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

Ludhiana Forging Cluster

Baseline Energy Audit Report
C-FORGE (India)

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Brief 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	:	**C-FORGE (India)**
Address	:	10084, Kot Mangal Singh, CK Janta Nagar, Ludhiana
Contact Person	:	Mr. Sharanjeet Singh (Cell No: 9814161909)
Products	:	Bolts, Nuts, Industrial Fasteners and Auto Parts
Production	:	1 Tones/day
DIC Number	:	030091100829 (Part-II)
Bank Details	:	Tamilnadu Mercantile Bank, Miller Ganj, Ludhiana Account Number: 169700050900163
TAN / PAN No.	:	PAN: AEHPSO951H
Contract demand	:	89.58 kVA

2. Existing Major Energy Consuming Technology

FO Based re-heating technology

- Conventional Technology with higher losses
- Prevailing energy consumption 0.10 liters of FO per kg of the production

Lathes Machine

- Manually operated lathe machines for machining job work including threading, turning, grinding, drilling etc.
- Electrical motor rating of 3 HP with production of around 90-100 pieces per hour per set of lathe machine.

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Measures

- Replacement of FO fired re-heating furnace with 100 kW induction re-heating furnace
- Replacement of manual lathe machines by two numbers of CNC based Special Purpose Machine (SPM), one each for turning and facing operation.

Table 1: *Cost Economic Analysis*

Proposed Technology	Estimated Energy Savings (%)	Savings (in Rs.)	Investment (in Rs.)	Simple Payback period (Years)
Induction re-heating furnace (100 kW)	65.3	828,000	1,380,894	1.7
SPM – Turning Machine	76.0	170,088	550,000	3.2
SPM – Facing Machine	75.3	163,822	550,000	3.4
Total		**1,161,910**	**2,480,894**	

Introduction

1.1 ABOUT THE UNIT

M/s C-FORGE (India) was started in the year 1990 and is engaged in manufacturing of different types of wheel nuts, bolts, industrial fasteners and auto parts in various sizes as per the customer requirement. The manufacturing unit is located at Plot No 10084, Kot Mangal Singh Chowk, Janta Nagar, Ludhiana - 141003, Punjab.

The raw material procured by the unit for making bolts and other auto components include Mild Steel, EN8, EN15 etc.

The production of M/s C-FORGE (India) is 1.0 tonnes/ day approximately. The unit is using two different forms of energy for various process and utility applications in premises, those are:

- Furnace Oil (FO)
- Electricity

The average monthly FO consumption was 3000 liters approximately (when the FO was operating) whereas the average monthly electricity consumption comes around 20193 kWh. The unit spends around Rs.1,50,000/- monthly on purchasing the FO @ Rs. 50 per Liter. The average electricity bill of the unit is Rs. 1,52,395 per month. The FO is purchased from local supplier and electricity is taken from Punjab State Power Corporation Limited.

To manufacture the products, the unit has installed a FO based re-heating furnace, forging press, pressing machine, grinding/ facing/ trimming lathes, threading machine, cold forging hammers, nut making machines, drawing 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 0.80 kWh/kg (694.63 kCal/kg) of product respectively. The total specific energy consumption (in kCal) is 1918.63 kCal/ kg of product. Details of annual electrical and thermal energy consumption and specific energy consumption details in M/s C-FORGE (India) is presented in table below:

Table 1.1: ***Details of M/s C-FORGE (India)***

S. No	Parameter	Value	Unit
1	Name and address of unit	M/s. C-FORGE (India), Plot No 10084, Kot Mangal Singh Chowk, Janta Nagar, Ludhiana - 141003, Punjab	
2	Contact person	Ms. Sharanjeet Singh	
3	Manufacturing product	Bolts, Nuts, Industrial Fasteners and Auto parts	
4	Daily Production	1 Tonnes/ day	
	Energy utilization		
5	Average monthly electrical energy consumption	20193	kWh per month

S. No	Parameter	Value	Unit
6	Average monthly thermal (FO) energy consumption	3000	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	0.80772	kWh/Kg of product
		694.6392	kCal/kg of product
9	Specific energy consumption	1918.6392	kCal/kg of product
10	Electrical energy cost	6.0579	Rs/Kg of product
11	Thermal energy cost	6	Rs/kg of product
12	Total energy cost	12.0579	Rs/kg of product

Note:

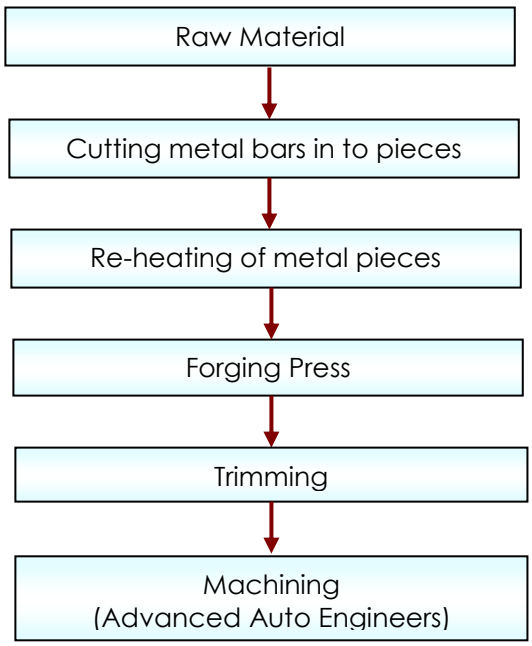
^1: Specific gross calorific value of FO is considered as 10,200 kcal / liters

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

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

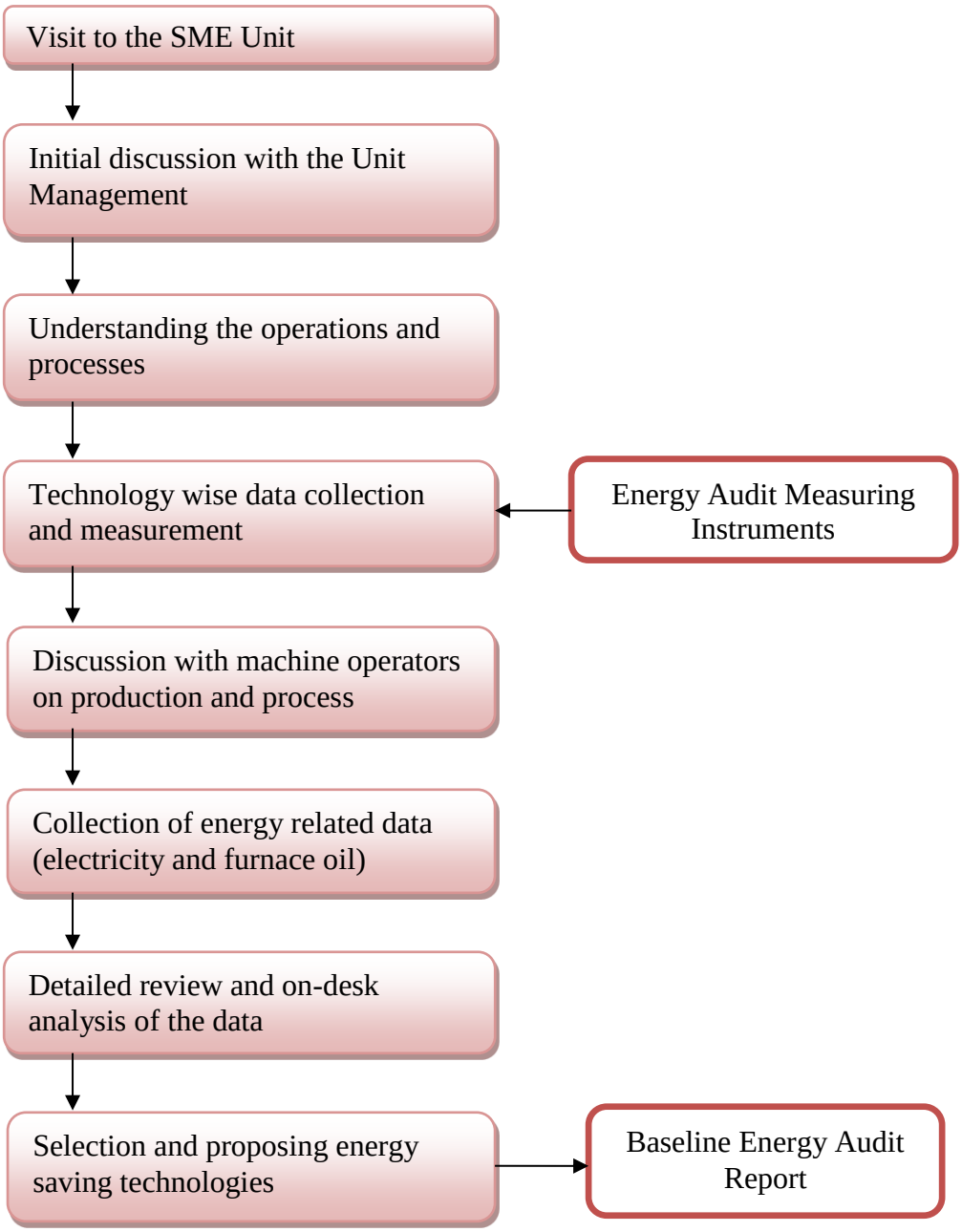
1.2 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at manufacturing of forged products at M/s C-FORGE (India) are presented below:



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.



1.4 PRESENT TECHNOLOGIES ADOPTED

The list energy consuming installed in C-FORGE (India) and used for forging process are as follows:

S.N.	Equipment	Energy Source	Energy consumption	Year of Installation
1	Cutting Press	Electricity	5 HP	15 years old
2	Re-heating	Electricity	100 kW	5 years old
3	Forging press	Electricity	5 HP + 10 HP	5 years back
4	Trimming press	Electricity	3 HP	1990

Study and Observations

2.1 RE HEATING FURNACE (FURNACE OIL FIRED)

2.1.1 Present Process

M/s C-FORGE (India) was using a Furnace Oil (FO) fired reheating furnace to heat the metal pieces for forging process. The metal pieces are kept inside the furnace and heated for a period of 20-25 mins. depending upon the size of the raw material and product to be formed. The metal piece to be forged is heated to a temperature of 1150-1200 deg. C. 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.

Due to high energy cost and environmental concerns, the unit has stopped the reheating process using the FO based re-heating furnace. The unit is now planning to install an Induction type re-heating furnace.

Table 2.1: ***Production figures on FO based reheating furnace***

Particulars	Values
Daily production (Kgs)	1,000
Fuel consumption FO (In Liters)	100
Operating hours	11
Cost of Fuel (In Rs.)	50
Calorific Value of Fuel (In Kcals)	10,200

The energy consumption and production data related to the furnace oil based re-heating furnace installed at C-FORGE (India) is shown in Table 2.1. As discussed with the unit management, initially, before start of the forging of the metal pieces, the re-heating furnace was pre-heated for about 30 minutes along with the material to be heated/ forged. After half an hour heating, forging of metal pieces is started, after completion of the one batch another batch of metal pieces is feed for the heating. The cost of furnace oil noted as Rs. 50 per liter.

2.1.2 Observations

Some observations and drawbacks of the present re-heating FO technology:

- **Conventional Technology**

The exiting furnace is very old installed in year 1996 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.

- **Material deterioration:**

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 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 archive in a minimum time, which would help in reducing the excessive heating of the material and reduction in scale loss.

- **High energy consumption:**

As per the data collected during the energy audit activity, the reheating furnace consumes around 0.02 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.

- **Low production rate:**

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.

- **Environmental and Health Issues:**

The existing reheating furnace requires furnace oil as a source of energy which is burnt to heat the metal pieces. The burning of FO releases harmful gases like CO, CO_2, SO_X, NO_X, smoke etc. During the preliminary visit, it was also noted black soot is coming out of the furnace and getting deposited in the factory itself. The black soot is basically due to the incomplete combustion of the FO, which ageing reduces the efficiency of the furnace and increases the fuel loss. The 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.

- **Lack of skilled labour:**

Another factor which is creating the problem in Ludhiana is shortage of skilled workforce. Present re-heating technology requires 2-3 workers to control the furnace operations and feed in / discharge of material from the furnace.

- **Ideal running of forging press:**

It was noted that there is miss match between the operating capacity of the furnace and forging press. As studied, in a cycle of 5 minutes, the re-heating furnace produces only 10-13 pieces which were being forged in 2 minutes only the remaining

3 minutes the forging press runs ideal. During this ideal running time, the forging press only consumes energy instead of producing any output.

- **Choking at blower suction end:**

While studying the re-heating furnace, it was seen that the suction inlet of the blower is not working properly and there was no suction of the air.

- **Space constrained for storing fuel:**

It was observed during baseline audit, another big issue is fuel storage problem. C-FORGE (India) has space limitations and there for finding problems with maintaining the inventory of the furnace oil in the unit.

2.1.3 Conclusion

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

Benefits of the EE re-heating technology:

- 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

2.1.4 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 2.2.

Table 2.2: *Energy saving calculation for Induction Furnace*

Parameter	Unit	Value
Furnace oil consumption on re-heating furnace	Liters	9.09
Production in terms of Kg	Kg/hour	90.91
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.10
Cost of energy consumption	Rs./Kg	5
Power consumed by proposed induction furnace (rated capacity 100 kW operating at 74 kW)	kW	74
Production in terms of Kg	Kg/hr	180
Specific energy consumption on induction reheating furnace	kWh/Kg	0.41
Cost of energy consumption	Rs./Kg	3.08
Reduction in cost of energy required	Rs./Kg	1.92
Operating hours	Hrs	8

Parameter	Unit	Value
Annual operating days	Days	300
Annual cost savings	Rs	828,000
Investment required for Induction furnace (100 kW)	Rs	1,380,894
Simple payback period	Years	1.7

As per the detailed calculations done, it is proposed to install an induction re-heating furnace of capacity 100 kW (proposed for larger products also). The data was gathered for 22mm nut. To reheat the metal pieces, the proposed furnace must be run at 74 kW with production of 180 kg/ hour. The cycle time required to re-heat the metal piece of 200 gram was calculated as 4-5 seconds.

The cost of energy saved per Kg of material forged is calculated as Rs. 1.92. The investment required for implementing the induction technology estimated as Rs 18 Lakhs with annual saving of Rs 8.28 Lakhs. The simple payback period of the technology is 2.2 years.

Basic details and energy utilization pattern of C-Forge (India)

S. No	Parameter	Value	Unit
1	Name and address of unit	M/s. C-FORGE (India), Plot No. 331-A, Industrial area -A, Near Cheema Chowk, Ludhiana - 141003, Punjab	
2	Contact person	Ms. Sharanjeet Singh	
3	Manufacturing product	Bolts, Nuts, Industrial Fasteners and Auto parts	
4	Daily Production	1 Tonnes/ day	
	Energy utilization		
5	Average monthly electrical energy consumption	20193	kWh per month
6	Average monthly thermal (FO) energy consumption	3000	Liters per month
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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 = 180 Kg

Induction furnace capacity requirement (theoretical) = 180/2.7 kW/hr
= 66.66 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%) = 66.66 kW/hr /.90
= 74.07 kW/hr
= 74 kW approximately

Heating cycle time calculation:

Hourly material to be heated = 180 kg

Weight of the metal pieces = 200 gram

No. of pieces to be heated in an hour = 900 pieces

Heating time required per piece = 4-5 seconds

Keeping in mind the variety of products manufactured by C-FORGE (India) having variable weight, size, geometry, composition etc. induction furnace of 100 kW is proposed.

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

Energy Saving Calculation for Induction Furnace

Parameter	Unit	Value
Furnace oil consumption on re-heating furnace	Liters	9.09
Production in terms of Kg	Kg/hour	90.91
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.10
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Operating hours	Hrs	8
Annual operating days	Days	300
Annual cost savings	Rs	828,000
Investment required for Induction furnace (100 kW)	Rs	1,380,894
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.*