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

Ludhiana Forging Cluster

Baseline Energy Audit Report
K S Industries

Submitted to

Submitted by

InsPIRE Network for Environment

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Contents

ANNEXES

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	:	KS Industries
Address	:	E-306, Phase-IV, Focal Point, Ludhiana
Contact Person	:	Mr. Atul Kapoor - 9417237396
Products	:	Various Auto parts
Production	:	1 ton per day
DIC Number	:	030091105495 Part - II
Bank Details	:	Union Bank of India, Acc. No- 397305040001098 Branch: Miller Ganj
TIN / PAN No.	:	AJWPK8823G
Contract demand	:	91.63 kVA

2. Existing Major Energy Consuming Technology

Resistive type electrical heater

- Conventional Technology with higher losses
- Prevailing energy consumption 0.875 kWh per kg of the production

Lathe Machine

- Manually operated lathe machines (3 nos. of machines) for machining job work including threading, turning, grinding, drilling etc. Electrical motor rating of 3 HP each, with combined production of around 25 pieces per hour.
- Manually operated lathe machines (2 nos. of machines) for reducing cross section and threading. Electrical motor rating of 3 HP and 5 HP respectively, with combined production of around 80 pieces per hour.

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Saving Measures

- Replacement of existing furnace with 50 kW induction re-heating furnace
- Replacement of 3 nos. of manual lathe machines by one Special Purpose Machine (SPM) for turning operation
- Replacement of 2 nos. of manual lathe machines by one Special Purpose Machine (SPM) for long thread reducing operation

Table 1: *Cost Economic Analysis*

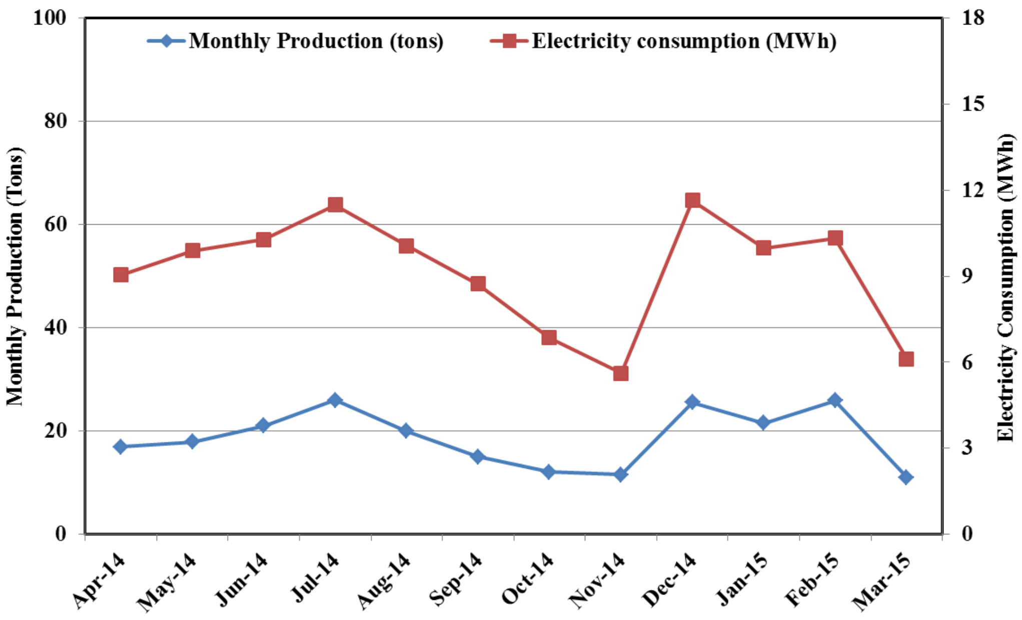
Proposed Technology	Estimated Energy Savings (%)	Savings (in Rs.)	Investment (in Rs.)	Simple Payback period (Years)
Induction re-heating furnace (50 kW)	59	1,223,894	936,510	0.8
SPM – Turning Machine	76	248,334	550,000	2.2
SPM- Long Thread Reducing Machine	73	215,775	650,000	3.0
Total		**1,552,178**	**1,950,000**	

Introduction

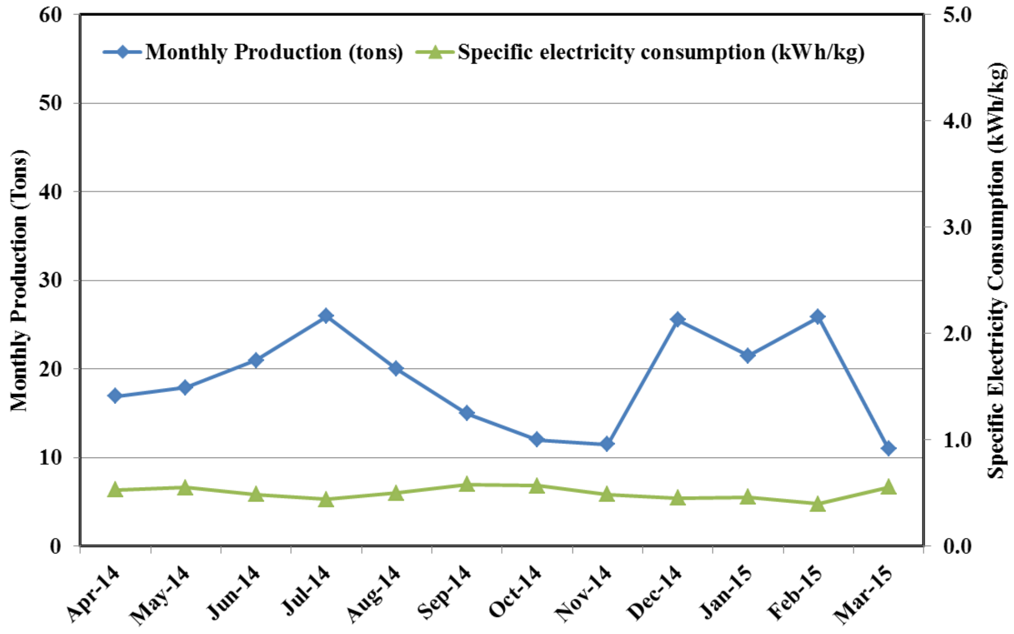
1.1 ABOUT THE UNIT

K S Industries is engaged in manufacturing of various auto parts of different sizes as per the customer requirement. The raw material procured by the unit for making bolts and other auto components include Mild Steel, EN8 etc.

The daily production of the unit is around 1000 kgs per day. K S Industries is using primary energy, namely, Furnace Oil (FO) and Electricity supply from SEBs for various process and utility applications in premises. The average monthly FO consumption in the unit is 489 liters. It was observed that the average monthly electricity consumption is 9,169 kWh. 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***

According to the assessment of the energy consumption data collected, the specific thermal energy consumption and specific electrical energy consumption is 0.026 L/kg (267 kcal/kg) of product and 0.49 kWh/kg (422.08) of product respectively. The total specific energy consumption (in kCal) is 689.2 kCal/ kg of product. Details of annual electrical and thermal energy consumption and specific energy consumption details in K S Industries are presented in table below:

Table 1.1: ***Details of K S Industries***

SN	Parameter	Value	Unit
1	Name and address of unit	K S Industries	
2	Contact person	Mr. Atul Kapoor	
3	Manufacturing product	Various Auto Parts	
4	Daily Production	1 ton	
	Energy utilization		
6	Average monthly electrical energy consumption	9,169	kWh per month
7	Average monthly thermal (FO) energy consumption	489	Liters per month
8	Average specific thermal energy consumption^1	0.026	Liter /kg of product
		267.1	kCal/kg of product
9	Specific electrical energy consumption^2	0.49	kWh/Kg of product
		422.08	kCal/kg of product
10	Specific energy consumption	689.2	kCal/kg of product
11	Electrical energy cost	3.55	Rs/Kg of product
12	Thermal energy cost	1.0	Rs/kg of product
13	Total energy cost	4.55	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.
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 manufacturing of forged products at K S Industries are presented below:

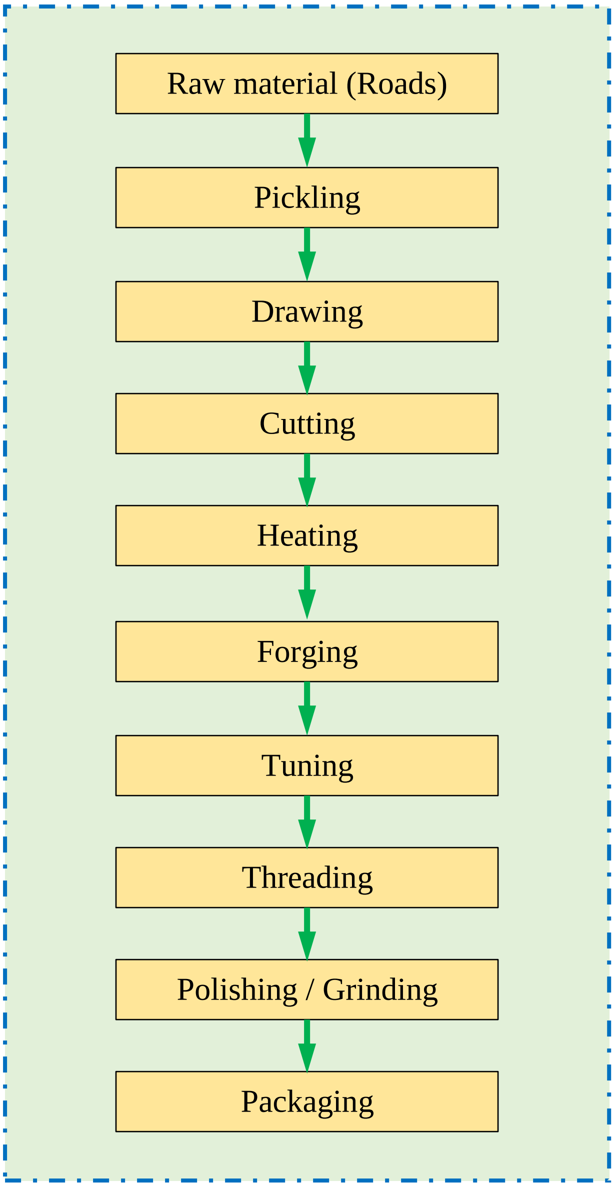
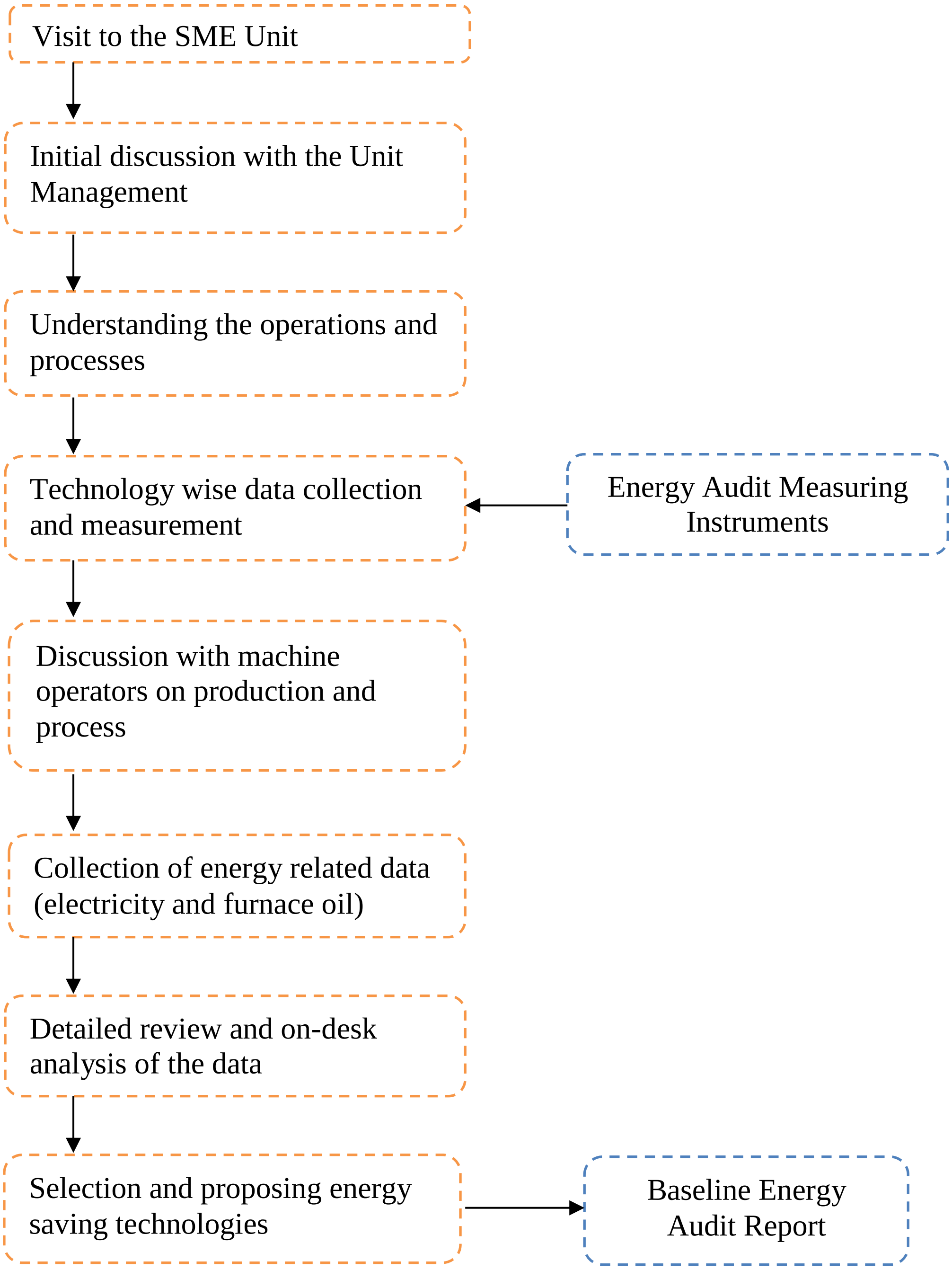


Figure 1.2: *Flow chart of the production process*

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/tons), etc.



Present Process, Observations and Proposed Technology

2.1 RE HEATING FURNACE (ELECTRICAL RESISTIVE BASED)

2.1.1 Present Process

K S Industries has installed electrical resistive based heating furnace to heat the metal pieces for forging process. After heating the pieces at desired temperature, the heated metal piece is then kept on the forging die having the cavity of the product to be formed. The hot metal piece is then forged on the forging press into the product.

2.1.2 Observations

The exiting electrical resistive heating furnace is observed to be less efficient. Since, the efficiency of such furnace is lower, new technology induction furnaces maybe installed for re-heating process. The specific energy consumption of existing furnace is observed to be around 0.875 kWh per kg of the production which is higher in comparison to the latest technologies available for carrying out the same purpose.

Conclusion:
As per the past studies conducted in forging industries, the replacement of electrical resistive based heating furnace with an induction re-heating furnace saves some 60% of the energy cost. The production rate of the furnace observed during study is observed to be low and varies with the product size (Ref Table 2.1). Therefore, it is proposed to replace both these existing electrical resistive based heating furnace with energy efficient induction reheating furnaces.

This replacement would provide following benefits:

- Reduces Specific Energy Consumption
- User friendly technology
- Improved quality of the product output

2.1.4 Cost Economics Analysis

The comparison of electrical resistive based heating furnace 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 2.***

Table 2.1: *Cost Economic Analysis of proposed induction furnace*

Parameter	Unit	Value
Electricity load of existing electrical resistive heater	kW	24.5
Production in terms of Kg	Kg/hour	28
Specific energy consumption on existing electrical resistive heater	kWh/Kg	0.875
Cost of energy consumption	Rs./Kg	6.32

Parameter	Unit	Value
Power consumed by proposed induction furnace (rated capacity 50 kW operating at 50 kW)	kW	50
Production in terms of Kg	Kg/hr	140
Specific energy consumption on induction reheating furnace	kWh/Kg	0.36
Cost of energy consumption	Rs./Kg	2.68
Reduction in cost of energy required	Rs./Kg	3.64
Operating hours	Hrs	8
Annual operating days	Days	300
Annual cost savings	Rs	1,223,894
Investment required for Induction furnace (50 kW)	Rs	936,510
Simple payback period	Years	0.8

As per the detailed calculations done, it is proposed to install an induction based re-heating furnace of capacity 50 kW for carrying out heating of heavier metal pieces. Based on the discussion with unit management, it came out that maximum weight of the individual piece would be around 2.8 kgs and the cycle time required to re-heat the metal piece (approx. 40 piece batch) would be completed within 60 secs.

The cost of energy saved per Kg of material forged is calculated as Rs. 3.64. The investment required for implementing the induction technology is estimated to about Rs 9.36 Lakhs with annual saving of Rs 12.23 Lakhs. The simple payback period of the technology is 0.8 years.

2.2 SPECIAL PURPOSE MACHINES (SPM)

2.2.1 Present Process:

K S Industries has installed manually operated lathe machines for various components machining job work like facing, turning, grinding, drilling etc. These machine runs on electrical motors having the capacity varying between 3 HP & 5 HP with production/ machining of around 25 pieces per hour for facing, turning, grinding & drilling operation and around 80 pieces per hour for reducing & threading operations.

2.2.2 Observations

Since these machines are manually operated, the process through which components are manufactured is very slow and time consuming. Apart from the slow process, the components manufactured are not very precise, identical and of high quality. Some times what happens that the machine keeps on running even there is no component on the machine or the operator is busy in some other work. All these factors lead to the loss of energy and production of low quality components.

2.2.3 Conclusion

In order to promote the energy efficiency and reduction in the overall energy cost in the factory, it is recommended to replace the existing manual machines by automatic special purpose machine (SPMs). Since the modified machines will run on the pre-installed programming technique, the consumption of electricity will only happen when there is a function or operation required on the component. In the ideal condition the machine will remain in dead mode/ no operation mode.

Apart from the operation, the machine automatically loads the component for machining. The cycle time of the each component will be fixed in the business logic of the PLC / SPM machine therefore each component will take specific time for processing or machining. The SPM machines results in substantial energy savings depending upon the type of component, operation, material, cycle time etc.

Benefits of the Automatic SPM/ CNC machines:

- Reduced energy consumption
- Faster operation and reduced down time
- Improved product quality and symmetrical product dimensions
- Higher productivity
- Environment friendly technology

2.2.4 Cost Economics Analysis

Based on the present operating condition of the plant, the following replacements are being suggested:

- Replacement of 3 nos. of manual lathe machines engaged in facing, turning, grinding & drilling operations by one Special Purpose Machine (SPM) for turning operation
- Replacement of 2 nos. of manual lathe machines engaged in reducing & threading operations by one Special Purpose Machine (SPM) for long thread reducing operation

Table 2.2. shows the comparison of production on old manual/ conventional lathe machine and modified SPM machine for turning operation, specific energy consumption, cost savings, investment required and simple payback period of the investment.

Table 2.2: *Cost Economic Analysis of proposed induction furnace Proposed SPM for turning operation*

Parameter	Unit	Value
Power consumed by conventional turning machine	kW	6.714
Production on conventional turning machine	Pcs/hr	25
Specific power consumption on conventional machine	kWh/Pcs	0.269
Power consumed by SPM turning machine (motor capacity 7.5 HP) @ 80% Loading	kW	4.476
Production on SPM turning machine (Projected)	Pcs/hr	70
Specific power consumption on SPM machine	kWh/Pcs	0.064
Reduction in specific power consumption	kWh/Pcs	0.205
Percentage savings	%	76.2
Daily operating hours	Hrs	8
Annual operating days	Days	300
Annual electricity savings	kWh	34,376
Annual cost savings	Rs.	248,334
Investment required	Rs.	550,000
Simple payback period	Years	2.2

As per the detailed calculations, it is proposed to convert 3 nos of existing manual lathes into automatic Special Purpose Machine (SPM) – Turning Machine. The specific power consumption on a manual machine is 0.269 kWh/ pcs, whereas, the specific power consumption in modified SPM-Turning machine would be around 0.064 kWh/pcs resulting in 76% savings in electrical energy. The investment required for making an SPM machine would be around Rs 5.5 Lakhs with annual saving of Rs 2.48 Lakhs. The simple payback period of the technology is 2 years.

Table 2.3. shows the comparison of production on old manual/ conventional lathe machine and modified SPM machine for long thread reducing operation, specific energy consumption, cost savings, investment required and simple payback period of the investment.

Table 2.2: ***Cost Economic Analysis of proposed induction furnace Proposed SPM for long thread reducing operation***

Parameter	Unit	Value
Power consumed by conventional lathe machine used for reducing and threading operations	kW	5.968
Production on conventional machine	Pcs/hr	80
Specific power consumption on conventional machine	kWh/Pcs	0.0746
Power consumed by SPM long thread reducing machine (motor capacity 5 HP) @ 80% Loading	kW	2.984
Production on SPM reducing machine (Projected)	Pcs/hr	150
Specific power consumption on SPM reducing machine	kWh/Pcs	0.020
Reduction in specific power consumption	kWh/Pcs	0.055
Percentage savings	%	73.3
Daily operating hours	Hrs	8
Annual operating days	Days	300
Annual electricity savings	kWh	19,694
Annual cost savings due to electricity	Rs.	142,275
Annual cost savings due to material savings	Rs.	73,500
Total annual cost savings	Rs.	215,775
Investment required	Rs.	650,000
Simple payback period	Years	3.0

As per the detailed calculations, it is proposed to convert 2 nos of existing manual lathes into automatic Special Purpose Machine (SPM) – Long Thread Reducing Machine. The specific power consumption on a manual machine is 0.0746 kWh/ pcs, whereas, the specific power consumption in modified SPM-Long Thread Reducing machine would be around 0.020 kWh/pcs resulting in 73% savings in electrical energy. The investment required for making an SPM machine would be around Rs 6.5 Lakhs with annual saving of Rs 2.15 Lakhs. The simple payback period of the technology is 3 years.

Basic details and energy utilization pattern of M/s K S Industries

SN	Parameter	Value	Unit
1	Name and address of unit	K S Industries	
2	Contact person	Mr. Atul Kapoor	
3	Manufacturing product	Various Auto Parts	
4	Daily Production	1 ton	
	Energy utilization		
6	Average monthly electrical energy consumption	9,169	kWh per month
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11	Electrical energy cost	3.55	Rs/Kg of product
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13	Total energy cost	4.55	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.

The unit operates for 25 days a month.

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 = 115 Kg

Induction furnace capacity requirement (theoretical) = 120/2.7 kW/hr
= 44.44 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%) = 44.44 kW/hr /0.90
= 49.38 kW/hr
= 50 kW approximately

Heating cycle time calculation:

Hourly material to be heated = 120 kg
Weight of the metal pieces = 2.8 kg
No. of pieces to be heated in an hour = 40 pieces
Heating time required per piece = 1 minute approximately

Keeping in mind the variety of products manufactured by K S Industries (India) having variable weight, size, geometry, composition etc. induction furnace of 50 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
Electricity load of existing electrical resistive heater	kW	24.5
Production in terms of Kg	Kg/hour	28
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Cost of energy consumption	Rs./Kg	6.32
Power consumed by proposed induction furnace (rated capacity 50 kW operating at 50 kW)	kW	50
Production in terms of Kg	Kg/hr	140
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Cost of energy consumption	Rs./Kg	2.68
Reduction in cost of energy required	Rs./Kg	3.64
Operating hours	Hrs	8
Annual operating days	Days	300
Annual cost savings	Rs	1,223,894
Investment required for Induction furnace (50 kW)	Rs	936,510
Simple payback period	Years	0.8

Note:

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

Energy Saving Calculation for SPM Machines – Turning Operation

Parameter	Unit	Value
Power consumed by conventional turning machine	kW	6.714
Production on conventional turning machine	Pcs/hr	25
Specific power consumption on conventional machine	kWh/Pcs	0.269
Power consumed by SPM turning machine (motor capacity 7.5 HP) @ 80% Loading	kW	4.476
Production on SPM turning machine (Projected)	Pcs/hr	70
Specific power consumption on SPM machine	kWh/Pcs	0.064
Reduction in specific power consumption	kWh/Pcs	0.205
Percentage savings	%	76.2
Daily operating hours	Hrs	8
Annual operating days	Days	300
Annual electricity savings	kWh	34,376
Annual cost savings	Rs.	248,334
Investment required	Rs.	550,000
Simple payback period	Years	2

Energy Saving Calculation for SPM Machines – Long Thread Reducing Operation

Parameter	Unit	Value
Power consumed by conventional lathe machine used for reducing and threading operations	kW	5.968
Production on conventional machine	Pcs/hr	80
Specific power consumption on conventional machine	kWh/Pcs	0.0746
Power consumed by SPM long thread reducing machine (motor capacity 5 HP) @ 80% Loading	kW	2.984
Production on SPM reducing machine (Projected)	Pcs/hr	150
Specific power consumption on SPM reducing machine	kWh/Pcs	0.020
Reduction in specific power consumption	kWh/Pcs	0.055
Percentage savings	%	73.3
Daily operating hours	Hrs	8
Annual operating days	Days	300
Annual electricity savings	kWh	19,694
Annual cost savings due to electricity	Rs.	142,275
Annual cost savings due to material savings	Rs.	73,500
Total annual cost savings	Rs.	215,775
Investment required	Rs.	650,000
Simple payback period	Years	3.0

Note:

*** The cost of SPM machines is an indicative value gathered from discussions with SPM machine suppliers. It may vary from operation to operation and product to product.*