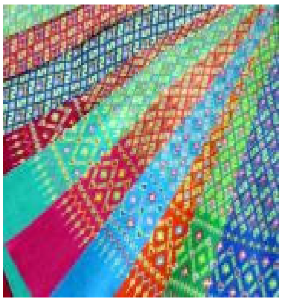
DETAILED PROJECT REPORT
ON
INSTALLATION OF WASTE HEAT RECOVERY SYSTEM IN STENTER
(PALI TEXTILE CLUSTER)







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INSTALLATION OF WASTE HEAT RECOVERY SYSTEM IN STENTERS

PALI TEXTILE CLUSTER

BEE, 2010

Detailed Project Report on Installation of Waste Heat Recovery System in Stenter

Textile SME Cluster, Pali, Rajasthan (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **PAL/TXT/WHR/15**

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We have received very encouraging feedback for the BEE SME Program in various SME Clusters. Therefore, it was decided to bring out the DPR for the benefits of SMEs. We sincerely thank the officials of BEE, Executing Agencies and ISTSL for all the support and cooperation extended for preparation of the DPR. We gracefully acknowledge the diligent efforts and commitments of all those who have contributed in preparation of the DPR.

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List of Abbreviations

- BEE - Bureau of Energy Efficiency
- DPR - Detailed Project Report
- DSCR - Debt Service Coverage Ratio
- FD - Forced Draft
- GHG - Green House Gases
- HP - Horse Power
- IBR - Indian Boiler Regulation
- IRR - Internal Rate of Return
- MoP - Ministry of Power
- MSME - Micro Small and Medium Enterprises
- NPV - Net Present Value
- ROI - Return On Investment
- SME - Small and Medium Enterprises
- TFH - Thermic Fluid Heater
- WHR - Waste Heat Recovery
- CERs - Certified Emission Reduction

EXECUTIVE SUMMARY

Pali has evolved as one of the most important production centers in the Textile Dyeing and Finishing sector despite there being nothing favorable for proliferation of a cluster. The place lacks all possible resources, from raw materials to fuels, Dyes & Chemicals and above all water which is the most important for processing of textiles. Today there are over 350 units in Pali alone and the production of all of these combined together crosses 5.5 million meter per day mark.

All the Industries in Pali cluster are in SME sector. These Industries process Manmade Fiber, Natural Fiber and blends. The units mainly process lower value clothes and the quality of fabric used is less than 100gm per RM. Few units have their own brand. Most of the units do job work for traders and the job works are also done process wise. Thus there are different units specializing in a particular process.

The process adopted by the units can be divided into three major classes –

a. Pre treatment

b. Dyeing and Printing

c. Finishing

The majority of units mainly do hand processing and a few (less than 20%) units do power processing. However, the output of the power process units far exceeds those of hand processing units.

Energy forms a major chunk of the processing cost with over 30% weightage in the cost basket. As per the preliminary and detailed energy audit findings, there exists potential of saving over 20% electricity and 30% fuel in the applications in power process industries with over all general pay back period of less than one year. Hand process industries are very less energy intensive, though, there also exists a saving potential of over 20%. The payback period in these industries is higher due to their working schedule and lower utilization of facilities.

The units in Pali cluster use disperse dyes for coloration of Polyester fabric or polyester contained in blends. Heat setting is necessary in these textiles and also finishing after Dyeing – Washing or Printing – Dye Fixation – Washing processes. Stenter is used for the two processes and this is very energy intensive process. Going by connected load and also by the absolute electricity consumption in textile dyeing and processing units, stenter happens to have a share upwards of 50%.

During Energy Audit, major flaws were observed in process control of Stenters. None of the units were found to be equipped with automatic process control facilities leading to large scale deviation from process parameters causing wastage of energy. The basic process parameters for the stenters are Residual Moisture, Humidity in Exhaust, Temperature of the fabric, Dwell Time for Heat Setting, Velocity of Air Jet etc. However, none of these are controlled and setting is done on manual estimation basis which has possibility of error.

Typically one stenter consumes between 40 to 55 kWh per hour electricity and 50 to 60 kg per hour RPC. The implementation of Waste Heat Recovery system (Air to Air) in stenters has a potential to save 20% to 30% energy. To be on safer side, only 20% savings has been considered for calculation of Energy Conservation Potential.

This DPR highlights the details of the study conducted for assessing the potential for installation of Air to air Waste Heat Recovery system (Air to Air) in Stenter, possible Energy saving, and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, and schedule of Project Implementation.

Total investment required and financial indicators calculated such as monetary saving, IRR, NPV, DSCR and ROI etc for proposed technology is furnished in Table below:

S.No	Particular	Unit	Value
1	Project cost	₹ (in Lakh)	10.25
2	Fuel Saving (RPC)	MT/year	75.2
3	Monetary benefit	₹ (in Lakh)	5.64
4	Debit equity ratio	Ratio	3:1
5	Simple payback period	years	1.8
6	NPV	₹ (in Lakh)	10.46
7	IRR	% age	37.45
8	ROI	% age	22.17
9	DSCR	ratio	2.26
10	CO_2 saving	MT	200
11	Process down time	Days	2

The projected profitability and cash flow statements indicate that the project implementation will be financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Pali Textile Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up gradation through studies and pilot projects in these SMEs clusters.

***Major activities in the BEE -SME program are furnished below*:**

Activity 1: Energy Use and Technology Audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity Building of Stake Holders in Cluster on Energy Efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting of energy efficiency projects in the clusters

Activity 3: Implementation of Energy Efficiency Measures

To implement the technology up gradation projects in clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of Innovative Financing Mechanisms for Implementation of Energy Efficiency Projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1.0 INTRODUCTION

1.1 Brief Introduction about Cluster

Pali is the District Head Quarter of the Pali District situated at a distance of approx. 300 KMs from Jaipur and 70 KMs from Jodhpur. Pali can also be reached from Ahmedabad via Abu Road and has direct train connectivity to Ahmedabad and Mumbai. The nearest airport having commercial flights plying is at Jodhpur. The map depicting Pali district and its distances from various towns is produced below in fig. 1.

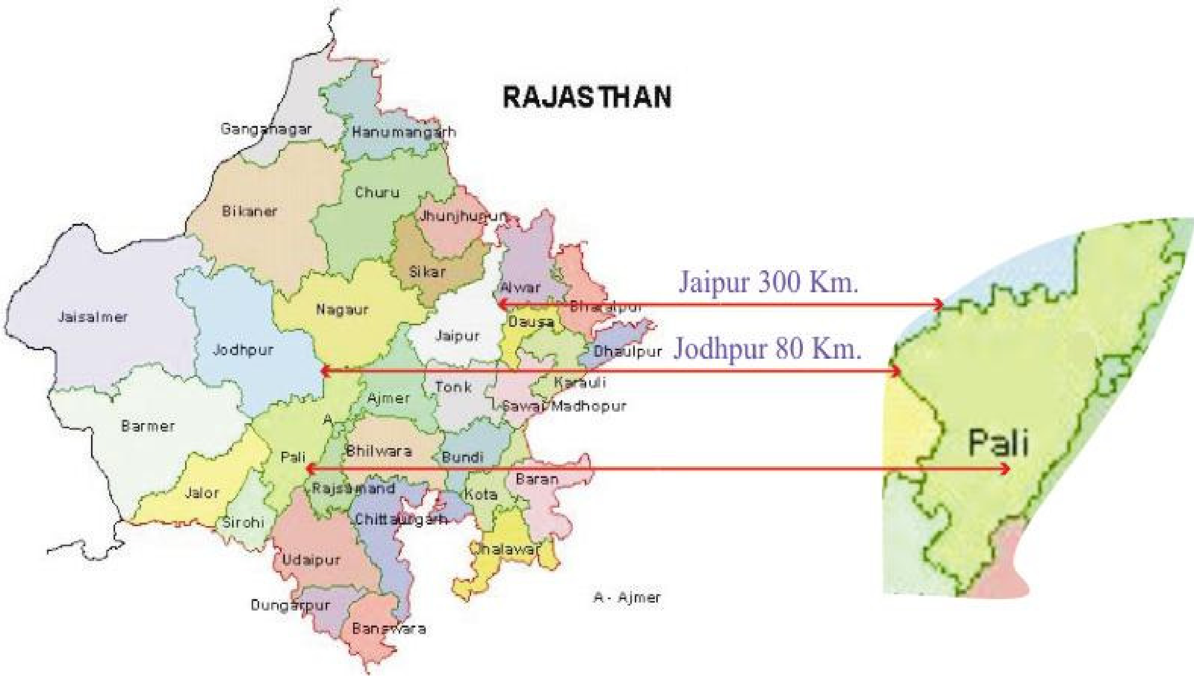


Fig. 1.1 – Pali – Geographical Map

Pali District is rich in minerals and the abundance of limestone deposits has made it home for 5 cement companies. There are several other SME units producing various lime based products. Despite there being non availability of requisite resources like raw material and consumables locally, a dense population of textiles dyeing and processing units has sprung up at Pali.

The Pali textile cluster is one of the biggest SME textile clusters in India having over 350 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. Over 150 industries are in the process of setting up their facilities in the Punayata Road Industrial area.

Balotra, Jodhpur and Bhilwara are other textile clusters in Rajasthan. These clusters work on more or less similar processes and use same machines, though their output differs. Details of energy consumption scenario at Pali textile cluster are furnished in Table 1.1 below:

Table1.1 Details of annual energy consumption scenario at Pali Textile Cluster

S. No	Type of Fuel	Unit	Value	% contribution (KLOE)
1	Electricity	MWh /year	51.3	16.6
2	Firewood	MT/year	27161	25.6
3	Steam Coke	Tonne/year	2967	5
4	Lignite	MT/year	16635	15.7
5	Diesel	Klitre/year	89.6	0.3
6	Residual Pet coke	Mt/Yr	11820	36.6

1.1.1 Energy usages pattern

Electrical energy Usage

The Cluster has two types of units – Hand Process and Power Process. Hand Process units mainly process cotton and consume very less electricity. These units consume electricity in the range of 4000 kWh to 5000 kWh per month. The hand process units outsource the finishing to other power process units. Power process units are energy intensive units and consume electricity in the range of 100000 kWh to 300000 kWh per month. Various Electricity consuming equipments in the hand process units are Fans, Tube Lights, and Computers etc. Power Process units have Stenter, Jet Dyeing Machine, Loop Agers, Boiler and Thermopac auxiliaries, Flat Bed Printing Machines etc. Stenter happens to be the biggest Electricity guzzler.

Thermal Energy Usage

Hand process units in the cluster are mainly involved in Table Printing, Kier Boiling and Jig dyeing. Heat for the process is obtained from direct burning of wood. Some units also have open type stenter wherein heating is done by directly burning wood beneath the clothes. Power Process units mainly use Thermal Energy Stenters, Kiers, Jet Dyeing Machines, Sanforizers, Loop Agers, Mercerisers, Scouring, Reduction and Clearance etc. These units use Residual Pet Coke, Lignite, Coal and Wood in Boilers and Thermopacs to make heat usable in machines. Typical Power Process Units use 100 MT to 300 MT RPC (85 MTOE to 256 MTOE) per month. The hand process units use 3 MT to 15 MT wood per month.

1.1.2 Classification of Units

The Textile units in the Pali Cluster can be categorized into two types based on availability of machinery in the units –

- Hand Process Units and
- Power Process Units

Pali Textile Cluster mainly consists of hand process units and over 250 out of a total population of 350 units are hand process units. These units are mainly owned by artisans or traditional colormen (Rangrej).

On the basis of type of cloth processed, the units can be classified as

- Cotton (Natural fiber) Processing Units
- Synthetic clothes (Manmade fibers) Processing Units

Based on output, the units can be classified as

- Dyeing Units
- Printing units
- Finishing Units

Scale of Operation

Most of the units in the Pali textile cluster are micro units. All the units are in Micro, Small or Medium sector with none of the units being in large scale sector.

Products Manufactured

Different types of products manufactured in Pali Textile Cluster. The marketed products are:

- ✓ Sarees (Lower Price Range)
- ✓ Rubia Blouse Clothes
- ✓ Lungies
- ✓ Turbans
- ✓ African Prints

1.1.3 Production process of Textile dyeing and finishing

The process adopted in Textile Dyeing and Finishing depends upon the fabric processed. The processes are different for Cotton, Polyester and Blended fabrics. The process flow chart for different processes depending upon fabric processed with location of stenter in the process are drawn below –

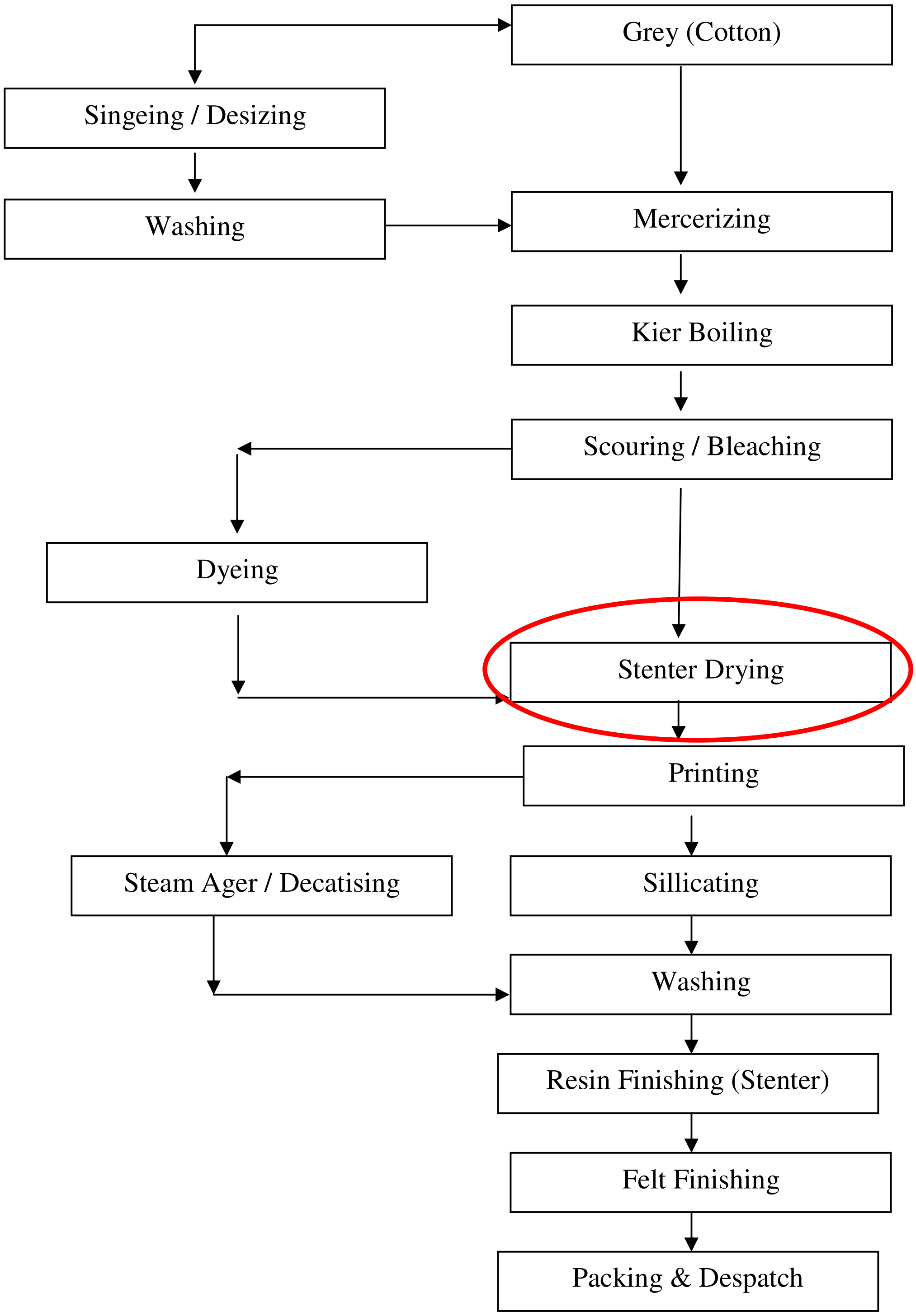


Fig. 1.2 – Process Flow Diagram of Cotton Dyeing and Printing

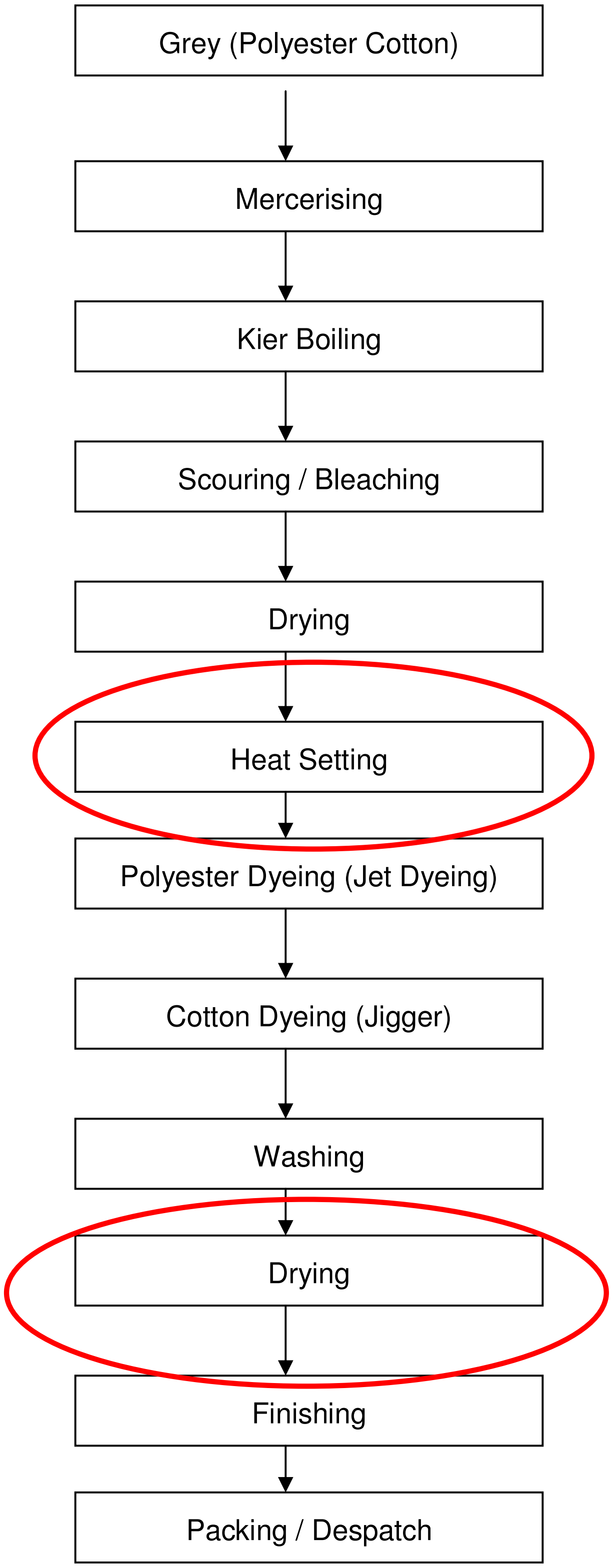


Fig. 1.3 – Process Flow Diagram of Polyester Cotton Dyeing and Finishing

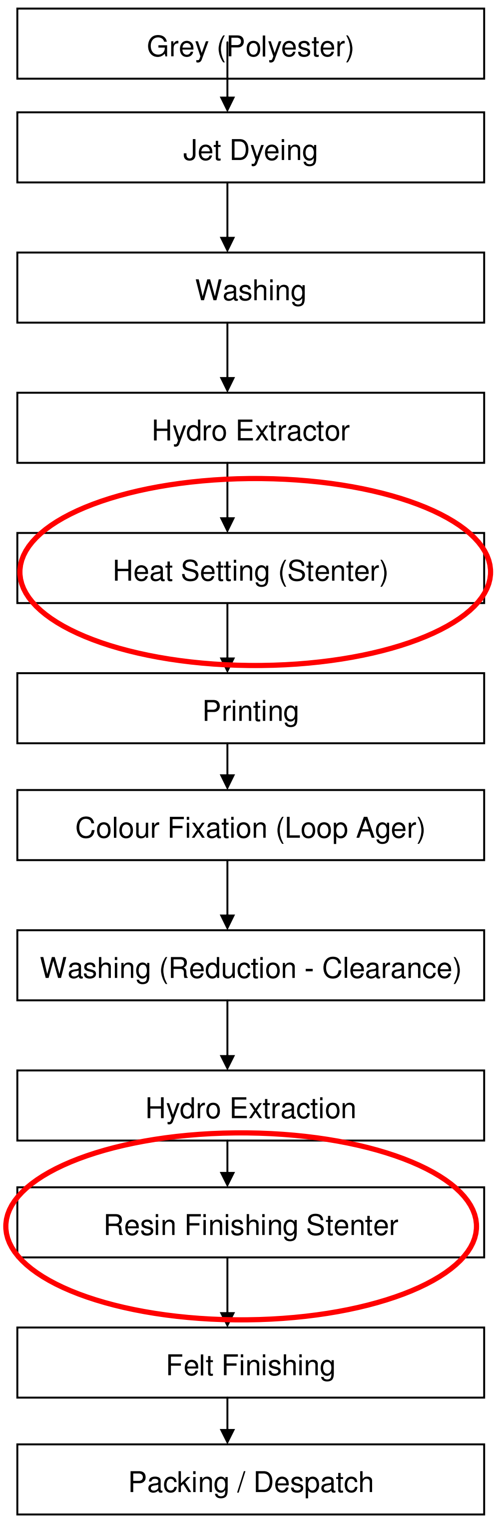


Fig. 1.4 – Process Flow Diagram of Polyester Printing and Finishing

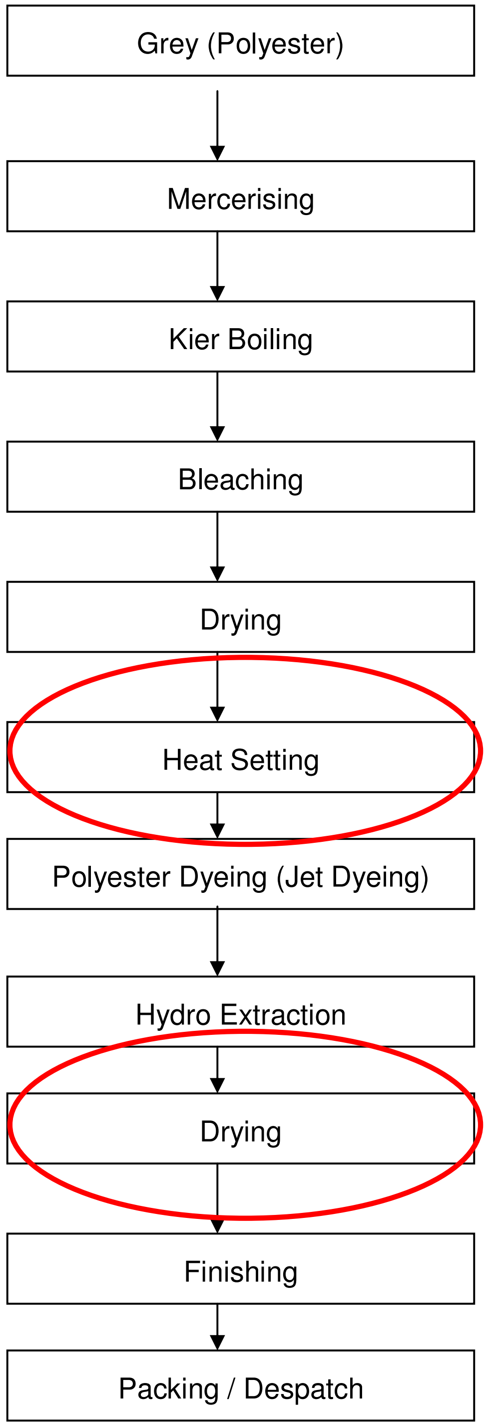


Fig. 1.5 – Process Flow Diagram of Polyester Cotton Dyeing and Finishing

1.2 Energy performance in existing situation

1.2.1 Average production

A typical unit works 5 days a week and the daily production of these units are in the following Table 1.2 below:

Table 1.2 Annual productions from a typical unit

Type of product	*Production (RM/Day)*		
Scale of Unit	**Micro**	**Small**	**Medium**
Finished Fabric	10000	30000	100000

1.2.2 Fuel consumption

Energy consumption both electrical and thermal by a typical textile dyeing and processing unit in Pali cluster is given in table 1.3 below:

Table 1.3 Annual energy consumption

Energy	*Electricity (kWh per year)*			*Thermal Energy (MTOE per year)*		
Scale of Unit	Micro	Small	Medium	Micro	Small	Medium
Consumption	48000	360000	2400000	30	100	300

1.2.3 Specific Energy Consumption (SEC)

The benchmark available for different processes in textile dyeing and processing industry in UK is given in Table 1.4 below:

Table 1.4 Specific Energy Consumption Values

S.No.	*Machine*	*Process*	*Energy Required (GJ/Te)*
1	Desizing Unit	Desizing	1.0-3.5
2	Kier	Scouring/Bleaching	6.0-7.5
3	J-Box	Scouring	6.5-10.0
4	Open Width range	Scouring/Bleaching	3.0-7.0
5	Low Energy Steam Purge	Scouring/Bleaching	1.5-5.0
6	Jig / Winch	Scouring	5.0-7.0

S.No.	Machine	Process	Energy Required (GJ/Te)
7	Jig / Winch	Bleaching	3.0-6.5
8	Jig	Dyeing	1.5-7.0
9	Winch	Dyeing	6.0-17.0
10	Jet	Dyeing	3.5-16.0
11	Beam	Dyeing	7.5-12.5
12	Pad / batch	Dyeing	1.5-4.5
13	Continuous / Thermosol	Dyeing	7.0-20.0
14	Rotary Screen	Printing	2.5-8.5
15	Steam Cylinders	Drying	2.5-4.5
16	Stenter	Drying	2.5-7.5
17	Stenter	Heat Setting	4.0-9.0
18	Package / Yarn	Preparation / Dyeing (Cotton)	5.0-18.0
19	Continuous Hank	Scouring	3.0-5.0
20	Hank	Dyeing	10-16.0
21	Hank	Drying	4.5-6.5

SOURCE – CARBONTRUST UK

SEC in Pali Cluster

For the units involved in Processing of Polyester and printing it to make Saree, the Specific Energy Consumption was observed and furnished in Table 1.5 below:

Table 1.5 Specific energy consumption

S.No	Particulars	SEC
1	Average Specific Electricity Consumption	1.2 kWh/kg (Best Observed Value – 0.95 kWh/kg)
2	Average Specific Thermal Energy Consumption	15000 kCal/kg (Best Observed Value – 10932 kCal/kg)

1.3 Identification of technology/equipment

1.3.1 Description of technology/ equipment

Pretreatment of textiles and also Dyeing, Printing, washing etc. involve use water which needs to be removed from fabric before undertaking final finishing or thermosol process or heat setting. Stenters are mainly used in textile finishing for heat-setting, drying, thermosol processes and finishing. Thus Stenter is one of the most common machinery found in a textile dyeing and finishing industry.

It can be roughly estimated that, in fabric finishing, each textile substrate is treated on average 2.5 times in a stenter. Pali has a population of more than 100 stenters installed in industries. The stenters available in Pali are both open and closed type. These stenters are used for assigning requisite finish, temperature stability and dye curing.

In Cotton Dyeing, stenter is used after pretreatment and dyeing as a finishing process. In Cotton Printing, Stenter is used before printing but after pretreatment. In case of Polyester or PC Dyeing, stenter is used twice, once for heat setting and then again for final finish. Similarly, in case of Polyester and PC Blend Printing, stenter is used twice, once for heat setting and then for final finishing after dye curing.

Stenter happens to be the largest Energy Consuming Machinery available in a textile Dyeing and Finishing Industry. For a 5 Chamber Stenter, the connected load is approx. 90 HP and the Thermal Energy Consumption rating is 4.0 Lac kCal per hour. The major Electrical Energy load happens to be that of 10 no. of fans provided for circulation of hot air having motor rating of 7.5 HP each.

Thermal Energy required for stenters is supplied by Thermopac. The hot thermal fluid at a temperature of 235°C to 300°C is pumped to the stenter with the help of a continuous running pump. The blowers blow air onto a grid of heat exchanger tubes containing hot thermic fluid which then is guided onto the fabric through nozzles. The blower motors are generally two speed motors for controlling speed of the blower. Some of the new Stenters have been provided with VFD for control of speed. Some units have installed VFD as retrofit to the stenter blower motors.

The temperature in each compartment is controlled in modern stenters with the help of a motor operated flow control valve which bypasses hot fluid if temperature in a chamber exceeds preset temperature. Varying the speed of the motor rotating the endless chain can also vary the speed of the fabric.

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

A typical stenter is depicted in the following photograph:-

Fig. 1.6 – Photograph of Stenter

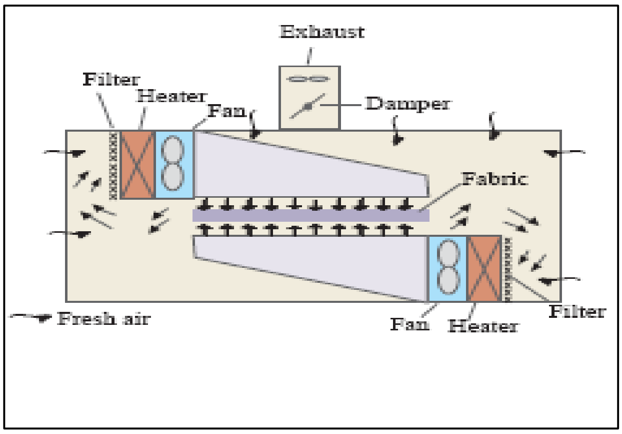


Fig. 1.7 – Schematic of air flow in stenter

1.3.2 Role in process

Textile stenters have two main purposes – convection drying so as to remove the moisture in the fabric and secondly to provide for fabric width control. During the previous stages of processing the fabric is subjected to length wise tension to varying degrees resulting in shrinkage in width. In the stenter, width control is achieved with the aid of a series of clips or pins mounted on a pair of endless chains. Apart from these functions, stenters are also used for the following purposes:

a. Dry-heating process like, heat setting of synthetic fabrics and their blends

b. Dry curing process namely, resin finishing with built-in catalysts

In Pali, Stenter is used for drying as well as finishing of Cotton and also for Heat Setting as well as Finishing of Polyester and PC Blend. Stenter is indispensable for Dyeing and Printing of polyester and Blends. Cotton fabric is processed on open stenter. Stenter is generally not used for Drying purpose as drying is done in open air by hanging the fabric in sun. Mechanical dewatering process is also used in case of Polyester and PC Blend. All the stenters are equipped with 3 bowl mangles for dewatering which is used if any chemical is applied with water as carrier.

Analysis of cost of ownership of stenter as per PLEVA given below reveals that there is a saving potential of 27% minimum.

Table 1.6 Life Cycle Cost Analysis of stenters

S.No.	Cost Head	% age Weightage
1	Machine Cost	16
2	Labor Cost	11
3	Heat energy	23
4	Electricity	12
5	Maintenance	6
6	Spare Parts	3
7	Others	2
8	Potential of Energy Savings	27

Energy Consumption details

Energy break up for Heat setting in a stenter is as given in Table 1.7below:

Table 1.7 Energy break up for Heat setting in a stenter

S.No.	Component	Energy Content (GJ/Te)	% age
1	Evaporation	0.20	4.30
2	Air Heating	3.55	76.2
3	Fabric	0.25	5.40
4	Case	0.23	4.90
5	Chain	0.10	2.10
6	Drive	0.33	7.10
7	Total	4.66	100

Energy break up for a typical stenter is shown in Table 1.8below:

Table 1.8 Energy break up for a typical stenter

S.No.	Component	Energy Content (GJ/Te)	% age
1	Evaporation	2.54	41.0
2	Air Heating	2.46	39.7
3	Fabric	0.29	4.6
4	Case	0.39	6.3
5	Chain	0.09	1.5
6	Drive	0.43	6.9
7	Total	6.20	100.0

As is obvious from above table, only 5.4% of heat given to stenter is utilized in heating the fabric in case of Heat Setting. Heat gained by fabric in any typical stenter operation is 4.6% only. It is further evident that approx. 95% stenters is used for the purpose of moisture evaporation, released to atmosphere or wasted.

Typical Sankey diagram for a stenter having no Energy Conservation Measures is as below:

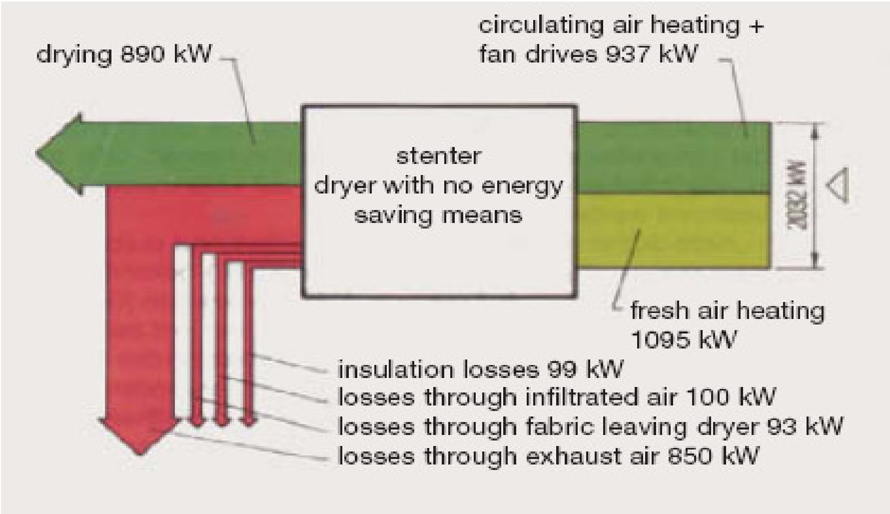


Fig. 1.8 – Sankey diagram for a stenter without Energy Conservation Measure

Typical Sankey Diagram for a stenter with Energy Conservation Measures is as below:

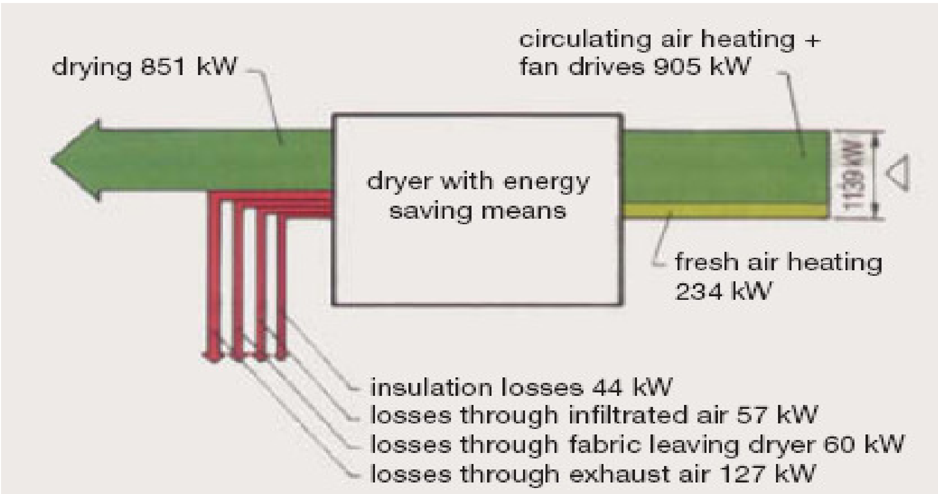


Fig. 1.9– Sankey diagram for a stenter with Energy Conservation Measure

1.3.3 Energy audit methodology

The following methodology was adopted to evaluate the performance of Stenters which is shown in Fig. 1.10.

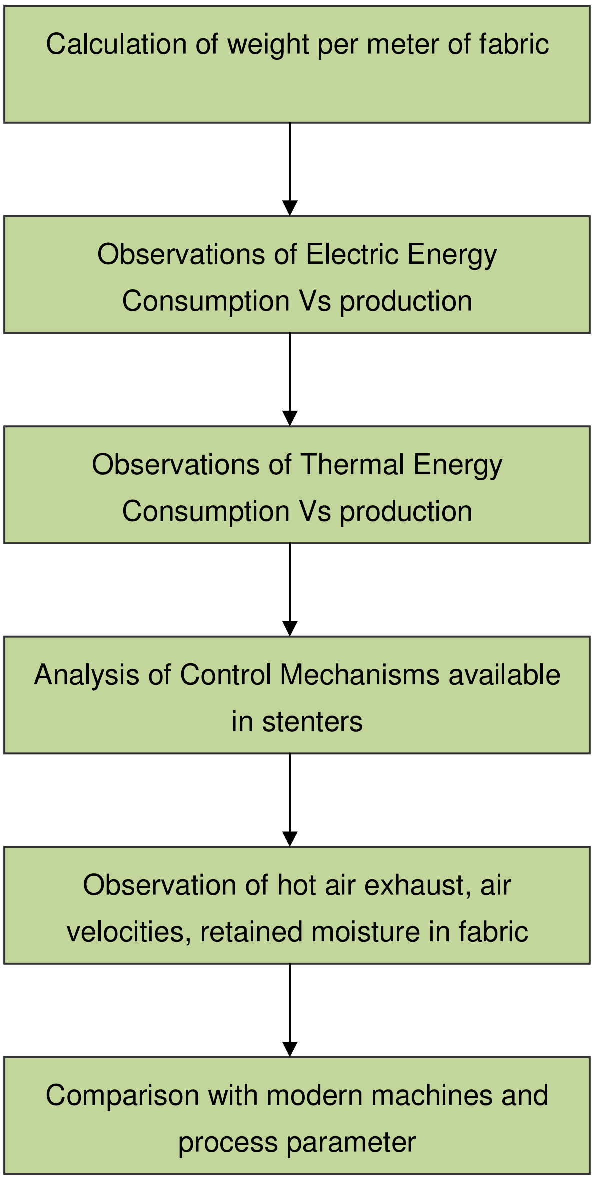
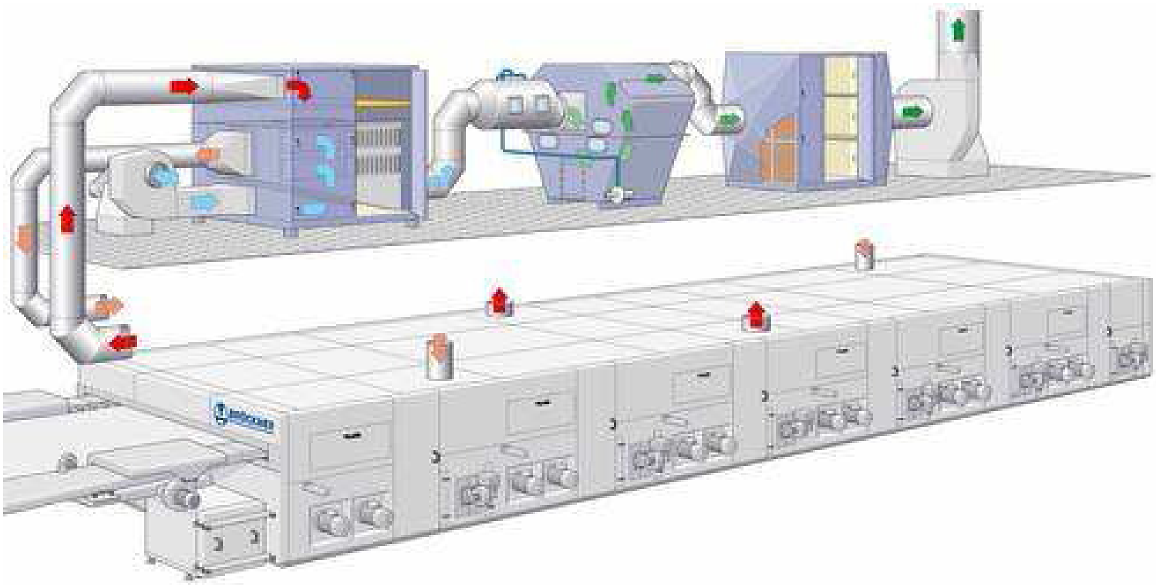


Fig. 1.10 Energy Audit methodologies

1.3.4 Design and operating parameters specification

Typical specification of stenters is placed at Annexure 6. Also, the brochure of M/s Bruckner is placed at Annexure 1. Out of total heat used by stenters, over 39% heat in resin finish and 76% heat in Heat Setting is wasted with hot air released in air. 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. 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.

Exhaust air from stenters, condensation equipment etc, contains a high quantity of energy in the form of heat in addition to moisture and impurities. A range of manufacturers offer tried and tested equipment for recovering heat from dryer exhaust air, based on the most usual air exchange. Secondary measures, which postulate the first stage of exhaust air optimisation as an effective primary measure, are involved. Heat recovery efficiency may not apparently be improved by processing with an increased exhaust air quantity, i.e. with smaller vapour content in the exhaust air. A typical waste heat recovery system is depicted in the following figures.



1.3.5 Operating efficiency analysis

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

1. **Air to air heat recovery**- In this option, 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 ^{O}C and can be used directly to process/boiler feed.

As per attached brochure of M/s Bruckner, upto 35% heat energy can be saved by installing the heat recovery system. As per the attached quotation of another German manufacturer M/s Montforts, average 20% heat energy saving is possible by using the waste heat recovery system. Consequently, 20% saving potential has been taken for calculation of Energy Saving potential.

1.4 Barriers in adoption of proposed technology/equipment

BEE promoted SME programme has the unique distinction of addressing all the identifiable barriers in adoption of Energy Efficiency Improvement technologies in SME sectors. Following actions have been taken in Pali Textile Cluster to remove the barriers:-

- Kick off Seminar to create awareness
- Energy Audit (Detailed and Preliminary) in over 78 units
- Capability building and involvement of institutional financers, local service providers and also domestic equipment manufacturers.
- Design and distribution of dissemination material containing most of the measures.
- Design and distribution of Cluster Manual containing technology gap assessment and cost benefit analysis of proposed Energy Conservation measures.
- Involvement of Industry Association, Department of Industries and local administration.

However, for the sake of identifying possible barriers to adoption of the proposed technologies, the following may be considered.

1.4.1 Technological Barrier

- There are no manufacturers of waste heat recovery equipment in India. However, as per the attached brochures of Bruckner, Germany and Montforts Germany, the system is being offered as standard fitment. These manufacturers also offer the system as retrofit. Only one industry in India has installed the system and is reaping the benefits. However, designing and installing the system indigenously possible.

- The proposed system is new for the Indian Industry on and would need good amount of convincing for adoption. Also, some sop may also be required for adoption and replication.
- Multi National Stenter manufacturers are offering the proposed technology as a standard add on to new systems. However, the proposition is not being presented with guaranteed cost benefit analysis to the entrepreneurs. The entrepreneurs are in Micro, Small and medium sector and they do not have trained or educated manpower.
- There is a severe paucity of quality technical consultants in the cluster. This also inhibits adoption of technology as there is nobody to convince the entrepreneurs.
- Non availability of local after sales service provider for the equipments is a major obstacle to adoption of any new and modern technology involving electronics.
- The majority of the textile unit owners / entrepreneurs do not have in-depth technical expertise nor do they have technically qualified manpower. This is a major barrier in acquiring knowledge about any innovation in the sector.
- The entrepreneurs in the MSME sector are averse to investment risks and tend to invest in proven technology only. Adoption of technology is higher in bigger units and these bigger units also become agents for demonstration and hence replication. Lack of any bigger unit in the cluster also is an impediment to adoption of newer technology.

1.4.2 Financial Barrier

- The applicability of the proposition is in power process units only. These units have very healthy financial position. Lack of finances is not the reason for non adoption of the proposed technology. However, availability of easy finances and also financial incentives would trigger and also accelerate adoption of the technology.
- Implementation of the proposed project activity requires approx. ₹ 10 lakh investment per machine and can be managed by loan only as internal accruals may not suffice.
- The investment decisions normally favour creation of additional facility and investment for Energy Efficiency Improvement features last in the priority of entrepreneurs. Consequently, interventions like the one undertaken by BEE are

necessary for promoting adoption of technologies.

- The subjective approach of the banks in deciding on grant of loans to entrepreneurs and also lack of pre declared formalities required for availing loan is the biggest impediment. On adherence to a time bound dispensation of the loan application is also an obstacle as the a new document is asked for ever time the entrepreneur visits the bank and the bank would refuse in the last moment citing untenable reason leaving the entrepreneur in the lurch. Facilitating delivery of finances is more important than packaging the finances.
- Most of the units in Pali textile cluster are debt free enterprises and the situation is ideal for any bank or financial institution to do advances. With end to economic slow down within sight, the demands are likely to pick up and the units would require scaling up their operations and also perking up their facility to meet enhanced demand. The inherent benefit of increase in profitability by precise process control is also up for taking.

1.4.3 Skilled manpower

The cluster very badly needs skilled manpower. There is no trained Dye Master, no trained electrician, no trained boiler operator or no trained maintenance man. The existing manpower has grown by on the job learning and has learnt the traditional methods of dyeing and processing. Propagation of learning of new technology is absolutely necessary.

1.4.4 Other barrier (If any)

Creation of Energy Champions is necessary to trigger large-scale adoption of proposed technologies. This is possible by sponsoring adoption of such technologies through financial help and also mitigation of investment risks through a mechanism that guarantees the savings. An ESCO can as well be involved in the process.

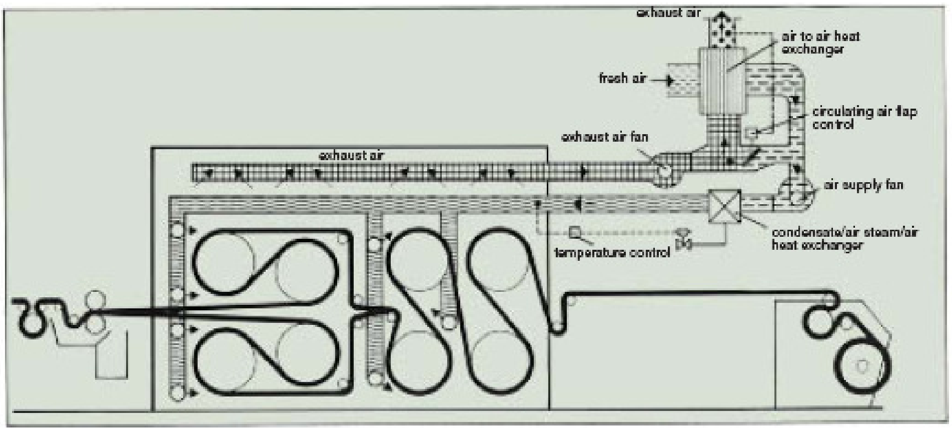
2.0 PROPOSED EQUIPMENT

2.1 Detailed description of technology proposed

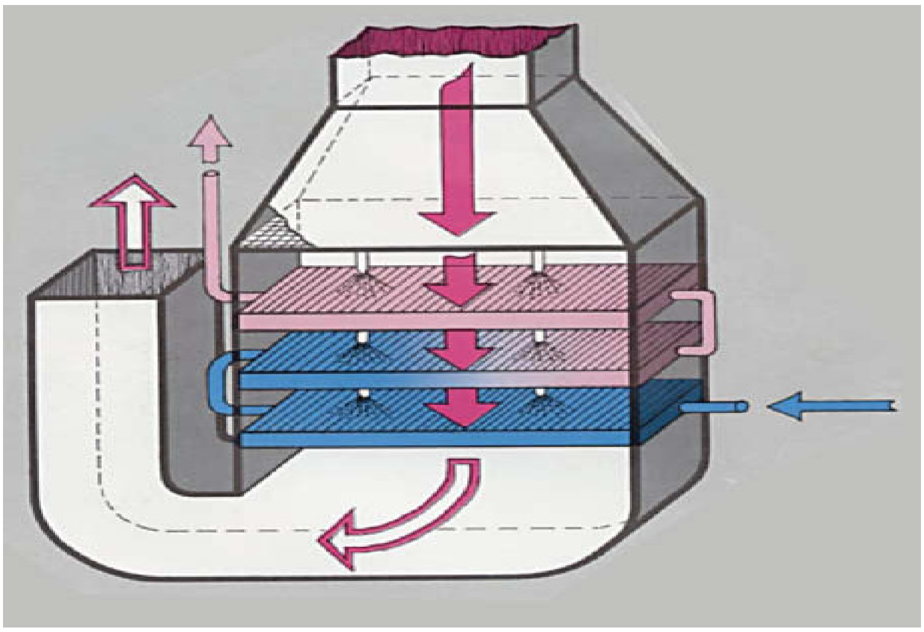
Background

Only one stenter with integrated waste heat recovery system has been installed in India. With an air/water heat exchanger, roughly 70% of energy can be saved. In this DPR Air to Air type waste heat recovery system has been considered.

A typical system is depicted below



Air to air Heat Recovery System



Air to water Heat Recovery System

The preheated air can form make up air and hence energy required to heat fresh air to the preheated temperature levels is saved. Also, hot water can be generated and used in the hot processes like dyeing or hot washing.

Maintenance seems to be a major problem as the tubes are prone to fouling. 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. 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.

Description of equipment

Heat exchangers fitted to the stenter consist of bundles of glass tubes to recover heat from the hot stenter exhaust. The material is selected so to take care of the impure hot air released by the stenter. Bruckner uses Aluminum Coated finned type heat exchanger.

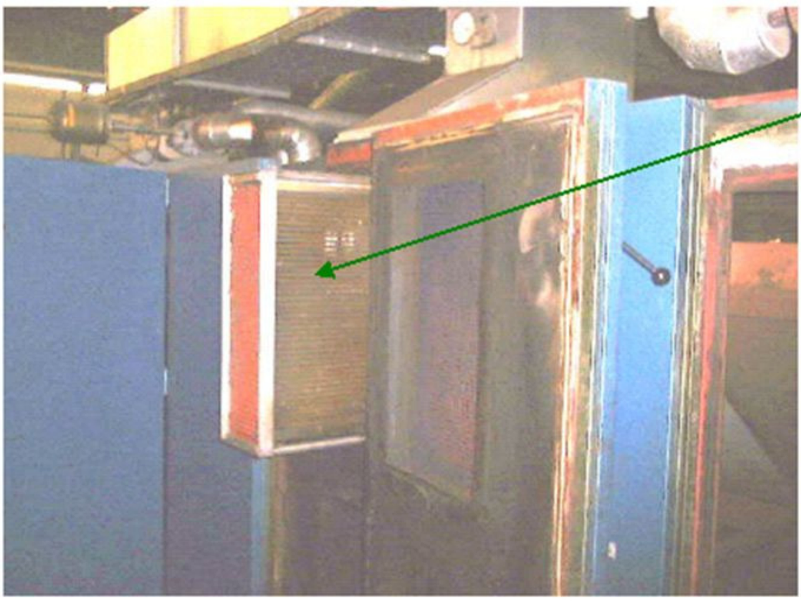
The tubes are fitted in a drawer like arrangement so as to facilitate cleaning. The WHR system is a counter flow type and can be any of the

– heat pumps,

– Plate exchangers,

– Circulation-linked ribbed pipe systems,

– Tubular exchangers.



Drawer like arrangement of Waste Heat Recovery system

2.1.1 Equipment specification

A complete brochure of the equipment is placed at Annexure 1.

2.1.2 Suitability over existing equipment

Major structural reinforcements are required for installation of the Waste heat Recovery System on to the stenter. However, it would require shut down of the unit for over a week for completion of the job.

2.1.3 Superiority over existing equipment

The system would improve precision of control on the existing process and hence would yield better results on productivity as well as quality fronts.

2.1.4 Availability of equipment

The system is not available indigenously and hence will have to be designed or imported from Montforts Germany, Bruckner Germany or Hitec Korea. Alternatively, the system will have to be designed and then installed. The whole process would take minimum 6 months for installation.

2.1.5 Source of equipment

German or Korean suppliers can supply the proposed system.

2.1.6 Technical specification of equipment

Technical specification of proposed technology is attached at Annexure 1.

2.1.7 Terms and conditions in sales of equipment

Term and condition are as per the attached brochure at Annexure 6.

2.1.8 Process down time during implementation

The proposed system is interdependent on existing system and integration would need shutdown of over a week.

2.2 Life cycle assessment and risks analysis

The unit will have a typical lifecycle of 10 years due to adverse working conditions and impure hot air coming in contact with the tube material.

2.3 Suitable Unit for Implementation of Proposed Technology

The proposed system can be implemented in almost all of over of 100 no. of Stenters. Total potential for energy saving would be 20000 MT per year if the proposition is implemented in all the machines.

3.0 ECONOMIC BENEFITS FROM PROPOSED EQUIPMENT

3.1 Technical benefit

3.1.1 Fuel saving

The proposition (Air to Air waste heat recovery system) would help save 75.2 MT RPC fuel per year in every stenter. Further, details of fuel saving are given in Annexure 4.

3.1.2 Electricity saving

No electricity saving is possible

3.1.3 Improvement in product quality

The system comes with precision process control protocol and hence product quality would certainly improve.

3.1.4 Increase in production

Precise process control will certainly improve production; however, the quantum of improvement will depend upon extant level of inefficiency.

3.1.5 Reduction in raw material

Raw material consumption is same even after the implementation of proposed technology.

3.1.6 Reduction in other losses

None

3.2 Monetary benefits

The monetary saving arising out of implementation of proposed technology in one Stenter would be ₹ 1.83 lakh per year. A Detail of monetary saving is furnished in Table 3.1 below:

Table 3.1 Details of monetary saving

S. No	Particular	Unit	value
1	Daily processing of Cloth with stenter speed @ 60mtr/min	mtr/day	86400
2	Theoretical Fuel Consumption (RPC)	MT/year	376
3	Saving @ 20% as projected by manufacturers	MT /year	75.2
4	Cost of fuel	₹/MT	7500
5	Monetary saving	₹/year	564000

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

Proposed equipment reduces the GHG emission by reducing electricity consumption.

3.3.2 Improvement in workers skill

Not contributing to any improvement in skill sets of workers. However, the automation would eliminate human intervention in precision control of process thereby reducing workload of the frontline workers. No retrenchment of labor is envisaged because of implementation of the proposed system.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

The fuel saving will have equivalent mitigation in terms of SPM and other pollutants otherwise likely to be released in the atmosphere.

3.4.2 Reduction in GHG emission

The equivalent saving in GHG emission for every Stenter would be 201 per year as per UNEP GHG Calculator.

3.4.3 Reduction in other emissions like SO_X

NIL

4.0 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of equipment implementation

4.1.1 Equipments cost

Cost of one set of equipment is about ₹ 8 Lakh based on the availability of the best system in the market. In the absence of a ready to buy system and a supplier, the cost estimate is the best guestmate.

4.1.2 Erection, commissioning and other misc. cost

Erection & commissioning cost is about ₹ 2.0 lakh. A detail of project installation cost is given in Table 4.1 below:

Table 4.1 Details of proposed equipment installation cost

S.No	Particular	Unit	cost
1	Equipment cost	₹ (in Lakh)	8.0
2	Erection & Commissioning cost	₹ (in Lakh)	2.0
3	EPC Cost	₹ (in Lakh)	0.25
4	Other misc. cost	₹ (in Lakh)	Nil
5	**Total cost**	₹ (in Lakh)	**10.25**

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost which is ₹ 2.56 lakh.

4.2.2 Loan amount.

Remaining 75% cost of the proposed project will be taken from the bank which is ₹ 7.69 Lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI's rate of interest for energy efficient projects. The loan tenure is 5 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 Financial indicators

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 5 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below. The cost of equipment considered is inclusive of hot water storage tanks also.

The project is expected to achieve monetary savings of ₹ 5.64 lakh per annum.

- The Operation and Maintenance cost is estimated at 4% of cost of total project with 5% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Based on the above assumptions, profitability and cash flow statements have been prepared and calculated in Annexure-3.

4.3.2 Simple payback period

The total project cost of the proposed technology is 10.25 lakh and monetary savings due to reduction in Electricity & Fuel consumption is 5.64 lakh hence, the simple payback period works out to be around 22 months.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be 10.46 Lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 37.50%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 22.17%.

Table 4.2 Financial indicators of proposed technology

S.No.	Particular	Unit	Value
1	Simple payback period	Months	22
2	NPV	₹ (in lakh)	10.46
3	IRR	% age	37.45
4	ROI	% age	22.17
5	DSCR	ratio	2.26

4.4 Sensitivity analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like when there is an increase in fuel savings or decrease in fuel savings. For the purpose of sensitive analysis, two following scenarios has been considered

- Optimistic scenario (Increase in fuel savings by 5%)
- Pessimistic scenario (Decrease in fuel savings by 5%)

In each scenario, other inputs are assumed as a constant. The financial indicators in each of the above situation are indicated along with standard indicators.

Table 4.3 Sensitivity analysis in different scenario

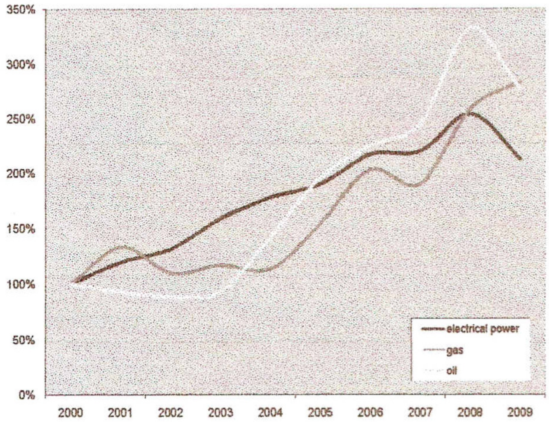
Scenario	IRR (% age)	NPV (₹ in lakh)	ROI (% age)	DSCR
Pessimistic	34.81	9.38	22.10	2.15
Realistic	37.45	10.46	22.17	2.26
Optimistic	40.07	11.54	22.23	2.38

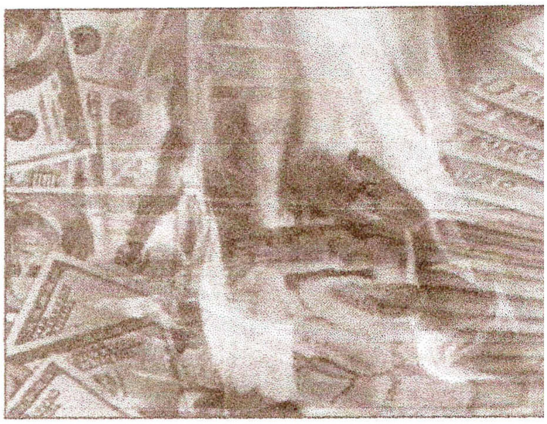
4.5 Procurement and Implementation Schedule

Total time period required for implementation of this technology is about 6 month and their details are given in Annexure 3.

Annexure -1: Information Brochure of equipment

Explosion of energy costs
Explosion der Energiekosten





Did you know that you throw your money "up the chimney" every single day?

Heat recovery systems are money saving machines. They guarantee immediate payback and they are a good investment in the future.

Payback calculation heat-recovery air/air on the example of a textile finishing machine (fresh air heated up from 25°C to 148°C)	
Stenter	8 compartments
Energy savings	1,530,000 kWh / year
Payback period	1.3 years
Payback calculation heat-recovery air/water on the example of a textile finishing machine (fresh air heated up from 25°C to 148°C)	
Stenter	8 compartments
Energy savings	2,660,000 kWh / year
Payback period	0.9 years
Basis for calculation	
Operating hours: 4800 h / year	electricity cost 0.107 €/kWh gas cost 0.033 €/kWh thermo oil cost 0.031 €/kWh

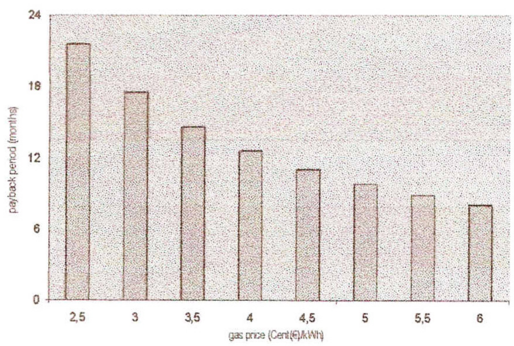
Wussten Sie, dass Sie jeden Tag Ihr Geld „durch den Kamin jagen"?

Wärmerückgewinnungsanlagen amortisieren sich ab dem ersten Tag und sind eine gute Investition in die Zukunft.

Amortisationsrechnung Wärmerückgewinnung Luft/Luft am Beispiel einer Textilausrüstungsanlage (Frischluftaufheizung von 25°C auf 148°C)	
Spannmaschine	8 Felder
Energieeinsparung	1.530.000 kWh / Jahr
Amortisationszeit	1,3 Jahre
Amortisationsrechnung Wärmerückgewinnung Luft/Wasser am Beispiel einer Textilausrüstungsanlage (Frischluftaufheizung von 25°C auf 148°C)	
Spannmaschine	8 Felder
Energieeinsparung	2.660.000 kWh / Jahr
Amortisationszeit	0,9 Jahre
Basis der Berechnung	
Betriebsstunden: 4800 h / Jahr	Strompreis: 0,107 €/kWh Gaspreis: 0,033 €/kWh Preis Thermalöl: 0,031 €/kWh

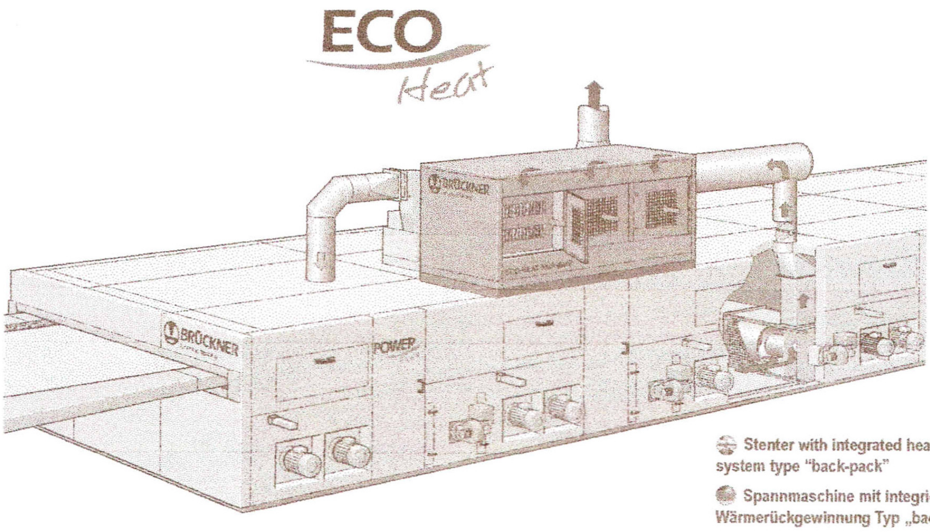
Payback period in case of further rise in energy costs
(heat recovery air/air)

Amortisationszeit bei zukünftigen Energiepreissteigerungen
(Wärmerückgewinnung Luft/Luft)



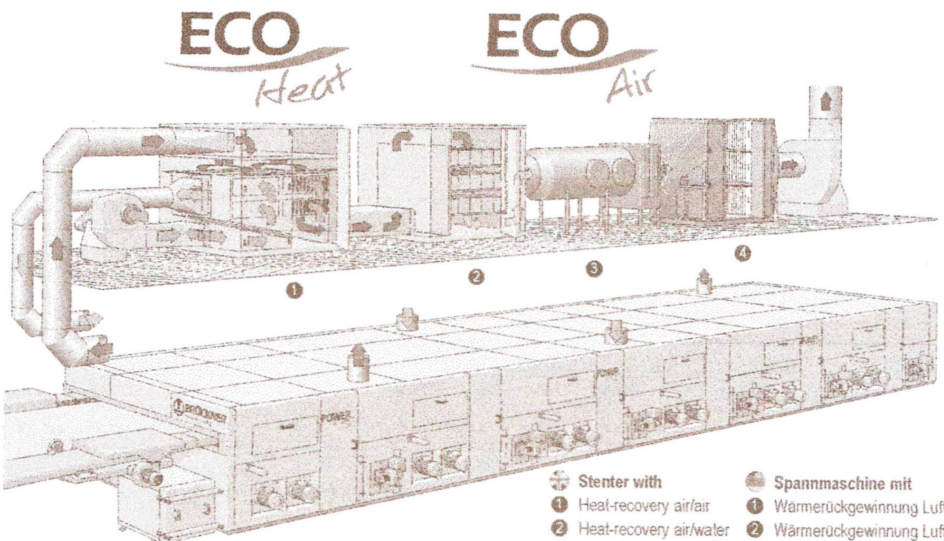
BRÜCKNER heat-recovery and air purification lines lead to an immediate reduction of your energy costs

BRÜCKNER Wärmerückgewinnungs- und Abluftreinigungsanlagen führen zu einer unmittelbaren Senkun



Stenter with integrated heat-recovery system type "back-pack"

Spannmaschine mit integrierter Wärmerückgewinnung Typ „back-pack"



Stenter with	Spannmaschine mit
1 Heat-recovery air/air	1 Wärmerückgewinnung Luft/Luft
2 Heat-recovery air/water	2 Wärmerückgewinnung Luft/Wasser
3 Nozzle-scrubber	3 Düsenwäscher
4 Electrostatic filter	4 Elektrofilter

ENERGY IS LIFE
BEE
CONSERVE IT

The ECO-HEAT product family

The BRÜCKNER ECO-HEAT product family comprises different types of heat recovery systems. The purpose of these systems is to save energy. The process makes use of the energy potential of the contaminated exhaust air in order to heat up fresh air or water via heat exchanger systems.
The heat exchanging process between hot exhaust air and cold fresh air leads to a condensation of the contaminated particles of the exhaust air flow. This is why our heat recovery systems form the first stage of an air purification process.

1. ECO-HEAT heat recovery systems air/air feed the heated fresh air back into the thermo process
2. ECO-HEAT heat recovery systems air/water heat up fresh water up to 60–90 °C.

Die ECO-HEAT Produktfamilie

Die BRÜCKNER ECO-HEAT Produktfamilie umfasst verschiedene Typen von Wärmerückgewinnungssystemen, deren Zweck in erster Linie darin besteht, Energie einzusparen.
Hierbei wird das Energiepotential der verschmutzten Abluft genutzt, um mittels Wärmetauschern Frischluft oder Frischwasser aufzuheizen.
Bei den Wärmetauschprozessen kommt es zu einer Abkühlung der Abluft und somit auch zu einer Kondensation bzw. einer Abscheidung von Schadstoffpartikeln. Auf diese Weise liefern unsere Wärmerückgewinnungs-systeme bereits den ersten Beitrag zur Abluftreinigung.

1. ECO-HEAT-Wärmerückgewinnungssysteme Luft/Luft führen die aufgewärmte Frischluft in den Trockner zurück.
2. ECO-HEAT-Wärmerückgewinnungssysteme Luft/Wasser erzeugen Warmwasser von 60–90°C.

	Objective	1st stage	2nd stage	3rd stage
1.	Energy saving	Heat recovery air/air	Heat recovery air/water	——
			Heat recovery air/air	
2.	Energy saving, air purification	Heat recovery air/air	Heat recovery air/water	Electro static filter
			Heat recovery air/air	
3.	Air purification (energy saving)	Heat recovery air/air	Vortex-scrubber	Electro static filter
4.	Air purification (energy saving)	Heat recovery air/air	Nozzle-scrubber	Electro static filter

	Ziel	1. Stufe	2. Stufe	3. Stufe
1.	Energieeinsparung	Wärmerückgewinnung Luft/Luft	Wärmerückgewinnung Luft/Wasser	——
			Wärmerückgewinnung Luft/Luft	
2.	Energieeinsparung, Abluftreinigung	Wärmerückgewinnung Luft/Luft	Wärmerückgewinnung Luft/Wasser	Elektrofilter
			Wärmerückgewinnung Luft/Luft	
3.	Abluftreinigung (Energieeinsparung)	Wärmerückgewinnung Luft/Luft	Wirbelwäscher	Elektrofilter
4.	Abluftreinigung (Energieeinsparung)	Wärmerückgewinnung Luft/Luft	Düsenwäscher	Elektrofilter

The ECO-AIR product family

The BRÜCKNER ECO-AIR product family comprises different types of air purification systems which are designed solely for the cleaning of contaminated exhaust air.
The ECO-AIR product portfolio consists of electrostatic filters and scrubbers, which can be flexibly combined in accordance to the particular requirements. ECO-AIR systems need to be individually engineered depending on the type and the amount of contamination, as well as on the particular rules and regulations at the location of the plant.
We are inviting you to take advantage of our profound experience in the field of air purification. BRÜCKNER is able to advise you comprehensively and to support you in order to comply with your local rules and regulations.

Die ECO-AIR Produktfamilie

Die BRÜCKNER ECO-AIR Produktfamilie umfasst verschiedene Anlagenkomponenten, die ausschließlich für die Reinigung der Abluft ausgelegt sind.
Das ECO-AIR Produktspektrum besteht aus Elektrofiltern und Wäschersystemen, welche bedarfsorientiert miteinander kombiniert werden können. Entsprechend der Schadstoffart und -menge sowie der landesspezifischen Grenzwerte müssen ECO-AIR-Anlagen individuell konzeptioniert werden.
In der Abluftreinigung gibt es keine Patentrezepte. Profitieren Sie von unserer langjährigen Erfahrung auf diesem Gebiet. Wir können Sie umfassend beraten und unterstützen – auch bei Genehmigungsverfahren und Behördengängen.

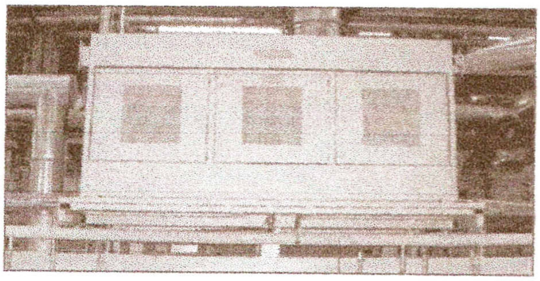
ECO-HEAT heat-recovery systems – air/air
ECO-HEAT Wärmerückgewinnungssysteme – Luft/Luft

The decisive benefits of ECO-HEAT air/air

- Uses exhaust air heat to heat up fresh air supplied to the dryer
- 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
- Highly efficient lamellar heat exchangers with anti-adhesion coating
- Optimum power density (clearly higher than in usual tubular heat exchangers)
- Optional: Automatic cleaning available

Die entscheidenden Vorteile von ECO-HEAT Luft/Luft

- Nutzung der Abluftwärme zur Aufheizung von Frischluft, die dem Trockner zurückgeführt wird
- Optimale Wartungsfreundlichkeit: die handlichen, schubladengroßen Wärmetauschermodule können problemlos entnommen und in speziellen Reinigungsbecken gereinigt werden.
- Kein mechanischen Hilfsmittel wie z.B. Bürsten erforderlich
- Hocheffiziente Lamellenwärmetauscher mit Antihaftbeschichtung
- Optimale Leistungsdichte (wesentlich höher als bei marktüblichen Röhrenwärmetauschern)
- Optional: Automatische Reinigung erhältlich

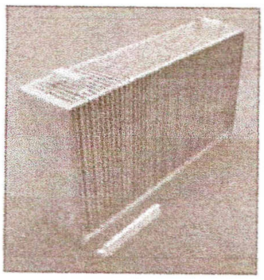


ECO-HEAT Back-Pack – heat recovery air/air integrated into the top of the dryer

Compact design: The back-pack version is integrated into the roof of the dryer – no additional scaffold, minimum piping, easy maintenance

ECO-HEAT Back-Pack – Wärmerückgewinnung Luft/Luft als in den Trockner integrierte Ausführung

Kompaktes Design: Die Back-Pack-Version ist in die Trocknerdecke integriert – kein zusätzliches Gerüst erforderlich, minimaler Verrohrungsaufwand, hohe Wartungsfreundlichkeit



Heat exchanger module air/air

Dimensions:	780 x 180 x 400 mm
Material:	Aluminium, coated
Heat exchanger:	Cross flow - fin type
Weight:	26 kg

Wärmetauschermodul Luft/Luft

Abmaße:	780 x 180 x 400 mm
Werkstoff:	Aluminium, beschichtet
Wärmetauscher:	Lamellen-Kreuzstrom
Gewicht:	26 kg

Annexure -2: Detailed financial analysis

Assumption

Name of the Technology	Waste heat Recovery system		
Rated Capacity	NA		
Details	**Unit**	**Value**	**Basis**
Installed Capacity	kg		
No of working days	Days	300	
No of Shifts per day	Shifts	1	(Assumed)
Capacity Utilization Factor	%age		
Proposed Investment			
Waste heat Recovery system	₹ (in lakh)	8.00	
Civil works, Erection and Commisioning	₹ (in lakh)	2.00	
Investment without IDC	₹ (in lakh)	10.00	
Interest During Implementation	₹ (in lakh)	0.25	
Total Investment	₹ (in lakh)	10.25	
Financing pattern			
Own Funds (Equity)	₹ (in lakh)	2.56	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	7.69	Feasibility Study
Loan Tenure	years	5.00	Assumed
Moratorium Period	Months	6.00	Assumed
Repayment Period	Months	66.00	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Fuel saving(RPC)	Tons/year	75.02	
Cost	₹/tons	7500	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest On Term Loan (₹ in lakhs)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	7.69	0.60	7.09	0.89
2	7.09	1.20	5.89	0.65
3	5.89	1.36	4.53	0.53
4	4.53	1.68	2.85	0.39
5	2.85	1.89	0.96	0.20
6	0.96	0.96	0.00	0.03
		7.69		

WDV Depreciation (₹ in lakhs)

Particulars / years	1	2
Plant and Machinery		
Cost	10.25	2.05
Depreciation	8.20	1.64
WDV	2.05	0.41

Projected Profitability

(₹ in lakhs)

Particulars / Years	1	2	3	4	5	6	7	8
Revenue through Savings								
Fuel savings	5.64	5.64	5.64	5.64	5.64	5.64	5.64	5.64
Total Revenue (A)	5.64	5.64	5.64	5.64	5.64	5.64	5.64	5.64
Expenses								
O & M Expenses	0.41	0.43	0.45	0.47	0.50	0.52	0.55	0.58
Total Expenses (B)	0.41	0.43	0.45	0.47	0.50	0.52	0.55	0.58
PBDIT (A)-(B)	5.23	5.21	5.19	5.17	5.14	5.12	5.09	5.06
Interest	0.89	0.65	0.53	0.39	0.20	-	-	-
PBDT	4.34	4.56	4.66	4.78	4.94	5.12	5.09	5.06
Depreciation	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
PBT	3.80	4.01	4.12	4.24	4.40	4.58	4.55	4.52
Income tax	-	0.99	1.58	1.62	1.68	1.74	1.73	1.72
Profit after tax (PAT)	3.80	3.02	2.53	2.61	2.72	2.84	2.82	2.80

Computation of Tax

(₹ in lakhs)

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	3.80	4.01	4.12	4.24	4.40	4.58	4.55	4.52
Add: Book depreciation	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Less: WDV depreciation	8.20	1.64	-	-	-	-	-	-
Taxable profit	(3.86)	2.92	4.66	4.78	4.94	5.12	5.09	5.06
Income Tax	-	0.99	1.58	1.62	1.68	1.74	1.73	1.72

Projected Balance Sheet

Particulars / Years	1	2	3	4	5	6	7	8
Liabilities								
Share Capital (D)	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56
Reserves & Surplus (E)	3.80	6.83	9.36	11.97	14.69	17.53	20.35	23.15
Term Loans (F)	7.09	5.89	4.53	2.85	0.96	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	13.45	15.28	16.45	17.38	18.21	20.09	22.91	25.71

Assets	1	2	3	4	5	6	7	8
Gross Fixed Assets	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25
Less: Accm. Depreciation	0.54	1.08	1.62	2.16	2.71	3.25	3.79	4.33
Net Fixed Assets	9.71	9.17	8.63	8.09	7.54	7.00	6.46	5.92
Cash & Bank Balance	3.74	6.11	7.82	9.30	10.67	13.09	16.45	19.79
TOTAL ASSETS	13.45	15.28	16.45	17.38	18.21	20.09	22.91	25.71
Net Worth	6.36	9.39	11.92	14.54	17.25	20.09	22.91	25.71
Dept equity ratio	2.77	2.30	1.77	1.11	0.37	0.00	0.00	0.00

Projected Cash Flow:

Particulars / Years	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Sources									
Share Capital	2.56	-	-	-	-	-	-	-	-
Term Loan	7.69								
Profit After tax		3.80	3.02	2.53	2.61	2.72	2.84	2.82	2.80
Depreciation		0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Total Sources	10.25	4.34	3.56	3.08	3.15	3.26	3.38	3.36	3.34
Application									
Capital Expenditure	10.25								
Repayment of Loan	-	0.60	1.20	1.36	1.68	1.89	0.96	-	-
Total Application	10.25	0.60	1.20	1.36	1.68	1.89	0.96	-	-
Net Surplus	-	3.74	2.36	1.72	1.47	1.37	2.42	3.36	3.34
Add: Opening Balance	-	-	3.74	6.11	7.82	9.30	10.67	13.09	16.45
Closing Balance	-	3.74	6.11	7.82	9.30	10.67	13.09	16.45	19.79

Calculation of Internal Rate of Return

(₹ in lakhs)

Particulars / year	***0***	***1***	***2***	***3***	***4***	***5***			
Profit after Tax		3.80	3.02	2.53	2.61	2.72	2.84	2.82	2.80
Depreciation		0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Interest on Term Loan		0.89	0.65	0.53	0.39	0.20	-	-	-
Salvage/Realizable value	(10.25)	-	-	-	-	-	-	-	-
Cash outflow	(10.25)	5.23	4.22	3.60	3.54	3.46	3.38	3.36	3.34
Net Cash flow		3.80	3.02	2.53	2.61	2.72	2.84	2.82	2.80
IRR	37.45								

NPV	10.46

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.31	0.32	0.34	0.36	0.37	0.39	0.41	0.43
Sub Total (G)	0.31	0.32	0.34	0.36	0.37	0.39	0.41	0.43
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.10	0.11	0.11	0.12	0.12	0.13	0.14	0.14
Interest on Term Loan	0.89	0.65	0.53	0.39	0.20	0.00	0.00	0.00
Depreciation *(H)*	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Sub Total (I)	1.53	1.30	1.18	1.05	0.87	0.67	0.68	0.69
Sales (J)	5.64	5.64	5.64	5.64	5.64	5.64	5.64	5.64
Contribution (K)	5.33	5.32	5.30	5.28	5.27	5.25	5.23	5.21
Break Even Point (L= G/I)	28.70%	24.50%	22.33%	19.79%	16.50%	12.81%	12.98%	13.16%
Cash Break Even {(I)-(H)}	18.55%	14.33%	12.12%	9.55%	6.22%	2.49%	2.63%	2.77%
Break Even Sales (J)*(L)	1.62	1.38	1.26	1.12	0.93	0.72	0.73	0.74

Return on Investment

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	3.80	4.01	4.12	4.24	4.40	4.58	4.55	4.52	22.28
Net Worth	6.36	9.39	11.92	14.54	17.25	20.09	22.91	25.71	100.50
									22.17%

Debt Service Coverage Ratio

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	3.80	3.02	2.53	2.61	2.72	2.84	2.82	2.80	17.53
Depreciation	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	3.25
Interest on Term Loan	0.89	0.65	0.53	0.39	0.20	0.00	0.00	0.00	2.66
TOTAL (M)	5.23	4.22	3.60	3.54	3.46	3.38	3.36	3.34	23.43

DEBT

Interest on Term Loan	0.89	0.65	0.53	0.39	0.20	0.00	0.00	0.00	2.66
Repayment of Term Loan	0.60	1.20	1.36	1.68	1.89	0.96	0.00	0.00	7.69
Total (N)	1.49	1.85	1.89	2.07	2.09	0.96	0.00	0.00	10.35
Average DSCR (M/N)	2.26								

Annexure -3: Details of procurement and implementation

S. No.	Activities	Months					
		1	2	3	4	5	6
1	Order Placement						
2	Fabrication & Transportation.						
3	Installation and commissioning						

Break up for process down time

S. No.	Activities	Days		
		2	4	6
1	Modification in exhaust duct.			
2	Fabrication & Transportation.			
3	commissioning and trials			

Annexure 4: Detailed equipment assessment report

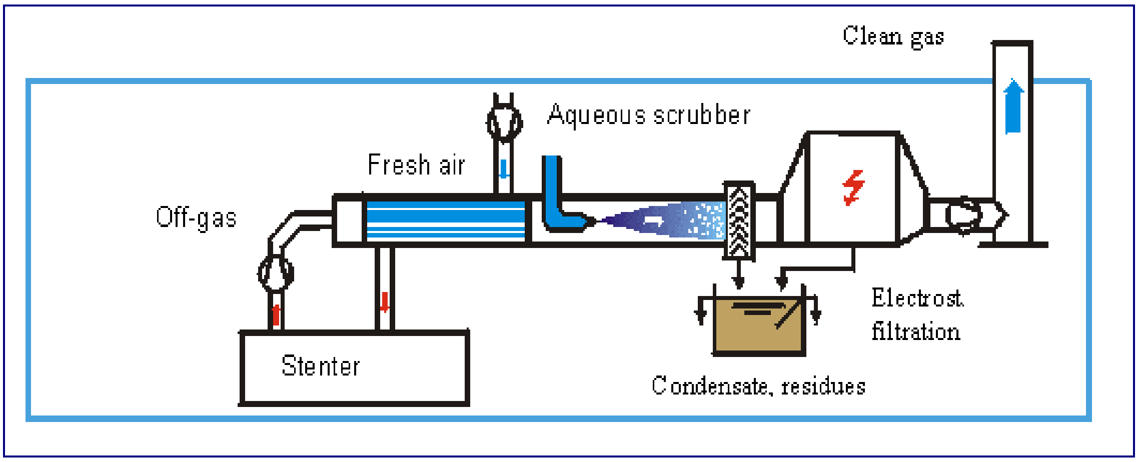
Calculation of Energy Saving Potential from waste heat recovery system in stenter

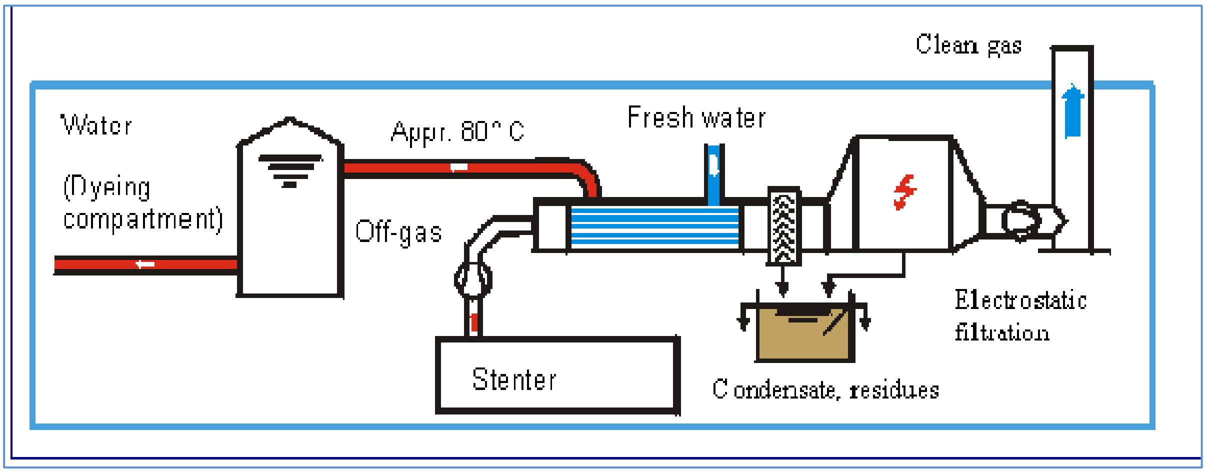
S. No	Particular	Unit	Value
1	Average Stenter speed	mtr/min	60
2	No. of operating hour per day	hr	24
3	Total operating days per year	days	300
4	Average daily processing of cloth	mtr/day	86400
5	Electricity load	kW	55
6	Daily electricity consumption	kWh	1320
7	Heat Energy required	kCal/hr	300000
8	Calorific value of fuel	kCal/kg	8200
9	Overall heat transfer efficiency	%age	60
10	Theoretical Fuel Consumption	kg/hr	52.2
11	Annual Fuel Consumption	MT per year	376
12	Heat available in flue gas	% age	39.7
12	Saving projected by manufacturers	% age	20
13	Total fuel saving	MT/year	75.2
14	Cost of fuel (RPC)	₹ / MT	7500
15	Total monetary saving per year	₹ in lakh	5.64
16	Total Investment	₹ in lakh	10.0
17	General Payback Period	Months	21.2

Annexure -5: Details of equipment service providers

S.No.	Technology	Name of Service Provider	Address	Contact Person and No.
1.	Installation Waste Heat Recovery for Stenters	M/s Bruckner, Germay represented directly by their Asia Office		
2	Installation Waste Heat Recovery for Stenters	M/s Montforts Germany through agent M/s ATE India Ltd.	M/s ATE Enterprises India Ltd. SCO 179, First Floor, Sector 38 C & D Chandigarh160036, Phone - 2697179	
3	Installation Waste Heat Recovery for Stenters	Hitec, Korea		

Annexure - 6Typical arrangement drawings for proposed system





for treatment of:	dimension stabil woven fabrics
nominal width:	200 cm
working width:	60 - 180 cm
speed range:	2,5 - 50 m/min
range control:	conventional
heating:	circulating oil
stenter chains:	pin chain

Monforts Textil · Postfach 10 17 01 · 41017 Mönchengladbach

Date	22.03.2010
Your message	
Agents	ATE

Reference Purpose

INDIEN

Quotation 45-06-1385-3

STENTER FRAME RANGE

- **Infeed combination**
- **Finishing padder MATEX 6000 Finish**
- **Straightening machine**
- **Stenter Frame MONTEX 6500 - 5F TwinAir with horizontally reversed stenter chains**
- **Outlet combination**

for treatment of:	dimension stabil woven fabrics
nominal width:	200 cm
working width:	60 - 180 cm
speed range:	2,5 - 50 m/min
range control:	conventional
heating:	circulating oil
stenter chains:	pin chain
in principle according to drawing:	45-061385-3

Infeed combination	
1. High cloth inlet	
• cloth guidance system Erhardt & Leimer BFA 3700 with KF 2020 pneumatic cloth guides and manual width adjustment (for a minimum fabric width of 65 cm)	3.400,-- EUR*
• Monforts supply	10.640,-- EUR
2. Cloth guiding frame	
• with floating rotary compensator for padder speed control	
• guiding roller for operating without padder	6.490,-- EUR
Finishing padder MATEX 6000 Finish	
3. Two-Bowl pad mangle with horizontal pad bowl arrangement	
• machine frame with traverses and claddings, discharge sheets made of stainless steel, large dimensioned pneumatic cylinders for achievement of high contact pressures	
• manual adjustment of the contact pressure	
• squeeze rollers: one driven roller, hard rubber and one even-pressure roller, soft rubber for a maximum contact pressure of 12t	
• 3 kW drive for counter-pressure roller	92.460,-- EUR
4. Liquor trough made of stainless steel	
• pneumatically lifted and lowered	
• level control system with pressure sensor	
• two-fold cloth passage	5.690,-- EUR
5. Expander unit for woven goods	
• curved expander roller before the nip	3.530,-- EUR

Straightening machine

6. Straightening unit
Mahlo ORTHOMAT RFMC-12

• execution 124 with 4 scanners	60.010,-- EUR*
• servohydraulic drive of skew and bow roller	
• 3 skew rollers	
• 2 bow rollers	
• detection by transmitted and reflected light	
• preset bias	
• PC with 15" TFT colour touch-screen	
• light regulation separately for each scanner	
• automatic scanner positioning	
• automatic scanner cut off	
• back-up control panel	
• safety gates	
• remote diagnostic package	
• speech output	
• standard colour RAL 7038 agate-grey	
• pedestal	530,-- EUR*
• cooling system for electrical side panel	2.900,-- EUR*
• cooling system for touch-screen	2.130,-- EUR*
• Monforts supply	110,-- EUR

Stenter Frame MONTEX 6500 - 5F TwinAir with horizontally reversed stenter chains

7. Stenter inlet with overfeed device

• fabric inlet frame with operating platform	
• upper traction roller	
• bottom traction roller	
• individual drives for the traction rollers 2.2 kW, 50 Hz each	
• overfeed device for pre-needling up to +60% as compared with the stenter chain speed	
• 2 guide rollers	37.060,-- EUR

8. Control box at the stenter inlet

• turnable into line of sight, with the necessary adjustment, operation and indication aggregates for the set-up and control of the stenter frame range	
• air conditioning	9.160,-- EUR

9. **Fabric infeed device**
    - 2 needling-in devices, selvedge tensioning device, right and left separately adjustable, 2 x 0.8 kW drive, pneumatically lifted and lowered
    - selvedge uncurlers with 2 driven uncurling spindles (LA 8201) made of stainless steel, 2 x 0.3 kW drive — 26.760,-- EUR

10. **Fabric feed device with high-tech stenter chains "Hercules"**
    - infeed track control with frequency controlled drive and selvedge feeler
    - inlet field 3100 mm long
    - 2 after-pin wheels for the inlet field tracks
    - pneumatic chain tensioner
    - chain tracks in the treatment chamber
    - outlet field 3200 mm long
    - 2 after-pin wheels for the outlet field tracks
    - 2 frequency controlled stenter chain drives, 3 kW, 50 Hz each
    - horizontally reversed pin chains with long-life lubrication
    - fabric outlet frame
    - depinning rollers — 193.740,-- EUR

11. **Electrical width adjustment with individual drive for each spindle**
    - 6 spindles for the treatment chamber, 0.55 kW drive each
    - 1 spindle for the outlet field, 0.55 kW drive
    - digital width indication at the inlet and outlet of the stenter frame — 32.490,-- EUR

12. Treatment chamber TwinAir plus

- 5 treatment fields, 3000 mm long each
- 150 mm thick insulation cladding for especially high thermal insulation
- Lift-O-Matic
  space saving pneumatic lifting doors, opening and closing at the push of a button
- air circulation filters Secuclean, insert filter system with traction filters for cleaning during production, bottom additional protective filters for the suction chamber
- CADstream nozzle system HLD with "down-stream" flow conduct
- TwinAir plus
  equipment for the constant flow-off of the circulating air from the fabric by division of the flowing air into a right and left partial flow
- **Integrated heat recovery**
  with air/air heat exchanger for cooling of the exhaust air and heating of fresh air. Integrated into the roof of the stenter as standard component of the internal exhaust air/fresh air ducts.
- 1 suction fan with frequency controlled drive motor, nominal efficiency 7.5 kW
- 1 connection tube for direct connection of the suction fan,
  1 supporting frame for the installation of the suction fan on the chamber roof
- 1 fresh air fan with frequency controlled drive motor, nominal efficiency 7,5 kW
- fresh air supply to the fronts of the chamber
  option:
- *1 service frame for the cleaning of the heat exchangers* — *3.660,-- EUR*
- **potential for energy saving**
  by means of heat recovery up to:
  15% on drying processes (130-150 °C)
  30% on heatsetting processes (180-200 °C)
  20% on combined processes

163.130,-- EUR

13. Compact front walls of the chamber

- cold air barriers at the fabric inlet and outlet openings — 22.690,-- EUR

14. Floor insulation
- special insulation panels made of mineral fibre, 100 mm thick, for machine installation directly on the ground floor of the factory hall — 1.740,-- EUR

15. Air circulation TwinAir with seperate upper/lower air guiding and electrical regulation of the air quantity
- for 5 treatment fields with 2 air circulation fans each
- frequency controlled high efficiency motors in the highest energy efficient Class EFF1, directly flanged,
  nominal efficiency 7.5 kW/1450 rpm speed range 580 up to 1450 rpm
- 2 frequency converters 7,5 kW each
- 4 frequency converter/s 15 kW each — 74.010,-- EUR

16. Bypass flaps to avoid markings on the fabric
- automatically closed at fabric standstill
- pneumatically controlled — 15.320,-- EUR

17. Circulating oil heating
- 5 air heaters for the treatment chamber
- 5 automatic temperature control system/s with motor regulating valves, max. temperature of circulating air 230° C
- shut-off valves to be provided by customer — 47.840,-- EUR

18. Exhaust air moisture measurement and control system
- 1 sensor Mahlo ZS 96 — 9.030,-- EUR

19. Cooling zone with CADstream nozzle system
- 1600 mm treatment length, drive motor directly flanged, nominal efficiency 11 KW, nominal speed 1500 rpm — 11.120,-- EUR

S20. **Monforts Qualitex 540**
central operating system Easy Touch

- all fabric transport drives with frequency-controlled AC-drives
- controlled deceleration of speed to final standstill for normal shutdown and emergency stop
- control and monitoring instruments in the inlet and outlet area
- switch cabinet
  - wired ready for connection - designed for ambient temperature of max. 40°C and a relative air humidity of 90%
- function control of electrical equipment by test runs and technical acceptance test before shipment of the range
- conventional range control
- TFT colour screen 12" (touchscreen)
  command input by touching the input fields
- additional conventional control elements
- input and display of the machine speed
- input and display of the stentering width
- input of temperature setpoints and indication of actual values
- input and indication of the fan speeds for circulating air and exhaust air (for frequency controlled drives)
- input and indication of the set values for the fabric transport drives
- integration of the Monformatic Professional (only with the corresponding equipment)
- set-up data administration
  database for 100 set-up records
- Qualitex is prepared for teleservice
- telediagnosis and service support (telephone line and telephone connection to the machine to be provided by customer)
- language change
- voltage stabilizer 50.690,-- EUR

21. **Power lines**

- power cables for the fabric transport drives
- power cables for the small drives
- power cables for the drives of the air circulation fans 7.650,-- EUR

22. Control lines
- control cables, ready for installation — 7.200,-- EUR

23. Switch cabinets, prepared for assembling of air condition
- air condition of standard practice with the accessory distribution and waste ducts to be provided by the customer
- necessary for ambient temperature of more than 40° C and a relative air humidity of more than 90%
- all individual switch cabinets are connected as a unit and are equipped with ducts for conditioned air flow; the air condition provided by the client can be assembled into specially prepared switch cabinets — 5.550,-- EUR

Outlet combination

24. Delivery support with driven traction roller
- 3 kW drive, 50 Hz — 22.710,-- EUR

25. Piece length measuring unit
- electrical metre or yard counter with pulse transmitter,
  digital display with 6 digits at control desk — 790,-- EUR

26. Plaiter
- cloth tension controllable
- lap length 1000 mm — 14.620,-- EUR

27. High-performance ionization unit Mahlo ANTISTAT AMW-2
- 1 ionization rod for the plaiter — 1.070,-- EUR*

Price for Monforts supply	**872.220,-- EUR**
Net price for devices of other make	**70.040,-- EUR ***
Total price of the range (excluding options)	**942.260,-- EUR**

Prices marked with a star are machine components which will be manufactured by sub-suppliers. These components are offered at a net price. The price includes the necessary connection parts and the corresponding design costs.

Terms of delivery and payment

The index figures mentioned are not binding. They might be increased or decreased according to the nature of the articles to be treated and to the prevailing operational conditions.

The prices are to be understood for a delivery FOB European port, as per INCOTERMS 2000, including container packing, excluding installation.

Paint finish:
Treatment chamber panels and housing parts are painted with structured paint agate-grey (RAL 7038). Certain functional parts have a uniform corrosion-protection by a silver grey varnish or zinc coating. Switch cabinets in grey according to DIN standards.

The prices quoted are valid for a period of 90 days.

Conditions of payment:
100 % out of an irrevocable and by a German bank confirmed letter of credit to be opened in our favour within 2 weeks after order placing with Deutsche Bank AG, Dresdner Bank AG or Commerzbank AG and to be payable at sight in Germany upon presentation of shipping documents. All banking charges outside Germany and confirmation charges of the German bank are on buyer's account.

Delivery time:
abt. 5 months after full clarification of all technical details and fulfilment of the terms stipulated. The time of delivery indicated is valid at the moment of the estimate. We reserve the right to fix exactly the time of delivery on placing of order corresponding to the conditions valid at that time.

Subject to technical alterations.

Country of Origin:
Federal Republic of Germany

For the rest our supply is subject to our 'General Terms and Conditions for the Supply of Machinery and Machine Parts' in conformity with the general terms of supply for the export of machinery and machine parts, as recommended by the VDMA (German Machinery and Plant Manufacturers' Association), Issue June 2002, as per enclosure.

A. MONFORTS Textilmaschinen GmbH & Co. KG

Enclosures

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HRA 3133 Mönchengladbach · Geschäftsführer: Dipl.-Ing. Roland Hampel, Dipl.-Kfm. Dipl.-Ing. Wolfgang Kaphahn
Persönlich haftende Gesellschafterin: A. Monforts Textilmaschinen-Verwaltungs-GmbH, Mönchengladbach HRB 4634
Commerzbank AG (BLZ 310 400 15) Kto. 1 920 180 00 IBAN: DE49 3104 0015 0192 0180 00 (COBADEFF310)
Deutsche Bank AG (BLZ 310 700 01) Kto. 5 988 100 00 IBAN: DE30 3107 0001 0598 8100 00 (DEUTDEDD310)
Dresdner Bank AG (BLZ 310 800 15) Kto. 9 408 836 00 IBAN: DE70 3108 0015 0940 8836 00 (DRESDEFF310)

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