BEE's National Program

on

Energy Efficiency and Technology Up-gradation in SMEs

Pali Textile Cluster

Baseline Energy Audit Report
Manoj Dyeing (P) Ltd.

   

Submitted to

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InsPIRE Network for Environment

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contents

List of Annexures

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List of Tables

List of Figures

List of Abbreviations

APH	Air-preheater
BEE	Bureau of Energy Efficiency
BD	Blow Down
BOP	Best Operating Practice
BFW	Boiler Feed Water
CETP	Common Effluent Treatment Plant
CSE	Center for Science and Environment
CRS	Condensate Recovery System
FD	Forced Draft
HP	Horse Power
ID	Induced Draft
kcal	Kilo Calories
kg	Kilogram
kVA	Kilo Volt Ampere
kW	Kilo Watts
MSME	Ministry of Micro Small and Medium Enterprises
RTHPA	Rajasthan Textile and Hand Processors Association
RO	Reverse Osmosis
SEC	Specific Energy Consumption
SFC	Specific Fuel Consumption
SPC	Specific Power Consumption
SME	Small and Medium Enterprise
SO	Sulphur Oxide
TDS	Total Dissolved Solids
TFH	Thermic Fluid Heater
VFD	Variable Frequency Drive

About The Project

The project titled "BEE's National Program on Energy Efficiency and Technology Up-gradation in SMEs" supported by Bureau of Energy Efficiency (BEE), Ministry of MSME and Rajasthan Textile and Hand Processors Association (RTHPA) aims to bring down the energy demand of MSME industries located at different clusters around the country. Pali Textile Processing cluster located at Pali, Rajasthan is one such cluster, which has been selected under the program. The project aims to support the MSME units in Pali to implement Energy Efficient Technologies in the SME units.

There are more than 400 Small and Medium Enterprise (SME) textile processing units operating in the various industrial pockets of Pali. The project aims to initially diffuse energy efficient technologies in selected units in the cluster. These units will act as demonstration units for long term and sustainable penetration of energy efficient technologies in the entire cluster. InsPIRE Network for Environment, New Delhi has been appointed as the executing agency to carry out the following activities in the cluster:

- Conducting pre-activity cluster workshop in the cluster.
- Conducting initial walk through audits in 5 representative units of the cluster.
- Identify and propose BEE on energy efficient process technologies, relevant to the cluster, with highest energy saving and replication potential, and their cost benefit analysis.
- Identify local technology/service providers (LSP) for the above technologies in the cluster
- Identify SME units willing to implement and demonstrate the energy efficient technologies
- Assist BEE to enter into a contract with each of the shortlisted SME units to enable implementation and showcasing of Energy Efficient technology.
- Conduct comprehensive Baseline Energy Audits in the shortlisted SME units wherein these technologies can be implemented and document the findings in the form of a report.
- Develop technology specific case studies (Audio-Visual and print) for each technology
- Prepare Best Operating Practices (BOP) document for the top 5 energy using equipment / process in the industry cluster
- Enumeration of common regularly monitorable parameter at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same with options including make, supplier, indicative cost specifications and accuracy of measurements.
- Carry out post implementation energy audit in the implemented units to verify energy savings as a result of EE technology implementation.
- Verify and submit to BEE all the relevant documents of each participating unit owner indicating his complete credentials, proof of purchasing the equipment, evidence of implementation and commissioning of the EE technology in the unit.

As part of the activities conducted under the energy efficiency program in Pali Textile cluster, detailed energy audits in 11 Textile units in Pali was conducted in the month of March and April'2016. This specific audit report details the findings of the energy audit study carried out at Manoj Dyeing (P) Ltd.

Executive Summary

1. Unit Details

Unit Name	:	**Manoj Dyeing (P) Ltd.**
Address	:	F-201A, Mandia Road, Pali, Rajasthan- 306401
Contact Person	:	Mr. Mukesh Jain, Director (Cell no: 9414121904)
Products	:	Cloth processing (cotton & polyester)
Production	:	65,000 to 75,000 meters of processed cloth per day
DIC Number	:	080201200058 Part-II
Bank Details	:	Bank of Baroda, Pali, A/c No.: 09790500014892, IFSC Code: BARBOPALIXX
TIN / PAN No.	:	TIN: 08023254843 PAN: AAECM0356N
Contract demand	:	101HP

2. Existing Major Energy Consuming Technology

Coke Based Steam Boiler

- Steam boiler with no provision for pre-heating of boiler feed water and combustion air. Also, the unit do not have boiler feed water treatment facility.
- Prevailing specific fuel consumption is 0.03 kgs of coke per meter of processed cloth. High TDS in the feed water leads to frequent blow-down of boiler.

Jet Dyeing Machine and Zero-Zero Machine

- 4 Nos of Jet Dyeing with no provision for condensate recovery.
- Each jet machine uses steam at 300 kg/hr with a production of 2000-2500 mtrs of processed cloth per batch from jet dyeing machines (2-3 hrs time required for one batch).

Jigger Machine

- A total of 13 numbers jigger machines used for cotton dyeing at elevated temperature (60-80^{0}C). Jiggers are not equipped with temperature monitoring and control system.
- Each jigger machine uses 2000-2500 liters of water in each cycle.

Mercerizing Machine

- One no. of mercerizing machine installed with DC motor for speed variation. 4 nos. of motors of ratings 7.5 HP, 10 HP, 3 HP and 3HP are used presently.

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Saving Measures

- Installation of economizer in thermic fluid heater for boiler feed-water pre-heating.
- Installation of RO system for treatment of feed water to boiler.
- Installation of condensate recovery system for jet dyeing machines.
- Installation of temperature monitoring and control system in jigger machines
- Installation of energy efficient motors with VFD in mercerizing machine

Table 1: ***Cost Economic Analysis***

Technology	Estimated Energy Savings (%)	Savings (in Rs)	Investment (in Rs)	Simple Payback period (Months)
Economizer in Thermic fluid exit	10.43	3,29,589	3,00,000	11
Reverse Osmosis (RO) system in steam boiler	4.4	1,06,368	2,00,000	23
Condensate Recovery System (CRS) in Jet Dyeing Machine	40	7,28,712	5,00,000	8
Energy efficient AC motors with VFD in mercerizing machine	30.00	2,84,002	2,50,000	10
Temperature Monitoring & Control in Jigger Machines (for 10 Jiggers)	5.70	4,92,252	2,50,000	6

Introduction

1.1 ABOUT THE CLUSTER

The Pali textile cluster is one of the biggest SME clusters in Rajasthan having over 350 member industries. The units in the cluster are mainly located in industrial areas namely Industrial Area Phase I & Phase II, Mandia Road Industrial Area and Punayata Industrial Area. Balotra and Bhilwara are other textile clusters in Rajasthan. These clusters also have similar processes and any intervention in Pali would benefit entrepreneurs in these clusters as well. Pollution of nearby river was a significant environmental issue. Center for Science and Environment (CSE) conducted a study to assess the situation behind the environmental issues. The units faced closure for a long time due to legal actions and decided to set up a Common Effluent Treatment Plant (CETP) for redressal the waste water related issues. The CETP is being operational under a trust managed by the entrepreneurs themselves.

Ironically, even though none of the resources required for textile processing is available locally, the textile cluster at Pali has grown despite the odds. The industrial area has no water and all the water required is transported from a distance of over 20 KM. The labour working in the cluster is mostly from outside Pali, at times from as far as Eastern UP and Bihar. Equipment suppliers are all based in Gujarat and Pali does not have enough local service providers or consultants. Even the grey (raw) cloth, dye and chemicals are brought mostly from Maharashtra and Gujarat. Coal or residual pet coke is also not available locally.

Only resource that is available locally is the entrepreneurship of the people, availability of clear sky for over 340 days in an year and good power availability. Presence of a pool of dye masters to process over 400 shades through colour recipe based on experience is another plus for Pali. Initially, Surat used to be the largest processing center for dyeing but a large portion of the job there got outsourced to Pali due to problems like Pollution, Flood, Plague etc.

1.2 ABOUT THE UNIT

M/s Manoj Dyeing (P) Ltd., Pali, was established in the year 2003 and is engaged in processing of cloth (both cotton and polyester) which includes raw cloth (grey) processing, dyeing and finishing operations. The manufacturing unit is located at F-201A, Mandia Road, Pali. The unit operation is overseen by Mr. Mukesh Jain, Director.

The raw material procured by the unit includes grey (raw cloth) purchased from various sources predominantly from Gujarat and Maharashtra. The unit operates for 12 hours per day, presently.

The daily production lies in the range of 65,000 to 75,000 meters of processed cloth per day. The major energy usage in the unit includes wet steam (generated from coke fired boiler) and electricity. The average monthly coke consumption (derived from reported date of last one year) in the unit is 35,377 Kgs. The average monthly electricity consumption (derived from reported date of last one year) is 36,364 kWh. ***Figure 1.1*** depicts monthly electricity consumption vis-à-vis total monthly production of the unit for last one year. ***Figure 1.2*** depicts monthly coke consumption vis-à-vis total monthly production for last one year.

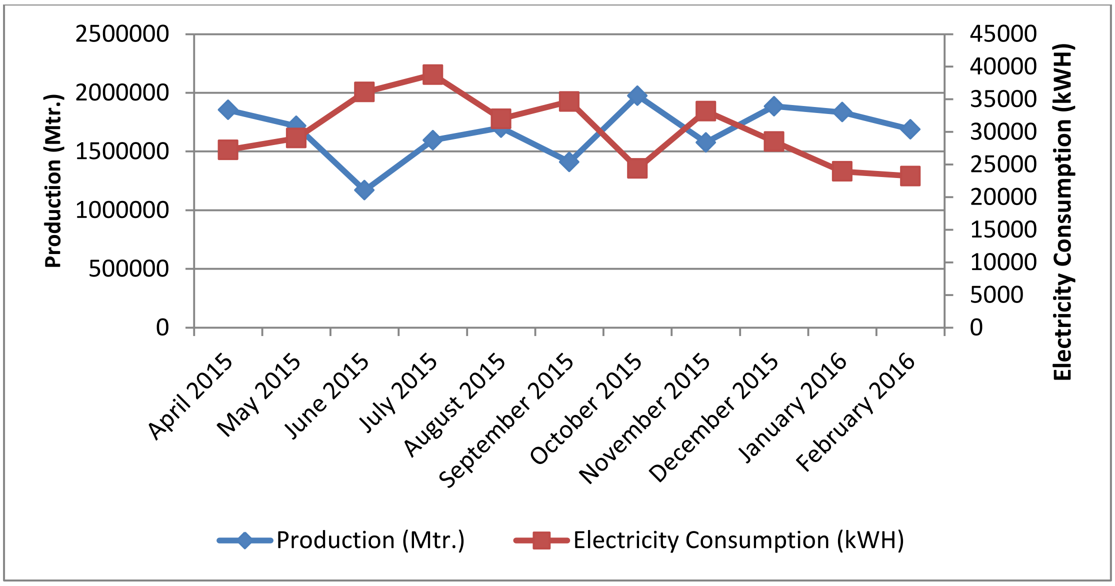


Figure 1.1: ***Monthly variation of production and electricity consumption***

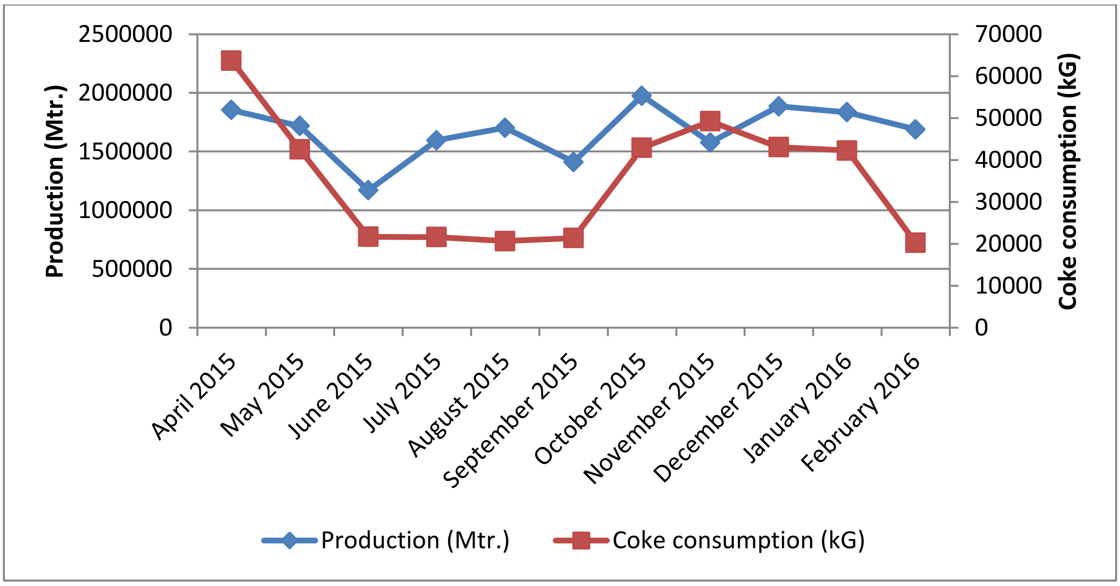


Figure 1.2: ***Monthly variation of production and coke cosumption***

Figure 1.3 and ***Figure 1.4*** below respectively depicts the variation in specific electrical energy consumption and specific thermal energy consumption vis-à-vis the monthly production for last one year.

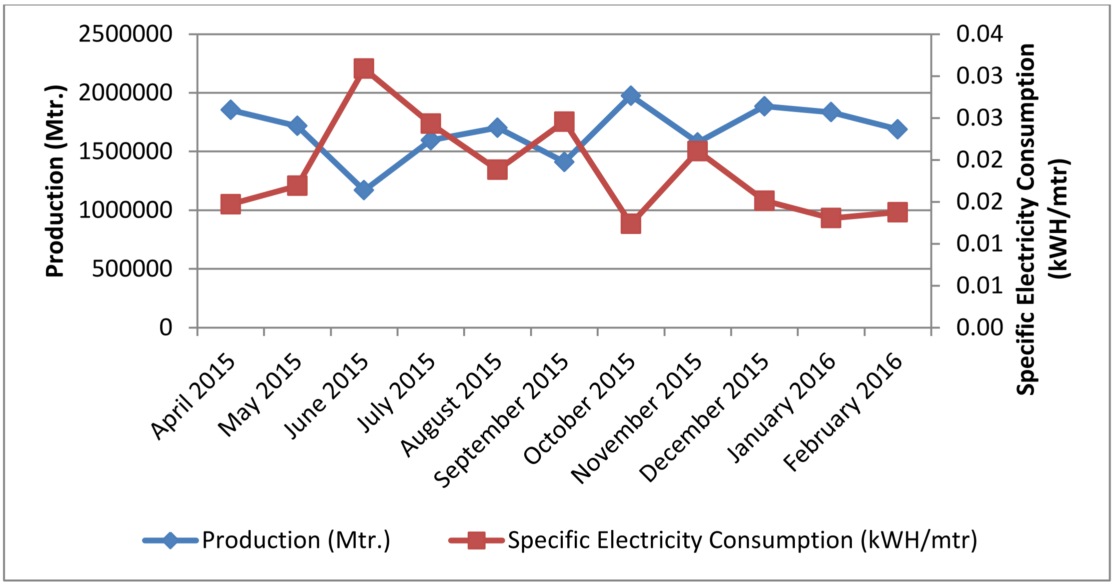


Figure 1.3: ***Variation in specific electrical energy consumption and monthly production***

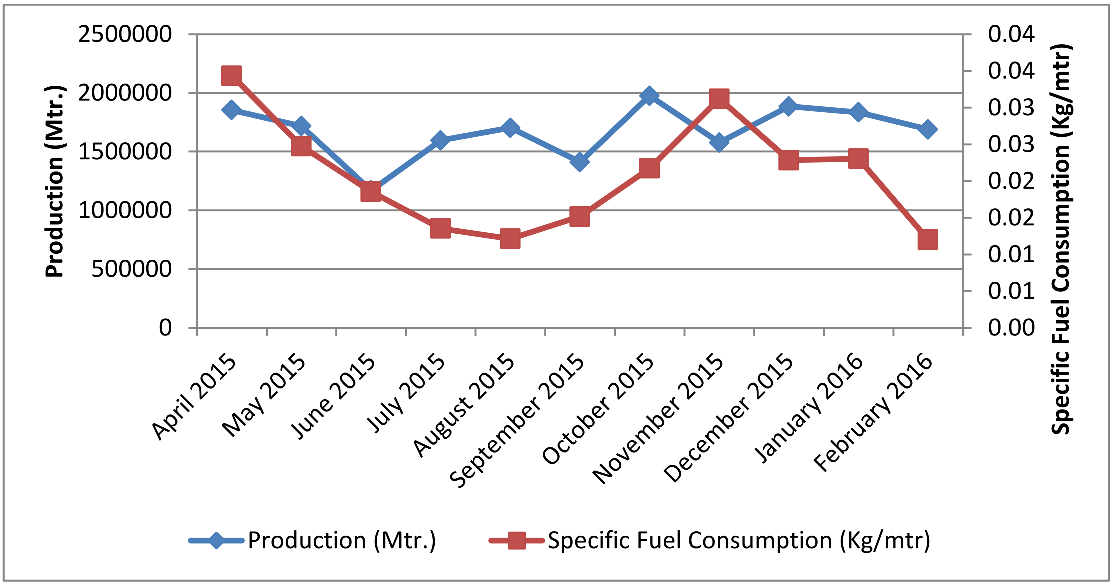


Figure 1.4: ***Variation in specific fuel consumption (coke) and monthly production***

According to the assessment of the energy consumption data as reported by the unit (filled in questionnaire attached), the specific thermal energy consumption of the unit varies from 101 kCal/mtr to 258 kCal/mtr over a period of one year with an average of 152 kCal/mtr. The specific electrical energy consumption of the unit varies from 0.01 kWh/mtr to 0.03 kWh/mtr over a period of one year with an average of 0.02 kWh/kg. The unit used coke as fuel with a calorific value of 8200 kCal/mtr. The total average specific energy consumption (in kcal), based on reported data for one year, is estimated as **169.28 kCal/mtr** of product. The energy consumption pattern for the unit has been summarized below at ***Table 1.1***.:

Table 1.1: ***Energy consumption details of Manoj Dyeing (P) Ltd.***

SN	Parameter	Unit	Value
1	Name and address of unit	Manoj Dyeing (P) Ltd., F-201A, Mandia Road, Pali, Rajasthan-306401	
2	Contact person	Mr. Mukesh Jain, Director	
3	Manufacturing product	Processed cloth (Cotton/ Polyester)	
4	Daily Production	65,000 to 75,000 mtr per day	
	Energy utilization		
5	Average monthly electrical energy consumption	kWh	30,108
6	Average monthly fuel (coke) energy consumption	kg	35,377
7	Average specific thermal energy consumption	kCal/mtr	153.21
8	Specific electrical energy consumption	kWh/mtr	0.02
9	Specific energy consumption[1,2]	kCal/mtr	169.28
10	Electrical energy cost[3]	Rs/mtr	0.12
11	Thermal energy cost[3]	Rs/mtr	0.16

Note:

[1]: Specific gross calorific value of Coke has been considered as 8200 kCal/kg

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

[3]: The unit operates for 25 days a month (1 shift of 12 effective hours per day).
Cost of electricity has been taken as Rs 6.50 / kWh
Cost of coke has been taken as Rs 7.5/kg

1.3 PRODUCTION PROCESS OF PLANT

The ***Figure 1.5*** below shows the typical process employed at processing of textile products at Manoj Dyeing (P) Ltd.:

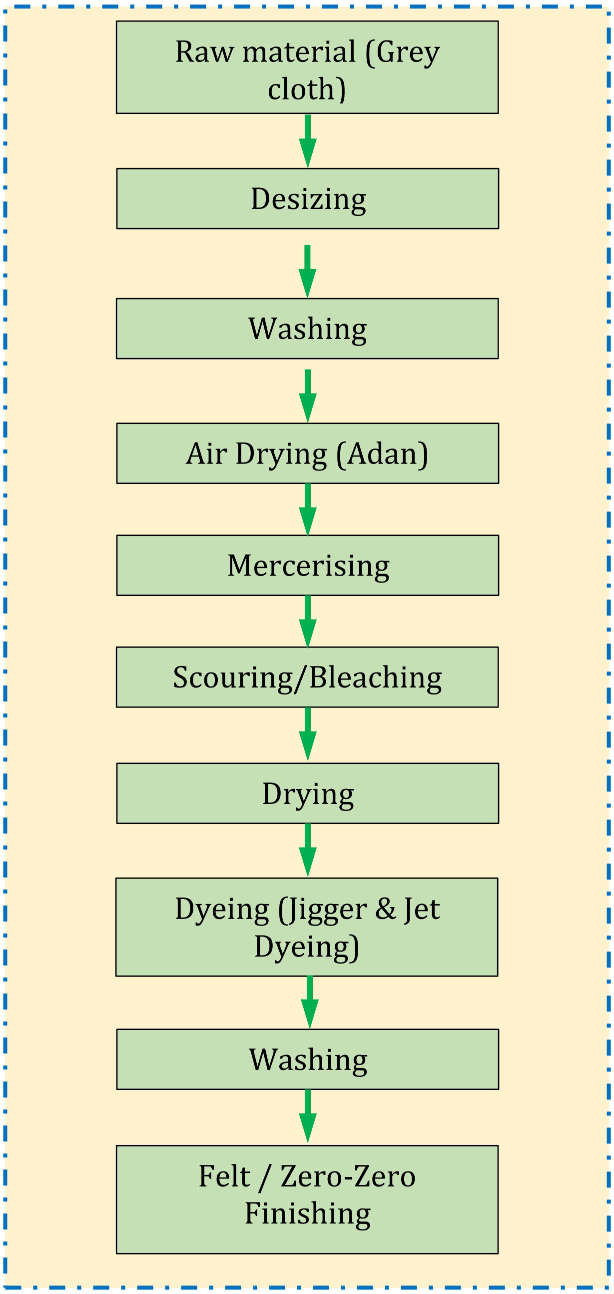


Figure 1.5: ***Production process at Manoj Dyeing (P) Ltd.***

1.4 ENERGY AUDIT METHODOLOGY

The primary objective of the energy audit was to quantify the existing energy consumption pattern and to determine the operating efficiencies of key existing systems. The key points targeted through energy audits were determination of specific energy consumption, various losses, operation practices like production, fuel consumption, steam utilization and losses, process temperatures, electrical energy consumptions etc. Pre – planned methodology was followed to conduct the energy audits. Data collected at all above steps were used to calculate various other operating parameters like material processing rate (mtr/hr), specific electricity consumption (kWh/kg), specific steam utilization (kg/kg), etc. The energy audit methodology is depicted in ***Figure 1.6*** below:

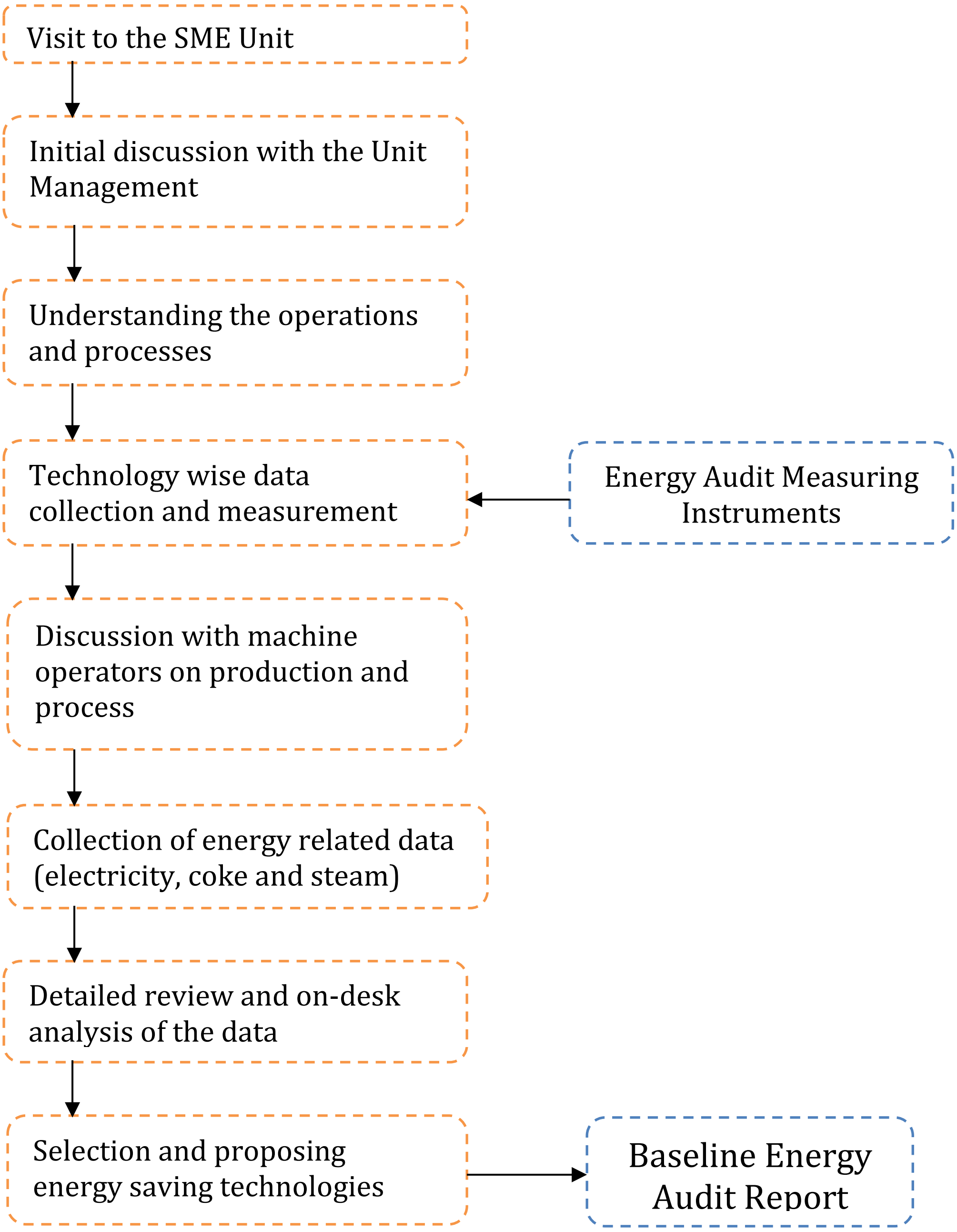


Figure 1.6: ***Energy audit methodology***

1.5 UNIT PHOTOGRAPHS

Caption: Mercerizing process at Manoj Dyeing

Caption: Caustic washing

Caption: Boiler unit at Manoj Dyeing

Caption: Fabric ready for dyeing

Caption: DC motor at Mercerizing unit

Caption: Coal used in the unit

Present Process, Observations and Proposed Technology

2.1 INSTALLATION OF ECONOMIZER IN THERMIC-FLUID HEATER EXIT

2.1.1 Present Process

Manoj Dyeing (P) Ltd. has installed a steam boiler of 2 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm^2. The unit also has a thermic-fluid heater (thermo-pack) of 1000 U capacity. Pet-coke is used as the fuel for the steam boiler. The heating chamber consists of a fluidized bed of coke wherein air is supplied from bottom. The heat generated by combustion of coke and air is used to heat water to form steam. The steam generated is used in various processes across the unit. The boiler operates for an average of 12 hours daily.

2.1.2 Observations

The steam boiler operating in the unit is a packaged boiler with fire tube design. Steam is the main agent of energy used in the textile processing unit. Thus, the boiler is the major energy utilizing source in the unit. The existing boiler used at Manoj Dyeing does not have provisions of waste heat recovery. The feed water to the boiler is fed at ambient temperature (35^{0}C) and the stack temperature was observed to be around 180^{0}C. Also, waste heat recovery system is not installed in the thermic-fluid heater. The flue gas temperature leaving the thermic-fluid heater was observed to be 240^{0}C. The combustion air to the boiler firing unit is also being fed at ambient temperature (35^{0}C). No monitoring is being done towards feeding of coke and air into the boiler. In order to analyze the boiler performance, a detailed study was carried out in the unit.

The specific fuel consumption of coke was observed to be around 0.07 kgs of coke per meter of the processed cloth which is higher in comparison to the values for other units. It was observed that during operation, fuel supply was controlled manually without controlling the air flow rate. Further, there was no provision for measuring the temperature inside the boiler heating chamber.

The flue gas temperature leaving at 240^{0}C from the thermic-fluid heater provides a potential for waste heat recovery. Stack temperature needs to be maintained above 120^{0}C in order avoid condensation of Sulphur oxides (SO) present in the flue gas which can cause corrosion. The available heat from a temperature difference of 120^{0}C is sufficient to rise the boiler feed water temperature by 60-65^{0}C. The increase in boiler feed water temperature can lead to substantial increase in boiler efficiency thus leading to reduction in specific fuel consumption.

2.1.3 Conclusion

As per the study conducted in the unit, it is suggested to install an economizer (boiler feed water heating system) in the thermic-fluid heater exit. This heat can be utilized to raise the boiler feed water temperature; thus pre-heating the boiler feed water.

The installation of the economizer in the thermic fluid heater and utilizing the same for pre-heating boiler feed water will lead to following benefits:

- Waste heat recovery
- Improvement in boiler efficiency
- Reduction in FD/ID fan power usage
- Improved environment

2.1.4 Cost Economics Analysis

The section below provides a cost benefit analysis for installation of economizer in the existing thermic-fluid heater for pre-heating boiler feed water of the unit:

Table 2.1: ***Cost Economic Analysis of proposed economizer***

SN	Parameter	Unit	Value
1	Quantity of steam generated per hr (Q)	kg/hr	2000
2	Quantity of fuel used per hr (q)	kg/hr	117
3	Working Pressure	kg/cm^2	10
4	Temperature of feed water	^oC	35
5	Type of fuel		Coke
6	Calorific Value of fuel	kCal/kg	8200
7	Enthalpy of steam	kCal/kg	665
8	Enthalpy of feed water	kCal/kg	35
9	Boiler Efficiency	%	131
10	Flue gas temperature (in thermic fluid heater)	^oC	240
11	Steam generation per Kg of fuel	kg/kg	17
12	Flue gas quantity	kg/kg	10
13	Quantity of flue gas	kg/hr	1141
14	Quantity of heat available in flue gas	kCal/hr	31504
15	Rise in feed water temperature	^oC	63
16	Savings in terms of fuel from pre-heated boiler feed water	%	10.43
17	Savings in terms of fuel	kg/hr	12
18	Annual operating hrs.	Hrs.	3600
19	Annual savings of fuel	kgs	43945
20	Annual cost savings	Rs/yr.	329589
21	Cost of economizer	Rs	300000
22	Pay-back	months	11

*Every rise of 6ºC in boiler feed water temperature through waste heat recovery would offer about 1% fuel savings.

As per the detailed calculations done, it is proposed to install an economizer in the existing thermic-fluid heater outlet and utilizing the heat to pre-heat the boiler feed water. The estimated fuel saving with the installation is 43,495 kgs annually which can save an amount of Rs. 3, 29,589 per year. Thus the cost of the economizer (estimated to be Rs. 3, 00,000) can be recouped in less than a year.

2.2 INSTALLATION OF ENERGY EFFICIENT MOTORS WITH VFD IN MERCERIZING MACHINE

2.2.1 Present Process

After cotton is dipped into a strong alkaline solution such as lithium hydroxide, caustic soda, or potassium hydroxide, the fibers get swollen and shrunk. The fibers are placed under tension while in this swollen state and then rinsed with water, the alkali gets removed and a permanent silk-like luster arises. This process is called mercerizing. Manoj Dyeing Pvt. Ltd. has installed a mercerizing machine which is presently run by 4 nos. of DC motors of 7.5 HP, 10 HP, 3 HP and 3 HP respectively. Based on the quality of fabric and mercerizing required, the speeds of the DC motors are varied.

2.2.2 Observations

In order to analyses the loading of the motors, a detailed study was carried out in the mercerizing machine. The respective ampere loading in the motor observed during the study was noted as 4 HP (for 7.5 HP motor), 3 HP (for 10 HP motor), 1.5 HP each for the 3 HP motors respectively. Thus, the motors were observed to be running at less than 50%. Considering the under capacity utilization of the motors during most of the period of operation of mercerizing machine, it is suggested to replace the existing DC motors with energy efficient AC motors of lower capacity with variable frequency drives installed with each motor. The respective proposed motor capacities are one motor of 5 HP and 3 motors with 3 HP rating each. The variable frequency drive will allow storage of energy during lean period, thus saving electrical energy used in the system.

2.2.3 Conclusion

As per the study conducted in the unit, it is suggested to replace the existing DC motors in the mercerizing machine with AC motors with VFD drives. The current motor ratings are over capacity and needs to be replaced with lower rating motors. VFD needs to be installed in the motor to take of the varying load.

The installation of the energy efficient AC motors with VFD will lead to following benefits:

- Higher efficiency of motors.
- Lower maintenance cost
- Controlled Starting Current
- Reduced Power Line Disturbances
- Lower Power Demand on Start
- Controlled Stopping
- Energy saving

2.2.4 Cost Economics Analysis

The section below provides a cost benefit analysis for installation of energy efficient AC motors with VFD in the existing mercerizing machine of the unit.

Table 2.2: *Cost Economic Analysis of proposed energy efficient AC motor with VFD*

SN	Parameter	Unit	Value
1	Power consumed by existing mercerizing machine	kWh	17.53
2	Annual consumption	KWh/year	126223
3	Production on existing mercerizing machine	mtr/hr	31250
4	Specific power consumption on existing mercerizing machine	kWh/mtr	0.0006
5	Power consumed by AC motors with VFD drives	kWh	12.27
6	Annual consumption	KWh/year	88356
7	Projected production on mercerizing machine	mtr/hr	31250
8	Specific power consumption (projected)	kWh/mtr	0.0004
9	Reduction in specific power consumption	kWh/Pcs	0.0002
10	Percentage savings	%	30.00
11	Daily operating hours	Hrs.	24
12	Annual operating days	Days	300
13	Annual electricity savings	kWh	37867
14	Annual cost savings	Rs.	284002
15	Investment required	Rs.	250000
16	Simple payback period	months	10.56

It is therefore proposed to replace DC motors with energy efficient AC motor with VFD in the existing mercerizing machine. The estimated energy saving with the installation is 37867 kWh annually which can save an amount of Rs. 284002 per year. Thus the cost of the AC motors with VFD (estimated to be Rs. 2, 50,000) can be recouped in less than 11 months.

2.3 CONDENSATE RECOVERY SYSTEM IN JET DRYING MACHINE

2.3.1 Present Process

Manoj Dyeing (P) Ltd. has installed 4 numbers of jet dyeing machines. These machines are used for pressurized dyeing (Colouring) process, used mainly for polyester based fabric. Steam at a working pressure of 3-4 kg/cm^2 along with water is used in the jet dyeing process. A significant amount of steam is lost during the heating operation of the jet dyeing process, as the portion of the latent heat is transferred to the equipment line resulting in condensate formation. Also, a significant amount of steam is transformed to condensate during the cooling cycle of the jet dyeing process. In addition to these, heat available in exit water generated during the process is wasted during the water recycling process. The unit has 4 numbers of jet dyeing machines, each having a capacity to use steam at 250 to 300 kg/hour. The jet dyeing operation is done in 5 batches in a day, each batch having a capacity of dyeing 2000-2500 meters of cloth per jet machine.

2.3.2 Observations

The jet dyeing process is a batch dyeing process in which dyeing is accomplished in a close tabular system, basically composed of an impeller pump and a shallow dye bath.

The fabric to be dyed is loosely collapsed in the form of a rope, and tied into a loop. The impeller pump supplies a jet of dye solution, propelled by water which transports the fabric into the dyeing system, surrounded by dye liquor, under optimum conditions. Turbulence created by the jet aids in dye penetration and prevents the fabric from touching from touching the walls of the tube, thus minimizing mechanical impact in the fabric. Steam is supplied during the heating process for better heat penetration and to create optimum dyeing conditions. Each operational cycle lasts for 2-3 hours which includes heating process, dyeing process and cooling operations. The cloths are dyed in pressurized conditions with the help of steam and water. A significant portion of steam is converted into water droplets due to condensation. When steam condenses, at the threshold or instant of phase change, the condensate temperature is the same as steam because only the latent heat has been lost, and the full amount of sensible heat remains. This condition is known as "Saturated Water". Not wasting, but rather recovering and reusing as much of this sensible heat as possible through installation of condensate recovery system.

2.3.3 Conclusion

In order to recover heat lost through condensate, it is proposed to install a condensate recovery system in the jet dyeing machines. Condensate recovery is a process to reuse the water and sensible heat contained in the discharged condensate. Recovering condensate instead of throwing it away can lead to significant savings of energy, chemical treatment and make-up water. Condensate can be reused in many different ways, for example:

- As heated feed water, by sending hot condensate back to the boiler's deaerator
- As pre-heat, for any applicable heating system
- As steam, by reusing flash steam
- As hot water, for cleaning equipment or other cleaning applications

The system includes a positive displacement condensate pump which can recover (suck) hot condensate and flash steam from the steam pipeline and feed the same into the boiler feed water tank. The pump may also be equipped with an in-built receiver for condensate which eliminates the need for a separate storage tank. The installation of the system will allow 100% recovery of condensate formed during the jet dyeing process. The technology can be suitably modified for mechanical or sensor based control.

Benefits of the condensate recovery system are:

- Reduced fuel cost

- Lower water related expenses
- Positive impact on safety and environment

2.3.4 Cost Economics Analysis

The section below provides cost benefit analysis for the installation of condensate recovery system (CRS) in the jet dyeing machine.

Table 2.3: *Cost Economic Analysis of proposed condensate recovery system in jet dyeing machine*

S N	Particular	Unit	Value
1	No. of Jet Dyeing Machine	no	4
2	Steam Consumption of Jet Dyeing M/c per hr	kg/hr	300
3	No.of Batches per day	no	5
4	Condensate recovery potential (considering heating cycle of 45 mins)	kg/day	4500
5	operating days	days	330
6	Sensible heat @ 4kg/cm^2	kcal/kg	144
7	Sensible heat @ 0.5 kg/cm^2	kcal/kg	111
8	Latent heat @ 0.5 kg/cm^2	kcal/kg	532
9	Flash steam quantity saved	kg/day	279
10	Savings with flash stem (A)	Rs	92115
11	Balance condensate stem	kg/day	4221
12	Temperature of condensate	°C	95
13	Make up water temperature	°C	35
14	Gain in enthalpy	kcal/d	253252
15	GCV of fuel	kCal/kg	8200
16	Cost of fuel	Rs/kg	7.5
17	Savings with condensate stem	Rs	191097
18	Total quantity of RO water generated per day	Ltr/day	4500
19	Cost of RO water per liter	Rs	0.3
20	Savings from Ro water per year (B)	Rs	445500
21	Total Saving (A+B)	Rs	728712
22	Cost of condensate recovery system	Rs	500000
23	Simple pay back	months	8
24	Fuel saving	kg/hr	209
25	Energy saving	%	40

* Cost of fuel taken as Rs 7.5/kg

The proposed installation of condensate recovery system in the jet dyeing machine will lead to a saving of Rs 7,28,712 annually. Thus the estimated cost of Rs 5,00,000 can be recouped in less than a year.

2.4 BOILER FEED WATER TREATMENT

2.4.1 Present Process

Manoj Dyeing (P) Ltd. has installed 1 number of steam boiler of 2 tonnes capacity. Since, Pali cluster do not have any internal source of water, water to be used in the boiler is sourced from nearby areas. Presently, the unit is not applying any kind of process treatment for the feed water to the boiler. The total dissolved solids (TDS) content in the boiler feed water intends to surplus the maximum permissible TDS of the boiler due to repeated use of water. This leads to frequent boiler blow-down operation of the boiler, where a certain amount of water is blown off and is automatically replaced by feed water thus maintaining the optimum level of total dissolved solids (TDS) in the boiler water. In Manoj Dyeing, boiler blow-down is carried out at a frequency of 4 hours every day. The frequency of blow-down is predominantly dependent of the high level of TDS in the boiler feed water. During each Blow-Down (BD) operation, a large quantity of energy in the form of steam is wasted into the atmosphere.

2.4.2 Observations

The TDS level of the feed water used for the steam boiler at Manoj Dyeing (P) Ltd. was reported to be 500 ppm, which when continuously used intends to surplus the permissible TDS level which is around 1000-1500 ppm. When feed water enters the boiler, the elevated temperature and pressure cause the components of water to behave differently. Under heat and pressure, most of the soluble components in the feed water come out of the solution as particulate solids, sometime in crystalized forms and other times as amorphous particles. When solubility of a specific component in water is exceeded, scale or deposits develop. Deposit in boilers may result from hardness contamination of feed water and corrosion products from the condensate and feed water system. Deposits and corrosion result in localized heating, efficiency losses and may ultimately result in failure of boiler tube and inability to produce steam. In order to avoid deposits or scale formation in the boiler lining, blow-down operation is carried out in the boiler. The process of blow-down involves blowing off a portion of the water and replacing it with fresh feed water.

In case of Manoj Dyeing, intermittent blow-down operation is practiced at frequency of 4 hours. The blow-down is done with the use of a valve fitted to discharge pipe at the lowest point of the boiler. The blow-down process is carried out for a period of 1-2 minutes. Approximately 1500-1700 liters of water is lost every day in the blow-down operation.

In order to reduce the blow-down operation in the boiler and to maintain the permissible level of TDS, it is suggested for pre-treatment of boiler feed water. This external treatment of boiler feed water can be done in a number of ways. One of the most feasible options is the 'Reverse Osmosis' processes.

2.4.3 Conclusion

In order to maintain the TDS of boiler feed water close to the permissible range, it is suggested to install a revise osmosis (RO) plant in the unit. When solution of differing concentration are separated by a semi-permissible membrane, water from less concentrated solution passes through the membrane to dilute the liquid of high concentration, which is called osmosis. If the solution of high concentration is pressurized, the process is reversed and water from the solution of high concentration flows to the weaker solution. This is known as reverse osmosis. The quality of water produced depends upon the concentration of the solution on the high-pressure side and pressure differential across the membrane. The process is suitable for waters with high TDS.

Installation of the RO system of required capacity can lead to considerable reduction in boiler blow-down, thus leading to a saving in steam. The membrane for RO system can be suitably selected based on the TDS level of the unit.

Benefits of the installation of the RO system are:

- Lower boiler blow-down
- Less make up water consumption
- Steam saving as a result of reduced blow down
- Reduced maintenance downtime
- Increased boiler life
- Reduced fuel cost

2.4.4 Cost Economics Analysis

The section below provides cost benefit analysis for the installation of RO system in the boiler feed water line:

Table 2.4: *Cost Economic Analysis of proposed RO system*

SN	Parameter	Unit	Value
1	Quantity of steam generated per hour	kg/hr	2000
2	Quantity of fuel used per hour	kg/hr	118
3	Quantity of fuel used to generate 1 kg of steam	kg/kg	0.059
4	**Without RO**		
5	Frequency of blow down per month	no.	75
6	No. of blow downs in a year	no.	900
7	Steam lost in each blow down	kg	533
8	Steam lost in year	kg	480000
9	Fuel used to generate lost steam	kg	28301.6
10	**With RO**		
11	Frequency of blow down	no.	25
12	No. of blow downs in a year	no.	300

SN	Parameter	Unit	Value
13	Steam lost in each blow down	kg	533
14	Steam lost in year	kg	159900
15	Fuel used to generate lost steam	kg	9427.971
16	Annual saving in fuel	kg	18873.63
17	Percentage saving in fuel consumption	%	4.4
18	Annual cost saving in fuel	Rs	94368.15
19	Annual cost saving in terms of make-up water and boiler maintenance	Rs	12000
20	Annual cost savings	Rs	106368
21	Equipment cost	Rs	200000
22	Pay back	months	23

The proposed Ro plant will lead to an annual fuel saving of 18,873 kgs of coal which implies a monetary saving of Rs 1,06,368 annually. Thus the estimated investment of Rs 2, 00,000 can be recouped in a period of 23 months.

2.5 TEMPERATURE MONITORING AND CONTROL IN JIGGER MACHINES

2.5.1 Present Process

Manoj Dyeing (P) Ltd. has installed a total of 13 Jigger machines with 3 HP motor each. These jigger machines are used for dyeing of cotton cloth at elevated temperature of 60-80^{0}C depending on the type of fabric and the dye used. Steam is fed into the system for the required amount of elevated temperature. Once the dyeing process is over, the hot water is drained out of the factory. The temperature requirement for water is different for different grades of dyes and quality of fabric. However, no temperature monitoring system has been installed in the jigger machines. Monitoring and control of temperature of water is done purely based on manual interference.

2.5.2 Observations

Dyeing of cotton fabric is done with the help of a jigger machine. In this process the fabric is rotated in a shallow dip containing hot water. The temperature of the water depends on the type of dyeing agent and the quality of the fabric. Typically a temperature range between 60^{0}C to 80^{0}C is adopted based on different fabric quality and dye. Steam is used to bring amount the required temperature in the process. In case of Manoj Dyeing, no temperature monitors is being installed in any of the jiggers. The monitoring of water temperature and its control is purely done by manual interference. A study of the jigger water temperature showed off-shooting of temperature at certain places. Thus, a significant amount of energy in the form of steam required to heat water is being lost due to the absence of temperature monitoring and control system. It is suggested for installation of sensor based automatic temperature control and monitoring system in the jiggers.

2.5.3 Conclusion

In order to maintain the correct temperature profile in the jigger water, it is suggested to install a sensor based temperature monitoring and control system. This system can be used to monitor the temperature level of water in the jiggers and control the flow of steam by a pneumatically operated valve. This will be lead to optimum utilization of steam in the jiggers thus leading to a substantial energy savings.

Benefits of the installation of the temperature monitoring and control system in Jiggers machines are:

- Precision temperature control
- Reduced energy consumption
- Better quality of production
- Savings in terms of feed water to jiggers.

2.5.4 Cost Economics Analysis

The section below provides cost benefit analysis for the installation of temperature monitoring and control system in jiggers. For calculation purpose, it has been assumed that the system is installed in 10 nos. of jiggers.

Table 2.5: *Cost Economic Analysis of jigger water temperature monitoring and control system*

SN	Particulars	Units	Value
1	Temperature observed in Jigger	°C	95
2	Temperature to be maintained	°C	80
3	Machine Capacity	kg	200
4	Steam pressure	kg/cm^2	4
5	Steam Enthalpy @ 4 Kg /cm^2 pressure	kCal/kg	657
6	Water Capacity	Kg	400
7	Specific heat coefficient (Cp)-water	kCal/kg ^{0}C	1
8	Specific heat coefficient (Cp)-fabric	kCal/kg ^{0}C	0.5
9	No. of batches per day	nos.	2
10	Saving of steam per batch	kg / hr	11
11	Saving of steam per day (considering 10 hrs heating period in 2 batch)	kg/day	114
12	Savings of steam per annum	kgs/annum	37648
13	Annual fuel savings	kgs	6563
14	Annual monetary savings	Rs	49225
15	Investment per jigger	Rs	25000
16	General payback period	Months	6
17	Annual fuel savings for 10 jiggers	Kgs	65634
18	Annual monetary savings for 10 jiggers	Rs	492252

SN	Particulars	Units	Value
19	Investment for 10 jiggers	Rs	250000
20	Pay-back	Months	6
21	Energy savings	%	5.70

*Cost of fuel taken as Rs 7.5/kg

The proposed temperature monitoring and control system in jigger machines (estimated for 10 units) will lead to an annual fuel saving of 65,634 kgs of coal which implies a monetary saving of Rs 4, 92,252 annually. Thus the estimated investment of Rs 2, 50,000 can be recouped in a period of 6 months.

Questionnaire

11

Energy Audit – Questionnaire Form

BEE National Programme
On
"Energy Efficiency in SMEs – Pali Textile Cluster"

Name of the MSME unit	Manoj Dyeing Pvt. Ltd.
Address:	F-201/A, Mandia Road
Ph. No:	02932-329315
Name of the respondent	Mukesh Jain
Designation:	Director
Mobile No. / Email id	9414121904 / mukesh.lasid@gmail.com
Unit details	
Year of Establishment	2003
Type of Products	Fabrics
Installed Capacity	500 Thans / Day
Operating hrs per day	24 Hours
Connected Load (kVA or kW please specify)	125 HP
Supply Voltage (Volt)	440 V.
Duration of electricity supply	11 KV / 440 V

Annual Energy Consumption/ Production

Financial Year (April to March)	2013-14	2014-15	2015-16
Coke consumed (kg)	382094	524790	400710
Biomass Briquettes	N.A.	N.A.	N.A.
Wood	N.A.	N.A.	N.A.
Cost of coke (in Rs.)	3311035	4675255	2953608
Electrical units consumed (In kWh)	270810	309810	331192
Electricity charges (in Rs.)	1865127	2202707	2471338
LDO/HSD/ FO consumption (L)			
Per Ton Fuel Cost (in Rs.)	8507	8841	7228
Than Production (Kg)	153786	166992	152954

Source and Calorific Value of Fuels:

Fuel	Source	Calorific Value (kCal)
Coke (Kg)	Pet Coke	8000
Biomass Briquettes	N.A.	N.A.

For : Manoj Dyeing Pvt. Ltd.
Director/Manager

	Wood	N.A	N.A
	HSD (L)	N.A	N.A
	LDO (L)	N.A	
	FO (L)	N.A	
	Electricity (kWh)	J.V.V.N. Ltd.	

Monthly Energy Consumption and Production Data

Month	Production ~~(Kg)~~ Than*	Coke consumption (Kg)	Biomass /Wood Consumption (Kg)	Electricity consumption (kWH)	HSD/LDO /FO (L)	Any other fuel (specify units)
April'15	14258	63670	N.A.	27266		
May'15	13214	42500		29040		
June'15	9000	21700		36122		
July'15	12277	21160		38782		
August'15	13090	20640		32014		
September'15	10853	21380		34660		
October'15	15190	42890		24418		
November'15	12130	49210		33190		
December'15	14497	43040		28520		
January'16	14107	42240		23938		
February'16	12994	20280		23242		
March'16						

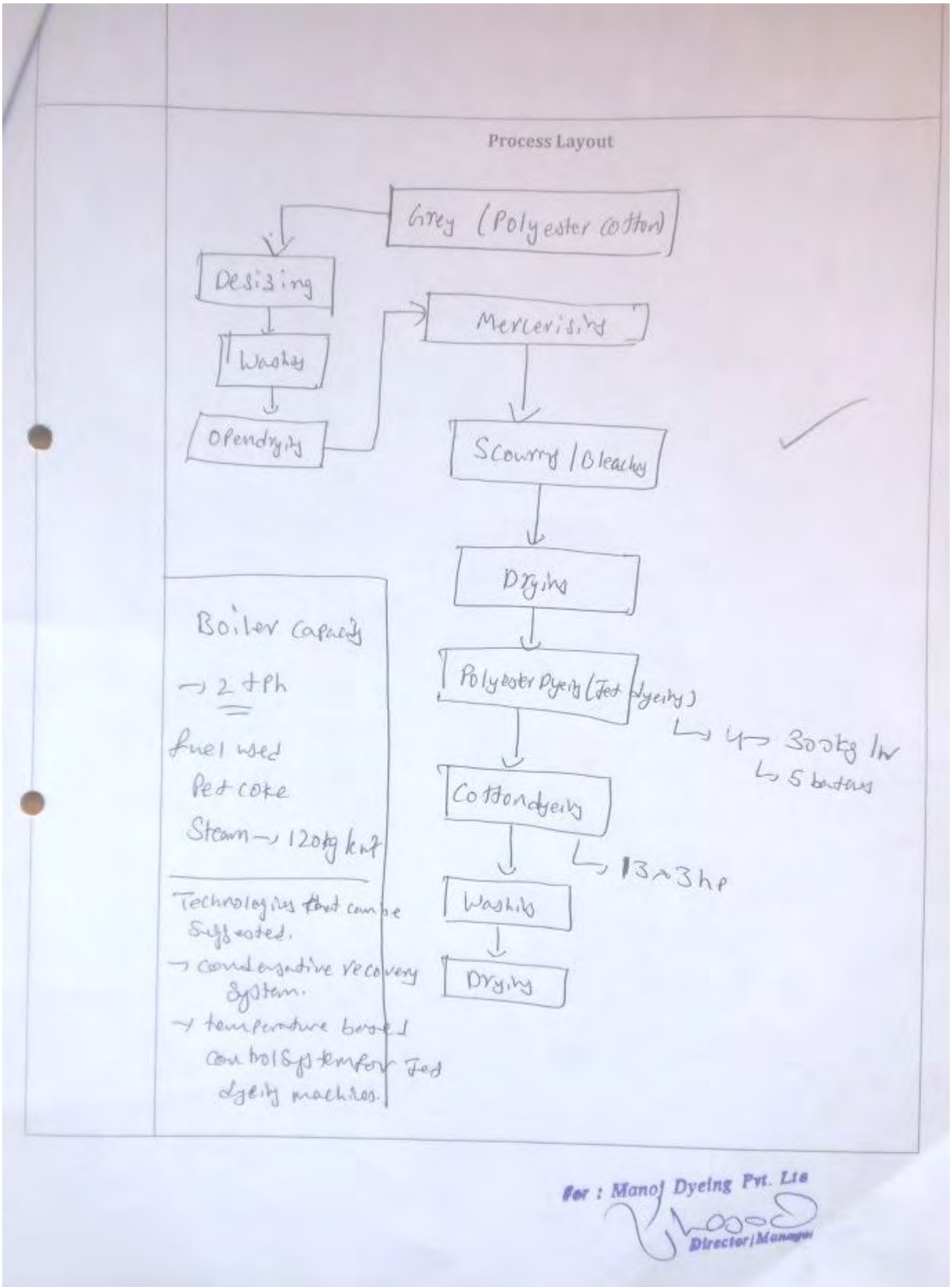
* 1 thon = 150 mtrs.

Cost variables per Kg of Production

Cost Variable	Cost/ kg of production
Electricity Cost	Rs 6.5/kwh
Coke Cost	Rs 7.5/kg
Fuel Cost (LDO/HSD/FO) etc.	NA
Labour Cost	NA
Material Cost	NA
Other Cost	NA

For : Manoj Dyeing Pvt. Ltd.

Director/Manager


Process Layout
Grey (Polyester cotton)
Desizing
Washing
Open drying
Mercerising
Scouring / Bleaching
Drying
Polyester Dyeing (Jet dyeing)
↳ 4 → 300kg /hr
↳ 5 batches
Cotton dyeing
↳ 13 ~ 3hp
Washing
Drying
Boiler capacity
→ 2 tph
fuel used
Pet coke
Steam → 120kg km²
Technologies that can be suggested.
→ condensative recovery system.
→ temperature based control system for Jet dyeing machines.
For : Manoj Dyeing Pvt. Ltd
Director/Manager

Steam Loss Chart

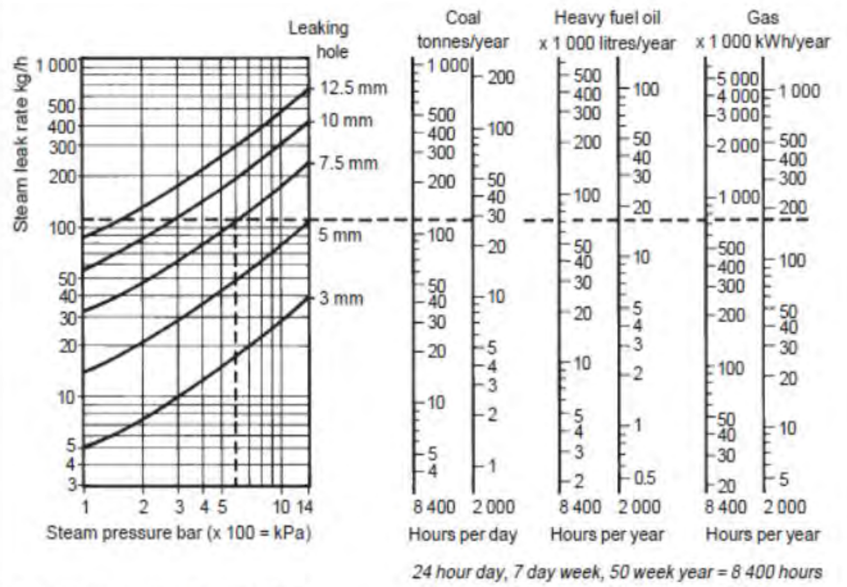


Fig. 23 Steam loss through leaks