Pali Textile Cluster

(Under BEE SME program)

Cluster Manual

PETROLEUM CONSERVATION RESEARCH ASSOCIATION
(Under Ministry of Petroleum and Natural Gas, Government of India)

BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

ACKNOWLEDGMENT

Indian Textile Industry mainly consists of the units in SME sector and contributes greatly to Indian GDP. The textile sector is one of the largest contributors to the Indian GDP and also forms major chunk of total Indian Exports.

The textile sector is very Energy intensive as well and hence draws focus whenever Energy Efficiency Improvement in Industries is considered. The very basic scale of production of these units makes them prone to inefficiencies in Energy as well as other resource utilization.

Freeing from quota regime has opened up new avenues for Indian Textile Industry. But this opportunity has brought fierce competition from our neighbors. Improving operating efficiency is going to be the key to survival and this intervention by Bureau of Energy Efficiency (BEE) is a welcome step.

The sincere help and support extended by the Rajasthan Textile and Hand Processors Association (RTHPA) Pali deserves accolades for facilitating the study. We express our sincere thanks to Shri Anil Mehta, President RTHPA, Shri Vinay Bamb, Secretary RTHPA and his other team members for all the help and support extended during the study. We also put on record the contributions of the entrepreneurs namely Shri Suresh Gupta, Shri Anil Gulechha, Shri Kesrimal Balad, Shri Rajendra Doshi, Shri Mangilal Gandhi and Shri Devraj Jain for their valuable suggestions and cooperation. In the end, special mention of Shri Padamchand Daga who contributed immensely to the study by way of sharing his model of Energy Management implemented successfully in his industry.

PCRA has been supporting units in SME sector continuously and has succeeded in triggering efforts for Energy Conservation in these Industries. However, the Pali cluster Job has gravitated the efforts of PCRA more intensely to the cluster. The initiative matches well with our Corporate Mission and provides us opportunity to deliver on the subjects included directly or indirectly in our Corporate Vision as well.

PCRA expresses its sincere thanks to Bureau of Energy Efficiency (BEE) for associating Petroleum Conservation Research Association in its prestigious Pan-India intervention in the SME Clusters aimed at improving performance of these clusters on Energy Consumption through proposed hard interventions. The intervention of BEE to integrate SMEs also in its scheme of things to bring about inclusiveness in its efforts for promoting Energy Conservation in Industrial Sector is one of its kind in India and one of the firsts in the world as well.

We thank the following persons from BEE for their valuable support and guidance in the entire process of study and report preparation

1) Dr. Ajay Mathur, DG BEE,
2) Shri J. Sood, Energy Economist, BEE
3) Shri Shashank Jain, Advisor BEE

The study may not have been possible but for the active support of PCRA officers who supported the study team through their valuable suggestions and guidance right from the very beginning till end. The following officers contributed whole-heartedly in the process of entire study:

1) Shri S.P. Goel, Dir (I/C), PCRA
2) Shri A.K. Goel, Director PCRA
3) Shri P.K. Motwani, CRC Northern Region
4) Shri Rajeev Sehgal, RC Northern Region

PCRA would further be working in the cluster for ensuring that the initiatives of BEE does bear fruit and the projects identified in this study actually get implemented. An impact analysis can also be considered at a definite interval to assess how much has been the Energy Saving triggered by this intervention. During onsite study, sufficient

awareness about the project was created and the entrepreneurs were motivated to adopt the project. The session of the entrepreneurs with the bankers was also very successful and the entrepreneurs seemed to be excited about the financial packaging of the project. It is observed that the project would succeed in its aim of improving Energy Efficiency in the complete cluster and the study as well as the intervention in the Pali Cluster would set bench mark for success in the Energy Efficiency in SME sector under clusters model.

Suman Kumar
State Coordinator, PCRA Rajasthan
Team Leader, Pali Cluster Implementation Project

CONTENTS

5. Conclusion

List of annexure:

Annexure I - Specifications	**Provided with detailed techno economics of Energy Saving Proposals**
Annexure II- List of Service Providers	**Enclosed at Page 161**
Annexure III – Quotations	**Enclosed in Annexure Vol. VII**

List of Appendix

Appendix 1 – Energy Audit Reports	**24 no. Energy Audit Reports Provided in Annexure Volumes I to VI**
Appendix 2 – Policy/guidelines (if any) of local bodies for improving energy efficiency in the cluster	**None**
Appendix III – State Government Guidelines	**Provided in Annexure Vol VII**
Appendix IV - Financial Schemes of Banks	**Provided in Annexure Vol VII**
Appendix V Name and address of units	**Provided in Annexure Vol VII**

List of References:

1. Cutting Your Energy Costs – A guide for the textile dyeing and finishing industry – Carbon trust UK
2. Benchmarking and Energy Management Schemes in SMEs, BESS, Intelligent Energy Europe
3. ECCJ literature
4. Energy Performance Benchmarking and best practices in Canadian textile wet processing, Natural Resources, Canada
5. Encyclopedia of Textile Finishing , Springer
6. Energy Conservation in Textile Wet Processing, Editors - M.L. Gulrajani and Sanjay Gupta, Omega Scientific Publishers
7. Economy Energy and Environment in Textile Wet Processing, Edited by S.S. Trivedi, Association of Chemical Technologists India

Executive Summary

Pali Cluster has very rightly been chosen under BEE SME programme as the units here are traditionally family owned which have not really progressed in pace with the technological advancements. The Cluster Manual has been prepared to present the overview of the cluster in terms of its features, growth potential, drivers for growth in past and future prospects. The cluster manual presents an account of present technology and the technological interventions required to improve the Energy Performance of the cluster.

The Cluster Manual also tries to identify the projects required to be undertaken for improving the Energy Intensity of the cluster and analyse them financially so as to trigger adoption in the cluster.

Net Energy Saving Opportunity of over 15% to 30% in Fuels and over 20% to 30% in Electricity has been observed.

The section on list of energy conservation opportunities and technology gap assessment in its complete perspective has been discussed and a complete techno economics of implementing the proposed technology has also been worked out. Sections also deal in availability of service providers in the cluster and also various barriers to implementation of the projects. A summary of the techno economics of the proposed technology has been provided in section 5.1.3.

The Cluster Manual has been prepared in such a way that it discusses Energy Saving Projects in entirety including cost benefit analysis and it can be adopted readily in any of the units.

1.

BEE's SME program:

Energy intensity of India is way above that of developed countries and is many times more than the world average. An analysis of sectoral contribution to the GDP vs Energy Consumption indicates that % contribution to GDP by industrial sector is only 26% as against the energy consumption figures of 41% (Source mospi.nic.in). Consequently, Industrial Sector gains priority over all other sectors for policy as well as regulatory interventions. The disproportionate contribution to GDP by Industrial Sector also signifies that there is huge untapped potential for Energy Conservation in the sector.

BEE is the apex regulatory body for formulation, promulgation and implementation of regulatory framework in India for Energy Conservation and has adopted the model of self-regulation and market principles to act as drivers for adoption of Energy Efficient Technologies. By bulk consumers.

The analysis of barriers to implementation of Energy Efficient technologies and processes in Industries clearly indicate that the technological development is skewed towards large industries due to its financial capability to support adoption and also scale of operation to justify investments. In the absence of technology suited for lower scale of operation of the units in SME sector and also lack of financing mechanism to support such up-gradations by the sector, the units in the SME sector continue to operate with the inefficient machinery and old technology, often developed in-house based on experience. Lack of stakeholders like consultants, training institutes, equipment suppliers ready to cater to the needs of these units makes such interventions much more difficult. Typical decision-making process for all new investments in the SME sector poses another very big barrier to technological interventions.

Many industries classified under SME operate in Energy Intensive sectors and lack of flow of information among those operating in the same sector makes it difficult for adoption of best practices and systems by other units. Also, these units do not have a mandatory requirement for conducting a reality check on their Energy Performance and hence an urgent need has been assessed for supporting these industries in terms of such studies to find out Energy Conservation Opportunities in these industries.

Keeping in view the specific needs of the SME sector based on a comprehensive barrier analysis, BEE has undertaken a series of ambitious projects to address all such barriers and facilitate adoption of Energy Efficient Technology and processes through a new model of interventions which is a combination of both soft as well as hard interventions.

1.1 Project objectives

The project is aimed at improving Energy Intensity of Indian Industries by interventions in the SME sector on a cluster model. The Energy Intensity in Indian Industrial Sector is intended to be improved by helping industries in the targeted SME sector (25 industrial clusters) improve their Energy Performance through soft interventions and also evolve the reliable and bonafide tools to take them through the entire process of implementation of Energy Efficiency Projects including financial arrangements.

The project also aims at creating forums for dissemination of best practices and best available technologies so as to create awareness among members of the cluster and also create some champions to create demonstration effect and hence trigger adoption of such technologies.

The significant milestones in the project have been set up to address specific needs of the industries in the SME sector and have been designed to overcome all the known barriers to implementation of Energy Efficient technologies and processes. The various modules to be covered under the project are –

1. Energy Use and Technology Analysis
2. Capacity Building,
3. Implementation of EE measures, and
4. Facilitation of Innovative Financing Mechanisms

The cluster model of the project aims at involving the units in the cluster in the process of study so as to discover technologies and processes suitable for the cluster in consultation with the consultants appointed for the clusters and involve Financial Institutions to thrash out financing issues. In fact the project aims at packaging the financial module for the projects identified in the study such that sufficient finance is readily available at the cheapest possible interest, which simultaneously offers benefit of all promotional incentives to the entrepreneur. Through collaborations with financial institution, this initiative of BEE also encompasses measures to address the issues of credit guarantee and preferred financing.

1.2. Expected project outcome

The project aims at creating opportunities for all the stakeholders in the cluster viz. Enterpreneurs, Service Providers, Equipment Suppliers, Financiers and above all the State. To Benchmark the present standards of operational parameters, a situation analysis has been conducted. The situation analysis has established the current technology and financial performance of the units in the cluster and has also identified other stakeholders in the cluster.

For developing insight into linkages among various actors in the cluster, a cluster manual is to be prepared. The cluster manual is a comprehensive document prepared after thorough analysis of the cluster so as to encompass all the variables in the cluster. This all inclusive epic is supposed to be the basic document on the basis of which all subsequent decisions including technical and financial decisions would be taken. The document is required to carry bonafide information on the population in the cluster with details like addresses, Phone Nos., Production Capacity, Technologies, Products Manufactured, Energy Saving Potential, Best Practices and details of the stake holders.

The project aims at conducting very comprehensive analysis of Energy Consumption pattern so as to cover every kind of technology and process present in the cluster with the sole aim of identifying implementable, viable and bankable Energy Efficiency Projects in the cluster.

The implementability of the project implies availability of suitable technical capability in the cluster to implement the project reliably and deliver projected results.

Viability of the project requires the identified projects to be technically and financially viable and hence should be able to be preferred by the entrepreneurs while considering any new investments. Rather, the projects should bring the issue of Energy Conservation to the fore and trigger new investments which in turn would improve competitiveness of the units. The technical viability, besides ensuring successful implementation, also considers maintenance issues, manpower issues and other issues necessary for sustained operation.

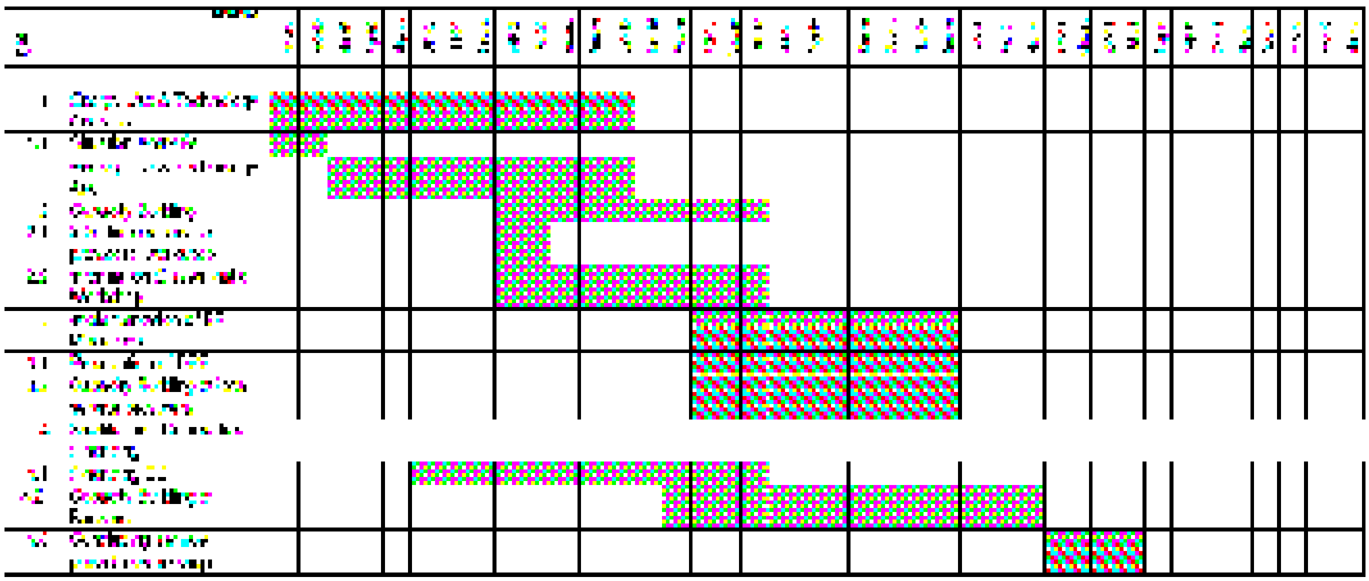
Bankability of the project requires the projects to stand the test of the banker in terms of technical feasibility and financial parameters like investments, returns etc.

For the purpose of ascertaining the project on technical and financial standards, Detailed Project Reports (DPRs) would be prepared for the identified technologies. These 15 DPRs need to address the requirements of every industry in the cluster.

The capability building of stakeholders viz. equipment suppliers, Service Providers, Consultants and Bankers is integral part of the project and a dissemination workshop is required to be conducted to inform all the stake holders on the significant achievement of the project.

1.3 Project duration

Starting in March 2009, the project is expected to be closed by Dec 2010. The following is the project implementation schedule :-



1.4 Identified clusters under the program

25 clusters have been identified under the project. The clusters identified by BEE for intervention are as below :-

a. Alwar Oil Mill Cluster
b. Bangalore Machinery Cluster
c. Bhimavaram Ice making Cluster
d. Bhubaneshwar Brassware Cluster
e. Cochin Seafood cluster
f. East and West Godawari Fire Bricks Cluster
g. Ganjam Rice Mills Cluster
h. North Gujarat Dairy cluster
i. Howrah Galvanising Cluster
j. Jagadhari
k. Jodhpur Lime Kiln Cluster
l. Jorhat Tea Estate Cluster
m. Ludhiana Batala, Jalandhur Hand Tools Cluster
n. Muzaffarnagar
o. Orissa
p. Vapi
q. Varanasi
r. Vellore
s. Ahmedabad
t. Jamnagar
u. Surat
v. Pali
w. Morbi

x. Solapur

y. Warangal

These 25 clusters have been taken up in 2 stages, 7 in the first stage and balance 18 in the second stage. Pali Cluster was taken up in the first stage.

2. Cluster scenario: Pali Textile Cluster

2.1 Overview of SME cluster:

The Pali textile cluster is one of the biggest SME clusters in India having over 350 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. Some of the units hitherto functioning in residential colonies are in the process of shifting to a new Industrial Area named Punayata Road Induatrial Area. Some others located in the nearby areas away from the Industrial Area are lying closed due to legal action.

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 big problem and even Center For Science and Environment (CSE) conducted a study to assess the real problem. The units faced closure for a long time due to legal action and decided to set up Central Effluent Treatment Plant. The CETP is functioning under a trust managed by the Enterprepreneurs themselves.

2.1.1 Cluster background :

The origin of the cluster dates back to ancient times when the Chhippas or Rangrej (colouring community) used to Dye dress called "Tool" worn by Muslim ladies. It was in 1940 when a composite mill in the name of Maharaja Shri Ummed Mills was established in Pali and the people in Pali got opportunity to be employed in the sector and learn the tricks of Textile Dyeing and Finishing. Strangely. The entrepreneurs who once worked for this mill and subsequently started doing jobbing for this mill itself own most of the old units in Pali. The development of the cluster got triggered by visit of traders to the city to deal with Maharaja Shri Ummed Mills, thus providing ready customers for the produce. The textile trading business in the bigger markets like Mumbai, Kolkata, Chennai is predominantly in the hands of people belonging to the Marwar region. This provided the entrepreneurs here access to the larger markets and also offered opportunity to network with the traders.

Contribution of this mill was immense in the growth of the cluster as it gave local enterpreneurs insight into the technology and process of textile dyeing and printing. Also, the trained manpower was drawn from the pool of workers who once worked for the mill.

Ironically, the textile cluster at Pali has grown despite all odds as none of the resources required for textile processing is available locally. 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 local service providers or consultants. Even the Grey and Dye and Chemicals are brought from Maharashtra and Gujarat. Even coal or Residual Pet Coke is not available locally.

Only resource available locally is the enterpreneurship of the people, availability of clear sky for over 340 days in a year and good power availability. Availability 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 and

Finishing but a large portion of the job there got outsourced from Pali due to problems like Pollution, Flood, Plague etc.

Opening of new markets like Africa and popularity of PC Blend, Polyester in African Prints provided the units here with great business opportunity which the entrepreneurs lapped up and grew many folds.

Evolution of Dyeing Process in Pali: -

Hand printing started in 60's with use of blocks for printing and dyeing was also started around the same time. A typical evolution process can be depicted as below :

Block Printing

↓

Pigment Table

↓

Dyeing

↓

Rotary Printing (phased out)

↓

Screen Printing by hand

↓

Automatic Flat Bed Printing

↓

Automatic Rotary Printing

2.1.2 Product manufactured

Initially, the units dyed cotton only. With passage of time, new units started working and the product portfolio also changed with time and demand pattern. The units progressively added dyeing of Voil, Poplin, PC Blend and Polyester in their product ranges.

On the basis of end products, the major products of the units here are – Blouse Pieces, Petticoat pieces, Lungies, Sarees, printed Poplin, turbans and African Prints. In fact, Pali is famous for Blouse Pieces.

The cluster mainly uses very thin fabric, mostly below 100 grams per meter. The product also is very cheap and caters to the lower strata of the society in some of the backward states.

2.1.3 Classification of units: -

The units here can be broadly classified into two segments –

1. Hand Process Units
2. Power Process ‘units

Hand Process Units

Indian traditional Dyeing system has been the one without consumption of power. These units depend mostly on manual labour. This actually is the traditional way of Dyeing and processing clothes. This process cannot be used for dyeing Polyester. The heat requirement in this process is obtained by directly burning wood or briquettes below the pot in which the fabric is soaked in water and heated. Production of these units is very low. These units suffer from poor quality and inconsistency in product quality.

Power Process Units

The Power Process Units are mainly those, which process man made fibers. These units need special care during the Dyeing and finishing process. Also, power driven machines have resulted in elimination of manual labour and many folds increase in production.

Though a no. of companies functioning in Pali do only trading, they have nothing to do with manufacturing process, but they are important link in the value chain, hence they also have been plotted below.

The distribution of units based on the above classification is depicted in Fig. 1 below :-

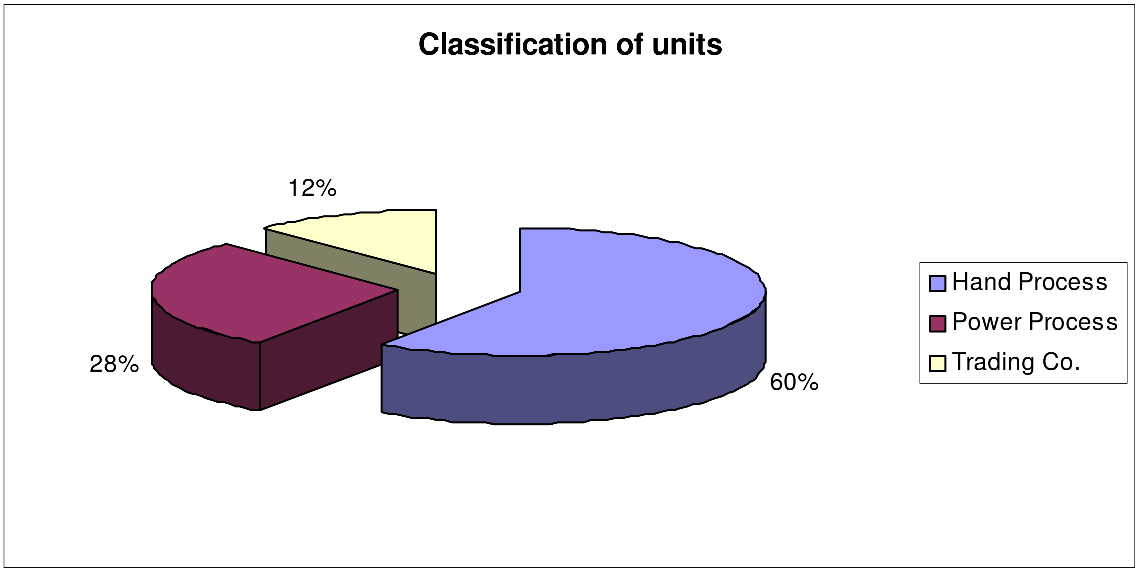


Fig. 1-Pali Cluster : Classification of industries

2.1.4 Production capacity detail :-

Most of the units operate round the clock. The units involved in power process produce anywhere between 40000 metres to 50000 metres per day. The production of hand process units is very less and would be in the range of 10000 to 15000 metres per day. However, as per the situation analysis, the total daily production of the cluster is to the tune of approx. 5500000 RM per day.

Going by the production levels, Pali happens to be one of the biggest centers for processing of textiles.

2.1.5 Raw materials used :-

The only raw material used by the units here is different grades of grey. The grey is procured from Malegaon, Ichalkaranji and Bhiwandi.

The various grades used by the units are Cotton, PC Blend and Polyester. The units here need dye and chemicals for processing of textiles. There are agents of various manufacturers in the city who supply Dye and Chemicals.

Printing is major part of the job and most of the units have their own designers and screen developers for completing the job. Some units get the designing done from other service providers available in the cluster. One of the units has a complete automatic printing machine for doing the screen job.

2.1.6 Marketing Network :-

Most of the units here do job work for traders operating from Pali as well as those from bigger cities like Mumbai, Kolkata and other such big markets. In this model of working, the traders arrange grey and different processes are accomplished at different places. The processors get only conversion cost.

Some other units have their own agent based marketing network. The order is taken by these agents and is passed on to the processors who in turn dispatch the required shades and grades. The agent does collection on behalf of the processor and gets his cut for the services rendered.

2.2 Energy Situation in the cluster:-

The textile Dyeing and Finishing requires use as of heat as well as Electricity for processing. Heat is used for dye application and dye fixation so as to ensure colour fastness. Heat is also required for Drying, Heat Setting, Colour development, Sanforizing and special finishes. Electricity is required for all the processing in power process units.

Over 51 Crore Kwh electricity was used in the year 2007-08. Other fuels used were Diesel, Wood, Lignite, Coke, Bio Mass Briquettes etc. Supply of lignite has now been discontinued and hence units are purchasing Residual Pet Coke now.

2.2.1 Types of fuels used and prices :

The units in the cluster have mainly Boilers and Thermopaks for catering to the heating requirements. The units presently use Steam Coal, Residual Petcoke, Wood and Biomass Briquettes for heating application. About a year ago, the units were using Lignite brought from Gujarat. However, with change in policy of not selling Lignite outside Gujarat, the units had to convert their Boilers and Thermopaks to Residual Pet Coke. Petroleum based Fuels, Gases or Biomass Gas is not at all used. One of the units has installed solar water heater for meeting its requirement of hot water.

Typically, RPC is available at a landed price of Rs. 7000/- to Rs. 7500/- per MT. The landed costs of other fuels are Coal – Rs. 4500/- per MT (4000 CV), Biomass Briquettes – R. 3500/- MT, Wood Rs. 2500/- to Rs 3500 per MT.

2.2.2 Fuels and electricity consumption in a typical unit :

Power and Fuel used by units in the cluster are proportional to output. The units into Hand Processing use very less power and fuel. Whereas the units into power process use huge quantities of power. For units sharing same utility facilities, the consumption is still higher.

The power process unit uses about 5 to 7 MT RPC per day. Smaller Units use 1000Kg to 1500 Kg wood / Coal per day. The units involved in printing used 160 Kwh to 500 kwh per day. Units involved in Power process use electricity to the tune of 3000 kwh per day.

2.2.3 Specific Energy Consumption

Typical values of Energy requirements for Textile Finishing Process are as below:

Machine	Process	Energy Required (GJ/Te)
Desizing Unit	Desizing	1.0-3.5
Kier	Scouring/Bleaching	6.0-7.5
J-Box	Scouring	6.5-10.0
Open Width range	Scouring/Bleaching	3.0-7.0
Low Energy Steam Purge	Scouring/Bleaching	1.5-5.0
Jig / Winch	Scouring	5.0-7.0
Jig / Winch	Bleaching	3.0-6.5
Jig	Dyeing	1.5-7.0
Winch	Dyeing	6.0-17.0
Jet	Dyeing	3.5-16.0
Beam	Dyeing	7.5-12.5
Pad / batch	Dyeing	1.5-4.5
Continuous / Thermosol	Dyeing	7.0-20.0
Rotary Screen	Printing	2.5-8.5
Steam Cylinders	Drying	2.5-4.5
Stenter	Drying	2.5-7.5
Stenter	Heat Setting	4.0-9.0
Package / Yarn	Preparation / Dyeing(Cotton)	5.0-18.0
Continuous Hank	Scouring	3.0-5.0
Hank	Dyeing	10-16.0
Hank	Drying	4.5-6.5

(soorce :-Carbontrust UK)

The values of Specific Energy Consumption as gathered from various sources are as below :-

INTERNATIONAL BENCHMARKS FOR ENERGY CONSUMPTION

- **KNITTING : 1.2 kWh/Kg**
- **SPINNING(RING YARN, COMBED) : 6.0 kWh/Kg**
- **WEAVING : 6.2 kWh/Kg**
- **FINISHING : 17.9 kWh/Kg**

(Source : ITMF Annual Conference Report – 2007)

Total Specific Energy Consumption for cotton dyeing : The total specific energy consumption is about 11 kWh/kg, whereas the consumption of electricity is about 2 kWh/kg.

Total Specific Energy Consumption for polyester dyeing : The total specific energy consumption is in the range of 11-18 kWh/kg. The consumption of electricity is about 1-2 kWh/kg.

SEC in Pali Cluster :

For the units involved in Processing of Polyester and printing it to make Saree, the Specific Energy Consumption was observed as follows

Average Specific Electricity Consumption	1.2 Kwh/Kg (Best observed Value- 0.95 Kwh/Kg)
Average Thermal Energy Consumption	15000 Kcal/Kg (Best Value- 10932 Kcal/Kg)

2.3 Manufacturing Process/Technology overview in a typical unit

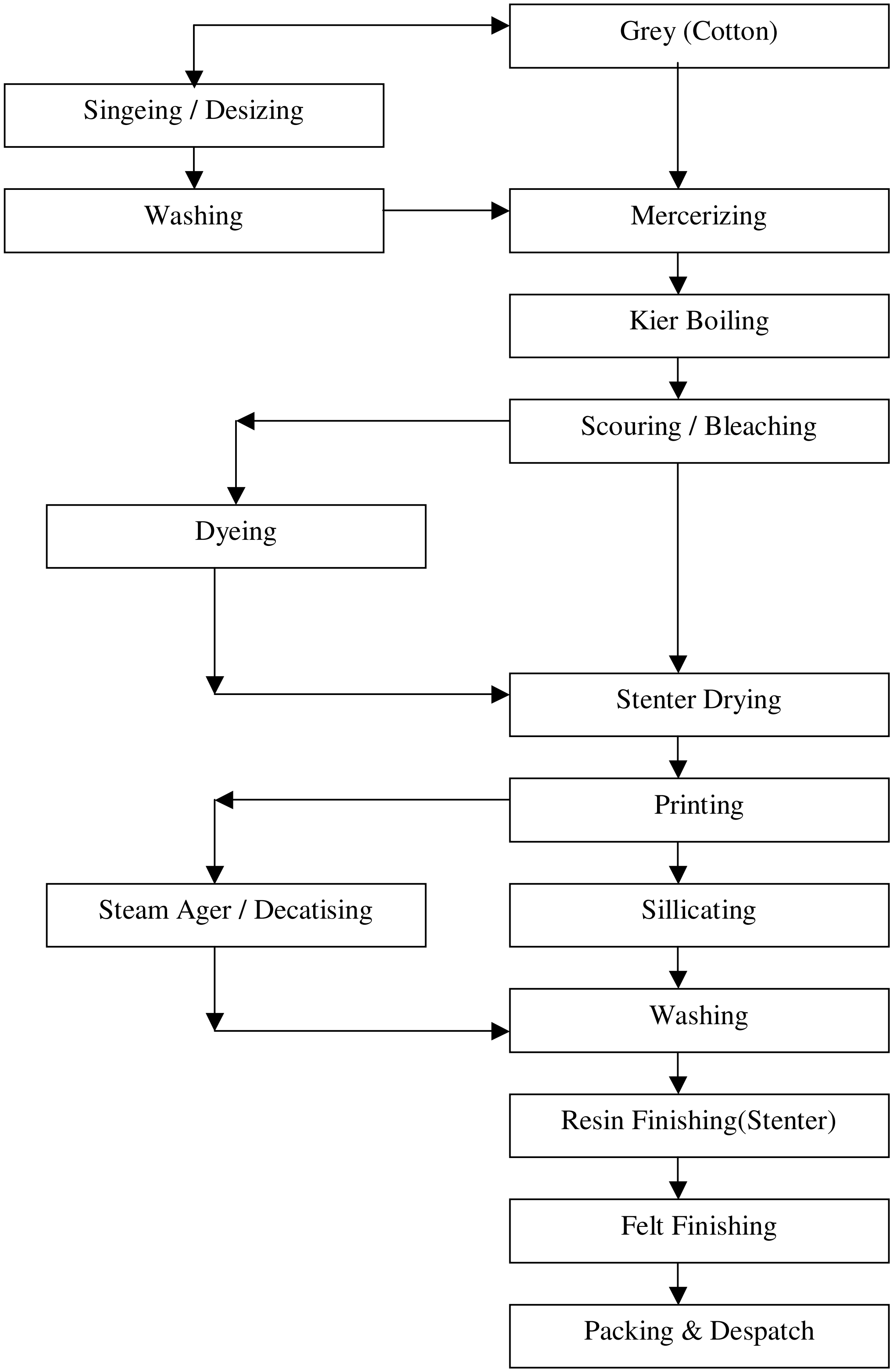
The process textile dyeing and processing industry is more or less similar. The technology is mature and there is literally no obsolescence in it.

Dyeing of cotton is being done in traditional fashion. Dyeing of Polyester needed a different technology because of its requirement of tensionless processing. Consequently, machines like Jet Dyeing, Air Jet Dyeing etc have been devised to serve the purpose. With conservation of resources gaining priority globally and it triggered development of new set of technology that are less Energy Consuming and less polluting.

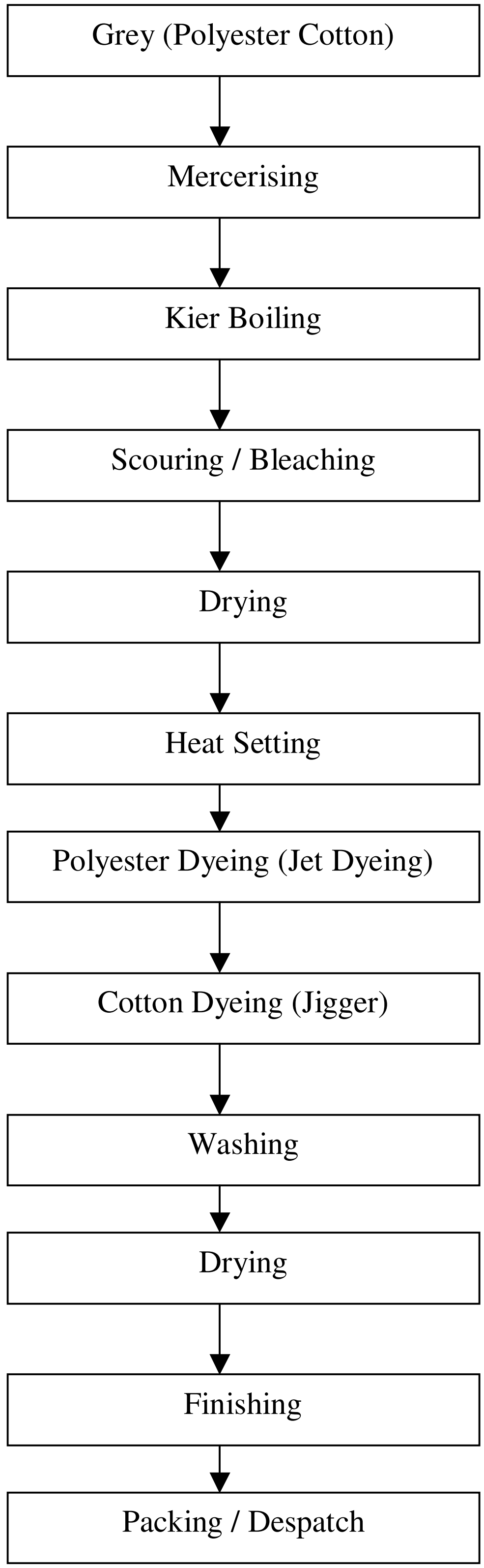
2.3.1 Process Flow Diagram

The units in Pali typically have more or less same process for Dyeing and Finishing depending upon the input fabric. However, depending upon the nature of output required, some processes are bypassed and some others may be done in combination. Process flow diagrams of different processes adopted in Pali SME cluster is produced below.

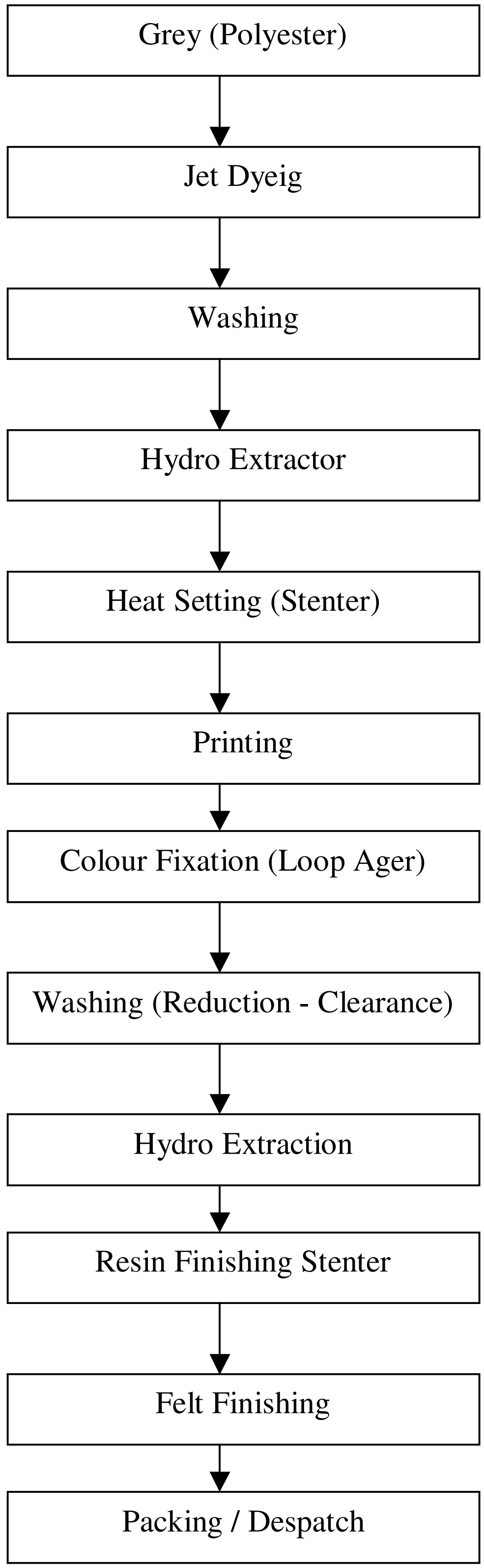
The process adopted for Printing of Cotton Fabric is as below :-



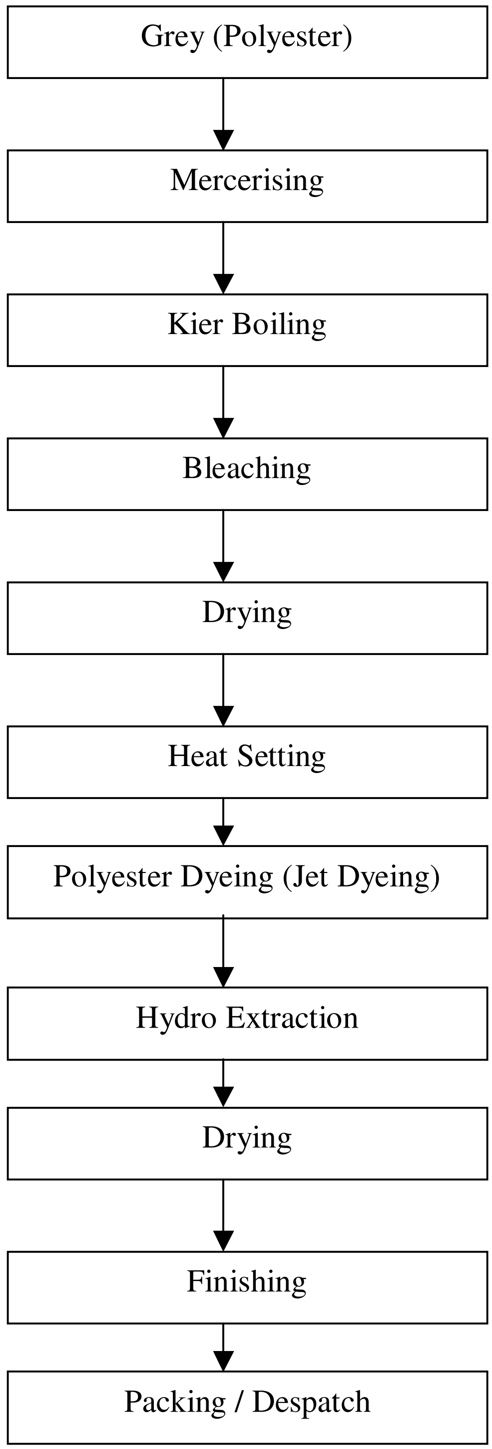
The process adopted for Dyeing of PC (Polyester Cotton) blend Fabric is as below :-



The process adopted for Printing of Polyester Fabric is as below :-



The process adopted for Dyeing of Fabric is as below :-



2.3.2 Process Details

The whole process of textile wet processing can be divided into 3 major parts –

Pretreatment

Dyeing

Drying and Finishing

Wet processes in pre-treatment

Wet pre-treatment includes various processes. All or only some of these processes may be required. The processes can be applied either as separate steps or as combined steps.

In wet pre-treatment batch, semi-continuous, and continuous processes can be used. Fabrics can be pretreated in open width or rope form. Regarding ecology and economy, continuous pre-treatment operations are preferred, but batch wise pre-treatment on dyeing machines is often used in those cases where a great variety of small lots are to be scheduled and handled. Besides, discontinuous pretreatment is often preferred due to high investment costs for a continuous equipment.

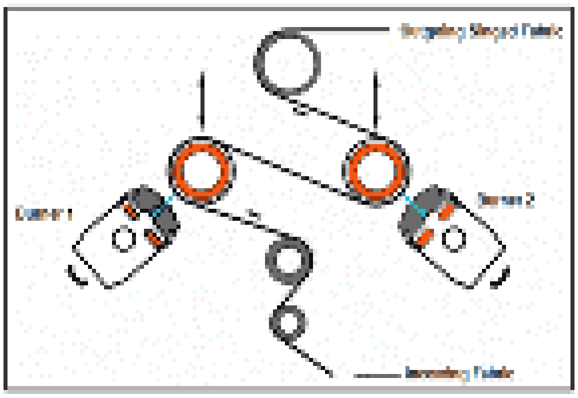
Various processes adopted in pretreatment are elaborated below:

Singeing :-

Singeing is essential when a smooth surface is of interest (esp. as pre-treatment step before printing processes). The textile passes directly over a flame, metal plate, or indirectly between heated ceramic devices by allowing time of contact between the singeing flame and the fabric to practically a fraction of a second. Protruding fibres are burned off. Mainly woven and knitted textiles made of cotton and cotton blends are treated on singeing machines. Synthetic materials are singed to reduce pilling effects.

Singeing is often combined with a device to extinguish sparks and a padding device to impregnate the textile directly after singeing with the desizing liquor.

A typical singeing machine is shown below :



The singeing process is seldom used in Pali. Out of all the units, only one unit in Pali has Singeing Machine, and that too was seldom used. The units mostly buy grey which does not really need Singeing.

Desizing

Desizing is a typical process step in pre-treatment of woven fabrics made of cotton and cotton blends but also necessary for all grey synthetic materials containing sizes.

Desizing is done as a first step in cotton pre-treatment or as a second step after singeing.

Desizing is done in order to remove the size from the warp yarns of the woven fabrics. Warp yarns are coated with sizing agents prior to weaving in order to reduce their frictional properties, decrease yarn breakages on the loom and improve weaving productivity by increasing weft insertion speeds. The sizing material present on the warp yarns can act as a resist towards dyes and chemicals in textile wet processing. It must, therefore, be removed before any subsequent wet processing of the fabric.

Many times desizing is combined with washing or mercerizing / bleaching.

Scouring (kier boiling)

To extract natural impurities (waxes, pectines, proteins, metal salts) cotton fabrics and their blends are treated in a discontinuous or continuous way with hot alkali. The scouring process can be carried out as separate pre-treatment step or in combination with bleaching or desizing. Besides alkali (mostly sodium hydroxide) complexing agents and surfactants are used in the scouring liquor. Main ecological impact in scouring is caused by non readily biodegradable surfactants and complexing agents as well as by a high COD-load due to the organic impurities removed from the fibres. COD-concentrations from 2000 to 6000 mg O2/l are typical.

Mercerizing

Mercerizing (treatment of cotton and cotton blends with strong alkali under tension) improves the dyestuff absorption and increases tensile strength. A good handle, better dimensional stability, and a resistant lustre are achieved. Mercerizing leads to a change in the crystalline structure of the cellulosis moelcules and to a swelling of the fibres.

Mercerization is possible

- on greige goods
- after desizing
- after desizing and scouring
- after bleaching
- after dyeing.

Woven fabrics are mercerized in full width, knitted fabrics in full width or in rope form. Normally, mercerising is mostly done with a hot sodium hydroxide liquor; only one installation in Germany uses ammonia which leads to more resistant effects and a very soft handle.

The sodium hydroxide concentration varies from 20% - 30%.

The process, done in a continuous way, consists of the following steps:

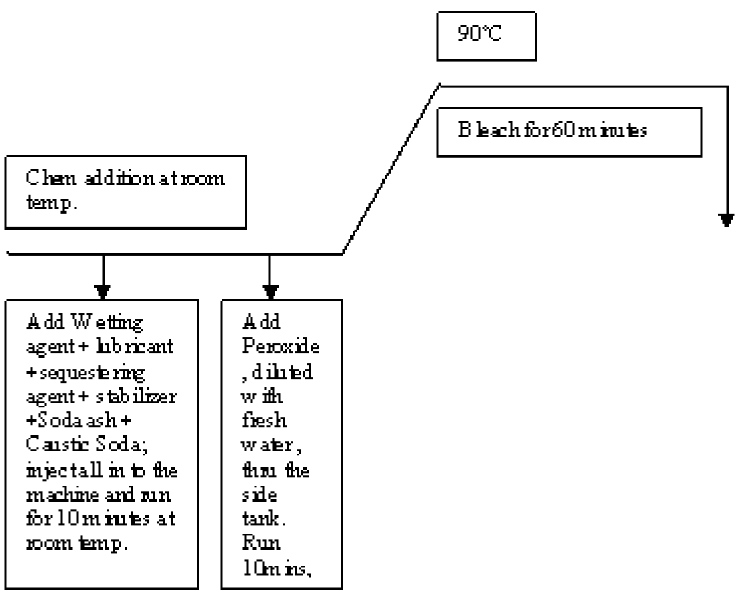
- padding of the textile with the lye
- drafting of the textile
- washing (under tension)
- acidifying, rinsing.

Note:- The units in the Pali Cluster have adopted Caustic Recovery very effectively and thus reducing not only processing cost but also the Chemical load in effluent.

Bleaching

Bleaching is an operation to remove the coloured impurities from textile fibers. Cotton in its natural form contains so many minerals, waxes, proteins and colouring matters, etc. In order to attain a bright substrate for dyeing, bleaching or printing and to make the fabric uniformly water absorbent, a pretreatment is essential. So the first and foremost textile processing operation is called pretreatment, that remove remove the unwanted matters, such as color, minerals, waxes and oils and stains from the greige material. The pretreament operation untilizes a lot of water and the quality of water plays a vital role in the cleansing of textile materials. Better the quality of water, better will be the processed goods.

Typical Bleaching process is as below :-

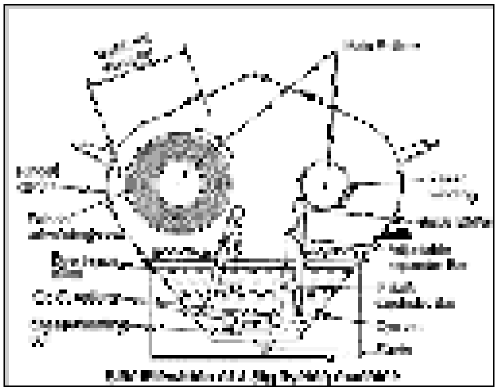


Jigger, winch, soft-flow, cabinet and continuous bleaching ranges such as Beninger are some of the routine machines used for textile bleaching.

Dyeing:

Dyeing is a method for colouring a textile material in which a dye is applied to the substrate in a uniform manner to obtain an even shade with a performance and fastness appropriate to its final use. Pali Cluster uses mainly Jet Dyeing Machines and Jigger for Dyeing Process.

The dyeing process requires thermal and electric energy. The thermal energy is supplied by steam. Besides the thermal energy, electric energy is also necessary to the moving force of the jig machine (shown in figure blow) is one of the oldest ways of dyeing fabric in open width. In this machine a batch of fabric is rolled backwards and forwards from one roller to another through the dye liquor. The direction of movement is automatically reversed as the machine reaches the end of the fabric roll. The duration of the dyeing process is monitored by the number of passages or ‘ends’ through the liquor. Machines open to the atmosphere can accommodate a roll of 500 to 1000 metres in length, but more modern enclosed machines can operate with a roll of 5000 metres. An enclosing lid helps to reduce heat losses and consequent temperature differences between the edge and the centre of the roll. Such differences lead to ‘listing’, a reduction in the dye uptake at the edges of the fabric. Pressurised jigs are available for the more difficult hydrophobic fibres. These operate at temperatures of up to 130 C, but beam dyeing is usually preferred for high-temperature dyeing. A liquor ratio of around 5:1 is the lowest used in conventional jig machines. The method is well suited to the dyeing of fabrics that are readily creased, such as taffetas, poplins, suitings and satins.



Latest Jig Dyeing Machines

Printing :

Hand Screen Printing

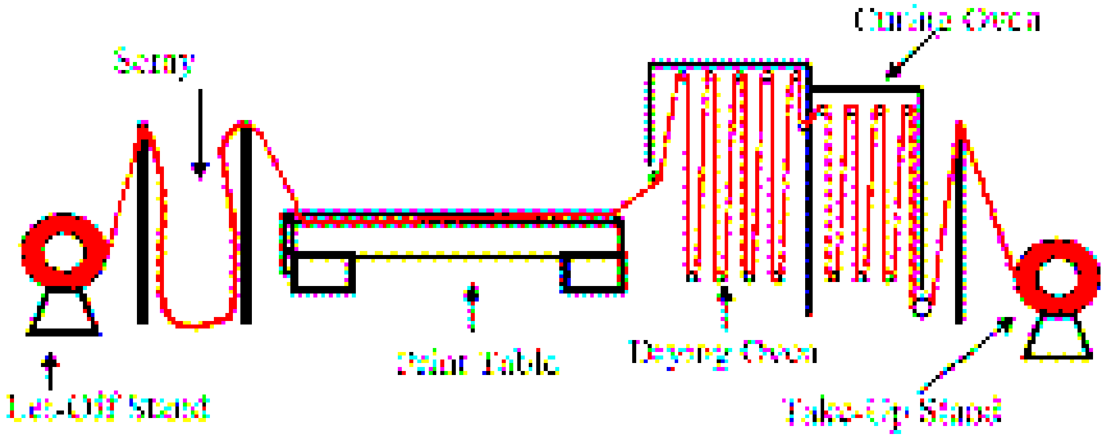
Many units in the cluster are involved in doing manual screen-printing. The screen used is same as the one used in case of flat bed printing. The fabric is spread on to a table and the screen is manually shifted while doing the printing. Ceiling fans are provided to dry up the printing pasts. Typically such units Consume power in Light and Fans only.

Pali cluster has a no. of units which do processing on Job Work basis. Such units may have a finishing section of their own or the fabric may be sent to other units for finishing.

Flat-Bed Screen Printing

The first of the modern printing methods is flat-bed screen printing. In the textile industry, this process is an automated version of the older hand operated screen printing. For each color in the print design, a separate screen must be constructed or engraved. If the design has four colors, then four separate screens must be engraved. The modern flat-bed screen-printing machine consists of an in-feed device, a glue trough, a rotating continuous flat rubber blanket, flat-bed print table harnesses to lift and lower the flat screens, and a double-blade squeegee trough. The in-feed device allows for precise straight feeding of the textile fabric onto the rubber blanket. As the cloth is fed to the machine, it is lightly glued to the blanket to prevent any shifting of fabric or distortion during the printing process. The blanket carries the fabric under the screens, which are in the raised position. Once under the screens, the fabric stops, the screens are lowered, and an automatic squeegee trough moves across each screen, pushing print paste through the design or open areas of the screens. The screens are raised, the blanket precisely moves the fabric to the next color, and the process is repeated. Once each color has been applied, the fabric is removed from the blanket and then processed through the required fixation process. The rubber blanket is continuously washed, dried, and rotated back to the fabric in-feed area.

The flat-bed screen process is a semi-continuous, start-stop operation. From a productivity standpoint, the process is slow with production speeds in the range of 15-25 yards per minute. Additionally, the method has obvious design limits. The design repeat size is limited to the width and length dimensions of the flat screen. Also, no continuous patterns such as linear stripes are possible with this method. However, this method offers a number of advantages. Very wide machines can be constructed to accommodate fabrics such as sheets, blankets, bedspreads, carpets, or upholstery. Currently, approximately 15-18% of printed fabric production worldwide is done on flat-bed screen machines. A typical schematic is produced below :-

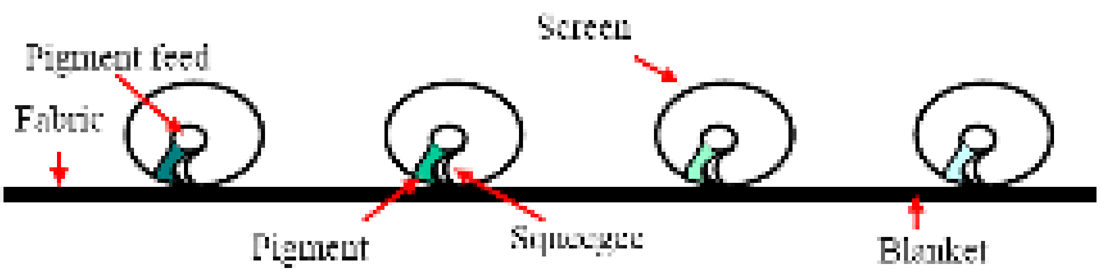


Rotary Screen Printing

In Rotary Screen printing machine, a flat screen is simply shaped into a roll by sealing the ends of the flat screen together and thus addresses the deficiencies of Flat Bed Printing Machines such as low productivity, and non-continuous patterns. The simple modification converts a semi-continuous process to a continuous one.

In basic operation, rotary screen and flat screen-printing machines are very similar. Both use the same type of in-feed device, glue trough, rotating blanket (print table), dryer, and fixation equipment.

Typical speeds are from 50-120 yards per minute (45-100 mpm) for rotary screen printing depending upon design complexity and fabric construction. Estimates indicate that this technique controls approximately 65% of the printed fabric market worldwide.



Drying and Finishing

Drying methods

Drying processes are carried out after every wet process (with exception of so called wet in wet processes which work with mechanical dewatered textiles without intermediate thermal drying step) and as a last step in finishing (often combined with heat setting) to make the textile goods ready for storage or delivery. Drying steps are in general very energy intensive. Depending on the drying temperature and the upstream processes considerable impacts to the off-gas due to volatile substances can be observed. Drying of the padded auxiliary is carried out by temperatures of approx. 120 °C; curing is carried out at temperatures between 150 °C and 180 °C.

Mechanical dewatering (predrying)

Mechanical dewatering of textiles previous to thermal processes is of considerable interest (in an ecological and economical sense) due to a high efficiency and a relative low energy consumption. The minimization of the moisture content in the textile goods allows shorter curing times in the following heat treatment. Mechanical dewatering is also used in wet/wet processes to reduce the water input to the subsequent bath.

The following methods are used:

- Squeezing mangle
- Suction devices
- Centrifugal extractors.

Thermal drying

Heat can be transferred with the following techniques:

- Convection drying (stenter, hot flue, perforated drum dryer, tumbler, yarn package drying)
- Contact drying (calender, cylinder drying machines)

- Infrared drying
- High-frequency drying.

Indirect heating is carried out with thermo oils, steam or hot water. In direct heating mainly natural gas (methane) or propane/butane is used.

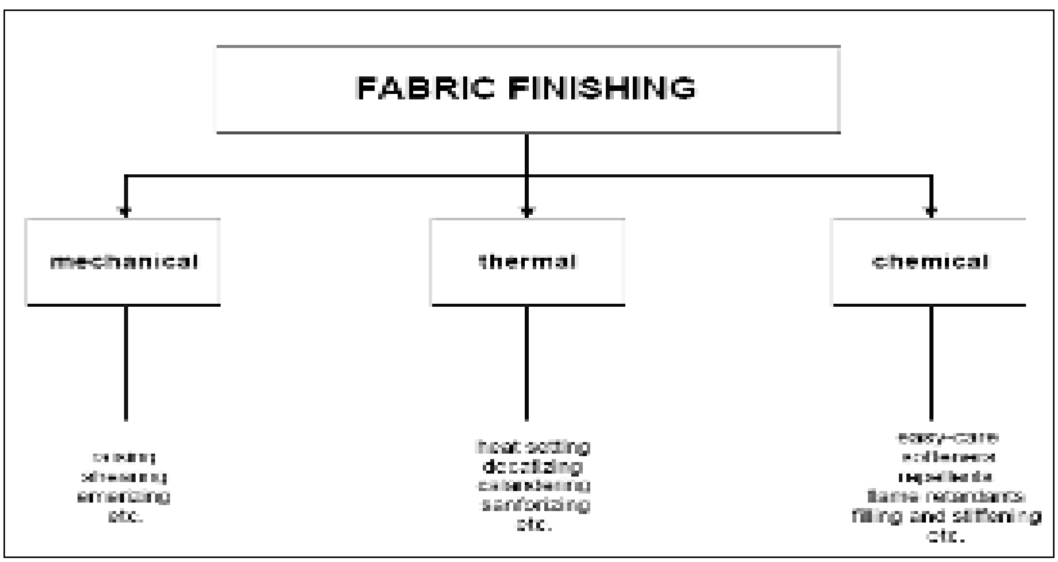
Heat Setting

Heat setting (also called thermofixation) is carried out on fabrics made of man-made fibres or blends of them with natural fibres to relax tensions in the textile fibres due to upstream fibre/yarn/fabric processing and to improve the dimensional stability of the textiles. Heat setting is carried out continuously in a stenter at temperatures between 170 – 220 °C.

The application of heat in heat setting can be done by **hot air**, on a pin stenter at 220°c for 20-30 seconds for polyester goods and at a lower temperature range of 190-225°C for 15 -20 seconds for polyamides. Acrylics may be heat set partially at 170-190 °c for 15-60 seconds to reduce formation of running creases.

Finishing

Typical fabric finishing processes are mentioned below :-



Steamer or Ager :

Fixation of polyester fabric is required to be done after printing. The steamer or ager is a continuous processing machinery wherein the fabric is exposed to saturated or superheated steam at a temperature of 170°C over 8 minutes. This allows synthetic fibres such as polyester to be continuously steamed. HT loop steamers are ideally suited to setting fabric that is sensitive to tension. These steamers have a temperature range between 100–180C. Steaming plays a decisive role in the fixation of dyes. The material is heated up rapidly in the steamer and wetted by the condensate. The dye migrates from the liquor into the fibre and is fixed. This process is an exhaust dyeing process with a short liquor ratio (1 : 0.7–1 : 1)

Polymerisation :

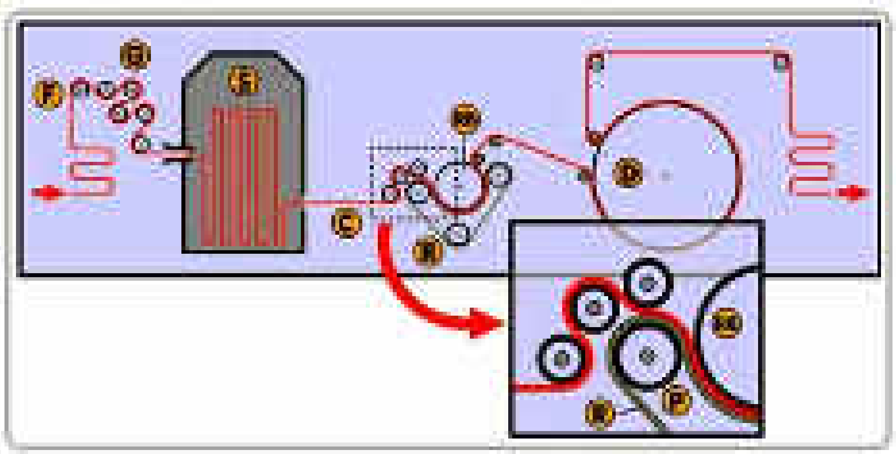
This is again curing process wherein hot air is used to raise temperature of printed fabric to 170°C and Thermopak supplies heat.

Sanforizing / Calender / Felt Finish

Sanforizing is a process of compressive shrinkage which is a Mechanical process for applying a Pre-shrunk finish and reducing residual shrinkage in textiles. One of the factors affecting the suitability for purpose of a textile is its ability not to shrink when it gets wet or is washed. Dimensional stability is required. The shrinkage of woven and knitted fabrics is partly attributable to tensions imposed during the manufacturing cycle These tensions are released in finishing.

But tension-free finishing alone is not sufficient for achieving a fully-shrunk finish. Methods of compressive shrinking are intended especially for fabrics in 100% cotton and its blends with synthetic fibres. The fabric entry to the rubber belt shrinking unit is formed by the sandwich created by a large heated cylinder and a continuous rubber belt (67 mm thick, 40 Shore hardness). The fabric is placed on the extended surface of the rubber belt and is thus forcibly contracted by the shortening of the surface of the rubber belt, with the smooth surface of the cylinder presenting virtually no impediment to this process. The greater the contact pressure of the rubber belt the greater the shrinkage.

The purpose of the process is to shrink fabrics in such a way that textiles made up of these fabrics do not shrink during washing. The process can be described by the following schematic:



Fabric passes through the skyer or other moistening device and is moistened by water and/or steam. This will lubricate the fibers and promote shrinkability within the fabric. Normally, a fabric must be moistened in such a way that every single thread achieves a moisture content of approximately 15%. This allows compression of the fabric with very little resistance.

When the fabric passes through the clip expander we obtain the required width. The clip expander also transports the fabric to the most important part of the machine: the rubber belt unit (indicated by arrows in above figure). By squeezing rubber belt between pressure roll and rubber belt cylinder , we obtain an elastic stretching of the rubber belt surface. The more we squeeze the rubber belt, the more the surface is stretched. This point of squeezing is known as the pressure zone, or the nip point.

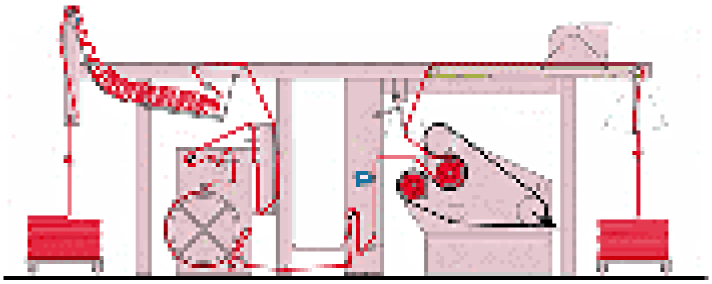
Fabric is now fed into the pressure zone. When leaving the pressure zone, the rubber belt recovers itself and the surface returns to its original length carrying the fabric with it. The effect of this action is a shorting of the warp yarn which packs the filling yarns closer together. At this actual moment, shrinkage occurs.

After compaction within the rubber belt unit, the fabric enters the dryer. Here the fibers are locked in their shrunken state by removing the moisture from the fabric.

Decatising

Decatizing (or decatising) mainly imparts dimensional stability to the textile fabrics. Also creases are removed and the fabric is smoothened. Here the principle involved is controlled relaxation of strains stored in a fabric. Fabric along with a felt are rolled in open width onto a perforated cylinder and subjected to super heated steam. Here it is important that the wool felt used should not be so hard that the silk fabric is not pressed flat.

Conventional continuous decatizers work with the suction principle by which temperatures of only up to 105°C can be achieved. Touch, lustre, volume, degree of fixation and elasticity can be influenced within wide bounds through humidity, temperature and pressure whereby the height of temperature is a decisive factor.



Washing

Fabric is washed several times during wet processing depending upon the processes it is subjected to. In most of the pretreatment, washing is an integral part of the process. Also, washing is done as an integral part of dyeing process as well. In case of printing, the dye fixation is done thereafter the fabric is taken for washing which precedes final finishing..

Washing before final finishing consists of process called reduction and clearance, wherein, the various processes degumming, hot washing, cold washing, alkali wash etc. is conducted. After washing, the cloth is dried and then taken for final finish. Many of the units in Pali adopt water reuse as well and the effluent from Dye wash is used in degumming process. Also, water of final wash is taken for washing of the belt of printing machines (Flat bed / Rotary).

2.4 Current policies and initiatives of local bodies, if any :-

Various incentive schemes of State and Central government are available to the units. However, these incentives are available only for Capital Expenditure and are tied with availing of loan.

Government of Rajasthan gives 5% interest subsidy on loans taken by units from scheduled banks. MSME DI under Ministry of SSI Government of India has a scheme of giving 15% upfront subsidy on loan amount upto a maximum of 15 Lacs. The units may get 5% interest subsidy under TUFs scheme of the Ministry of textiles, Govt. of India. Besides, Financial Institutions like SIDBI offer JICA line of credit for Energy Efficiency Projects at a concessional interest rate.

Detailed policies of the banks and other institutions for financing Energy Efficiency Projects are placed in the section at the end of this report.

2.5 Issues related to energy usage and conservation and barrier in technology up gradation

2.5.1 Energy availability :

Reliable and quality power is available in the cluster with maximum 2 hour pre announced power cut per day in Agriculture Season. The units have back up power in the form of Emergency DG Sets to have incessant working.

Fuel availability, though, is a problem as coal is not locally produced and only for Residual Pet Coke (RPC), there is no supplier other than Reliance Industries Ltd. The units in Pali had to suffer badly when supply of lignite from Gujarat was stopped by a government order. The units are always worried about uninterrupted supply of fuel.

2.5.2 Technological issues :-

Out of all the machinery required by the cluster, only Jigger, Kiers and Felt / Blanket finishing machines are manufactured locally in Pali. The units in Pali Cluster depend mainly on Gujarat for all their machinery requirements. Also, none of the outside machinery supplier has any Dealership or Service Point here in Pali. Thus, after sales service is always a problem for all the machinery.

Most of the units fall under Hand processing category, thus their requirement of machines is limited. Furthermore, non-availability of local consultants is the biggest roadblock in penetration of modern technology as there are not sufficient demontration centers in the vicinity to exhibit the working of new and modern machinery.

The units need to be taken through the process of making a business plan involving production as well as marketing and financial audit. The process would make the units amenable to interventions, soft or hard.

Every unit has different process and there is strong possibility of taking best practices of one unit to all other units. The cluster is a fit case for benchmarking of processes and propagating environmentally better processes. The issues of World Class manufacturing can be implemented in the cluster and benefit as envisaged in the Government of India policy can be extended to the units in the cluster.

2.5.3 Financial issues

The units in the cluster are not amenable to the idea of taking loans and this attitude also may be one of the factors responsible for non adoption of modern technology. The units here do not want to get into the hassle of taking loan due to contrasting demands of documents by the bankers.

The units here are literally free of any encumbrances and are fit case for extension of loans.

It is strongly felt that rather than packaging the finances with incentives like lower interest rates and subsidy etc., the delivery mechanism of loans needs to be facilitated by proactive and transparent methodologies.

Above all, the extension of any such facility needs to be time bound and decision like yes or no should be given immediately and firmly in numerous cases, the banks initially agree for extending loan and then suddenly refuse in the last minute creating a situation of desperation among entrepreneurs.

3.

Energy Audit and Technology Assessment

3.1 Methodologies

3.1.1 Energy use and technical study :-

Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings included the following:-

a) Discussions with the Enterpreneurs, Technology Suppliers, Review of Literature etc. for **identification of major areas of focus** and other related systems.

b) A team of professionals visited the plant and had discussions with the concerned entrepreneurs / supervisors to collect data/ information on the Load Distribution and Energy Consumption pattern. The data was analysed to evaluate the specific power consumption and also to arrive at a **base line energy consumption pattern**.

c) **Measurements and monitoring** with the help of appropriate instruments including continuous and/ or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.

Computation and in-depth analysis of the collected data, including utilization of computerised analysis and other techniques as appropriate was done to draw inferences and to **evolve suitable energy conservation plan/s** for improvements/ reduction in specific energy consumption.

3.1.1.1 Pre-energy audit activities

This formed major part of the project wherein a list of stakeholders including working units, Equipment Suppliers, Bankers, Service Providers, Deptt. Of Industries etc was prepared and a kick off seminar was organized to inform the stakeholders about the project. For creating mass awareness and also for sensitizing the entrepreneurs, press coverage was arranged.

Before starting the Energy Audit, help of the Government of Rajasthan was also sought. The Industry department of Govt. of Rajasthan was kind enough to depute an inspector from the District Industries Centre (DIC) to facilitate the complete project. The General Manager of DIC Pali along with staff helped in the complete Energy Auditing process, participated in the seminar and exhorted the Entrepreneurs to make use of this opportunity and cooperate for the success of the project, which was in their benefit.

The financial institutions were also present in the seminar. The Deputy General Manager of SIDBI made presentation on financial reengineering and also informed the house about JICA line of credit tied up for the project. The details of JICA line of credit viz. credit guarantee and collaterals etc. were deliberated in detail.

The clippings of newspaper report are enclosed.


ऊर्जा बचाओ अभियान

का आगाज आज

The kickoff seminar was followed by classification of units so as to cover the complete spectrum of process and vintage of technologies. A questionnaire was also developed to gather requisite details for the project.

Survey regarding technology availability and mechanism of delivery in Pali was conducted and proposals were obtained from the equipment suppliers.

कारखानों में ऊर्जा बचत के प्रयास जरूरी

भास्कर न्यूज | पाली

[illegible]

3.1.1.2 Preliminary energy study

The Preliminary Energy Audit involved physical visit of the units to fill up questionnaire and assess Energy use Pattern. The questionnaire also collected details of product, processes, equipments, best practices if any and other generic parameters. This also involved some preliminary measurements like Flue Gas Analysis, Measurements of Electrical Parameters etc wherever feasible. The Preliminary Energy Audit also resulted in finalization of typical Energy Assessment Plan for the machines available in the units.

3.1.1.3 Detailed energy study

Detailed Energy Audit involved mapping of Electrical Demand Pattern, Complete Analysis of Electricity Distribution Network, Recording of Electrical Parameters of all major electrical loads, Complete Analysis of Steam Generation, Distribution and Utilisation, Complete Analysis of Thermopaks and Heat Utilisation, Insulation Surveys, Assessment of Compressed Air System and other generic issues.

Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and assessment of Energy saving potential include the following:

- Collection of detailed data
- Discussions with the directors and sectional heads to understand the processes, Energy Monitoring System in place and future roadmap. The discussion also included presentation of our complete action plan for completing the Energy Audit job.
- **Measurements and monitoring** with the help of appropriate instruments including continuous and/ or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.
- Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques as appropriate were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.

3.2 Observations made during the energy use and technology studies carried out in the cluster

The following observations led to the conclusion on Energy use and Technology Gap :-

1. The units in Pali more or less have very good technology. However, the process control and automation system was not being used.
2. The industries would be ready to adopt the proposed system as Energy forms the biggest single expenses head for the entrepreneurs.
3. The units have adopted VFD very willingly even though the full benefit of the same is not being reaped. This shows that adoption of technology would not be a problem.
4. Biggest issue in adoption of technology, specially laden with automation and electronic circuit, is availability of after sales service or remedial service which is reliable and prompt.

3.2.1 Manufacturing process and technology /equipments employed

The units have different processes and equipments depending upon the jobs undertaken, domain of operation and Hand Process / Power Process.

Process adopted for Cotton Dyeing and Finishing. Process adopted for Cotton / Polyester Blend Dyeing and Finishing Process adopted for Polyester Dyeing and Finishing

List of Equipments Surveyed:-

1. Desizing & Singeing M/c
b. Washing Range
c. Merceriser
d. Bleaching JT
e. Kier Boiler
f. J Box
g. Soft Flow Machine
h. Jiggers
i. Jet Dyeing Machine
j. Stenters
k. Decatizing machines
l. Sanforizing Machines (Blanket Felt / Zero Zero Felt)
m. Loop Ager
n. Flat Bed Printing Machines
o. Rotary Screen Printing Machines
p. Electrical Distribution Network
q. Boiler and Steam Distribution cum utilization system
r. Thermopak and Heat transmission as well as utilization systems
s. Monitoring of Steam Traps

3.2.2 Energy consumption profile & availability

The various solid fuels used in the cluster is elaborated above under section 2.2.1. Electricity drawal pattern was recorded as far as practicable in the units taken up for Energy Auditing so as to have insight into the typical Consumption Profile of units. The measurement of Fuel Consumption was done as far as possible to arrive at the typical heating fuel consumption pattern.

The power is supplied from the nearby 133 KV substation and all the bigger consumers are supplied power at 11 KV. The quality of power is very good and there is hardly any power cut. Power cut to the tune of 2 hours per day is effected during agricultural season but the units have DG sets to take care of such exigencies.

Availability of heating fuel is very critical for the cluster as there are no local sources of the fuel. The units were earlier using Lignite brought from Gujarat but the same is not available for sale in Rajasthan anymore. Consequently, the units had to take urgent action to convert their Boilers and Thermopaks to Residual Pet Coke. Now most of the units use RPC for heating application. Some of the units use steam coke in their package boilers and some others use wood and Bio Mass Briquettes in boilers and other heating applications.

3.2.3 Capacity utilization factor

The power process units operate on more than 100% capacity utilization as against the installed capacity. However, there is urgent need to reduce idling and downtime of the equipments. The hand process units consist mainly of locally fabricated machines and hence no number can be assigned to rated capacity. Being dependent mainly on manual labour, these units have a lot of ground to cover to attain rated capacity or maximum capacity.

Even during Economic Recession, the units here succeeded in maintaining their production and there has been no retrenchment of workers.

3.2.4 Housekeeping practices

The units handle water, dyes, chemicals, grey fabric, Residual Petcoke etc. which create lot of muck inside the premises.The housekeeping of the units was found to be poor and needs improvement. However, the units conduct a complete cleaning and refurbishment of the works during yearly 10 days closure during Jain Festival.

3.2.5 Availability of data and information

Getting reliable data was the toughest part of the project as no unit was ready to divulge correct production and fuel consumption data. Such data of only very few units was made available and hence these data for other units have been extrapolated for arriving at the Energy Conservation Potential. The production systems available in the unit and physically assessed level of production was kept in mind while extrapolating such data and hence these data can be taken to be quite correct.

Furthermore, The group of companies having more than one unit do not have separate accounting of resources, specially that of fuel, and also production for different units are not differentiated. These units mostly are into different product segments and hence the calculation of SFC becomes difficult.

3.2.6 Other issues

One of the reasons for growth of the cluster in Pali despite all odds has been very high solar radiation i.,e. 6 to 7 kwh/m2 and dry climate for over 350 days per year which allows the units to dry clothes in sun. After every wet process, the cloth is spread in open to dry. Lot of cloth gets soiled or dirt spoils it during this open air drying process. The units need a solution to this and the same has been worked out in the project.

The biggest barrier to energy efficiency improvement in the cluster has been lack of trained and skilled manpower. Persons working in the cluster have learnt the job by experience under the tutelage of old workers and hence are not amenable to new ideas. These workers generally carry the notion that what they do is the best and new technology and practices only bring complexity and do not really improve performance.

One more issue plaguing the cluster is that most of the job is being got done on contract. In a few cases, the whole unit has been contracted to some body who operates it on behalf of the actual owners. Any technological intervention is simply not possible in such units as the facility is owned by the person who is not going to be benefited by any such initiative. Even for units being run by the owners, various sections like Dyeing, Stenter, Felt, Boiler & Thermopak etc. has been given to separate contractors. Even, electrical maintenance is with outsiders whose job is very adhoc.

The only priority seems to be getting production at any cost and the cost here is generally Energy which is not monitored and hence not accounted for. Here, increase of production is not with respect to any benchmark, rather it is based on local conditions and is supposed to be achieved without any technological intervention.

3.3 Technology gap analysis

3.3.1 Technology up-gradation

The Textile Wet Processing is a very old production process, which has got fully matured over the years, and the transformation in technology in the sector is very slow. There has not been any big bang technological breakthrough in the sector except discovery of some new Dye / Chemical / Enzyme to make the process more environmental friendly.

On Machineries front, only a couple of basic developments have taken place worldwide and these are use of Foam Finish Technlogy, Ultrasound Dyeing and Infra Red Heating. The foam finish technology has been getting discussed academically world over for a long time but it has been commercially implemented only recently. But this technology has not yet come to India. As far as use of Ultrasound Dyeing and Infrared drying is concerned, the same may not find use in the cluster as of now.

However initiative of technologists to build Energy Efficiency intrinsically into machinery itself and development of computer enabled process control methodology to existing machinery has brought sea change in the way textile processing is done.

The technology in an enterprise functioning in a non proprietary technology domain has 3 basic classification to describe the production process:-

1. The Equipments utilized
2. The process used and
3. The process parameters control system

a) Equipments Utilized

The units in the Pali Textile Cluster can broadly be classified as

a.1. Hand Process Units

a.2. Power Process Units

Hand Process Units: The hand process units typically function without much of machinery and the production is done by manual labour. These units necessarily function on thumb rules and process may not give output which is reproducible. Energy Utilization in these units is very low and the quality of output also is not that good. Also, production from these units is very less. The units under this category would need a paradigm shift in the way they do business from manual to mechanization and it would need reworking of the entire business plan and all the business processes viz. production, procurement, marketing etc would need complete reengineering.

Power Process Units : The power process units use machineries for most of the processes required for wet processing. The technology here is exhibited in the form of machineries here. The basic machinery used in the power process units of the cluster is same as those used anywhere else in the world. For example, the Jet Dyeing Machine, the Stenters, the Shrinking Machine are the one's which are used anywhere in the world for similar production process. In terms of utilities also, the units in Pali use very efficient Steam Generation and Utilization System and also the thermopak is as efficient as anywhere in the world.

However, some of the units use old model of the machines like open stenters and these need to be changed.

b) **Process Used :-** The process used in the Pali Textile Cluster is more or less same as that used anywhere in the world. There has always been variation of the basic process to impart special finish to the fabric. Only area of improvement identified in the process side is basically one required for facilitation of the dyeing process and this is use of computerized colour matching and automated colour kitchen so as to get the required shade with the least possible processing and also with minimum consumption of Dyes.

c) Process Parameter control system : The study could find immense opportunity of making the textile processing Energy Efficient by technologically modifying the process parameter control system.

Thus, the study did not really fiind any big bang technological change required to be introduced in the cluster. However, what is required is retrofit of smaller add-ons to the existing machinery so as to make energy consuming components of the machinery efficient and also and also use of automation to ensure precise process control. A table depicting machinery-wise intervention required is appended below:-

Machinery	Technology Gap identified
Jet Dyeing Machine	1. Insulation of the body of Jet Dyeing Machine 2. Installation of VFD in water pump 3. Provision of Energy Efficient Pumps 4. Waste Heat recovery from Dye Effluent
Stenter	a Moisture Control a. Temperature Control (Overheating) b. Speed control c. Humidity Control d. Blower control e. Blocking Excess Area in air nojjle f. Waste Heat recovery g. Idling Control h. Installation of Vacuum Slit in Stenter i. VFDs in stenter fans and installation of Energy efficient Fans j. Foam Finish Application System k. Optimisation of Nip Presure in mangle to improve mangle expression, installation of seam detection system
Flat Bed printing machine	a. Auto Temperature Control in Relax Dryer b. Blocking air jet nojjle in the relax dryer c. Installation of VFD in Fans
Machinery	Technology Gap identified
Roary Printing Machine	a. Auto Temperature Control in Relax Dryer b. Blocking air jet nojjle in the relax dryer c. Installation of VFD in Fans
Boiler	a. Hearth Area redesign b. FD and ID fan optimization, installation of VFD

	c. Installation of Oxygen Trim d. Installation of DM water Plant e. Installation of Air Preheater / Economiser for Waste Heat Recovery f. Soot Blowing and removal of scale from heat tranfer surfaces g. Flash Steam and Condensate recovery from Jet Dyeing Machine h. Flash Steam and Condensate recovery from Kiers i. Flash Steam and Condensate recovery from Soft Flow Machines j. Flash Steam and Condensate recovery from Decatising Machine / Felt Finishing Machine k. Refurbishment of insulation in pipelines l. Insulation of steam valves, condensate separators, Pressure Reduction Stations m. Insulation of condensate recovery lines Flash Steam Recovery Lines n. Maintenance of steam Traps o. Over capacity
Thermopak	a. Hearth Area Reduction b. FD and ID Fan Optimisation c. Installation of Oxygen Trim d. VFD in Thermic Fluid Circulation Pump e. Insulation of Auto Thermic Fluid Valves in Stenters
Jiggers	a. Temperature control system b. Computerised Colour Matching c. Provision of Cover d. Heat Recovery from Dye Effluent
Washing	a. Temperature Control
Cogeneration	a. Installation of cogeneration system
Solar Tunnel Dryer	a. Installation of Solar Tunnel Dryer
Solar Water Heater	a. Installation of Solar Water Heater System

The Energy Conservation Opportunities along with techno commercials is elaborated in respective segments in the next chapter.

3.4. ENERGY CONSERVATION MEASURES IDENTIFIED

3.4.1. List of Proposals For Energy Conservation including Technology Upgradation:-

The following proposals for Energy Conservation have been identified :

Proposals for Energy Saving in Pali Textile Cluster

1. Cogeneration
2. Solar Tunnel Dryer
3. Solar Water Heater
4. Boiler Optimization System
   a. Hearth Area redesign
   b. FD and ID fan optimization, installation of VFD
   c. Installation of Oxygen Trim
   d. Installation of DM water Plant
   e. Installation of Air Preheater / Economiser for Waste Heat Recovery
   f. Soot Blowing and removal of scale from heat tranfer surfaces
5. Condensate and Flash Steam Recovery System
   a. Flash Steam and Condensate recovery from Jet Dyeing Machine
   b. Flash Steam and Condensate recovery from Kiers
   c. Flash Steam and Condensate recovery from Soft Flow Machines
   d. Flash Steam and Condensate recovery from Decatising Machine / Felt Finishing Machine
6. Thermopak Optimisation System
   a. Hearth Area Reduction
   b. FD and ID Fan Optimisation
   c. Installation of Oxygen Trim
   d. VFD in Thermic Fluid Circulation Pump
7. Improvement of insulation in Steam and Thermic Fluid Distribution system
   a. Refurbishment of insulation in pipelines
   b. Insulation of steam valves, condensate separators, Pressure Reduction Stations

   c. Insulation of condensate recovery lines Flash Steam Recovery Lines
   d. Insulation of Auto Thermic Fluid Valves in Stenters
8. Maintenance of Steam Traps
9. Jet Dyeing Machine Optimisation System
   a. Provision of Insulation
   b. Provision of VFD in Pump
   c. Provision of Energy Efficient Pumps
10. Jigger Optimisation System
    a. Temperature control system
    b. Computerised Colour Matching
    c. Provision of Cover
11. Stenter Optimization system
    a. Moisture Control
    b. Temperature Control (Overheating)
    c. Speed control
    d. Humidity Control
    e. Blower control
12. Waste Heat Recovery from Stenter Exhaust, Ager Exhaust and Dye Effluents
13. Installation of Vacuum Slit in Stenter
14. VFDs in stenter fans and installation of Energy efficient Fans
15. Foam Finish Application System
16. Optimisation of Nip Presure in mangle to improve mangle expression, installation of seam detection system
17. Electrical Distribution Network optimization
18. Printing Machine Optimisation System
    a. Automatic Temperature Control System
    b. Fan speed Optimisation
    c. Blocking excess area in Air Jet

3.4.1.1 Proposal description including technology/product specifications for each proposal, Benefits of each proposal, Cost of implementation, Monetary savings and Simple Pay Back Period

The machineries used in the Pali Textile Cluster are the same as those used in any other place for similar application. Not much development has taken place all over the world on the basic machines and the basic processes. However, with the advent of IT age and advanced process control system and practices, the Energy Consumption profile elsewhere has undergone a sea change. The process control part has not yet made inroads into the cluster and hence huge opportunity to save Energy has been observed.

The opportunities mentioned in the following section have been identified keeping in mind the applicability, acceptability, maintainability and above all availability of space.

Some of the process control systems like waste heat recovery from Stenter Exhaust have been adopted worldwide and form part of standard feature of the machine. However, there are no fabricator available in India and hence the system needs to be developed.

There has been good development on the steamer front and 2 major developments viz. steam recirculation and heating and also direct firing of Flue Gas of Natural Gas has brought down the consumption of steam from 700-1200 Kg/hr to 300-600 Kg per hour. As per discussion with Ager Manufacturers, there is scope for further reducing the consumption but the system is not available and hence will have to be worked out.

Systems like foam finish have been adopted elsewhere but no company offers it here in India. Also, Ultrasonic Dyeing, Plasma Dyeing, RF heating etc have not found any takers in India and hence have not been included in the recommendations. Technology wise list of barriers in implementation is appended in the conclusion section.

The recommendations along with brief description and the Techno Commercial Economics are mentioned below :-

3.4.1.A ELECTRICITY DISTRIBUTION NETWORK

The industries in the cluster have there own employees taking care of minor fault in electricity utilisation system. All the industries invariably have outsourced the job of electrical system maintenance to Service Providers who are not adequately skilled. They are the one's who serve as consultants to the industries for any upgradation job in the Industry. Consequently, capacity building of these service providers becomes critical to any exercise of this sort as undertaken by BEE.

a) Tariff Structure at HT connection FOR units at

1.	Supply Authority	= Jodhpur Vidyut Vitran Nigam Ltd
2.	Supply Voltage	= 11 KV / LT depending upon load
3.	Contract Demand (CD)	= Upto 300 KVA
4.	Fixed Charges /Demand Charges	= @Rs 70 per KVA of (75% of CD or actual which ever is higher)
5.	Minimum Monthly Charges	= None
6.	Energy Charges	= Rs 4.01/ kWh
7.	Electricity Duty	= Rs 0.40 / kWh
8.	Municipal Tax	= nil
9.	Average Energy Charges	= Rs 4.5 /kWh (For PF 0.99)
10.	Service Charges	= nil
11.	Meter Rent	= Rs 900
12.	Transformer rent	= nil
13.	Power Factor Rebate/Penalty :	
	$0.99 \geq PF > 0.95$	= Rebate @ 1% for every step of 0.01
	$0.95 \geq PF \geq 0.90$	= no incentive, no penalty
	$0.90 > PF$	= Penalty @ 1% of energy charges for every step of 0.01

b) Maximum Demand : The Contract demand in most of the units were found to be in order with no scope for any reduction. In a few units, the potential for downward revision was observed and the same was pointed out to the units then and there for immediate action. A few units like Minerva Industries had paid penalty due to overshooting of MD and the same was not known to them. A couple of units have installed MD controller of SOCOMEC make. The units have been suggested to install MD controller and keep strict control over their maximum demand so as to take maximum benefit of saving in MD.

c) Power Factor : The units in the Industrial Area Ph I and Phase II maintain PF above 0.99. The units in the Mandia Road Industrial Area are happy maintaining PF above 0.90 so as to avoid penalty. It was gathered during the study that the entrepreneurs in the Mandia Road Industrial Area carry a notion that maintaining PF above 0.95 would increase electricity consumption. We succeeded in breaking the myth and make everybody understand the benefits of maintaining PF over 0.995 The cost benefit analysis is given below :

Calculation of Cost Benefit Analysis of improving PF	
Monthly Consumption	75000 Kwh
Yearly Consumption	900000 Kwh
Maximum Possible PF Rebate @ 4.5% for Energy cost @ Rs. 4.01 per kwh	Rs. 162405/-
For a 200 KW load, capacitor required for improving PF from 0.95 to 0.995	45 KVAR
Investment in Capacitor and Relay / Cable / Panel etc	1.0 Lacs
Simple Pay Back Period	7.4 months

Cluster Manual - Pali Textile Cluster

d) Other Recommendations:

a) A comprehensive Register or computerised file should be maintained to monitor the monthly energy bill parameters on monthly basis.

b) Presently no record of the capacitors installed in the Industry is maintained. The capacitor ratings is not recorded and no mechanism to ensure successful working of these capacitors exist. On weekly basis, the capacitor currents should be monitored. The failed and weak ones (consuming less than 75% of their rated current capacity) must be replaced immediately.

c) The new capacitors should be purchased of the kind wherein any capacitor of any one phase can be replaced independently, instead of the entire capacitor bank.

d) Fixed capacitors at the load end getting energised only after the load is switched on needs to be installed and the capacitors in the APFC panel is required for minor correction only. This would also reduce cable losses.

e) It is advised to note the readings of Energy meter on daily basis as per the format below.

Sr No	Date	Voltage	Current	Instantaneous power factor (Cosθ)	kWh	KVAh	Power Factor till date:	Maximum demand
					A	B	A/B	
1								
2								
3								

3.1.2 Potential Savings :

Only minor energy saving by way of reduction in cable losses takes place due to properly controlling PF at the load end. However, monetary saving accrues to the industries by way of incentive from utilities and also reduced maximum demand. Moreover, the utilities gain due to lesser KVA drawn by the Industries.

3.1.3 Cost Benefit Analysis of PF improvement

In a typical power process unit in Pali, Electricity consumption is to the tune of over 75000 Kwh per month. Considering the present PF to be 0.95, cost benefit can be calculated as below :-

3.4.1.B
PERFORMANCE OF DG SET

1. Most of the power process units have one or two DG sets but the operating hour is very less. The performance of the DG Sets is not being monitored, mostly due to non-availability of Energy Meter at the output.

   The performance test conducted on new DG sets established that they are o erating satisfactorily. However, the older one's need overhaul.

2. Observations & Recommendations:

a) The performance of DG Set should be monitored on the basis of Kwh / Ltr and not on Liter / Hr. Thus it is necessary to record the Kwh generated and also the fuel consumed. 3.8 Kwh/ltr to 4.2 kwh/ltr performance levels is satisfactory.

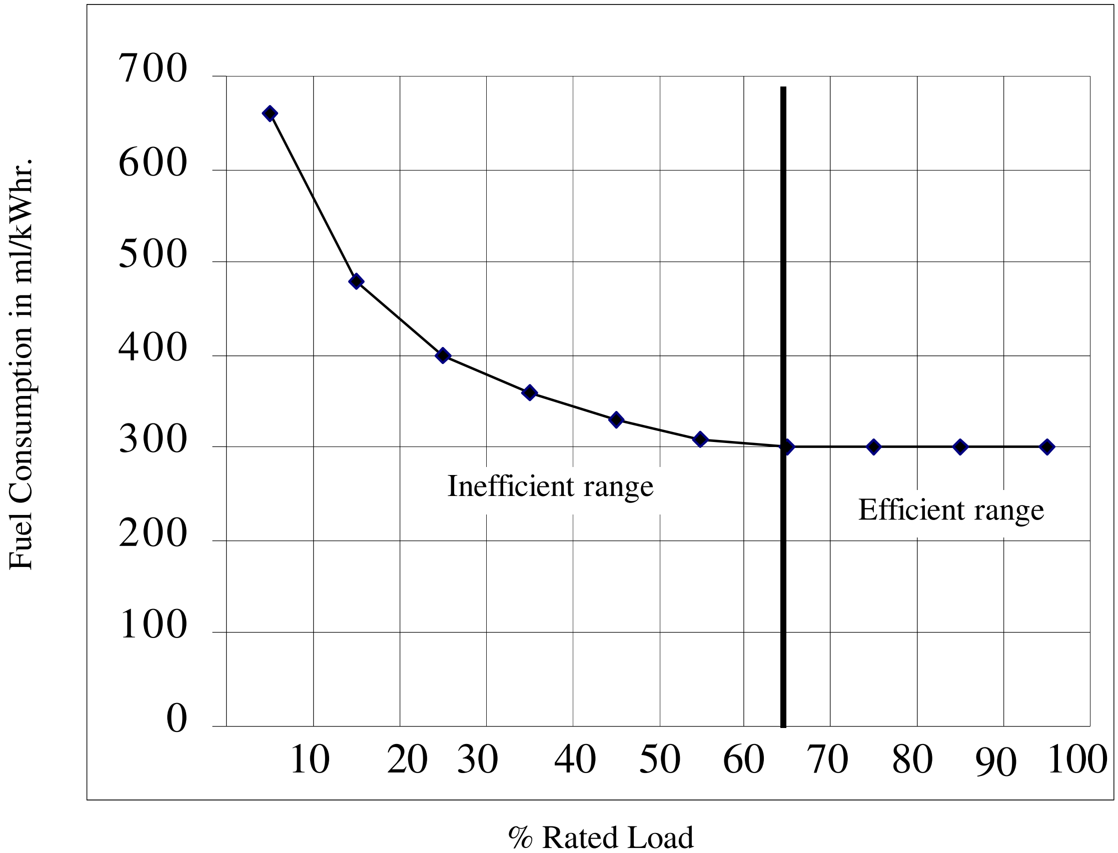
b) It should be ensured that the single-phase loads on the DG Set should be distributed appropriately so that the unbalance between the 3 phases is not more than 10% of the total DG Set capacity. Presently it is satisfactory.

c) The loading of the DG Set as shown in Fig.-1 significantly influences the fuel efficiency of a DG Set. The associated losses due to operation of the set below the optimum limit is reflected by significant increase in the specific fuel consumption as can be seen from the Fig. 1. Generator should be loaded between 65% to 85%. The loading beyond 85% does not give any extra efficiency, but it decreases engine life.

d) The lube oil consumption should not exceed 1% of fuel consumption.

e) DG room should be properly ventilated to achieve best results. The allowable temperature of inlet air is ambient ±5°C. Arrangements should be made to maintain required inlet air temperature, because for every 3°C rise in inlet air temperature there is 1% loss of fuel.

f) The following curve gives the fuel consumption corresponding to percent rated load.



Load Characteristics of DG Set

In Pali Cluster, DG set is available with most of the units but it is not used very often due to better power availability. Consequently, no Energy Saving Potential could be identified in the DG Sets.

3.4.1.C
STUDY OF MOTIVE LOAD

1. **Brief Description:** Efficiency of any given motor depends upon percentage loading to a great extent. As the percent loading of the motor decreases, the efficiency and Power Factor decreases. It is a fact that some margin should be kept while selecting size of any motor. Drop in efficiency becomes significant below 65% loading. It decreases very sharply below 40% loading.
2. **Measurement of Electrical Parameters of Different Motors:** Parameters like load Current (I), Power Factor (P.F), and terminal Voltage (V) and input Power (kW) were measured for the different motors. All the electrical parameters and percent loading (calculated) are tabulated in Annexure –1.

Criteria:

For Motor Loading analysis:

If % loading > 100%,	: Overloaded
If % loading >50% and < 100%	: Satisfactory
If % loading < 50%	: Under-loaded and operating in low efficiency zone

3 **Observations & Recommendations:**

1) The biggest motor in the cluster is that of the Thermic Fluid Pump and ID / FD fans of Boiler an Thermopak. The loading of the motors was conducted and was found to be above 50% levels.

2) It is recommended that motors burnt out should be re winded in standard rewinding workshop and motors burnt out thrice should be replaced by new motor and put in standby operation or for lower duty operation. Resistance per phase and no load input parameters of voltage & current of all the motors should be kept to compare it with the parameters after rewinding for evaluating the quality of rewinding.

3) The continuous operation motors should be replaced with extra energy efficient motors (EF I) with 93% efficiency (from standard efficiency chart motors between 22 KW to 37 KW have efficiency of 93%) as the extra capital cost is recovered in the first 1.5 years of operation by the amount of energy saved by these motors. This activity may be carried out after the motor is burnt out thrice or whenever there is an opportunity of finding alternate operation of the existing motors.

4) If the environment is very dusty, regular cleaning of the motors shall improve the life of the motors.

5) Motors should be preferably directly coupled. If it is belt driven, then instead of V Belts, more efficient flat belts should be preferred.

3.4.1.C
COMPRESSED AIR SYSTEM

The compressed air system is the costliest form of storing, transmitting and utilizing Energy as approx. 10% of the input energy gets converted into utilizable energy at the point of use. Rest of the power drawn by the compressor is dissipated by way of heat. The basic energy conservation approach in Air Compressor may broadly be classified as Demand Side Management and Supply side Management.

Brief Description: The textile dyeing and processing units need compressed air for instrumentation and mechanical squeezing. Stenter, Decatizing Machine and Flat Bed Printing / Rotary Screen Printing machines need compressed air for instrumentation. The mangle uses Air Pressure for squeezing water out of the fabric so as to reduce evaporation load on stenters.

Performance tests and measurement of output CFM / volumetric efficiency of compressor was conducted and the deficiencies were pointed out for rectification.

Observations and recommendations :

1. Pump up test – Evaluation of Free Air Delivered and Volumetric Efficiency should be conducted at regular intervals and any drop in the performance of the compressor should be addressed immediately.
2. Optimization of pressure setting of Compressors:

The running of Compressors is being controlled by pressure switches, which is set keeping in mind the required working pressure. On achieving the Unloading pressure, the compressors trips, and restarts on reaching the loading pressure. A ½ Kg/cm^2 reduction in compressed air pressure results in 5% reduction in energy consumptin and about 14% reduction in consumption. There are enough opportunity for energy saving in the cluster by reducing pressure settings. The loading or cut in process should be within 0.25 Kg/cm^2 of the required air pressure and the Loading unloading (cut in – cut out) band should be the narrowest possible.

3. **Reducing Leakage & Wastage by way of misuse**

Avoiding leakage is the single largest opportunity of saving electrical energy in compressed air system. Moreover leakage can be estimated at plant level by noting the compressor loading and unloading time, during idle time, when all the end use equipment are not working. Following were the observation when the test was perfor med using C-2 only

$$\% \text{ Leakage} = \frac{\text{On load time}}{\text{On load time + off load time}} \times 100$$

Compressed air, leaks frequently at the air receiver moisture drain, hose joints, shut off valve and Moisture separator. In most cases, they are due to poor maintenance rather than improper installation and if the resultant power wastage were fully appreciated, it would be seen that any expenditure on sealing leaks could easily be recovered in energy savings.

Following table, give an idea of the Power wastage for different hole size.

Sl. No.	Hole dia (inch)	Air leakage at 100 PSI Pressure (CFM)	Power required to compress air being wasted (KW)
1	1/64	0.4	0.1
2	1/16	6.5	1.0
3	1/8	23.2	3.5

Detection of large leaks is simple because they are easily audible during lunch breaks but as large leaks usually start as small leaks regular checking of joints, unions etc. with soap solution may identify them immediately.

Leakage’s can further be reduced by:

- Using welded joints in place of threaded joints.
- Blinding points where air is not required and
- Isolating distribution lines of shops where no activity takes place during certain shifts by closing, the isolating valves.

Places where compressed air is being used for cleaning, blowers with nozzles may be provided. This shall not only avoid running of second compressor but **also** shall reduce the leakage, which are occurring from the flexible pipe joints. More over, such points are often used by operators for cleaning their clothes and misusing it.

Reduction of pressure drop in the pipeline by choosing low friction coefficient pipeline material and designing the sizes so as to keep the pressure drop in pipelines to minimum possible.

Cost Benefit Analysis :

1. **Maintaining Optimum Pressure Levels**

This is a no cost measure and hence will have no investment. Quantum of Returns likely to accrue to an unit is anywhere between 5% to 25% depending upon existing pressure levels.

2. **Arresting Leakage**

This is another very cost effective measure. Investment required for arresting leakage is minimal, however returns may be upto even 50% depending upon amount of compressed air leakage present in the system.

34.1.D

STUDY OF ILLUMINATION

1. There are different types of light fittings in the plant. A detailed inventory of the lights with type, area and wattage were studied. The major areas of lighting application were as under :-

2. Folding Area : This is the folding and packaging are of the industry and houses large no. of Tube lights, at times over a hundred of them are installed. All the tube lights were observed to be T12 and high dust deposition was observed on these luminaries. The operating hour of these tube lights is mostly 24 hours.

3. Printing machines : Every printing Machine has 9 Tube Lights installed. These Tube lights were mostly without any luminary and hence the light was not getting focused onto the work area. These tube lights are installed at a good height from the printing machine and hence make a case for lowering the height of the fixtures. One industry has replaced all these tube lights by CFLs. The operating hour of these tube lights is mostly 24 hours.

4. Other lighting application is mainly near different machines and walkways and no cluster of light can be defined. A detailed estimation of the saving potential would be elaborated in the Energy Audit Report. The operating hour of these tube lights is mostly 24 hours.

5. **Recommendations:**

1) The plants are using 40 Watt T/L with conventional electromagnetic choke. These can be replaced by 36 Watt T/L with Electronic Ballast (as the electromagnetic choke consumes about 15 watts as compared to Electronic Ballast, which consume only 1 to 2 watts). Recently, electronic igniters have been introduced in the market, which can replace the existing Electro Magnetic Chokes without any modification in the fixtures.

2) As a second option, 40 Watt T/L with conventional electromagnetic choke can be replaced by 28 Watt T/L (T5). These tube lights should be given priority, during purchases for new buildings and expansion of existing building and places where the running hour is more than 10 hours per day.

3) Provision of single feeder for lighting of the entire unit can be made and an Automatic Voltage Regulator can be installed, which shall not only reduce the maintenance cost of the lighting but also reduce the energy bill.

4) In the following table a comparative data for some of the prevalent lighting fixture is given below, which can be considered as a guideline to improve the above illumination system.

LUMINOUS EFFICACY AND LIFE OF PREVAILING LIGHT SOURCES

S. No.	Light Sources	Lamp Wattage (Watts)	Lumens	Efficacy (Lumens/watt)	Choke Rating	Average Service life (hours)	Colour Rendering index
1	Incandescent lamps (GLS)	100	1,360	14		1,000	100
2	Fluorescent tubes Fluorescent tubes (super)	40 36	2,400 3,250	60 90	15 2	5,000 14,000	70 70
3	T5 Fluorescent lamps	28	2,700	96	2	18,000	70
4	Compact Fluorescent lamp	15	810	56		8,000	85
5	High pressure mercury vapour lamp:	80 125 250 400	3,400 6,300 13,000 22,000	43 50 52 55	9 12 16 25	5,000 5,000 5,000 5,000	45 45 45 45
6	Metal Halide	70 150 250 400	4,200 10,500 19,000 31,000	84 70 76 76	26 20 25 60	10,000 10,000 10,000 10,000	70 70 70 70

S. No.	Light Sources	Lamp Wattage (Watts)	Lumens	Efficacy (Lumens/watt)	Choke Rating	Average Service life (hours)	Colour Rendering index
7	Halogen	500	20,000	22		2,000	100
8	High pressure sodium lamp:	70 150 250 400	5,600 14,000 25,000 47,000	80 93 100 118	13 20 20 40	15,000 15,000 15,000 15,000	25 25 25 25

5.4.1. Other measures to reduce lighting loads are:

1) Use more energy efficient lamps, replace incandescent with fluorescent lamp. Above Table gives the comprehensive data on lumens/watt and normal life of some of the types of lights available in the country.

2) Use zone switching. Use task lighting. Keep the light source as close as reasonably possible to the work place; as the light intensity decreases exponentially as the distance from the light source to the task increases. As in the case of inspection.

3) Make effective use of daylight wherever possible.

4) Always keep reflector clean.

5) Clean luminaries to increase illumination. Normally 10 to 20 % light output reduces over a period of six months if not cleaned.

6) Improve colour & reflectivity of walls, ceilings to reduce lighting energy needs.

7) Train personnel to switch off the light whenever not required, posters as reminders can be placed on the doors for this purpose.

8) Wherever LUX level is specified it must be counter checked by LUX meter, before and after switching ON the light and unnecessary lights to be switched OFF immediately.

9) During breaks the lights of the specific workplace should be switched OFF, for which individual switches hanging at the worktable shall be helpful.

10) Where it is possible, the entire lighting load can be supplied through voltage stabilizer (AVR). On maintaining 210 V single-phase voltage tremendous scope of savings exists.

5.4.2 Cost Benefit Analysis :-

Cost Benefit Analysis of a typical unit in Pali is Appended below :-

Electricity Saving in lighting by voltage optimization		
Total No. of Tubelights – T12	65	65
Total Consumption considering 50 W load	Watt	3250
Lighting Load	KW	3.2
Saving in Electricity by reducing voltage by 10%	12%	0.384
Yearly saving	Kwh	1382.4
Monetary Equivalent	`@ 4.6/-	6359.04
Cost of AVR 4 KVA		10000
Pay Back Period	Months	18.9

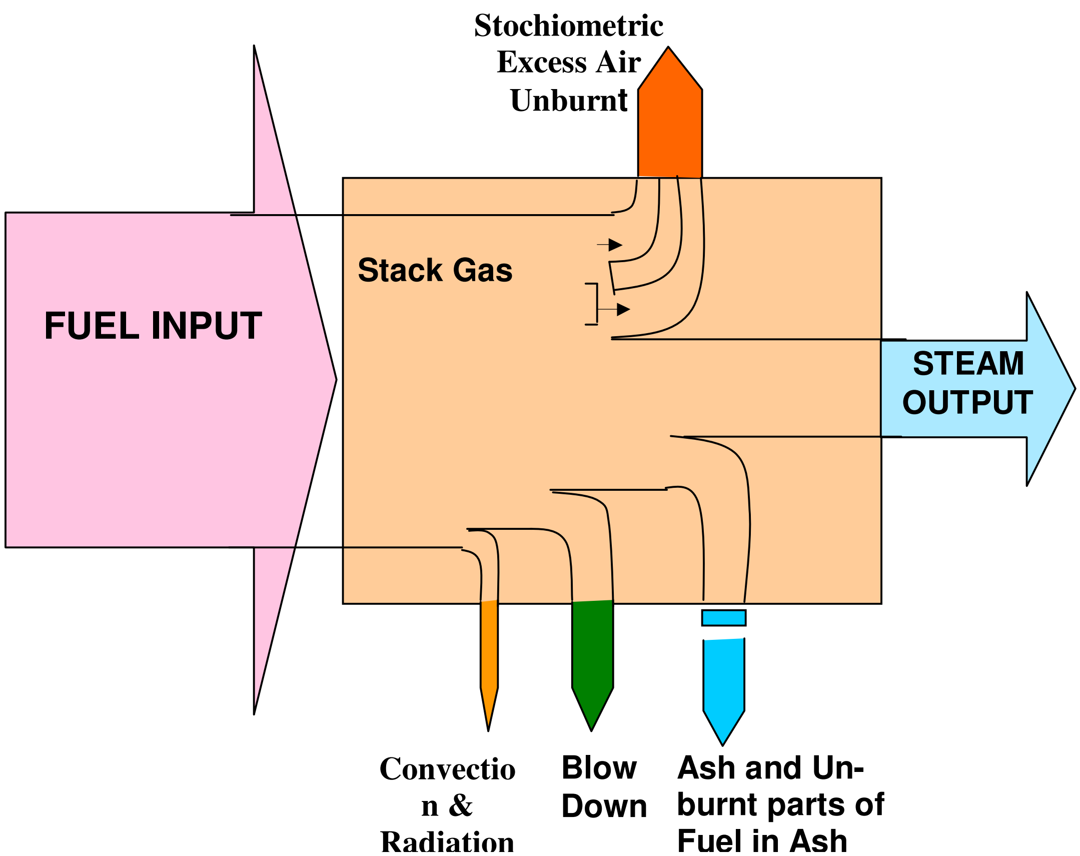
Electricity Saving in lighting : Replacement by Efficient Fittings		
Total No. of Tube lights – T12	128	128
Total Consumption considering 50 W load	Watt	6400
Consumption after Conversion to T5, 28 Watt	Watt/ hour	3584
Saving	Watt per hour	2816
Yearly Saving, 12 hour per day for 300 days	Kwh	10137.6
Monetary Equivalent	Rs	46632.96
Cost of T5 light fittings @ 450/-	Rs	57600
Pay Back Period	Months	14.8

3.4.1.E

STUDY OF BOILERS

Boiler is the most preferred Energy Conversion Device used for low temperature applications in a textile process house. Heat Value contained in a fuel cannot be used directly very efficiently in some textile process house and hence thermopacks are used. This heat value is used to raise steam that makes the process efficient and convenient. High efficiency boilers having Energy Efficiency of the order of 85% can be installed in all the industries. The boilers have capacity of 2 to 3 Tons per hour.

A map of typical energy streams of a boiler is indicated in figure.



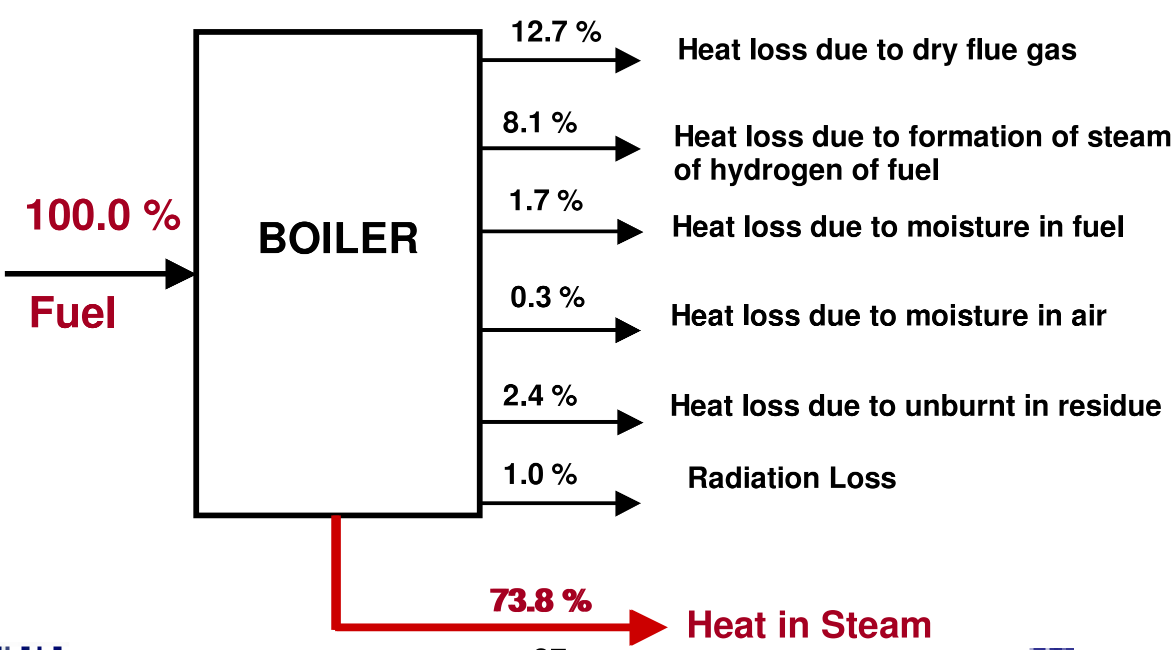
Typical Energy balance of the Boilers (Sankey Diagram)

The units in the cluster have installed wet back type package boilers and are very highly efficient. The Efficiency of grate fired boilers is lower and those using wood or coal or Bio mass Briquettes have very lower efficiency.

Some units initially installed high efficiency pulverized lignite fired CFBC boilers having very high efficiency. However due to disruption in the supplies of lignite from Gujarat, all these Boilers had to be converted to Residual pet coke Fired. Finding the economics to be favourable, even the grate fired boilers were converted to RPC fired CFBC boilers.

It was also observed that the recirculation load was very high, being to the tune of 28% and the GCV of the fly ash was found to be 3000 Kcal/Kg.

The typical quantitative representation of the losses is indicated below. It may kindly be noted that the biggest loss is the heat loss due to heat escaping with the dry flue gas. It needs to be mentioned here that the flue gas temperature required to be maintained goes on increasing with increase in sulphur content of the fuel. This can be a reason for lower efficiency of the pet coke fired boilers as sulphur content in the pet coke is of the order of 7-8%. But, the theoretical air requirement of pet coke is less as compared to coal, so the percentage heat loss in dry flue gases remains less in spite of higher temperature of flue gases. And hence the boiler of pet coke can have same efficiency.



The energy audit study was mainly focused on the following areas:

1. Study of Steam generation in Boilers and efficiency of Thermo packs.
2. Study of Steam Utilization.
3. Study of Insulation.

1) **Study of Boilers:** Efficiency of the boilers were calculated by mainly indirect method as direct method was not possible.

2) **Study of Steam Utilization:** Steam utilization were assessed to find out energy conservation opportunities.

3) **Study of Insulation:** Areas needing insulation and corresponding reduction of heat losses as well as the payback period was calculated.

Energy Conservation Opportunities: -

a) **Excess Air control and Installation of Oxygen Trim**

The units in Pali cluster are not really aware of the ill effects of excess air in combustion. Most of the places excess Oxygen was found to be in the range of 15% to 17% making excess air to be in the range of 250 to 425% when the Excess air can be reduced to 65% for combustion of RPC globules.

FLUE GAS ANALYSIS				
O_2%	**CO_2%**	**CO (ppm)**	**Temp. © (Tf)**	**Temp.amb.©(Ta)**
15	5.5	133	204	35

	C %	H2 %	S %	O2 %	N2 %	Ash %	Moisture %
Ultimate analysis of fuel =	80.9	3.57	7.5	0	0.95	0.01	7
Theoritical air requirement =	[(11.43C)+[{34.5X(H2-O2/8)}+(4.32XS)]/100kg/kg of oil =					**10.80**	**kg of air/kg of fuel**
% Excess air supplied (EA) = (O2/21-O2)X100 =		**250**	**kg of air/kg of fuel**				
Actual mass of air supplied (AAS)= [1+EA/100]Xtheo.Air =		**37.81**	Kg/Kg				
Mass of dry flue gas, (m) =	mass of CO2+mass of SO2+mass of N2 in fuel+mass of N2 in air supplied+mass of O2 in air supplied (kg/kg of fuel) =						**38.45** kg/kg of fuel

SENSIBLE HEAT LOSS EVALUATION		
Sensible heat loss= heat carried by flue gas due to excess air present in excess of actually required		
Heat loss at existing excess air =	1508.50	Kcal/kg of fuel
Excess air % at 8% O2 =	61.54	%
Hence, heat loss at 61.54% X-cess air =	678.29	Kcal/kg of fuel
Hence sensible heat loss =	830.21	Kcal/kg of fuel
Heat loss per hour =	124531.3	Kcal/hr
Fuel loss per hour =	**15.19**	**kg/hr**
Yearly Fuel Saving Potential	**127.57**	**MT**
Price of fuel =	6500	Rs./MT
Monetary Saving , Rs.	**829196.15**	**Per year**

Savings of Electricity in FD and ID Fan by reducing air handled Calculation of savings	
% Excess Air handled by FD & ID Fan	250.00
% Excess Air proposed to be handled	61.54
Ratio of actual Excess Air to Proposed Excess Air	4.0625
Power drawn by FD Fan, kw	12
Power Drawn by ID Fan, kw	10
Saving in Power of FD & ID Fan per year based on Affinity Law, kw/YR	121362.5
Monetary equivalent @ Rs. 4.5 per Kwh	546131.2
Investment in Oxygen Trim + VFD in FD & ID Fan	500000
General Payback Period, months	4.36

b) Hearth Area redesign

It was observed that most of the units using RPC had converted from Pulverized Lignite or Pulverized Coal to RPC by simply replacing the Fluidization Hearth with nozzles and lime bed, which also serves as a suppressant for SOx. However, the hearth area remained the same whereas smaller hearth area is needed in case of RPC as compared to Pulverized Lignite or Coal. The efforts to tune the boilers during energy auditing could not succeed as any further regulation of air with the help of guide vanes resulted in velocity of air becoming less than fluidization velocity. This resulted in insufficient combustion and hence drastic reduction in output.

Consequently, it is proposed that the nozzles in the dark zone may be plugged so as to achieve fluidization velocity with smaller quantity of air. The cost of the intervention would be Rs. 25000/- and the same would be paid off by way of saving from Oxygen trim.

c) Installation of VFD for ID Fan and FD Fans :-

FD & ID fans contribute to a significant extent in the overall auxiliary power consumption of the boiler. Several steps have been taken in the FD & ID fans in the boiler to reduce the auxiliary power consumption. Matching the requirement with the design offers excellent potential in this regard.

While converting the boilers to RPC fired, the vendor supplied higher capacity FD and ID fans and removed the old ones. IT was observed that the guide vanes were already 80% closed thus making a case for combustion air regulation. Some of the units have installed VFD in FD and ID fans but they are not getting complete benefit due to non availability of feedback based modulation system.

Energy Saving Proposal

Guide vane is an energy inefficient practice of capacity control as part of the energy fed to the fan is lost across it.

Good potential for energy saving exists by avoiding Guide Vane control and installing a variable frequency drive (VFD) to the boiler FD fan.

This VFD can also be hooked up to the Oxygen Trim to get benefit of modulation in fan capacity required for ensuring 8% excess Oxygen.

The benefits have been calculated as above. However, this measure forms an integral part of the “Savings by Excess Air control”.

d) Installation of DM water Plant

Water is the biggest problem at Pali and the units survive on water brought from outside. A few units have installed RO water plants for Boiler Feed Water. However, most of the units do not have a DM water plant for use in Boiler. These units use scale depressant chemicals whose result is not verifiable. At a couple of places, the system for DM water has been installed but has not been commissioned.

As is known, use of non purified water in boiler results in scale formation in the boiler tubes and inhibits heat transfer. It also increases heat loss in Blow Downs as the blow down quantity is required to be increased. This may also lead to failure of boiler tubes due to over heating. Making provision for DM water is the most basic requirement for Boiler and hence needs to be provided immediately.

The savings arising out of the measure can not be calculated. However, this is the most basic requirement and hence needs to be provided for economy as well as reliable operation of the boiler.

e) Installation of Air Preheater / Economiser for Waste Heat Recovery with insulation of Dust Collector

The units at Pali had Air Preheater installed as standard equipment for pulverized Coal / Lignite fired boiler. However, the same was removed from the flue passage during conversion to RPC. It was gathered that the Air Preheaters were removed fearing that high temperature would result in failure of refractory lining.

In a few Boilers, the Flue Gas Temperature was found to be higher making a case for Waste Heat Recovery with the help of Air Preheater. In the boilers operating with RPC on CFBC design, dust collector has been provided for collection of the recirculation load. But these dust collectors are not insulated and a drop of 20°C was observed across it.

Bringing the air preheaters in the circuit will cost not more than Rs. 5000/- and the investment would be recovered in few days.

In units not having Air Preheater, the cost of providing air preheater would be Rs. 3.0 Lacs.

The Cost of providing insulation to dust collector would cost Rs. 40000/- @ Rs. 10000/- per sq. mtr.

Calculation of Savings :

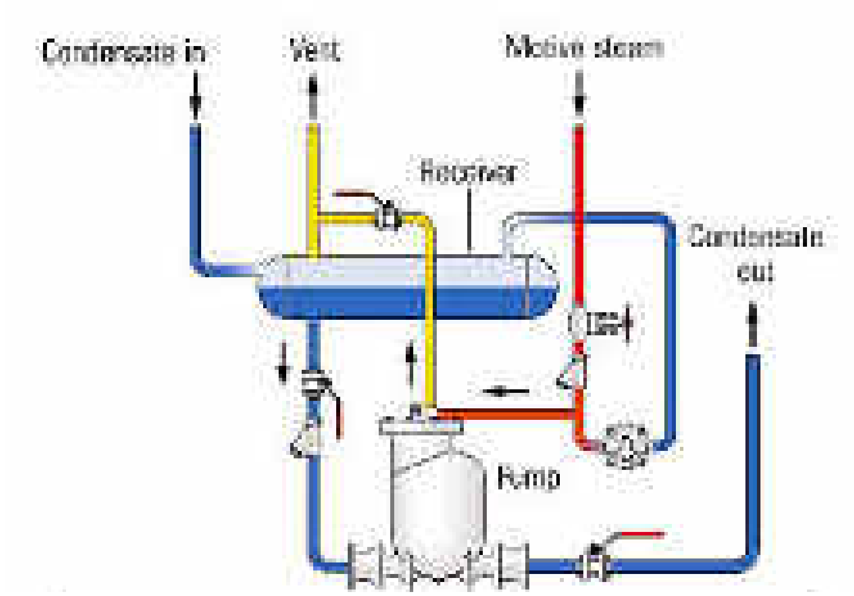
Savings by installing Waste Heat Recovery System in Boiler		
Fuel Flow Rate	150	Kg/hr
Mass of Air Handled	56.71	Kg/Kg fuel
Flue Gas Temperature	204	
Proposed Flue Gas Temperature	180	
Fuel consumption per year (MT)	1260	
Savings in Heat by WHR Kcal/yr	411601938	
Equivalent Fuel Quantity MT @ 8200	50.20	MT
Cost of Fuel Savings	326269.83	
Investment	300000	
Simple Pay Babk Period, Months	11.0	

Considering that temperature drop in Dust Collector is reduced to 10°C from earlier 20°C, additional saving would be

Savings by installing insulation of dust collector with WHR		
Fuel Flow Rate	150	Kg/hr
Mass of Air Handled	56.71	Kg/Kg fuel
Flue Gas Temperature	214	
Proposed Flue Gas Temperature	204	
Fuel consumption per year (MT)	1260	Kg
Savings in Heat by WHR Kcal/yr	235800180	Kcal/Yr
Equivalent Fuel Quantity MT @ 8200	28.76	MT
Cost of Fuel Savings	186914.78	Rs.
Investment	40000	Rs
Simple Pay Back Period, Months	2.6	Months

f) Flash Steam and Condensate recovery from Jet Dyeing Machine

When steam transfers its heat in a manufacturing process, heat exchanger, or heating coil, it reverts to a liquid phase called condensate. An attractive method of improving Boiler's energy performance is to increase the condensate return to the boiler. Recovery of condensate and using it as Boiler Feed Water has many benefits like - less make-up water requirement and saving in fuel by way of less sensible heat requirement and less boiler blow down also saving of chemicals and treatment costs. Condensate recovery also improves output of the boiler and in ideal condition of 100% condensate recovery, the rated capacity of the boiler can be achieved. A typical arrangement for condensate return is illustrated below:



A simple calculation indicates that energy in the condensate can be more than 10% of the total steam energy content of a typical system.

The typical consumption of a 250 Kg capacity Jet Dyeing Machine is 150 Kg Steam per hour and most of the units do not have systems to recover either of flash steam or condensate. Typically, 97% condensate is recoverable in a non direct injection type system and heat content in the condensate and also in Flash Steam is typically 10% each. A typical condensate recovery system with Flash Steam Recovery system would cost approx. Rs. 5.0 Lacs (Rs. 3.5 Lacs towards Condensate Pump and 1.5 Lacs towards flash Steam recovery system). Also, the system provided for 3 Jet Dyeing Machines of 250 kg capacity would have a general pay back period of less than 11 months. Condensate recovery from Steam Traps near these machines can also be considered by using the same system

Flash Steam Recovery Potential		
Jet Dyeing Machine		
No. of Jet Dyeing Machine	No.	3
Steam Consumption of Jet Dyeing M/c per hr	KG/hr	150
Flash Steam Recovery Potential (10%)	Kcal/hr	28800
Equivalent Fuel Saving Per year	MT	29.50
Equivalent Monetary Saving	`@6500/-	191765.9

Cost of System	Rs.	150000
Simple Pay Back Period	Months	9.39

Condensate Recovery potential		
Jet Dyeing Machine		
No. of Jet Dyeing Machine	No.	3
Steam Consumption of Jet Dyeing M/c per hr	KG/hr	150
Condensate Recovery Potential (90%)	KG/hr	405
Heat in condensate	Kcal/hr	24300
Equivalent Fuel Saving Per year	MT	24.89
Equivalent Monetary Saving	`@6500/-	161802.4
Cost of System		350000
Simple Pay Back Period	Months	25.96
Combined Pay Back Period for Condensate and Flash Steam Recovery System	Months	17

Pay back period would become more attractive if more no. of machines are there in the unit and even condensate discharge from steam traps are recovered. Similar System can be provided for Condensate and Flash Steam Recovery from Jiggers as well if indirect steam heating is provided.

g) Removal of Scale from Heat Transfer Surfaces

The RPC is having 8% Sulphur and considerable damage to the Boiler Tubes has been observed if the boiler is not purged immediately after it is closed. Also, due to poor water quality used in Boiler Feed Water, scale is formed, which inhibits heat transfer. One of the units does scale cleaning on a weekly basis and the Efficiency of Boiler in this unit was found to be close to rated efficiency.

Considering 2% improvement in efficiency for a boiler having yearly consumption of 1250 MT RPC and normal efficiency of 72%, ,

Expected RPC Consumption – 1250X0.72/0.74 = 1216 MT

Thus yearly savings generated out of the suggestion would be (1250-1216) MT = 34 MT.

The savings generated out of this can not be quantified and the suggestion is more towards maintenance practice which in any case is to be adopted by units.

h) Flash Steam and Condensate recovery from Decatising, Felt Finish and Soft Flow Machine

The process houses doing finishing also have either Decatising machine or Blanket and Felt Machines for compressive shrinkage as well as imparting required finish to fabric. The rated steam consumption of these units is 250 Kg/hr to 350 Kg/hr depending upon capacity. This makes a case for having Condensate and Flash Steam recovery system in these machines. One system for condensate recovery and Flash Steam would cost Rs. 5.0 lacs and the unit having 3 such machines will have a general pay back period of less than 11 months. Condensate recovery from Steam Traps near these machines can also be considered by using the same system.

Condensate Recovery potential		
Felt Finish & Blanket Finish Machine		
No. of Felt Finishing Machine	No.	1
Steam Consumption of Jet Dyeing M/c per hr	KG/hr	250
No. of Blanket Finishing Machine	No.	1
Steam Consumption of Jet Dyeing M/c per hr	KG/hr	250
Condensate Recovery Potential (90%)	KG/hr	450
Heat in condensate	Kcal/hr	27000
Equivalent Fuel Saving Per year	MT	27.66
Equivalent Monetary Saving	@6500/-	179780
Cost of System		350000
Simple Pay Back Period	Months	23.36

Flash Steam Recovery System		
No. of Felt Finishing Machine	No.	1
Steam Consumption of Jet Dyeing M/c per hr	KG/hr	250
No. of Blanket Finishing Machine	No.	1
Steam Consumption of Jet Dyeing M/c per hr	KG/hr	250
Heat in Flash Steam @ 10% at 3.5 Kg/cm2	Kcal/hr	32000
Equivalent Fuel Saving Per year	MT	32.78
Equivalent Monetary Saving	`@6500/-	213073.2
Cost of System		150000
Simple Pay Back Period	Months	8.45
Total Savings		392853.7
Net Py Back Period for combined system		15.27

Pay back period would become more attractive if more no. of machines are there in the unit and even condensate discharge from steam traps are recovered.

i) Steam Traps Leakage, Maintenance and condensate recovery

Steam trap installed in the unit is an important circuit element in the Steam Distribution system for improving process heat transfer efficiency. It was observed that the Steam Traps are generally not maintained properly and hence lot of useful energy is wasted. A table containing loss of steam by blowing of steam traps is appended below :- (From Boiler Efficiency Institute, where steam is discharging to the atmosphere.)

Leaking Steam Trap Discharge Rate - Steam Loss (lbs/hr)				
Trap Orifice Diameter (inches)	Steam Pressure (psig)			
	15	**100**	**150**	**300**
1/32	0.85	3.3	4.8	-
1/6	3.4	13.2	18.9	36.2
1/8	13.7	52.8	75.8	145
3/16	30.7	119	170	326
¼	54.7	211	303	579
3/8	123.0	475	682	1303

The units at Pali have maximum 2 no. steam traps. It is observed that the traps are mostly blowing or lying choked. The units must have a regular maintenance schedule for maintaining the Steam Traps for getting the benefit out of installation and also saving steam from blowing.

MAINTENANCE OF STEAM TRAPS

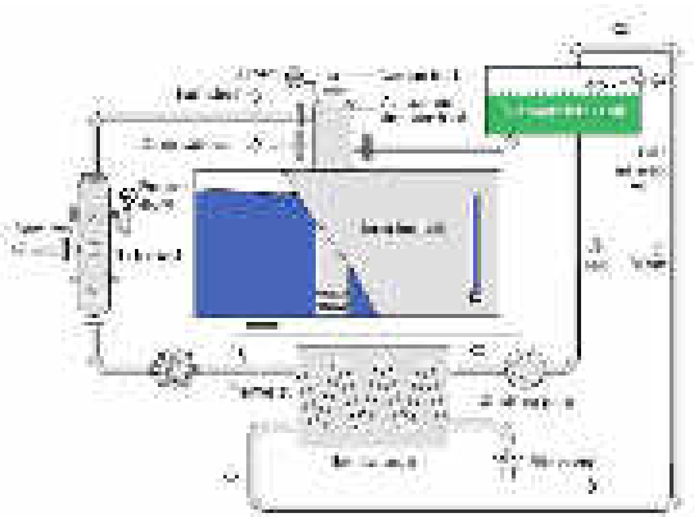
- Dirt and scale are normally found in all steam pipes
- Once some of the dirt gets logged in the valve seat, it prevents the valve from shutting down tightly thus allowing steam to escape
- In order to ensure proper working, steam traps should be kept free of pipe-scale and dirt. The best way to prevent the scale and dirt from getting into the trap is to fit a strainer

- It should be borne in mind that the strainer collects dirt in the course of time and will therefore need periodic cleaning.
- It is of course, much easier to clean a strainer than to overhaul a steam trap

j) Recover Heat from Boiler Blowdown:

Heat can be recovered from boiler blowdown by using a heat exchanger to preheat boiler makeup water. Any boiler with continuous blowdown exceeding 5% of the steam rate is a good candidate for the introduction of blowdown waste heat recovery. Larger energy savings occur with high-pressure boilers.

Managing the Blow Down: Units have manual blow down system. It was observed that the blow down is done manually 4 to 5 times every day. Blow Down Heat Recovery and Flash Steam Recovery System can be provided to raise hot water. This variation adds a cold water storage tank with a circulator pump through the heat exchanger. This option means that cold make-up water and blowdown do not have to occur at the same time in order to recover heat from the blowdown condensate.



Savings by recovery of heat considering blow down of 200 liters 5 times every day would generate savings as below: -

Boiler Blow Down Heat Recovery System		
Quantity of water discharged every Blow Down	200	ltrs
No. of Blow Down per day	5	
Total Blow Down quantity	1000	
Quantity of Heat in Flash Steam	10000	
Heat Recovery by cooling Blow Down water to 60C	70000	
Total Heat Recovery (Flash Steam + Hot Water)	80000	Kcal/day
Yearly heat recovery	28000000	Kcal/Yr
Equivalent Fuel	3.41	MT
Monetary Saving Potential @ Rs. 6500/- per Ton	22195.12	
Investment	50000	Rs.
General Pay Back Period	27	Months

k) Insulation of Steam Lines

Thermal insulation of hot pipes and other fittings is very much necessary for preventing heat from getting dissipated into atmosphere. In fact, providing requisite insulation to the hot surfaces is one of the most attractive methods for Energy Conservation.

The following table gives heat losses for 100 ft. horizontal un-insulated steel pipe. Losses are based on ambient temperature of 75 ^{o}F and zero wind velocity.

Heat Loss per 100feet of Uninsulated Steam Pipe (MMBtu/hr)				
Distribution line diameter (inches)	Steam Pressure (psig)			
	15	**150**	**300**	**600**
1	0.016	0.033	0.043	0.010
2	0.027	0.055	0.072	0.096
4	0.047	0.097	0.128	0.171
8	0.085	0.176	0.232	0.311
12	0.120	0.251	0.332	0.448

Install Removable Insulation on Valves and Fittings

During maintenance, the insulation that covers pipes, valves, and fittings is often damaged or removed and not replaced. Pipes, valves, and fittings that are not insulated can be safety hazards and sources of heat loss. Removable and reusable insulating pads are available to cover almost any surface. The pads are made of a noncombustible inside cover, insulation material, and a noncombustible outside cover that resists tears and abrasion. Material used in the pads resists oil and water and has been designed for temperatures up to 1,600°F. Wire laced through grommets or straps with buckles hold the pads in place.

Applications

Reusable insulating pads are commonly used in industrial facilities for insulating flanges, valves, expansion joints, heat exchangers, pumps, turbines, tanks, and other irregular surfaces. The pads are flexible and vibration-resistant and can be used with equipment that is horizontally or vertically mounted or that is difficult to access. Any high-temperature piping or equipment should be insulated to reduce heat loss, reduce emissions, and improve safety. As a general rule, any surface that reaches temperatures greater than 120°F should be insulated to protect personnel. Insulating pads can be easily removed for periodic inspection or maintenance, and replaced as needed. Insulating pads can also contain built-in acoustical barriers to help control noise

Uninsulated Area Calculation		
Item	Sq. Ft.	Eq. Area
Gate Valve 6"	8.8	0.81701
2" valve	4.1	0.380653
1" valve	3.5	0.324947
2" PRV	4.1	0.380653
2" Strainer	2	0.185684
50 mm pipe		0.189

Besides, the areas of other uninsulated surfaces can be calculated and used to get values of net heat loss due to higher surface temperature.

A typical techno economics of providing insulation is given below :

Total heat loss / hr (Hs) =		
S x A =	{[10+(Ts-Ta)/20] x (Ts-Ta)} x A	
Parameter	Before Recup.	
Av. Surface temperature, Ts ©	120	
Ambient temperature, Ta ©	35	
Area,A (m2)	3.5	
Hs (kCal/hr)	4239.4	
Total heat loss, Hs =	**4239.4**	**kCal/hr**
Yearly Heat Loss	30523500.0	
Equivalent Fuel Quantity MT of RPC	3.7	MT
Monetary Equivalent Rs per year	27917.8	
Investmentin Rs. @ Rs. 300/- per Sq. Ft.	11467.0	
General Pay Back period Months	4.9	

3.4.1.F

STUDY OF THERMOPAK

---

a) Energy Saving Opportunities in Thermopak

Typically 3 temperature levels are used in a textile wet processing unit. The temperature required for dyeing Polyester is 130°C and that for bleaching in kier again is to this degree. The temperature required for cotton dyeing and washing is 80°C to 90°C. Maximum temperature required in stenters is to the tune of 170°C. For meeting temperature requirement of 170°C, all steam will have to be raised to over 210°C and corresponding pressure. Thus distinctly 2 temperature levels are maintained and Thermic Fluid Heater or Thermopak is used for meeting higher temperature requirements. The Pali cluster has thermopak of 20 Lac Kcal/hr and 10 Lac Kcal/hr capacity.

The thermopak used to be CFBC type pulverized lignite / coal fired system. Which was later on changed to RPC based system. In this process, the Air preheater installed has been removed and also new bigger capacity FD fan has been installed. The same hearth area has been retained.

b) Excess Air control and Installation of Oxygen Trim

There exists very good potential of saving fuel by way of reduction of excess air in the Thermopak. Most of the places excess Oxygen was found to be in the range of 15% to 17% making excess air to be in the range of 250 to 425% when the Excess air can be reduced to 65% for combustion of RPC globules in a typical CFBC system.

Typical Flue Gas Analysis

FLUE GAS ANALYSIS				
O_2%	**CO_2%**	**CO (ppm)**	**Temp. © (Tf)**	**Temp.amb.©(Ta)**
15.5	4.3	168	204	35
Specific Heat (Cp)				
Flue gas	Hot air	Cold air		
0.23	0.24	0.25		
Humidity of air = 0.033kg/kg of dry air				

c. Typical Calculation for efficiency and Saving Potential

Efficiency evaluation of Process Thermopac by direct method							
Thermopac efficiency=Heat output/Heat input= (QX Density X (Tout-Tin)/q X GCV) X 100 =			**70.17**				
where, Q, quantity of thermic fluid in circulation(m3/hr) =			120				
q, quantity of fuel consumed(kg/hr) =			245				
Temperature of thermic fluid OUT (C) =			260				
Temperature of thermic fluid IN (C) =			235				
GCV, gross calorific value of fuel, Kcal/kg Petcoke =			8200				
q, quantity of ash used as fuel (kg/hr) =			70				
GCVof Ash as fuel, Kcal/kg =			3000				
Cp, Specific heat of HP Hytherm 500			0.72				
Density of HP Hytherm 500 (kg/m3)			720.9				
Efficiency evaluation of Process Thermopac by indirect method							
Thermopac efficiency = 100 - Heat loss due to (dry flue gas + evaporation of water formed due to H2 in fuel + moisture in air +moisture in fuel+partial combustion + radiation + unaccounted losses)							
	C %	H2 %	S %	O2 %	N2 %	Ash %	Moisture %
Ultimate analysis of fuel =	80.9	3.57	7.5	0	0.95	0.01	8
Theoritical air requirement =	[(11.43C)+[{34.5X(H2-O2/8)}+(4.32XS)]/100kg air /kg of fuel =				**10.80**	Kg/Kg	
% Excess air supplied (EA) = (O2/21-O2)X100 =					**282**		
Actual mass of air supplied (AAS)= [1+EA/100]Xtheoretical air(kgair/kg fuel) =					**41.25**	Kg/Kg	
Mass of dry flue gas, (m) =	mass of CO2+mass of SO2+mass of N2 in fuel+mass of N2 in air supplied+mass of O2 in air supplied (kg/kg of fuel) =				**41.89**	Kg/Kg	
Estimation of Heat losses							
1. % Dry flue gas losses =m X Cp X (Tf-Ta) X100 / GCV =				24.14	%		
2. % loss due to evaporatin of H2O formed by H2 in fuel (9XH2 {584+0.45(Tf-Ta)}/GCV X 100) =				3.14	%		
3. % loss due to moisture in air = AAS X humidity X 0.45 X (Tf -Ta) X 100 / GCV =				1.53	%		
4. % loss due to moisture in fuel =M X {584+0.45(Tf-Ta)}/GCV X 100 =				0.78	%		
5. % loss due to CO formation = {(%Cox%C)/(%CO+%CO2air)}x(5744/GCV) x 100 =				0.27	%		
6.% loss due to radiation & unaccounted losses (normally taken as 2%) =				2	%		
			TOTAL =	31.87	%		
Process Thermopak	**100 - (1+2+3+4+5+6) =**			**68.13**	**% (app.)**		

SENSIBLE HEAT LOSS EVALUATION		
Sensible heat loss= heat carried by flue gas due to excess air present in excess of actually required		
Heat loss at existing excess air =	1642.10	Kcal/kg of fuel
Excess air % at 8% O2 =	61.54	%
Hence, heat loss at 61.54% X-cess air =	678.29	Kcal/kg of fuel
Hence sensible heat loss =	963.81	Kcal/kg of fuel
Heat loss per hour =	236133.7	Kcal/hr
Fuel loss per hour =	**28.80**	**kg/hr**
Yearly Fuel Loss	241.89	MT
Monetary Equivalent	**1572305**	**per year**

Savings of Electricity in FD and ID Fan by reducing air handled Calculation of savings		
% Excess Air handled by FD & ID Fan	282.00	
% Excess Air proposed to be handled	61.54	
Ratio of actual Excess Air to Proposed Excess Air	4.5825	
Power drawn by FD Fan	18.5	KW
Power Drawn by ID Fan	12	KW
Saving in Power of FD & ID Fan per year based on Affinity Law	169025.1	Kw /hr (16 hrs per day, 350 days/year)
Monetary equivalent @ Rs. 4.5 per Kwh	760612.8	
Investment in Oxygen Trim + VFD in FD & ID Fan	500000	
General Payback Period	2.57	Months

d) Hearth Area redesign

It was observed that most of the units using RPC had converted from Pulverized Lignite or Pulverized Coal to RPC by simply replacing the Fluidization Hearth with nozzles and lime bed, which also serves as a suppressant for SOx. However, the hearth area remained the same whereas smaller hearth area is needed in case of RPC as compared to Pulverized Lignite or Coal. The efforts to tune the boilers during energy auditing could not succeed as any further regulation of air with the help of guide vanes resulted in velocity of air becoming less than fluidization velocity. This resulted in insufficient combustion and hence drastic reduction in output.

Consequently, it is proposed that the nozzles in the dark zone may be plugged so as to achieve fluidization velocity with smaller quantity of air. The cost of the intervention would be Rs. 25000/- and the same would be paid off by way of saving from Oxygen trim.

e) Installation of VFD for ID Fan and FD Fans :-

Background

FD and ID Fans are being used to handle many times more air than what is required. Also, the capacity of FD and ID fans are much more than what is being handled now and the input to the fans is being stifled with the help of guide vanes.

Present status

While converting the thermopak to RPC fired, the vendor supplied higher capacity FD and ID fans and removed the old ones. IT was observed that the guide vanes were already 80% closed thus making a case for combustion air regulation. Some of the units have installed VFD in FD and ID fans but they are not getting complete benefit due to non availability of feedback based modulation system.

Energy Saving Proposal

Guide vane is an energy inefficient practice of capacity control as part of the energy fed to the fan is lost across it.

Good potential for energy saving exists by avoiding Guide Vane control and installing a variable frequency drive (VFD) to the boiler FD fan.

This VFD can also be hooked up to the Oxygen Trim to get benefit of modulation in fan capacity required for ensuring 8% excess Oxygen.

Saving has been calculated in section **C**.

G Install Waste Heat Recovery for raising hot water / Insulation of Dust Collector

An economizer can be installed to arrest heat in Flue Gas. It was observed that the Flue Gas in Thermopak was leaving at temperature 220°C to 300 °C, thus giving enough opportunity to recover waste heat. The Cost Benefit Analysis is given below **:-**

Savings by installing Waste Heat Recovery System in Thermopak		
Fuel Flow Rate	250	Kg/hr
Mass of Air Handled	33.86	Kg/Kg fuel
Flue Gas Temperature	250	
Proposed Flue Gas Temperature	180	
Fuel consumption per year (MT)	1800	
Savings in Heat by WHR Kcal/yr	1023885418	
Equivalent Fuel Quantity MT @ 8200	124.86	MT
Cost of Fuel Savings @ Rs. 7500/- per MT	936480.5653	
Investment	300000	
Simple Pay Babk Period, Months	3.8	

Savings by insulation of dust collector		
Fuel Flow Rate	250	Kg/hr
Mass of Air Handled	22.69	Kg/Kg fuel
Flue Gas Temperature	251	
Proposed Flue Gas Temperature	231	
Fuel consumption per year (MT)	720	MT
Savings in Heat by WHR Kcal/yr	107800508	Kcal/Yr
Equivalent Fuel Quantity MT @ 8200	13.15	MT
Cost of Fuel Savings @ Rs. 7500/- per MT	98598	Rs.
Investment, @ Rs. 300/- per Sq. Mtr	60000	Rs
Simple Pay Babk Period, Months	7.3	Months

H Installation of VFD in Thermic Fluid Pump

The capacity of Thermopak utilized in the Pali cluster is 10 Lac Kcal/hr and 20 Lac Kcal/Hr. Normally this capacity is at least 20 to 30% more than the requirements. The Thermic Fluid Pump is a fixed velocity pump which remains operating even if no heat load is there on the thermopak because a minimum fixed circulation of thermic fluid has to be maintained through thermopak heating coils failing which the Fluid would get overheated and would get disintegrated. But the minimum quantity of thermic fluid required to be circulated through thermopak heating coils is much less than the flow of the pump. Also, the major load on thermopak is that of stenters which has MOVs diverting flow based on temperature of individual chambers of the stenter.

The above description makes the pump a case for installation for ensuring :

1. Only required flow through the unit
2. Handling idling periods of stenter
3. Handling flow diversion by Stenter MOVs
4. Always ensuring minimum flow required by thermopak

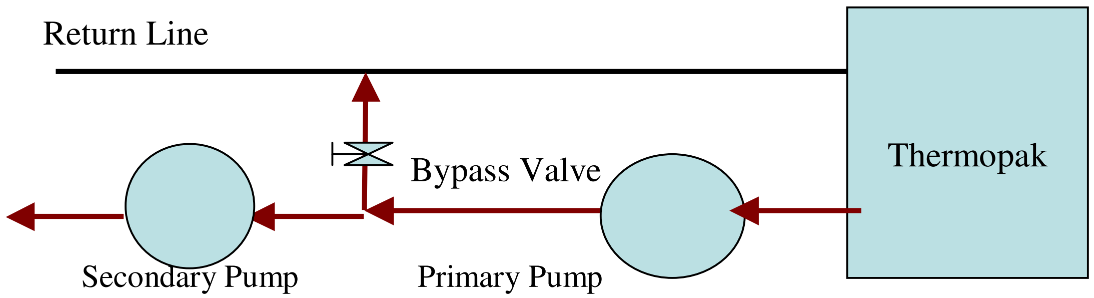
Presently, thermic fluid pump is the biggest load in a textile wet processing unit at Pali having rated power of 20 / 30KW and drawn power of 16/27 KW.

Even if flow is reduced by 20% which is minimum over capacity, Power saving would be

Savings of Electricity Thermic Fluid Pump		
Calculation of savings :		
% flow of pump before VFD	120.00	Cu Mtr/hr
% Excess Air proposed to be handled	96.00	Cu. Mtr/hr
Ratio of actual Excess Air to Proposed Excess Air	1.25	
Power drawn by thermic fluid pump	27	Kw
Saving in Power of FD & ID Fan based on Affinity Law	73785.6	Kwh
Monetary Equivalent @ Rs. 4.5 per kwh	332035.2	Rs.
Investment	100000	Rs.
General Pay Back Period	3.6	Months

Provision of primary-secondary arrangement of flow can be considered as per the following schematic diagram which would save huge energy and facilitate implementation as well.

Primary Secondary arrangement in Thermic Fluid Line



3.4.1.G

STUDY OF STENTER

a) Energy Conservation in Stenter :

Stenter is the single largest energy Consuming machinery in textile wet processing Industries. Typical consumption of a single stenter is 4 Lac Kcal and 60 Kwh per hour. And thus holds maximum promise in terms of saving Energy.

Stenters are mainly used in textile finishing for

- heatsetting
- drying
- thermosol processes
- and finishing.

It can be assumed (rough estimation) that in finishing as an average every textile material is treated 2.5 times in a stenter which is therefore often the bottle neck in textile finishing mills.

To give a –surely rough - assessment energy consumption of energetic optimized stenters is in the range of 3500-4500 kJ/kg textile. However energy consumption depends strongly on the process that is carried out.

Main heat demand needed in a stenter is caused by water evaporation and the heat losses due to the output of hot air.

Therefore as a first step before heating in a stenter is carried out mechanical dewatering of the textiles should be done in a efficient way. In addition air/textile ratio should be kept as low as technical and economical possible.

The stenter is used for heat setting or resin finishing in the textile process houses at Pali. There are open type as well as closed type stenters operating in the Cluster.

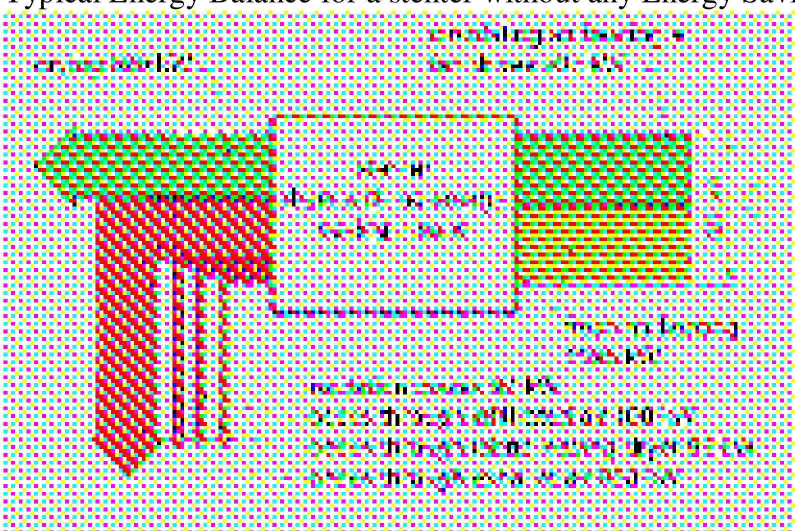
Open Stenters are very inefficient ones used mainly as a process for heat setting the fabrics. Heat is provided by burning wood or LPG in a open hearth kept below the fabric.

The closed Stenters are modern ones having various features. These have automatic temperature control system for different chambers and the temperture is controlled by Motor Operated Valves in the Thermic Fluid Line. A No. of such stenters have dual speed motors and VFD has been retrofitted in many others.

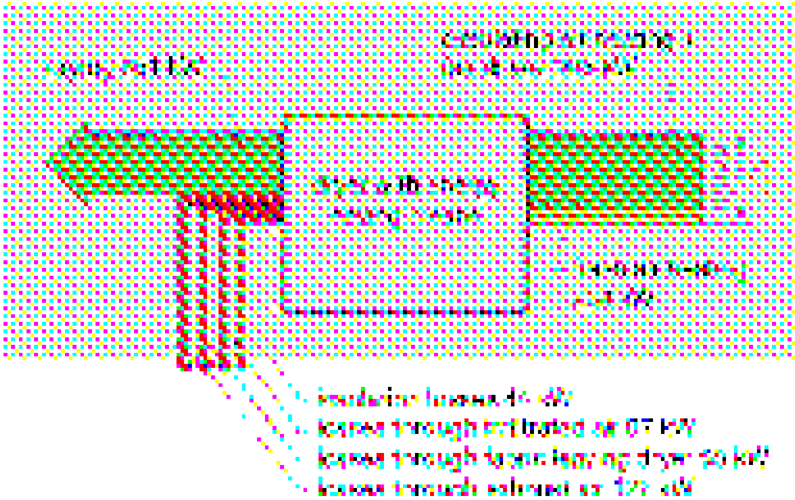
Typical Energy Balance of a Stenter

Component	% Heat Used
Water Evaporation	41
Air Heating	39.7
Fabric	4.6
Case	6.3
Chain	1.5
Drives	6.9

Typical Energy Balance for a stenter without any Energy Saving Measure is as below :



Typical Energy Balance for a stenter with Energy Saving Measure is as below :



b) Processes accomplished in Stenters :-

Heat Setting :- Before being fed into the Stenter for Heat setting, the fabric undergoes pretreatment process and moisture is removed either by Hydro Extractor or by drying in Sun. However, At Pali, the fabric is once again dipped into an acidic solution, mangled and then fed to the Stenter for maintaining pH balance required for printing or other subsequent process. It is observed that the dipping before heat setting is a redundant process and the desired property could have been obtained during the pre treatment process in Jet Dyeing Machine by proper process control.

Resin Finish :- After Dyeing and fixation, the cloth is dipped into a solution containing resin. Subsequently, the cloth is mangled and then fed into Stenter for finish.

Mangle Expression :- Indicates wet pick up or moisture carryover after squeezing the fabric in mangles. Mostly 3 bowl mangles having maximum 10 Tons nip pressure are used. Typically, such mangles have above 65% moisture carryover which can be improved to above 45% by using proper mangle coating material and also suitable pressure.

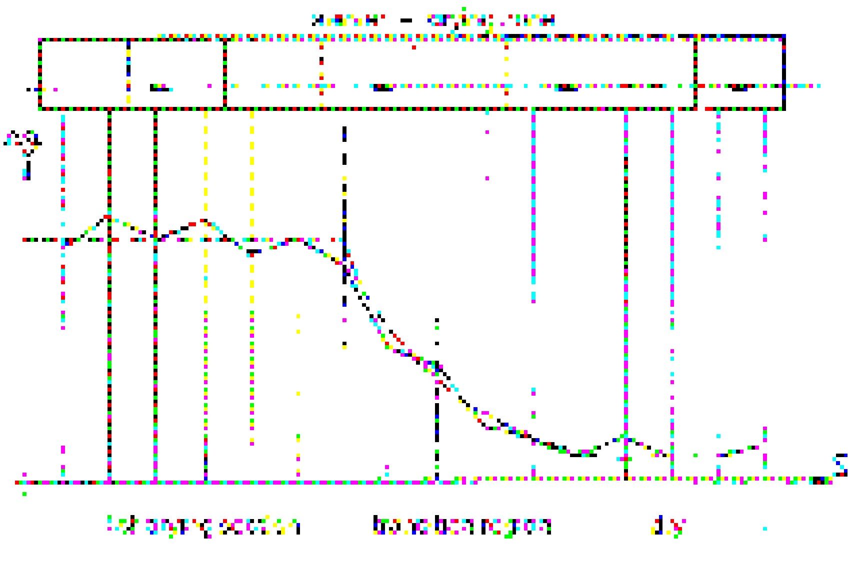
Drying in hot air involves the following stages:

1st stage: heating of the material with temperature rising to the wet bulb temperature.

2nd stage: establishment of constant temperature conditions until all the water has been transported to the surface of the material. This wet bulb temperature is independent of the temperature and moisture contentof the air used for drying. A high evaporative capacity is achieved with high temperature air circulation.

3rd stage: a further increase in temperature occurs when all the water has evaporated; at this point the material
assumes the same temperature as the drying air.

Temperature Profile of fabric is shown below :-



Energy Conservation Opportunities in Stenter operation in Textile Wet Processing :

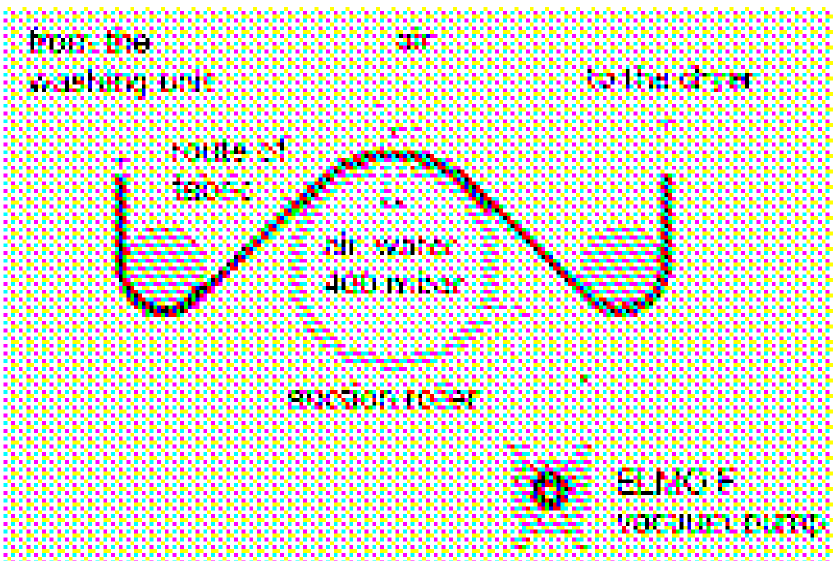
Use Mechanical Pre drying:

Mechanical pre Drying methods such as Mangling, Centrifugal drying, Suction Slot or Air Knife Dewatering are used to reduce Drying Costs. A Suction Slot is 3 times more Energy Intensive than a typical mangle but provides better moisture removal. Also, contact drying is 5 times more energy intensive than suction slot. Energy consumption in a stenter can be reduced by 15% if moisture of incoming textiles is reduced from 60% to 50% [Fischer, 1992]. Typically, 1 KW Energy is consumed for removing 1 Kg water in a suction slot.

c) Energy Conservation Measures in Stenter

A Vacuum Suction Slot

With this method, water is extracted from the textile in open width as it passes over a slotted or perforated box in which vacuum is maintained by a pump. The final moisture regain depends on operating parameters, such as initial moisture regain , vacuum pressure, and production speed, and is also highly dependent on textile construction and fiber hydrophilicity. The energy requirements (700 kJ/kg of water removed) are high compared with squeezing , but much lower than for thermal methods .



Typically, the suction slot available today has a rated electrical load of 15 KW and considering actual power consumption to be 13 KW removing only 10% moisture, Saving would be-

As per Energy Balance of Stenters, 41% energy is utilized in evaporation.

Installation of Suction Slit in Stenters	
Typically, the suction slit available today has a rated electrical load of 15 KW and considering actual power consumption to be 13 KW removing only 10% moisture, Saving would be-	
Fabric Speed in stenter	70 mtr/min
Weight of fabric	80 gm/mtr
Moisture removed with 60% wet pick up And 7% retained moisture	222.6 Kg/hr
Heat Required for evaporation h=640kcal/kg	142464 Kcal
Total heat required by stenter	3.5 LacKcal/hr

Power Required	60 Kwh/hour
Moisture removed with 50% wet pick up And 7% retained moisture	180.6 Kg/hr
Heat Required for evaporation h=640kcal/kg	115586 Kcal
Total heat required by stenter	2.8 LacKcal/hr
New Speed of stenter	75mtr/min
Power Required for 60 mtr	48Kwh/hour
Net Saving in heat per hour	70000 Kcal/hr
Total yearly fuel saving (300 days/yr)	61 MT RPC
Monetary Equivalent	4.57 Lacs
Investment	2.0 Lacs
General Payback Period	5.2 months

It is apparent that the power consumed in running vacuum slot is approximately equal to the anticipated power saving by way of increased output to the extent of 25%.

B Fabric Moisture indicator and Automatic over drying controller for Stenters :-

Over Drying is a common problem. Fabrics have natural moisture levels and drying below these levels would mean over drying. The typical natural moisture levels at 20°C and 65% RH is given below :-

Fiber	Moisture Regain Value (%)
Cotton	7
Wool	16-18
Viscose	12.5
Polyester	0.4
Acrylic	1.5
Polypropylene	0

Presently, estimation of Dryness is done feeling the fabric by hand and visually guessing. Generally, the fabric is over dryed.

Energy Saving Calculation by Installation of Fabric Moisture Control	
Assume weight of fabric(Normal grade used at Pali)	0.07 Kg/m2
Content of moisture at stenter entry	70%
Moisture Content now	5%
Standard Moisture Regain Value	7%
Fabric Width	1.2 Mtr
Speed of fabric in stenter	60 Mtr/Min.
Energy required per hour for drying from 70% to 5%	= 0.07X1.2X60(70-5)/100 = 196.56 K Cal per Minute

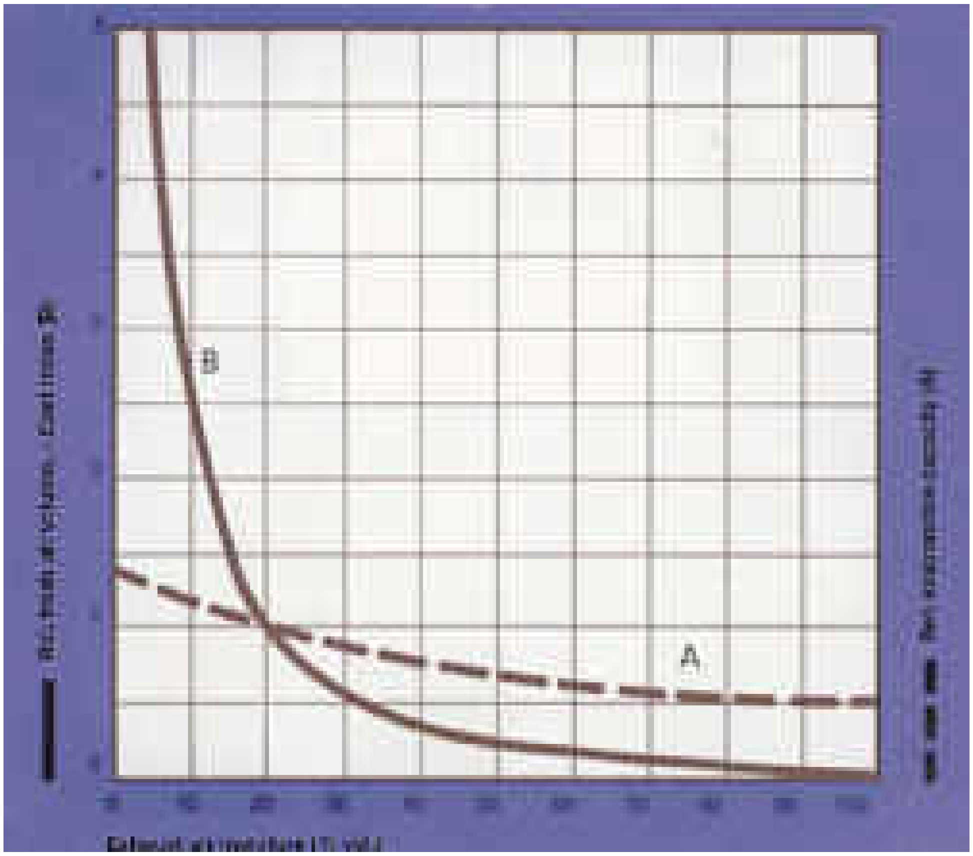
Energy required per hour for drying from 70% to 7%	0.07X1.2X60(70-7)/100 190.51 K Cal per Minute
i.,e. 3 % less Heat is required if over drying by 2°C is avoided. Considering, evaporation efficiency in stenter to be 39.7% (as per standard energy balance) the saving works out to 3X100/39.7 = 7.5%.	
Energy Saving by 7.5% Heat Energy saving, rating of stenter 3 Lac Kcal/hr and assuming it to be operating at 3 Lac Kcal/Kg	7.5% of 3 Lac Kcal = 22500 Kcal per hour
Taking 70% as efficiency of the Thermopak and 8200 Kcal as GCV, net saving of fuel per hour	22500/(8200*0.7) = 3.9 Kg per hour
Yearly saving Potential	3.9X24X350 /1000 = 28.08 MT/Year
Monetary Equivalent @ Rs. 7500/- per MT	Rs. 210600/-
Investment	Rs. 50000/-, No recurring Expenses
General Pay Back Period	2.8 months

C) Optimise Exhaust humidity Control

Currently, stenters in Pali do not have any control on the humidity of exhaust air released from stenters. An optimum for the moisture content in the exhaust air resp. circulation air is approx. in the range of 100 to 120 g water/kg (at temperatures between 160-180°C). Optimisation of exhausts can be achieved by controlling the exhaust humidity to between 0.1 and 0.15 kg water/ kg dry air. This is called the Wadsworth criterion.

Reduction in fresh air consumption in stenter from 10Kg/Kg of fabric to 5 Kg/Kg of fabric transpires to Energy Saving of 57%.

In most of the units in Pali Cluster, the exhaust air fan is kept in off position and the exhaust air comes out from fabric exit opening.



Saving Calculation by installation of Exhaust humidity Control in Stenter	
Stenter Speed per minute	90
Production per hour	5400
Additional production per yearby 5% production increase	1782000
Electricityconsumption kw/hr	55
Electricity consumption per meter	0.01
Saving in electricity consumption per year by icreased production Kwh	18150
Monetary Equivalent @ Rs. 4.6/- per kwh	81675
Fuel consumption per hour	120
fuel consumption per meter	0.022
Saving in fuel consumption per year by increased production MT/Yr	39.6
Monetary Equivalent @ Rs. 7500/- per MT	297000
Net Saving	378675
Investment Rs.	250000
General Payback Period	8

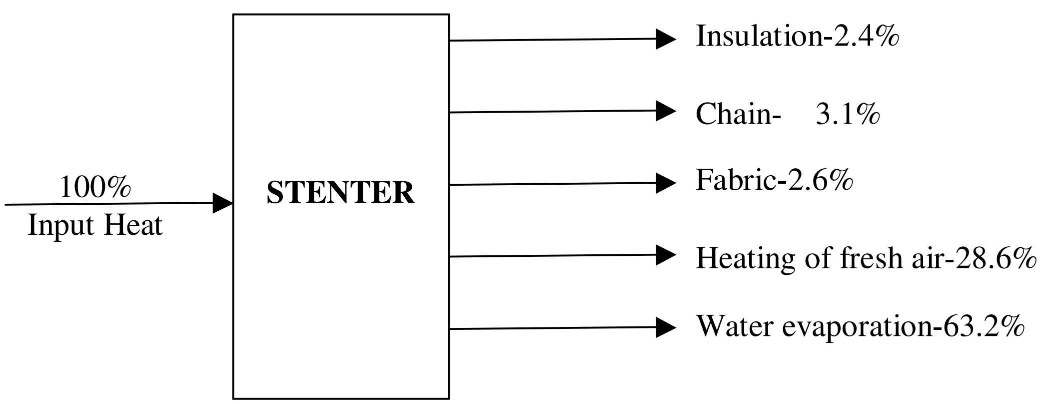
D Install Heat Recovery Equipment

The exhaust from stenters in case of Heat Setting is at a temperature of 140°C and that in case of resin finish is 120°C. This provides enough opportunity to recover waste heat and use it for heating incoming air to the stenter or heat process water required in the unit.

SAVING IN STENTER MACHINE BY USE OF EXHAUST GASES

There are 3 main processes on stenter-1.drying 2.finishing 3.heat setting (dry/wet).

THERMAL HEAT DISTRIBUTION OF STENTER



There are two options to use the heat of exhaust gasses:

1. Air to air heat recovery- In this the heat of exhaust gases is used to heat the fresh air. It reduces process heat demand by 12 to 15% and in case of dry heat setting it is even 30%.
2. Air to water—Water can be heated up to 90 degree centigrade and can be used directly to process/boiler feed.

On Conservative basis for Thermopack using pet coke @ 750 kg/day for heat input to stenter, the use of this gas will contribute to saving of Rs. 15,75,000/-

Benefits of system: High energy savings, therefore payback times of clearly less than 1.5 years by heat-recovery air/air: Uses exhaust air heat to heat up fresh air supplied to the stenter.

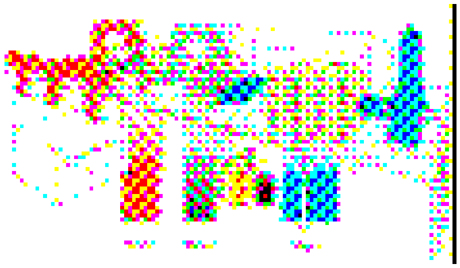
1. Heat-recovery air/water: Uses exhaust air heat to heat up service water for wet finishing (for example washing, dyeing, bleaching) Very easy maintenance: The easy-to-handle heat exchanger modules sized like a drawer can be removed without any problems and cleaned in special cleaning tanks. No mechanical tools such as brushes etc. are required

Automatic cleaning available as an option

Highly efficient lamellar heat exchangers with anti-adhesion coating

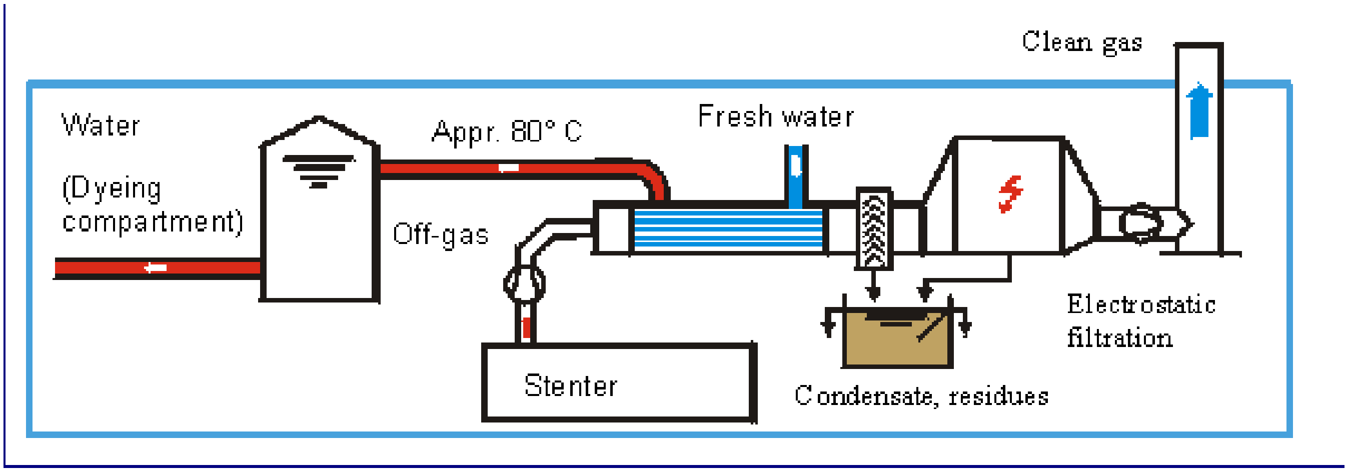
Optimum power density (clearly higher than in usual tubular heat exchangers)

Cleaning of the heat recovery devices in some cases has to be done weekly. Proper scheduling in finishing minimizes machine stops and heating-up/cooling down steps and is

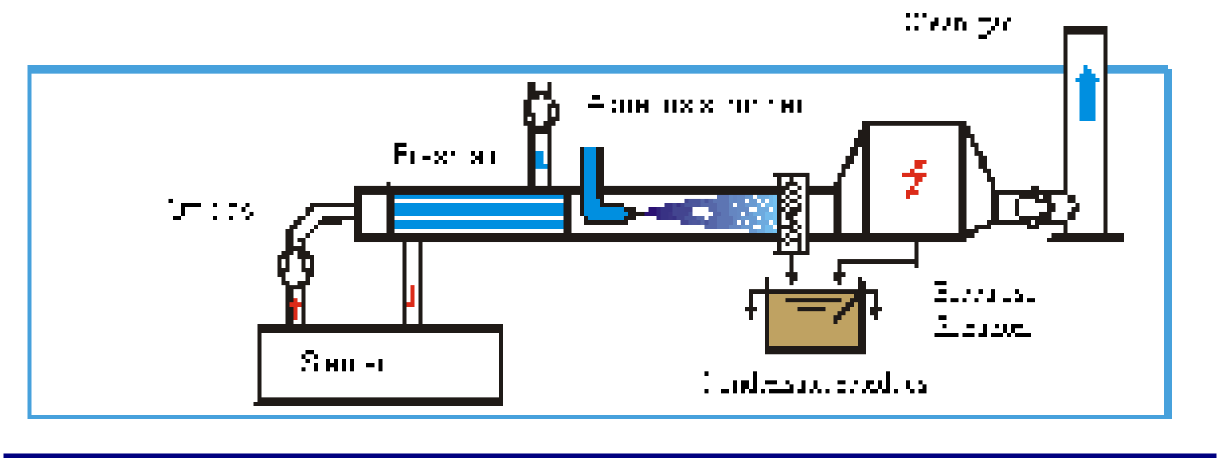


therefore a prerequisite for energy saving. Heat Recovery System in Stenters Cost Benefit Analysis of Waste Heat Recovery

As per the stdies of ECCJ and also claims of Montforts, upto 30% Energy Savings has been realised by waste heat recovery alone. The cost of implementation is aprox. Rs. 5.0 lacs having Pay back Period of less than 6 months. A typical schematic for air to water and air to air heat recovery of the system is given below :-



Air to Water Heat recovery system



Air to Air Heat Recovery System

Calculation of savings from waste heat recovery system in stenters	
Daily processing of Cloth with stenter speed @ 60mtr/min	86400 mtr/day
Daily Electricity Consumption with a load of 55 KW	1320 Kwh (55X24)
Theoretical Fuel Consumption considering Heat Energy Consumption Of 3 Lac Kcal/hr capacity and 60% overall heat transfer efficiency	300000/(0.7X8200) = 52.2 Kg/hr =52.2X24X300 = 376 MT per year
Saving @ 20% as projected by manufacturers	75.2 MT
Monetary saving per year @ Rs. 7500/- per MT	Rs. 564000
Total Investment	Rs. 10.0 Lacs
General Payback Period	21.2 months

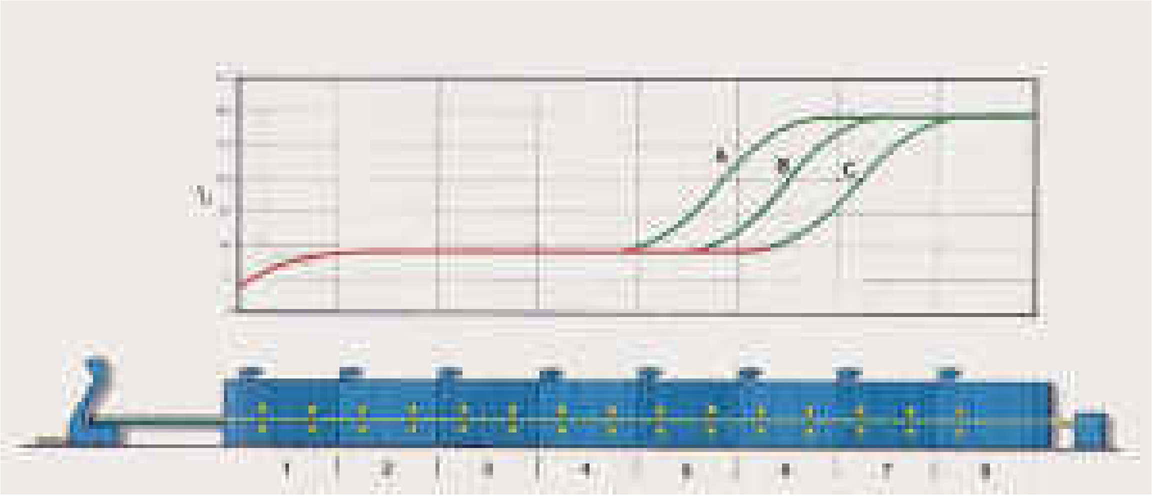
E Fan Speed Regulation by providing VFD

Stenters are used for finishing or heat setting of fabric. The process occurs in 3 stages as also depicted in the following graph:-

b) Heating of Fabric

c) Evaporation of Moisture

d) Dwell time for heat setting or finishng



Air Jet is mainly required in the evaporation process and to some extent in the fabric heating process. The holding process requires maintaining above specified temperature and hence air jet velocity is not critical here. Even in the evaporation process, maximum evaporation takes place at a air jet velocity of 32 ft/sec.

Thus, installation of VFD in Stenter Fans to have a complete auto feedback modulation system stands to give huge benefits in terms of Energy Savings. VFDs can be used to :-

a) Modulate speed in the first section to heat fabric very fast Modulate speed of fans in the second and third Chamber so as to ensure air jet velocity of 32Ft/Sec

b) Modulate Fans in the 4th and 5th chamber so as to maintain temperature above rated temperature

Most of the stenters in Pali Cluster have 2 speed fans or VFD for regulation of fan speeds. Strangely, VFDs have been installed to smoothen the starting current and hence work mainly as soft starter. The VFD is not at all used for modulating air supply in the system and energy saving feature of auto feedback control system or even manual speed modulation and hence no benefit is accruing to the units. In one of the units, the fan in the 5th chamber has been removed completely and still the stenter is running at the same speed.

It is proposed to permanently run the fans of 4th and 5th chamber on slow speed in stenters having 2 speed fans and reduce fan speed in stenetrs having VFD. The saving would accrue as per the following details :

Calculation of Savings by modulation of stenter fans by installing VFD	
All the stenters in Pali have 5 chambers and 10 fans of 7.5 HP (5.6 KW), some of them have been provided with two speed or VFD	
Power Consumed by Stenter Fans at high speed	4.2 KW
Power Consumed by Stenter Fans at slow speed	1.7 KW
Considering that fans in last two chambers i.e. 4th and 5th are run on slow speed, Saving in electricity	=4(4.2-1.7) = 10 KWhr
Yearly saving	10X24X300 = 72000 KWhr per year
Equivalent Monetary Savings @ Average cost of Rs. 4.6 per Kwh	3.31 Lacs
Cost of 5 no. vfd of 12 KW each to run 2 motors each	Rs. 2.5 Lacs
General Pay Back Period	9.1 months

Alternatively, it is suggested that VFD be installed in all the fan motors and a complete feedback control system to modulate fan speed as mentioned above be implemented. The The benefits would accrue as per the following details :-

Saving in 1st chamber by reducing speed by nominal 10%

Saving in 2nd and 3rd chamber by reducing speed by 5%

Saving in 4th and 5th chamber by reducing speed equivalent to slow speed

Investment 2.5 Lacs (5 no. VFD considering one vfd to run 2 fans of same chamber)

Even if we consider saving to be equivalent to those generated by reducing speed of fan in 4th and 5th chamber only, the Simple Pay Back Period would be 9 months only.

F Stopping Air Circulation Fans during idling of stenter -

It was observed that the stenter remains idle for at least one hour every day. This stoppage is for durations ranging from 5 to 15 minutes. As per normal practice, the fans remain operating at high speed even when the stenter is idling to seemingly avoid overheating and yellowing of fabric. It is suggested that the fans be brought to slow speed when stenter is idling by providing interlocking.

Yearly Savings by implementing the proposition	= 2X350X10X(4.2-1.7)
	= 17500 Kwh/yr
Monetary Equivalent	= Rs. 78750 per year
Investment towards interlocking and automation –	= Rs. 100000/-
Simple Pay back period	= 15.2 months

G Temperature Control

As per the process accomplished in stenters, the fabric temperature is raised, then evaporation of moisture takes place and then dwell time is given for heat setting or curing. 2 most important parameters for the process are

a) Process temperature required to be achieved and

b) Dwell Time

The above parameters are ensured in the cluster by way of maintaining chamber temperature. This is not a full proof system and hence instrumentation is required to be provided for ensuring exact temperature required and also the required dwell time.

In normal practice, there is always overheating of fabric and hence dissipation of heat. It is suggested that a system be provided to ensure required temperature and dwell time. Implementation of the measure has been found to generate 5% increase in fabric speed through the stenter.

Calculation of Energy saving potential and Pay Back

Saving by implementing Fabric Temperature Control	
As per the claims of the manufacturer, the system results in increase of speed of stenter by at least 5%.	
a) Savings in Electricity	
By way of 5% increase in fabric speed	60X.05X60X300X22

through stenter	= 1188000 mtr/year
Daily processing of Cloth with stenter speed @ 60mtr/min	= 86400 mtr/day
Electricity Consumption with a load of 55 KW	55X24 = 1320 Kwh
Saving in Electricity Consumption per year	1188000X1320/88400 = 17739 Kwh per year
Monetary Equivalent @ Rs. 4.6/- per kwh	Rs. 81559/- per year
b) Saving in Fuel Consumption	
Fuel Consumption considering Heat Energy Consumption Of 3 Lac Kcal/hr capacity and 70% stenter efficiency	300000/(0.7X8200) = 52.2 Kg/hr
Thus Fuel Saving for 1188000 mtr	1188000X52.2/86400 = 17.226 MT per year
Monetary Equivalent @ Rs. 7500/- per MT	Rs. 129195/- per Yr
Total savings = a+b	Rs. 210674/-
Investment	4.0 lacs
General Pay Back Period	23 months

H Installation of Energy efficient Fans

Old Fans provided in stenters were axial fans having inherent efficiency of 70%. Modern Radial Fans have efficiency of 80% as per information from stenter manufacturers and hence would help save electrical energy.

Cost of 10 no. Fan Replacement = 3.0 Lacs

Electricity savings by way of high efficiency of fans = (50-50X0.7/0.8)X24X300

= 45000 Kwh/Yr

= 2.07 Lacs

Simple Pay Back period = 17.4

I Foam Finish Application –

This is a new development wherein the chemicals required for finishing are applied onto the fabric with the help of foam applicator. This results in wet pick up of 25% as against normal wet pick up of 60% - 65% in case of dip application followed by squeezing in a mangle. The technology is not available in India and can be adopted after it becomes available.

J Nip Pressure Optimization in mangle and seam detection system

Most of the stenters in Pali Custer have 3 bowl inclined type Mangle having rated highest nip pressure of 10kg/cm2. The pressure is applied by way of pneumatic cylinder but the chart depicting correlation of pneumatic cylinder vs nip pressure and resultant mangle expression is not available. Understandably, full benefit of mangle is not being accrued to the units. Also, higher nip pressure is not applied for the fear that the fabric may get torn near joint of 2 pieces. It is proposed to install a seam detection system and increase pressure in mangle to have 10% lower wet pick up.

Yearly Saving in Energy with 10% lower wet pick up		
(As calculated in A above)	=	Rs. 4.57 Lacs
Cost of system	=	Rs. 50000/-
Simple pay back period	=	1.2 months

K Blocking of Air Jet

The width of stenter and also that of the air jet nozzle is 1.6 Meter whereas the width of fabric generally processed is 1.2 meter. It is apparent that the air thrown by jet situated in 0.4 meter length is wasted. This provides opportunity to reduce air jet flow by blocking 15 cm of air jet on either side, i.,e reduce air flow by 0.4/1.6 i.,e. 25%.

Electrical load of fans in 5-chamber stenter		
Saving in fan power by reducing air flow by 25%		
Maximum Electrical Load of fans	=	42 KW
Net Saving per year 42X0.25X24X350	=	88200 KW
Monetary Equivalent @ Rs. 4.5/- per kwh	=	Rs. 396900/-
Cost of implementation	=	Rs. 50000/-

General Pay Back Period = 1.5 Months

L Nozzle Design

With optimized nozzles and air guidance systems, energy consumption can be reduced, specially if nozzle systems are installed that can be adjusted to the width of the fabric Some proprietary nozzle design in stenters claim higher evaporation efficiency and hence can be adopted.

M Thermal insulation and plugging leaks

Proper thermal insulation of stenter encasement reduces heat losses to a considerable amount. Proper selection of the insulation material and a suitable thickness of the insulation can lead to energy savings. However it has to be kept in mind that heat losses due to radiation are only in a range of 2-4% of the total heat demand of the stenter. The condition of insulation in the Pali Cluster was found to be satisfactory. However, leak of hot air was found in some of the places, which can be plugged to save energy.

3.4.1.H

STUDY OF DYEING PRINTING & FINISHING MACHINES

A Energy Conservation in Jigger / Jet Dyeing Machine

Following is the details of various cycles accomplished in Jet Dyeing Machine / Jigger

A. Study of process - Scouring on Jumbo

Batch Size - 1000 mtr

S. No.	Process Step	Existing		
		Temp.	**Time**	**Water**
		deg C	**min**	**L**
1	Loading of Dry Fabric		30	
	Wetting of Fabric		20	400
2	Filling with Water		10	300
	Addition of Chemicals			
	Temp Raise to 85 deg C	85		
	Run 4 ends		60	
3	Drain			
4	Filling with Water		10	400
	Temp Raise to 85 deg C			
	Hot wash	85		
	Run 2 ends		30	
5	Drain			
6	Filling with Water		10	400
	Addition of Acetic Acid			
	Run 2 Ends		30	
	TOTAL		**200**	**1500**

B. Study of Process - Polyester dyeing on Jet

Batch Size 150 kg				
		Existing		
		Temp.	Time	Water
S. No.	Process Step	deg C	min	L
1	Loading of fabric for dyeing		**5**	
2	Filling with Water		5	600
	Dye bath preparation & Heating			
	40 - 80 @ 3 deg C		15	
	80 – 110 @ 1.5 deg C		20	
	110 - 135 @ 1 deg C		25	
	Holding for dyeing		30	
3	Dye bath Cooling upto 80 deg C		18	
4	Overflow Wash & Drain		20	1500
5	Unloading of dyed fabric		5	
	TOTAL		**138**	**2100**

C. Study of Process - Sulphur Dyeing on Jigger

Batch Size - 1000mtr				
S. No.	**Process Step**	**Existing**		
		Temp.	**Time**	**Water**
		deg C	**min**	**L**
1	Fabric Loading Dry		20	
	Filling with Wate,Fabric Wetting		10	200
2	Drain			
3	Filling With Water		5	200
	Heating upto 65 deg C		5	
	Run 4 ends for RC treatment	65	30	
4	Drain			
5	Filling water			200
	Addition of Dyes Chemicals &		30	
	Temp. raise & Vatting			
	Run 8 ends in color for Dyeing	60 - 80	60	
	Addition to match match shade			
	and levelling, Run 8 ends		60	
	Run 4 end for cooling dyebath		30	
6	Drain & Overflow Washing		30	500

S. No.	Process Step	Existing		
		Temp.	Time	Water
		deg C	min	L
7	Filling with Water		5	200
	Heating upto 65 deg C		5	
	Run 4 ends for Oxidation	65	30	
8	Drain			
9	Filling with water		5	200
	Heating upto 85 deg C		5	
	Addition of Chem. For Soaping			
	Run 4 ends for soaping	80	30	
10	Drain			
11	Filling with water		5	200
	Heating upto 85 deg C		5	
	Run 2 ends for Hot wash	80	15	
12	Drain			
13	Filling with Water		5	200
	Run 2 ends for Cold wash &		15	
	Neutralize			
	TOTAL		**425**	**1900**

D. Study of Process - Cotton / Vis Reactive dyeing

S. No.	Process Step	Existing			
	Batch Size 1000mtr	**Temp.**	**Time**	**Water**	**Time**
		deg C	**min**	**L**	**min**
1	Fabric Loading		20		10
	Filling with water & fabric wetting		10	200	10
2	Filling with water		5	200	
	Heat up to 65 deg C		5		
	Run 4 ends for RC	65	30		30
3	Drain				
4	Filling with water		5	300	5
	Addition of dye, chem & heating		30		20
	Run 12 ends in color for dyeing	60 - 80	60		60
	Run 8 ends for addition & match	60 - 80	60		30
5	Run 8 ends for color fixation		60		30
6	Drain				
7	Over low wash for removal of superficial dye, Run 6 end		30	500	30
8	Drain				
9	Filling with water heat up to 80 C			300	
	Run 4 ends for Hot Wash	80	30		30
10	Drain				

S. No.	Process Step	Existing			
		Temp.	Time	Water	Time
		deg C	min	L	min
11	Filling with water heat upto 80 C			300	
	Addition of chemicals				
	Run 4 ends for Soaping	80	30		30
12	Drain				
13	Filling with water heat upto 80 C			300	
	Run 4 ends for Hot Wash	80	30		30
14	Drain				
15	Filling with water heat upto 80 C			300	
	Addition of chemicals				
	Run 4 ends for Soaping	80	30		30
16	Drain				
17	Filling with water heat upto 80 C			200	
	Run 4 ends for Hot Wash	80	30		30
18	Drain				
19	Filling with water, Heat upto 50 C		5	200	5
	Addition of Dye Fixer & A Acid		5		
	Run 4 ends for Dye fixation	50	20		20
	TOTAL		**495**	**2800**	**400**

Energy Conservation Potential

B **Waste Heat Recovery from Jigger & Jet Dyeing Dye effluent Hot Cycle remains for 10.5 hours every day.**

A jigger discharges 800 ltr water in one batch which is of 425 minutes duration. Thus there ar 3 batches for a jigger every day, consequently, it releases 2400 ltr water at 80°C per day. Similarly, one jet dyeing machine has a capacity of 600 ltr water and cycle time is 3 hours (8batches per day) i.e. one jet dyeing machine discharges 4800 ltr hot water at 80°C per day.

Cost benefit Calculation for 1 jigger :

Heat recoverable in 2400 ltr water at 80°C	= 2400X1X(80-60)
	= 48000 Kcal/day
Yearly Saving of equivalent RPC considering	
Boiler efficiency to be 75%	= 40000X350/(0.75X8200)
	= 2.8 MT
Monetary Equivalent @ Rs. 6500/- per MT	= Rs. 18200/-
Investment	= Rs. 40000/-
General Pay Back Period	= 27 months

All the units in Pali into cotton or blend dyeing has more than 1 jigger and the maximum no. observed was 32. Thus for 10 no. jiggers, the pay back period would be 3 months only.

Cost benefit Calculation for 1 jet Dyeing Machine :

Heat recoverable in 2400 ltr water at 80°C	= 4800X1X(80-60)
	= 96000 Kcal/day
Yearly Saving of equivalent RPC considering	
Boiler efficiency to be 75%	= 96000X350/(0.75X8200)
	= 5.5 MT
Monetary Equivalent @ Rs. 6500/- per MT	= Rs. 35750/-
Investment	= Rs. 40000/-
General Pay Back Period	= 13.4 months

Jiggers are there in Pali cluster units in multiple nos. and hence the pay back would be very attractive.

C Installation of VFD in Pump motor of Jet Dyeing Machine

Currently, the pump runs at full rpm even though pressure requirement is lower in other than heating cycle. As per the typical cycle adopted Polyester Dyeing, pressure of inside the machine is between 1.5 to 3.5 Kg/cm2 for 55 minutes only out of a total cycle of 3 hours whereas the pump keeps running at full RPM and the pressure is controlled manually.

Duration of pressure above 1.5 Kg/cm2	=	55 Minutes
Total Cycle Time	=	180 minutes
Pressure Ratio	=	3.5/1.5
Corresponding Power Ratio as per affinity law	=	$(3.5/1.5)^2$
Power drawn at 3.5 Kg/ **cm**^{2}	=	**8kw**
Power Drawn at 1.5 Kg/cm^2	=	$8/(3.5/1.5)^2$ KW = 1.46 KW
Power Saving per day	=	(8-1.46)X135X8/60= 117.72 KW
Yearly Power Saving	=	117.72X350 = 41202 KWH
Monetary Equivalent @4.5/-	=	Rs. 185406/-
Investment @ 10000/m^2	=	100000/
Simple Pay back period	=	less than 7 months

D Energy Conservation in Steamers

3.10.1 Prevent air intake in the steamer: In the steaming process, constant and reproducible conditions must be achieved in the steamer atmosphere. A disruptive factor can be the intake of air in the steamer, for example via the enter and exit splits. This air reduces the temperature in the steamer and makes the atmosphere unstable. In some processes, oxygen disrupts the chemical reactions important for fixating dyes. As a result of these disruptions, more steam than necessary is added to establish the desired conditions as yet. Keeping the splits in the steamer as small as possible can reduce the steam consumption. Modern Steamers come with air curtain to stop ingress of air .

3.10.2 Ensure proper steam conditioning in the steamers:

3.10.3 The proper steam conditioning is important. Most processes use saturated steam. Make sure the steam is not overly heated. this has a detrimental effect on the temperature and moisture content of the fabric. Sub-optimal steam conditions will generally result increased steam consumption.

3.10.4 Reuse of Steam in Loop Steamer and heat recovery system

E **Printing Machine Optimization System**

In Pali, the Printing machines are installed in units involved in printing of sarees and African Prints. There must be over 100 Flat Bed Printing Machine and one rotary screen printing machine in the cluster. The following measures can be taken for energy conservation in the cluster :-

i) Automatic Temperature Control System for Float Dryer

The printed fabric is dried in a float dryer immediately after printing so that the printed motifs are retained during handling before fixation and curing. A typical temperature control system can be provided through which required temperature is achieve by On OFF control. The control will be used to stop the fans and hence additional heat addition to the system.

The benefits can not be quantified however, the investments only Rs. 20000/- per unit and the pay back would be very attractive.

ii) Fan speed Optimization

Like in stenter, the Fan speed can be optimized to ensure same rate of drying but at lower power consumption. The Energy Saving can not be quantified. Investment would be to the tune of providing one VFD costing Rs. 50000/-. The pay back period is expected to be very attractive.

iii) Blocking excess area in Air Jet

The width of the float dryer is 1. Mtr whereas the fabric width processed is 1.2 Mtr. Thus there is potential to reduce air flow by 25%.

Maximum Electrical Load of fans	=	6 KW
Saving in Power @ 25%	=	1.5 KW
Yearly power saving – 1.5X.25X24X350	=	3150 KW
Monetary Equivalent @ Rs. 4.5/- per Kwh	=	Rs. 14175/-
Investment	=	Rs. 10000/-
General Pay Back Period	=	9 months

iv) Control of idling

The machine remains idle for over 3 hours in small durations for 5 to 15 minutes each, but the fan remains operating. It is proposed to interlock the movement of belt with that of the fan. The anticipated savings are calculated below :-

Maximum power consumption	=	6 KW
Power Saving per day by stopping circulation fan for 3 hours	=	6X3 Kwh
Yearly power saving – 6X3X350	=	6300 Kwh
Monetary Equivalent	=	Rs. 28350/-
Proposed Investment	=	Rs. 10000/-
General Pay Back Period	=	4.3 months

F Application of Solar Energy for Generating Hot Water for Dyeing / Boiler Feed Water

The units in Pali cluster use hot water for Dyeing in jigger and also for washing range. The hot water presently is raised mostly through direct injection of steam. In some units, the water is heated in jiggers directly by burning wood beneath the jigger shell. The water is required at about 80°C and solar water heater can supply water at this temperature. The typical cost benefit analysis is as below :-

Cost of 1000 ltrs Solar Water Heating System = Rs. 100000.00

Heat required for heating water from 40°C to 80°C = 1000*(80-40) = 40000 Kcal/day

Efficiency of heating by wood in open condition = 50%

Wood Required	= 40000/(0.5X2000)
	= 40 Kg/day
Monetary Equivalent @ Rs. 3.5/- per kg	= Rs. 140 per day
Yearly Saving Potential	= Rs. 49000/- per year
General Pay Back Period	= 25 Months

It is proposed to install the system in units using primitive ways of raising hot water like burning wood directly and the pay back period also is very favourable. Adding benefits like accelerated depreciation and, subsidies etc will make the investment very attractive.

G Solar Tunnel Dryer –

This a system developed to harness solar radiation for slow drying of goods. The system would find application in Pali Cluster as sun drying by hanging in open stand forms major part of the processing and every cloth is dried in this fashion at least twice during processing.

Solar Tunnel Dryer has following benefits over current system :

1. The temperature achieved is 20°C more than normal atmospheric temperature.
2. Natural Draft creates air circulation inside the dryer thus hastening the evaporation process.
3. Provision for forced circulation of air can be provided.
4. Drying time stretches by 2 hours beyond sun set.

These are the findings of an R&D development project undertaken by PCRA to support adoption of the technology for industrial use.

The units in Pali Cluster would immensely benefit by this technology as the expected benefits are :

1. Reduction of moisture content by at least 5%
2. Quality improvement as the system is fully covered and would prevent the clothes from dirt, dust and other flying objects. A few cases of damage by fire has occurred due to flying objects.

Calculation of savings:

As calculated in 3.8.1, saving for 5% moisture reduction	=	2.66 lacs
Anticipated Cost of the system	=	2.0 lacs
Simple Pay Back Period	=	9 months

H Provision of cogeneration

Cogeneration has been a proven method to maximize heat utilization in a power generation unit having process heat requirements. Development of smaller size turbines has facilitated use of cogeneration in small units as well. There was a bottleneck in adoption of this technology as power output varied in line with heat load of the system. But with availability of condensing type system, stable and reliable power output has been ensured. Typical cost benefit analysis is as below :

Power output for 3tph boiler	=	200 KW
Auxiliary Power Consumption	=	20 KW
Yearly cost of power generated @ Rs. 4.5 per kwh	=	180X24X350X4.5
	=	Rs. 68.0 Lacs
Additional fuel consumption	=	Nil
Cost of maintenance	=	Rs. 5 Lacs per year
Other Exigencies	=	13 Lacs
Net Monetary Benefit	=	50 Lacs per year
Additional cost of implementing cogeneration		
(over and above the cost of boiler)	=	Rs. 65 Lacs
General Pay Back Period	=	16 months

The system can be adopted by units going in for new boiler.

3.4.1.7
Issues / Barriers in implementation of Proposals

The following barriers are anticipated in implementation of identified Energy Saving Proposals :

1. **Attitudinal Barrier :-**Energy Saving is a mindset and it will have to be brought to the top of priority list of enterpreneurs**.**
2. **Amenability to financing :** The entrepreneurs in Pali are averse to the idea of taking loan. In this respect, a typical financial plan of the unit would help in making them understand the importance of financing for growth.
3. **Lack of Maintenance facility :** Any high end system would need maintenance and Pali lacks this basic facility.
4. **Technology Availability :** This is not likely to affect the adoption except in only a couple of cases like foam finish. For other cases, indigenous system would be developed once demand is there.
5. **Financial Facility :** Sufficient incentive is available in terms of TUFs (Textile Upgradation Fund), CLCSS (Credit Linked Capital Subsidy Scheme), Interest Subsidy Scheme of Government of Rajasthan etc. Also, various line of credit like JICA is available with SIDBI for SME financing. What is needed is ease of delivery in financial products.
6. **Performance Guarantee :-** Till the time technologies prove their proposed benefits, the units would like to hedge their investments and hence a performance guarantee would be needed.

3.4.2 Availability of Technology or Product in Local / National / International Market

The products mentioned under Energy Conservation measures identified are all available in India except Stenter Waste Heat Recovery System. However, there is adequate possibility of the system to be developed in India. Similarly, vendor for Dye effluent heat recovery system could not be located in India. But this system can be got fabricated and would work very well.

There is also mention of Foam Finish Technology which is a breakthrough technology commercialized recently but not on offer in India. The cost benefit analysis of this system has not been done as the input on operating cost, first cost etc. is not available. It is gathered that the system can reduce fuel consumption in stenters by over 30%. This system can be considered as and when it arrives in India.

3.4.3 Availability of local Service Providers who can take up above proposals

There are no local service providers who could take up the jobs. In fact, service providers visit Pali from Ahmedabad and Surat. The list of loca service providers is appended below. However, lack of local service providers is not going to affect adoption of technology as service providers are available in Jodhpur / Jaipur and even those present in Ahmedabad and Surat have been supporting the cluster.

The service Providers in the cluster are :-

1. M/s Kalani Agency
   121, Veer Durgadhish Colony, Near Canal
   Pali, Phone – 9414120186, 9314020186
2. Diamond Engineering Works
   F-400 a, Mandia Road Industrial Area
   Pali,
   Phone – 02932-231597
3. Sheetal Machinery
   GA-99, Mandia Road
   Pali
   Phone-02932-230785

Other standard manufacturers of machineries are based in Ahmedabad, Surat and Mumbai. For sensors and automation product of Mahlo and Pleva make, M/s ATE India Limited can be contacted. For similar products, M/s Semitronics, an Indian Company can also be contacted.

3.5

IDENTIFICATION OF TECHNOLOGIES FOR DPRS

Most of the technologies mentioned under the Energy Conservation Opportunities list deserve to be considered for DPR. However, the ones having higher investment value and also having higher energy potential have been considered for preparig DPR.

3.5.1 Justification for technologies/equipments identified for DPR preparation :

A **Cogeneration :** Use of steam is mandatory for the units involved in Textile Wet Processing and typical capacity available in the units is 2 to 3 TPH. Cogeneration is proven technology for maximizing Steam Utilization efficiency. With the development of smaller steam turbines which run at pressures like 42 Kg/cm2 and produce 1 Kw power for every 14 Kg steam. Further development of condenser for this scale of turbine, power availability has become reliable and free from steam load of the unit which otherwise keeps fluctuating.

B **Solar Tunnel Dryer** : This is very badly required by the industries in Pali. Pali has very high solar insolation and clear sky is available for over 340 days every year, the units prefer drying the fabric by hanging in open atmosphere. This makes the fabric vulnerable to dirt deposition, specially during stormy days, and there has been a few cases of fire also due to source of ignition coming from sky, i.,e. firecracker etc.

The Solar tunnel not only increases effective drying temperature by 20°C over atmospheric temperature but also stretches drying time by 2 hours in the evening. Small amount of air circulation takes place due to draft creation. However, forced circulation also can be provided. More than 100 units would adopt this technology. The technology has been got customized by PCRA through Maharana Pratap Agriculture University and efforts are on for its replication.

C **Solar Water Heater** : This has been mandated by Government of Rajasthan under regulation formulated under Energy Conservation Act 2003.

D **Boiler Optimization System:**

It includes the followig:-

a) Hearth Area redesign

a. FD and ID fan optimization, installation of VFD

b. Installation of Oxygen Trim

c. Instillation of Air Preheater / Economizer for Waste Heat Recovery

Over 100 Boilers are operating in the Cluster. The systems mentioned above will have potential to be widely replicated.

E **Condensate and Flash Steam Recovery System**

1. Flash Steam and Condensate recovery from Jet Dyeing Machine

2. Flash Steam and Condensate recovery from Kiers

3. Flash Steam and Condensate recovery from Soft Flow Machines

4. Flash Steam and Condensate recovery from Decatising Machine / Felt Finishing Machine

The system for steam distribution and utilization is available in almost 100 units and these units necessarily have above machines for steam utilization.

F **Thermopak Optimization System**

a Hearth Area Reduction

b. FD and ID Fan Optimization

c. Installation of Oxygen Trim

d. VFD in Thermic Fluid Circulation Pump

Pali cluster has population of over 50 thermopaks and this caters to the most energy intensive process of Drying and Finishing requirements. The Saving potential is very high and replication potential also is high.

G **Improvement of insulation in Steam and Thermic Fluid Distribution system**

a Refurbishment of insulation in pipelines

b Insulation of steam valves, condensate separators, Pressure Reduction Stations c Insulation of condensate recovery lines Flash Steam Recovery Lines

d Insulation of Auto Thermic Fluid Valves in Stenters

Improvement in insulation is the easiest, most effective and one of the cheapest possible solution available for saving of Heat. It has very wide application and almost all manufacturing units in Pali need this. The technology (except that for the valves) is generic, known to everybody and can be implemented locally.

H Jet Dyeing Machine Optimisation System

a. Provision of Insulation

b Provision of VFD in Pump

c Provision of Energy Efficient Pumps

d. Waste Heat Recovery from dye Effluent

Pali cluster has a population of over 200 Jet Dyeing Machines and all these machines work 24 hours per day. Replication potential is very high.

I Jigger Optimization System

A Temperature control system

B Computerized Colour Matching

C Provision of Cover

Pali cluster has a population of over 400 jiggers and replication potential of the proposal is very high. The technology proposed is very generic in nature and can be easily implemented.

J Stenter Optimization system

A Moisture Control

B Temperature Control (Overheating)

C Speed control

D Humidity Control

E Blower control

F Installation of Vacuum Slit

Stenter is the most energy intensive machinery in textile wet processing. There are over 100 stenters in the cluster and hence replication potential is very high. The systems proposed above are for monitoring and control of process parameters and are modular in nature. The technologies can be provided one after the other in modular fashion or even in combination. Will have very good acceptability.

K Waste Heat Recovery from Stenter Exhaust, Ager Exhaust and Dye Effluents

Waste heat recovery per say is very generic technology utilized everywhere for Optimizing heat utilization. The heat recovery system for stenter is a specific technology having very little presence in India. The proposal is for a new technology introduction and has thus some risk.

L VFDs in stenter fans and installation of Energy efficient Fans

Most of the units have installed VFD and also the fans installed in new stenters are Energy efficient. However, the project will involve implementation of a complete auto feedback control system to monitor process parameters and hence would generate savings. IT will have high acceptability and hence very high replication potential.

M Foam Finish Application System – This is a system recently commercialized worldwide and is not available here in India.

N Optimization of Nip Presure in mangle to improve mangle expression, installation of seam detection system. The implementation of this system needs study to be conducted for optimization of the existing machinery. The machine is dovetailed to stenters and has very implication at very low cost.

O Printing Machine Optimization System

- A Automatic Temperature Control System
- B Fan speed Optimisation
- C Blocking excess area in Air Jet

The technologies proposed are more or less same as that in Stenters and hence stands great chance for adoption by units.

4.0
Environmental benefits

4.1 Reduction in waste generation

The systems proposed above for improving Energy Efficiency in the cluster and also the technologies proposed for interventions do not necessarily reduce generation of waste.

4.2 Reduction in GHG emission such as CO_2, NOx, etc

The systems proposed above would necessarily mitigate GHG emission by way of reduced emission of CO_2.

4.3 Reduction in other emissions like SOx, etc.

The interventions referred in above sections will not result in any reduction in emission of Sox.

5 CONCLUSION

5.1 List of Energy Efficiency Measures identified for implementation in Pali Textile cluster :

5.1.1 Cogeneration
5.1.2 **Solar Tunnel Dryer**
5.1.3 **Solar Water Heater**
5.1.4 **Boiler Optimization System**
5.1.4.1 Hearth Area redesign
5.1.4.2 FD and ID fan optimization, installation of VFD
5.1.4.3 Installation of Oxygen Trim
5.1.4.4 Installation of DM water Plant
5.1.4.5 Installation of Air Preheater / Economiser for Waste Heat Recovery
5.1.4.6 Soot Blowing and removal of scale from heat tranfer surfaces
5.1.4.7 Condensate and Flash Steam Recovery System
5.1.4.8 Flash Steam and Condensate recovery from Jet Dyeing Machine
5.1.4.9 Flash Steam and Condensate recovery from Kiers
5.1.4.10 Flash Steam and Condensate recovery from Soft Flow Machines
5.1.4.10.1.1 Flash Steam and Condensate recovery from Decatising Machine / Felt Finishing Machine

5.1.1 Thermopak Optimization System
5.1.1.1 Hearth Area Reduction
5.1.1.2 FD and ID Fan Optimization
5.1.1.3 Installation of Oxygen Trim
5.1.1.4 VFD in Thermic Fluid Circulation Pump

5.1.2 Improvement of insulation in Steam and Thermic Fluid Distribution system
5.1.2.1 Refurbishment of insulation in pipelines
5.1.2.2 Insulation of steam valves, condensate separators, Pressure Reduction Stations
5.1.2.3 Insulation of condensate recovery lines Flash Steam Recovery Lines
5.1.2.4 Insulation of Auto Thermic Fluid Valves in Stenters

5.1.3 Maintenance of Steam Traps

5.1.4 **Jet Dyeing Machine Optimization System**
5.1.4.1 Provision of Insulation
5.1.4.2 Provision of VFD in Pump
5.1.4.3 Provision of Energy Efficient Pumps

5.1.5 **Jigger Optimization System**

5.1.1
List of Technologies identified for implementation in Pali Textile Cluster :

1. **Cogeneration**
2. **Solar Tunnel Dryer**
3. **Solar Water Heater**
4. **Boiler Optimization System**
    a. Hearth Area redesign
    b. FD and ID fan optimization, installation of VFD
    c. Installation of Oxygen Trim
    d. Installation of DM water Plant
    e. Installation of Air Preheater / Economiser for Waste Heat Recovery
    f. Soot Blowing and removal of scale from heat tranfer surfaces
5. **Condensate and Flash Steam Recovery System**
    a. Flash Steam and Condensate recovery from Jet Dyeing Machine
    b. Flash Steam and Condensate recovery from Kiers
    c. Flash Steam and Condensate recovery from Soft Flow Machines
    d. Flash Steam and Condensate recovery from Decatising Machine / Felt Finishing Machine
6. **Thermopak Optimisation System**
    a. Hearth Area Reduction
    b. FD and ID Fan Optimisation
    c. Installation of Oxygen Trim
    d. VFD in Thermic Fluid Circulation Pump
7. **Improvement of insulation in Steam and Thermic Fluid Distribution system**
    a. Refurbishment of insulation in pipelines
    b. Insulation of steam valves, condensate separators, Pressure Reduction Stations
    c. Insulation of condensate recovery lines Flash Steam Recovery Lines
    d. Insulation of Auto Thermic Fluid Valves in Stenters
8. **Maintenance of Steam Traps**
9. **Jet Dyeing Machine Optimisation System**
    a. Provision of Insulation

b. Provision of VFD in Pump

c. Provision of Energy Efficient Pumps

10. Jigger Optimization System

a. Temperature control system

b. Computerised Colour Matching

c. Provision of Cover

11. Stenter Optimization system

a. Moisture Control

b. Temperature Control (Overheating)

c. Speed control

d. Humidity Control

e. Blower control

f. Waste Heat Recovery from Stenter Exhaust, Ager Exhaust and Dye Effluents

g. Installation of Vacuum Slit in Stenter

h. VFDs in stenter fans and installation of Energy efficient Fans

i. Foam Finish Application System

j. Optimisation of Nip Presure in mangle to improve mangle expression, installation of seam detection system

12. Printing Machine Optimisation System

a. Automatic Temperature Control System

b. Fan speed Optimisation

C Blocking excess area in Air Jet

5.1.2
TECHNOLOGY GAP ASSESSMENT

Technology gap assessment for all energy saving proposals/measures identified for the cluster

Machinery	Technology Gap identified
Jet Dyeing Machine	5. Insulation of the body of Jet Dyeing Machine 6. Installation of VFD in water pump 7. Provision of Energy Efficient Pumps 8. Waste Heat recovery from Dye Effluent
Stenter	d. Moisture Control e. Temperature Control (Overheating) f. Speed control g. Humidity Control h. Blower control i. Blocking Excess Area in air nojjle j. Waste Heat recovery k. Idling Control l. Installation of Vacuum Slit in Stenter m. VFDs in stenter fans and installation of Energy efficient Fans n. Foam Finish Application System o. Optimization of Nip Presure in mangle to improve mangle expression, installation of seam detection system
Flat Bed printing machine	a. Auto Temperature Control in Relax Dryer b. Blocking air jet nojjle in the relax dryer c. Installation of VFD in Fans
Roary Printing Machine	d. Auto Temperature Control in Relax Dryer e. Blocking air jet nojjle in the relax dryer f. Installation of VFD in Fans
Thermopak Boiler	f. Hearth Area Reduction g. FD and ID Fan Optimization h. Installation of Oxygen Trim i. VFD in Thermic Fluid Circulation Pump j. Insulation of Auto Thermic Fluid Valves in Stenters 19. Hearth Area redesign 20. FD and ID fan optimization, installation of VFD 21. Installation of Oxygen Trim 22. Installation of DM water Plant

	23. Installation of Air Preheater / Economiser for Waste Heat Recovery 24. Soot Blowing and removal of scale from heat tranfer surfaces 25. Flash Steam and Condensate recovery from Jet Dyeing Machine 26. Flash Steam and Condensate recovery from Kiers 27. Flash Steam and Condensate recovery from Soft Flow Machines 28. Flash Steam and Condensate recovery from Decatising Machine / Felt Finishing Machine 29. Refurbishment of insulation in pipelines 30. Insulation of steam valves, condensate separators, Pressure Reduction Stations 31. Insulation of condensate recovery lines Flash Steam Recovery Lines 32. Maintenance of steam Traps 33. Over capacity
Jiggers	e. Temperature control system f. Computerised Colour Matching g. Provision of Cover h. Heat Recovery from Dye Effluent
Washing	a. Temperature Control
Cogeneration	a. Installation of cogeneration system
Solar Tunnel Dryer	a. Installation of Solar Tunnel Dryer
Solar Water Heater	a. Installation of Solar Water Heater System

5.1.3
Techno Economics for Energy Saving Proposals

ECO's	Energy Savings		Estimated Investments (Rs Lacs)	Simple Payback Period (Months)
	Quantum (KWh) / MTOE	Monitory (Rs Lacs)		
Improving PF		1.62	1.0	7.4
Pressure optimization in Air Compressors	Not Quantified	NQ	NQ	Immediate
Arresting Leakage	NQ	NQ	NQ	NQ
Lighting Voltage Optimization	1382 kwh	0.06	0.1	19.9
Replacing light fittings with Energy Efficient	10137 kwh	.47	.576	14.8
Excess Air Control in Boilers	109 MTOE	8.29	5.0	4.36
Provision of VFD for ID/FD Fan (with excess air control)	121362 Kwh	5.46	2.0	4.4
Waste Heat Recovery for Boiler	42.9 MTOE	3.26	3	11
Insulation of Dust Collector (In combination with Waste Heat Recovery System)	24.6 MTOE	1.86	0.4	2.6
Heat Recovery From Boiler Blow Down	2.9 MTOE	0.22	0.5	27
Insulation of steam lines	3.7 MTOE	0.28	0.11	4.9
Flash Steam Recovery in Jet Dyeing Machine	25.2 MTOE	1.91	1.5	9.4
Condensate Recovery in Jet Dyeing Machine	21.3 MTOE	1.61	3.5	26
Flash Steam Recovery in Decatizing / Felt finishing machines	28 MTOE	2.13	1.5	8.5
Condensate Recovery in Decatizing / Felt finishing machines	23.6 MTOE	1.79	3.5	23.4

ECO's	Energy Savings		Estimated Investments (Rs Lacs)	Simple Payback Period (Months)
	Quantum (KWh) / MTOE	Monitory (Rs Lacs)		
Thermopak Excess Air Control with VFD in ID and FD Fan	206 MTOE 169025 KWH	23.32	5	2.6
Installation of VFD in Thermic Fluid Pump	73285	3.32	1.0	3.6
Insulation of Dust Collector with Waste Heat Recovery System	11.2 MTOE	0.98	0.6	7.3
Installation of additional Dust Collector, 1 each for Boiler and Thermopak	**22.5 MTOE**	***1.96***	***4***	***24***
Waste Heat Recovery System For Thermopak	106 MTOE	9.36	3	3.8
Installation of Suction Slit before entry to Stenter but after mangle	52.1 MTOE	4.57	2	5.2
Blocking Air passage in stenetrs	88200 Kwh	3.96	0.5	1.5
Fabric Moisture Control in Stenters to avoid over drying	24 MTOE	2.16	0.5	2.8
Waste Heat Recovery for Stenter	64.2 MTOE	5.64	10	21.2
Stopping fans during idling	17500 kwh	0.78	1	15.2
Fabric Temperature Control	17739 kwh 14.7MTOE	2.1	4	23
Installation of Energy Efficient Fans in Stenter	75000 kwh	2.07	3	17.4
Installation of foam finish	NQ	NQ	NQ	NQ
Mangle Nip Pressure Optimization	52.1 MTOE	4.57	0.5	1.2
Savings by VFD in stenter fans	72000	3.31	2.5	9.1

ECO's	Energy Savings		Estimated Investments (Rs Lacs)	Simple Payback Period (Months)
	Quantum (KWh) / MTOE	Monitory (Rs Lacs)		
Implement Exhaust Humidity Optimization and Control for stenters	22.5MTOE 18150 Kwh	2.81	2.5	10.7
Installation of VFD for Jet Dyeing Machine Water Pump	*41202*	*1.85*	*1*	*7*
Waste Heat Recovery from Jigger Dye Effluent	2.4 MTOE	*0.182*	*0.4*	*27*
Waste Heat Recovery from Jet Dyeing Dye Effluent	4.7 MTOE	*0.35*	*0.4*	*13.4*
Stopping Idle Running of Float Dryer of Flatbed Printing Machine	6300 kwh	*0.28*	*0.1*	*4.3*
Flat Bed Auto Temperature Control	6.2 MTOE	*0.54*	*0.25*	*5.5*
Provision of Solar Water Heater, 1000 ltr		*0.49*	*1*	*25*
Provision of Solar Tunnel Dryer		2.66	*2*	*9*
Cogeneration System		*50*	*65*	*16*
Total	**869.8 MTOE + 711282 Kwh**	**156.042**	**132.846**	**10.2**

5.1.4
Barriers in implementation of identified Energy Saving Proposals

The following barriers are anticipated in implementation of identified Energy Saving Proposals :

1. **Attitudinal Barrier :-**Energy Saving is a mindset and it will have to be brought to the top of priority list of enterprepreneurs**.**
2. **Amenability to financing :** The entrepreneurs in Pali are averse to the idea of taking loan. In this respect, a typical financial plan of the unit would help in making them understand the importance of financing for growth.
3. **Lack of Maintenance facility :** Any high end system would need maintenance and Pali lacks this basic facility.
4. **Technology Availability :** This is not likely to affect the adoption except in only a couple of cases like foam finish. For other cases, indigenous system would be developed once demand is there.
5. **Financial Facility :** Sufficient incentive is available in terms of TUFs (Textile Upgradation Fund), CLCSS (Credit Linked Capital Subsidy Scheme), Interest Subsidy Scheme of Government of Rajasthan etc. Also, various line of credit like JICA is available with SIDBI for SME financing. What is needed is ease of delivery in financial products.
6. **Performance Guarantee :-** Till the time technology prove their proposed benefits, the units would like to hedge their investments and hence a performance guarantee would be needed.

5.1.5

Technologies for DPR

The 5 technologies identified for DPR are mentioned below :-

1. Boiler Performance Optimization system
2. Thermopak performance optimization system
3. Stenter performance optimization system
4. Dyeing and printing Energy Performance Optimization System
5. Renewable Energy Source adoption

Each of the above interventions have more than one component. These can further be classified in 3 or more packages each to give a total of 15 DPRs.

5.2
Summary of level of awareness on energy efficiency and energy efficient products in the cluster

The cluster lacks information and awareness on Energy Conservation issues very badly. The people carry a no of myths which are against the issues of Energy Conservation. There are no vendor either in the cluster to promote Energy Conservation.

In this respect, larger units are more aware due to their capability to hire educated manpower. Consequently, units in Industrial Area Phase I and II have adopted more energy efficient ways of doing the business. One of the units has rather adopted many of the Energy Conservation Measures proposed above. However, the no. of such progressive units is only 10.

-:-