A Study on Energy Conservation in Textile Industry

Y. Dhayaneswaran · L. Ashokkumar

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Abstract In textile mill, electricity consumption is in increasing trend, due to modernised machines and continuous usage of the equipments in inefficient operating parameters. The energy cost is around 15 % to 20 % over the production cost and it stands next to raw material cost. Hence now a day's area of focus is towards energy consumption at load end and by optimizing the efficiency of the motor. In this paper, influence of motors and process of optimisation in textile mill on energy conservation is discussed with practical data.

Keywords Energy · Textile mill · Energy audit · Motor efficiency

Introduction

In textile industry, electricity consumption and power cost is in increasing trend due to modernised machines and continuous usage of the machines in inefficient operating parameters. Apart from the power cost, man power is also shortage in textile mills due to dusty environment inside the mill and heavy noise from the textile machines. Due to these reasons workers are not showing interest in working at textile mills, which compel mill management to deploy more automated machines. Hence, textile machinery manufacturers are integrating automation in the machines, indirectly requirement of power of the machines is increased.

The main objective of the textile mill is to produce yarn (thread) from the raw cotton which requires six stages of process. These are discussed briefly for readers understanding. The textile mill can be split into three systems namely, card sliver, combed sliver and ring spinning system.

The card sliver system consists of blowroom and carding machine, which does the function of removing the foreign particle from the raw cotton and convert the same into thick yarn (sliver).

The combed sliver system consists of draw frame and comber machines, the draw frame machine ensures the uniformity in thickness of the sliver and comber machine removes the unwanted short fibre in the sliver.

Ring spinning system consists of Speed frame and Ring frame machine, which does the conversion of sliver (thick thread) into yarn (thin thread). Ring frame is the final product of the spinning mill.

Energy Distribution in Textile Mill

Energy audit had been conducted in one of the leading textile mill, which is located in Southern part of Tamil nadu. Installed power of the mill had been gathered from the mills and plotted in Table 1 department-wise. From the Table 1, Figs. 1 and 2, the major power govern area had been recognized to adopt energy saving concepts.

From the above data it was found that the major power saving regions are preparatory process, Ring frame, humidification plant and compressor. Apart from the above, cable loss and power factor also plays a major task in textile mills to conserve the energy. It was observed that the power factor is changing from 0.8 to 0.96 at load end of the machines. Also, the voltage fluctuates from 395 VAC to 430 VAC at load side of the machines.

Y. Dhayaneswaran (✉)
Lakshmi Machine Works Limited, Coimbatore, India
e-mail: dhayaneswaran_y@yahoo.com

L. Ashokkumar
PSG College of Technology, Coimbatore, India

Table 1 Power distribution in textile mills including productive and non productive machines

Description	Installed, kW	Total load, %
Blowroom	58.78	2.39
Carding	327.6	13.32
Drawframe	61	2.48
Comber	59.23	2.41
Speed frame	68.32	2.78
Ring frame	1,158.88	47.12
Autoconer	196.35	7.98
Winder	26.4	1.07
Humidification plant	284.3	11.56
Waste collection	45.48	1.85
Buffing	7	0.28
Compressor	93	3.78
Lighting	35.15	1.43
Seawage plant	7.25	0.29
Water pump–hostel	18.7	0.76
Admin office, QC, hostel	11.84	0.48
Total power	2,459.28	100

Fig. 1 Power distribution in textile mills including productive and non productive machines

As a preliminary audit, actual data of units consumed and actual yarn production had been collected from the mills for a complete year in month-wise. From the data, for producing 1 kg of yarn, on an average 8.45 units of electricity are consumed during the year of 2010.

Energy Saving in Blowroom Department

The blowroom department is the first department where the mixings or materials from the bales are opened to smaller

tufts and cleaned from external impurities like seed coats etc. The cleaning is achieved by means of a combination of revolving beaters either positioned vertically or horizontally and grid bars are suitably arranged. The following machines are arranged in an order (lines 1, 2, 3) and material from one machine is conveyed to the next machine by means of air suction created by fans for removing the waste. The machines will be running depending upon the production requirement. (Table 2)

From Table 3, 54 induction motors are employed to eliminate the impurities from the raw cotton. Out of 54, 15 motors are underutilized while conducting power study by using Hioki make (type no: PW3198) power analyser. Selective motor data has been tabulated in Table 4 before and after changing appropriate motor power with respect to load. Also, motor connection changed from delta to star.

In Table 4, the motor runs with abnormality have been mentioned and the same are running for 24 h in the plant. As a result, a unit saved per hour is 2.15 kWh, so 51.6 units per day would be saved, in turn 1,548 units per month would be saved by adopting the above technique.

In the mills, the blowroom line is running continuously irrespective of requirement of material (cotton) request from the subsequent other machine (carding machine). Hence, start stop ratio of blowroom line has been tuned as 95:5 ratio. By doing so, 37.46 kWh per day has been saved during power audit. This is not only improving the opening and cleaning efficiency of blow room machines, but it also saves power. Thus, 1,123.9 kWh would be saved per month (Table 5).

In blowroom department, to collect the wastes from the above mentioned machines, a centralised waste collection system is installed. The waste collection system consists of three fan motors connected with pipeline of individual machines according to the suction pressure requirement. By reducing the pressure from 1,000 Pa to 700 Pa in the waste collection system, energy has been saved around 102 kWh per day. The power study data has been pointed out in the Table 6.

Re-engineering of filter plant i.e., reducing the suction pipe length between the machines, by using solenoid valves suction flap can be opened and closed for a period of set time for individual machines to save the power. By resizing of motors based on the power drawn saves the power at mills. However, in this mill, there is no scope in doing energy saving by re-engineering of the filter plant.

Energy Saving in Ring Spinning

In accordance with Fig. 1, ring spinning region is contributing around 50 % of total installed power. Combination of Speed frame and Ring frame is called as ring

Fig. 2 Productive and non-productive machines power (kWh) consumption per hour

Table 2 Units consumed per kilogram in the textile mill before conducting energy audit

Month/ year	Electricity board units consumption, kWh (A)	Diesel generator units consumption, kWh (B)	Total yarn production, kg (C)	Units consumed for 1 kg of yarn production, UKG [UKG = (A + B)/C]
Jan-10	681,336	9,444	82,314	8.39
Feb-10	665,835	8,424	81,789	8.24
Mar-10	582,894	8,182	66,633	8.87
Apr-10	517,456	10,700	60,893	8.67
May-10	672,131	9,081	86,157	7.91
Jun-10	722,904	8,912	89,864	8.14
Jul-10	645,080	26,210	81,897	8.20
Aug-10	629,830	15,810	75,604	8.54
Sep-10	659,453	10,336	79,063	8.47
Oct-10	501,443	4,500	59,202	8.55
Nov-10	367,966	550	45,219	8.15
Dec-10	373,216	1,708	40,524	9.25

spinning region, which reduces the thickness of sliver and mainpart twist which is required for winding. During power audit more concentration was given on Ring frame machines to conserve the energy in this mill. On observation, the Ring frame machines were running with lesser efficiency (91.5 %) on main motor. Hence, replaced higher efficiency motor (94.5 %) in one machine as trial basis and study had been conducted with same process and machine parameters, which gave good energy saving on Ring frame

machine. The gists of results are tabulated below Table 7. As per European Directive, EuP Directive 2005/32/EC nominal minimum efficiency level for IE3 motor for 30 kW with 4 pole motor is 93.6.

Number of spindles	960
Count processed, K	30's
Max spindle speed, rpm	18,000
Ring dia, mm	38

Table 3 Name of the machines with motor power in blowroom department

Machine with motor name	Power, kW
MBO (LB2/2)	
Feed roller motor	0.37
Lattice motor	0.75
Beater motor	3
Conveyor belt motor	0.75
Total	4.87
Total power for 3 lines	14.61
Condensor	4.5
Total power for 3 lines	13.5
Mono cylinder	
Beater motor	2.2
Total power for 3 lines	4.4
Scutcher	
Star roller motor	0.37
Stripper roller motor	0.75
Beater 1	3
Beater 2	3
Material supply motor	3
Cutting motor	0.09
Total	10.3
Total power for 3 lines	30.9
ERM	
Ventilator motor	3.7
Beater motor	4
Material supply motor	0.55
Total	8.25
Total power for 3 lines	8.25
Hopper feeder (LB3/1)	
Star roller motor	0.37
Stripper roller motor	0.75
Total	1.12
Total power for 3 lines	3.36
Ventilator	3
Total power for 3 lines	9

Based on the study result, the payback period was calculated as mentioned below and submitted to the mill management.

Investment in Rs/motor/machine, Rs.	90,000 (approx)
Unit saved/day/machine	51
Unit saved/month/22 machines	1,122
Amount saved per year (Rs. 4.45/unit), Rs.	82,837
Payback period, months	13

Next extensive scope in Ring frame machine is the optimisation of speed curve pattern. In Ring frame machine, the speed of the machine can be set (spindle speed) with respect to length of the yarn produced from the machine. By setting the speed curve such a way that the maximum

speed will be reached before 25 % of the final length of the yarn to be produced. By doing so, there is a considerable power saving in the machine. This method is very easy as there is no speculation for doing this exercise. The same has been done and subsequent are the results.

Avg spindle speed, rpm	18,000
Total run time, min	145
Yarn breakage/100 spl/h	4.65
Average load, A	35.94
Average load, kW	24.46
Units/doff/machine, kWh	59.02
Total production, kg	46.9
UKG/doff	1.259
Units saved/day/machine, kWh	11
Units saved/day/22 machine, kWh	242

Figures 3 and 4 explains about the power against speed of the machine for the whole doff (final yarn length) of the machine. From the Figs. 3 and 4, it is clear that by optimising the speed curve, peak load of the motor power can be decreased and utilisation of the motor can be enhanced.

For every Ring frame and Speed frame machines, there is an over head travel cleaning device (OHTC) installed to blow and suck the cotton flies sediment throughout the machine, which travels from one end to other end of the machine. Instead of continuous running of OHTC from one end to other end of the Ring frame and Speed frame machine, every reversal at end of the machine, OHTC is stopped for 1 min to 5 min. This has given good energy saving without any investment. The detailed study report is mentioned in the Table 8.

The above referred optimisation technique has been incorporated in all the 22 Ring frame machines. Thus, the energy saved per day for 22 machines is 313.5 kWh.

Alike, this concept has been incorporated in the speed frame machine also. In the Speed frame machine, energy saving per day per machine is 5.4 kWh. Total number of machines available in this mill is 5. Hence, total energy saving per day per 5 machines is 27 kWh.

The Ring frame machine has fan motor, which is used to suck the broken thread while machine is running. Power study has been conducted in fan motor of Ring frame machine by installing energy efficient excel fans (less weight) instead of conventional aluminium fans. (Fig. 5)

Power of the motor, kW	4.0
Conventional fan units/h, kWh	3.6
Energy efficient fan units/h, kWh	2.75
Energy saving/day/machine, kWh	20.4
Energy saving/day/22 machines, kWh	448.8

It was noticed in the mills that the empty cops and spindles were old one for ten of the machines. The empty spool (generally it is called as cops. This is the plastic

Table 4 Units saved after changing a new motor and wiring connection changed from delta to star

Name of the motor	Make/kW	Actual power, kW	Percentage of load	Power—after implementation, kW	Power saving, kWh/h
Material feed motor	Kirloskar/7.5	2.5	33.33	1.5	1
Ventilator motor	LEDL/4.0	5.5	137.5	NA	0.55
Condensor motor	LEDL/5.5	3.2	58.18	2.6	0.6

Table 5 Power saved after increasing start stop ratio of blowroom line

Blowroom line	Power consumption/h, kWh	After increasing run ratio
Line I & II	23.484	22.123
Line III	10.090	9.89
Total power consumed	33.574	32.013

Table 6 Units saved after optimising waste collection pressure in carding waste collection system

Actual power consumed (before)/h (with 1,000 Pa)	Actual power consumed (after)/h (with 700 Pa)	Power savings/h
30.926	26.676	4.25

component, where the thread wound over it while machine is running) and spindles (this is the mechanical component which is coupled through the belt drive from the motor shaft for spinning the yarn) are the resulting components of Ring frame machines, which are used to spin the yarn. By replacing less weight spindles and empty spool will give the energy savings in Ring frame machines. However, the same had not been tried in this mill.

Air leakage noticed in most of the machines during power audit. Air leakage observed in the machines, wherever the air hoses had been connected for machine application in particular for automatic doffer and top arm for individual spindles. By replacing the new hose and joints,

Table 7 Power saved after installing energy efficiency motor in Ring frame machines

Motor	30 kW at 91.5 % eff	34 kW at 94.5 % eff	Units saved/doff
Units/doff/machine, kWh	38.73	32.07	6.66

air leakage inside the machines will reduce the compressor ON time, which saves compressor energy (Fig. 6).

Energy Saving in Humidification Plant

In the mills humidification plant is installed for maintaining the RH (relative humidity) and temperature for processing the yarn. As the numbers of motors are more, there is a towering of scope in energy saving in this zone. Individual motor study had been conducted in humidification plant and found that the motors were loaded greater than rated power. Also, the power factor of the individual motor looks as to be poor in humidification plant.

In this mill, there were four plants to maintain the relative humidity in the spinning mill. The power study had been conducted for individual motors in all the four plants. Tables 9, 10 and 11 exemplify the motor load pattern in humidification plants. The load pattern of the motor was considered as 92 % maximum. During the power study if the load percentage of the motor load increased to greater than 92 %, the same were marked as over loaded. The power study had been taken for complete mill plant.

Fig. 3 Measured power consumption during hole doff with respect to speed and power. (after optimisation of speed curve)

Fig. 4 Measured power consumption during hole doff with respect to speed and power. (before optimisation of speed curve)

By servicing and optimising the motors which are marked as over loaded, considerable power saving will be achieved. The same are illustrated below.

Plant A, kWh/h	4
Plant B, kWh/h	4.14
Plant C, kWh/h	6.01
Plant D, kWh/h	0.07
Total units saved/day, kWh/day	341.28

Put together, 341 units per day can be saved.

Energy Saving in Compressor

In this mill, reciprocating compressor of 500 cfm is used for operating the machine. Following are the compressor details.

Motor power, kW	93
Compressor cooling motor, kW	5.5
Chiller fan motor, kW	1.6
Compressor loading time, s	62
Compressor unloading time, s	19

Power study had been conducted before tuning of ON and OFF time in the compressor. While conducting power study on the cooling motor, it overloaded by 1.36 kW (considered 92 % is the maximum load).

Compressor power, kWh	76.56
Cooling motor, kWh	6.42
Fan motor, kWh	1.1.4

After tuning compressor ON and OFF time (6 and 7 bar, respectively) by correcting the air leakage inside the plant and machines, following are the power savings obtained. As well, the overloaded motor bearing had been changed, as the drive end bearing failed.

Compressor power, kWh	71.56
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Consequently, 6.36 kWh/h had been saved by doing the above exercise. Hence, 152.64 kWh would be saved per day.

Table 8 Power saved after changing power save mode in OHTC of Ring frame machine

Parameters	Normal mode	Power saving mode
HS end stop time, s	5	123
TS end stop time, s	5	123
Run time	2 min 23 s	2 min 23 s
Units consumed/h, kWh	2.068	1.276
Units saved/hour/machine	0.792	
Total run h/day, h	18	
Units saved/day/machine, kWh	14.256

Fig. 5 Energy efficient fan motor vanes installed in Ring frame machine

Heating Lamp Removal

In the speed frame machine, to avoid over lapping of the sliver (thick yarn), heating lamps are used for increasing the temperature. 8 incandescent lamps were used for a machine (power 1 kW/lamp). Total numbers of speed frame machines available in the mills are 6. On an average, the heating lamp would be switched on about 3 h/day when the RH % is worst.

kWh consumed for heating lamp/machine/3 h	24
kWh consumed for heating lamp/6 mc/3 h	144

Fig. 6 Compressor hot air duct is near to Speed frame machine

Through circulating hot exhaust air of the compressor, heating lamp has been switched off. Hence, 144 units had been saved per day.

Summary of the Study

The energy study had been conducted in the textile mill for productive and non-productive machines. After conducting power audit, total energy saving per month in textile mill is as given in Table 12.

In accordance with the above table, 56,053 kWh is saved per month. Considering unit cost of Rs. 4.50, total amount Rs. 2,52,239 had been saved during month.

Table 9 Actual power consumption of the humidification plant motors (plant A): this plant for preparatory section

Name of the motor	Name plate details		Actual power consumption				Load, %	Difference, kW
	kW	I	V	I	P.F	kW		
Exhaust motor: 1 (plant II)	5.5	11.4	402	10.9	0.94	7.3	132	2.2
Exhaust motor: 2 (plant I)	5.5	11.4	413	13.37	0.61	6	108	0.89
Supply fan motor: 1 (plant II)	5.5	11.4	414	10.55	0.74	5.6	101	0.5
Pump motor: 1 (plant I)	5.5	11.4	415	8.63	0.69	4.3	77.6	

Table 10 Actual power consumption of the humidification plant motors (plant B): this plant for combed sliver system

Name of the motor	Name plate details		Actual power consumption				Load, %	Difference, kW
	kW	I	V	I	P.F	kW		
Exhaust motor: 1 (plant I)	11	22	373	20.66	0.79	11	96.9	0.52
Exhaust motor: 2 (plant I)	11	22	376	20.08	0.8	10	94.1	0.27
Pneumafil exhaust motor (plant II)	11	22	371	23.7	0.87	13	123	3.35
Pump motor: 1 (plant I)	5.5	11.4	404	8.21	0.72	4.3	77.5	
Pump motor: 2 (plant I)	7.5	14.8	397	10.31	0.81	5.9	78	
Supply fan motor (plant I)	7.5	14.8	380	5.05, 5.05, 8.48	0.44	Motor problem (1 phase drawing more current)		
Supply fan motor (plant I)	7.5	14.8	376	7.25, 8.42, 8.52	0.56	Motor problem (2 phases are drawing more current)		
Supply fan motor (plant I)	7.5	14.8	379	9.88	0.73	4.8	63.6	

Table 11 Actual power consumption of the humidification plant motors (plant C): this plant for Ringspinnig system and autoconer section

Name of the motor	Name plate details		Actual power consumption				Load, %	Difference, kW
	kW	I	V	I	P.F	kW		
Pneumafil exhaust motor (Spg)	9.3		398	11.4	0.66	5.1	55.3	
Exhaust motor (Spg)	7.5	14.8	381	13.3	0.81	7.1	94.4	0.18
Supply fan-1 (Spg)	7.5	14.8	389	7.66	0.98	5.2	69.3	
Supply fan-2 (Spg)	7.5	14.8	394	6.9	0.97	4.5	60.3	
Exhaust motor (preparatory)	5.5	11.4	381	14.7	0.81	8	145	2.9
Supply fan motor (preparatory)	5.5	11.4	376	10.2	0.75	5.1	92.9	0.05
Pump motor	5.5	11.4	375	13.5	0.88	7.9	144	2.88
Exhaust fan	15	28.5	406	9.42	0.9	6.1	40.5	Under loading

Table 12 Total energy savings/month

Location	kWh saved/month
Preparatory—motor	1,548
Preparatory—process	1,123
Preparatory—waste collection	3,060
Ringframe—motor	1,122
Ringframe—speed curve	7,260
Ringframe—OHTC	9,390
Ringframe—fan motor	13,440
Humidification plant	10,230
Compressor	4,560
Heating lamp	4,320
Total units saved	56,053

Conclusion

In India, there are many textile industries. Hence, by incorporating the above technique in all the textile mills, ample energy can be saved. In general, most of the mills

have not included renewable energy techniques in productive and non-productive machines. By means of adopting these techniques, significant energy saving can be realised.

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