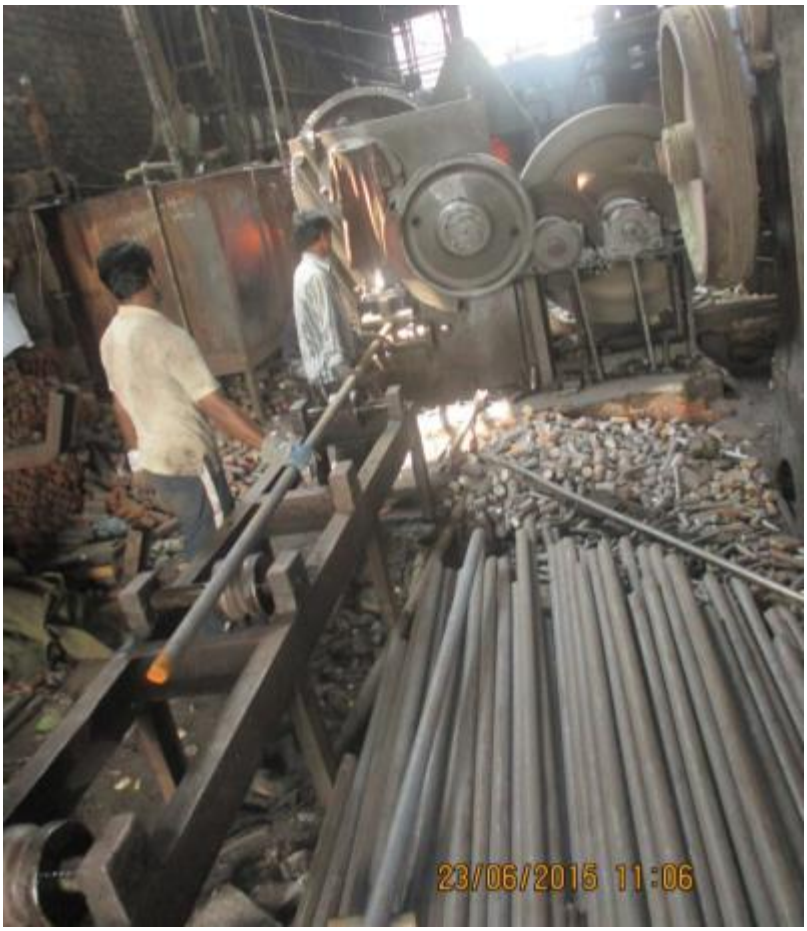

Figure 1.3: ***Long rods being cut into small pieces using shearing machines***

Figure 1.4: ***Cut pieces being put into the furnace***

Figure 1.5: ***Heating of the material inside the oil fired reheating furnace***

Figure 1.6: ***Forging press and heated material being forged in the press***

Figure 1.7: ***Trimming press and material after trimming operation***

Figure 1.8: ***Finished product***

Figure 1.9: ***Grinding of the pieces***

Figure 1.10: ***Pieces after grinding***

1.3 ENERGY AUDIT METHODOLOGY

The primary objective of the energy audit was to quantify the existing fuel consumption pattern and to determine the operating efficiencies of existing systems. The key points targeted through energy audits were determination of specific fuel consumption, various losses, operation practices like hot metal temperature, production, fuel consumption, scale formation etc. Pre – planned methodology was followed to conduct the energy audits. Data collected at all above steps was used to calculate various other operating parameters like material feeding rate (Kg/hr), fuel firing rate, specific fuel consumption (kg/tonne), etc.

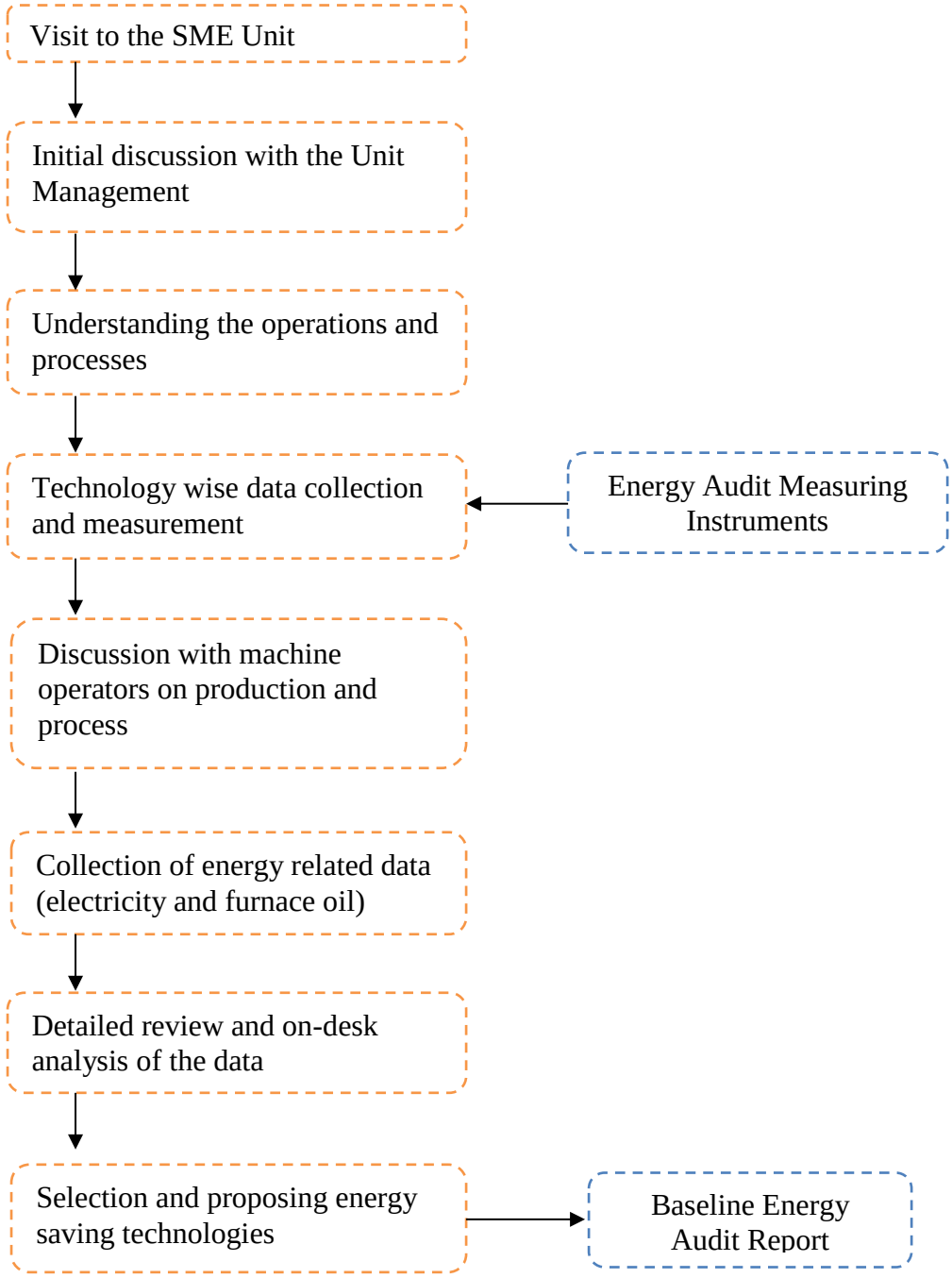

Figure 1.11: ***Energy audit process***

1.4 PRESENT TECHNOLOGIES ADOPTED

The list energy consuming installed in M/s Radhe Mohan Forging Pvt. Ltd. and used for forging process are as follows. The unit has installed four oil fired heating furnaces of different capacity for carrying out heating operation. Unit has also installed one induction furnace of smaller capacity. With each re-heating furnace, forging press is attached. For carrying out the finish operation, unit has also installed shot ballast machine. Based on the observation made during audit, it was found that most of the energy consumption is in the heating furnaces.

Table 1.2: ***List of energy consumption equipment installed***

SN	Equipment	Number	Energy Source	Rated capacity	Hrs of operation	Production
1	Cutting machine	01	Electricity	50 hp	4	120-150 pieces per hr
2	Oil Fired Heating Furnace	01	Electricity & Furnace Oil	25 ltrs/hr, Thermal 7.5 hp, 5 hp Electrical	20	250 kg per hrs
3	Forging Press	03	Electricity	2 T (50 hp), 4 T (75 hp) & 6 T (200 hp)	20	250 kg per hrs
4	Trimming machines	03	Electricity	2 T (7.5 hp), 4 T (10 hp) & 6 T (25 hp)	20	
	Grinding Machine	2	Electricity	3 hp	20	2.5 tons per day
7	Shot Blast	01	Electricity	10 kW	10	300 – 350 kg/hr

Present Process, Observations and Proposed Technology

2.1 ELECTRICITY CONSUMPTION PATTEN

The unit has got connected load of 500 kW and electricity supply is received at a voltage of 11 KV. The contract demand of the unit is 500 kW. However, as evident from the electricity data for the last one year, the average MDI was 181 kW. The maximum MDI recorded was 140 kW. The power factor in the unit was also found to be in the range of 0.94 to 0.95. Figure 2.1 provides the monthly variation of MDI in the unit.

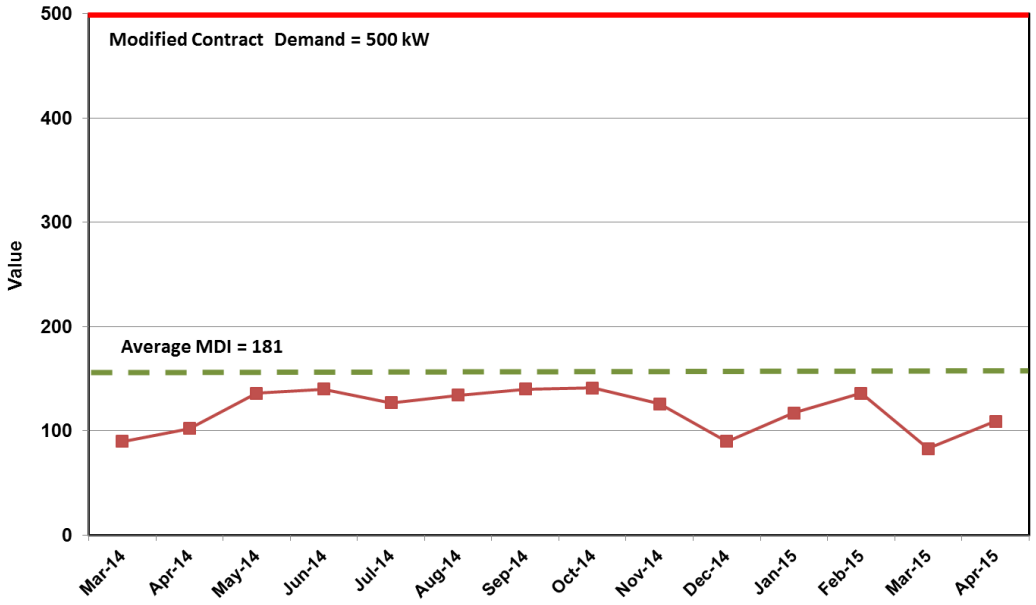

Figure 2.1: *Monthly variation of MDI in the unit*

2.2 HEATING FURNACE (FURNACE OIL FIRED)

2.2.1 Present Process

M/s Radhe Mohan Forging (P) Ltd. has installed two Furnace Oil (FO) fired reheating furnace (batch type) to heating the metal piece for forging process. In a batch type furnace, a batch of metal pieces are kept inside the furnace and heated to a temperature of 1200 ◦ C for a period of 45-60 mints depending up on the type of product to be formed. After that, the heated metal piece is then kept on the forging die having the cavity of the product to be formed. The hot metal piece then forged on the forging press into the product.

The reheating furnace installed consumes around 1000 Liters of FO per day with average production of approximately 10 tonnes/ day. The thermal energy consumption as well as the cost for per kg of production comes out to be 0.12 Liters (1224 kcal/kg) and 4.8 rupees respectively.

2.2.2 Observations

The exiting furnace is very old installed in year 1993 and was fabricated by the local manufacturer without following any design standards. The burner used in the furnace is also based on the conventional design having manual control option for fuel firing rate. Since the flame of the furnace directly hits the surface of the metal during the heating period varying from 20 – 30 minutes deteriorates the atomic/ grain structure of the piece and also leads to the higher scale formation due to the oxidation of the metal at high temperature ultimately leading to material/ production loss. In order to attain the exact temperature profile of the material in less time, 3Ts has to be followed, Time, Turbulence and Temperature, if these three parameters can be followed in a right manner proper temperature can be achieved in a minimum time, which would help in reducing the excessive heating of the material and reduction in scale loss.

As per the data collected during energy audit activity, the reheating furnace consumes around 0.12 liters of FO per kg of the production which higher if we compare the same with the latest technologies available in the market like induction heating furnace. Since the existing furnace is open type and most of the heat of the flame goes out of the furnace leading to higher heating time and more fuel consumption. Because of this the material under heating takes time to attain the desired temperature profile and thus leads to the lower production rate. Apart from the open heating, labor handling the furnace also responsible for slower production rate due to their own unorganized pattern of working.

In addition, the existing reheating furnace usage furnace oil as a source of energy to heat the metal pieces. The burning of FO releases harmful gases like CO, CO_2, SO_X, NO_X, smoke etc. During the visit, it was observed that furnace has no exhaust mechanism, ID fan and flue gas pipe, to pass the flue gases out of the factory. All these factors affect the environment and also the health of the worker handling the furnace and other machineries installed in the factory. As per observations done during field visit, it was observed that unit has space limitations and there for finding problems with maintaining the inventory of the furnace oil in the unit.

Figure 2.2: ***Re-heating furnace in operation***

Conclusion:

As per the past studies conducted in forging industries, the replacement of the FO fired re-heating furnace with an induction re-heating furnace saves up to 60% of the energy cost. The production rate of the furnace observed during the walk through study is approximately 30-40 pieces per hour, which is again, quit low.

Based on the above observations done during the baseline data collection and discussions with the unit management it is proposed to replace the existing re-heating technology (FO Based) with Energy Efficient Induction Reheating furnace.

This replacement would provide following benefits

- Environmental cleaner technology
- Reduces Specific Energy Consumption
- Faster operation and reduced scale formation
- User friendly technology
- Improved quality of the product output
- Higher output with fewer crop cuts or short bars

2.2.3 Cost Economics Analysis

The comparison of FO based re-heating technology and induction technology, specific energy consumption, cost savings, investment required and simple payback period of the investment on induction technology is given in Table **2.1**. The detailed calculation to finalize the size of induction furnace is provided as **Annexure 3.**

Table 2.1: ***Cost economics analysis for Induction furnace***

Parameter	Unit	Value
Furnace oil consumption on existing re-heating furnace	Liters/hr	45
Production in terms of Kg	Kg/hour	500
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.09
Cost of energy consumption	Rs./Kg	4.5
Power consumed by proposed induction furnace (rated capacity 250 kW operating at 185 kW)	kW	206
Production in terms of Kg	Kg/hr	500
Specific energy consumption on induction reheating furnace	kWh/Kg	0.412
Cost of energy consumption	Rs./Kg	3.09
Reduction in cost of energy required	Rs./Kg	1.41
Operating hours	Hrs	20
Annual operating days	Days	300
Annual cost savings	Rs	1,44.000
Investment required for Induction furnace (300 kW)	Rs	2,500,000
Simple payback period	Years	1.7

As per the detailed calculations done, it is proposed to install an induction re-heating furnace of capacity 300 kW for carrying out heating of heavier metal pieces. Based on the discussion with concerned person in the unit, it came out that maximum weight of the individual piece is around 37 kgs. The cycle time required to re-heat the metal piece of 37 kgs would be around 5 mins.

The cost of energy saved per Kg of material forged is calculated as Rs. 1.41. The investment required for implementing the induction technology estimated as Rs 25 Lakhs with annual saving of Rs 14.44 Lakhs. The simple payback period of the technology is 1.7 years.

Annexure 1

Basic details and energy utilization pattern of Radhe Mohan Forging (P) Ltd.

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Note:

^1: Specific gross calorific value of FO is considered as 10,200 kcal / liters

^2: Thermal equivalent for one unit of electricity is 860 kCal/kWh.

^3: The unit operates for 25 days a month.

Annexure 2

Induction furnace capacity and heating cycle time calculation

Induction furnace capacity calculations:

Induction furnace design standard: 2.7 – 3 kg/ kW/hr

Hourly material to be heated = 250 Kg

Induction furnace capacity requirement (theoretical) = 250/2.7 kW/hr
= 92.6 kW/hr

As discussed with technology manufacturer, we have taken the lower value 2.7 kg/kW/hr for calculations.

Induction furnace capacity requirement (actual) (efficiency = 90%) = 92.6 kW/hr /0.90
= 103 kW/hr
= 103 kW approximately

Heating cycle time calculation:

Hourly material to be heated = 250 kg
Weight of the metal pieces = 4 gram
No. of pieces to be heated in an hour = 62 pieces
Heating time required per piece = 1 minute approximately

Keeping in mind the variety of products manufactured by Hindustan Hammers (India) having variable weight, size, geometry, composition etc. induction furnace of 150 kW is proposed.

Note:

*** For more accurate capacity options, induction furnace manufacturer should be consulted prior to the implementation*

Annexure 3

Energy saving calculation for Induction furnace

Parameter	Unit	Value
Furnace oil consumption on existing re-heating furnace	Liters/hr	45
Production in terms of Kg	Kg/hour	500
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.09
Cost of energy consumption	Rs./Kg	4.5
Power consumed by proposed induction furnace (rated capacity 250 kW operating at 103 kW)	kW	206
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Annual operating days	Days	300
Annual cost savings	Rs	1,44.000
Investment required for Induction furnace (300 kW)	Rs	2,500,000
Simple payback period	Years	1.7

Note:

*** The cost of induction furnace is an indicative value gathered from discussions with furnace suppliers. It may vary according to the heating requirement and the material to be heated.*