STEAM TRAPPING AND CONDENSATE RECOVERY SYSTEM FOR JET DYEING MACHINES

(*For Surat Textile Cluster*)

Cluster Brief:

Surat, known as the synthetic capital of India, is house to about 400 textile processing units, involved in processing of synthetic sarees and dress materials. The textile processing units can be broadly classified into 'Dyeing' units and 'Printing' units. Most of the units have the facilities of both dyeing and printing. The sarees and dress materials produced in Surat cluster are not only marketed in India but also exported to various countries. The textile processing units in Surat, are mainly micro, small and medium enterprises (MSMEs) and are spread over various location like Palsana, Sachin, Pandesara and Surat city industrial areas. The main raw material for the cluster is polyester grey cloth which is sourced from local polyester producers in and around Surat. Majority of the industries located in Surat are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid, leading to a high share of energy cost. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

Existing practice:

Steam at a working pressure of 3-4 kg/cm^2 is used in the textile processing units in a number of machines. For e.g. zero-zero machines are used for finishing operations wherein the fabric is rotated in circular rubber drum with blanket of steam rotating around it. Similarly, jet dyeing machines are used for pressurized dyeing (colouring) process, used mainly for polyester based fabric. A significant amount of steam is lost during the heating operation of the jet dyeing process, as the portion of the latent heat is transferred to the equipment line resulting in condensate formation. Also, a significant amount of steam is transformed to condensate during the cooling cycle of the jet dyeing process. In addition to these, heat available in exit water generated during the process is wasted during the water recycling process. Not wasting, but rather recovering and reusing as much of this sensible heat is possible through installation of condensate recovery system. Also in typical units, no traps or thermodynamics traps are used in these pressurized steam machines. Thermodynamic traps work on the difference in dynamic response to velocity change in the flow of compressible and incompressible fluids. As steam enters, static pressure above the disk forces the disk against the valve seat. The static pressure over a large area overcomes the high inlet pressure of the steam. As the steam starts to condense, the pressure against the disk lessens and the trap cycles. This essentially makes a TD trap a "time cycle" device: It will open even if there is only steam present, this can cause premature wear. If non-condensable gas is trapped on top of the disc, it can cause the trap to be locked shut. In the current process, it was observed that the TD traps are not being able to remove condensate properly.

Proposed technology:

In order to recover heat lost through condensate, it is proposed to install a condensate recovery system in the jet dyeing machines. Condensate recovery is a process to reuse the water and sensible heat contained in the discharged condensate. The system includes a positive displacement condensate pump which can recover (suck) hot condensate and flash steam from the steam pipeline and feed the same into the boiler feed water tank. The pump may also be equipped with an in-built receiver for condensate which eliminates the need for a separate storage tank. The installation of the system will allow 80-100% recovery of condensate formed during the jet dyeing and the zero-zero process. The technology can be suitably modified for mechanical or sensor based control.

In addition to the condensate recovery system, it is suggested to install pneumatically operated float traps in steam unit of jet dyeing machine in place of TD traps. These float traps will be able to filter out condensate in the machine exit and allow steam to pass through the line. The amount of steam being discharged along with the condensate can be saved in the process.

Justification of technology selection:

Recovering condensate instead of throwing it away can lead to significant savings of energy, chemical treatment and make-up water. Condensate can be reused in many different ways, for example:

- ✓ As heated feed water, by sending hot condensate back to the boiler's deaerator
- ✓ As pre-heat, for any applicable heating system
- ✓ As steam, by reusing flash steam
- ✓ As hot water, for cleaning equipment or other cleaning applications

In addition, the installation of the float-traps in the steam utilizing units will lead to following benefits:

- ✓ Higher capacity turndown trap
- ✓ Complete Space Optimization – Area required for installation is less
- ✓ No welding required
- ✓ No Inline leakages
- ✓ Lesser Radiation losses
- ✓ Reduced transportation costs

Steam generated by a boiler contains heat energy which is used to heat the product. When steam loses it energy by heating the product, condensate is formed. Also, a part of energy contained by steam is lost through radiation losses from pipes and fittings. After losing this heat, steam gets converted into condensate. If this condensate is not drained immediately as soon as it forms, it can reduce the operating efficiency of the system by slowing the heat transfer to the process. Presence of condensate in a steam system can also cause physical damage due to water hammer or corrosion. A Steam trap is an automatic drain valve which distinguishes between steam and condensate. A steam trap holds back steam & discharges condensate under varying pressures or loads. The steam traps should have good capacity to vent out air and other non-condensable gases quickly while holding back the live steam.

Energy & monitoring saving:

For calculating the energy and monetary benefits, a typical case of a textile processing unit using 8 tph steams is considered. The benefits envisaged through installation of condensate recovery and steam traps have been summarized in the table below:

Parameters	Unit	Existing	proposed
Steam generation	kg/h	8000	
Steam consumption in Jet dyeing	%	25	
Condensate recovery	%	0	80
Recovered condensate	kg/h	1600	
Heat saving	kcal/h	44800	
Fuel saving	kg/h	11.7	
Annual fuel saving	t/y	43	
Monetary saving annually by fuel	Rs Lakh/y	1.8	
Annual RO water saving	t/y	5856	
RO water price	Rs./KL	45	
Monetary saving through condensate recovery	Rs Lakh/y	2.6	
Total Estimated investment	Rs Lakh	6	
Total Monetary saving	Rs Lakh	4.4	
Simple payback period	years	1.37	

The benefits can be summarized as:

- ✓ 2-3 % reduction in specific fuel consumption
- ✓ 15 – 20 % saving in annual RO water consumption
- ✓ Reuse of sensible heat which would have lost in condensate

Replication Potential:

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 20% in the cluster. Based on 20% replication, the overall project benefits will be as follows:

Parameter	Units	Value
Annual fuel saving (one unit)	t/y	43
Annual thermal energy saving (one unit)	MJ/y	863789
Annual fuel saving (considering 20% replication)	t/y	2751
Annual CO_2 emission saving (one unit)	tCO_2/yr	86
Annual CO2 emission saving (considering 20% replication)	tCO_2/yr	5506
Estimated investment in technology (one unit)	Rs in Lakh	6
Estimated investment in technology considering 20% replication (assuming price down due to demand aggregation)	Rs in Lakh	704
Total Investment	in million USD	1
Life time energy saving	TJ	9
Life time CO_2 saving	tCO_2/yr	55061