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SHAKTI SUSTAINABLE ENERGY FOUNDATION

ENERGY IS LIFE BEE CONSERVE IT

Technology Compendium

On

Energy Saving Opportunities

Textile Sector

August 2013

Disclaimer

This report is part of Shakti Sustainable Energy Foundation (SSEF) and Confederation of Indian Industry, CII – Godrej GBC's effort to assist the Indian industry achieve greater energy efficiency levels and to facilitate designated consumers meet their Perform, Achieve & Trade (PAT) targets set by Bureau of Energy Efficiency (BEE), Government of India.

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Foreword by Director General – Bureau of Energy Efficiency

With the growth of economy, the demand for energy has grown substantially. Further, the high level of energy intensity in certain major industrial sectors, and more so, the variation between the most & least efficient facility within them is a matter of concern. In such scenario, efficient use of energy resources and their conservation assume tremendous significance and become imperative for sustainable growth of the industrial economy and the country at large.

The efficient use of energy and its conservation is the best option to meet the increasing energy demand, Government of India has enacted the Energy Conservation Act, 2001. The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency services in the country and provides the much-needed coordination between the various entities.

The Ministry of Power and Bureau of Energy Efficiency (BEE) are entrusted with the task of preparing the implementation for the National Mission on Enhanced Energy Efficiency (NMEEE) under National Action Plan on Climate Change (NAPCC). This mission has a component which deals with the market based mechanism to improve the energy efficiency in energy intensive large industries and facilities by certification of energy savings which could be traded.

This scheme known as Perform, Achieve and Trade (PAT) is expected to save about 6.686 million metric tonne of oil equivalent (mMtoe) by 2014-15. Eight industrial sectors namely Power, Iron & Steel, Fertilizer, Cement, Aluminium, Pulp & Paper, Textile and Chlor-alkali have been included in this scheme where in about 478 industries (known as Designated Consumers (DCs)) are covered. In the ensuing PAT scheme, all the DCs will be required to achieve a reduction of Specific Energy Consumption (SEC) from their baseline SEC within 3 years time (2012-13 to 2014-15).

These industry specific technology compendiums will provide ready-to-use information on national & international energy conservation opportunities, Best Operating Practices (BOP), Best Available Technologies (BAT), with their techno-economic considerations. These compendiums will be helpful for DCs to prepare their energy efficiency action plans and to achieve their SEC reduction targets set by BEE.

I am sure that this Technology Compendium manual will receive an overwhelming response from the cross section of the industry. I take this opportunity to thank Shakti Sustainable Energy Foundation (a part of Climate Works Foundation) for supporting this initiative.

(Ajay Mathur)

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EXECUTIVE SUMMARY

The Indian Textiles Industry plays an important role in the growth of the Indian economy. Apart from providing one of the basic necessities of life, the textiles industry also plays a pivotal role through its contribution to industrial output, employment generation, and the export earnings of the country.

Currently, textile sector contributes about 14% to industrial production, 4% to the gross domestic product (GDP), and 17% to the country's export earnings. It provides direct employment to over 35 million people. The sector is the second largest provider of employment after agriculture. Thus, the growth and all round development of this industry has a direct bearing on the improvement of the economy of the nation.

Textile sector a unique position as a self-reliant industry, from the production of raw materials to the delivery of finished products, with substantial value-addition at each stage of processing. The textile industry is undergoing a major reorientation towards non-clothing applications of textiles, known as technical textiles, which are growing roughly at twice rate of textiles for clothing applications and now account for more than half of total textile production.

According to Energy Conservation Act any textile Industry consuming greater than 3000 MTOE is declared as designated consumer. There are 90 designated consumers considered for the PAT cycle. The energy savings of 66013 metric ton of oil equivalent /year (MTOE) is expected to be achieved, which is around 1% of total national energy saving targets assessed under PAT.

The Technology compendium is a small effort to facilitate the Designated Consumers of Perform Achieve and Trade scheme of BEE. A composite mill of 15000 TPA is taken as a reference plant. By implementing the proposals in this compendium the reference plant described can achieve 813 MTOE savings.

The textiles sector has witnessed a spurt in investment during the last five years. The main engine of investment has been the Technology Upgradation Fund Scheme (TUFS). The increased investment will help to upgrade technology. Competitiveness is a driver for energy efficiency improvement for the companies. Quantum of investment upfront investment required and pay-back period are the main decision factors. Energy efficiency funds similar to TUFS can be made available to the Textile Industries in PAT to implement projects on energy efficiency fronts.

METHODOLOGY

The following Methodology was adopted in developing the Technology compendium for Textile sector

Formation of technology advisory group:

A Group consisting of key industrial experts from textile sector has been identified. The following experts constituted the Technology Advisory Group;

- Mr Nitin Shrivastava, General Manager, Raymond UCO Denim Pvt. Ltd
- Mr P Senthil Kumar, Asst. VP – Engineering, M/s. Bombay Rayon Fashions Ltd.,
- Mr G.Sundaram, Factory Manager, Anglo French Textiles
- Mr Ashok Jain, Vice President – Works, Visaka Industries Ltd
- Mr S. H. Mistry, G.M.Engineering, Priyadarshini Sahakari Soot Girni Ltd
- Bombay Textile Research Association

Secondary Research:

Secondary research was an important activity through which this project received inputs. Project inputs were collected from various secondary sources. Some of them include:

- National / International best practices manuals
- Textile sector journals
- International Practices through BEE and Ministry of Textiles
- Stakeholder interactions – Industry experts, Technology service providers, Funding Agency, Etc.,
- CII Detailed Energy Audit Reports
- CII Energy award questionnaires – last several years
- PAT Baseline Energy Audits conducted in various Textile Industries
- Best practices captured from the National & International Conferences

Stakeholder Interactions:

The team has interacted with several technology service providers to gain their perceptions on the Best available energy efficient technology and to identify existing and in-development technologies to assess their utility.

Review and Analysis:

All the information derived from the secondary research and stakeholder consultation phases were studied and analyzed. The analyzed data was incorporated to the report.

- Mapping of Technologies/Process and sub-processes in the Textile sector
- Understanding of energy trends from the past and adaptation of technology and its influence on energy performance in the Textile sector
- Identification of clean technologies available in Textile sector
- Identification of best operating practices in Textile sector this also includes;

  - Energy savings
  - Environmental benefits
  - Investment required
  - Payback period
  - Technology providers

Draft report on Textile Technology compendium had been prepared and advice has been obtained from various working groups in an Industry. The draft report consists of Indian sector overview, Energy consumption trend and growth trends of the sector, Policy / Regulations favourable and non favourable to Sector, List of best practices and Technology Proposed.

1.0 INDIAN TEXTILE INDUSTRY

The textile industry has played an important role in the development of human civilization over several millennia. Coal, iron/steel and cotton were the principal materials upon which the industrial revolution was based. Technological developments from the second part of the eighteenth century onwards led to an exponential growth of cotton output, first starting in the U.K., and later spreading to other European countries. The production of synthetic fibers that started at the beginning of the twentieth century also grew exponentially.

The world population will grow to 9.3 billion[1] people by the year 2050. The global per capita consumption of energy for the year 2008 is 10.4 kg/person[2]. The global per capita consumption has increased from 9.8 kg/person to 10.4 kg/person for the period from 2005 to 2008.

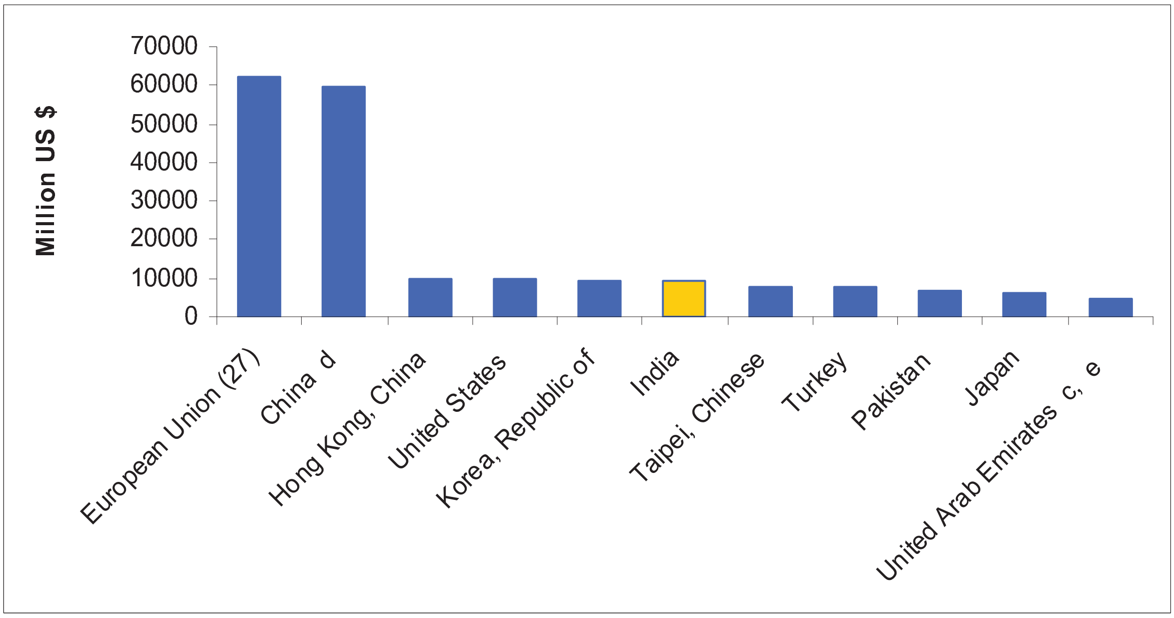


Figure 1 Leading Exporters of Textiles in 2009[3]

Indian Textile Industry is one of the leading textile industries in the world. Though was a predominantly unorganized sector till 1991, the scenario started changing after the economic liberation of Indian Economy. The opening up of the economy gave the much needed thrust to the textile industry which has become one of the largest players in the world.

The Indian textiles industry is extremely varied, with the hand-spun and hand-woven sector at one end of the spectrum, and the capital intensive, sophisticated mill sector at the other. The decentralized powerlooms / hosiery and knitting sector form the largest section of the textiles

[1] United Nations Department of Economic and social affair http://esa.un.org
[2] A survey of world apparel fiber consumption survey – FAO and ICAC
[3] International Trade Statistics 2010, WTO,

sector. The close linkage of the industry to agriculture and the ancient culture, and traditions of the country make the Indian textiles sector unique in comparison with the textiles industries of other countries. This also provides the industry with the capacity to produce a variety of products suitable to the different market segments, both within and outside the country.

The Textile sector in India can be classified into many sub - divisions such as spinning, weaving, dyeing, printing, processing etc. The distribution of all the textile units in India is displayed below. Out of these 3307 plants in India only 90 plants have been enlisted as designated consumers and have been declared targets in the PAT scheme. The distribution of Textile Industry has been showed in the figure below explaining the % share in each state.

Table 1 Distribution of Textile Mills in India as on November 1st 2012[4]

Sr no	State	No of Mills
1	Andhra Pradesh	187
2	Assam	7
3	Bihar	6
4	Chhattisgarh	1
5	Dadra Nagar Haveli	12
6	Daman & Diu	2
7	Delhi	2
8	Goa	1
9	Gujarat	115
10	Haryana	163
11	Himachal Pradesh	18
12	Jammu & Kashmir	2
13	Jharkhand	1
14	Karnataka	62
15	Kerala	39
16	Madhya Pradesh	63
17	Maharashtra	218
18	Manipur	1
19	Orissa	19
20	Pondicherry	15
21	Punjab	140
22	Rajasthan	78
23	Tamil Nadu	2002
24	Uttar Pradesh	109
25	Uttaranchal	13
26	West Bengal	31
	Total	**3307**

[4] Office of Textile Commissioner

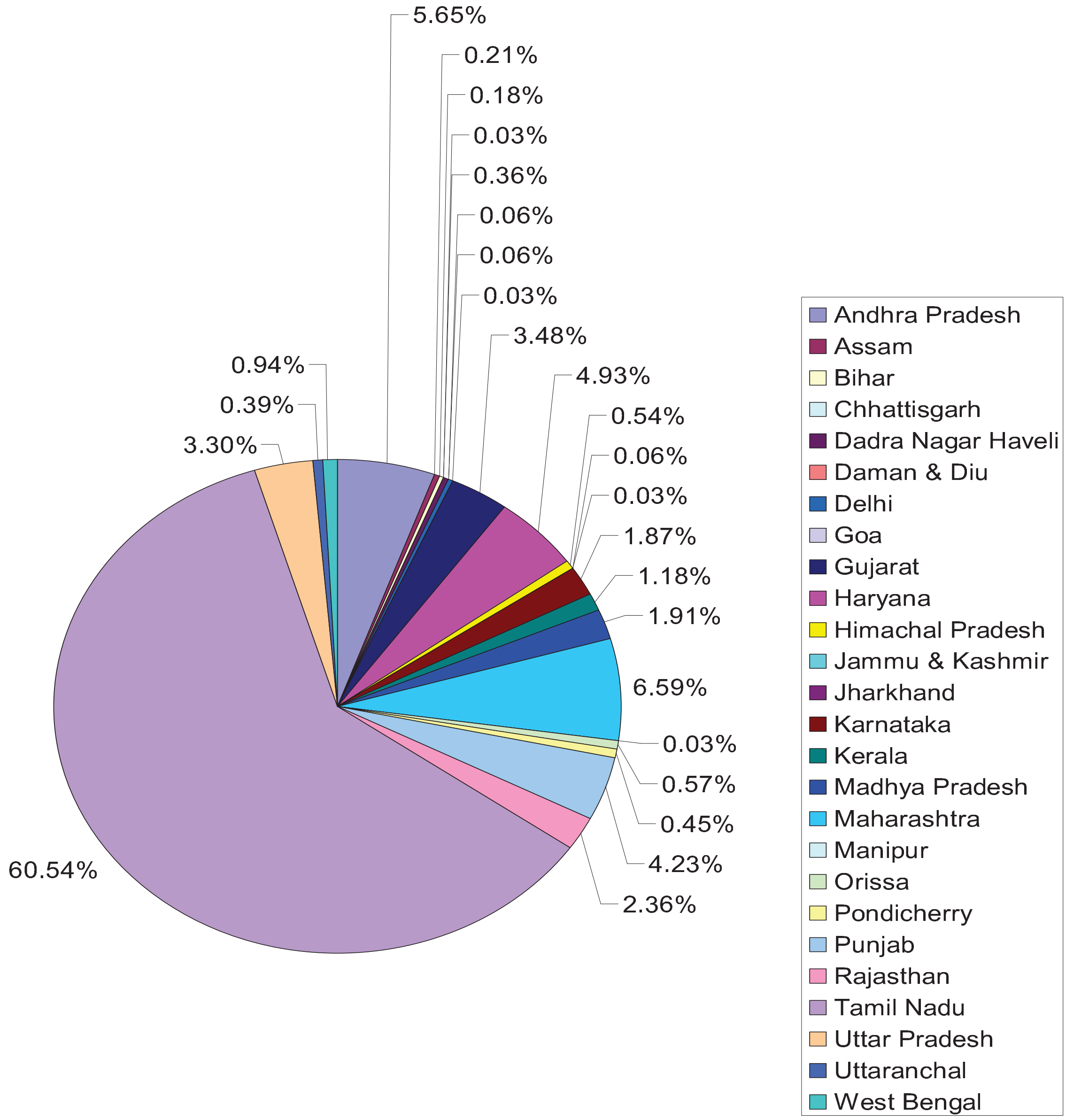


Figure 2 State wise Distribution of Textile Manufacturing units[5]

[5] Ministry of Textiles

The textile industry in India is a key sector in terms of employment as it is the second largest employment provider after agriculture with direct employment of about 35 million. Cotton is the predominant fabric used in the Indian textile industry – nearly 60% of overall consumption in textiles and more than 75% in spinning mills is cotton. India is among the world's largest producers of cotton with over 9 million hectares under cultivation, and an annual crop of around 3 million tons. Processes and technologies differ considerably across factories. Composite mills cover complete sets of processes, from raw material to final products, however most manufacturing units tend only to deal with a part of the process. India's textile industry is generally divided into the organized and the unorganized sector. The organized sector includes spinning mills and composite units. The unorganized sector comprises power looms, handlooms and garment sectors.

The Government of India has promoted a number of export promotion policies for the textile sector. This includes various incentives under Focus Market Scheme and Focus Product Scheme. The coverage of Market Linked Focus Product Scheme for textile products and extension of Market Linked Focus Product Scheme is incorporated by the Indian government to increase the Indian shares in the global trade of textiles and clothing. It has also allowed 100 per cent FDI in textiles under the automatic route.

Due to policy measures initiated by the Government in the recent past, the Indian textiles industry is in a stronger position than it was in the last six decades. The industry which was growing at 3-4 percent (CAGR) during the last six decades has now accelerated to an annual growth rate of 8-9 per cent in value terms.

The textiles industry complements the growth of several industries and institutions such as the defence forces, railways, and government hospitals, which are the key institutional buyers of technical textiles. The market is expected to grow to US$ 31 billion by 2020, at a CAGR of 10 per cent. The industry includes production of flexible packaging material for industrial, agricultural and consumer goods. Among the other segments, protech, oekotech, spotech and geotech have significant growth potential.

1.1 Capacity and Capacity Utilization

The Textile sector grew at 3-4% Compound annual growth rate during the last six decades has now accelerated to an annual growth rate of 8-9 % in value terms. As per the Eleventh Five Year Plan, it was projected to fast-track to a growth rate of 16% in value and is further expected to reach US$ 115 billion (exports US$ 55 billion and domestic market US$ 60 billion) by 2012.

Production of raw cotton grew to 32.5 million bales in FY11 from 28 million bales in FY07, while production of man-made fibre rose to 1,281 million kgs in FY11 from 1,139 million kgs in FY07. Production of yarn grew to 6,233 million kgs in FY11 from 5,183 million kgs in FY07.

Table 2 Installed capacity of Cotton and Man-Made Fibre Textile Mills[6]

Year	No of Mills	Installed Capacity			
		Spindles	Rotors	Looms	Knitting Machines
1980	831	21401432	94799	107080	353
1990	1200	28718346	134733	109780	373
2000	2781	43772262	535422	112714	586
2006	2952	43351948	595337	71774	765
2007	3043	44427603	644099	67297	780
2008	2997	43712861	651649	54818	780
2009	1830	40705891	491504	55456	780
2010	3130	46124692	693045	55504	895
2011	3394	49247104	781253	56340	748
2012	3293	48559400	777047	52272	1141

India earns about 27% of its total foreign exchange through textile exports. The textile industry contributes nearly 14% of the total industrial production of the country. Fabric production rose to 60,996 million sq meters in FY 2011 from 55,276 million sq meters in 2007 – 08.

Table 3 Yarn production in India[7]

Financial Year	Cotton Yarn	Blended Yarn	100% Non Cotton Yarn	Total Production
	Qty. Million kgs	Qty. Million kgs	Qty. Million kgs	Million kgs
2005-2006	2521	588	349	3458
2006-2007	2824	635	355	3813
2007-2008	2948	677	378	4003
2008-2009	2899	655	361	3914
2009-2010	3079	707	407	4193
2010-2011	3491	796	427	4713
2011-2012	3121	779	459	4359

Table 4 Cloth production in India in Million Sq. Mtrs.[4]

[6] http://www.txcindia.com Office of the Textile Commissioner

[7] Ministry of Textiles

Financial Year	Cotton Cloth	Blended Cloth	100% Non Cotton Cloth	Total Qty.
2005-2006	23873	6299	18655	48826
2006-2007	26225	6882	19582	52689
2007-2008	27205	6888	21183	55276
2008-2009	26898	6766	20534	54198
2009-2010	28790	7769	22438	58996
2010-2011	31201	8135	21663	60999
2011-2012	30592	8395	21580	60566

There were 1946 cotton/man-made fibre textile mills (non-SSI) in the country with an installed capacity of 43.13 million spindles; 5, 20,000 rotors and 52,000 looms as on 30.11.2011.

Over the years, production of cloth in the mill sector is showing a steady growth since 2003-04 onwards and was 58,996 million sq. meter in 2009-10. The total production of cloth by all sectors i.e. mill, powerloom, handloom, hosiery and khadi, wool and silk has shown an upward trend in recent years. The Cloth production in 2010-11 is 60566 million sq. mtrs. The cloth production during April-Oct (2011-12) showed a decrease by 6.5%

The capacity utilization in the spinning sector of the organized textile mill industry ranged between 80 to 90 % while the capacity utilization in the weaving sector of the organized textile mill industry ranged between 41 to 62 %.[8]

[8] Ministry of Textiles

1.2 MAJOR PLAYERS IN THE INDIAN TEXTILE INDUSTRY

Table 5 Major Players in Indian Textile Industry

Company	*Business Areas*
Welspun India Ltd	Home Textiles, bathrobes, terry towels
Vardhman Group	Yarn, Fabric, sewing threads, acrylic fibres
Alok Industries Ltd	Home textiles, woven and knitted apparel fabric, garments and polyester yarn
Raymond Ltd	Worsted suiting, tailored clothing, denim, shirting, woolen outwear
Arvind Mills Ltd	Spinning, weaving, processing and garment production(denims, shirting, khakis, knitwear
Bombay Dyeing & Manufacturing Company Ltd	Bed linen, towels, furnishings fabricator suits, shirts, dresses and saris in cotton and polyester blends

Welspun India Limited

Established in 1985 as Welspun Winilon Silk Mills Pvt. Ltd, a synthetic yarn business, Welspun's textile business emerged in its current form in 1995 with the incorporation of Welspun India Limited. One of the top three home textile manufacturers in the world, with world class manufacturing facilities in India. The business is spread across the world with a distribution network in over 32 countries including U.S.A., U.K, Europe, Canada and Australia with more than 90% of the total produce being exported.

Vardhman Group

A leading textile conglomerate in India having a turnover of $700 million. Spanning over 24 manufacturing facilities, the Group business portfolio includes Yarn, Greige and Processed Fabric, Sewing Thread, Acrylic Fibre and Alloy Steel. Vardhman Group manufacturing facilities include over 8,00,000 spindles, 65 tons per day yarn and fibre dyeing, 900 shuttleless looms, 90 million meters per annum processed fabric, 33 tons per day sewing thread, 18000 metric tons per annum acrylic fibre.

Alok Industries Ltd

Alok was established in 1986 as a private limited company, with our first polyester texturising plant being set up in 1989. Over the years, Alok has expanded into weaving, knitting, processing, home textiles and garments. Alok also provide embroidered products through Grabal Alok Impex Ltd., our associate company. Alok also has an international presence in the retail segment through its associate concern, Grabal Alok (UK) Limited. This entity owns more than 200 outlets across England, Scotland and Wales's vending value for money ranges for menswear, womenswear, childrenwear, footwear, homeware and accessories.

Raymond Limited

With a capacity of 31 million meters in wool & wool-blended fabrics, Raymond commands over 60% market share in worsted suiting in India and ranks amongst the first three fully integrated manufacturers of worsted suiting in the world. Raymond produces high-value pure-wool, wool-blended and premium polyester viscose worsted suiting in addition to half a million blankets and shawls. The company exports products to over 55 countries including USA, Canada, Europe, Japan and the Middle East.

Arvind Mills Ltd

Arvind Limited started with a share capital of Rs 2,525,000 ($55,000) in the year 1931. With the aim of manufacturing the high-end superfine fabrics Arvind invested in very sophisticated technology. With 52,560 ring spindles, 2552 doubling spindles and 1122 looms in addition to full-fledged facilities for dyeing, bleaching, finishing and mercerizing. The sales in the year 1934, three years after establishment were Rs 4.576 million and profits were Rs 0.282 million. Steadily producing high quality fabrics, year after year, Arvind took its place amongst the foremost textile units in the country.

Bombay Dyeing

The Bombay Dyeing & Mfg. Co. Ltd., established 1879 is the flagship company of the Wadia Group engaged mainly into the business of Textiles. The entire production is divided into two broad streams of weaving, spinning and winding. The production is over 300,000 meter of fabric/day.

1.3 Growth trends

The growth pattern of the Indian textile industry in the last decade has been considerably more than the previous decades, primarily on account of liberalization of trade and economic policies initiated by the Govt. in the 1990s. Fiscal duty structure of the textile industry has also influenced to a great extent the growth and the structure of the industry.

India's Textile exports %- FY 2010

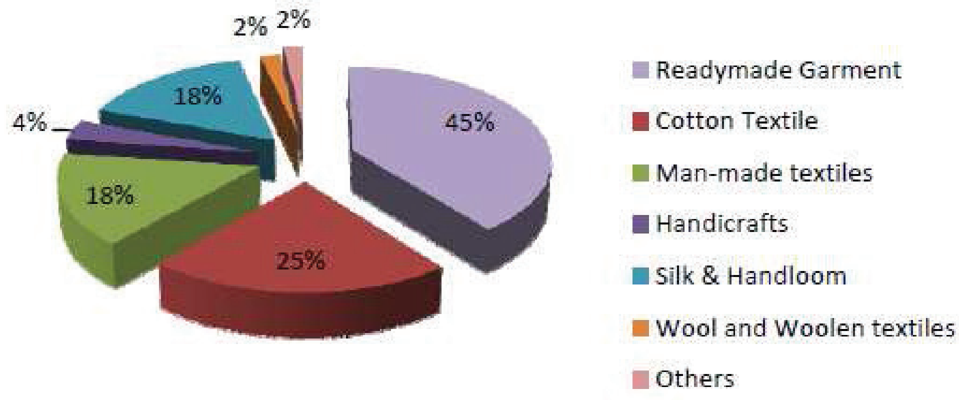


Figure 3 India's textile export by categories

Fabric production rose from 60,996 million sq meters in 2011 from 52689 million sq meters in 2007. Production of raw cotton grew to 32.5 million bales in 2011 from 28 million bales in 2007, while Manmade fibres rose to 1,281 million kgs in 2011 from 1139 million kgs in 2007.Production of yarn grew to 6,233 million kgs in 2011 from 5,183 million kgs in 2007. India has the potential to increase its textile and apparel share in the world trade from the current level of 4.5% to 8 % and reach US $ 80 billion by 2020[9]. Exports of textile grew to US $ 27.76 Billion in 2011 from US $ 22.16 Billion in 2008.

Textile production covering man-made fibre, man-made filament yarn and cotton yarn is showing a decreasing trend. Blended and 100% non cotton yarn production recorded an increase of 5.2% during 2011-12 (April – October 2011). The production of spun yarn during April-Oct. (2011-12) has shown a decrease of 8.1%. The production of cotton yarn during 2011-12 (April-Oct. 2011) recorded a decrease of 12.7%.

[9] CITI Report, March 2012

India's Textile Exports (In US$ Billion)

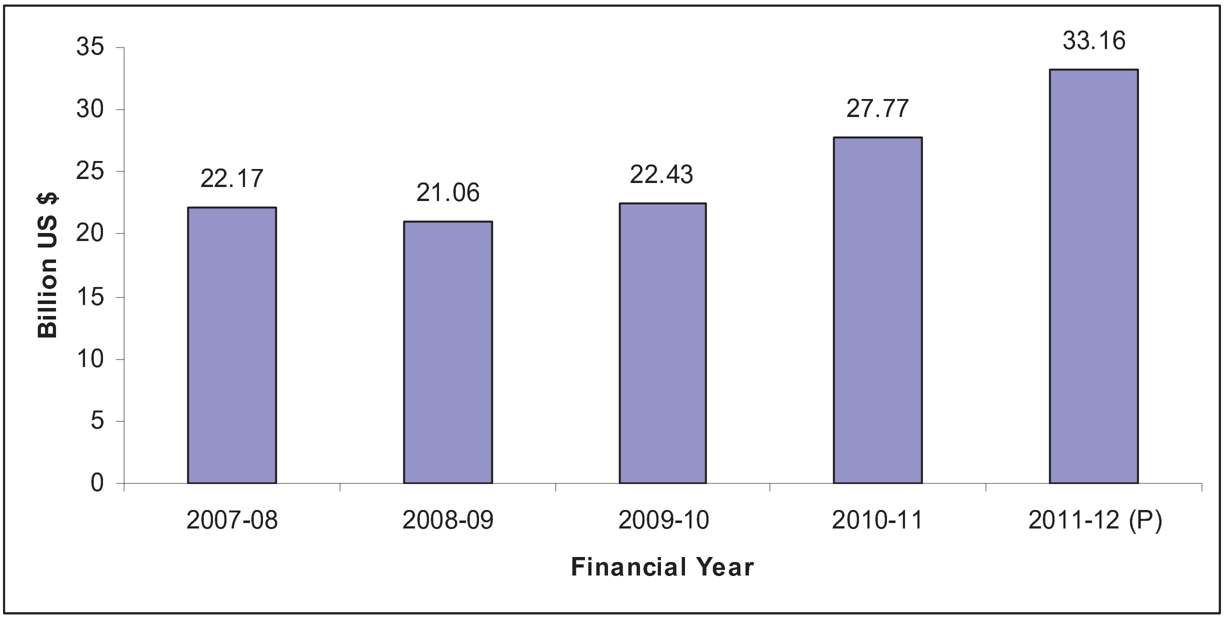


Figure 4 India's textile export value from 2007-08 to 2011-12 (in US$ Billion)[10]

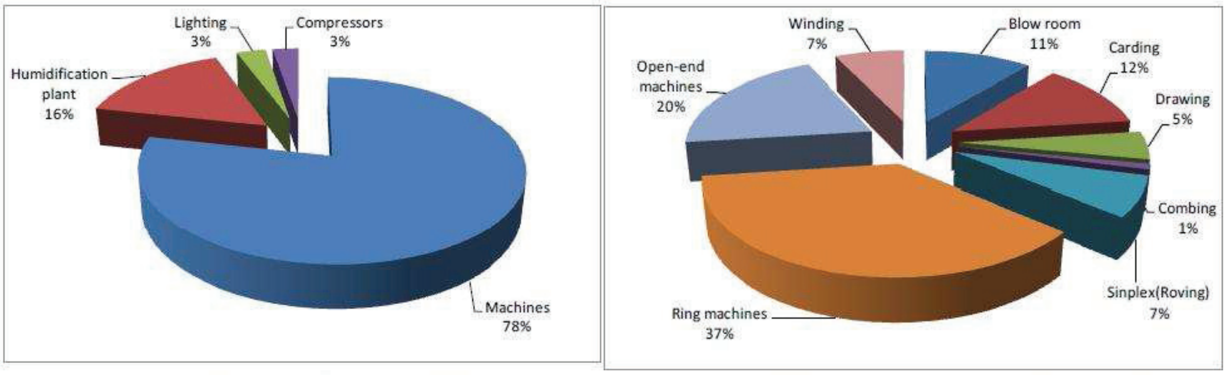
Cloth production by mill sector showed marginal increase of 4.6% during April-Oct. (2011-12) (provisional). During the same period cloth production by power loom and hosiery sector showed a decrease of 4.4% and 17.8% respectively. However the cloth production in handloom sector showed an increase of 3%. India has the potential to increase its textile and apparel share in the world trade from the current level of 4.5% to 8% and reach US$ 80 billion by 2020.

[10] Ministry of textiles

2.0 ENERGY CONSUMPTION PATTERN IN TEXTILE INDUSTRY

Textile industry is an energy intensive industry. The wet processing division of textile is highly energy intensive and holds the majority share of energy in the Textile sector. As the new technology in automation for textile has replaced manual processing the energy consumption of the textile industry has increased by adopting newer technologies. The latest machinery provides a very low downtime and increased production. Though the energy consumption of the machines has augmented by implementation of additional automation in the machinery, the specific energy consumption of the machines has come down improving energy efficiency. Therefore adopting newer technologies improves energy efficiency of the textile machinery.

Electricity is the major type of energy used in spinning plants, especially in cotton spinning systems. If the spinning plant just produces raw yarn in a cotton spinning system, and does not dye or fix the produced yarn, the fuel may just be used to provide steam for the humidification system in the cold seasons for preheating the fibers before spinning them together. Therefore, the fuel used by a cotton spinning plant highly depends on the geographical location and climate in the area where the plant is located. The breakdown of final energy use in a sample spinning plant that has both ring and open-end spinning machines is given below:



spinning machines

Note: The graph on the right shows the breakdown of the energy use by the category "machines" that is shown in the graph on the left

Figure 5 Breakdown of energy usage in spinning plant[11]

Wet-processing is the major energy consumer in the textile industry because it uses a high amount of thermal energy in the forms of both steam and heat. The energy used in wet-processing depends on various factors such as the form of the product being processed (fiber, yarn, fabric, cloth), the machine type, the specific process type, the state of the final product, etc. The break – up of energy consumption during the various operation of spinning, weaving and wet processing of textile is as follows

[11] Energy Use, Loss and Opportunities Analysis US DOE, 2004

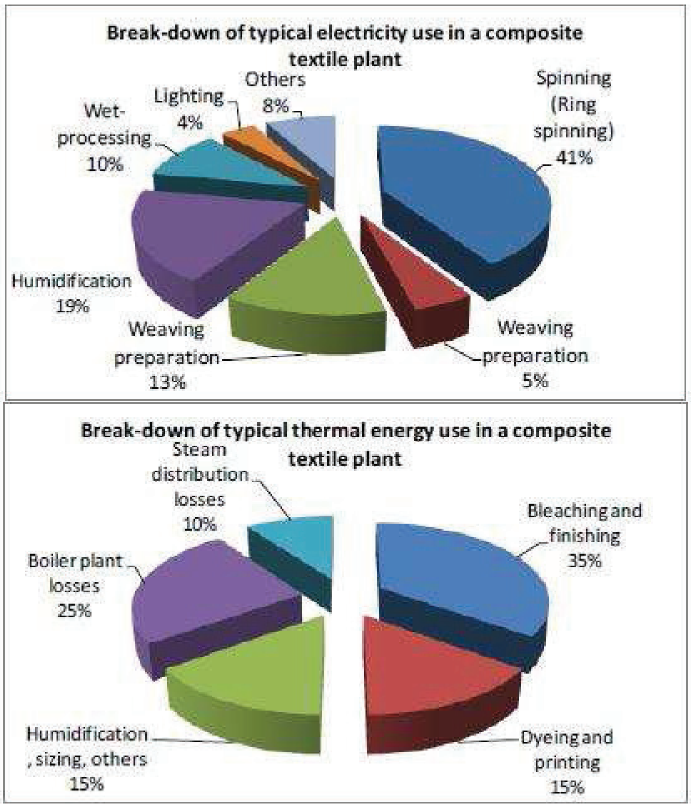


Figure 6 Breakdown of typical electricity and thermal energy used in a composite textile plant[12]

The wet processing operation consumes almost 50% of the total energy requirement of a composite textile mill. This is an attributable that wet processing operation involves heating of large quantities of water, drying of wet fabric, high temperature such as heat setting, high temperature, dyeing and curing operation etc.

Steam plays a vital role in the wet processing of fabrics not only due to the fact that steam cost is more than 30% of the total processing cost. In spite of such an important role of steam for cloth, processing, generally the aspects of steam generation, distribution and the Utilization are operating at a lower efficiency due to vintage systems in most of the textile mills.

Indian Textile industry has to compete in the global front, where the developed countries with advanced technology have a lower cost of energy compared to the outdated technologies in the Indian Textile Industry. Energy cost especially thermal energy cost can become a significant measure in comparing Indian textile Industry Internationally.

[12] Industrial Technologies Program, Energy Matters USDOE 2004

2.1 Challenges faced by textile Sector

The textile industries in developing country like India are facing intensified competition in both, their export and domestic markets. The ongoing economic reforms and changes at the international economic scene including the emergency of World Trade Organization (WTO) have brought about certain challenges and several opportunities before the textile industry of India. The Indian textile industry exemplifies many of the opportunities from globalization. The textile industry has to compete in the global market with the obsolete technology available. The obsolete technology is one such hindrance, there are many hindrances like increase of raw material cost, inferior quality of coal, scarcity of power etc.(explained below). The energy cost in a textile industry varies from 10 - 17% of the total production cost. Energy efficiency can play a major role in reducing the Textile Industry

2.1.1 Increase in Raw Material cost

Raw material cost plays an important role in the textile Industry. The cost of cotton bales has increased significantly whereas the yarn prices are restricted to be rised above a certain value. Due to this problem the profit margin of textile industry has reduced.

2.1.2 Inferior quality of coal

The quality of coal received by some plants is lower in calorific value. Also, the ash content of the coal is very high. Firing a lower calorific value coal provides a lower power output and lower thermal energy. Also handling the ash also becomes a hindrance for the industry.

2.1.3 Scarcity of power

Power scarcity is a major crisis in India. Many spinning mills in India are dependent on their State Electricity Board for power. Many State Electricity Boards have declared two power holidays for the companies due to the shortage of power. The companies are also restricted to operate at a lower maximum demand. Due to this restriction in power many plants operate at lower capacities or are forced to run their diesel generators. Running diesel generators further increase their cost of production. For some plants it is not economical to run on diesel generators.

2.1.4 Vintage of plants

The technology available in the global market is better and has lower specific energy consumption leading to the lower cost of production. In order to compete with the global market, Indian textile Industries has to significantly improve their technology on energy efficiency front. Modern automated spinning machines have lower specific energy consumption compared to outdated machines used in the industry. The major hindrance for technology upgradation is investment for purchase of new machines. In the current scenario such bulk investments may put the textile Industry in jeopardy for sustaining in the global market.

2.2 Policies favouring growth of textile sector

Government policy has played a fundamental role in shaping the growth, structure and technological evolution of the textile sector in India. The strong demand from domestic and export market coupled with conducive policy environment provided by the Government has catalyzed the growth of the textile industry. With the objective of accelerating growth in investments and exports; Government of India has launched several schemes. Some of the major schemes are discussed below:

2.2.1 Technology Upgradation Fund Scheme (TUFS)

The Technology Upgradation Fund Scheme (TUFS) is the flagship Scheme of the Ministry of Textiles which was launched on April 1, 1999. It was launched to enable firms to access low interest loans for technology upgradation.

The Scheme mainly provides for :

- Reimbursement of 5% (4% for spinning machinery) interest charged by the financial institutions
- Coverage of exchange rate fluctuation not exceeding 5% (4% in respect of spinning machinery) points per annum in respect of foreign currency loans instead of 5% interest support
- 5% interest reimbursement plus 10% capital subsidy for specified finishing machinery, garmenting machinery and technical textiles machinery.

2.2.2 Scheme for Integrated Textile Parks (SITP)

Infrastructure is a major bottleneck in Indian textile industry. The main objective of SITP is to provide industries with world - class infrastructure in order to setup their textile units to meet international environment and social standards.

2.2.3 Development of Mega Cluster

The broad objectives of the Mega cluster approach Scheme is to enhance the competitiveness of the Powerloom clusters, Handloom clusters & Handicraft clusters, in terms of increased market share and ensuring increased productivity by higher unit value realization of the products. The scheme comprises of following components:

Comprehensive Powerloom Cluster Development Scheme:-To assist entrepreneurs to set up world-class units with modern infrastructure, latest technology and adequate training and human resource development along with appropriate market linkages

Comprehensive Handloom Cluster Development Scheme: - To address the challenges faced by weavers within the cooperative sector and outside, due to poor infrastructure in some clusters

Comprehensive Handicraft Cluster Development Scheme:-To enhance the competitiveness in terms of access to technology, increased market share, ensure effective integration of scattered artisans and linking them to SMEs, generate additional livelihood opportunities, provide linkages in terms of adequate infrastructure technology, product security and other such components.

2.2.4 Integrated Skill Development Scheme (ISDS)

Integrated Skill Development Scheme was launched by the Ministry of Textiles to train candidates according to the industry needs, provide professionals skills in multiple fields in textiles, and provide knowledge to the working professionals on the developments in the industry.

2.2.5 Technology Mission of Technical Textiles (TMTT)

Government has launched TMTT with two mini missions for a period of five years (from 2010-11 to 2014-15). The aim of TMTT is to address the issues like lack of basic infrastructure in terms of testing facilities, lack of market development support, skilled manpower, lack of R & D, absence of regulatory measures, absence of specifications and standards for technical textiles etc. The total fund outlay for TMTT is Rs 200 Crores.

Mini Mission I of TMTT is aimed at Standardization, creating common testing facilities with national international accreditation, indigenous development of prototypes and resource center with IT infrastructure, incubation centre by establishing four new Centers of Excellence (COEs) and upgradation of existing four COEs. Mini Mission II of TMTT is to provide support under 6 components, i.e.,

a. Support for business start-up
b. Providing fund support for organizing workshops
c. Social compliance through standardization, regulatory measures
d. Market development Support for marketing support to bulk and institutional buyers
e. Market development Support for export sales and
f. Contract Research and Development through IITs/TRAs/Textile Institutes

In addition, FDI policy for manufacturing in this sector is quite hassle free as 100% FDI is allowed under the automatic route. Apart from these larger schemes which target a broad range of industry, there are various schemes specifically targeted to help decentralized sectors grow like handloom, silk and powerloom.

2.3 Energy Consumption of Textile Industry in India

The total energy consumed by the textile sector in MTOE including all DCs and Non DCs is 1.8616[13] million MTOE. As per PAT the average energy consumption of all the plants for the baseline period of PAT (FY 07-08 to FY 09-10) is 1.2059 million MTOE. There are 90 designated consumers in Textile sector who are nominated for PAT scheme. A textile Industry should consume a minimum of 3000 MTOE to be certified as a designated consumer, to enroll into the PAT scheme. The combined target reduction of these designated consumers will result in reduction of 0.66 million MTOE. The designated consumers of PAT are subdivided into Spinning, Processing, Composite and Fiber units. The Specific energy consumption of these divisions of textile is given in the figure below.

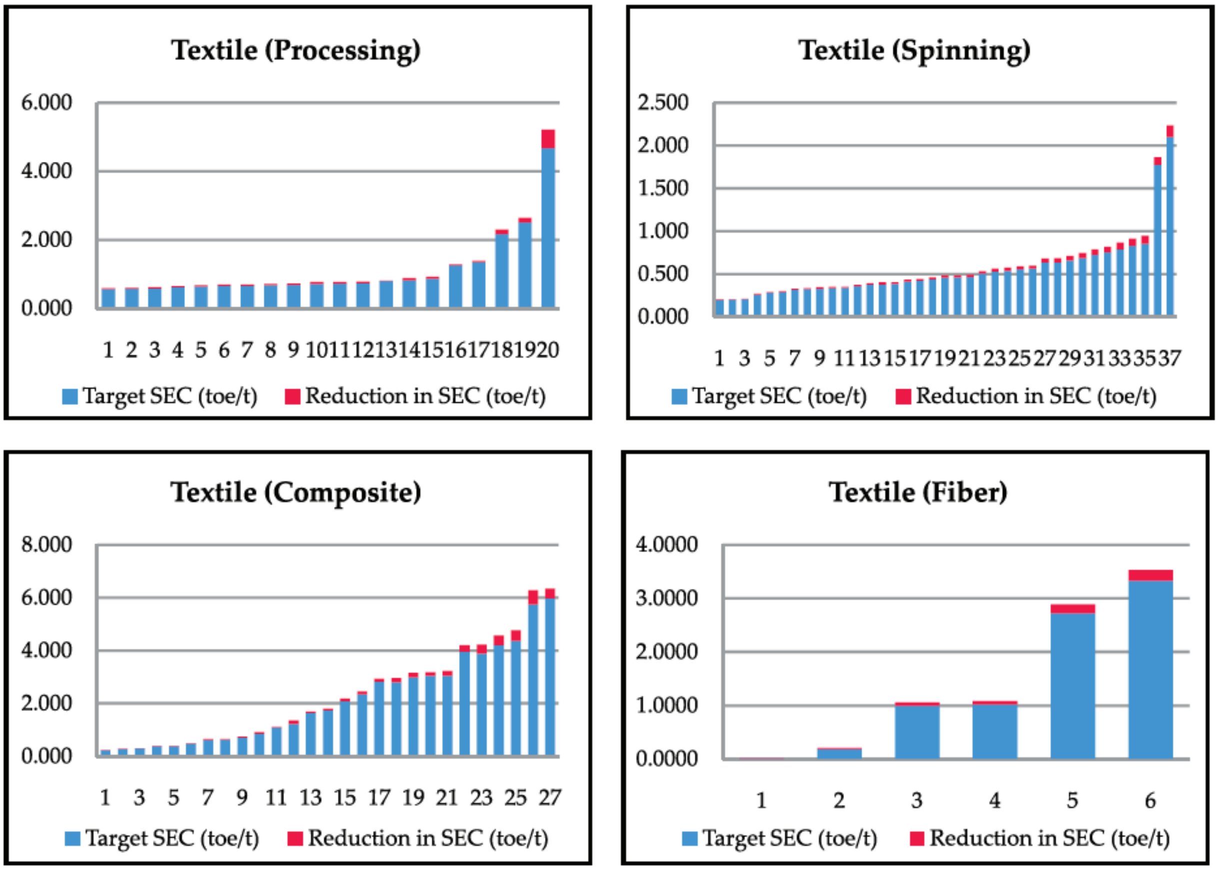


Figure 7 Specific Energy consumption of designated consumers of PAT in Textile

The maximum energy is consumed by textile processing and composite unit as it consumes large quantities of thermal energy for processing. The majority of the plants in the PAT scheme is from Spinning sector but the specific energy consumption is not as high as a composite mill or Processing mill as the spinning sector majorly uses only electrical energy for their consumption.

[13] Energy Statistics 2012

2.4 Specific Energy Consumption norms for various divisions in Textile Industry

Modernizing of the products in textile Industry can be a source for improvement in energy efficiency. The conventional spinning mills run at a lower speed and has higher energy consumption compared to the modernized spinning mill which run at high speed machines which have lesser energy consumption compared to the conventional mills in the country. A conventional cotton mill in India has an energy consumption of 4.72 kWh/kg[14] of cotton yarn produced, whereas the international norm for spinning mill is 3-3.5kWh/kg. The powerloom sector consists of weaving machines with shuttles. These weaving machines can be upgraded to modernized shutleless weaving machines. The potential for saving by replacing with shutleless machines is very high as only 1% of the machines in the country are operating with shutlless feature. The modern continuous dyeing machines in India have very high production rate to the thermal energy used for the machine.

According to the Asian Regional Research Program in Energy, Environment, and Climate (ARRPEEC) survey, the energy consumption norms for a textile industry is given in the table below

Table 6 Energy Consumption norms for various divisions in Textile

Section	Energy consumption norms
Spinning	3-3.5 kWh/kg of yarn
Weaving	2.9 to 3.1 kWh per meter of fabric
Knitting	0.09 – 0.2 kWh/kg of fabric
Dyeing	Electrical : 0.04 to 0.15 kWh per kg of fabric Thermal : 4-9kg of steam/kg of fabric

[14] SITRA norms

3.0 MAPPING STAKEHOLDER INITIATIVES

Indian Textile Industry is one of the key energy intensive Industries, which is also a designated consumer under the PAT program. Textile industry in India, in particular the decentralised sector, is passing through a period of crisis. With the implementation of WTO, it has become difficult to compete globally with the existing technology and operational deficiencies. It is inevitable to address both the issues with a sense of urgency for our survival globally. Several initiatives have been taken by the sector by itself in terms of energy efficiency and productivity improvement opportunities with the help of industrial associations and suppliers.

3.0.1 Industry Organizations

In order to cater a conducive environment to promote the growth of Indian Textile Industry there are several national organizations which works closely with government in terms of various policy issues, enhancing efficiency, competitiveness, growth and development opportunities for the sector.

Major industry organizations working closely with the Textile sector to cater to its growth Include

- Textile Association of India (TAI)
- Confederation of Indian Textile Industry (CITI)
- Northern India Textile Research Association (NITRA)
- South India Textile Research Association (SITRA)
- Man-Made Textiles Research Association (Mantra), Surat
- The Bombay Textile Research Association
- Ahmedabad Textile Industry's Research Association (ATIRA)
- Confederation of Indian Industry (CII)

Textile Association of India (TAI)

The Textile Association (India) is the foremost largest textile professional body of India, striving for the growth of India's largest single Textile Industry and also largest in the world textiles. It is established in the year 1939 with 126 founding members and currently has more than 22000 strong memberships with 27 affiliated Units, spread throughout the length and breadth of the country. The Textile Association (India) provides for professional growth of technologists managers, traders, researchers, entrepreneurs, teachers and consultants on the Indian textile scene. It caters to the needs of all fibers, products and all sectors of the Indian industry.

Website: - www.textileassociationindia.org

Confederation of Indian Textile Industry (CITI)

Confederation of Indian Textile Industry (CITI), is the new name of Indian Cotton Mills' Federation (ICMF). ICMF had been established in March 1958 and later incorporated as a company in February 1967. Originally, ICMF represented the organized textile units in spinning and composite sectors comprising mills producing cotton yarn, blended and man-made spun yarn, fabrics and home furnishings. As of now, CITI includes all the 12 Member Associations of the erstwhile ICMF as regular Members, 8 other industry associations as Associates Members and 7 Corporate Members. Besides this, Chairman of Cotton Textiles Export Promotion Council (Texprocil), Synthetic and Rayon Textiles Export Promotion Council (SRTEPC) and Apparel Export Promotion Council (AEPC) are members to the Committee of CITI on reciprocal basis.

Website: - www.citiindia.com

Northern India Textile Research Association (NITRA)

Northern India Textile Research Association (NITRA) is one of the prime textile research institutes in the country. The textile industry and Ministry of Textiles, Government of India jointly established NITRA in 1974 for conducting scientific research and providing support services to Indian textiles industry. NITRA's prime activities include research & development, technical consultancy, quality evaluation of materials, manpower training, technical publication and providing facilitating services to the decentralized powerloom sector through its seven service centres. NITRA renders multifarious services through 13 technical divisions engaging more than fifty experienced technical personnel. NITRA has a clientele of about 1200 textiles and allied sector units. The portfolio also includes overseas clients from U.K., Spain, Indonesia, Thailand, Ethiopia, Sudan, Bangladesh and Nepal.

Website: - www.nitratextile.org

South India Textile Research Association (SITRA)

South India Textile Research Association (SITRA) is one amongst the chain of laboratories in the country. It is sponsored by the Textile industry and supported by the Ministry of Textiles, Government of India. It is an autonomous scientific research organization. It is governed by a Council of Administration consisting of twenty-six members who include representatives of the Industry, the Central and State Governments and the scientists from reputed Institutions.

Website: - www.sitra.org.in

MAN-MADE TEXTILES RESEARCH ASSOCIATION (MANTRA), SURAT

The main objective of MANTRA is to render testing, consultancy and other services to the local, decentralized textile weaving, texturing and processing industry on various aspects of technology with a view to improving the quality of fabrics, reducing cost and bringing about better utilization of raw materials.

Website: - www.mantrasurat.org/

The Bombay Textile Research Association

BTRA has grown leaps and bounds over the years since its inception in 1954 to meet the technological needs of the Indian textile industry as well as to achieve S&T objectives set at the national level. BTRA members include not only textile units but also manufacturers from man-made fibre, machinery, dyes and chemical auxiliaries industries. The BTRA zone largely comprised composite mills and from the beginning, the R & D and services were fine-tuned to satisfy their comprehensive requirements.

Website: - www.btraindia.com/

Ahmedabad Textile Industry's Research Association

ATIRA is an autonomous non-profit association for textile research. It is the largest of its kind in India for textile and allied industries. ATIRA was established on 13th December 1947, and started in 1949 after due recognition by the Council of Scientific and Industrial Research under the Ministry of Science and Technology, Government of India. Later it was linked to the Ministry of Textiles. The Science and Technology activities of ATIRA extend over a wide field. The R&D activities include Process Optimization for improved processed control, leading to better quality, cost reduction and export promotion, development of New Products, Processes and Design of New Instruments, equipments and machinery with emphasis on Industry/user collaboration/sponsorship as far as possible. Supportive studies in areas of Environmental Pollution, Management, Human Relations and Policy Aspects.

Website: - http://www.atira.in

Confederation of Indian Industry (CII) & CII- Sohrabji Godrej Green Business Centre

CII is a non-government, not-for-profit, industry led and industry managed organization founded over 117 years ago plays a proactive role in India's development process. CII works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes.

CII - Sohrabji Godrej Green Business Centre (CII - Godrej GBC) is one of the 10 Centres of Excellences of the Confederation of Indian Industry (CII). CII-Sohrabji Godrej Green Business Centre offers advisory services to the industry in the areas of Green buildings, energy efficiency, water management, environmental management, renewable energy, Green business incubation and climate change activities. The Centre sensitizes key stakeholders to embrace Green practices and facilitates market transformation, paving way for India to become one of the global leaders in Green businesses by 2015.

CII – Godrej GBC has been very closely associated with energy efficiency improvement of the Indian industry. CII – Godrej GBC had carried out more than 1300 detailed energy audits till date in different sectors of industries. CII Godrej GBC has also been involved in the development of the Investor manual for the textile sector under IREDA and has identified and developed Energy Efficiency Best practices for Textile Industries under ADB project. CII Godrej GBC has also conducted energy efficiency improvement studies across various textile clusters in the country

Website: - www.cii.in and www.greenbusinesscentre.com

3.1 TEXTILE PRODUCTION PROCESS

The textile industry produces a wide range of products. The production process includes four main activities: spinning, weaving and knitting, wet processing and stitching (sewing). The production from fibers to spun yarn takes place through the spinning process and constitutes the first stage. Then the yarn is weaved to make fabrics in looms. Most woven fabrics retain the natural color of the fibers from which they are made and are called "grey fabrics" at this stage. These fabrics then undergo several different processes including bleaching, printing, dyeing and finishing; these are grouped under the category of wet processing. Finally, the stage from fabrics to garments is done by stitching. The industry uses cotton, jute, wool, silk, man-made and synthetic fibers as raw material.

3.1.1 Spinning

Spinning involves opening/blending, carding, combing, drawing, drafting and spinning. It uses four types of technologies: ring spinning, rotor spinning, air jet spinning and friction spinning. Ring spinning is the most used in India with its main advantage being its wide adaptability for spinning different types of yarn. Rotor spinning technology is also widely used.

Mixing

This is the first process where different varieties of fibers from several lots are blended in order to produce a uniform result and also make small tufts from a bale.

The bales coming from out state or local market are first kept in godown. This care is taken to avoid any fire or damage to the bales. Whenever they are required, they are brought to the mills by tractors and they are kept near the mixing bins.

Blow room

This process is the necessary and most important department without which it is not possible to produce quality yarn which is the final requirement of the mills. In this process, opening and closing of cotton is done by various beats and make laps for next process

The various blow room machines are,

1. Bale plucker.
2. HCC-High Capacity Condenser.
3. MPM- Multi Pneumatic Mixing.
4. Automixing.
5. ERM-I & II
6. CCM- Color Contamination Checking machine
7. Material Transport Fan.
8. Chute.

Carding

There are total 42 carding machines. This is preliminary process in spin yarn manufacture. Here fibers are further opened and individualized by passing the material through fine wire points. This process removes most of the impurities and a certain amount of short broken of immature fibers.

Combing

This is a subsequent to carding process. Combing is done to produce yarns which are used for production of high class standard of products. For comber S.L (Sliver Lap) and R.L (Ribbon Lap) is prepared. This removes the short fibers and improves the length uniformity of cotton to make it high quality yarn.

Drawing

A process in yarn manufacture in which sliver is elongated by passing it through a series of pairs of rollers, each of rollers, each moving faster straight in the fibers and create greater uniformity.

Inter

This operation attenuates the draw frame sliver to get a rove and gives a slight twist, so as to get some straight, which is next feed to spinning machine to spin yarn.

Spinning

In this process, the rove is drafted to get the repaired density and twist for greater strength. The yarns are wound in corps (spindles) from this section, the corps are sent to post spinning section with the spinning advice slip, signed by spinning incharge.

Winding

In this section, bobbin cops are wounded on large cones suitable for markets. Yarns are cleared of objectionable faults and wound on large packages with uniform tension. The weight of the cones packages varies as per the customer's requirements.

3.1.2 Weaving

Weaving is the most common method used for producing fabrics. The process is carried out of two sets of threads, which interlaces lengthwise yarns (warp yarns) with widthwise ones (weft or filling yarns).

To prevent the warp yarns from breaking during weaving the warp threads are coated with a size of 80-90°C before weaving, to increase their tensile strength and smoothness. Natural starches are the most commonly used sizes, although compounds such as polyvinyl alcohol, resins, alkali – soluble cellulose derivatives, and gelatin glue have been used. The sizing compound is dried at 100-130°C on the threads and remains a part of the cloth until it is removed in the subsequent processes.

Knitting

In knitting fabric is formed through interlocking series of yarn loops by using hooked needles. Rows of stitches are formed so that each row hangs on the row behind it, usually using sophisticated, high speed machinery

3.1.3 Wet Processing

The fabric produced from the weaving or knitting is in rough condition, contains impurities and is often termed grey fabric. Fabric processing (wet processing) is done to improve the appearance and serviceability of the fabric. The main operations carried out in this step include pretreatment, dyeing, printing and finishing. The wet processing, consumes high quantities of water, chemicals and thermal energy.

Table 7 Summary of main wet operations in textile manufacturing

Summary of the main wet processing operations n textile manufacturing	
Process	**Purpose and conditions**
Singeing	Direct or Indirect flames are used to remove fuzzy fibers, followed by quenching
Desizing	The sizing ingredients are removed from the grey fabric by dissolving them. Desize formulation depends on the nature of the sizing agents, i.e. enzymatic or oxidative treatments are used for starch sized fabrics, whilst acrylate sizes can be removed by hot water (80-90°C). PVA can be removed by using hot water in the presence or absence of peroxygens.
Scouring	The scouring process is carried out to remove impurities such as wax, fatty acids, oils, etc, present in the fabric. Scouring is carried out in alkaline conditions (with Sodium hydroxide) under high pressure and

	temperature (above 100^{o}C)
Bleaching	Bleaching is used to whiten fabrics and yarns. Different chemicals such as hypochlorites, hydrogen peroxides (temperature 90-95^{o}C), etc, are used as bleaching agents. The process conditions during bleaching vary with the type of agent used. Once bleaching is complete the bleaching agent must be completely removed, either by thorough washing or through the use of enzymes.
Mercerization	Mercerizing increases the tensile strength, luster and dye uptake of cotton, fabric or yarn, which is treated with cold sodium hydroxide solution(temperature 18^{o}C, time 20-40 sec). This causes swelling of the fiber, which results in an increase in the the dye intake.
Dyeing	Dyeing is employed to give an all-over shade to the fabric. It basically involves diffusion of dye molecules into the textile fabric, which imparts the required color. Dye bath formulation and dyeing conditions depends on the dye stuff classes used. Batch and Continuous techniques are available for dyeing the textile material. Jigger, winch, Padding, Mangle and Jet dyeing are some of the important dyeing machines used.
Printing	Printing is a process by which colored patterns are produced on the fabric. The color is applied to the prepared fabric on the specific areas and then treated with steam, heat or chemicals to fix the color to achieve a planned design. Pigment or wet or discharge printing can also be used. Final washing of the fabric is carried out to remove excess paste and leave a uniform color

3.1.4 Finishing

The stage includes final operations necessary for making the textile presentable and attractive. It imparts the final aesthetic, chemical and mechanical properties to the fabric as per the end use requirements to improve appearance, texture or quality. The finishing operations include:

3.1.5 Drying

Drying removes the moisture from the fabric using drying machines such as stenter/drying cylinders

3.1.6 Providing Dimensional Stability

The fabric which is in a distorted condition is brought to the required dimensions of width and length in a process called heat setting at around 140-150^{o}C. The heating medium used is thermic fluid/steam.

3.1.7 Calendering

A kind of glossy skin is formed ion the fabric surface during calendaring. The damp fabric is pressed hard against a hot, polished metal surface until it dries

3.1.8 Softening

After Calendering, the fabric becomes a little stiff. Breaking down this stiffness is called softening. The fabric is led through the softening machine so that it touches the studded rollers lightly and drags them around. In this way, the surface of the fabric is lightly distributed making it much softer.

Depending upon the type of fabric to be processed and the final product, any or all of the above processing operations can be carried out.

PRODUCTION PROCESS

Spinning

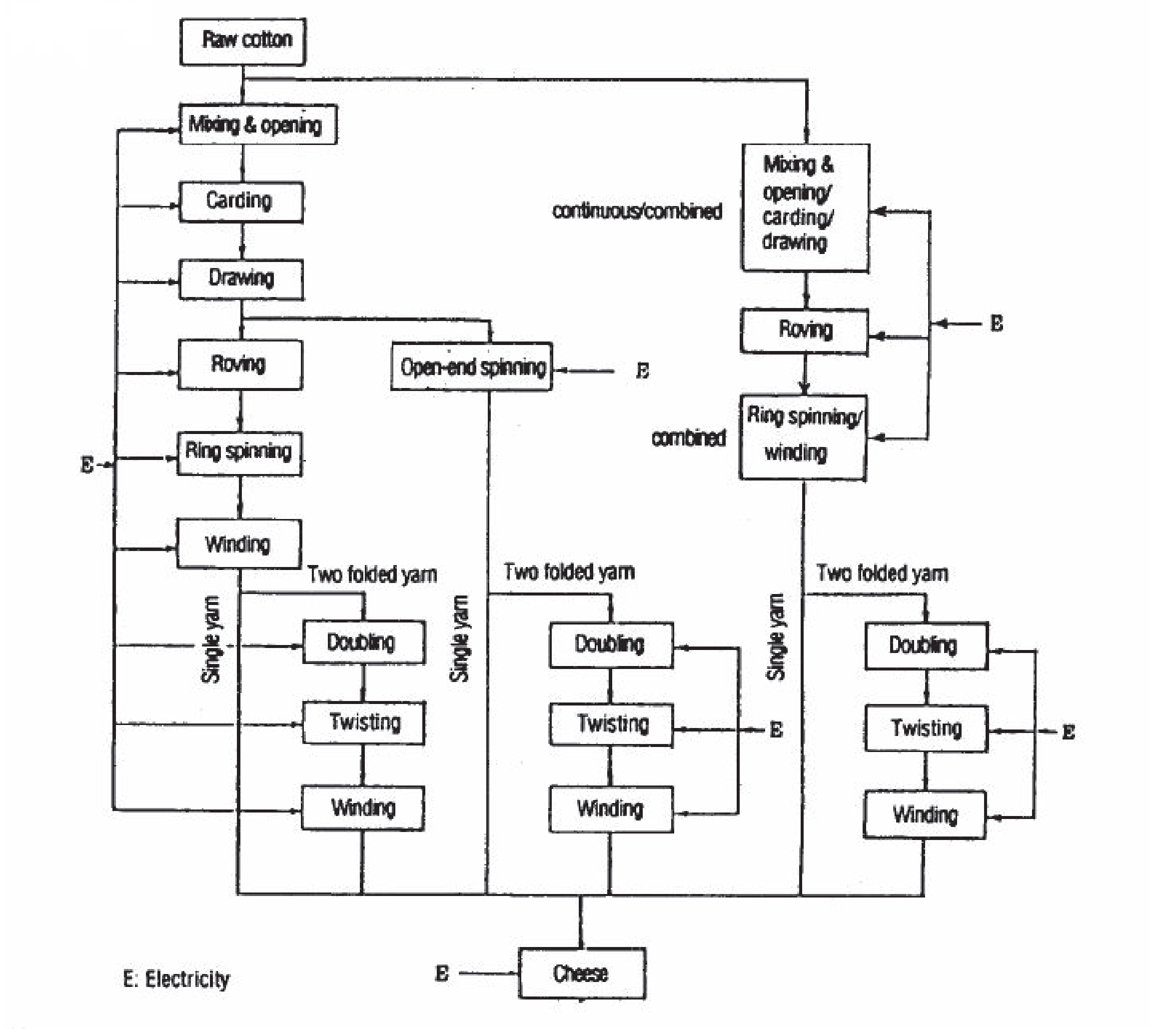


Figure 8 Production flow diagram spinning unit

Weaving

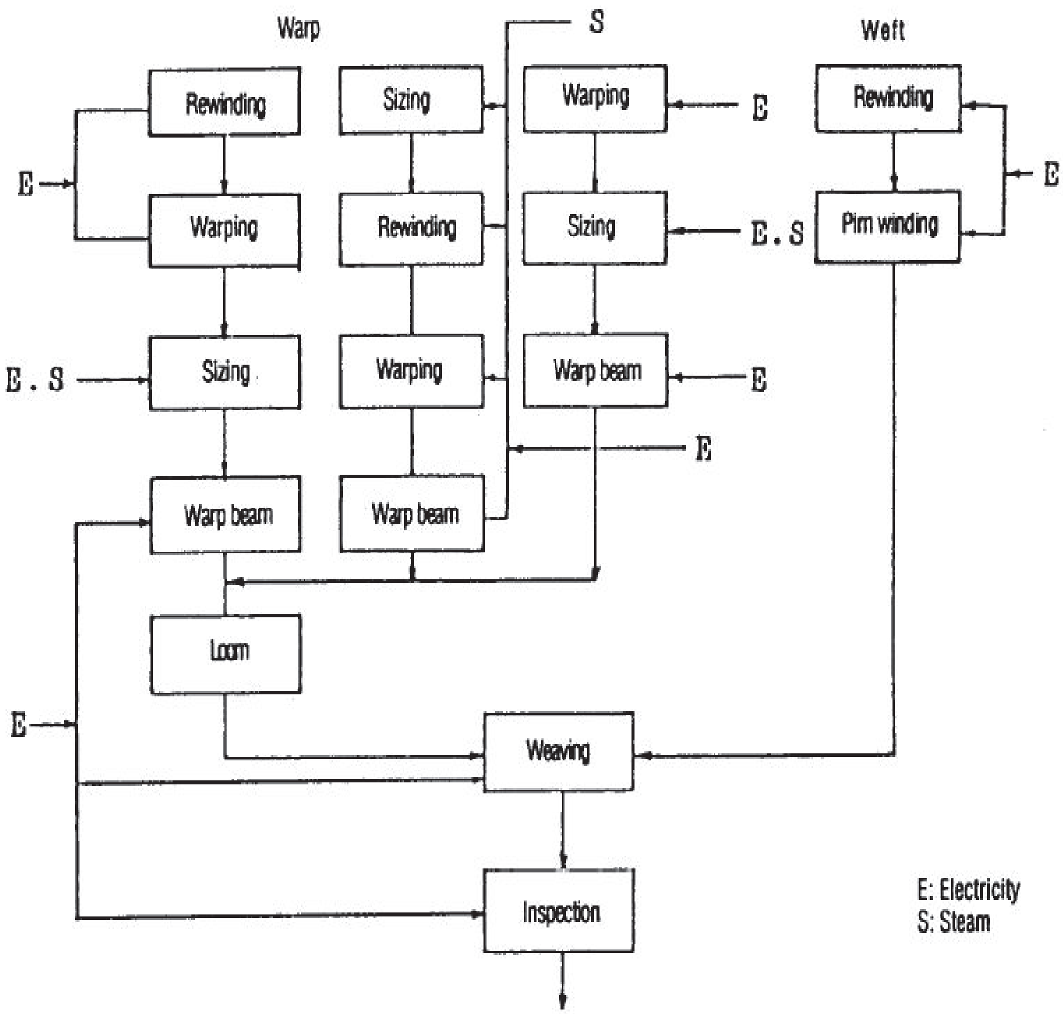


Figure 9 Production flow diagram weaving

Dyeing & Finishing

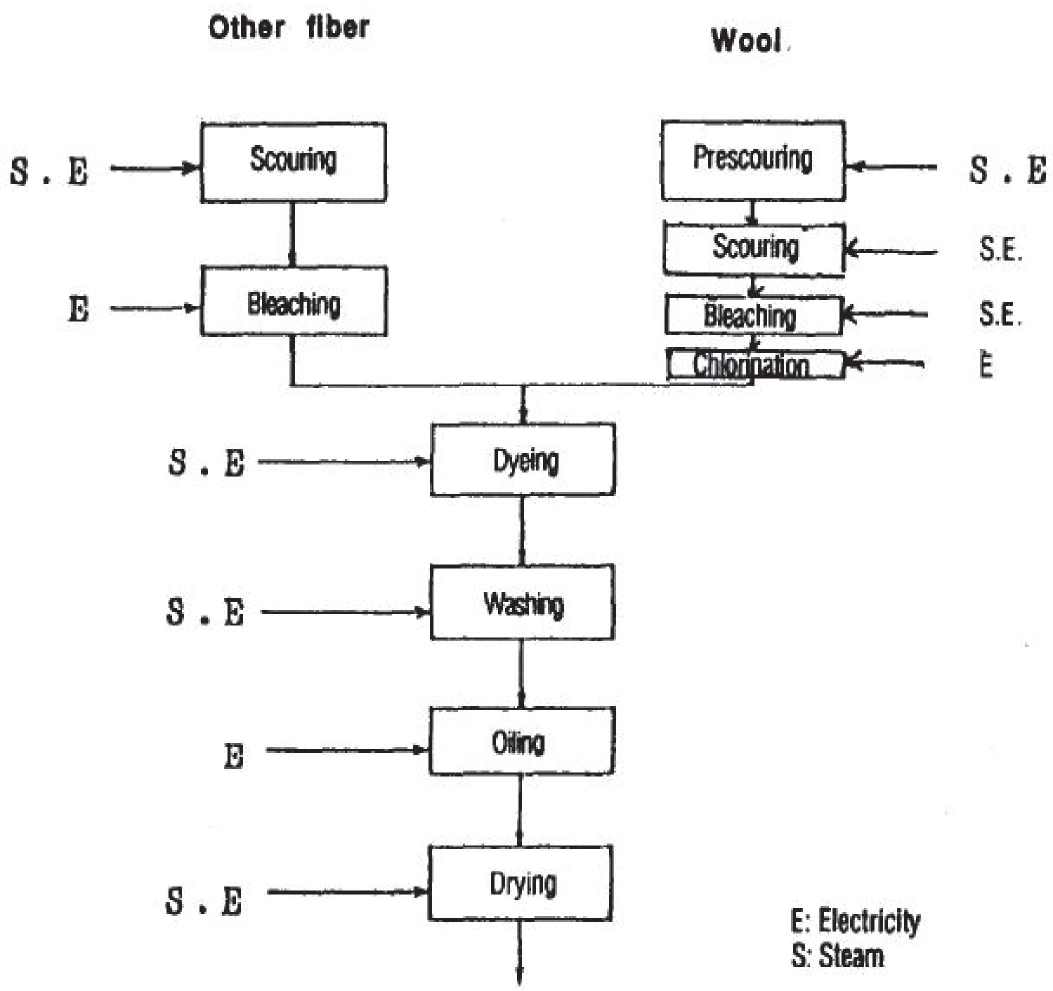


Figure 10 Production flow diagram dyeing and finishing

3.2 POTENTIAL FOR ENERGY EFFICIENCY IMPROVEMENT

The textile industry is one of the longest industrial chains in manufacturing industry and is characterized by production of diverse outputs. This fragmentation and heterogeneity make it difficult to classify industrial practices and to compare Indian practices with international norms. Products are numerous and depend on the type of fibers used, the density and quality of the thread, the colors and the process being operated.

Spinning

Existing textile spinning units in India can be segregated into three types, i.e. conventional, modern and semi-modern. Conventional units have conventional machines where the production rate is low and the fluff or dust liberation from the process is within tolerable limits. Modern units have high speed machines and higher production rates with increased fluff and dust generation. Semi-modern units are units which fall between modern and conventional.

Weaving

Powerlooms produce nearly 60% of the fabric output. Less than 1% of all power looms are shuttleless, and, in the organized mill sector, less than 6% are shuttleless looms. These levels are much lower than those of several developed and developing countries, which have seen a high replacement rate of old looms with modern shuttleless looms; more than 80% of looms in Taiwan, Korea and the U.S. are shuttleless.

Wet processing

The processing industry is decentralized and is marked by hand processing units, independent units and the composite mill sector. Indian processing industry has deployed low-end technology with few technology upgrade initiatives. The Asian Regional Research Program in Energy, Environment and Climate (ARRPEEC) has been working at assessing the energy saving potential in the Indian textile industry. They assessed average energy use in the textile industry and found that energy consumption varies from 3 to 3.5 kWh of electricity per kilogram of yarn in a modernized spinning mill. In the case of weaving, it varies from 2.9 to 3.1 kWh per meter of fabric. For knitting units, the energy consumption stands at 0.09 to 0.2 kWh per kg of fabric. In the case of dyeing it is 0.04 to 0.15 kWh per kg of fabric. Steam consumption in a fabric dyeing unit may vary from 4 to 9 kg of steam per kg of fabric. Measures for improvement in energy efficiency have been adopted by some large-scale mills. However, Small and Medium Industries (SME), which form the backbone of the Indian economy, continue to use older technologies. The awareness level of energy conservation remains poor among the SMIs. ARRPEEC estimated that SMIs have a potential to save 15 to 20% of their energy consumption.

4.0 ACTION PLAN FOR ENERGY EFFICIENCY IMPROVEMENT

The textile industry continues to be the second largest employment generating sector in India. The textile sector in India uses obsolete machinery. Adopting newer technologies will bring natural energy saving into the Textile Industry. Due to the non availability of funds the textile Industry is unable to implement newer technologies in the sector.

Reasons for high operating SEC

- Higher raw material cost
- Vintage of plants
- Operation in lower capacity utilization
    - Power crisis
    - Non – availability of market
- Availability of skilled labour

Approach for Energy Efficiency

- Upgradation of newer energy efficient technologies
- Funding for newer technologies
- Continuous uninterrupted supply of power to the Industries

Perform, Achieve & Trade Act (PAT)

Under PAT mechanism all the designated consumer are required to reduce their energy consumption by certain percentage. This policy is sure to drive the energy efficiency activities of the industry on a longer run.

The PAT benefits can be best utilized in textile sector. Upgradation to newer technologies which have a higher payback can be brought down by including the benefits obtained from ECerts (Energy saving Certificates) in the PAT cycle. This idea drives the market to achieve maximum energy savings. The textile sector has to reduce the target energy consumption by 0.66 million MTOE, which is around 1% of the PAT target. The minimum target is around 1% of energy consumption and the maximum target is around 10.6% in terms of specific energy consumption for the plant.

4.1 List of Energy Efficiency Opportunities

The three major factors for energy conservation in the textile industry are high capacity utilization, fine-tuning of equipment and technology up gradation. The various opportunities for Energy-efficiency Improvement are:

Spinning

1. Install Energy Efficient Pnuemafil Fans in Ring Frames
2. Avoid Idle Operation of Motors by Providing Stop Motion Circuit for Blow Room
3. Install VFD For Autocoro Suction Motor and operate at lower suction pressure
4. Use of energy-efficient spindle oil
5. False ceiling in Ring spinning section to reduce the humidification load
6. Installation of energy-efficient motor in Ring frame
7. Installation of energy-efficient excel fans in place of conventional aluminum fans in the suction of Ring Frame
8. Installation of a soft starter on motor drive of Ring frame
9. Installation of Variable Frequency Drive on Autoconer machine
10. Intermittent mode of movement of empty bobbin conveyor in the Autoconer/cone winding machines

Processing

11. Reduce the Speed of Exhaust Fans in Stenters
12. Install Variable Frequency Drive for Water Circulating Pumps of Jet Dyeing Machine
13. Combine Preparatory Treatments in wet processing
14. Cold-Pad-Batch pretreatment up to 38% of pretreatment fuel use
15. Installing Covers on Nips and Tanks in continuous washing machine
16. Installing automatic valves in continuous washing machine
17. Reduce live steam pressure in continuous washing machine
18. Introducing Point-of-Use water heating in continuous washing machine

19. Use of integrated dirt removal/grease recovery loops in wool scouring plant
20. Installation of Variable Frequency Drive on pump motor of Top dyeing machines
21. Heat Insulation of high temperature/ high pressure dyeing machines
22. Installation of VFD on circulation pumps and color tank stirrers
23. Reducing the process temperature in wet batch pressure-dyeing machines
24. Use of steam coil instead of direct steam heating in batch dyeing machines (Winch and Jigger)
25. Reducing the process time in wet batch pressure-dyeing machines
26. Installation of covers or hoods in atmospheric wet batch machines
27. Careful control of temperature in atmospheric wet batch machines
28. Recover heat from hot rinse water
29. Energy-efficiency improvement in Cylinder dryer
30. Recover Condensate and Flash Steam
31. Select Processes for their Low Water Add-on Characteristics
32. Avoid Intermediate Drying
33. Operate Cylinders at Higher Steam Pressures
34. Conversion of Thermic Fluid heating system to Direct Gas Firing system in Stenters and dryers
35. Introduce Mechanical De-watering or Contact Drying Before Stenter
36. Close Exhaust Streams during Idling
37. Efficient burner technology in Direct Gas Fired systems and improve combustion efficiency
38. General energy-efficiency measures for wet-processing
39. Automatic steam control valves in Desizing, Dyeing, and Finishing
40. The recovery of condensate in wet processing plants
41. Heat recovery from the air compressors for use in drying woven nylon nets
42. Utilization of heat exchanger for heat recovery from wet-processes wastewater

Humidification plants

43. Install High Efficiency Atomisers in Lieu of Nozzles in Humidification Plants

44. Install VFD For Humidification Fans and Reduce Speed During Favourable Condition

Others

45. Install Transvector Nozzle for the Cleaning Applications

46. Convert V-belt Drives to Synthetic Flat Belt Drives For The TFO Machines

4.1.1 BAT –BEST AVAILABLE TECHNOLOGY

Spinning

1. Installation of electronic Roving end-break stop-motion detector instead of pneumatic system
2. High-speed carding machine
3. Replacement of lighter spindle in place of conventional spindle in Ring frame
4. Synthetic sandwich tapes for Ring frames
5. Optimization of Ring diameter with respect to yarn count in ring frames
6. The use of light weight bobbins in Ring frame

Processing

7. Install Waste Heat Recovery Systems for Stenters
8. Combine Preparatory Treatments in wet processing
9. Cold-Pad-Batch pretreatment up to 38% of pretreatment fuel use
10. Bleach bath recovery system
11. Installing heat recovery equipment in continuous washing machine
12. Reduce live steam pressure in continuous washing machine
13. Introducing Point-of-Use water heating in continuous washing machine
14. Interlocking the running of exhaust hood fans with water tray movement in the yarn mercerizing machine
15. Energy saving in cooling blower motor by interlocking it with fabric gas singeing machine's main motor
16. Enzymatic removal of residual hydrogen peroxide after bleach
17. Enzymatic scouring
18. Automated preparation and dispensing of chemicals in dyeing plant
19. Dye Dissolving and Distribution
20. Automated dyestuff preparation in fabric printing plants

21. Automatic dye machine controllers
22. Cooling water recovery in batch dyeing machines (Jet, Beam, Package, Hank, Jig and Winches)
23. Cold-Pad-Batch dyeing system
24. Discontinuous dyeing with airflow dyeing machine
25. Equipment optimization in winch beck dyeing machine
26. Equipment optimization in jet dyeing machines
27. Single-rope flow dyeing machines
28. Replace conventional dyeing equipment with Microwave dyeing equipment
29. Reducing the process time in wet batch pressure-dyeing machines
30. Jiggers with a variable liquor ratio
31. Heat recovery of hot waste water in Autoclave
32. Reducing the need for re-processing in dyeing
33. Introduce Mechanical Pre-drying
34. Reduce Idling Times and Use Multiple Fabric Drying
35. The use of radio frequency dryer for drying acrylic yarn
36. The use of Low Pressure Microwave drying machine for bobbin drying instead of dry-steam heater
37. High-frequency reduced-pressure dryer for bobbin drying after dyeing process
38. The Use of Sensors and Control Systems in Stenter
39. Dyeing Textiles with Supercritical Carbon Dioxide

4.1.2 BEST PRACTICES

TECHNOLOGY - 1

OPTIMIZE THE POWER CONSUMPTION OF HUMIDIFICATION PLANT

BACKGROUND

Humidification plants are major consumers of power in any textile unit and are considered to be the heart of the plant. Humidification plants are catering to the RH and temperature requirement at different sections. The objective of running the Humidification plants is to maintain the desired relative humidity and temperature inside the plant rooms.

The Major constituents of Humidification plants are as follows:

- Return air fans
- Supply air fan
- Pumps
- Nozzles for water atomization
- Control dampers

Performance of Humidification plants depends on the heat load of the section and ambient conditions. In any Humidification plant there are two parameters that can be controlled one is temperature and other is relative humidity.

Temperature is controlled with the help of optimizing the flow rate of the air and RH is being controlled by the cooling water pump.

Ambient conditions does change during different seasons and following trends are obtained

Summer Days

- High temperature and Less humidity
- Both needs to be controlled

Summer Nights

- Temperature comes down
- Humidity is still lower

Winter days and nights

- ❖ Temperature comes down
- ❖ Medium Temperature

Monsoons

- ❖ Temperature is in medium range
- ❖ RH is Very High

ENERGY SAVING PROJECT

A 15000 TPA spinning mill in India has optimized its humidification system based on the below explanation.

HUMIDIFICATION PLANT PUMPS

Valve throttling can be avoided in the pumps. Economical feasibility of installing a VFD or installing a new energy efficient pump should be considered. Valve throttling as is an inefficient way of controlling the flow, part of energy goes as waste in overcoming the pressure drop across the valve.

ENTHALPY CONTROL SYSTEM

In any humidification unit ambient condition plays a major role in the power consumption. The intake quantity of fresh air and return air depends on the enthalpy values of the ambient and return air. An enthalpy control system sense and compares the fresh air and returns air enthalpies and adjusts the damper positions accordingly in such a way that the enthalpy of resultant air should be minimum. In this way it will reduce the load on the pump during favourable conditions.

HUMIDIFICATION PLANT SUPPLY AIR AND RETURN AIR FANS

Supply air fans and return air fans are the major consumer of energy in any Humidification plant. The major function of supply air fans and return air fans are to maintain the desired temperature inside the plant room. These fans are designed for peak ambient conditions, however for the favourable conditions like winters and summer nights excess circulation leads to lowering of temperature which in turn leads to higher power consumption.

Variable frequency drive was installed to the fan and a close loop feedback based on the room temperature was given to VFD. VFD will increase or decrease the speed of fan based on the room temperature and optimize the power consumption.

As a thumb rule 50% decrease in speed of the fan will lead to reduction of power consumption by 75%.

POTENTIAL FOR REPLICATION

There is a good potential to conserve energy in whole of the Textile sector by optimizing humidification system in the plant.

OPTIMIZE THE POWER CONSUMPTION OF HUMIDIFICATION PLANT ***(Reference plant :* 15000 TPA Spinning Mill*)***		
	Without PAT	With PAT benefit
Energy savings	Rs 3.29 million	Rs 3.29 million
MTOE equivalent	55	55
PAT benefit[15]	--	Rs 0.55 million
Total benefit	Rs 3.29 million	Rs 3.84 million
Investment	Rs 7.34 million	Rs 7.34 million
Payback period	39 months	31 months
Replication Potential		
Number of plants	30% of spinning mills	
MTOE Savings for the entire sector	4750	

[15] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY – 2

REPLACE ALUMINIUM BLADES WITH FRP BLADES FOR HUMIDIFICATION PLANT

BACKGROUND

The atmospheric conditions with respect to temperature and humidity play very important part in the manufacturing process of textile yarns and fabrics. The properties like dimensions, weight, tensile strength, elastic recovery, electrical resistance, rigidity etc. of all textile fibre whether natural or synthetic are influenced by Moisture Regain.

Moisture regain is the ratio of the moisture to the bone-dry weight of the material expressed as a percentage. Many properties of textile materials vary considerably with moisture regain, which in turn is affected by the ambient Relative Humidity (RH) and Temperature. If a dry textile material is placed in a room with a particular set of ambient conditions, it absorbs moisture and in course of time, attains equilibrium.

Air moving devices are always broken into two halves, 1. Return Air fans and 2.Supply Air fans. The return air fans return the air to the plant room from where it may circulated or exhausted in the mill The supply air fans- supply air to the mill from the plant room. Air washer is a device for intimately mixing water and air. The intimate contact between these two elements is best brought about- for this application- by drawing air through a spray chamber in which atomized water is kept in transit.

Humidification plants are catering to the RH and temperature requirement at different sections. The humidification plant consists of a set of Supply & Return air fans. These Humidification plants generally have aluminium blades for air washer fans.

The recent FRP blades have improved aerodynamic characteristics and are much more energy efficient as compared to Aluminium blades. There is a good potential to replace aluminium blades with FRP blades. This would reduce the power consumption of the fans by 15 - 20%.

ENERGY SAVING PROJECT

A 15000 TPA spinning mill in India has saved 20% of energy by replacing aluminium blade fans with FRP blade fans in humidification plants.

REPLICATION POTENTIAL

Typically this can be implemented in spinning and weaving department of the textile sector and has a good potential to reduce the energy consumed by fans in the humidification plants.

Replace Aluminium Blades With FRP Blades For Humidification Plant Supply And Return Air Fans *(Reference plant : 15000 TPA Spinning Mill)*		
	Without PAT	With PAT benefit
Energy savings	Rs 1.09 million	Rs 1.09 million
MTOE equivalent	18	18
PAT benefit[16]	--	Rs 0. 18 million
Total benefit	Rs 1.09 million	Rs 1.27 million
Investment	Rs 2.00 million	Rs 2.00 million
Payback period	22 months	19 months
Replication Potential		
Number of plants	30% of spinning mills	
MTOE Savings for the entire sector	2000	

[16] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY – 3

INSTALL ENERGY EFFICIENT PNUEMAFIL FANS IN RING FRAMES

BACKGROUND

The main function of the pnuemafil fans in Ring frame machine is to remove fluff from cotton fiber threads and preparing cones of yarn, which is further used for preparation of yarn beams. Normally 5 – 7.5 kW motor is installed for Pnuemafil fan of Ring Frame machine, and conventional pnuemafil fan consumes 4.1 – 4.5 kW. Nowadays energy efficient fan with suction tube is available which are specially designed and can reduce power consumption atleast by 20%.

ENERGY SAVING PROJECT

A 15000 TPA spinning mill in India has replaced Pneumafill fans with energy efficient fans and has achieved energy savings to the tune of 20% per fan.

Comparison

❖ **For G 5/1 Ring Frames**

Table 8 Comparison on Conventional Pneumafil fan and Energy Efficient Fan

S. No.	Special Features	Conventional Pneumafil Fans	Energy Efficient Fans	
1	Weight	14 kgs	6.5 kgs	6.2 kgs
2	Fan Diameter	490 mm	460 mm	420 mm
3	kWh consumed	5.00	3.97	2.41

***Comparative study on Impeller and Suction tube**

Table 9 Comparison on conventional fan and energy efficient fan

Spindle No.	Conventional Fan 490 mm dia with suction tube	Energy Efficient fan with 490 mm dia and suction tube	Energy Efficient fan with 490 mm dia and suction tube
(OE) 505	115	150	110
(Middle) 751	50	100	70
(GE) 1008	30	85	60

Energy efficient pneumafil fans for ring frame machines and energy conservation to a tune of 3 kW/fan was obtained.

INSTALL ENERGY EFFICIENT PNUEMAFIL FANS IN RING FRAMES (Reference plant : 15000 TPA Spinning Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs 3.00 million	Rs 3.00 million
MTOE equivalent	51	51
PAT benefit[17]	--	Rs 0.51
Total benefit	Rs 3.00 million	Rs 3.00 million
Investment	Rs 2.00 million	Rs 2.00 million
Payback period	8 months	7 months
Replication Potential		
Number of plants	40% of Spinning mill	
MTOE Savings for the entire sector	7800 MTOE	

[17] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 4

INSTALL VFD FOR AUTOCORO SUCTION MOTOR

BACKGROUND

In the spinning department, autocoro machine is used for manufacturing yarn. Autocore machine draws cotton rope and prepares finer count yarn (7s / 16s / 2 X 50s / 2 X 40s etc.) which is further used as raw material for processing in process department. Autocoro machine is used to get required count of the yarn and in the process it removes fluff and other impurities from the yarn.

Normally, based on type of count, constant suction pressure is maintained in the suction box of autocoro machine. Suction pressure is varies with the count of the yarn. The maximum suction pressure required is 85 mbar, which is sufficient for the process. But due to accumulation of fluff in suction box and choking of suction net suction pressure is varied or maintained high. As a very high suction pressure is maintained the power consumption of the Autocoro suction motor is high.

ENERGY SAVING PROJECT

A 15000 TPA synthetic yarn unit in India has optimized the operation of autocoro suction motor. Variable frequency drive was installed for autocoro suction motor and a feedback signal was linked with the suction pressure which made the suction motor operate at a lower speed.

INSTALL VFD FOR AUTOCORO SUCTION MOTOR (Reference plant : 15000 TPA Spinning Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs 1.87 million	Rs 1.87 million
MTOE equivalent	27	27
PAT benefit[18]	--	Rs 0.27
Total benefit	Rs 1.87 million	Rs 2.14 million
Investment	Rs 3.00 million	Rs 3.00 million
Payback period	20 months	17 months
Replication Potential		
Number of plants	40% of Spinning mill	
MTOE Savings for the entire sector	2400 MTOE	

[18] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 5

INSTALL VARIABLE FREQUENCY DRIVE FOR WATER CIRCULATING PUMPS OF JET DYEING MACHINE

BACKGROUND

A dyeing machine which dyes the cloth by forcibly contacting the jet flow of dyestuff solution is called jet dyeing machine. It executes efficient dyeing in such a manner that the tension on the cloth is decreased as much as possible, and that the cloth dyes evenly with a relatively small amount of dyestuff.

1) Dyestuff solution is partially taken in from the bath, and released from a venturi-tube into the flow of the dyestuff solution circulating through an enclosed bent passage.

2) The cloth is guided into the central zone of the circulating dyebath, conveyed through the bath, and dyed.

3) As the cloth is naturally circulated along the flow, the tension of the cloth is much decreased from that of other dyeing methods.

The Jet dyeing machines are used for washing and dyeing the fabrics. For washing the fabrics hot water is circulated inside the jet-dyeing machine. A dedicated centrifugal pump for individual jet dyeing machine remains in continuous operation for circulating the hot water inside the machine

- During the washing process the pressure requirement for water circulation varies over a period of time. The initial pressure requirement for water circulation is in the range of 1-1.5 kg/cm2. For maintaining the required pressure a control valve provided at the outlet of the centrifugal pump is manually throttled based on the pressure gauge indication provided at the down side of the control valve. This condition prevails for atleast 30-35% of the batch time.

- During the washing process, as heating of water takes place in the jet dyeing machines the pressure gradually increases. After certain period of time the required pressure for water circulation is in the range of 2.0-2.5 kg/cm2. The pressure requirement and the time taken for washing varies depending upon the fabrics. During the maximum pressure requirement the control valve provided at the outlet of the pump is kept fully opened.

- When the valve is throttled, there is a significant pressure loss and hence energy loss occurs across the control valve. There is a good potential to save energy by avoiding the pressure loss across the control valve. This can be achieved by installing variable frequency drive for the centrifugal pumps. Instead of throttling the control valve the speed of the centrifugal pump has to be varied using the variable frequency drive to meet the required pressure.

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India has optimized water circulating pumps in Jet dyeing machine and has successfully achieved energy savings. Variable Frequency Drive was implemented for the centrifugal pump in each jet-dyeing machine and the control mechanism provided so as to reduce the speed of the pump to meet the required pressure. The valve throttling was totally eliminated by implementing this mechanism and thereby eliminating the pressure loss.

INSTALL VARIABLE FREQUENCY DRIVE FOR WATER CIRCULATING PUMPS OF JET DYEING MACHINE (Reference plant : 15000 TPA Spinning Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs 1.87 million	Rs 1.87 million
MTOE equivalent	27	27
PAT benefit[19]	--	Rs 0.27
Total benefit	Rs 1.87 million	Rs 2.14 million
Investment	Rs 3.00 million	Rs 3.00 million
Payback period	20 months	17 months
Replication Potential		
Number of plants	40% of Composite mill	
MTOE Savings for the entire sector	2400 MTOE	

[19] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 6

INSTALL WASTE HEAT RECOVERY SYSTEMS FOR STENTERS

BACKGROUND

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:

- Dry-heating process like, heat setting of synthetic fabrics and their blends
- Dry curing process namely, resin finishing with built-in catalysts
- Partial curing of pigments dyeing Stenters being a major energy consumer in a textile mill offers opportunities for energy conservation.

DRYING PROCESS

Drying is achieved by impinging high velocity air jets uniformly across the full width of the fabric on both sides. The air being used is heated to a temperature of about 140-150oC. The hot air is recalculated and a certain amount of air is continuously removed from the system through exhaust fans so as to avoid buildup of excessive humidity. To that extent, the system is supplemented by fresh air. The schematic of the drying process is shown below.

Figure 11 Waste heat recovery system for stenters

The stenters located in the processing section are major consumers of steam in any textile unit. The stenters are being used for drying, stretching and finishing. The fabric enters the stenters after the pre-drying cylinders with moisture of about 60 – 65 %. This moisture needs to be dried and vented out in the stenters. The stenters have normally two exhaust blowers which are operating continuously venting hot air & moisture at temperatures around 100 deg C. At the processing plant the jigger dyeing section needs hot water at temperatures ranging from 40 deg C to 80 deg C. Presently steam is being used for supplying this heat. There is a good potential to install waste-heat recovery systems for stenter exhaust and utilize this recovered heat for dyeing machines.

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India has installed waste heat recovery system for Stenters and has achieved energy saving of 20-30% in fuel consumption.

INSTALL WASTE HEAT RECOVERY SYSTEMS FOR STENTERS (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs 3.00 million	Rs 3.00 million
MTOE equivalent	70	70
PAT benefit[20]	--	Rs 0.7
Total benefit	Rs 3.00 million	Rs 3.70 million
Investment	Rs 5.50 million	Rs 5.50 million
Payback period	22 months	18 months
Replication Potential		
Number of plants	70% of Composite mill	
MTOE Savings for the entire sector	4700 MTOE	

[20] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 7

INSTALLATION OF HEAT RECOVERY SYSTEM IN MERCERISER MACHINES

BACKGROUND

A treatment of cotton yarn or fabric to increase its luster and affinity for dyes. The material is immersed under tension in a cold sodium hydroxide (caustic soda) solution in warp or skein form or in the piece, and is later neutralized in acid. The process causes a permanent swelling of the fiber and thus increases its luster. It is the process of treatment of cellulosic material with cold or hot caustic conditions under specific conditions to improve its appearance and physical as well as chemical properties.

PURPOSE OF MERCERIZING

- To improve the lusture
- To improve the strength
- To improve the dye uptake and moisture regain.

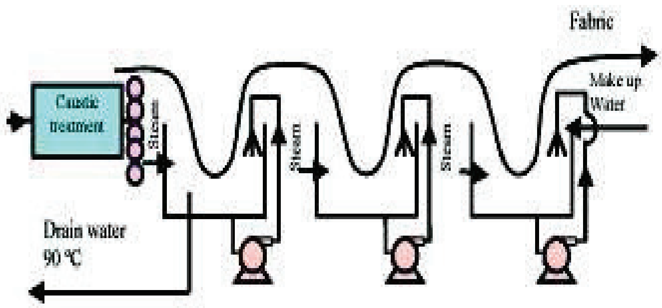


Figure 12 Mercerizing process

WHAT IS THE MERCERIZING PROCESS

The mercerizing involves these three subsequent steps,

1) Impregnation of the material in relaxed state, cold caustic solution of required strength and wettability.
2) Stretching while the material is still impregnated in the caustic solution.
3) Washing off the caustic soda from the material while keeping the material still in the stretch state.

Mercerizing is a very important stage of textile processing. It consists of treating the fabric in a stretched condition (fabric not allowed to shrink), with 270 grams/litre caustic soda solution giving a dwell time of 50 seconds. The Caustic is washed off while in the stretched stage. Residual caustic is washed with hot water using a counter current system.

The counter current washing consists of a series of water baths heated with steam. The baths are interconnected with each other. The fresh water make-up enters at one end while the spent water at about 90^{o}C is drained off at the other end. First sent to a filter and then to PTHE before draining at a temperature of 40^{o}C. A water pump was installed to pump make-up water at a temperature of 30^{o}C through the PTHE. The makeup water could be pre-heated to a temperature of 80^{o}C.

Figure 13 Plate heat exchanger for heat recovery in merceriser

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India has installed waste heat recovery system for Mercerize and has achieved energy saving of 20-30% in terms of fuel consumption.

The heat recovery system resulted in reduced steam consumption in the water baths, which in turn reduced the fuel (LSHS) input to the boiler to the tune of 122 tons/year. The addition of two water pumps (for two Mercerizes) increased the power consumption by a marginal 10 kW.

INSTALLATION OF HEAT RECOVERY SYSTEM IN MERCERISER MACHINES (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs 2.40 million	Rs 2.40 million
MTOE equivalent	120	120
PAT benefit[21]	--	Rs 1.20
Total benefit	Rs 2.40 million	Rs 3.60 million
Investment	Rs 1.00 million	Rs 1.00 million
Payback period	5 months	4 months
Replication Potential		
Number of plants	50% of the composite mills	
MTOE Savings for the entire sector	4700 MTOE	

[21] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 8

INSTALLATION OF VARIABLE SPEED DRIVE FOR WEIR WASH PUMP OF MERCERISING MACHINE

BACKGROUND

The mercerising operation is a very important process in textile processing. During the water washing stage, the water from each of the baths, is sprayed on the fabric, using small pumps.

Typically the delivery valves on the down stream of pumps are frequently throttled depending on the construction of the fabric. Any throttling operation results in energy loss, quantum depending on the extent of throttling.

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India has replaced weir wash pumps of Mercerising machines. All the ten pumps were fitted with variable speed drives (VSD) so as to control the speed and thereby the flow. Consequent to the installation of VSDs, delivery valves were kept fully open, thereby saving pressure loss across them.

PREVIOUS STATUS

Each machine had five baths with one pump each and total energy consumed by 10 pumps (from 2 machines) was recorded to be 22 units/hr.

PROJECT CONCEPT

The Flow control of a pump by throttling of delivery valve is a highly energy inefficient practice. The best method of control is by installing a variable speed drive and reducing the pump down-time.

The mill did not face any problem during installation of variable speed drives. The project was implemented in about a month’s time.

The company achieved the following benefits:

- Exact Matching of flow requirements
- Energy savings of 17 units/hr from 10 pumps
- Reduction in down time of pumps

INSTALLATION OF VARIABLE SPEED DRIVE FOR WEIR WASH PUMP OF MERCERISING MACHINE (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 0.35 million	Rs. 0.35 million
MTOE equivalent	6	6
PAT benefit[22]	--	Rs 0.06
Total benefit	Rs. 0.47 million	Rs. 0.53 million
Investment	Rs 0.90 million	Rs 0.90 million
Payback period	23 months	21 months
Replication Potential		
Number of plants	50% of Composite mills	
MTOE Savings for the entire sector	280 MTOE	

[22] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 9

REPLACEMENT OF ELECTRICAL HEATING IN POLYMERISER TO THERMIC FLUID HEATING

BACKGROUND

In a polymeriser machine, the cloth is exposed to air at a temperature of 160^{o}C for curing. Curing is important to improve the crease recovery properties of cotton fabrics. The air from a centrifugal blower passes through electrical heaters and the hot air is blown on the fabric. Electrical energy is a high-grade energy, which is normally recommended for temperatures above 300^{o}C. The cost of electrical heating is about 3 to 4 times that of thermal heating. Thermic fluid heating (based on oil or coal) is a very economical option, which is being followed in many industries.

In switching over to thermic fluid heating, it is not necessary to remove the electrical heaters. The electrical heaters can be kept as stand-by. When the thermic fluid system is taken for maintenance, electrical heating system can serve as a stand-by.

A polymeriser machine generally has a temperature requirement of 160^{o}C. The connected load is around 10 kW. The failure rate of heaters is high in addition to the high cost of energy consumption.

A good potential exits to save energy by using waste process heat or full utilization of boiler capacities to replace electrical heating with thermal heating.

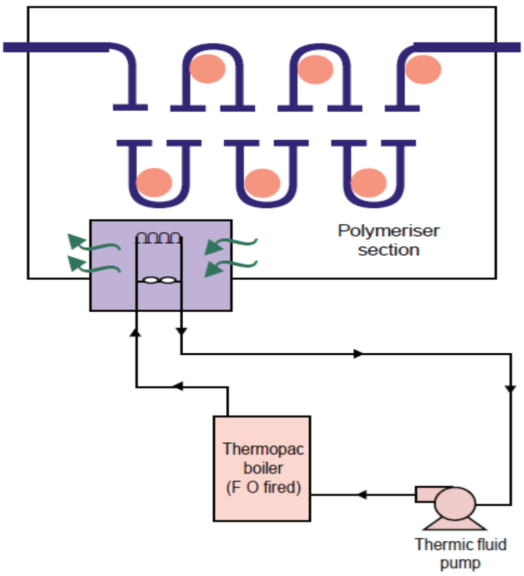


Figure 14 Schematic of thermic fluid heating in polymeriser

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India has replaced electrical heating with thermal heating for polymeriser. The project was implemented in about a month's time. The quality of curing was observed to be the same.

In the proposed plant a thermic fluid heater used for stenters had an additional capacity. Thermic fluid coils were installed in the polymeriser machine in place of the electrical heaters, which could achieve the temperature of 160^{0}C. The quality of the fabric was also not affected.

BENEFITS

The mill team achieved two benefits

- Energy cost savings
- Elimination of maintenance / replacement of electrical heaters

REPLACEMENT OF ELECTRICAL HEATING IN POLYMERISER TO THERMIC FLUID HEATING (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 0.20 million	Rs. 0.20 million
MTOE equivalent	6	6
PAT benefit[23]	--	Rs 0.06
Total benefit	Rs. 0.20 million	Rs. 0.23 million
Investment	Rs 0.04 million	Rs 0.04 million
Payback period	3 months	2 months
Replication Potential		
Number of plants	50% of Composite mills	
MTOE Savings for the entire sector	140 MTOE	

[23] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 10

HEAT RECOVERY IN BLEACHING RANGE

BACKGROUND

Bleaching is a chemical treatment employed for the removal of natural coloring matter from the substrate. The source of natural color is organic compounds with conjugated double bonds , by doing chemical bleaching the discoloration takes place by the breaking the chromophore , most likely destroying the one or more double bonds with in this conjugated system. The material appears whiter after the bleaching.

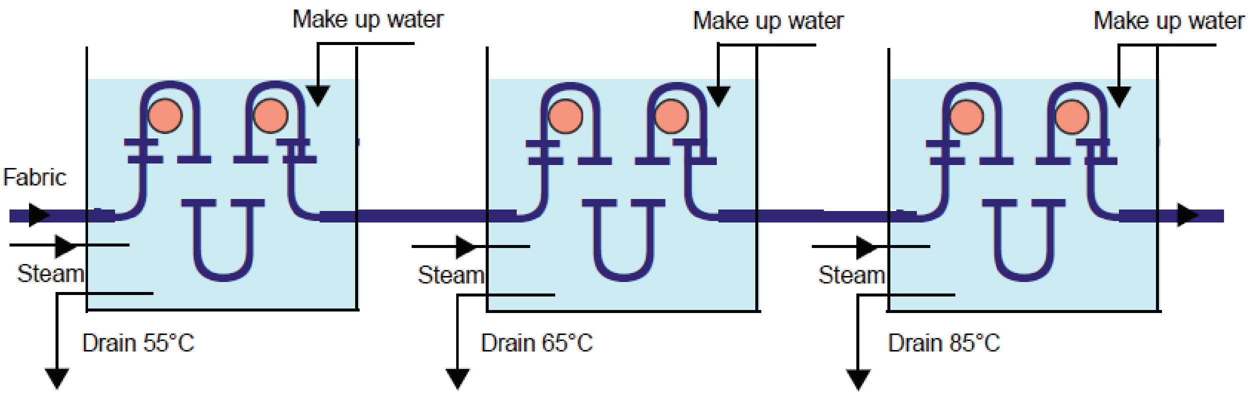


Figure 15 Water & Steam Flow Diagram in bleaching system

Natural fibres, i.e. cotton, wool, linen etc. are off-white in colour due to colour bodies present in the fibre. The degree of off-whiteness varies from batch-to-batch. Bleaching therefore can be defined as the destruction of these colour bodies. White is also an important market colour so the whitest white has commercial value. Yellow is a component of derived shades. For example, when yellow is mixed with blue, the shade turns green. A consistent white base fabric has real value when dyeing light to medium shades because it is much easier to reproduce shade matches on a consistent white background than on one that varies in amount of yellow.

Bleaching may be the only preparatory process or it may be used in conjunction with other treatments, e.g. desizing, scouring and mercerizing. The combination of such treatments for an individual situation will depend on the rigorousness of the preparation standard and economic factors within the various options. Other chemicals will be used in addition to the bleaching agent. These serve various functions such as to activate the bleaching system, to stabilize or control the rate of activation, to give wetting and detergent action, or to sequester metallic impurities. This section gives consideration to the selection of bleaching agents and to the role of the various chemicals used in conjunction.

During the bleaching process, the fabric is treated with sodium hypochlorite or hydrogen peroxide. After bleaching the cloth is thoroughly washed in a series of baths. The baths are maintained at different temperatures by direct injection of steam. The initial temperature of water required is 55°C and final temperature 85°C.The hot water is generated by direct injection of steam. The used water in the baths was being drained separately at different temperatures. The schematic of the system is shown below:

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India has installed waste heat recovery system for bleaching range. The mill installed a project to recover the heat in the drain water. The schematic of the project is shown below:

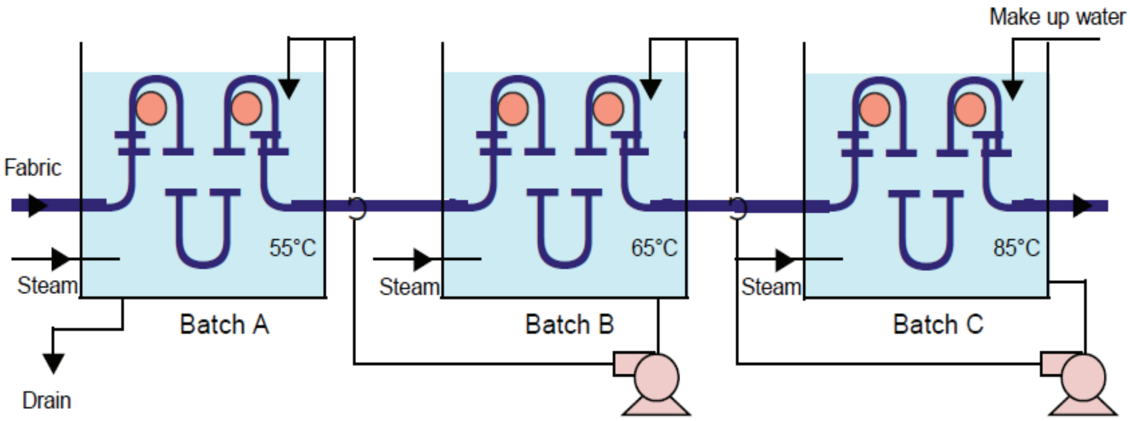


Figure 16 Waste heat recovery system installed in bleaching system

The temperature of drain water which is at 85°C in Bath C is pumped to the Bath B .From Bath B at 65°C, the water is pumped to Bath A. Finally, the water from Bath A is drained at 55°C; this resulted in lower steam consumption in the Bleaching range.

IMPLEMENTATION STATUS

The project was implemented in about 3 month's time without affecting production. The energy saving was in the steam consumption amounting to 12 T/day.

The plant achieved 3-fold benefits:

- Reduced steam consumption
- Substantial savings in make-up water quantity
- Reduction of load in the effluent treatment plant

HEAT RECOVERY IN BLEACHING RANGE (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 2.20 million	Rs. 2.20 million
MTOE equivalent	100	100
PAT benefit[24]	--	Rs 1.00 million
Total benefit	Rs. 2.20 million	Rs. 3.20 million
Investment	Rs 0.4 million	Rs 0.4 million
Payback period	3 months	2 months
Replication Potential		
Number of plants	50% of Composite mills	
MTOE Savings for the entire sector	4800 MTOE	

[24] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 11

INSTALLATION OF PHOTOCELLS FOR SPEED FRAMES

BACKGROUND

Speed frames are provided with pneumafil suction arrangement near the front roller. Whenever any breakage of roving occurs at the suction keeps drawing the rove till the break is detected, frame stopped and the ends are connected again. This leads to roving losses in addition to the energy consumption for the pneumafil blower.

A photocell detector is installed to detect front breakages. Whenever the photocell detects breakage, the machine is stopped. The operator will then connect the broken rove and restart the machine. This totally eliminates the requirement of the Pneumafil blower and also roving losses.

However, if this concept is adopted during the project stage itself, the investment on Pneumafil blowers can be avoided. The benefits achieved were 2-fold:

- 100 % energy savings by avoiding the pneumafil blowers
- Reduction in roving losses breakages.

ENERGY SAVING PROJECT

A 15000 TPA spinning mill in India has installed photocells for speed frames and has achieved specific energy consumption reduction of 0.05 kWh/kg. The project has been implemented without any loss of production. The time taken to install this in all the 5 machines was about 4 weeks.

INSTALLATION OF PHOTOCELLS FOR SPEED FRAMES (Reference plant : 15000 TPA Spinning Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 0.24 million	Rs. 0.24 million
MTOE equivalent	4	4
PAT benefit[25]	--	Rs 0.04 million
Total benefit	Rs. 0.24 million	Rs. 0.28 million
Investment	Rs 0.4 million	Rs 0.4 million
Payback period	2 months	2 months
Replication Potential		
Number of plants	30% of Spinning mills	
MTOE Savings for the entire sector	460 MTOE	

[25] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 12

INSTALLATION OF TIC CONTROL FOR PROCESSING MACHINES

BACKGROUND

In textile processing, there are a number of machines viz., washers, jiggers, etc., which need hot water at about 85°C. The heating of water is by direct injection of steam. If the temperature monitoring is manually done, the temperature of the water bath can go as high as 95°C, resulting in excess consumption of steam. If the temperature of the bath can be auto-controlled substantial savings in steam can be achieved.

The schematic of the control is shown below:

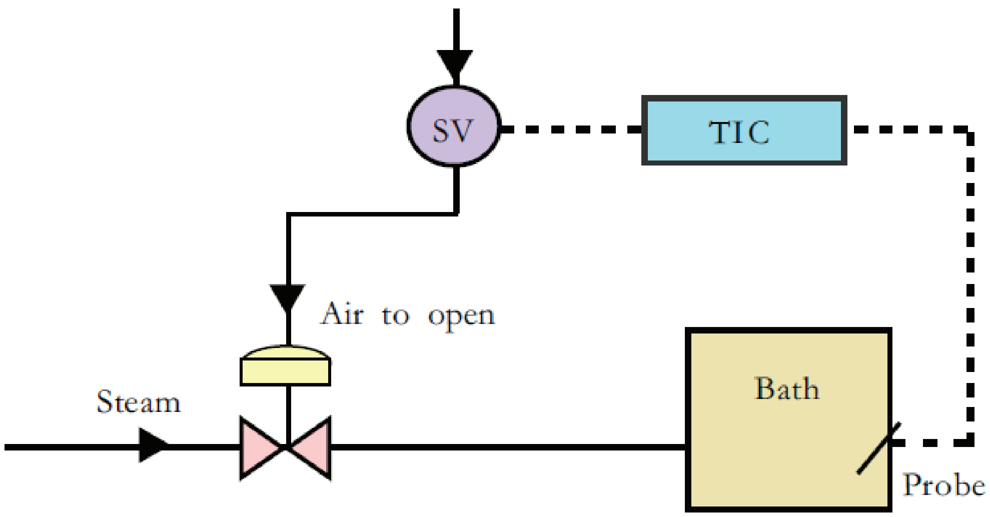


Figure 17 Schematic diagram of TIC controller for processing

ENERGY SAVING PROJECT

A 15000 TPA spinning mill has installed TIC control and has successfully achieved reduction in energy consumption.

IMPLEMENTATION STATUS

TIC system was installed in 30 machines viz., washers, jiggers, merceriser, and cheese dyeing machines. The implementation was completed in a month's time.

The Temperature Indicating Controller (TIC) is set to a temperature of 85°C. When the temperature of the bath goes above 85°C, a signal is sent to the steam control valve to close. The probe continuously senses the temperature of the bath, and the steam control valve is accordingly regulated.

INSTALLATION OF TIC CONTROL FOR PROCESSING MACHINES (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 0.24 million	Rs. 0.24 million
MTOE equivalent	5	5
PAT benefit[26]	--	Rs 0.04 million
Total benefit	Rs. 0.24 million	Rs. 0.28 million
Investment	Rs 0.3 million	Rs 0.3 million
Payback period	9 months	8 months
Replication Potential		
Number of plants	30% of composite mills	
MTOE Savings for the entire sector	570 MTOE	

[26] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 13

OPTIMIZATION OF BALLOON SETTINGS IN TFO MACHINES

BACKGROUND

The process of twisting and doubling is an indispensable means of improving certain yarn properties and satisfying textile requirements that cannot be fulfilled by a single yarn. The method of twisting two or more single yarns is called doubling, folding or ply twisting. Such yarns are designated as doubled yarn, folded yarn or plied yarn and the machines which conduct this work are called doublers, ply-twisters or two-for-one (TFO) twisters.

Traditionally, ring doublers were used for ply twisting spun yarns and uptwisters were used for twisting filament yarns. Nowadays, TFO twisters are gaining world-wide acceptance in both the spun yarn and filament yarn sectors mainly because of their inherent advantages like the production of long lengths of knot-free yarns, which facilitates better performance in the subsequent processes and results in higher productivity.

In two-for-one twisting machines,the balloon tension of yarn accounts for about 50% of total energy consumption. The balloon diameter can be reduced with a reduction in yarn tension. This measure saves about 4% of total energy consumption in TFOs.

It has been observed that TFOs consume less electricity at lower balloon settings. Balloon size can be optimized by taking account of various studies with respect to different yarn counts.

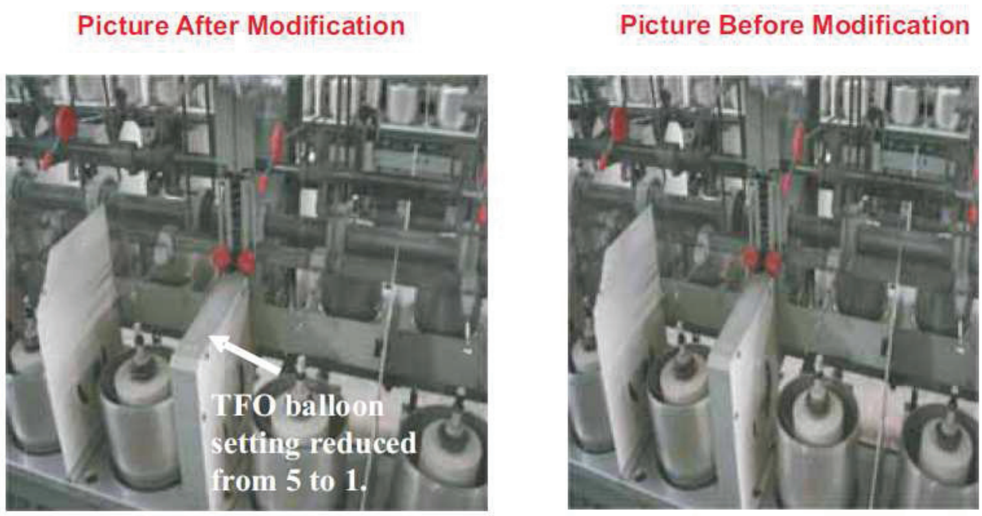


Figure 18 Optimization of Balloon Settings in TFO Machines after & Before Modification

ENERGY SAVING PROJECT

A 15000 TPA spinning mill has optimized balloon settings in spinning mills to achieve energy savings in TFO machines to the tune of 4%.

OPTIMIZATION OF BALLOON SETTINGS IN TFO MACHINES (Reference plant : 15000 TPA Spinning Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 1.30 million	Rs. 1.30 million
MTOE equivalent	22	22
PAT benefit[27]	--	Rs 0.22 million
Total benefit	Rs. 1.30 million	Rs. 1.52 million
Investment	Nil	Nil
Payback period	Immediate	Immediate
Replication Potential		
Number of plants	30% of Spinning mills	
MTOE Savings for the entire sector	2500 MTOE	

[27] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 14

INSTALLATION OF SYNTHETIC FLAT BELTS FOR SPINNING RING FRAMES

BACKGROUND

In a composite textile mill, spinning ring frames are major energy consumers. They consume as high as 30% of the total energy of the mill. In a spinning mill, the consumption of the ring frames can be as high as 60% of the total energy consumption. Any effort to save energy in this area contributes in reducing the overall energy consumption. Conventionally, ring frame drives are fitted with V-belts, where the slippage losses are high, due to the wedging effect. The wearing out of all the belts is not uniform, resulting in uneven tension, which has to be checked and corrected periodically.

The present trend is to go for synthetic flat belts,which are nylon sandwiched belts. These belts have the following advantages:

- ❖ No slippage losses.
- ❖ The elasticity of the belt being higher, frequent tensioning of belt is eliminated
- ❖ The transmission efficiency of V-belts is about 88% vis-a-vis 98% obtainable in synthetic flat belts.

While switching over from V-belts to synthetic flat belts, it is necessary to change the pulleys, to ones of appropriate size.

Figure 19 Synthetic flat belts for ring frames

ENERGY SAVING PROJECT

A 15000 TPA spinning mill has installed synthetic flat belts in Spinning ring frames machines and reduced power consumption for 92 ring frame machines and has reduced 15 units/day/per ring frame. The machines were driven by 12.5 HP for slow speed operation and 17.5 HP for high-speed operation.

INSTALLATION OF SYNTHETIC FLAT BELTS FOR SPINNING RING FRAMES (Reference plant : 15000 TPA Spinning Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 1.30 million	Rs. 1.30 million
MTOE equivalent	30	30
PAT benefit[28]	--	Rs 0.22 million
Total benefit	Rs. 1.30 million	Rs. 1.52 million
Investment	Rs 0.25 million	Rs 0.25 million
Payback period	2 months	2 months
Replication Potential		
Number of plants	30% of Spinning mills	
MTOE Savings for the entire sector	3400 MTOE	

[28] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

TECHNOLOGY - 15

DYEING TEXTILES WITH SUPERCRITICAL CARBON DIOXIDE

BACKGROUND

The supercritical CO_2 uses less energy than conventional dyeing process. Due to the raising costs of energy and water this system can be used to reduce both energy and water with an environmentally friendly solution. Carbon capture and storage can be effective for a system which is using CO_2 supercritical process.

Advantages of Supercritical CO_2 :

- Low energy consumed for heating the dye liquor
- Drying process is not required
- Inexhaustible source (atmosphere, combustion processes, and natural geologic deposits)
- Biodegradable as a nutrient promoting plant growth
- No disposal problems – Can be collected from the process as an uncontaminated gas and can be reused
- Higher diffusion rate of supercritical CO_2 with polymers
- Lower viscosity making the dye circulation faster
- Non exhausted dye stuff is recuperated in the form of a powder
- No need for auxiliary agents, disposing agents, adulterants, etc.

Supercritical fluid CO_2, polyester and other synthetics can be dyed with modified disperse dyes. The supercritical fluid CO_2 causes the polymer fibre to swell allowing the disperse dye to easily diffuse within the polymer, penetrating the pore and capillary structure of the fibres. The viscosity of the dye solution is lower, making the circulation of the dye solutions easier and less energy intensive. This deep penetration provides effective coloration of polymers which are characteristically hydrophobic. Dyeing and removing excess dye are processes that are done in the same vessel. Residue dye is minimal and may be extracted and recycled.

BENEFITS ACHIEVED

Supercritical CO_2 dyeing has reduced energy consumption due to the following reasons:

- Higher heat capacity of Supercritical CO_2 heating the dye liquor faster
- Low viscosity of the dye liquor
- No post treatment required

ENERGY SAVING PROJECT

A 15000 TPA composite mill in India is considering implementing this emerging technology of supercritical CO_2. This technology can be used for Dyeing of polyesters and other synthetics. Supercritical CO_2 reduces power consumed for dyeing by 30% of conventional Dyeing. This can be implemented in textile process industries.

DYEING TEXTILES WITH SUPERCRITICAL CARBON DIOXIDE (Reference plant : 15000 TPA Composite Mill)		
	Without PAT	With PAT benefit
Energy savings	Rs. 3.20 million	Rs. 3.20 million
MTOE equivalent	275	275
PAT benefit[29]	--	Rs 2.75 million
Total benefit	Rs. 3.20 million	Rs. 5.95 million
Investment	Rs 13.00 million	Rs 13.00 million
Payback period	49 months	27 months
Replication Potential		
Number of plants	80% of Spinning mills	
MTOE Savings for the entire sector	39000 MTOE	

[29] PAT benefits calculated based on the MTOE Savings. One MTOE equals Rs.10154 for the year 2011-12 as per the PAT notification. Refer Annexure 2 for detailed calculation.

5.0 FUTURE ENERGY SAVING OPPORTUNITIES

Bio Tech Textiles[30]

Biotechnology defined as the application of living organisms and their components to industrial products and processes is not an industry in itself, but an important technology that will have a large impact on many different industrial sectors in the future.

The major application of Biotech Textiles focuses on

- Improvement of plant varieties used in the production of textile fibres and in fibre properties.
- Improvement of fibres derived from animals and health care of the animals.
- Novel fibres from biopolymers and genetically modified micro-organisms
- Replacement of harsh and energy demanding chemical treatments by enzymes in textile processing
- Environmentally friendly routes to textile auxiliaries such as dyestuffs
- Novel uses for enzymes in textile finishing
- Development of low energy enzyme based detergents
- New diagnostic tools for detection of adulteration and Quality Control of textiles
- Waste management

[30] Fibre2fashion : http://www.fibre2fashion.com/industry-article/technology-industry-article/biotech-textiles/biotech-textiles1.asp

6.0 COST ABATEMENT CURVE

Table 10 List of Energy Saving options for a reference plant

	Description of proposal	Investment, Rs/MTOE	savings, MTOE
A	OPTIMIZATION OF BALLOON SETTINGS IN TFO MACHINES	0	22
B	REPLACEMENT OF ELECTRICAL HEATING IN POLYMERISER TO THERMIC FLUID HEATING	4000	6
C	HEAT RECOVERY IN BLEACHING RANGE	8333	100
D	INSTALLATION OF HEAT RECOVERY SYSTEM IN MERCERISER MACHINES	8333	120
E	INSTALLATION OF SYNTHETIC FLAT BELTS FOR SPINNING RING FRAMES	8413	30
F	INSTALL ENERGY EFFICIENT PNUEMAFIL FANS IN RING FRAMES	39216	51
G	DYEING TEXTILES WITH SUPERCRITICAL CARBON DIOXIDE	47273	275
H	INSTALLATION OF TIC CONTROL FOR PROCESSING MACHINES	60000	5
I	INSTALL WASTE HEAT RECOVERY SYSTEMS FOR STENTERS	78571	70
J	INSTALLATION OF PHOTOCELLS FOR SPEED FRAMES	100000	4
K	REPLACE ALUMINIUM BLADES WITH FRP BLADES FOR HUMIDIFICATION PLANT SUPPLY AND RETURN AIR FANS	111111	18
L	INSTALL VFD FOR AUTOCORO SUCTION MOTOR	111111	27
M	INSTALL VARIABLE FREQUENCY DRIVE FOR WATER CIRCULATING PUMPS OF JET DYEING MACHINE	111111	27
N	OPTIMIZE THE POWER CONSUMPTION OF HUMIDIFICATION PLANT	133455	55
O	INSTALLATION OF VARIABLE SPEED DRIVE FOR WEIR WASH PUMP OF MERCERISING MACHINE	300000	3

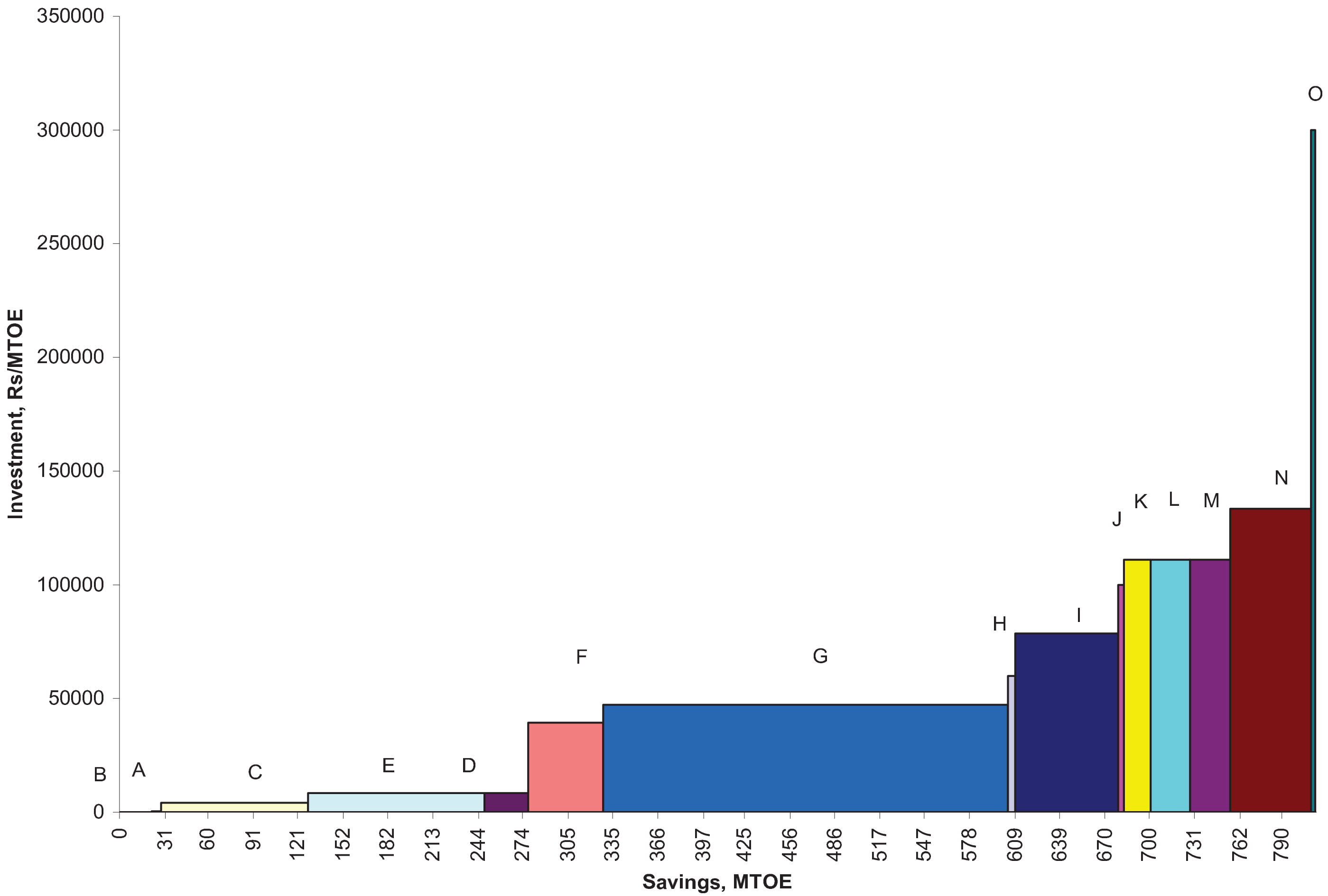


Figure 1 Cost curve : Investment vs Savings in MTOE of proposed projects

7.0 CONCLUSION

PAT is an opportunity to prioritize the energy reduction project that offers shorter pay-back period. PAT also helps in the reducing the input cost of the product thereby designated consumers can increase their competitiveness in the global market. With the increase in investments in the Indian textile sector, the subsequent increase in the industrial production, and the positivity observed by the Textile sector has resulted in progress and development of the sector.

Textile has its diverse classification of plants such as spinning, weaving, dyeing, processing. In order to include all these parts of the industry a 15000 TPA composite mill is taken as reference. By implementing the proposals in this compendium it can be said that the Textile sector can achieve 813 MTOE savings.

Developing a technology compendium on Textile Sector is a small effort to assist designated consumers in formulating resilient actions to achieve their PAT targets. The exhaustive list of 15 energy saving projects would give directions to designated consumers to focus on energy conservation projects.

Integrating the spectral needs and continued investments with technical advancements will completely modernize the industry chains across the country, and further assist in reaping benefits for the Indian Textile sector.

Apart from that, few other options like installation of high-efficient motors, installation of High efficient fans, optimization of the design of a pumping system, optimization of compressed air systems and lighting system efficiency improvement would result in enormous energy savings.

Reduction in resource intensity along with improved operational efficiency will be one of the key drivers for the industry to grow at a steady pace and thereby being global competitive.

Annexure – 1:GHG INVENTORIZATION

The Indian Textile Industry has a Green House gas emission of 1.8679 million tonnes of CO2 equivalent for the year 2007[31]. Assuming that the technological intervention in the past five years has not significantly changed the energy efficiency of textile industry the emission for 2012 is estimated as 2.2 million tonnes of CO_2.

Out of the projects mentioned around 0.31 million MTOE of the share in total energy savings for the sector is electrical. The rest share of thermal energy consumption is 0.49 million MTOE. The electricity emission factor is 10.6 Tonnes of CO_2/MTOE. For thermal energy savings a factor of 3.86 Tonnes of CO_2/MTOE is considered[32]. The entire sector emissions for all the listed projects comes to 0.51 million tonnes of CO_2, which is around 23.7% of the estimated absolute emissions of 2.20 million tonnes of CO_2 equivalent.

Table 11 Technology wise saving potential

Description of proposal	Sectoral savings, MTOE	Sectoral Savings MTOE	Thermal / Electrical savings	Multiplication factor	Tons of CO2 equivalent saved
OPTIMIZATION OF BALLOON SETTINGS IN TFO MACHINES	22	2500	Electrical	10.60	26500
REPLACEMENT OF ELECTRICAL HEATING IN POLYMERISER TO THERMIC FLUID HEATING	6	140	Thermal	3.86	541
HEAT RECOVERY IN BLEACHING RANGE	100	4800	Thermal	3.86	18536
INSTALLATION OF HEAT RECOVERY SYSTEM IN MERCERISER MACHINES	120	4700	Electrical	10.60	49820
INSTALLATION OF SYNTHETIC FLAT BELTS FOR SPINNING RING FRAMES	30	3400	Electrical	10.60	36040
INSTALL ENERGY EFFICIENT PNUEMAFIL FANS IN RING FRAMES	51	7800	Electrical	10.60	82680
DYEING TEXTILES WITH SUPERCRITICAL CARBON DIOXIDE	275	39000	Thermal	3.86	150602
INSTALLATION OF TIC CONTROL FOR PROCESSING MACHINES	5	570	Thermal	3.86	2201
INSTALL WASTE HEAT RECOVERY SYSTEMS FOR STENTERS	70	4700	Thermal	3.86	18149
INSTALLATION OF PHOTOCELLS FOR SPEED FRAMES	4	460	Electrical	10.60	4876

[31] India Green House gas emissions 2007
[32] Refer Annexure – 2 for calculation

REPLACE ALUMINIUM BLADES WITH FRP BLADES FOR HUMIDIFICATION PLANT SUPPLY AND RETURN AIR FANS	18	2000	Electrical	10.60	21200
INSTALL VFD FOR AUTOCORO SUCTION MOTOR	27	2400	Electrical	10.60	25440
INSTALL VARIABLE FREQUENCY DRIVE FOR WATER CIRCULATING PUMPS OF JET DYEING MACHINE	27	2400	Electrical	10.60	25440
OPTIMIZE THE POWER CONSUMPTION OF HUMIDIFICATION PLANT	55	4750	Electrical	10.60	50350
INSTALLATION OF VARIABLE SPEED DRIVE FOR WEIR WASH PUMP OF MERCERISING MACHINE	3	280	Electrical	10.60	2968

The GHG emissions for the reference plant is estimated and listed in the Table 11. The reader may understand that all the energy saving proposals mentioned need not be implemented in the reference plant of 15000 TPA considered. Therefore, adding up all the GHG emissions may be misleading for a reference plant.

Annexure - 2: BASIS OF SAVINGS ESTIMATION/SAMPLE CALCULATION

Basis for calculation:

Operating hours of the plant	=	8000 hrs
Plant size	=	10000 TPA
Cost of electrical energy	=	Rs. 3.50 / kWh
1 MTOE value	=	Rs. 10,154

Sample Calculation:

Savings without PAT

Energy saved	=	50 kW
Annual savings	=	50 kW X Rs. 3.50 / kWh X 8000 hrs
	=	Rs. 1.40 million kWh/ annum
Investment	=	Rs. 2.00 million
Payback	=	Rs. 2.00 million / Rs. 1.40 million X 12 months
	=	18 months

Savings with PAT

Energy saved	=	50 kW
Annual savings	=	50 kW X Rs. 3.50 / kWh X 8000 hrs
	=	Rs. 1.40 million / annum
MTOE saved	=	50kW x 8000 hours
	=	400000 kWh
	=	400000 kWh X 860 kCal/kWh

	=	344 million kWh
	=	34 MTOE
MTOE savings	=	34 X Rs. 10, 154 / MTOE
	=	Rs. 0.34 million

Miscellaneous:

1 kWh	=	860 kCal
1 MTOE	=	10^7 kCal

Cost of heat (sample calculation):

1 Mtoe	=	1 * 10^7 kcal
1 Mtoe	=	Rs. 10154[33]
Annual coal savings	=	5000 kg
Calorific value	=	6000 kcal / kg
Kcal savings	=	5000 kg * 6000 kcal / kg
	=	30000000 kcal
Mtoe savings	=	30000000 kcal / 1 * 107 kcal
	=	3 Mtoe
Annual cost savings	=	Rs. 10154 / Mtoe * 3 Mtoe
	=	Rs. 30462

[33] BEE PAT notification

Calculation of GHG emissions:

GHG emission depends on the type of fuel being used i.e.., coal, diesel, furnace oil or electricity. Emission reduction for a particular project has been arrived on the basis of CO_2 emitted per MTOE.

If a process runs only with electricity, then CO_2 emitted per MTOE is calculated as follows:

Electricity (1 kWh)	=	860 kcal
Electricity emission factor	=	0.91 kg of CO_2/kwh
1 MTOE	=	10^7 kcal
kWh / MTOE	=	10^7 kcal / 860 kcal
	=	11627.9 kwh / MTOE
Tons of CO_2 / MTOE	=	0.91 kg of CO_2/kWh[34] x 11627.9 kWh / MTOE
	=	10.6 MT of CO_2 / MTOE

Similarly,

Coal	=	4.2 tons of CO_2 / MTOE
Oil products	=	2.8 MT of CO_2 / MTOE

The energy share of coal and oil products for the textile sector is 75.8% and 24.2%[35] respectively. The emission factor for coal and oil products is 4.2 Tonnes of CO_2/MTOE and 2.8 tonnes of CO_2/MTOE.

Emission factor for thermal energy savings	=	4.2 x 0.758 + 0.242 x 2.8
	=	3.86 Tonnes of CO_2/MTOE

In order to calculate the GHG emission savings, the projects have been classified based on the type of savings it achieves. For example, if a project gives coking coal savings, the MTOE savings has been multiplied with the corresponding coking coal CO_2 emission / MTOE and the value is arrived.

[34] Central Electricity Authority
[35] Energy Statistics 2012

Example 1,

Type of project	=	Thermal
MTOE saved	=	100 MTOE
Emission factor for thermal energy	=	3.86 Tons of CO_2 / MTOE
GHG savings	=	100 MTOE x 3.86 tons of CO_2 / MTOE
	=	386 tons of CO_2

Example 2,

Type of project	=	Electrical
Fuel saved	=	electricity
MTOE saved	=	100 MTOE
Coking coal tons of CO_2 / MTOE	=	10.6
GHG savings	=	100 MTOE * 10.6 tons of CO_2 / MTOE
	=	1060 tons of CO_2

ANNEXURE 3 : LIST OF EQUIPMENT/TECHNOLOGY SUPPLIERS

Textile Machinery & Humidification Systems

1. BATLIBOI INDIA (www.batliboi.com)
2. BRUCKNER (http://www.voltas.com)
3. KARL MEYER(www.karlmayer.com)
4. LMW (http://www.lmw.co.in)
5. Machines Highest Megatronic GmbH
6. ICOMATEX (http://www.icomatex.com)
7. LUWA India Ltd(www.luwa.com)
8. Kirloskar Toyoda Textile Machinery Pvt., Ltd (www.kttml.com/)
9. KEYSTONE AIR SYSTEMS (http://www.textilehumidification.com)
10. Excel Airtechnics (P) Ltd (http://www.excelair.co.in)
11. AQUA FOG MAX HUMIDIFICATIONS (http://www.aquafogmax.com/)
12. Best Air Engineering (India) Pvt Ltd.(http://www.bestairindia.com)
13. A Monforts Textilmaschinen GmbH & Co KG (http://monforts.com)
14. Ciess Texaux Speciality Chemical Pvt Ltd (http://www.ciesstexaux.com/)
15. Dipit International
16. Huntsman International (India) Pvt Ltd (www.huntsman.com/)
17. Tong Siang Co., Ltd. (http://yeh-group.net)
18. Deven Suoercritical (http://www.scfe.in/)
19. Tatham Limited (William Tatham, Ltd)
20. Oerlikon (www.oerlikon.com/)
21. PICANOL (www.picanol.be/)
22. Rieter (www.rieter.com)
23. Temac (www.temacindia.com/)
24. Loepfe (http://www.loepfe.com/en)

Energy Efficient Transformers

1. ABB Limited (www.abb.co.in)
2. CG (Crompton Greaves Limited) (www.cgglobal.com/)
3. Kirloskar Brothers Ltd
4. Vijay Electricals Ltd

Energy Efficient Motors

1. ABB Limited
2. Baldor products (www.baldor.com)
3. Bharat Bijlee Limited (www.bharatbijlee.com/)
4. CG (Crompton Greaves Limited)
5. Kirloskar Brothers Ltd
6. Siemens Limited (www.siemens.co.in)

Compressors

1. Atlas Copco (Compressors) (www.atlascopco.in/)
2. Elgi Equipments Limtied (www.elgi.com/)
3. Godrej & Boyce Mfg.Co.Ltd (www.godrej.com)
4. Ingersoll Rand (www.ingersollrand.co.in/)
5. Kaeser Compressors India Pvt.Ltd (www.kaeser.com)
6. Kirloskar Pneumatic Company Limited (www.kpclapps.com/)

Solar heating technologies

1. CETHAR Limi ted
2. Forbes Mar shall
3. Tata Power Solar Systems Limited (http://www.tatapowersolar.com)

Energy efficient steam systems

1. Forbes Marshall (www.forbesmarshall.com)

Variable frequency drives

1. Danfoss
2. L & T - MHI Boilers Private Limited
3. Rockwell
4. Schneider Electric
5. Siemens Limited
6. Yantra Harvest Energy Pvt Ltd

Thermic fluid heaters

1. Forbes Marshall (www.forbesmarshall.com)
2. Thermax (www.thermaxindia.com/)

Lighting

1. Asian Electronics Limited (AEL)
2. Beblec (India) Pvt.Ltd
3. CG (Crompton Greaves Limited)
4. Legrand
5. Philips Electronics India Limited
6. Puravi Electrotech
7. Servomax India Ltd

Transvector Nozzles

1. General Imsubs Pvt. Ltd.

ABBREVIATIONS:

ADB – ASIAN DEVELOPMENT BANK

BAT – BEST AVAILABLE TECHNOLOGIES

BEE – BUREAU OF ENERGY EFFICIENCY

BOP – BEST OPERATING PRACTICES

BTRA – BOMBAY TEXTILE RESEARCH ASSOCIATION

CAGR – COMPOUND ANNUAL GROWTH RATE

CCM – COLOR CONTAMINATION CHECKING

CITI – CONFEDERATION OF INDIAN TEXTILE INDUSTRY

CMIE - Centre for Monitoring Indian Economy Pvt. Ltd

DIA – DIAMETER

GDP – GROSS DOMESTIC PRODUCT

HCC – HIGH CAPACITY CONDENSER

IREDA – INDIAN RENEWABLE ENERGY DEVELOPMENT AGENCY

K – KILO WATT

kAL – KILO CALORIES

KGS - KILOGRAMS

LBNL – LAWRENCE BERKELEY NATIONAL LABORATORY

LSHS – LOW SULPHUR HEAVY STOCK

MANTRA - MAN-MADE TEXTILES RESEARCH ASSOCIATION

mMTOE – MILLION METRIC TONNE OF OIL EQUIVALENT

MPM – MULTI PNEUMATIC MIXING

MTOE – METRIC TONNE OF OIL EQUIVALENT

MW – MEGA WATT

NITRA – NORTHERN INDIAN TEXTILE RESEARCH ASSOCIATION

PAT – PERFORM, ACHIEVE & TRADE

SEC – SPECIFIC ENERGY CONSUMPTION

SITRA	– SOUTH INDIAN TEXTILE RESEARCH ASSOCIATION
TAI	– TEXTILE ASSOCIATION OF INDIA
TFO	– TWO FOR ONE
TIC	– TEMPERATURE INDICATOR CONTROL
TPA	– TONS PER ANNUM
UNIDO	– UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
FAO	– FOOD AND AGRICULTURAL ORGANIZATION OF UNITED NATION
ICAC	– INTERNATIONAL COTTON ADVISORY COMMITTEE

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5. Handy Manual For Energy Conservation In Textile Industry - UNIDO, 1992
6. Energy Use, Loss and Opportunities Analysis US DOE, 2004
7. International Trade statistics 2010 WTO
8. IREDA Investors manual
9. CII Energy Efficiency Bulletin
10. CII Energy Audits