Automation of cabinet and career dyeing machine

(*For Varanasi Textile Cluster*)

Cluster Brief:

Varanasi is considered to be India's oldest city. The city exhibits a very rich amalgamation of religion, faith, culture and traditional practices. Apart from faith and religious values, Varanasi has been known worldwide for its typical and traditional hand woven Benaresi silk sarees. Textile industry has been a leading employment provider in the area. Most of the people associated with textile industry are into weaving (Handloom or power loom). In addition, most of the textile industry is home or cottage industry.

There are few industries in Varanasi with high volume of production and are involved in yarn dyeing and saree dyeing and printing activities. This number in Varanasi is mere 10. In order to form a sizable cluster, textile industries in Varanasi, Bhadohi, Chandauli and Jaunpur districts have been included to form one cluster. The total number of units after combining textile units in these districts comes to 40. The textile units visited in the cluster have at least one of the following processes:

1. Spinning
2. Mechanised weaving
3. Polyester yarn dyeing
4. Woollen yarn dyeing
5. Carpet yarn dyeing
6. Fabric (Saree) dyeing
7. Block printing
8. Screen printing
9. Digital printing
10. Garment manufacturing

The major energy consuming equipment installed and regularly used in the visited units are IBR-boilers/ thermic fluid heater, dyeing machines, dryers and hydro extractors. In Varanasi, out of 10 units; 2 units have thermic fluid heater installed and remaining have boilers without any heat recovery provisions.

Apart from electrical energy, the units use either rice husk or coal lumps to meet their thermal energy requirements. Based on the data collected from the units during surveys and energy audits, the contribution of both forms of energy is represented below:

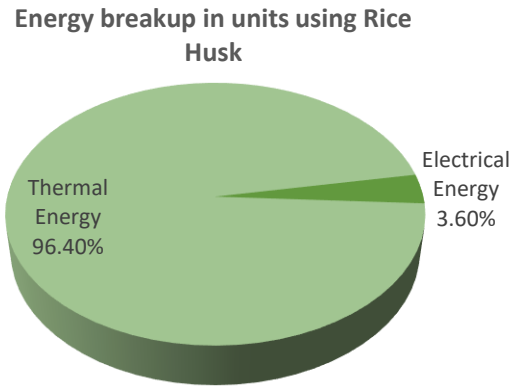

Figure 1: Energy break-up of units using rice husk as fuel

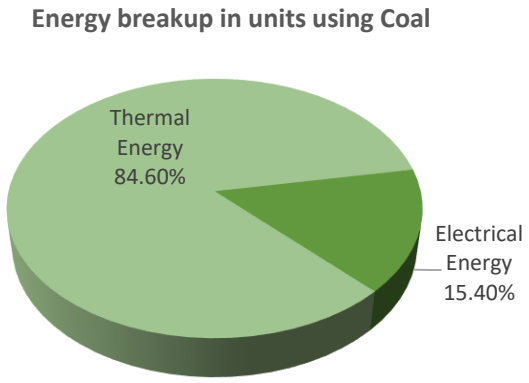

Figure 2: Energy break-up of units using rice husk as fuel

Existing practice:

In any wet processing unit in textile industry, apart from utilities, most of the electricity is consumed in the dyeing machines.

The different type of fabric and yarn dyeing machines are:

a) Soft flow Machines
b) HTHP dyeing Machines
c) Jet Dyeing Machines
d) Air flow dyeing machines
e) Carrier dyeing machine
f) Cabinet dyeing machines

The majority of the units in Varanasi textile cluster are yarn dyeing units. Therefore, the machines used are HTHP dyeing machines, cabinet dyeing machines and carrier dyeing machines.

These machines are equipped with motors that operate in forward and reverse directions. The motor changes its direction in every 150 second. Due to constantly changing direction of motor operation high inrush current is measured. Also, the motor of machines is currently operating at a frequency of 50Hz.

Proposed technology:

It is proposed to make the operation of the dyeing machine more flexible by installing VFD. Installing the VFD will give the operator a bandwidth of operating at different speeds. Thus, improving the overall product quality and at the same time reducing the electricity consumption. Based on the detailed analysis, site visits and measurements during energy audit, it is proposed to install VFD on dyeing machines with motors with rated load of 7.5 hp and above, thus, reducing the electricity requirement of the dyeing machines.

Justification of technology selection:

In the existing system, the average processing time for each batch is 5 hours. This means that the motor will change the direction 120 times. In these 120 seconds, the power consumption of the motor is 3 times the normal operating power. Also, all the motors of the dyeing machine are operating at the input frequency, i.e. 50 Hz, however, for most of the fabrics and yarns a frequency of 42 Hz to 44 Hz is sufficient. Using the VFD to reduce the input frequency is further going to reduce the electricity consumption of the system.

Despite the advantage of reduction in electricity consumption and improved product quality, the major challenge for penetration of this technology is lack of awareness. Most of the units are not aware of such systems and their benefits. Only two units in the whole cluster has installed this system to reduce their electricity consumption

Energy & monitoring saving:

For calculating the energy and monetary benefits, a typical case is considered where two batch per machine are produced an motors currently operating at 50 Hz input frequency. This input frequency is proposed to be 44 Hz.

The benefits envisaged through implementation of this technology have been summarized in the table below

Tech-2

Parameter	Unit	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6	Motor 7	Motor 8	Motor 9
Number of days unit operate in a year	Nos.	300	300	300	300	300	300	300	300	300
Rated Power	hp	7.5	10	12.5	15	20	25	30	40	75
Number	Nos.	24	9	2	5	6	1	1	5	1
Capacity	kW	5.6	7.46	9.33	11.19	14.92	18.65	22.38	29.84	55.95
Rated rpm of motor	rpm	1500	1500	1500	1500	1500	1500	1500	1500	1500
Regular operating power	kW	5.04	6.71	8.4	10.07	13.43	16.79	20.14	26.86	50.36
Operating power in changing direction	kW	12.6	16.775	21	25.175	33.575	41.975	50.35	67.15	125.9
Production time of one bath	second	18000	18000	18000	18000	18000	18000	18000	18000	18000
Total batch produced in a day	Nos.	2	2	2	2	2	2	2	2	2
Operation of motor in one direction	sec	150	150	150	150	150	150	150	150	150
Total number of times the motor changes direction in a day	Nos.	240	240	240	240	240	240	240	240	240
Electricity consumed by motor while changing direction	kWh	0.84	1.12	1.4	1.68	2.24	2.8	3.36	4.48	8.39
Electricity consumed by motor in regular operation	kWh	50.4	67.1	84	100.7	134.3	167.9	201.4	268.6	503.6
Total electricity consumed in a day	kWh	51.24	68.22	85.4	102.38	136.54	170.7	204.76	273.08	511.99
Operating frequency after installing VFD	Hz	44	44	44	44	44	44	44	44	44
rpm of motor after reducing frequency	rpm	1320	1320	1320	1320	1320	1320	1320	1320	1320
Power consumed by motor after reducing input frequency	kW	3.43	4.57	5.72	6.86	9.15	11.44	13.72	18.3	34.32
Electricity consumed by motor after installing VFD	kWh	34.3	45.7	57.2	68.6	91.5	114.4	137.2	183	343.2

Tech-2

Parameter	Unit	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6	Motor 7	Motor 8	Motor 9
Electricity saving in a day	kWh	16.94	22.52	28.2	33.78	45.04	56.3	67.56	90.08	168.79
Total daily electricity savings by all machines	kWh	406.56	202.68	56.4	168.9	270.24	56.3	67.56	450.4	168.79
Total annual electricity savings by all machines	kWh	121968	60804	16920	50670	81072	16890	20268	135120	50637
Average p.f. of the units		0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Total annual electricity savings by all machines	kVAh	123200	61418.18	17090.91	51181.82	81890.91	17060.61	20472.73	136484.9	51148.48
Cost of 1 unit electricity	₹/ kVAh	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Total annual financial savings	₹	1170400	583472.7	162363.6	486227.3	777963.6	162075.8	194490.9	1296606	485910.6
Estimated cost of 1 system	₹	20000	25000	30000	35000	50000	60000	75000	120000	200000
Average installation cost	₹	4000	4000	4000	4000	4000	4000	4000	4000	4000
Total cost of installation of 1 system	₹	24000	29000	34000	39000	54000	64000	79000	124000	204000
Cost of installation of all systems	₹	576000	261000	68000	195000	324000	64000	79000	620000	204000
Payback	months	6	6	6	5	5	5	5	6	6

The benefits can be summarized as:

- ✓ Reduction in electricity consumption
- ✓ Improvement in product quality

Replication Potential:

Based on the surveys, audits and discussion with associations and unit owners, it is estimated that the technology has a replication potential in at least 15 units of the cluster. Based on replication potential in 15 units, the overall project benefits will be as follows:

Parameters	Units	Values
Total electricity savings expected in cluster	kWh	554349
Total oil equivalent savings expected in cluster	toe	44.67
Total investment in cluster	₹	2391000
Total financial savings in cluster	₹	5319510

Availability of the technology

There are good many technology providers available in India and many of them have their base in Delhi and UP. The following are the technology providers available in the cluster.

1. YASKAWA India Pvt Ltd.,
   Plot No. 426, Udyog Vihar Phase 4, Gurgaon, Haryana - 122016, India
2. ABB

   14 Mathura Road,Plot No - 14 , Mathura Road, Faridabad, Haryana - 121003
   Phone: +91 129 2567181
3. Schneider

   DLF Cyber City, Phase II, Gurgaon - 122002, Gurgaon, India
4. L&T

   9th Floor, Ambadeep Building, 14, Kasturba Gandhi Marg, New Delhi - 110001
5. Delta Group

   HSIIDC, plot no 43, Sector 35, Gurugram, Haryana 122001

Effect on the process

This technology has no effect on the existing production process. It will reduce the electricity consumption required for operation of dyeing machine.