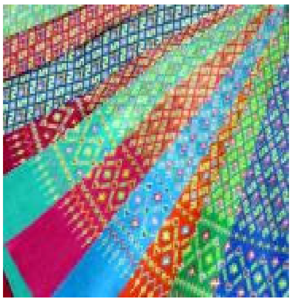
DETAILED PROJECT REPORT
ON
INSTALLATION OF AIR PRE HEATER IN THERMOPAC
(PALI TEXTILE CLUSTER)







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INSTALLATION OF AIR PRE HEATER IN THERMOPAC

PALI TEXTILE CLUSTER

BEE, 2010
Detailed Project Report on Installation of Air Pre Heater in Thermopac
Textile SME Cluster, Pali, Rajasthan (India)
New Delhi: Bureau of Energy Efficiency;
Detail Project Report No.: **PAL/TXT/APH/14**

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Acknowledgement

We sincerely appreciate the efforts of industry, energy auditors, equipment manufacturers, technology providers, consultants and other experts in the area of energy conservation for joining hands with Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India for preparing the Detailed Project Report (DPR) under BEE SME Program in SMEs clusters. We appreciate the support of suppliers/vendors for providing the adoptable energy efficient equipments/technical details to the SMEs.

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.

CONTENTS

List of Annexures

List of Figures

List Of Tables

List of Abbreviations

- BEE - Bureau of Energy Efficiency
- DPR - Detailed Project Report
- DSCR - Debt Service Coverage Ratio
- GHG - Green House Gases
- HP - Horse Power
- 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
- RPC - Reliance Pet Coke

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, none of the Thermopacs were found to be equipped with waste heat recovery system like Air Pre heater; and also awareness about the waste heat recovery system is low.

Typically Thermopac consumes between 250 to 300 kg/hr RPC and saving potential due to installation of Air Pre heater in Thermopac would be 82.46 MT RPC per year.

This DPR highlights the details of the study conducted for assessing the potential for installation of Air pre heater system in Thermopac, 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)	2.5
2	Fuel saving (RPC)	MT/year	82.46
3	Monetary benefit	₹ (in Lakh)	6.18
4	Debit equity ratio	Ratio	3:1
5	Simple payback period	years	1.8
6	NPV	₹ (in Lakh)	19.80
7	IRR	% age	182.03
8	ROI	% age	24.31
9	DSCR	ratio	9.54
10	CO_2 saving	MT	216.9
11	Process down time	Days	6

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.

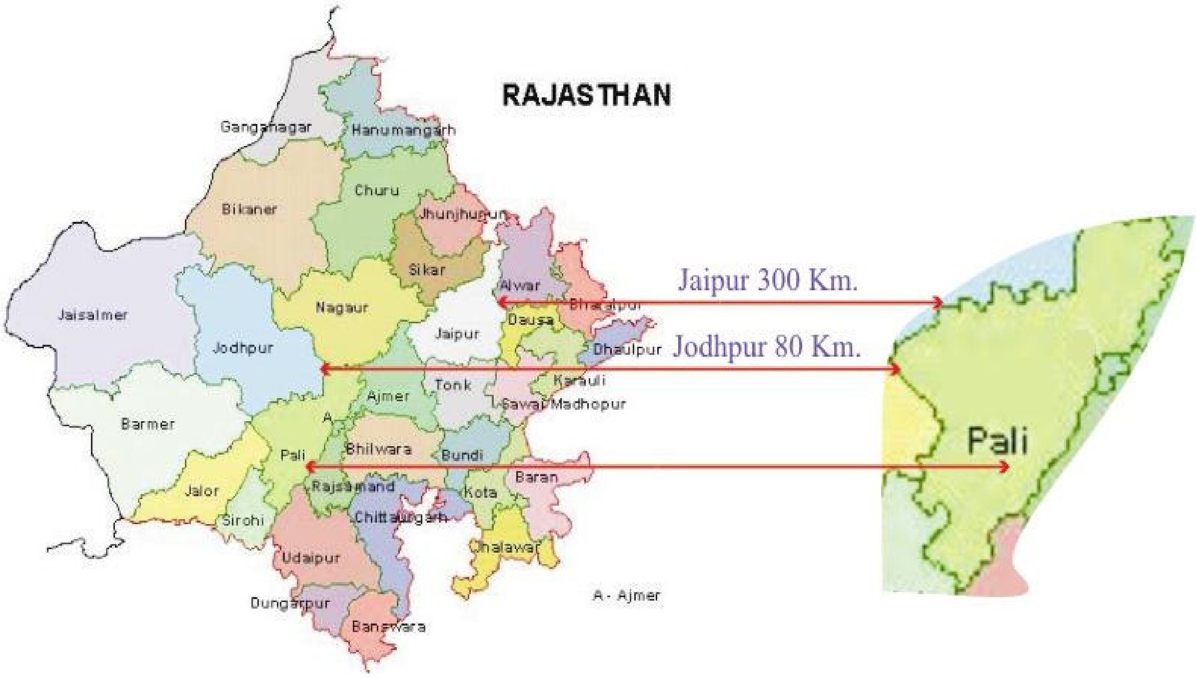


Fig. 1.1 – Pali – Geographical Map

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 use of Thermopac in the process are drawn below –

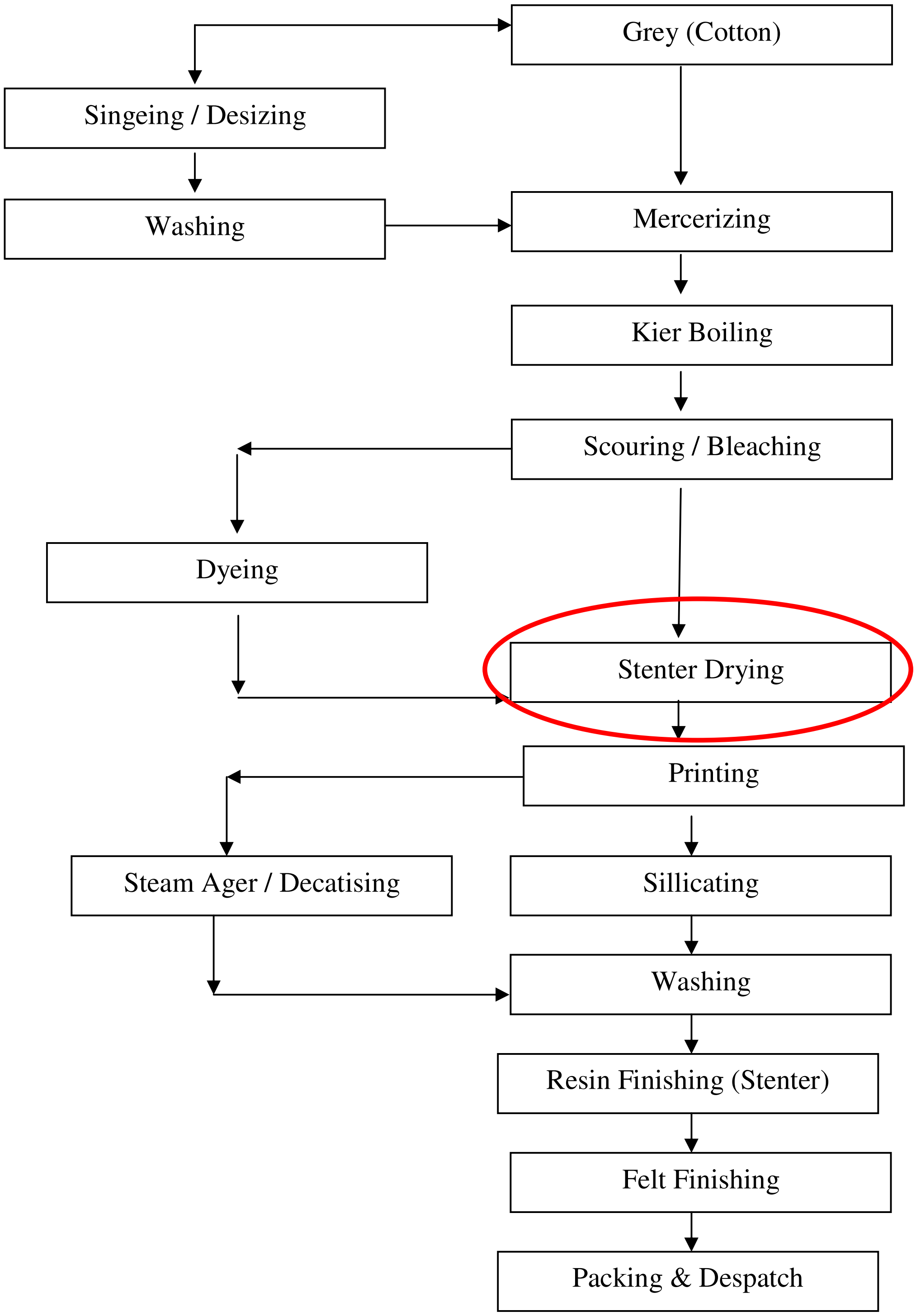


Fig. 1.2 – Process Flow Diagram of Cotton Dyeing and Printing

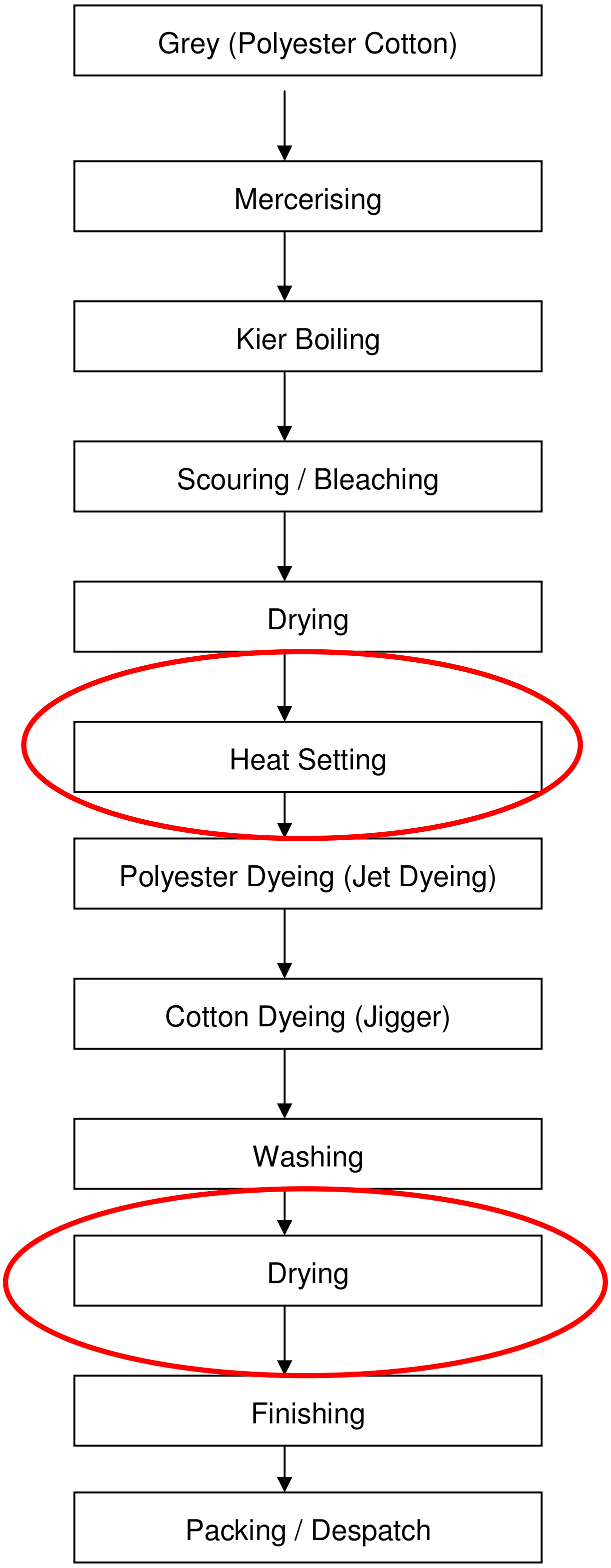


Fig. 1.3 – Process Flow Diagram of Polyester Cotton Dyeing and Finishing

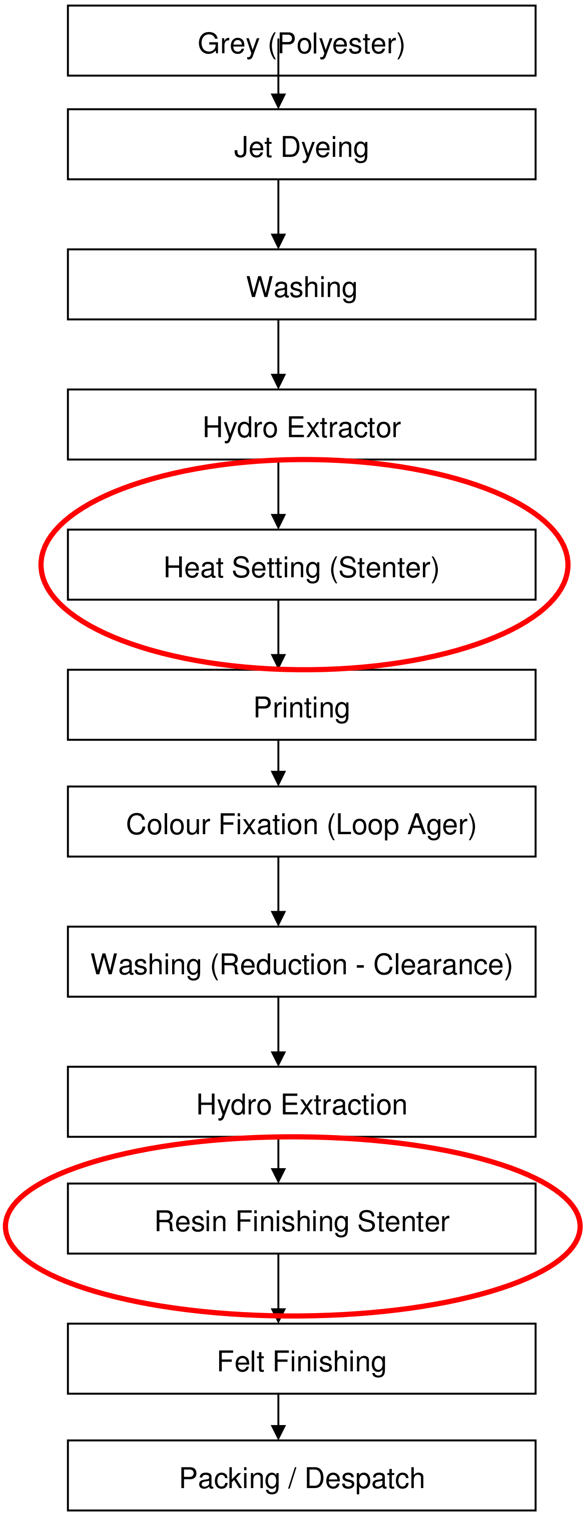


Fig. 1.4 – Process Flow Diagram of Polyester Printing and Finishing

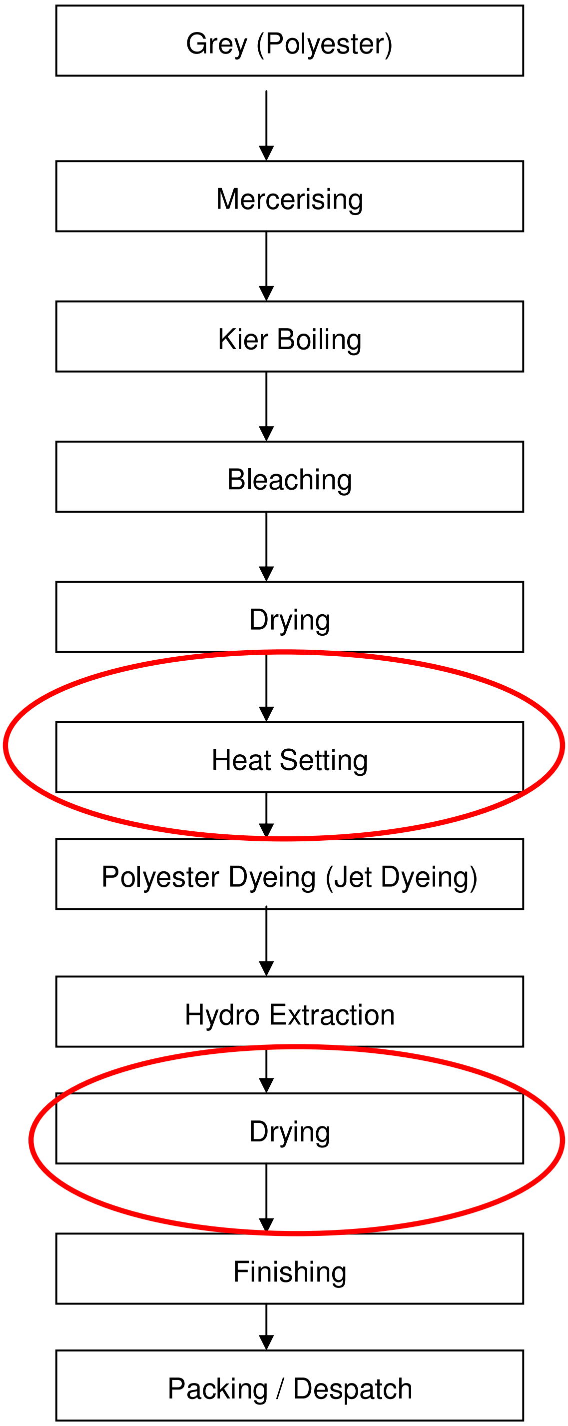


Fig. 1.5 – Process Flow Diagram of Polyester Cotton Dyeing and Finishing

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

Process of Fabric Dyeing and Processing has been shown in Fig. 1.2 to 1.5. As is obvious, low temperature heating (Sub 100°C) is required in Scouring, Mercerising, bleaching, Jigger Dyeing for cotton, Reduction and Clearance. Also, higher temperatures are required in Jet Dyeing, Dye fixation and calendaring / Felt finishing. Stentering requires very high temperatures to the tune of 180°C. Heat for getting this temperature is supplied from a Thermic Fluid Heater (Thermopac). Capacity of Thermopacs available in Pali Textile Cluster ranges from 1,00,000 kCal /hr to 2,00,000 kCal/hr.

All the Thermopacs in the Pali Textile Cluster were designed to operate on pulverized lignite. Due to ban on Lignite supply from Gujarat, the units have shifted to RPC (Residual Pet Coke) supplied by Reliance industries Ltd.

For the purpose of fuel switching, the combustion was converted to bubbling fluidized bed and the lime bed was created to take care of high Sulphur content in the fuel. However, the conversion was done without engineering the system eroding combustion efficiency to lower levels.

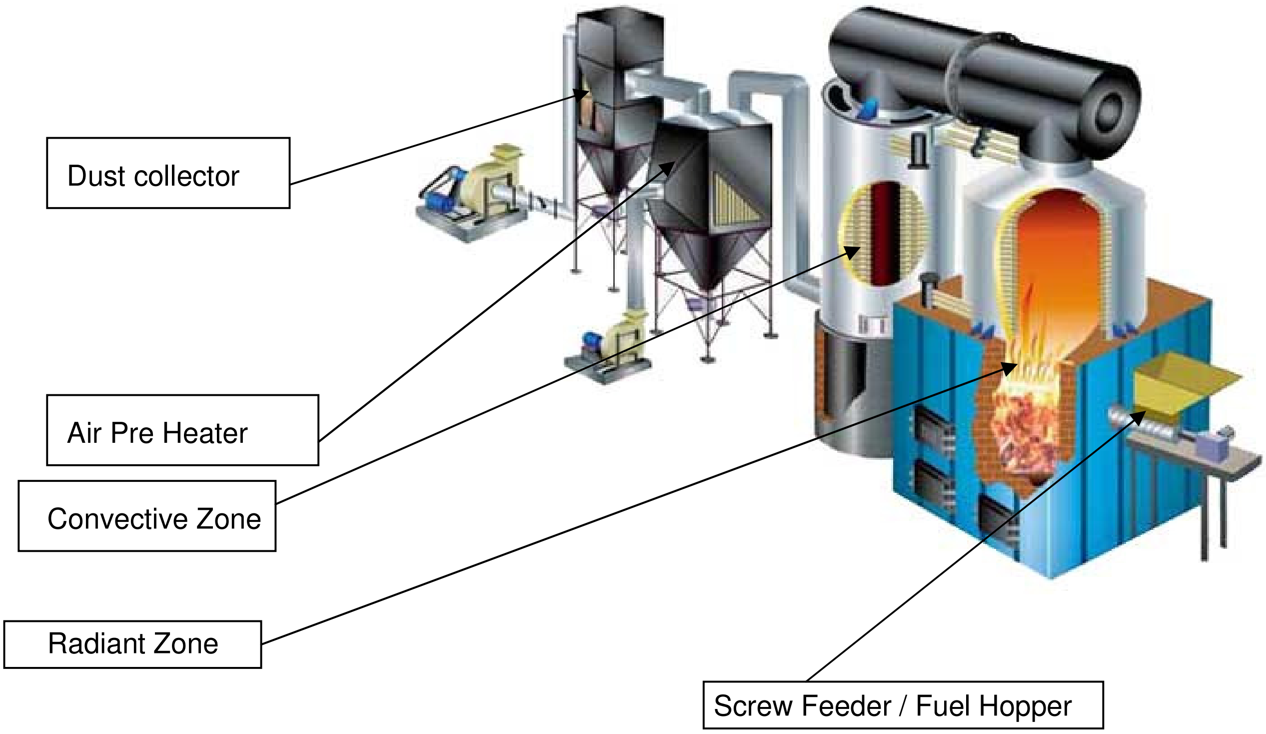


Fig. 1.6 – Sketch of thermic fluid heater with air pre heater and Dust Collector

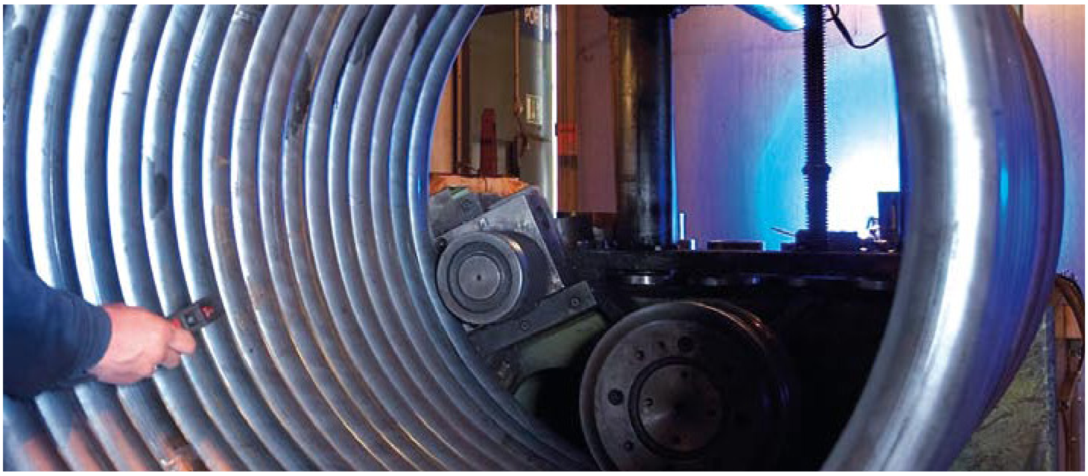


Fig. 1.7 – Arrangement of Tubes inside Thermic Fluid Heater

The typical specification is attached as Annexure 7.

1.3.2 Role in process

Temperature setting in a stenter chamber at Pali Cluster ranges from 180°C to 210°C. This temperature is achieved by circulating heated thermic fluid through heat exchangers and raising air temperature so that the desired temperature is achieved in the stenter. The set point for thermic fluid heater was observed to be from 235°C to 260°C.

The energy balance for Thermic Fluid Heater is no different from that of a Boiler in terms of loss by way of release of sensible heat in flue gases. The matter gets worse with increase in excess air.

1.3.3 Energy audit methodology

The following methodology was adopted to evaluate the performance of Thermopac which is shown in Fig. 1.8.

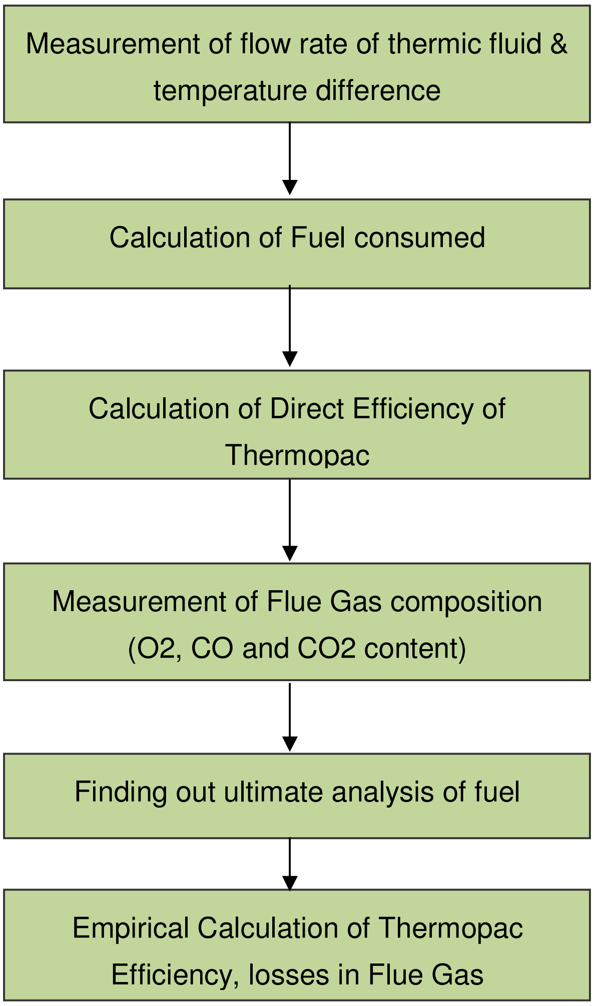


Fig. 1.8 Energy Audit methodologies

1.3.4 Design and operating parameters specification

As is obvious from Table 1.6, combustion efficiency decreases by increase in flue gas temperature. However, the same can be improved by installing system for recovery of the sensible heat from hot flue gases. It was gathered during field study at Pali that all the Thermic Fluid Heaters were fluidized bed type designed to work on pulverized lignite and had Air Pre heater as standard feature. However, during conversion for facilitating fuel switch, the air pre heaters were removed. On further enquiry with the service provider, it was informed that the air pre heater was intentionally removed from the circuit so as to reduce the temperature inside the Thermopac to facilitate use of Residual Pet Coke.

Table 1.6 – Effect of Excess Air and Stack Temperature on Combustion Efficiency

Combustion Efficiency (% age)						
Excess (%age)		*Net Stack Temperature (°F)*				
Air	*Oxygen*	*200*	*300*	*400*	*500*	*600*
9.5	2.0	85.4	83.1	80.8	78.4	76.0
15	3.0	85.2	82.8	80.4	77.9	75.4
28.1	5.0	84.7	82.1	79.5	76.7	74.0
44.9	7.0	84.1	81.2	78.2	75.2	72.1
81.6	10.0	82.8	79.3	75.6	71.9	68.2

1.3.5 Operating efficiency analysis

The units in Pali cluster are not really aware of the ill effects of non recovering sensible heat from the Flue Gas and excess air in combustion. It was observed that the Flue Gas in Thermopac was leaving at temperature 250°C to 300 °C, thus giving enough opportunity to recover waste heat. A suitably designed air pre heater can be installed to recover heat from Flue Gas up to a temperature of 180 °C, in view of high Sulphur fuel used.

The Sankey diagram for Thermic Fluid Heater is as below in Fig. 1.9.

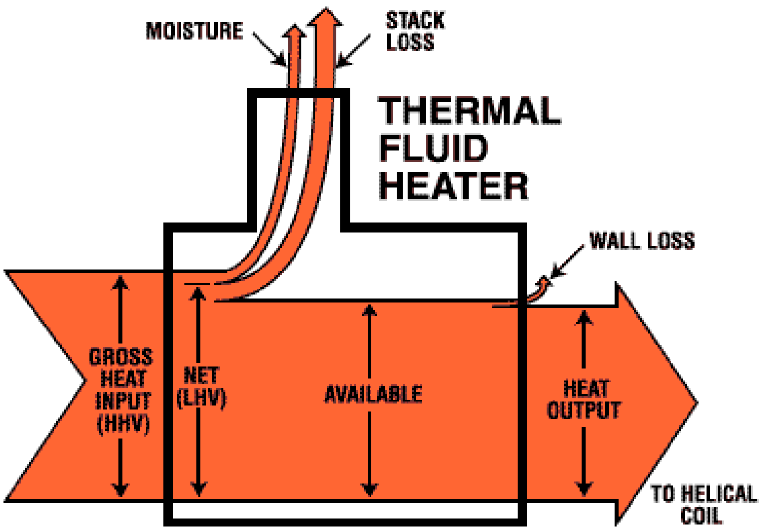


Fig. 1.9 Sankey diagram of Thermopac

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

- The proposed technology was already installed in the cluster and is available readily.
- Non-availability of technology or aversion to adoption for any other reason does not seem to be the case for non adoption as the proposed system was already present in most of the Thermopacs. All the suppliers are offering the system as standard fitting. It is only lack of knowledge and comfort of proven guaranteed results that has been keeping the entrepreneurs away from adopting this technology.
- 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. ₹ 3 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

The proposed equipment is a typical air to air heat exchanger that would heat incoming combustion air and in the process recover heat from outgoing flue gas. As per a thumb rule, a reduction in Flue Gas Temperature by 22°C would results in 1% fuel saving. The proposed system would be designed to reduce Flue Gas temperature from 250°C to 180°C and hence would result in 3.5% fuel saving.

Components of the proposed system

The proposed system is a fabrication of MS sheet and recuperator tubes and will not have any moving parts. The location of the system is proposed to be before the Dust Collector. A typical sketch is shown in fig. No. 2.1 below:

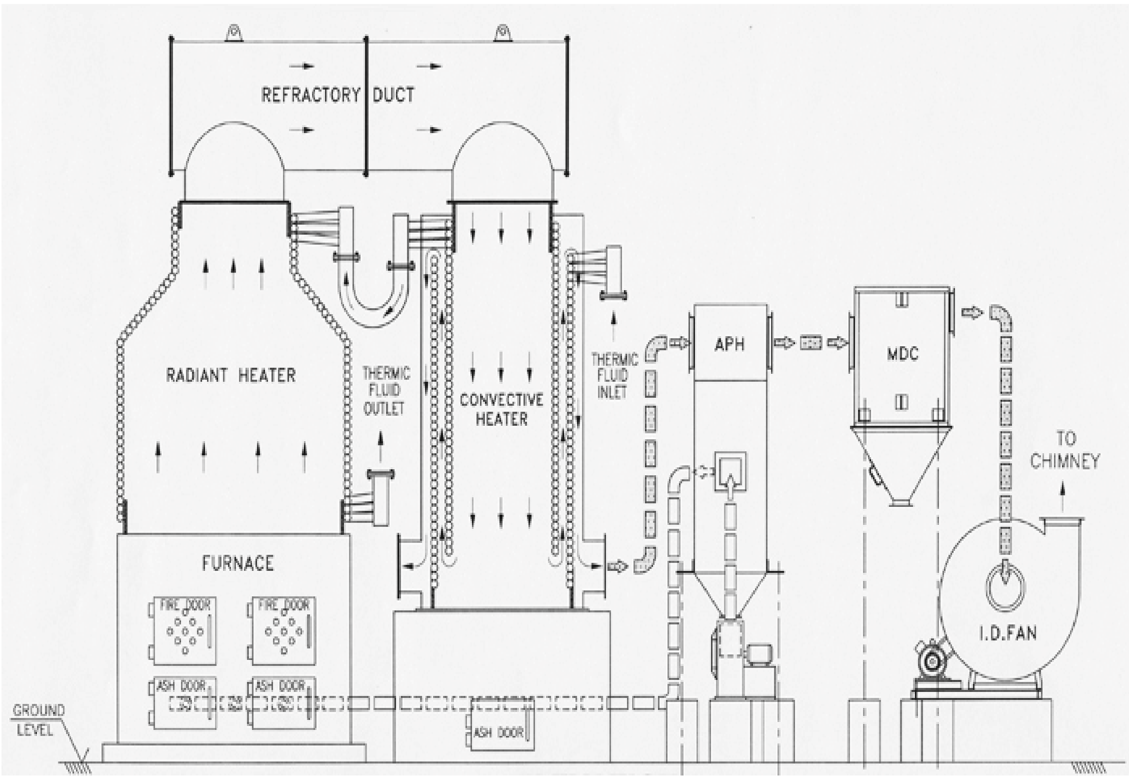


Fig. 2.1 Sankey diagram of Thermopac

2.1.1 Equipment specification

A complete brochure of the equipment is placed at Annexure 7.

2.1.2 Suitability over existing equipment

The proposed system can be retrofitted to existing Thermopac with minimal modification of combustion gas duct.

2.1.3 Superiority over existing equipment

The system would recover heat from flue gas and hence equivalent savings in Fuel consumption would be recorded.

2.1.4 Availability of equipment

The system can be delivered within 3 to 4 weeks of placement of order through manufacturers in Japiur.

2.1.5 Source of equipment

This technology is already available in many Thermopacs installed in the cluster and can as well be got fabricated locally. The equipment is of generic technology and is readily available indigenously without any complications related to patent or copyright.

2.1.6 Technical specification of equipment

Technical specification of proposed technology is attached at Annexure 8.

2.1.7 Terms and conditions in sales of equipment

No specific terms and conditions are attached to sale of the equipment.

2.1.8 Process down time during implementation

Installation of the proposed system would need modification in the flue duct. Also, tuning will be critical as additional pressure drop would happen in the draft system. A minimum down time of one week is required for installation of the equipment.

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 over 20 no of Thermopacs in Pali. Total potential for energy saving would be 1665 MT RPC (1949 MTOE) 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 would help save 82.46 MT RPC fuel per year in every Thermopac. Further, details of fuel saving are given in Annexure 5.

3.1.2 Electricity saving

No electricity saving is possible

3.1.3 Improvement in product quality

None

3.1.4 Increase in production

None

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 Thermopac would be ₹ 6.18 lakh per year. Detail of saving calculation is given in Annexure 5.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

Proposed equipment reduces the GHG emission by reducing fuel 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

None

3.4.2 Reduction in GHG emission

The equivalent saving in GHG emission for every Thermopac would be 216.9 MT per year as per UNEP GHG Calculator.

3.4.3 Reduction in other emissions like SO_X

Considerable reduction in emission of SO_X is anticipated as the fuel being used contains high 8% Sulphur.

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 ₹ 2.22 lakh (2.1 lakh + 4% CST+ 2% Freight) as per the quotation from M/s Punjab Engineers and Fabricators. The quotation is attached as Annexure 2.

4.1.2 Erection, commissioning and other misc. cost

Erection & commissioning cost is about ₹ 0.28 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)	2.22
2	Erection & Commissioning cost	₹ (in Lakh)	0.28
3	Interest during implementation	₹ (in Lakh)	Nil
4	Other misc. cost	₹ (in Lakh)	Nil
5	**Total cost**	₹ (in Lakh)	**2.5**

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost which is ₹ 0.63 lakh.

4.2.2 Loan amount.

Remaining 75% cost of the proposed project will be taken from the bank which is ₹ 1.88 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 8 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 ₹ 6.18 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 2.50 lakh and monetary savings due to reduction in Electricity & Fuel consumption is 6.18 lakh hence, the simple payback period works out to be around 5 months.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be 21.00 Lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 219.26%. 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 23.06%.

Details of financial indicators are shown in Table 4.2 below:

Table 4.2 Financial indicators of proposed technology

S.No.	Particular	Unit	Value
1	Simple payback period	Months	5
2	NPV	₹ (in lakh)	19.80
3	IRR	% age	182.03
4	ROI	% age	24.31
5	DSCR	ratio	9.54

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	173.56	18.71	24.26	9.07
Realistic	182.03	19.80	24.31	9.54
Optimistic	190.48	20.89	24.35	10.00

4.5 Procurement and Implementation Schedule

Total time period required for implementation of this technology is about 6 week and their details are given in Annexure 4.

ANNEXURE

Annexure 1 Efficiency evaluation of Thermopac

Typical Flue Gas Analysis

Flue gas analysis				
O2%	CO2%	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		0.033 kg/kg of dry air

Indirect Method

Thermopac efficiency=Heat output/Heat input= (QX Density x (Tout-Tin)/q x GCV) x100

S.No.	Particular	Unit	Details
1	Q, quantity of thermic fluid in circulation	(m3/hr)	120
2	q, quantity of fuel consumed	(kg/hr)	245
3	Temperature of thermic fluid OUT	(oC)	260
4	Temperature of thermic fluid IN	(oC)	235
5	Calorific value of fuel, Pet coke	kCal/kg	8200
6	q, quantity of ash used as fuel	(kg/hr)	70
7	GCV of Ash as fuel,	kCal/kg	3000
8	p, Specific heat of HP Hytherm 500	kCal/kg	0.72
9	Density of HP Hytherm 500	(kg/m3)	720.9
10	Efficiency of Thermopac	(% age)	70.17

Direct Method

Ultimate analysis of fuel	C %	H2 %	S %	O2 %	N2 %	Ash %	Moisture%
	80.9	3.57	7.5	0	0.95	0.01	8

S. No	Particular	Unit	Value
1	Present O_2 level	% age	15.5
2	Theoretical air requirement	kg of air/kg of fuel	10.80
3	Excess air supply at present condition	% age	282
4	Actual mass of air supplied at present condition	kg of air/kg of fuel	41.25
5	Mass of dry flue gas	kg/kg of air	41.89
6	Dry flue gas losses	%age	24.14
7	loss due to evaporation of H2O formed by H2 in fuel	%age	3.14
8	loss due to moisture in air	%age	1.53
9	loss due to moisture in fuel	%age	0.27
10	loss due to radiation & unaccounted losses	%age	2.0
11	Total losses	%age	31.87
12	Thermopac efficiency	%age	68.13

Annexure -2: Quotation

P
PEF
F

PUNJAB ENGINEERS & FABRICATORS

Regd. Office & works :	G-755-56,Road No.9-F-2, V.K.I.Area, Jaipur-302013 (India)
Phones :	0141-2333478,
Mobile :	9829015145 , 9314933478
Fax :	0141-5108478
Specialist in :	Fuel Saving Device & Rolling Mills.

Date 1/12/10

To,
Suman Kumar
Joint Director
PCRA, Jaipur

Sub: Quotation for Dust Collector and Air Pre Heater

Dear Sir,

This is further to the telephone on the subject. The rates for Dust Collector and Air Pre heater as per your requirements are below: -

Dust collector – Rs. 250000.00 + CST (4%) + Cartage (2% within Rajasthan)

Air Pre Heater – Rs. 210000.00 + CST (4%) + Cartage (2% within Rajasthan)

The items would be ready for dispatch within 4 weeks of placement of order. The terms of payment would be 40% advance with work order and balance 60% before dispatch of material ex works.

Thanking You,

Yours Sincerely,
For Punjab Engineers & Fabricators

Manager

Annexure -3: Detailed financial analysis

Assumption

Name of the Technology	**Air Pre Heater In Thermopac**		
Rated Capacity	**NA**		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	kg		
No of working days	Days	300	
No of Shifts per day	Shifts	3	
Capacity Utilization Factor	%age		
Proposed Investment			
Waste heat Recovery system	₹ (in lakh)	2.22	
Erection and Commisioning	₹ (in lakh)	0.28	
Total Investment	₹ (in lakh)	2.50	
Financing pattern			
Own Funds (Equity)	₹ (in lakh)	0.62	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	1.88	Feasibility Study
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4	Feasibility Study
Annual Escalation	%age	5	Feasibility Study
Estimation of Revenue			
Fuel saving(RPC)	Tons/year	82.46	
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	1.88	0.06	1.82	0.22
2	1.82	0.14	1.68	0.18
3	1.68	0.24	1.44	0.16
4	1.44	0.48	0.96	0.12
5	0.96	0.60	0.36	0.07
6	0.36	0.36	0.00	0.01
		1.88		

WDV Depreciation **(₹ in lakhs)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	2.50	0.50
Depreciation	2.00	0.40
WDV	0.50	0.10

Projected Profitability

(₹ in lakhs)

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Revenue through Savings								
Fuel savings	6.18	6.18	6.18	6.18	6.18	6.18	6.18	6.18
Total Revenue (A)	6.18	6.18	6.18	6.18	6.18	6.18	6.18	6.18
Expenses								
O & M Expenses	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.14
Total Expenses (B)	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.14
PBDIT (A)-(B)	6.08	6.08	6.07	6.07	6.06	6.06	6.05	6.04
Interest	0.22	0.18	0.16	0.12	0.07	0.01	-	-
PBDT	5.87	5.90	5.92	5.95	5.99	6.05	6.05	6.04
Depreciation	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
PBT	5.73	5.77	5.79	5.81	5.86	5.91	5.92	5.91
Income tax	1.31	1.87	2.01	2.02	2.04	2.06	2.06	2.05
Profit after tax (PAT)	4.42	3.90	3.77	3.79	3.82	3.86	3.86	3.86

Computation of Tax

(₹ in lakhs)

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit before tax	5.73	5.77	5.79	5.81	5.86	5.91	5.92	5.91
Add: Book depreciation	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Less: WDV depreciation	2.00	0.40	-	-	-	-	-	-
Taxable profit	3.87	5.50	5.92	5.95	5.99	6.05	6.05	6.04
Income Tax	1.31	1.87	2.01	2.02	2.04	2.06	2.06	2.05

Projected Balance Sheet

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Liabilities								
Share Capital (D)	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Reserves & Surplus (E)	4.42	8.32	12.10	15.89	19.71	23.57	27.43	31.29
Term Loans (F)	1.82	1.68	1.44	0.96	0.36	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	6.86	10.62	14.16	17.47	20.69	24.19	28.05	31.91

Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross Fixed Assets	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Less: Accm. Depreciation	0.13	0.26	0.40	0.53	0.66	0.79	0.92	1.06
Net Fixed Assets	2.37	2.24	2.10	1.97	1.84	1.71	1.58	1.44
Cash & Bank Balance	4.49	8.39	12.05	15.50	18.85	22.48	26.48	30.47
TOTAL ASSETS	6.86	10.62	14.16	17.47	20.69	24.19	28.05	31.91
Net Worth	5.05	8.95	12.72	16.51	20.34	24.20	28.06	31.92
Dept equity ratio	2.90	2.68	2.30	1.53	0.57	-0.01	-0.01	-0.01

Projected Cash Flow:

Particulars / Years	0	1	2	3	4	5	6	7	8
Sources									
Share Capital	0.63	-	-	-	-	-	-	-	-
Term Loan	1.88								
Profit After tax		4.42	3.90	3.77	3.79	3.82	3.86	3.86	3.86
Depreciation		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total Sources	2.50	4.55	4.03	3.91	3.92	3.96	3.99	3.99	3.99
Application									
Capital Expenditure	2.50								
Repayment of Loan	-	0.06	0.14	0.24	0.48	0.60	0.36	-	-
Total Application	2.50	0.06	0.14	0.24	0.48	0.60	0.36	-	-
Net Surplus	-	4.49	3.89	3.67	3.44	3.36	3.63	3.99	3.99
Add: Opening Balance	-	-	4.49	8.39	12.05	15.50	18.85	22.48	26.48
Closing Balance	-	4.49	8.39	12.05	15.50	18.85	22.48	26.48	30.47

Calculation of Internal Rate of Return

(₹ in lakhs)

Particulars / year	0	1	2	3	4	5	6	7	8
Profit after Tax		4.42	3.90	3.77	3.79	3.82	3.86	3.86	3.86
Depreciation		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Interest on Term Loan		0.22	0.18	0.16	0.12	0.07	0.01	-	-
Salvage/Realizable value	(2.50)	-	-	-	-	-	-	-	-
Cash outflow	(2.50)	4.77	4.21	4.06	4.05	4.03	4.00	3.99	3.99
Net Cash flow		4.42	3.90	3.77	3.79	3.82	3.86	3.86	3.86
IRR	182.03								

NPV	19.80

Break Even Point

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11
Sub Total (G)	0.08	0.08	0.08	0.09	0.09	0.10	0.10	0.11
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Interest on Term Loan	0.22	0.18	0.16	0.12	0.07	0.01	0.00	0.00
Depreciation *(H)*	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Sub Total (I)	0.38	0.33	0.32	0.28	0.23	0.17	0.17	0.17
Sales (J)	6.18	6.18	6.18	6.18	6.18	6.18	6.18	6.18
Contribution (K)	6.11	6.11	6.10	6.10	6.09	6.09	6.08	6.08
Break Even Point (L= G/I)	6.14%	5.47%	5.18%	4.66%	3.80%	2.86%	2.72%	2.75%
Cash Break Even {(I)-(H)}	3.98%	3.31%	3.02%	2.50%	1.64%	0.70%	0.55%	0.58%
Break Even Sales (J)*(L)	0.38	0.34	0.32	0.29	0.24	0.18	0.17	0.17

Return on Investment

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	5.73	5.77	5.79	5.81	5.86	5.91	5.92	5.91	29.42
Net Worth	5.05	8.95	12.72	16.51	20.34	24.20	28.06	31.92	121.02
									24.31%

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Cash Inflow									
Profit after Tax	4.42	3.90	3.77	3.79	3.82	3.86	3.86	3.86	23.57
Depreciation	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.79
Interest on Term Loan	0.22	0.18	0.16	0.12	0.07	0.01	0.00	0.00	0.75
TOTAL (M)	4.77	4.21	4.06	4.05	4.03	4.00	3.99	3.99	25.12

DEBT

Interest on Term Loan	0.22	0.18	0.16	0.12	0.07	0.01	0.00	0.00	0.75
Repayment of Term Loan	0.06	0.14	0.24	0.48	0.60	0.36	0.00	0.00	1.88
Total (N)	0.28	0.32	0.40	0.60	0.67	0.37	0.00	0.00	2.63
Average DSCR (M/N)	9.54								

Annexure -4: Details of procurement and implementation

S. No.	Activities	Weeks					
		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	Cooling, hook up			
2	Hearth modification job			
3	Tuning, monitoring control stabilization			

Annexure 5: Detailed equipment assessment report

Calculation of Energy Saving Potential from installation of Air Pre heater in Thermopac

Ultimate analysis of fuel	C %	H2 %	S %	O2 %	N2 %	Ash %	Moisture%
	80.9	3.57	7.5	0	0.95	0.01	7

S. No	Particular	Unit	Value
1	Theoretical air requirement	kg of air/kg of fuel	10.80
2	Excess air supply	% age	150
3	Actual mass of air supplied at present condition	kg of air/kg of fuel	27.05
4	Flue gas temperature	^{o}C	250
5	Proposed flue gas temperature	^{o}C	180
6	Fuel firing rate	kg/hr	250
7	Heat available in flue gas	kCal/kg of fuel	450.8
8	Heat available in flue gas per hr	kCal/hr	112700
9	Heat goes to air pre heater	kCal/hr	112700
10	GCV of fuel	kCal/kg	8200
11	Fuel saving per hour	kg/hr	13.74
12	Total operating hour	hr/year	6000
13	Total fuel saving per year	MT	82.46
14	Cost of fuel (RPC)	₹ / MT	7500
15	Total monetary saving per year	₹ in lakh	6.18
16	Total Investment	₹ in lakh	2.5
17	General Payback Period	Months	5

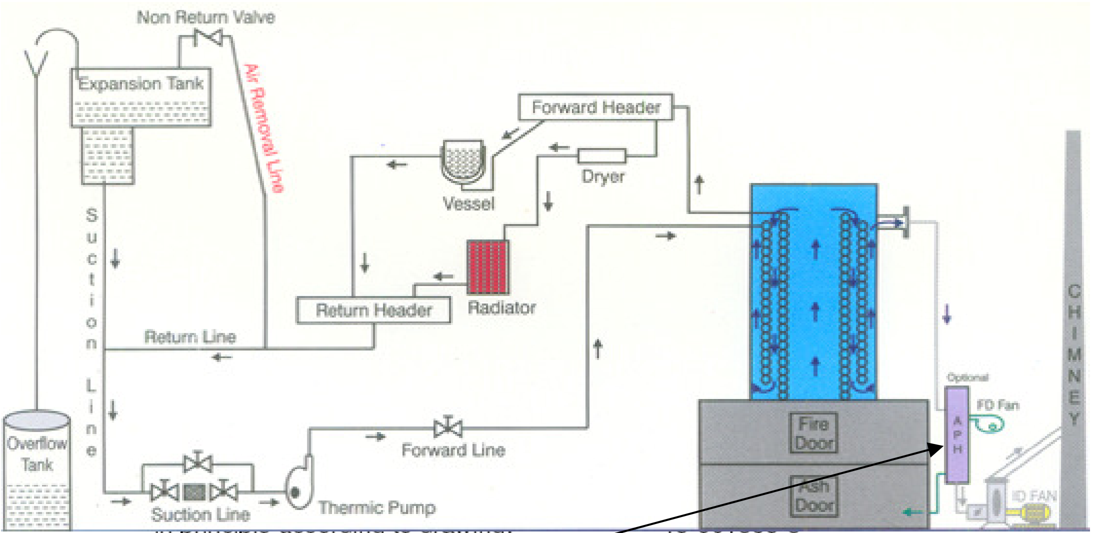
Annexure -6: Details of equipment service providers

S.No.	Technology	Name of Service Provider	Address	Contact Person and No.
1.	Installation of Air Preheater in Thermopak	M/s Punjab Engg.	G-755-756, Road No. 9F-2, VKIA Jaipur	Mr. Parthav Shah
2	Installation of Air Preheater in Thermopak	M/s Forbes Marshall	Delhi Office	
3	Installation of Air Preheater in Thermopak	M/s Thermax	JAIPUR	

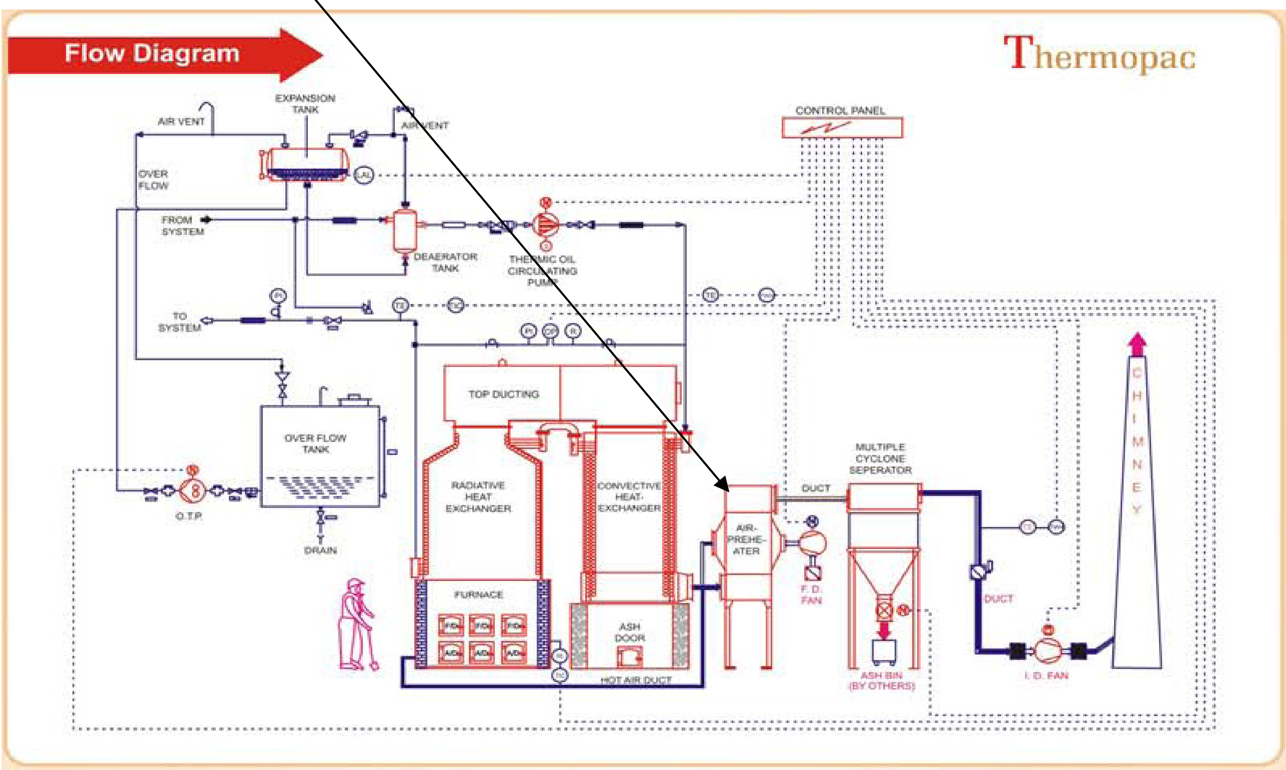
Quotation 45-06-1385-3

STENTER FRAME RANGE

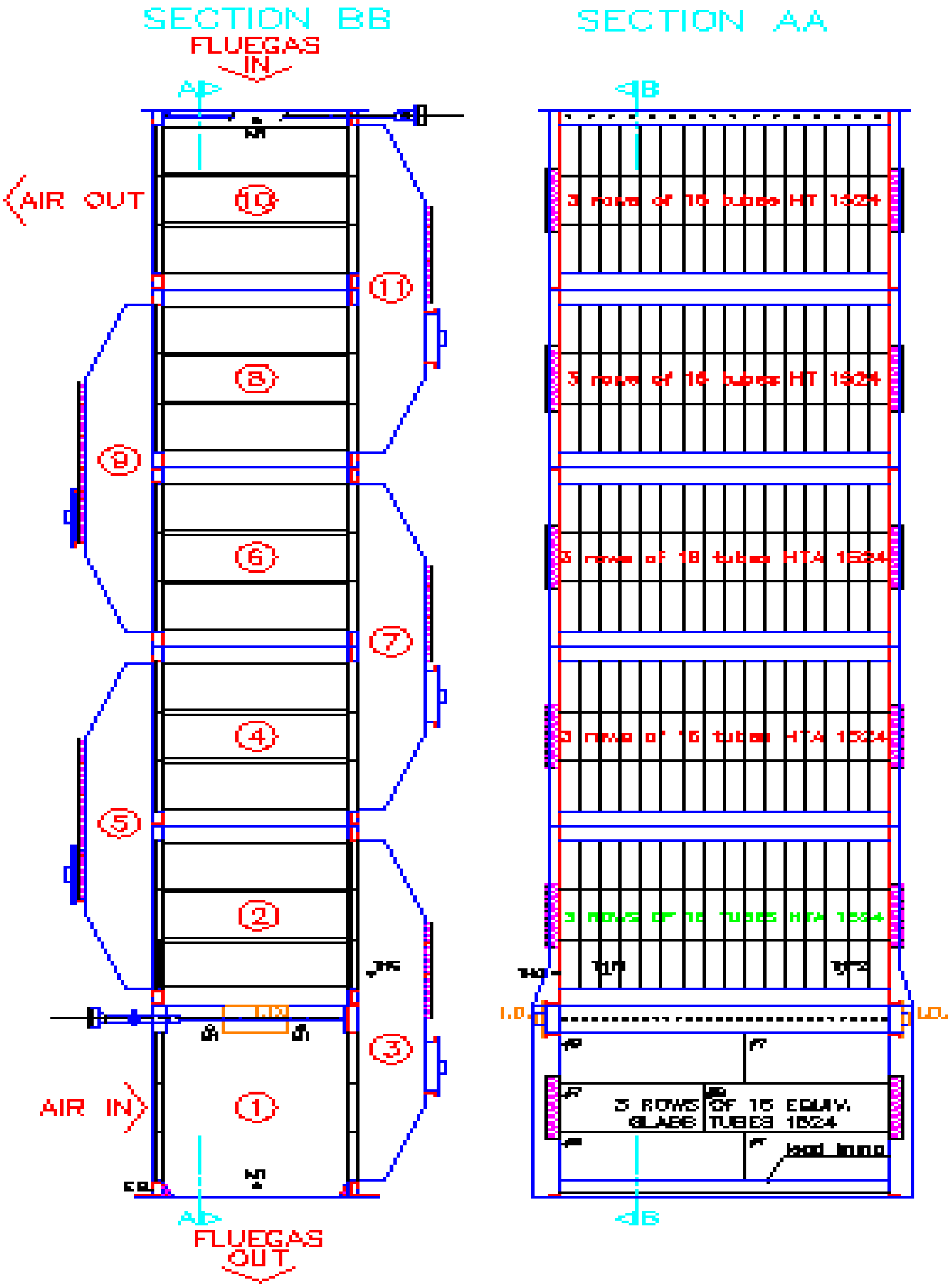
- **Infeed combination**



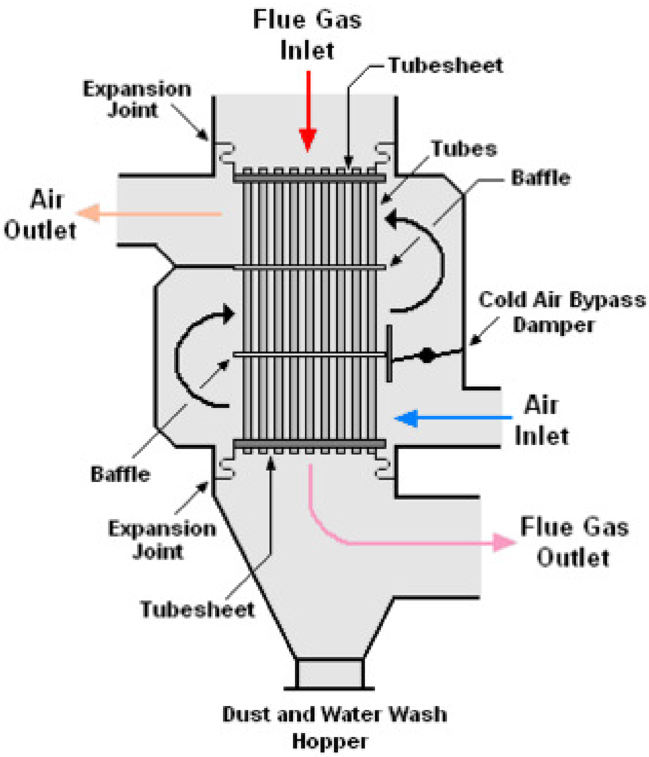
Air Pre Heater



ENERGY IS LIFE
BEE
CONSERVE IT



ENERGY IS LIFE BEE CONSERVE IT


Flue Gas
Inlet
Tubesheet
Expansion
Joint
Tubes
Baffle
Air
Outlet
Cold Air Bypass
Damper
Air
Inlet
Baffle
Expansion
Joint
Flue Gas
Outlet
Tubesheet
Dust and Water Wash
Hopper

Annexure – 8 Technical specification

Particular	Details
Type	Shell & Tube
Material	Shell - MS
No. of passes	2
Flue Gas Temperature at Inlet	250 °C
Flue Gas Temperature at Preheater outlet	180°C
Quantity of Flue Gas to be handled	7 MT per Hour
Pressure Drop	Not more than 6" WG

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

Petroleum conservation Research Association

(Under Ministry of Petroleum and Natural Gas)
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