Energy conservation audit and approaches for energy saving in textile process house - Part 3

Mr. Tanaji Kadam
The Bombay Textile Research Association, L B S Marg, Ghatkopar (W), Mumbai 400086

Abstract

By conducting the third party energy audit, the potential energy saving activities or opportunities can be highlighted depending upon plant situation and commercial feasibility. This paper describes some of the illustrative examples along with saving quantifications and those are implementable in a textile process house. These cases consists of covering the open bath to avoid the steam or energy loss due to evaporation, automation of temperature controller and heating system, avoiding heat losses from hot machine surfaces, recovery of heat from waste hot effluent drains, avoiding overheating of the fabric, optimizing air blower working in Effluent treatment plant (ETP) as per requirement etc. Apart from these examples, there are so many other opportunities for energy saving in a textile process house. For this a neutral third party auditing approach is required.

Keywords

Heat losses, Fuel consumption, steam wastage, textile processing, Hot surface, Heat recovery, Effluent, DO sensor, Air blower, ETP etc

Citation

Mr. Tanaji Kadam- "Energy conservation audit and approaches for energy saving in textile process house - Part 3 ", *BTRA Scan* - Vol. LIII No.3 July, 2024, Page no. 5 to 8, DOI: 10.70225/594679fulmoa

1.0 Introduction:

Related to this series of papers on energy conservation audit and approaches for energy saving in a textile process house, part 1 and part 2 are already published. In the part 1, the identification and small description of major energy-consuming processes in a textile process house, various utility usage and potential saving possibilities in them were discussed. In part 2 , the audit-frame work, procedure to conduct the energy audit, various key factors and calculations to be considered in an audit along with the task to be done. etc were explained.

In this part 3 , we will be explaining some of the illustrative examples of energy saving opportunities in various processes. These examples or cases are based on the outcome of our various mills surveys and audits carried out, the plant observations and suggestions given by BTRA Mumbai to the mills through the related assignments reports. In these illustrative examples we have focused more on the concept of energy saving and less focus on its calculation part. Wherever possible the calculations or savings estimations are given and they may change case to case depending on quantity, automation level, monitoring and heat wastage level.

*Corresponding author,
E-mail: tsd@btraindia.com

2.0 Energy saving potential in Textile wet processing mill

2.1 Making provision of cover or hood to open bath jigger dyeing machine.

As we are well aware that the evaporation losses from the open bath is higher than the closed bath. Also, it is to be noted that in the textile process house commonly the jigger dyeing machines are open and exhaust bath process. A significant amount of heat is lost from the bath surface when the hoods are not provided or open. So, by making the provision of hoods or cover for the open bath jigger dyeing machine. During the audit, an auditor should check whether the machine is equipped with a hood or not. In the case of hood provision on the machine , confirm whether it is closed or not during the dyeing process. If no provision of hood then

measure the bath temperature and by following the below table no.1 , the heat losses may be estimated.

Table.no. 1 Steam used by a Jig Machine with varying temperature and conditions [1]

Operating temperature ˚C	Steam use kg/hr	
	Hood open condition	Hood closed condition
80	60	23
90	61	28
95	73	34
100 (simmer)	91	55
100 (vigorous boil)	218	127

The above table shows tentatively hourly steam consumption patterns for open and closed bath jigger processes. Thus depending on the number of machines , working hours of jigger machine in hot condition per day you can calculate the heat losses and hence fuel consumption per day without cover or hood and suggest the provision of cover and hood for open bath jigger dyeing machine. Roughly, 40% steam saving seems to be feasible by implementing this suggestion.

2.3 Making provision of temperature indicator cum steam cut off system for jigger section

At the many process houses, it is common practice that for jigger machine processing, the direct steam heating system is used. Also, additionally at many places there is no provision for indicating the bath temperature and auto steam cut off system. In this case steam is continuously blowing in the bath even after the process temperature is achieved. This leads to a lot of steam wastage. To avoid such unaccountable steam wastage, a provision of temperature indicator cum auto cut off system is a must.

In such a system following are the recommendations to minimise the steam wastage

- ·Installation of temperature indicator cum steam auto cut off system
- ·Ideally the injected steam should be condensed completely as the bubble rises through the liquid. This is possible only if the inlet steam pressure is kept low i.e. 0.5-0.75 kg/cm2. If pressure is higher then instead of condensation, the steam directly gets evaporated from the bath surface.
- ·To get even heating and more thermal efficiency a distribution pipe with a large number of small holes (2 – 5 mm diameter facing downward direction) should be used.This will help in dissipating the bubble speed.

2.3 Heat Loss from hot machine surfaces

It is frequently observed that machines like soft flow dyeing machine, jet dyeing machines, hot washing tanks in soaper machine, steamers, stenter chambers, hot water collection tanks, steam condensate tanks etc. are used without the heat resistant insulations on them. Generally, if the surface temperature of such equipment is > 60°C then heat loss is significant and the insulation is recommended. The following are the equations to calculate the heat loss (both convective and radiant heat loss) from the hot surface.

Convective heat loss (W/M2) = qc = a x (Δt)0.25

Radiating heat loss (W/M2) =qr = 5.67 x e x [(Ts/100)ʌ4-(To/100) ʌ4]

Where

a = convective heat transfer coefficient (W/m2K)

e= emissivity

Ts= surface temperature in K

To = ambient temperature in K

Δt= Ts-To in K

By using above formulas, for the soft flow dyeing machine of area 25m2 and considering the surface temperature 70°C with convective heat transfer coeff a= 2.56 W/m2K and emissivity value e= 0.7

The estimated convective heat loss is 6438 W Estimated radiating heat loss is 13433W

Thus Total heat loss from the hot surface of the soft flow dyeing machine of area 25m2 will be 19871 W or 17062 Kcal/hour.

If we insulate the soft flow dyeing machine by heat resistant coating like ceramic coating then the estimated heat loss after insulation can be calculated by considering Ts= 45°C and emissivity e= 0.5 and the estimated value is 7054 Kcal/hour.

Thus by insulation we can save the heat loss of 17062-7054 = 10008 Kcal/hour.

In other terms , Equivalent coal or fuel (of cv 3000) saving per year of 300 days @80 % utilization and 70 % heating cycles will be 21 tonnes per year. Based on this the mill may estimate the payback period for the investment.

2.4 Heat Recovery from Hot effluents being drained to ETP

In a typical textile process house, there are many sources of hot effluents such as merceriser, CBR (continuous bleaching range), jet or soft flow dyeing machine, sopaer or washer, desize washer etc. There are two types of process i.e. continuous and exhaust process. In a continuous process a hot effluent (temperature range 80-95°C)is continuously drained to ETP with a specified flow rate. In the case of

exhaust batch process, almost 70-75% drains are hot (temperature range 60-85°C). Thus a significant amount of heat is being wasted through hot effluent discharge.

This waste heat can be used for preheating of cold process-water. Otherwise it must be heated by valuable steam. This hot water can be used in the same process or in other processes wherever required through a system of hot water storage tanks with insulation. Usually plate type heat exchangers are used because of space constraints and easy cleaning process. In textile process, by using heat exchanger system temperature gain i.e ΔT may be 20-30 °C.

This is explained by the following case study example of dyeing soaper machine with a hot effluent drain flow rate of 100 liters /min;

If we have a hot effluent at temperature Th1= 75°C and cold water temperature Tw1= 25°C

Then with a plate heat exchanger of efficiency of 70%,

The Exit temperature of hot effluent after heat exchanger(Th2) can be estimated by using the formula

Heat exchanger efficiency = (Th1-Th2) / (Th1-Tw1)°C x 1 Kcal/Kg°C =

0.7= (75-Th2)/(75- 25)

Thus by calculations, exit temperature of hot effluent after heat exchanger = Th2= 40°C

The temperature of cold water after heat exchanger =Tw2= (75-40)+25= 60 °C and this hot water is available for processing and due to use of heat exchanger, the steam required to raise the temperature of cold water from 25°C to 60°C is saved.

Energy saving = 100 lits/min X 60 x (60-25) x 1Kcal/Kg°C = 210000 Kcal/Hour

In terms of Steam saving = 210000Kcal/hour /(662 -25) = 329 Kg of steam per hour

In terms of fuel (of calorific value 5000 Kcal /kg) saving = 329 / 5 = 66 kg per hour

Fuel saving per year = 66 X 20 hours x300 days = 396 Tons per year

Similarly, the mill can estimate the savings for other continuous and group of exhaust processing machines and based on the capital cost of the plate type heat exchanger, the payback period can be estimated.

2.5 Prevention of overheating of fabric during drying and finishing

Depending on the type of fibre materials used(natural and or synthetic), each fabric has its own equilibrium moisture content in it. The equilibrium moisture content of cotton fabric is approximately 6.5-7%. After drying and or finishing when the fabric is left in atmospheric air, it absorbs the moisture from the air and reaches its equilibrium moisture level. This is applicable to all type of fabrics. Therefore unnecessarily excessive drying of the fabric should be avoided. By doing this, two things are addressed here i.e. loss of production and waste of energy.

The first step in achieving the energy saving is that the dried fabric samples should be checked for moisture content. The online moisture content system will be an added advantage and more effective. When the moisture content is fabric is lower than the equilibrium moisture level then to avoid the overdrying the following actions are taken

- In the case of stenter machine to increase the fabric speed, reduce the exhaust gas rate or reduce the drying set temperature etc is done
- In the case of a cylinder dryer to increase the machine speed and or reduce the steam pressure or heat input.

2.6 Use of online DO sensor linked to airblower through VFD for aeration tank of ETP

Textile processing waste-water is treated in aeration tank by biological treatment method. Here, soluble organic matters are converted to solid sludge by bacterial treatment. Here the main requirement is of oxygen. The oxygen requirements in this process are based on the amount required for biodegradation of organic matter and the amount required for endogenous respiration of micro- organisms[2]. A lot of air is supplied to aeration tank for the dissolved oxygen availability for bacteria survival. Thus to maintain Dissolved oxygen(DO) level in the aeration tank, the blowers are continuously run. Here it is to be noted that the air is continuously escaping from the water surface. Due to continuous running of air blowers, heavy power consumption is observed in this area. The significant power saving (up to 30-35%) can be achieved by installing DO meters/ DO sensors in aeration tank and linking them to Air blower through VFD (variable frequency drive). Here as per DO requirement the blower speed is lowered or increased and thus significant power saving is possible.

Energy and monetary saving estimation:-

Assumption:- 10 KW air blower is used and power rate is Rs 10/Kw

Operation hours per year = 24 hours/day x 300 days /per year = 7200

By using DO sensor system linked to air blower through VFD expected power saving is 30%

Per year estimated power saving = 10KW X 7200 hours/year X 0.3 = 25200 KW

In terms of money saving = 25200 X 10Rs/KW = Approximately Rs. 2.5 lakhs /Year

These are a few models of potential energy saving in textile processing. Similarly, the process house can think of following aspects for in depth study/audit to check energy saving possibilities. Some of the mills might have implemented these things.

- Counter flow washing in continuous washing machines will give opportunity for water and steam saving
- Heat recovery from exhaust air in continuous type dryers
- Reduction of hot exhaust air flow rate in continuous type dryer machines
- Maximising mangle squeezing to reduce moisture level before drying operation
- Inverter applications for centrifugal type of machines like fan, blower, compressor and pumps
- Introduction of fine bubble air dispensers for aeration tank in ETP
- Reduction in boiler excess air
- Heat recovery from boiler exhaust air/gas
- Maximization of steam condensate /flash steam recovery
- Reduction of steam pressure in the boiler
- Optimization /reduction of air pressure in air compressor
- Increasing temperature setting in air conditioned area

3. Conclusion

The various potential energy saving processes or aspects are given along with quantification and illustrative examples. The application and implementation may change depending upon the practical situation in the plant. The aspects like machine age, process requirements, space availability, current heating system and energy distribution system, safety, payback period, assumptions for certain calculations, capital cost and operational cost should be taken into the consideration while implementing these saving concepts. During the audit depending upon the energy usage practices, the saving opportunities can be detected and worked out. The main purpose of the energy saving audits and implementation is to ensure the sustainability, low carbon emission by reducing fuel consumption and lowering the operational cost. BTRA is providing service of third party audits in the field of energy conservation. This journey is endless as newer and newer commercially feasible technologies will be emerging in future.

References

1. Energy Audit Manual for Textile Industry published by PCRA Feb 2012, P 48
2. Handbook on ETP, water, recycling & sustainable technology published by BTRA Mumbai 2018, P 23