BEE's National Program

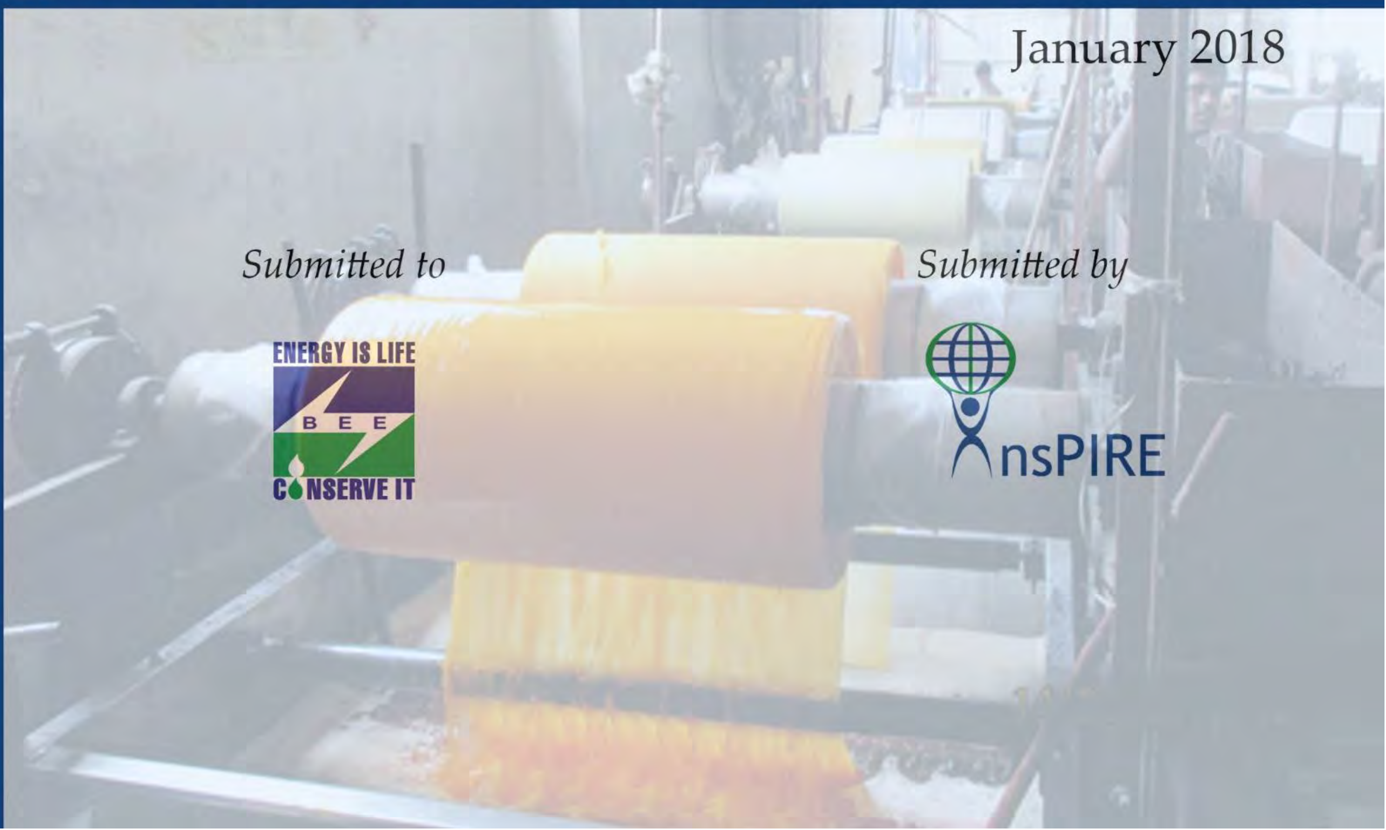
on

Energy Efficiency and Technology Up-gradation in SMEs

Pali Textile Cluster

CONSOLIDATED REPORT

January 2018



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Preface

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 proposes 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.

CHAPTER 1

Introduction

C H A P T E R 1

Introduction

1.1 MSME SECTOR – AN OVERVIEW

The MSME sector is an important pillar of Indian economy as it contributes greatly to growth of Indian economy with a vast network of around 30 million units, creating employment of about 70 million, manufacturing more than 6000 products, contributing about 45% to manufacturing output and about 40% of exports, directly and indirectly. This sector even assumes greater importance now as the country moves towards a faster and inclusive growth agenda. Moreover, it is the MSME sector which can help realize the target of proposed National Manufacturing Policy of raising the share of manufacturing sector in GDP from 16% at present to 25% by the end of 2022. However, owing to the recent insecure market conditions and escalating energy expense, the economic scenario of MSME sector, is transpiring gloomier endangering the long term profitability, competitiveness and sustainability.

However, a significant portion of the MSME units are energy-intensive where the cost of energy is 20-40% of the production cost, which implies huge energy saving potential. A study by BEE appraises the total energy efficiency market in India as INR 74,603 crore out of which, the share for MSME sector has been estimated at INR 12100 crore. But, in spite of huge energy efficiency potential in MSME sector, it is hurdled largely by following major barriers:

- Obsolete technology and lack of access to modern technological solutions resulting in low productivity.
- Very few programs to support technology development.
- Lack of local service providers to sustain energy efficient technologies.
- Lack of knowledge, financing and dedicated personnel for identifying energy efficiency improvements & opportunities.
- 90% of units are proprietorship concerns, which are limited on their managerial skills as well as amenability to new ideas.
- Perceptions of Energy efficiency measures are financially unviable.
- MSME units are reluctant to change & seek external technical assistance.

In the wake of the need, Government of India has set ambitious target of energy saving of 44.85 BU at consumer side by the terminal year 2016-17 of 12th Five year Plan which is equivalent to 60.17 BU on Bus bar side translating into 12,350 MW avoided capacity. In addition, total thermal energy saving equivalent to 21.30 Mtoe is targeted.

1.2 BEE-SME PROJECT AT A GLANCE

Under the 12th Five Year Plan, the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India, has taken an ambitious program on energy efficiency and technology up gradation in SME clusters in India. The program titled "BEE's National Program on Energy Efficiency and Technology Up gradation in SMEs" is being implemented by BEE with support from Ministry of MSME in five selected clusters in India. These clusters include Ludhiana, Punjab; Pali, Rajasthan; Kochi, Kerala; Indore, Madhya Pradesh and Varanasi, Uttar Pradesh. The project aims to set up demonstration units in these clusters, wherein energy efficient technologies will be implemented. Efforts will also be made to replicate the successful technologies and wider penetration of energy efficient technologies in the sector as a whole. The key components of the project include:

- Conducting pre-activity cluster workshop in the cluster.
- Conducting initial walk through audits in 5 representative units of the cluster.
- Approve energy efficient process technologies, relevant to the cluster, with highest energy saving and replication potential, and establish 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
- 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.
- Support the units towards implementation of energy efficient technologies.
- Carry out post implementation energy audit in the implemented units to verify energy savings as a result of EE technology implementation.
- 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.
- Release of financial incentive to units on submission of 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.

The textile cluster located at Pali, Rajasthan is one of the selected clusters under the BEE-SME program.

1.3 PALI TEXTILE CLUSTER – AN INSIGHT

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.

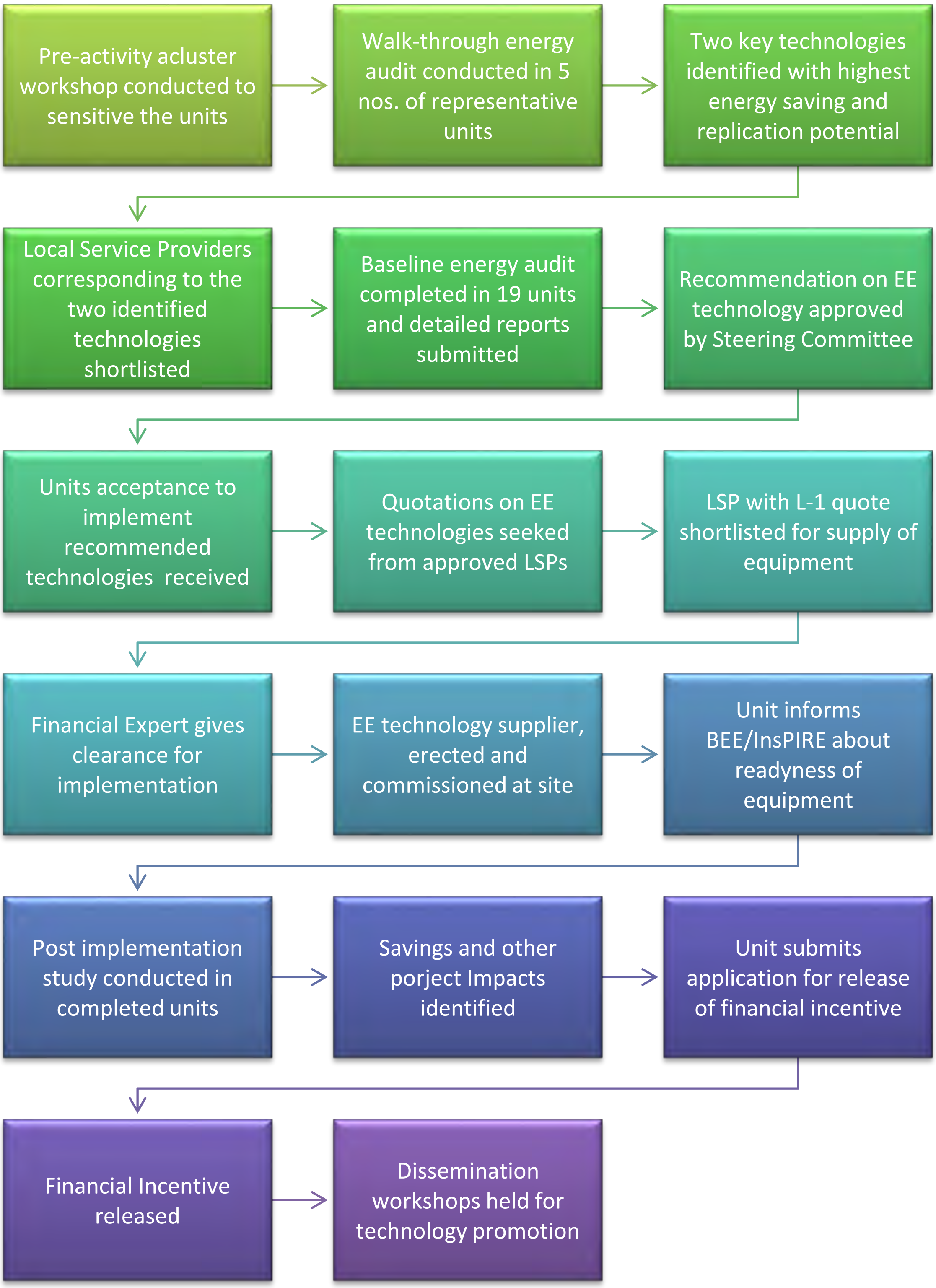
Ironically, even though none of the resources required for textile processing is available locally, the textile cluster at Pali has grown despite the odds. The industrial area has no water and all the water required is transported from a distance of over 20 KM. The labour working in the cluster is mostly 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 resources that are 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.

Twenty (11) units were selected from the cluster with the purpose of conducting baseline audit. Out of these, five (5) nos. of units has completed implementation, within the stipulated time period and as per the guidelines of implementation.

1.4 PROJECT IMPLEMENTATION METHODOLOGY

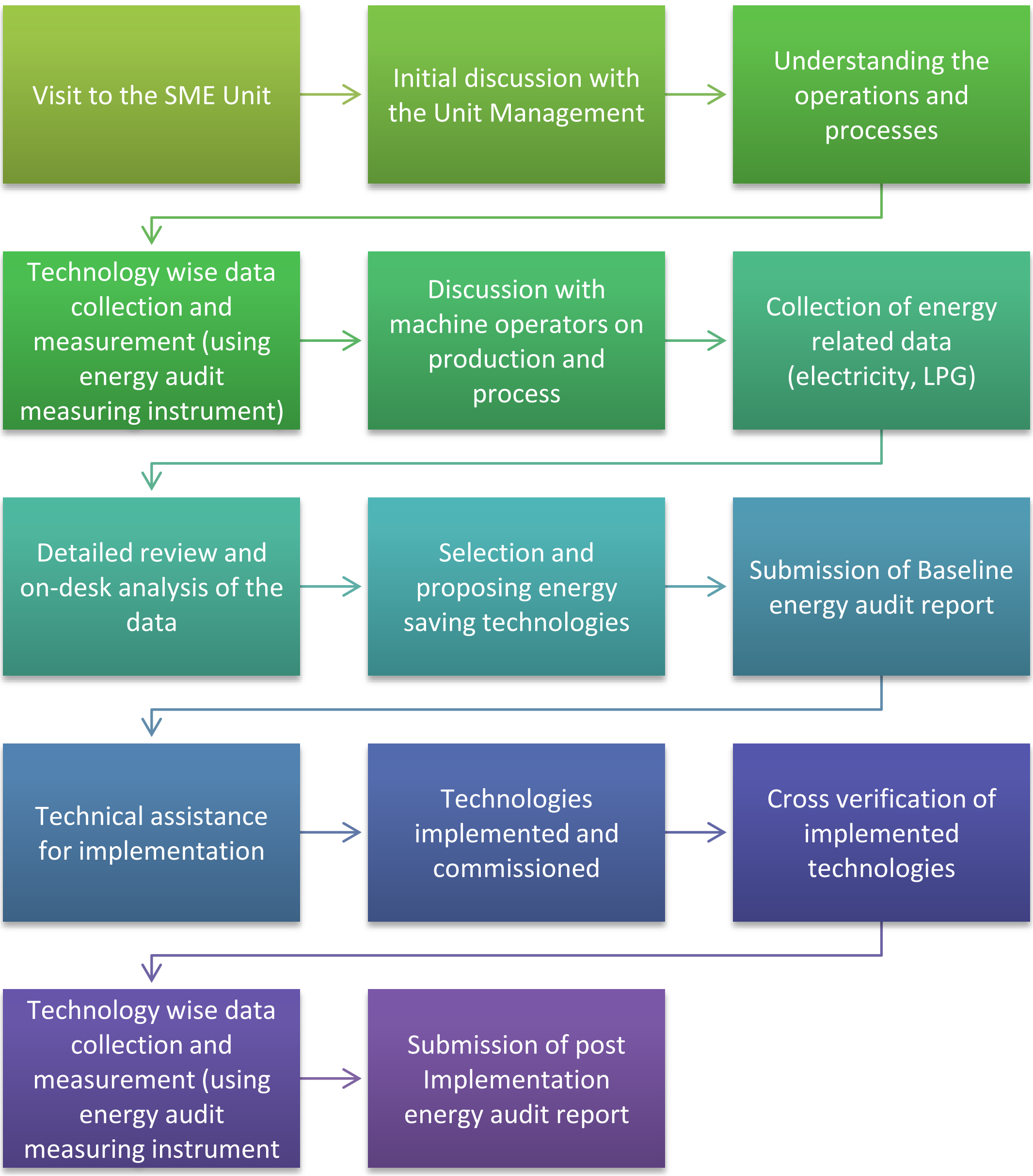
The BEE's National Program on Energy Efficiency and Technology Up gradation at Pali Textile Cluster followed the following implementation methodology:



Project Implementation Methodology

1.5 ENERGY AUDIT METHODOLOGY

The primary objective of the baseline energy audit was to quantify the baseline energy consumption pattern and identify technologies which can lead to reduction in energy consumption. Based on the suggestions under the baseline audit, the units have implemented the technologies. The primary objective of the post implementation energy audit was to cross-verify the implementation and document the impacts. The key points targeted through energy audits were determination of specific energy consumption, both thermal and electrical, productivity etc. Pre – planned methodology was followed to conduct the energy audits. The energy audit methodology followed for baseline and post implementation energy audits is depicted in Figure 1.2 below:



Energy audit methodology

1.6 IMPLEMENTED UNITS

Out of the 11 enrolled units under the cluster, five (5) units successfully completed the implementation of energy efficient technologies, as recommended under the project. Subsequent to the project implementation, cross-verification of the implementation was carried out by a 5 member team consisting of representatives from Bureau of Energy Efficiency, Local Association, Financial Expert and InsPIRE Network for Environment. The following 5 units are the ones who are eligible for financial incentive, as per the project guideline:

1. Simandhar Fabtex (P) Ltd , Pali
2. Manoj Dyeing, Pali
3. Shree Rajaram Mills, Pali
4. Shree Rajaram Process, Pali
5. Shree Rajaram Prints (P) Ltd, Pali

CHAPTER 2

Simandhar Fabtex (P) Ltd , Pali

C H A P T E R 2

2.1 EXECUTIVE SUMMARY

1. Unit Details

Unit Name	:	**Simandhar Fabtex (P) Ltd.**
Address	:	F-168/168A, Mandia Road, Pali, Rajasthan- 306401
Contact Person	:	Mr. Arvind Mehta, Director (Cell no: 9414120561)
Products	:	Cloth processing (Cotton)
Production	:	70,000 to 1,20,000 meters of processed cloth per day
DIC Number	:	RJSI/09143/21/17/FNL
Bank Details	:	Bank of Baroda, Suraj Pole, Pali, A/c No.: 09790200007750, IFSC Code: BARB0PALIXX
TIN / PAN No.	:	TIN: 08033260124 PAN: AAQCS1615N
Contract demand	:	215 KVA

2. Energy Efficient Technologies implemented vis-à-vis baseline energy audit recommendation

Technology recommended as per baseline energy audit (as approved by steering committee)	Technology implementation and cross-verified during post implementation energy audit
Economizer in Thermic fluid exit	Economizer in Thermic fluid exit
Air-preheater (APH) in steam boiler	Air-preheater (APH) in steam boiler
Waste heat recovery (WHR) with kier boiling unit	Waste heat recovery (WHR) with kier boiling unit
Temperature Monitoring & Control in Jigger Machines (for 10 Jiggers)	Not Implemented
Float Trap in Zero-Zero Machine	Float Trap in Zero-Zero Machine
Reverse Osmosis (RO) system in steam boiler	Reverse Osmosis (RO) system in steam boiler

3. Cost Economics Analysis: Projected (as per baseline) vs. Actual

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Economizer in Thermic fluid exit				
Baseline (Projected)	10.43	3,97,385	3,00,000	9
Post Implementation (Actual)	10.24	3,90,085	1,84,625	6
Air-preheater (APH) in steam boiler				
Baseline (Projected)	2.32	88,509	2,00,000	27
Post Implementation (Actual)	2.43	92,681	2,00,450	26
Waste heat recovery (WHR) with kier boiling unit				
Baseline (Projected)	14.21	2,57,498	5,50,000	36
Post Implementation (Actual)	12.09	2,19,147	7,49,050	42
Float Trap in Zero-Zero Machine				
Baseline (Projected)	5	2,58,885	2,00,000	9
Post Implementation (Actual)	4.25	2,20,052	1,97,019	11

Reverse Osmosis (RO) system in steam boiler				
Baseline (Projected)	10.40	6,04,533	5,00,000	10
Post Implementation (Actual)	4.4	2,65,973	5,64,952	25

4. Project Impacts

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
Economizer in Thermic fluid exit	10.24	63.97	304.40
Air-preheater (APH) in steam boiler	2.43	15.20	72.32
Waste heat recovery (WHR) with kier boiling unit	12.09	17.11	81.43
Float Trap in Zero-Zero Machine	4.25	24.06	114.48
Reverse Osmosis (RO) system in steam boiler	4.40	27.77	132.13

Assumptions / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor power is 0.9 tCO2 per MWh
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

2.2 ABOUT THE UNIT

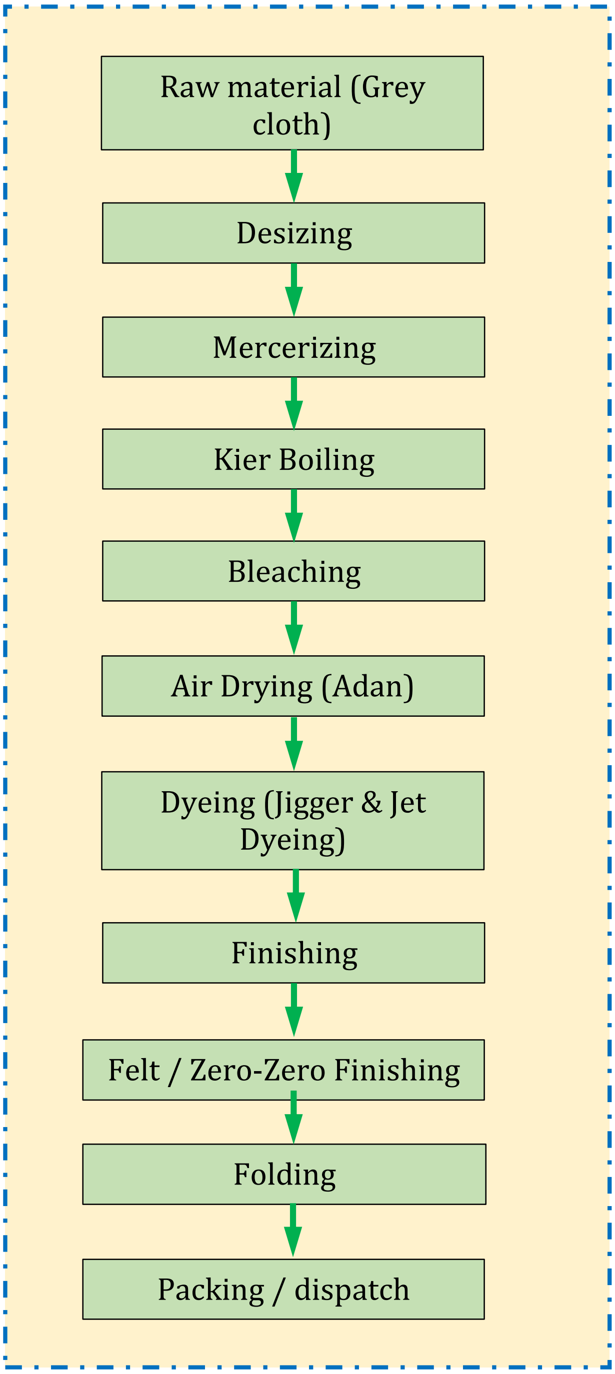
M/s Simandhar Fabtex (P) Ltd., Pali, was established in the year 2000 and is engaged in processing of cotton cloth which includes raw cloth (grey) processing, dyeing and finishing operations. The manufacturing unit is located at F-168/168A, Mandia Road, Pali. The unit operation is overseen by Mr. Arvind Mehta, 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 70,000 to 1,20,000 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 52,913 kgs. The average monthly electricity consumption (derived from reported date of last one year) is 46,460 kWh

2.3 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at processing of textile products at Simandhar Fabtex (P) Ltd.



Production process at Simandhar Fabtex (P) Ltd.

2.4 POST IMPLEMENTATION ENERGY AUDIT OUTCOME AND RESULTS

2.4.1 Installation of Economizer In Thermic-Fluid Heater Exit

2.4.1.1 Baseline Scenario

Simandhar Fabtex (P) Ltd. has installed a steam boiler of 3 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.

The exiting steam boiler 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.

2.4.1.2 Present Scenario

An Economizer is installed at the thermic fluid exist; which recovers heat from a temperature of 120^{0}C which is utilized for heating of boiler feed water temperature by 60-65^{0}C. The increase in boiler feed water temperature has led to substantial increase in boiler efficiency thus leading to reduction in specific fuel consumption.

Economizer:
Economizers are basically tubular heat transfer surfaces used to preheat boiler feed water before it enters the steam drum. By recovering the energy from the flue gas before it is exhausted to the atmosphere this performs a key function in providing high overall boiler thermal efficiency.

Working principle:

Boiler stack economizers are simply heat exchangers with hot flue gas on shell side and water on tube side with extended heating surface like Fins or Gills. Economizers must be sized for the volume of flue gas, its temperature, the maximum pressure drop allowed through the stack, what kind of fuel is used in the boiler, and how much energy needs to be recovered.

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
- Easy to integrate into production cells

- Reduced scaling

2.4.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Parameter	Units	Base Line	Post Implementation
Quantity of steam generated per hr (Q)	kg/hr	3000	3000
Quantity of fuel used per hr (q)	kg/hr	211.6	211.6
Working Pressure	kg/cm2	10	10
Temperature of feed water	deg C	35	35
Type of fuel		Coke	Coke
Calorific Value of fuel		8200	8200
Enthalpy of steam	kCal/kg	665	665
Enthalpy of feed water	kCal/kg	35	35
Boiler Efficiency	%	109	109
Flue gas temperature (in thermic fluid heater)	deg C	235	235
Steam generation per Kg of fuel	kg/kg	14	14
Flue gas quantity	kg/kg	15	15
Quantity of flue gas	kg/hr	3174	3174
Quantity of heat available in flue gas	kCal/hr	83952	83952
Rise in feed water temperature by installation of Economizer	deg C	61.5	
Every rise of 6ºC in boiler feed water temperature through waste heat recovery would offer about 1% fuel savings.			
Savings in terms of fuel for pre-heated boiler feed water	%	10.24	
Savings in terms of fuel	kg/hr	21.67	
Annual operating hrs	hrs	3600	
Annual savings of fuel	t	78.02	
Annual cost savings	Rs/yr.	390085	
Cost of economizer	Rs	184625	
Pay-back	months	5.68	
Annual Reduction in Energy Consumption	toe	63.97	
Annual CO_2 emission reduction	t CO_2/year	304.40	

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of economizer is 78.02t. The actual investment made to implement economizer is Rs 1.86lakhs with annual saving of Rs. 3.90 Lakhs. Thus, the investment made will be recovered within 5 months.

2.4.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of thermic fluid exists without Economizer used during the baseline vis-à-vis the thermic fluid exists with Economizer used in the post implementation study has been shown below:

Snap shot of Thermic fluid exist without economizer at Simandhar Fabtex (P) ltd

Snap shot of Thermic fluid exist with economizer at Simandhar Fabtex (P) ltd

2.4.2 Installation of air-preheater for boiler combustion air

2.4.2.1 Baseline Scenario

Simandhar Fabtex (P) Ltd. has installed a steam boiler of 3 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm^2. 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.

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 Simandhar Fabtex does not have provisions of waste heat recovery. Combustion air to the boiler is fed at ambient temperature (35^{0}C) and the flue gas exit temperature was observed to be around 180^{0}C. No monitoring is being done towards feeding of coke and air into the boiler. In order to analyse the boiler performance, a detailed study was carried out in the unit.

2.4.2.2 Present Scenario

An Air preheater is installed at the steam boiler which provides a potential for waste heat recovery for combustion pre-heating. Stack temperature needs to be maintained above 120^{0}C in order avoid condensation of Sulphur oxides present in the flue gas which can cause corrosion. The available heat from a temperature difference of 60^{0}C is sufficient to rise the combustion air temperature by 100-120^{0}C. The increase in combustion air temperature has led to substantial increase in combustion efficiency in the boiler heating chamber thus leading to reduction in specific fuel consumption.

The installation of the air preheater in the steam boiler and utilizing the same for pre-heating combustion air will lead to following benefits:

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

2.4.2.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed combustion air-preheater

Parameter	Unit	Base line	Post Implementation
Exit flue gas temperature	deg C	190	190
Stack dew temperature	deg C	120	120
Available temperature for heat transfer	deg C	70	70
Quantity of steam generated per hour	kg/hr	3000	3000
Quantity of fuel in the boiler	kg/hr	211.6	211.6
Specific heat of water	kCal/ kg deg C	1	1
Steam generation per Kg of fuel	kg/kg	14.18	14.18
Flue gas quantity	kg/kg	19.35	19.35
Quantity of flue gas	kg/hr	4095	4095
Quantity of heat available in flue gas	kCal/hr	65937	65937
Rise in combustion pre-heat temperature	deg C	51.1	
Savings in terms of fuel from pre-heated combustion air	%	2.43	
Savings in terms of fuel	kg/hr	5.15	
Annual operating hrs	hrs	3600	
Annual savings of fuel	kgs	18536	
Annual cost savings	Rs/yr.	92681	
Cost of air pre-heater	Rs	200450	
Pay-back	months	26.0	
Annual Reduction in Energy Consumption	toe	15.20	
Annual CO_2 emission reduction	t CO_2/year	72.32	

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

- Every rise of 21ºC in combustion air pre-heat temperature through waste heat recovery would offer about 1% fuel savings.

The fuel saved by installation of air preheater is 18536 kgs. The actual investment made to implement air preheater is Rs 2.04 lakhs with annual saving of Rs. 0.92 Lakhs. Thus, the investment made will be recovered within 26 months.

2.4.2.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler without air preheater used during the baseline vis-à-vis the boiler with air preheater used in the post implementation study has been shown below:

Snap shot of boiler without air preheater at Simandhar Fabtex (P) ltd

Snap shot of boiler with air preheater at Simandhar Fabtex (P) ltd

2.4.3 Installation of Waste Heat Recovery in Kier Boiler Unit

2.4.3.1 Baseline Scenario:

Shree Rajaram mills, Kier boiling operation is carried out by indirect heating. Hot water at temperature of around 90ºC is fed into the boiler. After the heating operation, water is drained out. A significant amount of heat energy present in the water is wasted in the process.

The Kier Boiling process is a batch process which last for a period of approximately 2 days, which including heating and cooling cycle for the fabrics. Both water and steam is fed into the boiler unit. Approximately 30,000 to 40,000 meters of cloth is processed per batch in the kier boiling unit. Steam at a working pressure of 3-4 kg/cm^2 is used along with hot water at around 120ºC. Around 4000-5000 liters of water is used in each kier boiling process. A significant amount of energy is lost when hot water utilized in the process is drained out.

2.4.3.2 Present Scenario

A waste heat recovery unit installed at the outlet of the kier boiling unit. The waste heat recovered is re-utilized in the system thus leading to significant energy saving.

The system has a heat exchanger unit which will recover energy from hot water being discharged from the boiler. In the process, pre-heated water can be achieved for boiler feeding.

Benefits of the waste heat recovery system are:

- Reduced fuel cost
- Lower water related expenses
- Positive impact on safety and environment

2.4.3.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed waste heat recovery unit with kier boiling unit

Parameter	Unit	Base line	Post Implementation
Capacity of kier boiling unit	mtr/batch	40000	40000
Water used in each batch	kg	7500	7500
Process for one batch	days	2	2
Input water temperature (ambient temperature)	deg C	35	35
Required temperature for kier boiling	deg C	120	120
Output temperature of drained water	deg C	100	100
Heat available in water	kcal / batch	487500	487500
Quantity of fuel saved for 100% recovery of waste heat	kg / batch	126	
Annual fuel saving	kg/yr.	20871	
Annual monetary saving due to fuel saving	Rs/yr.	156534	
Annual monetary saving due to water saving	Rs/yr.	62614	
Total annual cost saving	Rs/yr.	219147	
Investment	Rs/yr.	749050	
Pay-back	months	42	
Energy saving	%	12.09	
Annual Reduction in Energy Consumption	toe	17.11	
Annual CO_2 emission reduction	t CO_2/year	81.43	

Assumption /conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of waste heat recovery system is 20871 kgs. The actual investment made to implement waste heat recovery system is Rs 7.49 Lakhs with annual saving of Rs. 2.19 Lakhs. Thus, the investment made will be recovered within42 months.

2.4.3.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler without waste heat recovery system used during the baseline vis-à-vis the waste heat recovery system used in the post implementation study has been shown below:

Snap shot of kier boiling unit without waste heat recovery system at Simandhar Fabtex (P) ltd

Snap shot of kier boiling unit with waste heat recovery system at Simandhar Fabtex (P) ltd

2.4.4 Installation of Float Traps In Zero-Zero Machine

2.4.4.1 Baseline Scenario

Simandhar Fabtex (P) Ltd. has installed 2 nos. of zero-zero machines having a capacity of 200 kgs each. The unit has a steam boiler of 3 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm2 in the jet dyeing machines. In the condensate outlet, thermodynamic (TD) traps are installed in blanket cylinder and rubber cylinder. TD traps are not able to remove condensate properly. As a result, the operator by-pass the valve to remove the condensate in the heating cycle. Thus, a significant amount of steam is lost in each heating cycle.

2.4.4.2 Present Scenario

Float traps in steam unit of zero-zero machines has been installed in the place of TD traps. Installed float traps able to filter out condensate in the machine exit and allow steam to pass through the line. The amount of steam being discharged along with the condensate has been saved in the process.

The installation of the float-traps in the steam utilizing units will lead to following benefits:

- Higher capacity turndown trap
- Complete Space Optimization – Area required for installation is less
- No welding required
- No Inline leakages

- Lesser Radiation losses
- Reduced transportation costs

2.4.4.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed float traps in zero-zero machine

Parameter	Unit	Base line	Post Implementation
Bypass Valve size	mm	25	25
Percentage opening of bypass valve	%	15	15
Orifice size of opened valve	mm	3	3
Operating pressure	kg/cm2	4	4
Steam loss through opened by pass valve	kg/hr	8.5	8.5
Total steam leakage /day (considering 50% live steam leakage loss)	kg/day	102	102
No. of cylinders in zero- zero machine	no.	4	4
No. of zero-zero machine	no.	2	2
Quantity of steam saved (considering 4 cylinders of zero-zero machine and 1 gotta machine)	kg/day	510	
Energy saved	%	4.25	
Quantity of fuel saved daily	kg/day	89	
Annual fuel saving	kg/yr.	29340	
Annual cost saving	Rs/yr	220052	
Investment	Rs	197019	
Pay back	months	11	
Annual Reduction in Energy Consumption	toe	24.06	
Annual CO_2 emission reduction	tCO_2/year	114.48	

* Cost of fuel taken as Rs 7500/MT

Assumption /conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of float traps is 29340 kgs. The actual investment made to implement float traps is Rs 2.20 Lakhs with annual saving of Rs. 1.97 Lakhs. Thus, the investment made will be recovered within 11 months.

2.4.4.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler without float traps used during the baseline vis-à-vis the float traps used in the post implementation study has been shown below:

Snap shot of zero zero machine without float trap at Simandhar Fabtex (P) ltd

Snap shot of zero zero machine without float trap at Simandhar Fabtex (P) ltd

2.4.5 Boiler Feed Water Treatment

2.4.5.1 Present Process:

Simandhar Fabtex (P) Ltd. has installed 1 number of steam boiler of 3 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 Simandhar Fabtex, 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.

2.4.5.2 Present Scenario

In order to maintain the TDS of boiler feed water close to the permissible range, revise osmosis (RO) plant was installed 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

2.4.5.3 Cost Economics Analysis

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

Cost Economic Analysis of proposed RO system

Particulars	Units	Calculation
Quantity of steam generated per hour	kg/hr	3000
Quantity of fuel used per hour	kg/hr	211.6
Quantity of fuel used to generate 1 kg of steam	kg/kg	0.071
Without RO		
Frequency of blow down per month	no.	100
No. of blow downs in a year	no.	1200
Steam lost in each blow down	kg	533
Steam lost in year	kg	640000
Fuel used to generate lost steam	kg	45141.33
With RO		
Frequency of blow down	no.	25
No. of blow downs in a year	no.	300
Steam lost in each blow down	kg	533
Steam lost in year	kg	159900
Fuel used to generate lost steam	kg	11278.28
Annual saving in fuel	kg	33863.05
Percentage saving in fuel consumption	%	4.4
Annual cost saving in fuel	Rs	253972.9
Annual cost saving in terms of make-up water and boiler maintenance	Rs	12000
Annual cost savings	Rs	265973
Equipment cost	Rs	564952
Pay back	months	25
Annual Reduction in Energy Consumption	toe	27.77
Annual CO2 emission reduction	tCO2/year	132.13

*Cost of fuel taken as Rs 7.5/kg

Assumption /conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by RO plant is 33863 kgs. The actual investment made to implement RO plant is Rs 5.64 Lakhs with annual saving of Rs. 2.65Lakhs. Thus, the investment made will be recovered within 25 months.

2.5.3.4 Snap-shot of implementation (before and after)

Snap shot of installation of RO plant in Simandhar Fabtex limited

Snap shot of RO plant at Simandhar Fabtex (P) ltd

CHAPTER 3

Manoj Dyeing

CHAPTER 3

3.1 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. Energy Efficient Technologies implemented vis-à-vis baseline energy audit recommendation

Technology recommended as per baseline energy audit (as approved by steering committee)	Technology implementation and cross-verified during post implementation energy audit
Economizer in Thermic fluid exit	Not Implemented
Reverse Osmosis (RO) system in steam boiler	Not Implemented
Condensate Recovery System (CRS) in Jet Dyeing Machine	Condensate Recovery System (CRS) in Jet Dyeing Machine
Energy efficient AC motors with VFD in mercerizing machine	Energy efficient AC motors with VFD in mercerizing machine
Temperature Monitoring & Control in Jigger Machines (for 10 Jiggers)	Not Implemented

3. Cost Economics Analysis: Projected (as per baseline) vs. Actual

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Condensate Recovery System (CRS) in Jet Dyeing Machine				
Baseline (Projected)	40	7,28,712	5,00,000	8
Post Implementation (Actual)	37.33	5,82,969	3,05,543	6
Energy efficient AC motors with VFD in mercerizing machine				
Baseline (Projected)	30	2,84,002	2,50,000	10
Post Implementation (Actual)	23	2,15,460	1,95,363	11

4. Project Impacts

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
Condensate Recovery System (CRS) in Jet Dyeing Machine	37.33	6.68	31.78
Energy efficient AC motors with VFD in mercerizing machine	23	2.47	25.86

Assumptions / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor power is 0.9 tCO2 per MWh
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

3.2 ABOUT THE UNIT

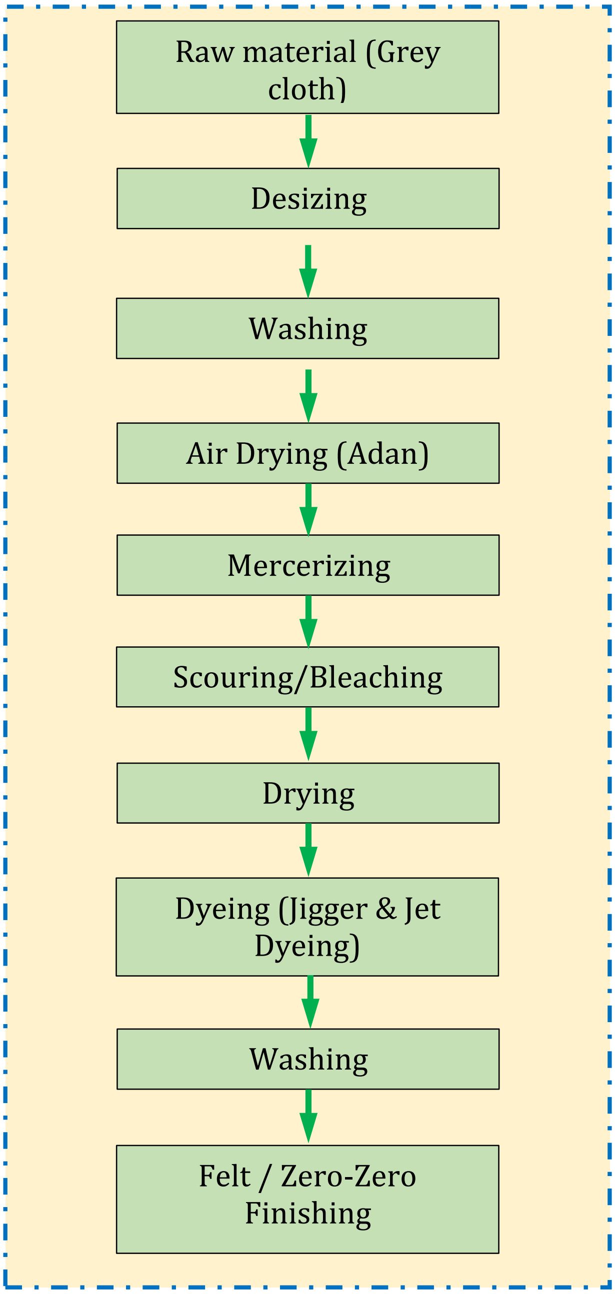
M/s Manoj Dyeing (P) Ltd., Pali, was established in the year 2003 and is engaged in processing of cloth (both cotton and polyester) which includes raw cloth (grey) processing, dyeing and finishing operations. The manufacturing unit is located at F-201A, Mandia Road, Pali. The unit operation is overseen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

3.3 PRODUCTION PROCESS OF PLANT

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



Production process at Manoj Dyeing (P) Ltd.

3.4 POST IMPLEMENTATION ENERGY AUDIT OUTCOME AND RESULTS

3.4.1 Installation of Energy Efficient Motors with VFD in Mercerizing Machine

3.4.1.1 Baseline Scenario

Manoj Dyeing Pvt. Ltd. has installed a mercerizing machine which runs with 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. It was observed that motors are running at less than 50%. Considering the under capacity utilization of the motors during most of the period of operation of mercerizing machine

3.4.1.2 Present Scenario

The Energy Efficient Ac motors of lower capacity with variable frequency drives installed with each motor with motor capacities of 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.

The installation of the energy efficient AC motors with VFD has led 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

3.4.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed energy efficient AC motor with VFD

Parameter	Unit	Value
Baseline Scenario		
Power consumed by existing mercerizing machine	kW	17.53
Annual consumption	KWh/year	126216
Production on existing mercerizing machine	mtr/hr	31250
Specific power consumption on existing mercerizing machine	kWh/mtr	0.0006
Post Implementation Scenario		
Power consumed by AC motors with VFD drives	kW	13.54
Annual consumption	KWh/year	97488
Production on existing mercerizing machine	mtr/hr	31250
Specific power consumption (projected)	kWh/mtr	0.0004
Savings		
Reduction in specific power consumption	kWh/mtr	0.00013
Annual electricity savings	kWh	28728

Parameter	Unit	Value
Percentage savings	%	23
Daily operating hours	Hrs.	24
Annual operating days	Days	300
Annual cost savings	Rs.	215460
Investment required	Rs.	195363
Simple payback period	months	10.88
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	2.47
Annual CO2 emission reduction	t CO_2/year	25.86

Assumption / conversion factors:

- 1 toe = 0.04186 TJ
- Emission factor power is 0.9 tCO2 per MWh
- CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The power consumption saved by implementing AC drives with VFD is 28728 kWh. The actual investment made to implement the energy efficient AC drives with VFD is Rs 1.95 lakhs with annual saving of Rs. 2.15 Lakhs. Thus, the investment made will be recovered within 11 months.

3.4.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler Dc motors used during the baseline vis-à-vis the EEF-1 motors with VFD used in the post implementation study has been shown below:

Snap shot of Mercerizing unit running with DC motor

Snap shot of Mercerizing unit which runs with EEF-1 motors with VFD

3.4.2 Condensate Recovery System in Jet Drying Machine

3.4.2.1 Baseline Scenario

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.

3.4.2.2 Present Scenario

In order to recover heat lost through condensate, Monoj Dyeing has installed 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 has led to significant savings of energy, chemical treatment and make-up water for boiler.

Benefits of the condensate recovery system are:

- Reduced fuel cost
- Lower water related expenses
- Positive impact on safety and environment

3.4.2.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed condensate recovery system in jet dyeing machine

Particular	Unit	Base line	Post Implementation
No. of Jet Dyeing Machine	no	4	4
Steam Consumption of Jet Dyeing M/c per hr	kg/hr	300	280
No.of Batches per day	no	5	5
Condensate recovery potential (considering heating cycle of 45 mins)	kg/day	3600	3360
operating days	days	330	330
Sensible heat @ 4kg/cm2	kcal/kg	144	144
Sensible heat @ 0.5 kg/cm2	kcal/kg	111	111
Latent heat @ 0.5 kg/cm2	kcal/kg	532	532
Flash steam quantity saved	kg/day	223	208
Balance condensate stem	kg/day	3377	3152
Temperature of condensate	°C	95	95

Particular	Unit	Base line	Post Implementation
Make up water temperature	°C	35	35
Savings with flash stem (A)	Rs	73692	
Gain in enthalpy	kcal/d	202602	
GCV of fuel	kCal/kg	8200	
Cost of fuel	Rs/kg	7.5	
Savings with condensate stem	Rs	152878	
Total quantity of RO water generated per day	Ltr/day	3600	
Cost of RO water per liter	Rs	0.3	
Savings from Ro water per year (B)	Rs	356400	
Total Saving (A+B)	Rs	582969	
Cost of condensate recovery system	Rs	305543	
Simple pay back	months	6	
Fuel saving	kg/hr	168	
Energy saving	%	37.33	
Annual Reduction in Energy Consumption (in terms of post implementation productivity)	toe	6.68	
Annual CO_2 emission reduction	tCO_2/year	31.78	

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission
- Every rise of 21°C in combustion air pre-heat temperature through waste heat recovery would offer about 1% fuel savings.

The fuel saved by installation of condensate recovery system is 8,153 kgs. The actual investment made to implement air preheater is Rs 5 lakhs with annual saving of Rs. 5.82 Lakhs. Thus, the investment made will be recovered within 6 months.

3.4.2.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler without air preheater used during the baseline vis-à-vis the condensate recovery system in Jet Dyeing machine used in the post implementation study has been shown below:

Snap shot of Jet dyeing without condensate recovery system at Manoj Dyeing Pvt. Ltd

Snap shot of Jet dyeing with condensate recovery system at Manoj Dyeing Pvt. Ltd

CHAPTER 4

Shree Rajaram Mills

C H A P T E R 4

4.1 EXECUTIVE SUMMARY

Unit Details

Unit Name	:	**Shree Rajaram Mills**
Address	:	F-338 to 342, Mandia Road Industrial Area, Pali, Rajasthan- 306401
Contact Person	:	Mr. Manish Gupta, Manager (Cell no: 9314464807)
Products	:	Cloth processing (cotton & polyester)
Production	:	70,000 to 80,000 meters of processed cloth per day
DIC Number	:	1266/STA/IMO/2005
Bank Details	:	Bank of Baroda, Suraj Pole, Pali, A/c No.: 09790500014855, IFSC Code: BARB0PALIXX
TIN / PAN No.	:	TIN: 08023254261 PAN: ABWPC1521H
Contract demand	:	300 kVA

2. Energy Efficient Technologies implemented vis-à-vis baseline energy audit recommendation

Technology recommended as per baseline energy audit (as approved by steering committee)	Technology implementation and cross-verified during post implementation energy audit
Installation of temperature based automation system in thermopac	Not Implemented
Reverse Osmosis (RO) system in steam boiler	Not Implemented
Condensate Recovery System (CRS) in Jet Dyeing Machine	Condensate Recovery System (CRS) in Jet Dyeing Machine
Temperature Monitoring & Control in Jigger Machines (for 10 Jiggers)	Not Implemented
Condensate Recovery System (CRS) in Zero-Zero Machine	Condensate Recovery System (CRS) in Zero-Zero Machine
Float Trap in Jet Dyeing Machine	Float Trap in Jet Dyeing Machine
Float Trap in Zero-Zero Machine	Float Trap in Zero-Zero Machine
Condensate Recovery System (CRS) In kier boiling unit	Condensate Recovery System (CRS) In kier boiling unit
Float Trap in Kier boiling unit	Float Trap in Kier boiling unit
Installation of VFD for blowers of thermopac & boiler	Installation of VFD for blowers of thermopac & boiler

3. Cost Economics Analysis: Projected (as per baseline) vs. Actual

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Condensate Recovery System (CRS) in Jet Dyeing Machine				
Baseline (Projected)	16.67	3,03,630	5,00,000	20
Post Implementation (Actual)	15.33	2,79,339	1,22,615	5
Condensate Recovery System (CRS) in Zero-Zero Machine				

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Baseline (Projected)	13.33	6.61,332	4,00,000	7
Post Implementation (Actual)	12.00	6,99,563	1,22,615	2
Condensate Recovery System (CRS)In kier boiling unit				
Baseline (Projected)	40	11,91,418	5,50,000	6
Post Implementation (Actual)	35	10,20,196	1,22,615	1
Float Trap in Kier boiling unit				
Baseline (Projected)	2.5	38,832	2,00,000	62
Post Implementation (Actual)	5	2,07,108	1,97,019	6
Float Trap in Jet Dyeing Machine				
Baseline (Projected)	27	3,23,606	2,75,000	10
Post Implementation (Actual)	25	3,23,606	75,052	3
Float Trap in Zero-Zero Machine				
Baseline (Projected)	5	2,58,885	2,00,000	9
Post Implementation (Actual)	10	2,07,108	2,78,574	16
Installation of VFD for blowers of thermopac & boiler				
Baseline (Projected)	6.67	3,02,130	1,50,000	5.96
Post Implementation (Actual)	20	4,02,840	1,54,290	4.60

4. Project Impacts

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
Condensate Recovery System (CRS) in Jet Dyeing Machine	15.33	3.20	15.24
Condensate Recovery System (CRS) in Zero-Zero Machine	12.00	8.02	38.18
Condensate Recovery System (CRS) In kier boiling unit	35.00	11.70	55.67
Float Trap in Kier boiling unit	5.00	22.60	107.74
Float Trap in Jet Dyeing Machine	25.00	35.38	168.40
Float Trap in Zero-Zero Machine	10.00	22.60	107.74
Installation of VFD for blowers of thermopac & boiler	20.00	4.62	48.34

Assumptions / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor power is 0.9 tCO2 per MWh
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

4.2 ABOUT THE UNIT

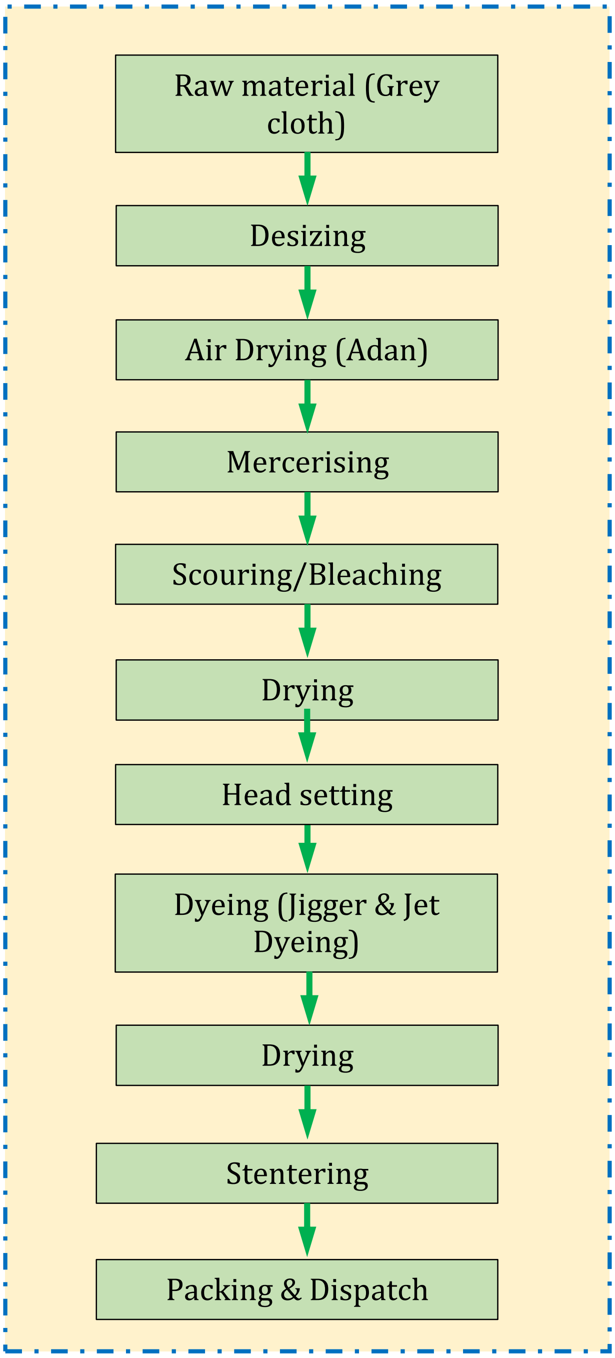
M/s Shree Rajaram Mills, Pali, was established in the year 2007 and is engaged in processing of cloth (both cotton and polyester) which includes raw cloth (grey) processing, dyeing and finishing operations. The manufacturing unit is located at F-338 to 342, Mandia Road Industrial Area, Pali. The unit operation is overseen by Mr. Manish Gupta, Manager.

The raw material procured by the unit includes grey (raw cloth) purchased from various sources predominantly from Gujarat and Maharashtra. The unit operates for 24 hours per day, presently.

The daily production lies in the range of 70,000 to 80,000 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 1,18,344 Kgs. The average monthly electricity consumption (derived from reported date of last one year) is 90,162 kWh.

4.3 PRODUCTION PROCESS OF PLANT

The Figure below shows the typical process employed at processing of textile products at Shree Rajaram Mills:



Production process at Shree Rajaram Mills

4.4 POST IMPLEMENTATION ENERGY AUDIT OUTCOME AND RESULTS

4.4.1 Condensate Recovery System in Jet Dyeing Machine

4.4.1.1 Baseline Scenario

Shree Rajaram mills have installed 2 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.

4.4.1.2 Present Scenario

In order to recover heat lost through condensate, Rajaram mills has installed 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 has led to significant savings of energy, chemical treatment and make-up water for boiler.

Benefits of the condensate recovery system are:

- Reduced fuel cost
- Lower water related expenses
- Positive impact on safety and environment

4.4.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed condensate recovery system in jet dyeing machine

Particular	Unit	Base line	Post Implementation
No. of Jet Dyeing Machines	no	2	2
Steam Consumption of Jet Dyeing M/c per hr	kg/hr	230	230
No.of Batches per day	no	5	5
Condensate recovery potential (considering heating cycle of 45 mins)	kg/day	1725	1725
operating days	days	330	330
Sensible heat @ 4kg/cm2	kcal/kg	144	144
Sensible heat @ 0.5 kg/cm2	kcal/kg	111	111
Latent heat @ 0.5 kg/cm2	kcal/kg	532	532
Flash steam quantity saved	kg/day	107	107

Particular	Unit	Base line	Post Implementation
Balance condensate stem	kg/day	1618	1618
Temperature of condensate	°C	95	95
Make up water temperature	°C	35	35
Savings with flash stem (A)	Rs	35311	
Gain in enthalpy	kcal/d	97080	
GCV of fuel	kCal/kg	8200	
Cost of fuel	Rs/kg	7.5	
Savings with condensate stem	Rs	73254	
Total quantity of RO water generated per day	Ltr/day	1725	
Cost of RO water per liter	Rs	0.3	
Savings from Ro water per year (B)	Rs	170775	
Total Saving (A+B)	Rs	279339	
Cost of condensate recovery system	Rs	122615	
Simple pay back	months	5	
Fuel saving	kg/hr	69	
Energy saving	%	15.33	
Annual Reduction in Energy Consumption (in terms of post implementation productivity)	toe	3.20	
Annual CO_2 emission reduction	tCO_2/year	15.24	

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission
- Every rise of 21°C in combustion air pre-heat temperature through waste heat recovery would offer about 1% fuel savings.

The fuel saved by installation of condensate recovery system is 3552 kgs. The actual investment made to implement air preheater is Rs 1.22 lakhs with annual saving of Rs. 2.79 Lakhs. Thus, the investment made will be recovered within 5 months.

4.4.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler without air preheater used during the baseline vis-à-vis the condensate recovery system in Jet Dyeing machine used in the post implementation study has been shown below:

Snap shot of Jet dyeing without condensate recovery system at Shree Rajaram Mills

Snap shot of Jet dyeing with condensate recovery system at Shree Rajaram Mills

4.4.2 Condensate recovery system in ZERO-ZERO (FELT) machine

4.4.2.1 Baseline Scenario

Rajaram Mills have installed 2 numbers of zero-zero machines. These machines are used for finishing operations wherein the fabric is rotated in circular rubber drum with blanket of steam rotating around it. Steam at a working pressure of 4-5 kg/cm^2 is used in the process. A significant amount of steam is lost during the operation, as the portion of the latent heat is transferred to the equipment line resulting in condensate formation. The unit has 2 number of zero-zero (felt) machines, each having a capacity to use steam at 200 kg/hour. Around 30,000 meters of cloth is processed in zero-zero machine every day.

4.4.2.2 Present Scenario

In order to recover heat lost through condensate, Rajaram mills has installed a condensate recovery system in the zero-zero 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 has led to significant savings of energy, chemical treatment and make-up water for boiler.

Benefits of the condensate recovery system are:

- Reduced fuel cost
- Lower water related expenses
- Positive impact on safety and environment

4.4.2.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed condensate recovery system in zero-zero machine

Particular	Unit	Base line	Post Implementation
No. of Zero -Zero Machines	no	2	2
Steam Consumption of Jet Dyeing M/c per hr	kg/hr	180	180
Operating hours per day	hrs	12	12
Condensate recovery potential (considering heating cycle of 45 mins)	kg/day	4320	4320
operating days	days	330	330
Sensible heat @ 4kg/cm2	kcal/kg	144	144
Sensible heat @ 0.5 kg/cm2	kcal/kg	111	111
Latent heat @ 0.5 kg/cm2	kcal/kg	532	532
Flash steam quantity saved	kg/day	268	268
Balance condensate stem	kg/day	4052	4052
Temperature of condensate	°C	95	95
Make up water temperature	°C	35	35
Savings with flash stem (A)	Rs	88430	
Gain in enthalpy	kcal/d	243122	
GCV of fuel	kCal/kg	8200	
Cost of fuel	Rs/kg	7.5	
Savings with condensate stem	Rs	183453	
Total quantity of RO water generated per day	Ltr/day	4320	
Cost of RO water per liter	Rs	0.3	
Savings from Ro water per year (B)	Rs	427680	
Total Saving (A+B)	Rs	699563	
Cost of condensate recovery system	Rs	122615	
Simple pay back	months	2	
Fuel saving	kg/hr	54	
Energy saving	%	12.00	
Annual Reduction in Energy Consumption (in terms of post implementation productivity)	toe	8.02	
Annual CO_2 emission reduction	tCO_2/year	38.18	

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission
- Every rise of 21°C in combustion air pre-heat temperature through waste heat recovery would offer about 1% fuel savings.

The fuel saved by installation of condensate recovery system is 8894 kgs. The actual investment made to implement air preheater is Rs 1.22 lakhs with annual saving of Rs. 6.99 Lakhs. Thus, the investment made will be recovered within2 months.

4.4.2.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of zero – zero machine without condensate recovery system used during the baseline vis-à-vis the condensate recovery system in zero- zero machine used in the post implementation study has been shown below:

Snap shot of zero-zero machine without condensate recovery system at Shree Rajaram Mills

Snap shot of zero-zero machine with condensate recovery system at Shree Rajaram Mills

4.4.3 Condensate recovery system in kier boiling unit

4.4.3.1 Baseline Scenario

Shree Rajaram mills, Kier boiling operation is carried out by indirect heating. Hot water at temperature of around 90^{0}C is fed into the boiler. After the heating operation, water is drained out. A significant amount of heat energy present in the water is wasted in the process.

The Kier Boiling process is a batch process which last for a period of approximately 2 days, which including heating and cooling cycle for the fabrics. Both water and steam is fed into the boiler unit. Approximately 30,000 to 40,000 meters of cloth is processed per batch in the kier boiling unit. Steam at a working pressure of 3-4 kg/cm^2 is used along with hot water at around 120^{0}C. Around 4000-5000 liters of water is used in each kier boiling process. A significant amount of energy is lost when hot water utilized in the process is drained out.

4.4.3.2 Present Scenario

In order to recover heat lost through condensate, Rajaram mills has installed a condensate recovery system in the zero-zero 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 has led to significant savings of energy, chemical treatment and make-up water for boiler.

Benefits of the condensate recovery system are:

- Reduced fuel cost
- Lower water related expenses
- Positive impact on safety and environment

4.4.3.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed condensate recovery system in kier boiling unit

Particular	Unit	Base line	Post Implementation
No. of kier boiling	**no**	**3**	**3**
Steam Consumption of Jet Dyeing M/c per hr	kg/hr	350	350
No.of Batches per day	no	1	1
Condensate recovery potential (considering heating cycle of 45 mins)	kg/day	6300	6300
operating days	days	330	330
Sensible heat @ 4kg/cm2	kcal/kg	144	144
Sensible heat @ 0.5 kg/cm2	kcal/kg	111	111
Latent heat @ 0.5 kg/cm2	kcal/kg	532	532
Flash steam quantity saved	kg/day	391	391
Balance condensate stem	kg/day	5909	5909
Temperature of condensate	°C	95	95
Make up water temperature	°C	35	35
Savings with flash stem (A)	Rs	128961	
Gain in enthalpy	kcal/d	354553	
GCV of fuel	kCal/kg	8200	
Cost of fuel	Rs/kg	7.5	
Savings with condensate stem	Rs	267536	
Total quantity of RO water generated per day	Ltr/day	6300	
Cost of RO water per liter	Rs	0.3	
Savings from Ro water per year (B)	Rs	623700	
Total Saving (A+B)	Rs	1020196	
Cost of condensate recovery system	Rs	122615	
Simple pay back	months	1	
Fuel saving	kg/hr	158	
Energy saving	%	35.00	
Annual Reduction in Energy Consumption (in terms of post implementation productivity)	toe	11.70	
Annual CO_2 emission reduction	tCO_2/year	55.67	

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission
- Every rise of 21°C in combustion air pre-heat temperature through waste heat recovery would offer about 1% fuel savings.

The fuel saved by installation of condensate recovery system is 12971 kgs. The actual investment made to implement air preheater is Rs 1.22 lakhs with annual saving of Rs. 11.65 Lakhs. Thus, the investment made will be recovered within 1 month.

4.4.3.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of kier boiler without condensate recovery system used during the baseline vis-à-vis the condensate recovery system in kier boiler used in the post implementation study has been shown below:

Snap shot of kier boiler without condensate recovery system at Shree Rajaram Mills

Snap shot of kier boiler with condensate recovery system at Shree Rajaram Mills

4.4. 4 Installation of Float Traps in Kier Boiling

4.4.4.1 Baseline Scenario

Rajaram Mills has installed 1 number of kier boiling units to perform scouring operations in the fabric. The unit has a steam boiler of 3 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm2 in the kier boiling unit. In the condensate outlet, thermodynamic (TD) traps are installed. TD traps are not able to remove condensate properly. As a result, the operator by-pass the valve to remove the condensate in the heating cycle. Thus, a significant amount of steam is lost in each heating cycle.

4.4.4.2 Present Scenario

Float traps in steam unit of kier boiling machines has been installed in the place of TD traps. Installed float traps able to filter out condensate in the machine exit and allow steam to pass through the line. The amount of steam being discharged along with the condensate has been saved in the process.

The installation of the float-traps in the steam utilizing units will lead to following benefits:

- Higher capacity turndown trap
- Complete Space Optimization – Area required for installation is less
- No welding required
- No Inline leakages
- Lesser Radiation losses
- Reduced transportation costs

4.4.4.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Baseline Scenario		
Bypass Valve size	mm	25
Percentage opening of bypass valve	%	15
Orifice size of opened valve	mm	3
Total steam required for the process	kg/hr	400
Post Implementation Scenario		
Bypass Valve size after installation of Flot traps	mm	15
Percentage opening of bypass valve	%	15
Total steam required for the process (using float traps)	kg/hr	380
Savings		
Reduction in steam(from base line to post implementation)	kg/hr	20
Total steam recovered per day	kg/day	480
Energy Saved	%	5
Quantity of fuel saved daily	kg/day	84
Annual fuel saving	kg/yr	27614
Annual cost saving	Rs/yr	207108
Investment	Rs	107964
Pay back	months	6
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	22.6
Annual CO_2 emission reduction	t CO_2/year	107.74

* Cost of fuel taken as Rs 7500/MT

Assumption /conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of float traps is 27614 kgs. The actual investment made to implement float traps is Rs 1.07 Lakhs with annual saving of Rs. 2.07 Lakhs. Thus, the investment made will be recovered within 6 months.

Snap shot of kier boiler without float trap at Shree Rajaram Mills

Snap shot of kier boiler with float trap at Shree Rajaram Mills

4.4.5 Installation of Float Traps in Jet Dyeing

4.4.5.1 Baseline Scenario

Rajaram Mills has installed 2 nos. of jet dyeing machines having a capacity of 250 kgs each. The unit has a steam boiler of 3 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm^2 in the jet dyeing machines. In the condensate outlet, 25 NB thermodynamic (TD) traps are installed in 3 nos. of jet dyeing machine. 2 jet dyeing machine, no traps have been installed in one of the machine whereas float trap installed in the other machine is not functioning properly.

4.4.5.2 Present Scenario

Float traps in steam unit of Jet Dyeing machines has been installed in the place of TD traps. Installed float traps able to filter out condensate in the machine exit and allow steam to pass through the line. The amount of steam being discharged along with the condensate has been saved in the process.
The installation of the float-traps in the steam utilizing units will lead to following benefits:

- Higher capacity turndown trap
- Complete Space Optimization – Area required for installation is less
- No welding required
- No Inline leakages
- Lesser Radiation losses
- Reduced transportation costs

4.4.5.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Baseline Scenario		
Bypass Valve size	mm	25
Percentage opening of bypass valve	%	20
Orifice size of opened valve	mm	5
Total steam required for the process	kg/batch	120
Post Implementation Scenario		
Bypass Valve size after installation of Float traps	mm	15
Percentage opening of bypass valve	%	15
Total steam required for the process (using float traps)	kg/hr	90
Savings		
Reduction in steam(from base line to post implementation)	kg/hr	30
No.of jet machines	No	2
Total steam recovered per day	kg/day	750
Energy Saved	%	25
Quantity of fuel saved daily	kg/day	131
Annual fuel saving	kg/yr	43148
Annual cost saving	Rs/yr	323606
Investment	Rs	75052
Pay back	months	3
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	35.38
Annual CO_2 emission reduction	t CO_2/year	168.4

* Cost of fuel taken as Rs 7500/MT

Assumption /conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of float traps is 43148 kgs. The actual investment made to implement float traps is Rs 0.75Lakhs with annual saving of Rs. 3.23 Lakhs. Thus, the investment made will be recovered within 3 months.

Snap shot of Jet Dyeing Machine without float trap at Shree Rajaram Mills

Snap shot of Jet Dyeing machine with float trap at Shree Rajaram Mills

4.4.6 Installation Of Float Traps in Zero Zero Machine

4.4.6.1 Baseline Scenario

Rajaram Mills has installed 2 nos. of zero-zero machines having a capacity of 200 kgs each. The unit has a steam boiler of 3 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm2 in the jet dyeing machines. In the condensate outlet, thermodynamic (TD) traps are installed in blanket cylinder and rubber cylinder.

4.4.6.2 Present Scenario

Float traps in steam unit of zero-zero machines has been installed in the place of TD traps. Installed float traps able to filter out condensate in the machine exit and allow steam to pass through the line. The amount of steam being discharged along with the condensate has been saved in the process.

The installation of the float-traps in the steam utilizing units will lead to following benefits:

- Higher capacity turndown trap
- Complete Space Optimization – Area required for installation is less
- No welding required
- No Inline leakages
- Lesser Radiation losses
- Reduced transportation costs

4.4.6.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Baseline Scenario		
Bypass Valve size	mm	25
Percentage opening of bypass valve	%	15
Orifice size of opened valve	mm	3
Total steam required for the process	kg/hr	200
Post Implementation Scenario		
Bypass Valve size after installation of Flot traps	mm	15
Percentage opening of bypass valve	%	15
Total steam required for the process (using float traps)	kg/hr	180
Savings		
Reduction in steam(from base line to post implementation)	kg/hr	20
Total steam recovered per day	kg/day	480
Energy Saved	%	10
Quantity of fuel saved daily	kg/day	84
Annual fuel saving	kg/yr	27614
Annual cost saving	Rs/yr	207108
Investment	Rs	278574
Pay back	months	16

Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	22.6
Annual CO_2 emission reduction	t CO_2/year	107.74

* Cost of fuel taken as Rs 7500/MT

Assumption /conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of float traps is 27614 kgs. The actual investment made to implement float traps is Rs 2.78Lakhs with annual saving of Rs. 2.07 Lakhs. Thus, the investment made will be recovered within 16 months.

Snap shot of zero zero Machine without float trap at Shree Rajaram Mills

Snap shot of zero zero machine with float trap at Shree Rajaram Mills

4.4.7 Installation of VFD for Blowers of Thermopac & Boiler

4.4.7.1 Baseline Scenario

Blowers of the existing boiler & thermopac was been operating without control of speed mechanism. According the temperature of the boiler & thermopac the blowers are operated manually.

4.4.7.2 Present Scenario

A VFD is installed for the boiler & thermopac blower. Variable frequency drive will allow storage of energy during lean period, thus saving electrical energy used in the system.

The installation of VFD led to following benefits:

- Reduced Power Line Disturbances
- Lower Power Demand on Start
- Controlled Stopping
- Energy saving

4.4.7.3 *Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)*

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed VFD for blowers of thermopac & blower

Parameter	Unit	Value
Baseline Scenario		
Power consumed by existing blowers installed in steam boiler	kWh	37.30
Annual consumption	KWh/year	268560
Steam generated by existing steam boiler	kg/hr	4000
Specific power consumption on existing FD fan	kWh/kg	0.009
Post Implementation Scenario		
Power consumed by blowers with VFD drives	kWh	29.84
Annual consumption	KWh/year	214848
Projected production on boiler	kg/hr	4000
Specific power consumption (projected)	kWh/kg	0.0075
Savings		
Reduction in specific energy consumption	kWh/kg	0.00187
Reduction in specific energy consumption in kcal	kcal/kg	1.60
Annual electricity savings	KWh	53712
Annual Cost Savings	Rs	402840
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	4.62
Percentage reduction in energy consumption	%	20.00
Investment made on VFD	Rs	154290
Simple payback period	months	4.60
Annual CO_2 emission reduction	t CO_2/year	48.34

Assumption / conversion factors:

- 1 toe = 0.04186 TJ
- Emission factor power is 0.9 tCO2 per MWh
- CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The power consumption saved by implementing VFD is 53712 kWh. The actual investment made to implement the VFD is Rs 1.54lakhs with annual saving of Rs. 4.02 Lakhs. Thus, the investment made will be recovered within 5 months.

4.4.7.4 *Snap-shot of implementation (before and after)*

A comparison of the snap-shots of boiler blower without VFD used during the baseline vis-à-vis the boiler blower with VFD used in the post implementation study has been shown below:

Snap shot of boiler without VFD at Shree Rajaram Mills

Snap shot of boiler with VFD at Shree Rajaram Mills

CHAPTER 5

Shree Rajaram Process

C H A P T E R 5

5.1 EXECUTIVE SUMMARY

1. Unit Details

Unit Name	:	**Shree Rajaram Process**
Address	:	F-329, Mandia Road Industrial Area, Pali, Rajasthan- 306401
Contact Person	:	Mr. Ratan Dhariwal, Manager (Cell no: 9001556789)
Products	:	Cloth processing (Finishing & Felt)
Production	:	50,000 to 70,000 meters of processed cloth per day
DIC Number	:	RJSI/21/17/06828
Bank Details	:	Bank of Baroda, Suraj Pole, Pali, A/c No.: 09790200008137, IFSC Code: BARB0PALIXX
TIN / PAN No.	:	TIN: 08363254365 PAN: AANHS0271G
Contract demand	:	

2. Energy Efficient Technologies implemented vis-à-vis baseline energy audit recommendation

Technology recommended as per baseline energy audit (as approved by steering committee)	Technology implementation and cross-verified during post implementation energy audit
Oxygen based automation and control system in boiler	Not Implemented
Reverse Osmosis (RO) system in steam boiler	Not Implemented
Condensate Recovery System (CRS) in Zero-Zero Machine	Condensate Recovery System (CRS) in Zero-Zero Machine
Float Trap in Zero-Zero Machine	Float Trap in Zero-Zero Machine
Installation of VFD For FD Fan	Installation of VFD For FD Fan

3. Cost Economics Analysis: Projected (as per baseline) vs. Actual

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Condensate Recovery System (CRS) in Zero-Zero Machine				
Baseline (Projected)	16.67	4,43,073	5,00,000	13
Post Implementation (Actual)	30.03	4,85,808	1,22,615	3
Float Trap in Zero-Zero Machine				
Baseline (Projected)	5	2,58,885	2,00,000	9
Post Implementation (Actual)	10	2,07,108	74,000	4
Installation of VFD For FD Fan				
Baseline (Projected)	76.6	60,426	50,000	9.9
Post Implementation (Actual)	30.03	60,480	23,000	4.5

4. Project Impacts

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
Condensate Recovery System (CRS) in Zero-Zero Machine	8.33	5.57	26.51
Float Trap in Zero-Zero Machine	10.00	22.06	107.74
Installation of VFD For FD Fan	30.03	0.69	7.26

Assumptions / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor power is 0.9 tCO2 per MWh
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

5.2 ABOUT THE UNIT

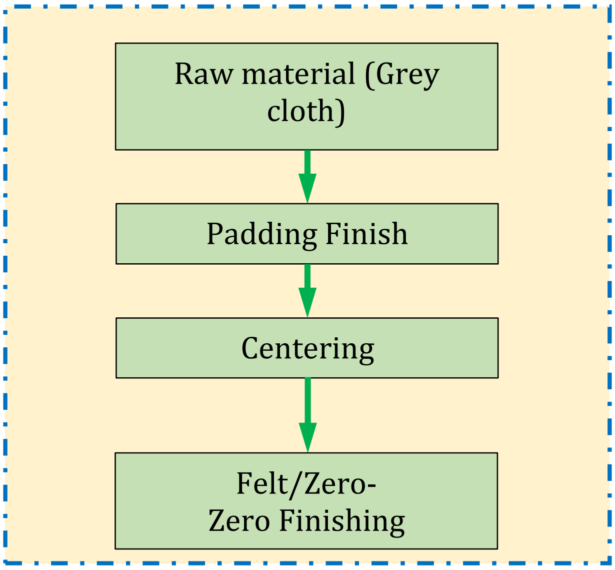
M/s Shree Rajaram Process, Pali, was established in the year 1995 and is engaged in processing of cloth (both cotton and polyester) which includes raw cloth (grey) processing, dyeing and finishing operations. The manufacturing unit is located at F-329, Mandia Road Industrial Area, Pali. The unit operation is overseen by Mr. Ratan Dhariwal, Manager.

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 50,000 to 70,000 meters of processed cloth per day. The major energy usage in the unit includes wet steam (generated from biomass fired boiler) and electricity. The average monthly biomass consumption (derived from reported date of last one year) in the unit is 23,090 Kgs. The average monthly electricity consumption (derived from reported date of last one year) is 4,310 kWh.

5.3 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at processing of textile products at Shree Rajaram Prints (P) Ltd



Production process at Shree Rajaram Process

5.4 POST IMPLEMENTATION ENERGY AUDIT OUTCOME AND RESULTS

5.4.1 Installation of VFD for FD fan

5.4.1.1 Baseline Scenario

FD fan of the existing boiler was been operating without control of speed mechanism. According the temperature of the boiler the FD fan is operated manually.

5.4.1.2 Present Scenario

A VFD is installed for the boiler & thermopac blower. Variable frequency drive will allow storage of energy during lean period, thus saving electrical energy used in the system.

The installation of VFD led to following benefits:

- Reduced Power Line Disturbances
- Lower Power Demand on Start
- Controlled Stopping
- Energy saving.

5.4.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The unit vis-à-vis the baseline energy audit data.

Parameter	Unit	Value
Baseline Scenario		
Power consumed by existing blowers installed in steam boiler	kWh	3.73
Annual consumption	KWh/year	26856
Steam generated by existing steam boiler	kg/hr	4000
Specific power consumption on existing FD fan	kWh/kg	0.001

Post Implementation Scenario		
Power consumed by blowers with VFD drives	kWh	2.61
Annual consumption	KWh/year	18792
Projected production on desizing machine	kg/hr	4000
Specific power consumption (projected)	kWh/kg	0.0007
Savings		
Reduction in specific energy consumption	kWh/kg	0.0003
Reduction in specific energy consumption in kcal	kcal/kg	0.24
Annual electricity savings	KWh	8064
Annual Cost Savings	Rs	60480
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	0.69
Percentage reduction in energy consumption	%	30.03
Investment made on VFD	Rs	23000
Simple payback period	months	4.56
Annual CO_2 emission reduction	t CO_2/year	7.26

The power consumption saved by implementing VFD is 8064 kWh. The actual investment made to implement the VFD is Rs 0.23 lakhs with annual saving of Rs. 0.61 Lakhs. Thus, the investment made will be recovered within 4 months.

Assumption / conversion factors:

- 1 toe = 0.04186 TJ
- Emission factor power is 0.9 tCO2 per MWh
- CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

5.4.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler blower without VFD used during the baseline vis-à-vis the boiler blower with VFD used in the post implementation study has been shown below:

5.4.2 Installation of VFD for FD fan

5.4.1.1 Baseline Scenario

FD fan of the existing boiler was been operating without control of speed mechanism. According the temperature of the boiler the FD fan is operated manually.

5.4.1.2 Present Scenario

A VFD is installed for the boiler & thermopac blower. Variable frequency drive will allow storage of energy during lean period, thus saving electrical energy used in the system.

The installation of VFD led to following benefits:

- Reduced Power Line Disturbances
- Lower Power Demand on Start
- Controlled Stopping
- Energy saving.

5.4.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The unit vis-à-vis the baseline energy audit data.

Parameter	Unit	Value
Baseline Scenario		
Power consumed by existing blowers installed in steam boiler	kWh	3.73
Annual consumption	KWh/year	26856
Steam generated by existing steam boiler	kg/hr	4000
Specific power consumption on existing FD fan	kWh/kg	0.001
Post Implementation Scenario		
Power consumed by blowers with VFD drives	kWh	2.61
Annual consumption	KWh/year	18792
Projected production on desizing machine	kg/hr	4000
Specific power consumption (projected)	kWh/kg	0.0007
Savings		
Reduction in specific energy consumption	kWh/kg	0.0003
Reduction in specific energy consumption in kcal	kcal/kg	0.24
Annual electricity savings	KWh	8064
Annual Cost Savings	Rs	60480
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	0.69
Percentage reduction in energy consumption	%	30.03
Investment made on VFD	Rs	23000
Simple payback period	months	4.56
Annual CO_2 emission reduction	t CO_2/year	7.26

The power consumption saved by implementing VFD is 8064 kWh. The actual investment made to implement the VFD is Rs 0.23 lakhs with annual saving of Rs. 0.61 Lakhs. Thus, the investment made will be recovered within 4 months.

Assumption / conversion factors:

- 1 toe = 0.04186 TJ
- Emission factor power is 0.9 tCO2 per MWh
- CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

5.4.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler blower without VFD used during the baseline vis-à-vis the boiler blower with VFD used in the post implementation study has been shown below:

CHAPTER 6

Shree Rajaram Prints (P) Ltd

Mehram Industries

6.1 EXECUTIVE SUMMARY

1. Unit Details

Unit Name	:	**Shree Rajaram Prints (P) Ltd.**
Address	:	E-226 to 229, Punayata Industrial Area, Pali, Rajasthan- 306401
Contact Person	:	Mr. Rahul Gupta, Manager (Cell no: 8003291297)
Products	:	Cloth processing including printing and dyeing
Production	:	20,000 to 40,000 meters of processed cloth per day
DIC Number	:	RJ26B0000079
Bank Details	:	Bank of Baroda, Suraj Pole, Pali, A/c No.: 09790500015049, IFSC Code: BARB0PALIXX
TIN / PAN No.	:	TIN: 08173260629 PAN: AAICS0464M
Contract demand	:	400 KVA

2. Energy Efficient Technologies implemented vis-à-vis baseline energy audit recommendation

Technology recommended as per baseline energy audit (as approved by steering committee)	Technology implementation and cross-verified during post implementation energy audit
Installation of temperature based automation system in thermopac	Not Implemented
Installation of oxygen based automation system in steam boiler	Not Implemented
Reverse Osmosis (RO) system in steam boiler	Not Implemented
Temperature monitoring and control system in washing range	Temperature monitoring and control system in washing range
Energy efficient AC motors with VFD in Desizing unit	Energy efficient AC motors with VFD in Desizing unit
Installation of VFD for blowers of thermopac & boiler	Installation of VFD for blowers of thermopac & boiler

3. Cost Economics Analysis: Projected (as per baseline) vs. Actual

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Temperature monitoring and control system in washing range				
Baseline (Projected)	69.4	1,42,912	50,000	4
Post Implementation (Actual)	55.56	1,14,329	1,33,848	14
Energy efficient AC motors with VFD in Desizing unit				
Baseline (Projected)	30	1,63,150	2,00,000	14
Post Implementation (Actual)	25	1,35,959	2,60,000	23

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (months)
Installation of VFD for blowers of thermopac & boiler				
Baseline (Projected)	6.67	3,02,130	1,50,000	5.96
Post Implementation (Actual)	6.63	66,780	89,000	16

4. Project Impacts

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
Temperature monitoring and control system in washing range	55.56	12.50	59.48
Energy efficient AC motors with VFD in Desizing unit	25.00	1.56	16.32
Installation of VFD for blowers of thermopac & boiler	6.63	0.57	8.01

Assumptions / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor power is 0.9 tCO2 per MWh
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

6.2 ABOUT THE UNIT

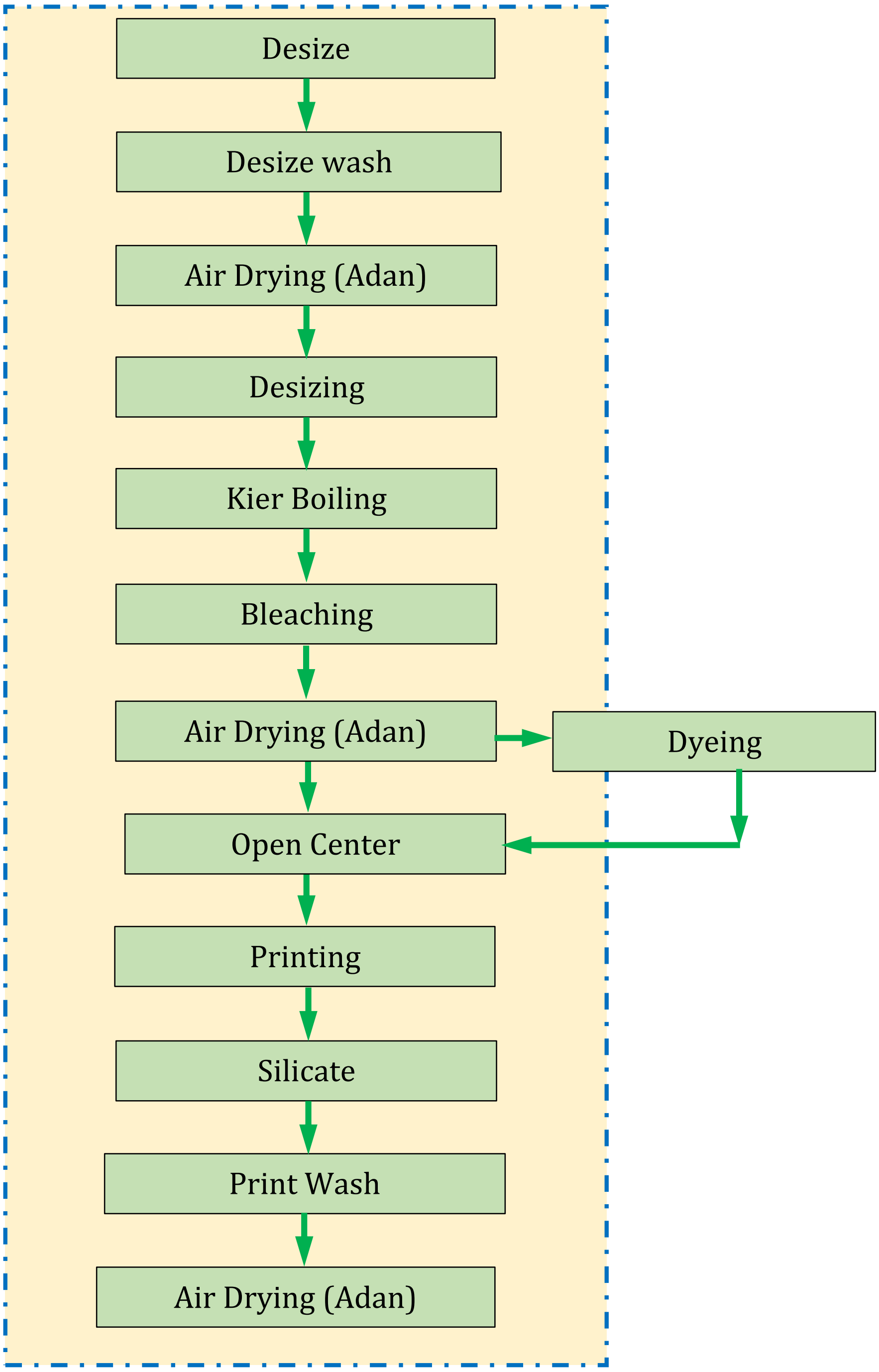
M/s Shree Rajaram Prints (P) Ltd., Pali, was established in the year 2015 and is engaged in processing of cloth (both cotton and polyester) which includes raw cloth (grey) processing, dyeing, printing and finishing operations. The manufacturing unit is located at E-226 to 229, Punayata, Pali. The unit operation is overseen by Mr. Rahul Gupta, Manager.

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 20,000 to 40,000 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 86,000 Kgs. The average monthly electricity consumption (derived from reported date of last one year) is 31,485 kWh.

6.3 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at processing of textile products at Shree Rajaram Prints (P) Ltd



Production process at Shree Rajaram Prints (P) Ltd.

6.4 POST IMPLEMENTATION ENERGY AUDIT OUTCOME AND RESULTS

6.4.1 Temperature Monitoring and Control In Washing Ranges

6.4.1.1 Baseline Scenario

Shree Rajaram Prints (P) Ltd. has one no. of washing range for washing of printed fabrics. This washing operation is done in high temperature, with recommended range between 60-80 ^{0}C. However, the process is manually controlled presently with no control on temperature of water for washing. Thus, a significant portion of energy is lost as hot water is drained out of the system after the process is over.

6.4.1.2 Present Scenario

In order to maintain the correct temperature profile in the washing water, a sensor based temperature monitoring and control system was installed. This system is used to monitor the temperature level of water in the washing range and control the flow of steam by a pneumatically operated valve. This has led to optimum utilization of steam in the washing range thus leading to a substantial energy savings.

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

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

6.4.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Parameter	Unit	Value
Baseline Scenario		
Temperature observed in washing range	deg C	95
Quantity of water used	kg	2500
Energy used in the process	kcal	237500
Post Implementation Scenario		
Temperature observed in washing range	deg C	75
Quantity of water used	kg	2500
Energy used in the process	kcal	187500
Savings		
Reduction in energy due to installation of temperature	kcal	50000
Heat energy wasted considering boiler efficiency of 60%	kcal	83333
Fuel saved	kg/batch	10
No. of batches per day	no.	5
Daily fuel saving	kg/day	51

Parameter	Unit	Value
Annual fuel savings	kg/yr	15243.9
Annual monetary savings	Rs/yr	114329
Investment	Rs	133848
Pay-back	Months	14
Energy saving	%	55.56
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	12.5
Annual CO_2 emission reduction	t CO_2/year	59.48

Assumption / conversion factors:

- Specific gross calorific value of Pet coke has been considered as 8200 kcal /kg
- 1 TOE (tonnes of oil equivalent) = 0.04186 TJ (Tera Joule)
- Emission factor Pet Coke has been considered as 113.67 t CO_2 per TJ (as per IPCC guideline)
- CO_2 emission reduction calculation has been considered based on equivalent reduction in CO_2 emission

The fuel saved by installation of temperature monitoring system is 15.24t. The actual investment made to implement economizer is Rs 1.33 lakhs with annual saving of Rs. 1.14 Lakhs. Thus, the investment made will be recovered within 14 months.

6.4.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of thermic fluid exists without temperature monitoring system used during the baseline vis-à-vis the with temperature monitoring system used in the post implementation study has been shown below:

Snap shot of Thermic fluid exist without economizer at Shree Rajaram Prints (P) Ltd

Snap shot of Thermic fluid exist with economizer at Shree Rajaram Prints (P) Ltd

6.4.2 Installation of Energy Efficient Motors with VFD in Desizing Machine

6.4.2.1 Baseline Scenario

Desizing is an operation carried out to remove loses fiber, hairy fiber, protruding fiber from the surface of the fabric. Desizing, irrespective of what the Desizing agent is, involves impregnation of the fabric with the Desizing agent, allowing the Desizing agent to degrade or solubilize the size material, and finally to wash out the degradation products. Rajaram Prints Pvt. Ltd. has installed a Desizing machine and a Desizing washing unit which is presently run by 2 nos. of DC motors of 3 hp and 7.5 hp rating respectively. Based on the quality of fabric and Desizing required, the speeds of the DC motors are varied.

6.4.2.2 Present Scenario

The Energy Efficient AC motors of lower capacity with variable frequency drives installed with each motor with motor capacities of 3 motors of 3 hp each with the variable frequency drive will allow storage of energy during lean period, thus saving electrical energy used in the system.

The installation of the energy efficient AC motors with VFD has led 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

6.4.2.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed VFD in Desizing machine

Parameter	Unit	Value
Baseline Scenario		
Power consumed by existing desizing machine	kWh	10.07
Annual consumption	KWh/year	72511
Production on existing desizing machine	mtr/hr	31250
Specific power consumption on existing desizing machine	kWh/mtr	0.00032
Post Implementation Scenario		
Power consumed by AC motors with VFD drives	kWh	7.55
Annual consumption	KWh/year	54383.4
Projected production on desizing machine	mtr/hr	31250
Specific power consumption (projected)	kWh/mtr	0.0002
Savings		

Parameter	Unit	Value
Reduction in specific energy consumption	kWh/mtr	0.00008
Reduction in specific energy consumption in kcal	kcal/mtr	0.07
Annual electricity savings	KWh	18128
Annual Cost Savings	Rs	135959
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	1.56
Percentage reduction in energy consumption	%	25
Investment made on VFD	Rs	260000
Simple payback period	months	23
Annual CO_2 emission reduction	t CO_2/year	16.32

Assumption / conversion factors:

- 1 toe = 0.04186 TJ
- Emission factor power is 0.9 tCO2 per MWh
- CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The power consumption saved by implementing AC drives with VFD is 18128 kWh. The actual investment made to implement the energy efficient AC drives with VFD is Rs 2.60 lakhs with annual saving of Rs. 1.35 Lakhs. Thus, the investment made will be recovered within 23 months.

6.4.2.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler Dc motors used during the baseline vis-à-vis the EEF-1 motors with VFD used in the post implementation study has been shown below:

Snap shot of Mercerizing unit running with DC motor at Shree Rajaram Prints (P) Ltd

Snap shot of Mercerizing unit which runs with EEF-1 motors with VFD at Shree Rajaram Prints (P) Ltd

6.4.3 Installation of VFD for Blowers of Thermopac & Boiler

6.4.3.1 Baseline Scenario

Blowers of the existing boiler & thermopac was been operating without control of speed mechanism. According the temperature of the boiler & thermopac the blowers are operated manually.

6.4.3.2 Present Scenario

A VFD is installed for the boiler & thermopac blower. Variable frequency drive will allow storage of energy during lean period, thus saving electrical energy used in the system.

The installation of VFD led to following benefits:

- Reduced Power Line Disturbances
- Lower Power Demand on Start
- Controlled Stopping
- Energy saving

6.4.3.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Cost Economic Analysis of proposed VFD for blowers of thermopac & blower

Parameter	Unit	Value
Baseline Scenario		
Power consumed by existing blowers installed in steam boiler	kWh	18.65
Annual consumption	KWh/year	134280
Steam generated by existing steam boiler	kg/hr	4000
Specific power consumption on existing FD fan	kWh/kg	0.005
Post Implementation Scenario		
Power consumed by blowers with VFD drives	kWh	13.06
Annual consumption	KWh/year	94032
Projected production on Boiler	kg/hr	3000
Specific power consumption (projected)	kWh/kg	0.0044
Savings		
Reduction in specific energy consumption	kWh/kg	0.00031
Reduction in specific energy consumption in kcal	kcal/kg	0.27
Annual electricity savings	KWh	8904
Annual Cost Savings	Rs	66780
Annual Reduction in Energy Consumption (in terms of post implementation production)	toe	0.57
Percentage reduction in energy consumption	%	6.63
Investment made on VFD	Rs	89000
Simple payback period	months	16
Annual CO_2 emission reduction	t CO_2/year	8.01

Assumption / conversion factors:

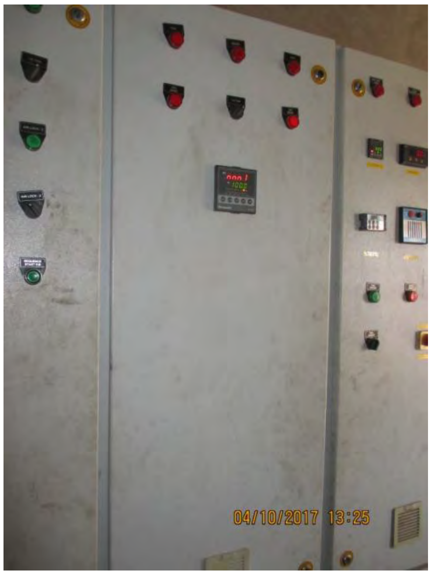
- 1 toe = 0.04186 TJ
- Emission factor power is 0.9 tCO2 per MWh
- CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The power consumption saved by implementing VFD is 8904 kWh. The actual investment made to implement the VFD is Rs 0.89 lakhs with annual saving of Rs. 0.66 Lakhs. Thus, the investment made will be recovered within 16 months.

6.4.3.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of boiler blower without VFD used during the baseline vis-à-vis the boiler blower with VFD used in the post implementation study has been shown below:

Snap shot of boiler without VFD at Shree Rajaram Prints (P) Ltd



Snap shot of kier boiling unit with waste heat recovery system at Shree Rajaram Prints (P) Ltd

CHAPTER 7

Best Operating Practices for Energy Intensive Technologies

Best Operating Practices for Energy Intensive Technologies

7.1 BEST OPERATING PRACTICES: AN INTRODUCTION

Steam is the main agent of energy used in the textile processing unit. Thus, the boiler is the major energy utilizing source in a typical textile unit which accounts for 70% to 80% of the total energy consumption. The heating operation in a typical textile unit is carried out in a boiler. Thermal energy in the form of pet coke is used as a fuel. Other critical equipment in the textile process includes Jet dyeing, Kier boiling, Jiggers & zero-zero machines.

A typical textile processing unit consists of a boiler of 2-3 tonne capacity which is used to produce steam at a working pressure of 4-5 kg/cm2 and a thermic-fluid heater (thermo-pack) of 1000 U capacity. Pet-coke is commonly used as 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.

Like all manufacturing process, efficiency of a unit depends on the performance and efficiency of key technologies installed. The assignment envisages development of cluster specific 'Best Operating Practices (BOPs)' for the top 5 energy intensive equipment/process in the industry cluster on the basis of:

- process/technology used in the cluster
- energy audits conducted in 11 textile units in the cluster

Based on the outcome of the energy audits in 11 units under Pali textile cluster, following 5 technologies has been identified as key energy intensive technologies and best operating practices corresponding to these technologies has been listed under subsequent chapters:

- Boilers
- Kier Boiling unit
- Jet Dyeing unit
- Motors
- Pumps

The list of equipment suppliers discussed with, under the assignment, is placed at ***Annexure 1***.

7.2 BEST OPERATING PRACTICES: BOILERS

7.2.1 Introduction

A boiler is an enclosed vessel that provides a means for combustion and transfers heat to water until it becomes hot water or steam. The hot water or steam under pressure is then usable for transferring the heat to a process. Water is useful and cheap medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment and should be treated carefully.

Liquid when heated up to the gaseous state this process is called evaporation.

The heating surface is any part of the boiler; hot gases of combustion are on one side and water on the other. Any part of the boiler metal that actually contributes to making steam is heating surface. The amount of heating surface of a boiler is expressed in square meters. The larger the heating surface a boiler has, the more efficient it becomes.

Boilers

7.2.2 Operating principle

The basic working principle of boiler is very simple and easy to understand. The boiler is essentially a closed vessel inside which water is stored. Fuel (generally coal) is bunt in a furnace and hot gasses are produced. These hot gasses come in contact with water vessel where the heat of these hot gases transfer to the water and consequently steam is produced in the boiler. The steam is subsequently used in various processes, directly or indirectly.

7.2.3 Use of Boilers in Textile units

Packaged steam boiler is used to generate wet steam required for the process in textile units. Steam is used at a working pressure of 4-5 kg/cm^2. Generally 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.

The steam boiler operating in the unit is a packaged boiler with water 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 these units.

..4 Best operating practices for Boilers

Some practices that are suggested to be followed while operation of boilers is listed below:

➲ BOP 1: Boiler Maintenance

Boiler maintenance must be systematic to minimize energy consumption and downtime due to un-anticipated failures. Responsibility should be assigned for performing and keeping written records with checklists of daily, weekly, monthly and annual maintenance tasks. Maintenance items that you should incorporate into your boiler's routine include inspections, cleaning of fire- and water-side heat transfer surfaces, and insulation upkeep.

A tune-up helps identify and address off-design equipment performance or undesirable site-specific operating practices/constraints before attempting to optimize boiler performance. Negative-draft boilers should be checked for air leakage using smoke-generating sticks, a lighter flame, or ultrasonic equipment. High oxygen readings caused by air leaks can lead operators to reduce the air-to-fuel ratio, resulting in wasted fuel in the stack. Check for steam and water leaks using ultrasonic probes for steam leaks in water-tube boilers. Any boiler with a water storage tank can be checked by shutting off the make-up water supply and observing the water level in the tank over a specified period of time. Prior to testing, the operator must be absolutely certain that low-water cutoff controls are functioning properly.

➲ BOP 2: Air-to-Fuel Ratio

Efficient operation of any combustion equipment is highly dependent on a proper air-to fuel ratio. Due to the mechanics of combustion, it is necessary to provide more air than would be required to provide exactly the right quantity of oxygen (O_2) to burn all the fuel without any O_2 left over. Because air is comprised of approximately 21 percent O_2 and 79 percent nitrogen (N2), in delivering the right amount of O_2, nearly four times as much N_2 is also delivered. Nitrogen absorbs heat and carries it out the stack, resulting in a loss to the system. Minimizing excess air, consistent with complete combustion, minimizes this heat loss. Complete carbon combustion forms carbon dioxide (CO_2) as heat is released. Incomplete combustion forms carbon monoxide (CO) and less than one-third as much heat is released. CO is an un-burned combustible and, in the stack gas, an efficiency loss to the system. Most systems will also display a calculated combustion efficiency value. Even with continuous monitoring of the flue gas, non-optimum air-to-fuel ratios may result due to air leaking in upstream of the analyzer; infrequent or incorrect analyzer calibration; insufficient combustion air supply at full load; or an analyzer placed at a non-representative location.

➲ BOP 3: Combustion Uniformity

Complete combustion at efficient excess air levels requires the fuel and air to be uniformly mixed throughout the primary combustion zone. In multi-burner gas boilers, non-uniform combustion can result if the fuel and air are not evenly distributed due to a malfunctioning burner. The natural tendency when encountering noticeable CO levels is to raise excess air levels for the whole boiler, causing the other burners to operate at unnecessarily high O_2 levels. Uniform combustion can quite often be achieved by simple adjustments to the air register or damper settings. In other cases, further diagnostic testing is required. Considerable insight into combustion uniformity can be obtained by mapping the O_2 profile at the economizer exit. Systems exist that will automatically measure and map O_2 concentrations on a continuous basis. A complete combustion uniformity assessment typically involves an evaluation of combustibles and oxides of nitrogen (NOx) emissions.

➲ BOP 4: Blowdown Management

Blowdown is essential for maintaining low concentrations of dissolved solids in the water (skimming blowdown) or removing solids that have settled out of the water (bottom blowdown). Both practices result in unavoidable energy losses as hot water is wasted to the drain, and a balance must be maintained between acceptable results and energy losses. Skimming blowdown is best used as a continuous process; bottom blowdown is best done periodically as several short blowdowns. Continuous blowdown makes the use of heat recovery devices more feasible.

➲ BOP 5: Load Management

When multiple boilers serve many loads, it is important to manage them as efficiently as possible. Individual boilers achieve maximum efficiency over a specific firing range. Units with high excess air requirements or significant radiation losses at low loads will have peak efficiency at a high load. Boilers with constant excess air levels and small radiation losses over the load range will exhibit peak efficiency at a lower load. Efficiencies should be determined over the full range of firing rates. More efficient boilers should be brought on line first as loads increase, and less efficient units should be taken off-line first as loads drop. Where possible, scheduling of loads can help achieve optimum system performance

➲ BOP 6: Reduce Steam Pressure

To the extent practical, steam should be generated at the lowest pressure that will meet the highest-pressure demand. Less fuel is required and lower stack temperatures result, improving efficiency. Savings may be as much as 1 or 2 percent, but actual savings depend on the starting pressure and the pressure reduction that is realized.

➲ BOP 7: Maintenance of Insulation

The primary mechanism for heat loss through the skin of an uninsulated boiler is radiant heat loss. The higher the temperature of the boiler skin (insulated or not), the greater the radiant heat loss to the surroundings. The first inch of insulation reduces heat loss by about 90 percent. Each additional inch obviously will have much less impact. One rule of thumb is that any surface above 120°F should be insulated, including boiler surfaces, steam or condensate piping and fittings. Removable insulating jackets are available for valves, flanges, pressure-reducing valves, steam traps and other fittings. In addition, damaged, missing or wet insulation should be repaired or replaced.

➲ BOP 8: Energy Savings Feasibility

Look for the following factors to determine how you can improve the efficiency of your boiler system:

- **Too much excess air** will show up as elevated stack temperatures, because the hot gases are being forced through the boiler too quickly, without time for adequate heat transfer. Generally, stack temperature should not be more than 150°F above the temperature of saturated steam at the boiler operating pressure.

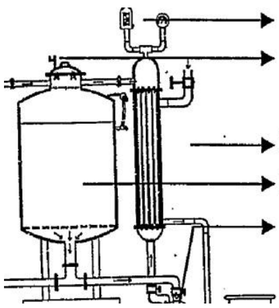
- **Boiler operation** logs should indicate whether excess air is too far out of limits of good practice. Gas-fired boilers should be able to operate at 5 to 10 percent excess air. This range corresponds to 1 to 2 percent O2, 11.9 to 12.3 percent CO2, and, depending on stack temperature, efficiencies of 85.2 to 85.4 percent.
- **On balanced-draft boilers**, normal O_2 readings coupled with high combustibles and/or low stack temperatures may indicate air leakage into the system or air preheater seal leakage, situations that need to be remedied. Air leakage may also be indicated if high O_2 readings are coupled with normal or even low stack temperatures.
- **Missing or degraded insulation** on boiler, steam and condensate lines and fittings.
- **Multiple boilers running at low fire simultaneously** may indicate potential improvements through load management. Low-fire conditions can be determined by asking the operator or comparing steam flow rates, as indicated by gauges or readouts at a control panel, to boiler ratings.

7.3 BEST OPERATING PRACTICES: KIER BOILING UNIT

7.3.1 Introduction

Special purpose machine is a kind of multi-tasking machine used for machining purpose. Kier boiling is a scouring process for cotton and linen in which the fibers are treated for removal of impurities by boiling with a 1% solution of caustic soda. Its main purpose is to remove most of the natural impurities such as wax, wood fragments and oil stains. Kier boiling process of cotton is performed in a kier boiler and the fabric is scoured in rope form by alkali liquor. Kier is a large cylindrical iron vessel. The kier may be open one as closed one and horizontal or vertical.

7.3.2 Operating Principle



Kier boiler is a long mild steel or cast iron cylindrical vessel provided with two perforated tube sheets (disc with a number of holes). One is placed at the bottom and another is top. These discs are connected by a number of tunes which carry the liquor from the bottom compartment to the upper one. In the Unit middle compartment steam is passed. Thus the tubes carrying the liquor are surrounded by steam which heats them.

The hot liquor from the multitublar heater is sprayed over the cloth, packed in the kier, through a hollow perforated ring. The liquid passes slowly over the packed cloth, collects below the false bottom, from where it is pumped into the auxiliary heater by a centrifugal pump and the cycle repeats.

7.3.3 Best operating practices for Kier Boiling Unit

➲ **BOP 1: Temperature control**

Kier boiling unit for scouring 130- 150^{0}C temperature is obtained. So, we have to control the temperature properly. Here gauge glass is used for indicating temperature.

➲ BOP 2: Check valve

Different check valve should be proper maintained, so that if they defective or leakage then greater problem might occur.

➲ BOP 3: Check pipes

If the pipes are rusty and leakage then proper flow wills not obtained. So, we have to maintain them properly.

➲ BOP 4: False bottom

The False bottom should be proper perforated otherwise it will creat more hamper in case of proper scouring.

➲ BOP 5: Steam pipe

We have to maintain proper steam supply by the steam pipe. So, steam pipe will not leakage.

➲ BOP 6: Water pipe

We have to maintain proper flow of proper flow of water in pipe. So, it will not be rusty or leakage

Float traps

➲ BOP 1: Choose Trap Locations Carefully

Even in cases where a steam distribution piping run is set in a straight line, steam traps should always be installed at least every 30 to 50 meters (100 to 160 ft), and at the bottom of risers or drops. Special care must also be taken to install steam traps in locations where there is a chance of condensate pooling so that condensate does not close off the cross-sectional pipe area, possibly causing it to be propelled at exceptionally high velocity.

➲ BOP 2: Provide Proper Support and Inclined Steam Piping

If piping support (e.g. pipe hangers) is set too far apart, the piping can deflect under its own weight. This type of problem can cause condensate to pool at unwanted locations even if piping is set at a slight inclination, so it is important to both:

- Set piping support at appropriate intervals, and
- Set piping at a slope of no less than 1 in 100.

Also, care should be taken when using the eaves of a building to adjust the inclination because the eaves themselves might be slightly inclined, which could adversely affect condensate flow and drainage

➲ BOP 3: Pay Attention to Drip Leg (Drain Pocket) Configuration

Steam trap connection sizes for applications other than heating or process typically range between 15 mm (1/2 in) and 25 mm (1 in). In some cases, piping of the same diameter as the steam trap is used to directly connect the trap to the steam line. However, this practice is not recommended in most cases because if the steam line is of a significantly larger diameter, then it is possible that rapidly flowing condensate cannot easily drop and enter into the rather narrow opening and will instead mostly pass by the collecting leg. Instead, properly sized, wider piping called a drip leg (collecting leg, or drain pocket) is typically installed to help enable the efficient and effective removal of condensate.

Sample guidelines for drip leg sizes are available in the table below. Also, the connection between the piping and drip leg should be set roughly 50 to 100 mm (2 in to 4 in) from the bottom of the drip leg to help prevent dirt and scale within the condensate from flowing into the trap. With this type of setup, a blowdown valve is usually installed on the mud leg cover to allow for dirt removal.

Guidelines for Drip Leg Dimensions

Main Diameter	Pocket Diameter	Pocket Depth (Automatic Start-up)
50 mm (2 in)	50 mm (2 in)	700 mm (28 in)
100 mm (4 in)	100 mm (4 in)	700 mm (28 in)
250 mm (10 in)	150 mm (6 in)	700 mm (28 in)
500 mm (20 in)	250 mm (10 in)	750 mm (28 in)

When sizing a drip leg, design with sufficient volume for the mud leg portion, and also for the back-up portion between cycles. The collecting leg can be especially important on start-up operation where slugs of condensate from warming up the piping or condensate released from previously closed valves can be experienced.

➲ BOP 4: Properly Remove Air and Condensate at End of Steam Line

At the end of steam distribution lines, it is important to remove the air that was initially present in the piping at start-up. Also, it is just as important to set up a drip leg for condensate drainage at the end of steam lines as it is for the other sections of the steam main.

To summarize, efficient removal of condensate requires at least the following:

- Carefully choosing steam trap locations
- Providing proper support and inclining the steam piping
- Configuring drip legs to allow for the smooth removal of condensate
- Properly removing air and condensate at end-of-lines

Because safety is an extremely important concern with steam piping configuration, always be certain to consult a steam specialist such as TLV when not sure how to proceed.

7.4 BEST OPERATING PRACTICES: JET DYEING UNIT

7.4.1 Introduction

Jet dyeing Machine generally used for dyeing fabric, dyeing polyester, dyeing clothe and others type of dyeing. Jet m/c resembles becks in that a continuous loop of fabric is circulated through the machine. There are different types of dyeing technique applied in dyeing machine like disperse dyes, reactive dyes, vat dyes, acid dyes, organic dyes etc. After Jet m/c fabric goes for Slitting Machine.

7.4.2 Operating Principle

In this machine, the dye tank contains disperse dye, dispersing agent, leveling agent and acetic acid. The solution is filled up in the dye tank and it reaches the heat exchanger where the solution will be heated which then passed on to the centrifugal pump and then to the filter chamber.

The solution will be filtered and reaches the tubular chamber. Here the material to be dyed will be loaded and the winch is rotated, so that the material is also rotated. Again the dye liquor reaches the heat exchanger and the operation is repeated for 20 to 30 minutes at 1350C. Then the dye bath is cooled down, after the material is taken out. Metering wheel is also fixed on winch by external electronic unit. Its purpose is to record the speed of the fabric. The thermometer, pressure gauge is also fixed in the side of the machine to note the temperature and pressure under working. A simple device is also fixed to note the shade under working.

Jet Dyeing unit

7.4.3 Best operating practices for Jet Dyeing Unit

Some practices that are to be followed while operation of jet dyeing unit is listed below:

Condensate recovery System

➲ **BOP 1: Maintenance**

A reasonable condensate system design specification is to provide a reliable and long operational life span of twenty plus years without a primary condensate system failure. Plant personnel must assume that the designs of condensate systems shall include reasonable maintenance and plant services. Certainly, lacking a proactive maintenance plan will reduce the anticipated lifespan of the condensate system.

➲ **BOP 2: Materials**

The condensate pipelines themselves are potentially subjected to a damaging corrosive element in the form of carbonic acid. The recommended material to use for a condensate system is stainless steel. Stainless steel greatly enhances the pipes ability to withstand the corrosive attack and therefore can provide a long reliable operational life. However, understanding the cost limitations to an all stainless steel condensate system, other alternatives are available. If carbon steel piping is used for economical consideration, schedule 80 pipe is used because of the heavier wall thickness which prolongs the life of the pipe in a corrosive environment.

➲ BOP 3: Connection Types

Welding the condensate pipe or using tubing with tube connectors will minimize leaks. Condensate pipe will expand and contract during normal thermal cycling of a steam system operation. Unfortunately; steam component manufacturers provide a large number of components with threaded (NPT) connections. The threaded connections are inherently a weak point in the steam/condensate system and will be the first item attacked by the corrosive carbonic acid, particularly the threads near the bottom of the pipe. Also, the threaded connections do not have the ability to withstand the expansion and contraction of the steam/condensate system, therefore leaks will occur.

The most common condensate piping connections are listed below in order of preference:

- Welded joints
- Tube material with tube connectors
- Flanges
- Threaded pipe only when necessary

➲ BOP 4: Pipe vs. Tubing

Tubing is an acceptable method of piping, yet it is typically underutilized. Tubing provides an improved connection of steam components and other devices in the system. Welding smaller pipe sizes is time consuming and expensive. Using tubing material reduces the number of welds that are needed in an installation.

➲ BOP 5: Maintainability

Most mechanical systems operate at peak performance levels following a new installation. However, it is the design of the system's maintainability which really determines the resiliency and reliability of the system. The system's components, including piping, tubing, steam traps, condensate pumps, etc., must be designed and installed with the consideration of how maintenance will be accomplished. Frankly, if the devices are not accessible by plant personnel, there will be little or no maintenance performed and the overall system integrity will deteriorate.

➲ BOP 6: Condensate Pipe/Tubing Sizing

Correct sizing of condensate lines is calculated differently from sizing other fluids transferred in pipes. Although condensate is hot water, sizing a condensate line as if it were hot water would result in an undersized line. Undersized condensate lines will create excessive backpressure in the system and problems (maintenance and process) will occur in the system.

The key item to remember is that there are two major differences between condensate and hot water. Condensate lines will contain two phases, condensate (liquid) and flash steam (gas.) Therefore, the correct size of a condensate line is somewhere between a hot water line and a steam line. With proper knowledge, a condensate line may be sized for the following:

- Condensate liquid load
- Flash steam load
- Neglect factor

This is defined as steam loss resulting from faulty steam traps or open bypass valves. This is more common in systems than typically acknowledged. Blow-by steam will add steam flow to the return line and must be included in the calculations.

Condensate that is free of flash steam may be pumped and sized as liquid only (single phase flow).

Condensate pipe velocities (liquid and flash steam) must be lower than 4500 feet per minute to prevent system water hammer and other damaging effects. Condensate piping velocities (liquid only) must be lower than 7 feet per second.

➲ BOP 7: Connecting into the Condensate Header

It is imperative that all condensate branch lines are connected into the top dead center of the main condensate header on a horizontal plane. This cannot be overstated and there is no exception to this rule.

Improper condensate connections are listed below:

- Connection to the bottom of a condensate header.
- Connection to the side of a condensate header.
- Connection to a vertical condensate header.

The condensate connections listed above will cause system problems. The primary issue or problem will be water hammer that will result from the improper connection location. Flash steam introduced to the main condensate header due to an improper connection location will interact with cooler condensate causing water hammer. Water hammer is the leading cause of premature **component failures in a steam/condensate system.**

➲ BOP 8: Pressure gauges

Finally, a note regarding pressure gauges. These devices, when properly installed in the condensate return system are a great advantage to assisting in identifying the process and steam system malfunctions. If pressure gauges are not installed, always put the necessary taps in the system for a pressure gauge. This will allow maintenance personnel to install a gauge during troubleshooting procedures. It is necessary to include a siphon pipe (pigtail) and isolation valve with each pressure gauge. The isolation valve must be rated for the pressure and temperature of the operating system. Additionally, a liquid filled pressure gauge will be more resilient to system vibrations.

Float traps

➲ BOP 1: Choose Trap Locations Carefully

Even in cases where a steam distribution piping run is set in a straight line, steam traps should always be installed at least every 30 to 50 meters (100 to 160 ft), and at the bottom of risers or drops. Special care must also be taken to install steam traps in locations where there is a chance of condensate pooling so that condensate does not close off the cross-sectional pipe area, possibly causing it to be propelled at exceptionally high velocity.

➲ BOP 2: Provide Proper Support and Inclined Steam Piping

If piping support (e.g. pipe hangers) is set too far apart, the piping can deflect under its own weight. This type of problem can cause condensate to pool at unwanted locations even if piping is set at a slight inclination, so it is important to both:

- Set piping support at appropriate intervals, and
- Set piping at a slope of no less than 1 in 100.

Also, care should be taken when using the eaves of a building to adjust the inclination because the eaves themselves might be slightly inclined, which could adversely affect condensate flow and drainage

➲ BOP 3: Pay Attention to Drip Leg (Drain Pocket) Configuration

Steam trap connection sizes for applications other than heating or process typically range between 15 mm (1/2 in) and 25 mm (1 in). In some cases, piping of the same diameter as the steam trap is used to directly connect the trap to the steam line. However, this practice is not recommended in most cases because if the steam line is of a significantly larger diameter, then it is possible that rapidly flowing condensate cannot easily drop and enter into the rather narrow opening and will instead mostly pass by the collecting leg. Instead, properly sized, wider piping called a drip leg (collecting leg, or drain pocket) is typically installed to help enable the efficient and effective removal of condensate.

Sample guidelines for drip leg sizes are available in the table below. Also, the connection between the piping and drip leg should be set roughly 50 to 100 mm (2 in to 4 in) from the bottom of the drip leg to help prevent dirt and scale within the condensate from flowing into the trap. With this type of setup, a blowdown valve is usually installed on the mud leg cover to allow for dirt removal.

Guidelines for Drip Leg Dimensions

Main Diameter	Pocket Diameter	Pocket Depth (Automatic Start-up)
50 mm (2 in)	50 mm (2 in)	700 mm (28 in)
100 mm (4 in)	100 mm (4 in)	700 mm (28 in)
250 mm (10 in)	150 mm (6 in)	700 mm (28 in)
500 mm (20 in)	250 mm (10 in)	750 mm (28 in)

When sizing a drip leg, design with sufficient volume for the mud leg portion, and also for the back-up portion between cycles. The collecting leg can be especially important on start-up operation where slugs of condensate from warming up the piping or condensate released from previously closed valves can be experienced.

➲ BOP 4: Properly Remove Air and Condensate at End of Steam Line

At the end of steam distribution lines, it is important to remove the air that was initially present in the piping at start-up. Also, it is just as important to set up a drip leg for condensate drainage at the end of steam lines as it is for the other sections of the steam main.

To summarize, efficient removal of condensate requires at least the following:

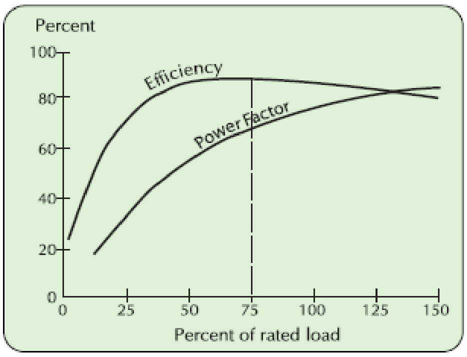
- Carefully choosing steam trap locations
- Providing proper support and inclining the steam piping
- Configuring drip legs to allow for the smooth removal of condensate
- Properly removing air and condensate at end-of-lines

Because safety is an extremely important concern with steam piping configuration, always be certain to consult a steam specialist such as TLV when not sure how to proceed

7.5 BEST OPERATING PRACTICES: MOTORS

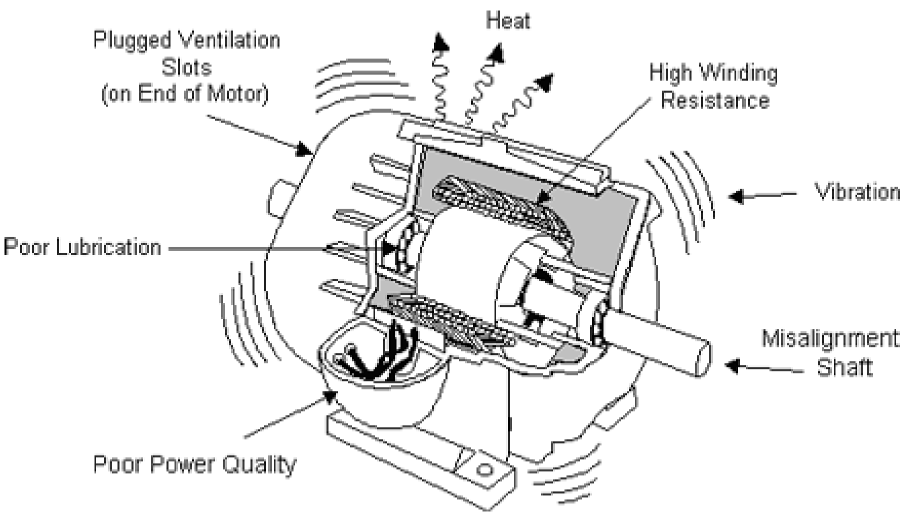
7.5.1 Introduction

Electrical motors are the principal source of motive power in any textile unit. Machine tools, auxiliary equipment and other utilities come equipped with one or more electric motors. A machine tool can have several electric motors other than the main spindle motor. These are used for allied operations. Motors are generally efficient, but their efficiency and performance depends on the motor load. Figure 5.1 shows the variation in efficiency and power factor vis-à-vis the total load, for a typical motor.



Motor efficiency / power factor vs load curve

Since there are many different types of motors in a textile unit, it is very important to maintain them and adopt proper operating practices. As they run for years, motors can become less efficient because of wear, breakdown of lubricants, and misalignment. Good motor-maintenance practice helps avoid or postpone these problems. A lack of maintenance can reduce a motor's energy efficiency and increase unplanned downtime. Scheduled maintenance is the best way to keep the motors operating efficiently and reliably.

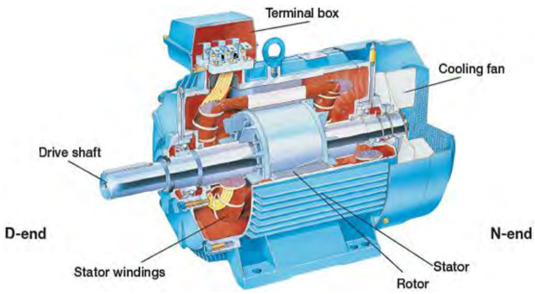


Operational problems of a motor

7.5.2 Types of motors

➲ Induction motors

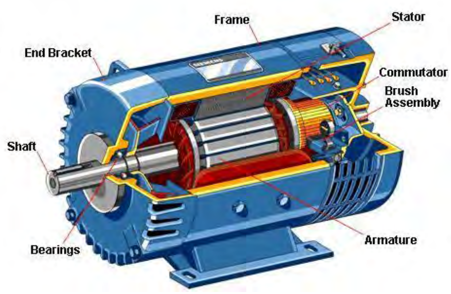
Induction motors are the most commonly used prime mover for various equipment in industrial applications. In induction motors, the induced magnetic field of the stator winding induces a current in the rotor. This induced rotor current produces a second magnetic field, which tries to oppose the stator magnetic field, and this causes the rotor to rotate. The 3-phase squirrel cage motor is the workhorse of industry; it is rugged and reliable, and is by far the most common motor type used in industry. These motors drive pumps, blowers and fans, compressors, conveyers and production lines. The 3-phase induction motor has three windings each connected to a separate phase of the power supply.



Sectional view: induction motor

➲ Direct-Current motors

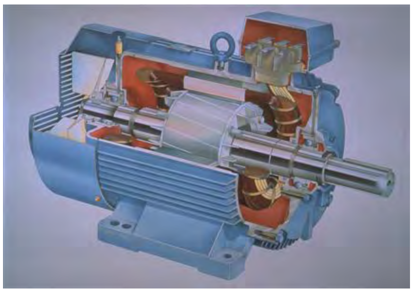
Direct-Current (DC) motors, as the name implies, use direct-unidirectional, current. Direct current motors are used in special applications- where high torque starting or where smooth acceleration over a broad speed range is required.



Sectional view: DC motor

➲ Synchronous motors

Synchronous Motor is called so because the speed of the rotor of this motor is same as the rotating magnetic field. It is basically a fixed speed motor because it has only one speed, which is synchronous speed and therefore no intermediate speed is there or in other words it's in synchronism with the supply frequency Alternating Current (AC) power is fed to the stator of the synchronous motor. The rotor is fed by DC from a separate source. AC power is fed to the stator of the synchronous motor. The rotor is fed by Direct Current (DC) from a separate source. The rotor magnetic field locks onto the stator rotating magnetic field and rotates at the same speed. The speed of the rotor is a function of the supply frequency and the number of magnetic poles in the stator. While induction motors rotate with a slip, i.e., rpm is less than the synchronous speed, the synchronous motor rotate with no slip, i.e., the Revolutions Per Minute (RPM) is same as the synchronous speed governed by supply frequency and number of poles. The slip energy is provided by the D.C. excitation power.



Synchronous Motors

7.5.3 Best operating practices for motors

BOP 1: Replace, rather than rewind, motors when appropriate

Motors are generally repaired more than once, with a typical loss of nearly 2 % in efficiency at each rewind. These motors are generally less efficient than their nominal ratings, and must be replaced appropriately. It is more common to rewind larger motors due to their high capital cost. But these motors usually operate at very high duty, and even a modest efficiency improvement may make it worthwhile to replace them with new, premium-efficiency motors rather than repair them.

BOP 2: Use appropriately sized motors for replacement

- Many motors are oversized for their applications, resulting in poor motor efficiency and excessive energy use. Always use motors sized according to the requirement of the load. It is good practice to operate motors between 75 -100 % of their full load rating because motors run most efficiently near their designed power rating.
- When replacing motors, always buy energy efficient motors instead of conventional motors. The cost of energy consumed by a conventional motor during its life is far greater than the incremental cost of the energy efficient motor.

BOP 3: Ensure voltage balance across motor terminals

A properly balanced voltage supply is essential for a motor to reach its rated performance. An unbalanced three-phase voltage affects a motor’s current, speed, torque, and temperature rise. Equal loads on all three phases of electric service help in assuring a voltage balance while minimizing voltage losses. The options that can be exercised to minimize voltage unbalance include:

- Balancing any single phase loads equally among all the three phases
- Segregating any single phase loads which disturb the load balance and feed them from a separate line / transformer

BOP 4: Reducing under-loading

Probably the most common practice contributing to sub-optimal motor efficiency is that of under-loading. Under-loading results in lower efficiency and power factor, and higher-than-necessary first cost for the motor and related control equipment.

- Carefully evaluate the load that would determine the capacity of the motor to be selected.

- For motors, which consistently operate at loads below 40 % of rated capacity, an inexpensive and effective measure might be to operate in star mode. A change from the standard delta operation to star operation involves re-configuring the wiring of the three phases of power input at the terminal box
- Motor operation in the star mode is possible only for applications where the torque-to-speed requirement is lower at reduced load.
- For applications with high initial torque and low running torque needs, Del-Star starters are also available in market, which help in load following derating of electric motors after initial start-up.

BOP 5: Regular up-keep

Properly selected and installed motors can operate for many years with minimal maintenance. Nonetheless, regular care will extend their life and maximize their energy efficiency. A list of such practices and measures is presented below.

- Clean motor surfaces and ventilation openings periodically. Heavy accumulations of dust and lint will result in overheating and premature motor failure.
- Properly lubricate moving parts to avoid unnecessary wear. Be sure to apply appropriate types and quantities of lubricant. Applying too little or too much can harm motor components.
- Keep motor couplings properly aligned. Correct shaft alignment ensures smooth, efficient transmission of power from the motor to the load. Incorrect alignment puts strain on bearings and shafts, shortening their lives and reducing system efficiency.
- Check motor for over-heating and abnormal noises/sounds, sparking and ensure proper bedding of brushes.
- Tighten belts and pulleys to eliminate transmission losses.

BOP 6: Install variable frequency drives

Motors frequently drive variable loads such as pumps, hydraulic systems and fans. In these applications, the motors' efficiency is often poor because they are operated at low loads. It is appropriate to use a Variable Frequency Drive (VFD) with the motor.

VFD in motors

BOP 7: Install capacitor banks

Induction motors are characterized by power factors less than unity, leading to lower overall efficiency (and higher overall operating cost) associated with a plant's electrical system.

- Install capacitors banks across motors with a high rating to reduce the distribution losses.
- Capacitors connected in parallel (shunted) with the motor are typically used to improve the power factor.
- The size of capacitor required for a particular motor depends upon the no-load reactive kVA (kVAR) drawn by the motor, which can be determined only from no-

load testing of the motor. In general, the capacitor is selected to not exceed 90 % of the no-load kVAR of the motor. (Higher capacitors could result in over-voltages and motor burnouts)

7.6 BEST OPERATING PRACTICES: PUMPS

7.6.1 Introduction

Pumps used in textile industries are centrifugal type. The main function of the pump is to convert energy of a prime mover into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. Improvements in efficiency of pumping systems can also:

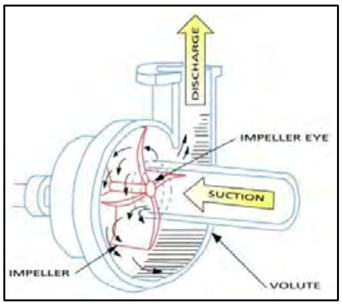
- Reduce energy costs
- Reduce maintenance requirements
- More closely match pumping system capacity to production requirements.

Centrifugal pump

7.6.2 Efficient pumping system operation

To understand a pumping system, one must realize that all of its components are interdependent. When examining or designing a pump system, the process demands must first be established and most energy efficient solution introduced. For example, does the flow rate have to be regulated continuously or in steps? Can on-off batch pumping be used? What are the flow rates needed and how are they distributed in time?

The first step to achieve energy efficiency in pumping system is to target the end-use. A plant water balance would establish usage pattern and highlight areas where water consumption can be reduced or optimized. Good water conservation measures, alone, may eliminate the need for some pumps.



Sectional view of a pump

Once flow requirements are optimized, then the pumping system can be analysed for energy conservation opportunities. Basically this means matching the pump to requirements by adopting proper flow control strategies. Common symptoms that indicate opportunities for energy efficiency in pumps are given in the table below:

Symptoms that indicate potential opportunity for energy savings

Symptoms	Likely reason	Best solutions
Throttle valve-controlled systems	Oversized pump	Trim impeller, smaller impeller, variable speed drive, two speed drive, lower rpm
Bypass line (partially or completely) open	Oversized pump	Trim impeller, smaller impeller, variable speed drive, two speed drive, lower rpm

Symptoms	Likely reason	Best solutions
Multiple parallel pump system with the same number of pumps always operating	Pump use not monitored or controlled	Install controls
Constant pump operation in a batch environment	Wrong system design	On-off controls
High maintenance cost *seats, bearings)	Pump operated far away from BEP	Match pump capacity with system requirement

7.6.3 Best operating practices for pumps

➲ BOP 1: Location of pump

The location of pump plays a significant role in energy consumption pattern for pumping unit. Guidelines for efficient pumping system are:

- Ensure adequate Net Positive Suction Head (NPSH) at site of installation
- Operate pumps near best efficiency point.
- Avoid pumping head with a free-fall return (gravity);
- Reduce system resistance by pressure drop assessment and pipe size optimization

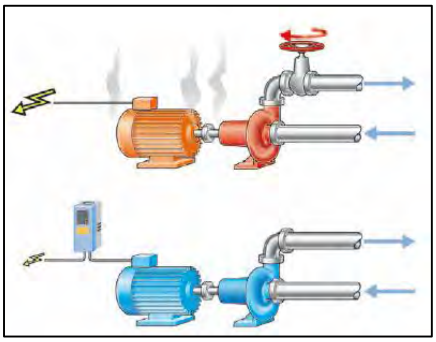
➲ BOP 2: Measurement and control

The pump efficiency can be determined by regular monitoring of key performance parameters like pressure, discharge flow etc.

- Ensure availability of basic instruments at pumps like pressure gauges, flow meters.
- Modify pumping system and pumps losses to minimize throttling.
- Repair seals and packing to minimize water loss by dripping.
- Balance the system to minimize flows and reduce pump power requirements.

➲ BOP 3: Use of variable speed drives

- Adapt to wide load variation with variable speed drives or sequenced control of multiple units.
- Stop running multiple pumps - add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.



Pictorial depiction of use of VFDs in pumps

➲ BOP 4: Pumping system design consideration

The efficiency of the pumps depends predominately by the design of the pumping system and selection of pumps of right capacity.

- Increase fluid temperature differentials to reduce pumping rates in case of heat exchangers.
- Conduct water balance to minimise water consumption
- Avoid cooling water re-circulation in DG sets, air compressors, refrigeration systems, cooling towers feed water pumps, condenser pumps and process pumps.

- In multiple pump operations, carefully combine the operation of pumps to avoid throttling
- Provide booster pump for few areas of higher head
- Replace old pumps by energy efficient pumps
- In the case of over designed pump, provide variable speed drive, or downsize / replace impeller or replace with correct sized pump for efficient operation.
- Optimise number of stages in multi-stage pump in case of head margins
- Reduce demand on Pumping System: Demand on pumping system can be reduced by:
    - Reducing consumption
    - Reducing leaks
    - Lowering pumping system flow rate
    - Lowering the operating pressure
    - Operating the system for a shorter period of time each day
    - Having the system off when not needed.

7.6.4 Do's and Don'ts in pump operation

The common dos and don'ts for efficient pumping operations are:

Summary of best operating practices for efficient operation of motors in textile units

Do's	Don'ts
• Replace throttling valves with speed controls	• Do not use inefficient pumps
• Reduce speed for fixed load	• Avoid pumping head with a free return (gravity)
• Replace motor with a more efficient motors	• Avoid water loss by dripping
• Ensure adequate NPSH at site of installation	• Stop running multiple pumps - add an auto-start for an on-line spare or add a booster pump in the problem area.
• Provide metering of components (such as flows, kWh)	• Avoid inadequate NPSH
• Operate pumps near best efficiency point	• Do not run the system when not needed
• Use booster pumps for small loads requiring higher pressures	• Avoid over loading the pump system

CHAPTER 10

Common Monitorable Parameters

C H A P T E R 10

Common Monitorable Parameters

8.1 COMMON MONITORABLE PARAMETER: A BRIEF

The project envisaged listing of common regularly monitorable parameters at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same. These monitorable parameters are considered basic necessity for controlling a unit's energy performance and maintaining overall efficiency. The methodology adopted for identification of the common monitorable parameter for the cluster is as follows:

- Detailed energy audits in selected units were carried out to comprehend the detailed process being adopted in the textile units and identify scope for energy saving potential.
- Along the same lines, mainly energy consuming process wise common monitorable parameters were identified. These common monitorable parameters have direct relationship with the energy performance of the unit. The values of these common monitorable parameters indicate the health and predict the behavior of any process.
- Instruments to measure these common monitorable parameters were identified subsequently. While developing the common monitorable parameter, the existing operating conditions and limitations of the units were considered.
- The suggested measures and instruments follow a set of basic necessity which every unit should follow. However, depending of development of the unit, the scope of monitoring parameters may to be extended in order to ensure a meticulous control of all performance related parameter of the unit.

The key process involved in a typical textile unit are desizing and mercerizing of raw material. Subsequently, the fabric is fed into the Kier Boiler where scouring operations takes place, then the fabric undergoes bleaching followed by Air Drying (Adan). The next step is coloring of the fibre using jigger or jet dyeing method. This is followed by the finishing process where the material fabric undergoes pre-shrinking in a zero-zero machine. Although, this is a typical layout, other process improvement methods are used, as per requirement, by different units. The Fabric is now ready for dispatch. The key process involved in the textile units are:

- Producing steam for processing of fibre using boiler
- Scouring & coloring using jiggers or jet dyeing machines
- Pre shirking the garment using zero- zero machine

The parameters listed under subsequent sections of the document highlights the key performance parameter which needs to be regularly monitored by the shop-floor and supervisory level. These parameters have direct relation with the unit's energy consumption. In order to be energy efficient, each unit should have a regular monitoring system. The ranges provided against each parameter provide a guideline to the operator / supervisor to follow consistent plant performance criteria.

8.2 COMMON MONITORABLE PARAMETER: BOILER

Packaged steam boiler is used to generate wet steam required for the process in textile units. Steam is used at a working pressure of 4-5 kg/cm2. Generally 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.

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.

In conventional system, the feed water to the boiler is fed at ambient temperature (35^{0}C) while the stack temperature goes as high as 240 ^{0}C.

The flue gas temperature leaving at 240^{0}C from the boiler can be recovered using an economizer. This can further be utilized to pre-heat the boiler feed water. 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.

The key parameter to be monitored during the boiler operation is monitoring the flue gas temperature and the inlet of the pre heated water temperature.

Parameter	**Temperature of flue gas (for Boiler)**
Criticality	To assess the flue gas temperature leaving at 240^{0}C from the boiler
Frequency of monitoring (suggested)	During each operational cycle
Measuring Instruments	Pyrometer
Range	350~700^{0}C

Parameter	**Inlet water temperature (for Boiler)**
Criticality	To assess the flue gas temperature leaving at 240^{0}C from the boiler
Frequency of monitoring (suggested)	During each operational cycle
Measuring Instruments	Temperature gauge
Range	60-70 ^{0}C

A sample log-book template for melting process is presented below:

Parameter	**Temperature of flue gas (^{0}C)**	**Water temperature (^{0}C)**	**Pet coke consumption kgs**	**Supervisor Signature**	**Remarks**
Range	350~700^{0}C	60-70 ^{0}C			
Date / Time					

8.2.1 Local Service providers

The following section provides details of local suppliers for digital Non-contact Optical Pyrometer and Ammeter/Clamp Meter that can be used for measuring Metal Pieces temperature and current in Induction Furnace:

Equipment Name / Reference	Application	Tentative Cost	Supplier
Digital Non-contact Optical Pyrometer	Measurement of flue gas temperature Temperature Range: 350°C - 700°C	INR 30,000 – 50,000	**Tempsens Instruments (i) Pvt Ltd** B-188 A, Road No.5 , Mia Udaipur, Rajasthan- 313003, India Phone : +91-294-3057700 Fax : +91-294-3057750 E-mail : info@tempsens.com Website: www.tempsens.com
			Toshniwal Industries Private Limited Industrial Estate, Makhupura, Rajasthan-305002, India Phone +91-145-6601111
			Babita Electronics Address: 75-A, Gurudwara road, suraj pole, Pali, Rajasthan Cell :+91- 9983410222/ +91-9214024937
Temperature Gauge	60-70 ^{0}C	INR 1500-2000 /piece	**Pioneer Industrial Instruments** Regd Office And Factory, Sr No 82/4, M No 1129, NDA Road, Kalupur, Ahmedabad – 380001 Cell:+91-8879157395
			Care Process Instruments No 6, 2nd Floor, Shree Hari Complex, Vatva GIDC, Ahmedabad - 382445, Near Kamal Estate, Phase 1 +91-79-40081550 +91-79-40083469

8.3 COMMON MONITORABLE PARAMETER: MERCERIZED MACHINE/ WASHING RANGE

In most of the textile units washing range for washing of printed fabrics. This washing operation is done in high temperature, with recommended range between 60-80^{0}C. However, the process is manually controlled presently with no control on temperature of water for washing.

In order to maintain the correct temperature profile in the washing 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 washing range and control the flow of steam by a pneumatically operated valve. This will be lead to optimum utilization of steam in the washing range thus leading to a substantial energy savings.

The following sections summarize the criticality, frequency of monitoring, instruments to be used and reference range for monitoring:

Parameter	Temperature
Criticality	Excess temperature causes energy wastage and lesser temperature will reduce the quality of material
Frequency of monitoring suggested)	Automatic
Measuring Instruments	Automatic temperature control system
Range	70^{o}c to 100 ^{o}c

A sample log-book template for Re-heating Furnace is presented below:

Parameter	Temperature (^{0}C)	Supervisor signature	Remarks
Range	70^{o}c to 100 ^{o}c		
Date / Time			

8.3.1 List of local suppliers:

The following section provides details of local suppliers for thermocouple for measuring furnace temperature:

Equipment Name / Reference	Application	Tentative Cost	Supplier
Automatic temperature control system	Measurement of different zones in machine	INR 15,000 per piece	**Micon Automation Systems Private Limited** Address: A-814, Siddhi Vinayak Towers, Off S. G. Road Behind DCP Office, Makarba Ahmedabad – 380051 +91-8079452461
			Electrocom Technology India Limited Address: 505, Sukhsagar Complex, Nr. Hotel Fortune Landmark, Ashram Road, Ahmedabad - 380013. +91-79-27562400 (Multiline) +91-79-64505103
			Micro Systems & Controls 140A, Santoshpur Avenue, Kolkata 700075, West Bengal, India Ph: +91-33-24163135 /+91-33-24168933 Mobile:+91-09830058416

8.4 COMMON MONITORIAL PARAMETER: JIGGERS

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.

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.

The following section describes the monitoring, measuring instruments to be used for measurement of temperature in jiggers:

Parameter	Temperature
Criticality	Excess temperature causes energy wastage and lesser temperature will reduce the quality of material
Frequency of monitoring suggested)	Automatic
Measuring Instruments	Automatic temperature control system
Range	70^{o}c to 100 ^{o}c

A sample log-book template for Re-heating Furnace is presented below:

Parameter	Temperature (^{0}C)	Supervisor signature	Remarks
Range	70^{o}c to 100 ^{o}c		
Date / Time			

8.4.1 List of local suppliers

The following section provides details of local suppliers for thermocouple for measuring furnace temperature:

Equipment Name / Reference	Application	Tentative Cost	Supplier
Automatic temperature control system	Measurement of different zones in machine	INR 15,000 per piece	**Micon Automation Systems Private Limited** Address: A-814, Siddhi Vinayak Towers, Off S. G. Road Behind DCP Office, Makarba, Ahmedabad – 380051 +91-8079452461
			Electrocom Technology India Limited Address: 505, Sukhsagar Complex, Nr. Hotel Fortune Landmark, Ashram Road, Ahmedabad - 380013. +91-79-27562400 (Multiline) +91-79-64505103

Equipment Name / Reference	Application	Tentative Cost	Supplier
			Micro Systems & Controls 140A, Santoshpur Avenue, Kolkata 700075, West Bengal, India Ph: +91-33-24163135 /+91-33-24168933 Mobile:+91-09830058416

8.5 COMMON MONITORIAL PARAMETER: MOTORS

A typical textile unit consists of several motors of different size and capacity installed in different areas. Most of the motors are in the range of 5 to 7.5 HP and operated depending on requirements. During the energy audits, it was observed that most of these motors are overloaded. Overloading can lead to overheating of the motors and may lead to its failure. It was recommended to replace these undersized motors with motors according to load requirement and they may be air-cooled. It was further suggested to install capacitor banks across motors having low power factor. In order to maintain the optimum efficiency of the motor, it is important to regularly monitor its key parameters.

Parameter	**Voltage**
Criticality	Operation of a motor on a continuous basis at either the high extreme or the low extreme voltage will shorten the life of the motor.
Frequency of monitoring (suggested)	Daily
Measuring Instruments	Voltmeter
Range	±5% of rated voltage

Parameter	**Current**
Criticality	The problem of over current has many symptoms and can eventually lead to permanent damage to the motor or electrical device. A few of the symptoms of over current in a motor are shorts, blown fuses and unintended switching on and off of the motor
Frequency of monitoring (suggested)	Daily
Measuring Instruments	Ammeter
Range	±5% of rated current

Parameter	**Speed**
Criticality	Running a motor above its rated speed can damage the motor permanently.
Frequency of monitoring (suggested)	Daily
Measuring Instruments	Tachometer
Range	As per manufacturer's recommendation

Parameter	**Power Factor**
Criticality	Since reactive power does not perform any work, PF indicates the percentage of useful energy from the total energy — and is best when it's as close to unity as possible. Low PF can contribute to low efficiency, higher losses, and unnecessary electric utility charges.

Frequency of monitoring (suggested)	Daily
Measuring Instruments	Clamp Meter

A sample log-book template for monitoring motor performance is presented below:

<table>
<tr><th>Parameter</th><th>Voltage (volt)</th><th>Current (amp)</th><th>Power factor</th><th rowspan="2">Supervisor Signature</th><th rowspan="2">Remarks</th></tr>
<tr><th>Range</th><td>±5% of rated voltage</td><td>±5% of rated current</td><td>Close to unity</td></tr>
<tr><th>Date /Time</th><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

8.5.1 List of local suppliers

The following section provides details of local suppliers for Ammeter / Clamp Meter for measuring parameters of motor:

<table>
<tr><th>Equipment Name / Reference</th><th>Application</th><th>Tentative Cost</th><th>Supplier</th></tr>
<tr><td></td><td rowspan="3">Measurement of current drawn</td><td rowspan="3">INR 2500-3000 /piece</td><td>Babita Electronics
Address :75-A, Gurudwara road, suraj pole, Pali
+91-9983410222/9214024937</td></tr>
<tr><td rowspan="2"></td><td>Maa Shree Yadey Electrical
Address: 22S, Nakora Market, Mandia Road, Pali Tel: +91-9829973510</td></tr>
<tr><td>Puran Electric
Address: Shop No. 4, Mandia road, Guldai Marg, Near OBC Bank, Pali
Tel: +91- 9414122287</td></tr>
</table>

CHAPTER 9

Case Studies

C H A P T E R 9

Installation of Air Preheater & Economizer in Boiler/thermic fluid heater

– A Case Study

Pali Textile Cluster

ABOUT THE CLUSTER

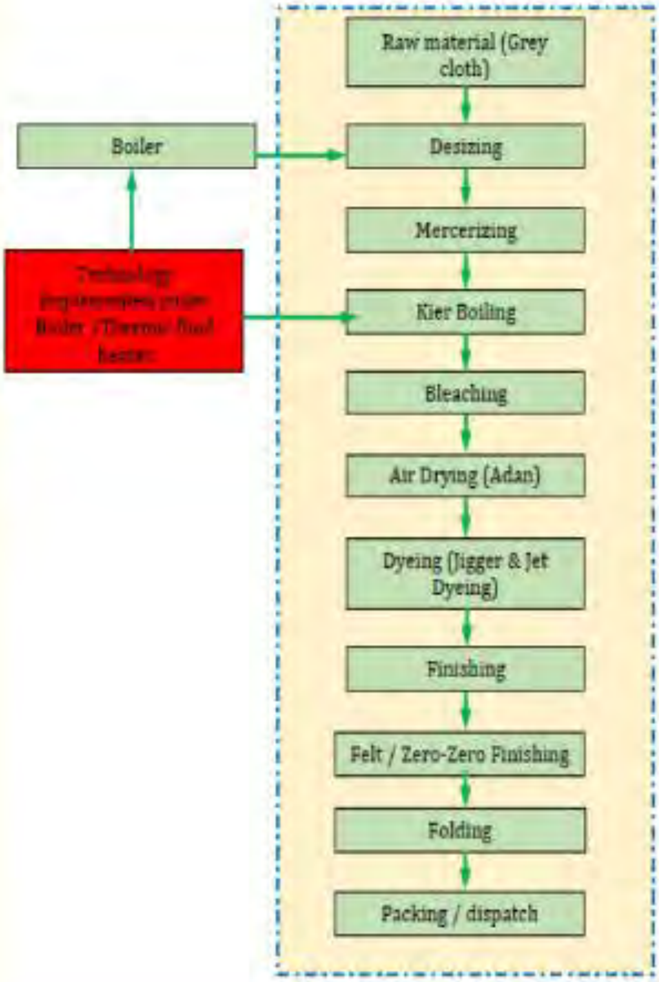
The Pali textile cluster is one of the biggest SME clusters in India having over 250 member industries. The units in the cluster are mainly located in two Industrial Areas namely Industrial Area Phase I & Phase II and Mandia Road Industrial Area.

The units are classified into two segments mainly: 1) Hand Process Units 2) Power Process Units.

ABOUT THE UNIT

Simandhar Fabtex (P) Ltd., Pali, was established in the year 2000 and is engaged in processing of cotton cloth which includes raw cloth (grey) processing, dyeing and finishing operations. The manufacturing unit is located at F-168/168A, Mandia Road, Pali, Rajasthan. The raw material procured by the unit includes grey (raw cloth) purchased from various sources predominantly from Gujarat and Maharashtra. The daily production lies in the range of 70,000 to 1,20,000 meters of processed cloth per day. The major energy usage in the unit includes wet steam (generated from coke fired boiler) and electricity.

PROCESS FLOW



BASELINE SCENARIO

During the baseline energy audit, Simandhar Fabtex (P) Ltd. has installed a steam boiler of 3 tonnes capacity to generate wet steam required for the process. Steam is used at a working pressure of 4-5 kg/cm2. 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.

Figure 1: *Conventional boiler without Economizer & Air pre heater*

The exiting steam boiler does not have provisions of waste heat recovery. The feed water to the boiler is fed at ambient temperature (35ºC) and the stack temperature was observed to be around 180ºC. 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 240ºC. The combustion air to the boiler firing unit is also being fed at ambient temperature (35ºC). No monitoring is being done towards feeding of coke and air into the boiler.

PRESENT SCENARIO

Based on the recommendation made as per the baseline energy audit, the unit has implemented Air preheater & Economizer in their existing boiler.

Air Pre heater: A Thermic fluid heater utilizes the heat produced in the system for processing of fabric at different segments. Energy used to heat the thermic fluid is mostly pet coke. Conventional units do not have provisions of waste heat recovery to recover the flue gas. Thus a significant amount of heat is lost as waste heat.

Installation of an air preheater can lead to recovery of heat from the exit of the heating chamber to pre-heat the air required for combustion. The pre-heated air can either be utilized in the thermic fluid heater or the boiler.

With an exit waste heat temperature of 180ºC; air pre-heat to the extent of 100ºC can be achieved.

Economizer:

Steam is the main agent of energy used in the textile processing unit. Thus, the boiler is the major energy utilizing source in a typical textile unit.

In conventional system, the feed water to the boiler is fed at ambient temperature (35ºC) while the stack temperature goes as high as 240ºC.

The flue gas temperature leaving at 2400C from the boiler can be recovered using an economizer. This can further be utilized to pre-heat the boiler feed water. A temperature difference of 120ºC is sufficient to rise the boiler feed water temperature by 60-65ºC. The increase in boiler feed water temperature can lead to substantial increase in boiler efficiency thus leading to reduction in specific fuel consumption.

BENEFITS

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

PROJECT IMPACTS

- Specific energy consumption: Replacement of economizer & Air preheater has led to reduction in specific energy consumption n from by 5 t0 10 %.
- The total annual energy saving is 15 to 30 Tonne of Oil Equivalent in a typical textile unit.
- This also leads to a reduction of 25 -30 tonnes of CO_2 emission per year

For any further details contact:
Bureau of Energy Efficiency, Ministry of Power, Government of India, 4th Floor, Sewa Bhawan, R. K. Puram, New Delhi - 110066, INDIA

Installation of Condensate Recovery System & Float traps – A Case Study

Pali Textile Cluster

ABOUT THE CLUSTER

The Pali textile cluster is one of the biggest SME clusters in India having over 250 member industries.

The units in the cluster are mainly located in two Industrial Areas namely Industrial Area Phase I & Phase II and Mandia Road Industrial Area. The units are classified into two segments mainly: 1) Hand Process Units 2) Power Process Units.

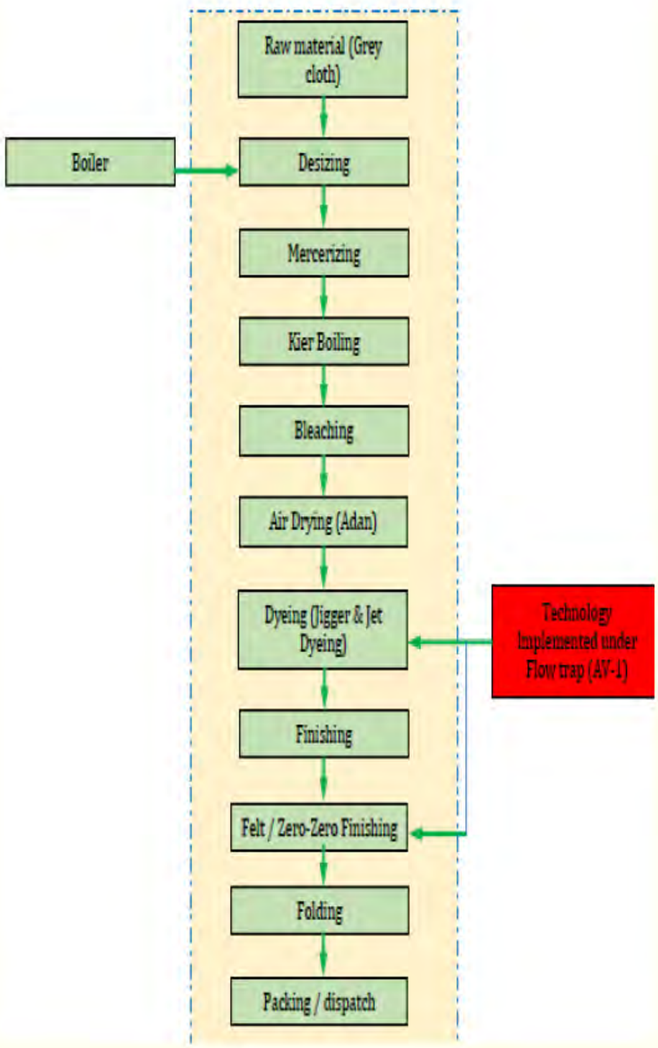
ABOUT THE UNIT

M/s Shree Rajaram Mills, Pali, was established in the year 2007 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-338 to 342, Mandia Road Industrial Area, Pali. The unit operation is overseen by Mr. Manish Gupta, Manager.

The raw material procured by the unit includes grey (raw cloth) purchased from various sources predominantly from Gujarat and Maharashtra. The unit operates for 24 hours per day, presently.

The daily production lies in the range of 70,000 to 80,000 meters of processed cloth per day. The major energy usage in the unit includes wet steam (generated from coke fired boiler) and electricity.

PROCESS FLOW



Note: Other units who have implemented Special Purpose Machine under the BEE-SME program in Pali Textile Cluster are Rajaram Mills, Rajaram Process, Simandher Fabtex & Manoj Dyeing

BASELINE SCENARIO

Shree Rajaram mills have installed 2 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/cm² 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. Also in the condensate outlet, 25 NB thermodynamic (TD) traps are installed in 3 nos. of jet dyeing machine. 2 jet dyeing machine, no traps have been installed in one of the machine whereas float trap installed in the other machine is not functioning properly.

Figure 1: ***Jet Dyeing Machine***

PRESENT SCENARIO

Based on the recommendation made as per the baseline energy audit, the unit has implemented condensate recovery system & float traps.

Condensate Recovery System:

A significant portion of steam is converted into water droplets due to condensation in machine operations. When steam condenses the temperature will remains same. This condensate also called as 'Saturated water' gets drained out, in the conventional process.

To recover heat lost through condensate, condensate recovery system is introduced in the process. This recovers the saturated water and the sensible heat contained in the discharged condensate. Recovering condensate instead of draining it away thus leads to significant savings in terms of energy.

Float Traps:

In the process the steam is used to heat the fabric. A substantial amount of steam is lost in the form condensate in absence of any traps or valves.

Loss of steam from the process can be avoided by installation of float or steam traps. This enables filtering of the condensate from the steam and passing it back to the boiler feed water. The condensate free steam thus passes through the system and is completely utilized.

BENEFITS

- Higher capacity turndown trap
- Complete Space Optimization – Area required for installation is less
- No welding required
- No Inline leakages
- Lesser Radiation losses
- Reduced transportation costs

PROJECT IMPACTS

- Specific energy consumption: Replacement of economizer & Air preheater has led to reduction in specific energy consumption from by 10 to 15%.
- The total annual energy saving is 25 to 40 Tonne of Oil Equivalent in a typical textile unit.
- This also leads to a reduction of 30 -40 tonnes of CO_2 emission per year

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For any further details contact:

Bureau of Energy Efficiency, Ministry of Power, Government of India, 4th Floor, Sewa Bhawan, R. K. Puram, New Delhi - 110066, INDIA

CHAPTER 10

List of Suppliers / Vendors

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List of Suppliers – Pali Textile Cluster

Technology	Manufacturer/ Supplier	Address	Contact Person	Contact No.	Email
Economizer in Steam Boiler/Thermic-Fluid Heater / Air preheater in boiler	F. J. Iron Industries	E-410, Mandia Road, Industrial Area, Pali, Rajasthan	Mohd. Aslam	9414122175	fjpali@yahoo.com
	Sachidanand Sales Corporation	Local Pali Office: 9, Mahaveer Udyog Nagar, Pali, Rajasthan	Subodh Bhanusali	9314023827	subodhajad@gmail.com
		Reg Address: E4/273, Dharampura-2, Chhehrata, Amritsar, Punjab	Kewal Singh	9779057754	skewal91@yahoo.com
	M.S. Engineering Works	G-31A, 2nd Phase Industrial Area,, Pali, Rajasthan	Madan lal Malviya	9214488641	msengineeringworks41@gmail.com
	R.K. Engineers	75 Main Mandia Road, Pali, Rajasthan	Ramzan Khan	9414121760	pali_rkengineer@yahoo.com
	Parihar Engineering Works	3/4, Vikas Nagar, Punayata Road, Pali, Rajasthan	Laxman Lal Parihar	9829020937	rakeshparihar10.rp@gmail.com
	Swastik Engineering Services	Shop No.4S, Anami House Complex Jeewan Nagar Chowk, Focal Point, Ludhiana.-141010, Punjab	Brijesh Singh	8725069101	swastikenggservices@gmail.com
Waste heat recovery in kier boiling unit	F.G. Iron Industries	E-410, Mandia Road, Industrial Area, Pali, Rajasthan	Mohd. Aslam	9414122175	fjpali@yahoo.com
	Sachidanand Sales Corporation	Local Pali Office: 9, Mahaveer Udyog Nagar, Pali, Rajasthan	Subodh Bhanusali	9314023827	subodhajad@gmail.com
		Reg Address: E4/273, Dharampura-2, Chhehrata, Amritsar, Punjab	Kewal Singh	9779057754	skewal91@yahoo.com
	M.S. Engineering Works	G-31A, 2nd Phase Industrial Area,, Pali, Rajasthan	Madan lal Malviya	9214488641	msengineeringworks41@gmail.com
	R.K. Engineers	75 Main Mandia Road, Pali, Rajasthan	Ramzan Khan	9414121760	pali_rkengineer@yahoo.com
	Parihar Engineering Works	3/4, Vikas Nagar, Punayata Road, Pali, Rajasthan	Laxman Lal Parihar	9829020937	rakeshparihar10.rp@gmail.com
Temperature monitoring & control system in Jigger machines / washing range	Forbes Marshall Pvt. Ltd.	Forbes Marshall, 4,Shetoor Bunglows, Opp.Drive in Petrol Pump, Ahmedabad-380 054	Swagat H. Parikh	9712913022	swagatparikh89@gmail.com
	Semitronik Instrument	17 CD, Archana Ind. Estate, Rakhial Road, Ahmedabad - 380 023 -	Dipak K. Vasanwala	9374722631	sales@semitronik.com

Technology	Manufacturer/ Supplier	Address	Contact Person	Contact No.	Email
		India.			
	Swastik Engineering Services	Shop No.4S, Anami House Complex Jeewan Nagar Chowk, Focal Point, Ludhiana.- 141010, Punjab	Brijesh Singh	8725069101	swastikenggservices@gmail.com
Condensate recovery system for Jet dyeing machine / zero-zero (felt) machine/ Kier boiling unit	Forbes Marshall Pvt. Ltd.	Forbes Marshall, 4,Shetoor Bunglows, Opp.Drive in Petrol Pump, Ahmedabad-380 054	Swagat H. Parikh	9712913022	swagatparikh89@gmail.com
	Royal Radiance Engineers (Thermax)	1665, Golden Udyog complex, Jharsa Road, Gurgaon -122001, Haryana	Vineet Singh	9810385043	vineet.rre@gmail.com
	Swastik Engineering Services	Shop No.4S, Anami House Complex Jeewan Nagar Chowk, Focal Point, Ludhiana.- 141010, Punjab	Brijesh Singh	8725069101	swastikenggservices@gmail.com
Float trap in Jet dyeing machine /zero-zero (felt) machine/ Kier boiling unit	Forbes Marshall Pvt. Ltd.	Forbes Marshall, 4,Shetoor Bunglows, Opp.Drive in Petrol Pump, Ahmedabad-380 054	Swagat H. Parikh	9712913022	swagatparikh89@gmail.com
	Royal Radiance Engineers (Thermax)	1665, Golden Udyog complex, Jharsa Road, Gurgaon -122001, Haryana	Vineet Singh	9810385043	vineet.rre@gmail.com
	Swastik Engineering Services	Shop No.4S, Anami House Complex Jeewan Nagar Chowk, Focal Point, Ludhiana.- 141010, Punjab	Brijesh Singh	8725069101	swastikenggservices@gmail.com
Boiler / Thermopac automation (oxygen based / temperature based)	Royal Radiance Engineers (Thermax)	1665, Golden Udyog complex, Jharsa Road, Gurgaon -122001, Haryana	Vineet Singh	9810385043	vineet.rre@gmail.com
	Semitronik Instrument	17 CD, Archana Ind. Estate, Rakhial Road, Ahmedabad - 380 023 - India.	Dipak K. Vasanwala	9374722631	sales@semitronik.com
	Ecolibrium Energy P Ltd.	504, Venus Atlantis, Nr Shell Petrol Pump, Prahladnagar, Ahmedabad, Gujarat-380015	Rajesh Deoli/Gajendra Giri	079-40165151	rajesh.deoli@ecolibriumenergy.com,gajendra.giri@ecolibriumenergy.com
	Swastik Engineering Services	Shop No.4S, Anami House Complex Jeewan Nagar Chowk, Focal Point, Ludhiana.- 141010, Punjab	Brijesh Singh	8725069101	swastikenggservices@gmail.com
Reverse Osmosis (RO) system	SepraTech Solutions Pvt. Ltd.	C-1B-303/21, GIDC Makarpura, Vadodara, Gujarat	V.Y. Jose/Nikhil Jose	Phone: 0265-2654455/66, Mobile:	jose@sepratech.in, nikhil@sepratec

Technology	Manufacturer/ Supplier	Address	Contact Person	Contact No.	Email
in steam boiler				8469493928	h.in
	Enhanced WAPP System (India) Pvt. Ltd.	914-B, Park Centra, Sector 30, Gurgaon, Haryana-122001	Sonu Tandon/Asit Ranjan (Local Setup at Pali, Mr. Rajesh Jain, Mobile: 9810133805)	Phone: 0124-6710000, Mobile: 8527196438	sales@wappsys.com
	Shree Padmawati Polymers	F-271, Mandia Road, RIICO Industrial Area, Pali-Marwar, Rajasthan	Rajesh Kothari	Phone: 02932-230316, Mobile: 9460818175	r.kothari@rediffmail.com
	Fairdeal Technologies Pvt. Ltd. (Channel Partner of Ion Exchange (I) Ltd.)	411, 4th Floor city Plaza, Banipark, Jaipur-302016, Rajasthan	M.A. Khan	Phone: 0141-2281578/579, Mobile: 9314691680	ftl_ion_jpr@rediffmail.com
	Mythree consulting Engineers	50-50-27, Flat No. 202, Susmitha Enclave, B.S. Layout, Seethammadhara, Visakhapatnam-530013	TRL Narasimham	8916451418, 9866077656	my3vizag@gmail.com
Installation of energy efficient AC motors with VFD for desizing / mercerizing machine / VFD in FD/ID blowers	Babita Electronics	75-A, Gurudwara road, suraj pole, Pali, Rajasthan	Navneet Tripathi	9983410222/9214024937	neetpali@gmail.com
	R.K Electrical	S-22, Nakora Market, Mandia Road, Pali, Rajasthan	Lunaram Prajapat	9829973510	lunaramprajapat1976@gmail.com
	Puran Electricals Repair	Shop No. 4, Mandia road, Gurlai Marg, Near OBC Bank, Pali-306401, Rajasthan	Puranmal Prajapat	9649622287/ 9828822287/ 9414122287	puranelectric@gmail.com
New Energy Efficient Boiler	Royal Radiance Engineers (Thermax)	1665, Golden Udyog complex, Jharsa Road, Gurgaon -122001, Haryana	Vineet Singh	9810385043	vineet.rre@gmail.com
	Forbes Marshall Pvt. Ltd.	Forbes Marshall, 4,Shetoor Bunglows, Opp.Drive in Petrol Pump, Ahmedabad-380 054	Swagat H. Parikh	9712913022	swagatparikh89@gmail.com
	Swastik Engineering Services	Shop No.4S, Anami House Complex Jeewan Nagar Chowk, Focal Point, Ludhiana.-141010, Punjab	Brijesh Singh	8725069101	swastikenggservices@gmail.com

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Govt. of India
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InsPIRE Network for Environment
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New Delhi- 110 016