Installation of Condensate Recovery System and Float Trap

A Case Study

Background

Micro, small and medium enterprises, jointly called as MSMEs, plays an important role in the Indian economy. There are around 26 million micro, small and medium enterprises units in the country, which provides employment to over 60 million people. Together, the MSME sector contributes over 45 % of industrial production and over 40% of exports. The role of MSME sector is set to grow in the economic profile of the country. However, the sector has some inherent issues. The sector is one of the major consumers of energy. The sector consumed an estimated 50.5 million tonne of oil equivalent in 2012. The annual expected growth of energy consumption is about 6 percent annually. It is estimated that 15-20% percent of energy consumed by the sector could be saved. But, due to the small size and traditional nature of business holding and management, it becomes difficult for MSME units to adopt energy efficiency measures, without external supports.

Under this background, the Bureau of Energy efficiency along with Ministry of MSME and cluster level associations, initiated a project titled "National Program on Energy Efficiency and Technology Up-gradation in SMEs". Five MSME clusters were identified all over India for executing intervention measures. Pali Textile cluster was one among them. The project here in Pali, is supported by the Rajasthan Textile and Hand Processors Association.

The Cluster

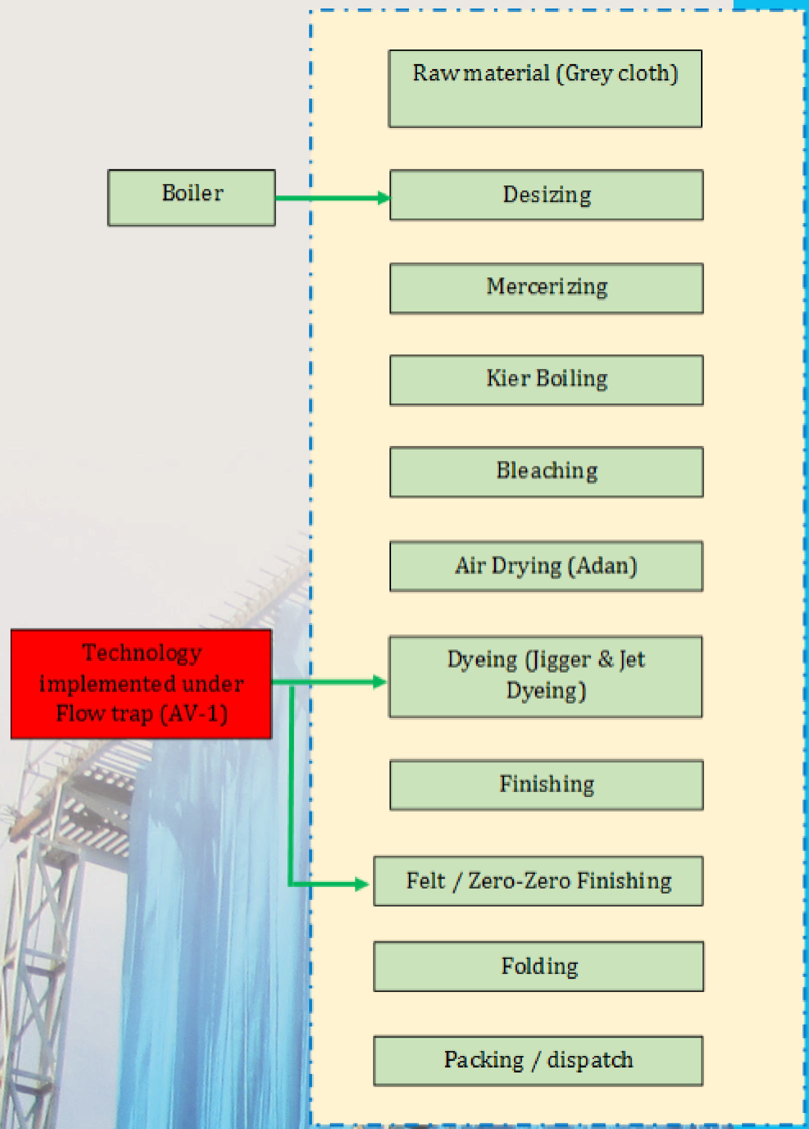
The Pali textile cluster is one of the biggest MSME clusters in India having over 250 member industries. The units in the cluster are mainly located in two Industrial Areas namely Industrial Area Phase I & Phase II and Mandia Road Industrial Area. The units are classified into two segments mainly: 1) Hand Process Units 2) Power Process Units.

The BEE-SME project aimed to initially implement energy efficient technologies in selected units in the cluster. These units will act as demonstration units for long term and sustainable penetration of energy efficient technologies in the entire cluster. Inspire Network for Environment was selected as the implementing agency for the program.

The Process

The typical flow of the textile process starts with the De-sizing and Mercerizing of raw material. Subsequently, the fabric is fed into the Kier Boiler where scouring operations takes place, then the fabric undergoes bleaching followed by Air Drying (Adan). The next step is colouring of the fabric using jigger or jet dyeing method. This is followed by the finishing process where the material fabric undergoes pre-shrinking in a zero-zero machine. Although, this is a typical layout, other process improvement methods are used, as per requirement, by different units.

The Fabric is now ready for dispatch. The entire processing of fabric in a Textile Processing unit requires steam as the major input. For continuous supply of steam, a boiler or a thermic fluid heater is used. The baseline energy audit revealed that boiler is the major energy guzzler in a typical textile processing units.



The Boiler: Baseline Scenario

Packaged steam boiler is used to generate wet steam required for the process in textile units. Steam is used at a working pressure of 4-5 kg/cm^2. Generally pet-coke is used as the fuel for the steam boiler. The heating chamber consists of a fluidized bed of coke wherein air is supplied from bottom. The heat generated by combustion of coke and air is used to heat water to form steam. The steam generated is used in various processes across the unit. The boiler operates for an average of 12 hours daily.

The steam boiler operating in the unit is a packaged boiler with water tube design. Steam is the main agent of energy used in the textile processing unit. Thus, the boiler is the major energy utilizing source in these units. Most of the units use conventional water tube boilers wherein a significant energy is lost through the flue gas. The baseline energy audits in the Pali textile units revealed that the flue gas generated from the heating chamber of a boiler and the thermic fluid heater is discharged at a significantly high temperature and not being utilized in these units. A significant potential for energy saving exists in these units with implementation of waste heat recovery system. Accordingly, installation of Air Pre-heater & Economizer was suggested.

Energy Efficient Technology

Predominately two technologies were implemented in the boiler section, under the BEE-SME program i.e., Air Pre heater & Economizer.

EE Technology 1: Air Pre heater for Boiler / Thermic fluid heater

A boiler produces steam which is subsequently used in different processes in a typical textile processing unit. Similarly, a Thermic fluid heater utilizes the heat produced in the system for processing of fabric at different segments. Energy used to heat the thermic fluid / water is mostly pet coke. Conventional units do not have provisions of waste heat recovery to recover the flue gas. Thus a significant amount of heat is lost as waste heat.

Air Pre-heaters are basically heat-exchangers installed in the exit flus gas duct of the boiler. The purpose of the air preheater is to recover the heat from the boiler flue gas which increases the thermal efficiency of the boiler by reducing the useful heat lost in the flue gas. As a consequence, the flue gases are also conveyed to the flue gas stack (or chimney) at a lower temperature, allowing simplified design of the conveyance system and the flue gas stack. It also allows control over the temperature of gases leaving the stack.

Working Principle

The most common air pre-heaters are tubular preheaters consisting of straight tube bundles which pass through the outlet ducting of the boiler and open at each end outside of the ducting. Inside the ducting, the hot furnace gases pass around the preheater tubes, transferring heat from the exhaust gas to the air inside the preheater. Ambient air is forced by a fan through ducting at one end of the preheater tubes and at other end the heated air from inside of the tubes emerges into another set of ducting, which carries it to the boiler furnace for combustion.

Installation of an air preheater can lead to recovery of heat from the exit of the heating chamber to pre-heat the air required for combustion. The pre-heated air can either be utilized in the thermic fluid heater or the boiler. With an exit waste heat temperature of 180 ^{0}C ; air pre-heat to the extent of 100 ^{0}C can be achieved .

EE Technology 2: Economizer for Boiler

Steam is the main agent of energy used in the textile processing unit. Thus, the boiler is the major energy utilizing source in a typical textile unit. In conventional system, the feed water to the boiler is fed at ambient temperature (35 ^{0}C) while the stack temperature goes as high as 240 ^{0}C.

The flue gas temperature leaving at 240 ^{0}C from the boiler can be recovered using an economizer. This can further be utilized to pre-heat the boiler feed water. A temperature difference of 120^{0}C is sufficient to rise the boiler feed water temperature by 60-65^{0}C. The increase in boiler feed water temperature can lead to substantial increase in boiler efficiency thus leading to reduction in specific fuel consumption.

Economizers are basically tubular heat transfer surfaces used to preheat boiler feed water before it enters the steam drum. By recovering the energy from the flue gas before it is exhausted to the atmosphere this performs a key function in providing high overall boiler thermal efficiency.

Working principle

Boiler stack economizers are simply heat exchangers with hot flue gas on shell side and water on tube side with extended heating surface like Fins or Gills. Economizers must be sized for the volume of flue gas, its temperature, the maximum pressure drop allowed through the stack, what kind of fuel is used in the boiler, and how much energy needs to be recovered.

The installation of the economizer in the boiler / thermic fluid heater and utilizing the same for pre-heating boiler feed water will lead to following benefits:

- Waste heat recovery
- Improvement in boiler efficiency
- Reduction in FD/ID fan power usage
- Improved environment
- Easy to integrate into production cells
- Reduced scaling

Cost benefit analysis

Cost benefit analysis for installation of a economizer in a typical unit is tabulated below:

Cost Economic Analysis of proposed economizer			
SN	**Parameter**	**Unit**	**Value**
1	Quantity of steam generated per hr (Q)	kg/hr	3000
2	Quantity of fuel used per hr(q)	kg/hr	211.6
3	Working Pressure	kg/cm^2	10
4	Temperature of feed water	°C	35
5	Type of fuel		Coke
6	Calorific Value of fuel		8200
7	Enthalpy of steam	kCal/kg	665
8	Enthalpy of feed water	kCal/kg	35
9	Boiler Efficiency	%	109
10	Flue gas temperature (in thermic fluid heater)	°C	240
11	Steam generation per Kg of fuel	kg/kg	14
12	Flue gas quantity	kg/kg	15
13	Quantity of flue gas	kg/hr	3097
14	Quantity of heat available in flue gas	kCal/hr	85466
15	Rise in feed water temperature	°C	63
16	Savings in terms of fuel from pre-heated boiler feed water	%	10.43
17	Savings in terms of fuel	kg/hr	22
18	Annual operating hrs.	Hrs.	3600
19	Annual savings of fuel	kgs	79477
20	Annual cost savings	Rs/yr.	397385
21	Cost of economizer	Rs	300000
22	Pay-back	Months	9

* Every rise of 6ºC in boiler feed water temperature through waste heat recovery would offer about 1% fuel savings.

** Cost of fuel taken as Rs 7.5/kg

Cost benefit analysis for installation of an air-preheater in a typical unit is tabulated below:

Cost Economic Analysis of proposed combustion air-preheater			
SN	**Parameter**	**Unit**	**Value**
1	Exit flue gas temperature	°C	180
2	Stack dew temperature	°C	120
3	Available temperature for heat transfer	°C	60
4	Quantity of steam generated per hour	kg/hr	3000
5	Quantity of fuel in the boiler	kg/hr	211.6
6	Specific heat of water	kCal/ kg °C	1
7	Steam generation per Kg of fuel	kg/kg	14.18
8	Flue gas quantity	kg/kg	20.69
9	Quantity of flue gas	kg/hr	4378
10	Quantity of heat available in flue gas	kCal/hr	60415
11	Rise in combustion pre-heat temperature	°C	48.8
12	Savings in terms of fuel from pre-heated combustion air	%	2.32
13	Savings in terms of fuel	kg/hr	4.92
14	Annual operating hrs.	Hrs.	3600
15	Annual savings of fuel	kgs	17702
16	Annual cost savings	Rs/yr.	88509
17	Cost of air pre-heater	Rs	200000
18	Pay-back	months	27.1

* Every rise of 21ºC in combustion air pre-heat temperature through waste heat recovery would offer about 1% fuel savings.

Implementation at a glimpse

Thermic fluid exist with economizer at Simandhar Fabtex

Air pre heater installed at Simandhar Fabtex

Implementation references

Economizer and air-preheater has been successfully implemented in the following units in Pali:

- M/s Simandhar Fab Tex Pvt. Ltd.

The benefits achieved by the plant has been summarized in the table below:

Energy Efficient Technology implemented	Investment (INR Lakhs)	Simple Payback period (months)	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
Economizer in Thermic fluid exit	1.84	6	10.24	63.97	304.40
Air-preheater (APH) in steam boiler	2.00	26	2.43	15.20	72.32

for more information

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