Textile Processing Water Conservation - a case study

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Abstract
To control the production cost, utility (water, steam and power) cost control is required and important. In a well-disciplined organisation, the utility cost to produce 1 kg of the textile should be properly monitored and controlled as per proposed benchmark standards. Among these three utilities, water is a very important utility as it is impacting on the production cost as well as the environment also. To optimize water consumption and hence effluent generation, the water conservation audit in the process house is a required and recommended activity. In this paper, a case study of a water conservation audit in one of the textile woven processing units is discussed with facts and figures based on the actual production data. The illustration of water monitoring and preparing a water balance, estimation of processes water consumption and machine/process is a wise effluent generation with opportunities for hot water recycling to reduce the water footprint is discussed in the paper. As an audit outcome, at least a 15% reduction in the water footprint in the process house was found to be possible. Textile processing mills can avail of this BTRA expert services for their unit.

Key words:
Water conservation, Textile processing, Recycling and reuse, Effluent, CRP, Water footprint, Steam

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1.0 Introduction

The four types of utilities i.e. water, steam, air and electricity are consumed while textile processing production and these utilities have their magnitude of impact on production costing, the environment, carbon footprint and pollution. Here, water as a utility is considered for conservation study. Water consumption is affecting production costing, and aquatic pollution and is indirectly related to fuel costing also. The more the water consumption the more will steam and hence fuel consumption accordingly, and thus the water consumption i.e. water footprint is contributing to the increase of the carbon footprint also. To reduce the water footprint, every textile process house should think and act for water saving wherever possible. Water saving is one aspect of water conservation. In totality, water conservation is the practice of making and understanding the total water balance, using water efficiently to reduce unnecessary water usage and wastage, finding the opportunity for maximum recycling of cold and hot water, reuse of the less contaminated water in the process again etc. So, to do this, the management should have a clear focus, actions and systems for

- Making and understanding the water balance
- Estimation of the water consumption for various machines processes and activities
- Estimation of evaporation losses during the process
- Estimation of effluent generation
- Maximum possible recycling and reuse

The BTRA Mumbai is involved in water conservation audits for textile processing units. This ent paper deals with the audit outcome of one of the fabric processing units. The savings effort made by the process house and further potential saving scope are discussed in this paper. This study outcome will be a guideline for other units. The information shared here may not fit as it is to all the textile process houses. The audit outcome will be depending upon their product mix, water input source, processing machine automation and set-up, process routes followed, work culture, customer quality requirements and type of effluent treatment plant and automation done on the machines.

Thus audit outcomes may vary from plant to plant. We suggest every textile process house should do this activity for business sustainability and cost control. The BTRA Mumbai is actively doing the water conservation audits of the process houses with the help of shopfloor experienced and qualified team of technicians.

In the present paper following aspects are discussed;

- Current water balance
- Monthly specific water consumption data
- Estimation of water consumption processes
- Estimation of water evaporation – processes

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- Estimation of effluent generation
- Hot water generation and potential consumption areas
- Water monitoring status and expectations
- Leakages and wastages

2.0 Current water balance

Water balance is the accounting of the water withdrawal from different input sources, water consumption for process house, boiler and domestic use, recycling of non-contact water, recycling of process water after RO treatment, evaporation losses and discharging of wastewater. A water balance helps you to understand and manage water and effluent efficiently, identify the areas with the greatest opportunities for cost savings, and detect leaks. The water balance for the processing unit under study is given in the below Table no. 1

Table 1 – The water balance for the processing unit

Sr. No.	Details	Quantity (KLD)
Water Source		
1	Industrial District corporation intake	3320
2	Borewell water (Max discharge 10 KL/HR)	100
3	Rainwater Harvesting	70
4	Recovered (RO recycle + steam condensates from MEE, CRP + machines)	2780
	Total	**6270**
Consumption		
1	Domestic use	310
2	Process house (fabric processing)	**4680**
3	Weaving	120
4	Made-ups	50
5	Boiler (Steam Condensate + RO recovered)	**820**
6	ETP	40
7	Gardening	250
	Total water consumption	**6270**
Effluent Generation		
	Coloured / Non -coloured	**5200**
Discharge		
1	Coloured / Non -Coloured after treatment to CETP	**2420**
Recycle		
1	RO Recovered	2120
2	MEE Recovered	180
3	Machine condensate	130
4	CRP condensate recovery	350
	Total	**2780**
Losses		
1	Process Loss	400
2	Domestic Loss (canteen + domestic use+ gardening)	270
3	Other Losses	400
	Total	**1070**

Note:- KLD means Kilo litres per day

The above water balance shows that major water consumption is at fabric wet processing and then for steam generation boiler. About 45 % of water is recovered, recycled and reused in the process house again and freshwater demand is about 55 %. The freshwater demand can be further reduced by increasing recycling through RO and steam /vapour condensates.

3.0 Monthly specific water consumption Data

The fabric production data for the period of April 2021 to Sept 2021 was analysed for total plant water footprint and processing water footprints as given in table 2. On average 53.9 litres of water is consumed for fabric processing and overall factory operations 80.8 litres of the fabric is consumed per kg of the fabric finished.

Table 2:- Overall plant and fabric processing water footprint

Month	Production in kg/month	Source (KL per month)	Consumption (KL per month)	Discharge (KL per month)	Specific water consumption for processing (Lit/kg)	Overall plant water footprint litres/kg
Apr-21	2474000	184700	129660	72800	52.4	74.7
May-21	2350000	198660	128540	73500	54.7	84.5
Jun-21	2293930	179860	127530	72100	55.6	78.4
Jul-21	1733300	176980	110750	71300	63.9	102.1
Aug-21	2412000	185760	119900	72600	49.7	77
Sep-21	2382200	176770	119320	70300	50.1	74.2
Total	**13645430**	**1102730**	**735700**	**432600**	**53.9**	**80.8**

To find out the water-saving opportunity areas, the process-wise water consumption data was estimated with the help of process knowledge/experience, process requirement, machine type, flow meter readings wherever available etc. Table no.3 shows the estimated water consumption for various wet processing machines.

Table 3:- Process-wise water footprint and benchmarking against BTRA standard [1]

Process	Water consumption	Benchmark water consumption
	Litres/kg	Litres/kg
Pretreatment	17-20	14-20
Dyeing by pad steam (CDR)	12-14	16-20
Dyeing by CPB and washing on the washer	25-26	15-20
Dyeing by pad dry and wash on washer 2	25-27	15-20
Printing	34-38	30 -45
Finishing	1-1.5	1- 1.5
Width stretch for printing	2-2.5	1- 1.5

Based on the above table and when comparing the present mill water consumption process-wise against BTRA Benchmarking norms, it was observed that the water consumption is under control except for the reactive dyed fabric washing on the washer. So, it is recommended to monitor the washing process more strictly for water metering(measurement) and leakages. During the audit, it was found that the leakages were more on the washer machine. Practically, it was observed that in both the washers, the water consumption was on the higher side i.e. 25-27 litres/kg of the fabric. The optimization of water consumption needs to be done at the washer through the correct monitoring and water inlet control and avoiding leakages. Also, the water consumption on the stenter for the width stretching process is on the higher side due to excess overflow from the padding trough.

4.0 Estimation of water losses:-

The water losses in the system are pertaining to evaporation losses during fabric drying, gardening water, water losses due to evaporation of the water from the floor, steam losses to the air, vapour losses from hot/boiling baths and all the heating baths etc. The following table gives the estimated quantification of the water losses in various forms. There is no flow meter generally used for water loss estimation. This has to be done on the basic process sequence followed, no time fabric dried, steam consumption, evaporation from a hot bath, steam condensation, process experience and engineering calculations. The below table no. 4 gives the estimated quantification of the water losses in the system. This also should be comparable with the difference between water consumption and effluent generation in the processes. In this case, major water losses are due to water evaporation in the drying process and gardening.

Table 4:- Estimated water losses:-

Water losses reason	Quantity KLD
Process loss - Water evaporation during the fabric drying	230
Process loss - Weaving and sizing	120
Canteen /domestic losses	20
Gardening	250
Other losses (floor water evaporation + excess steam losses to air, vapour losses from hot baths and other invisible losses etc)	400

3.0 Estimation of Effluent generation:-

While estimating the effluent generation quantities, all the possible sources should be considered. Here also, at each machine generally no flow meters are used at the drains. Hence, this estimation has to be done based on certain calculations and assumptions. This quantification is important because it will give an idea about the level of steam condensation, and pollution generated by each process and machine. The following table 5 gives the estimated data for the same based on a one-month production. Pad steam machine, Pretreatmentrange(PTR), pad steam, washing /soaper machine and printing colour kitchen are the major effluent generation processes.

Table 5:- Estimation of machines' effluent generation

Machine name	Avg Production	Estimated effluent generation
Unit-->	KG/Day	KLD
singeing quenching for machines 1 and 2	81000	100
PTR 1 and 2	81000	1020
Merceriser 1 and 2	50000	130
Pad Dry 1 and 2(Monforte)	22000	15
Pad steamer water seal water for machines 1 and 2	30100	280
Pad Steam 1 and 2	30100	480
Washers 1 and 2	22000	480
Jiggers and VDR	8010	155
Printing 1 and 2 with colour kitchen including engraving and washing	16500	320
All stenters finishing and width stretching	112000	65
Weaving and sizing	-	20
Made Up	700	60
Canteen and domestic water	-	290
CRP steam condensate, cooling water and vapour condensate	-	1400
softening plant backwash	-	120
Boiler blowdown	-	50
Leakage and others	-	130
Total Effluent generation in KLD		**5115**

6.0 Hot water generation and reuse possibility in the plant

During the water conservation audit, the hot water generation points were detected/identified and based on the water temperature and quality, the possibility of reuse of the same was thought and accordingly the suggestions for reuse were given. The below table no. 6 gives the quantification of the hot water generation and its current status in the mill.

Table 5:- Estimation of machines' effluent generation

Sr. no.	Hot water generation point/ activity	Appr. flow rate KLD	Temp. range °C	Status
1	CRP steam Condensate	90	90-95	Drained to Gutter and ETP
2	CRP vapour condensate	310	60-70	Drained to Gutter and ETP
3	CRP cooling water	1000	50-60	Drained to Gutter and ETP
4	Jiggers power pack cooling water	180	40-45	Recycled
5	Singeing burner cooling water	100	45-50	Recycled
6	AC panel cooling water	990	40-45	Recycled
7	VDR cooling cylinders water	810	40-45	Recycled
8	Sanforize rubber cooling water	100	40-4s	Recycled

From the above table, it is clear that reusable hot water is about 1400 KLD. From this 1400 KLD, steam condensate water can be used for boiler feed water. CRP vapour condensate and cooling water can be reused for mercerised, PTR and soaper machines. As estimated, the hot water demand from these machines is 1360 KLD. As per audit findings, at present about 200 KLD of hot water was being reused. So, there is a scope of 1160 KLD hot water for use at these machines. The potential steam saving by implementing this will be 45 tons per day and in terms of Rupees, it will be Rs. 112500 per day (at the rate of steam generation costing of Rs 2.5 per kg). In addition to this, by implementing this hot water reuse, the water footprint can be reduced by at least 15%

Requirements for the above implementation:-

i) We recommend installing an online condensate contamination detection system so that CRP cooling water, as well as vapour condensate, can be monitored for pH and TDS. This demands high-level maintenance of the CRP unit to avoid the carryover of caustic lye traces. Also, periodically once in a shift the TDS, pH along with iron contamination should be verified manually and maintain the record for the same. This will avoid the chances of the use of contaminated water and fear of the same.

ii) The level control system working on the hot water tank should be ensured with updated logic and sensors so that an uninterrupted water supply will be there to the process house either hot or cold through the same valve system to the machines. This is for avoiding valve operations change manually when hot water (vapour cooling water and condensate water) is not available.

7.0 Water monitoring system and requirements

Monitoring and measurement are the two most important aspects of ineffective industrial water management. if you cannot measure it, you cannot conserve it. You can't manage what you don't measure.

Metering here refers to measuring water flow rates and quantities at various points of use. These readings of water measurement at various points can be developed into a database or water record of a particular premise or industry or process. Most of the machines were found to be equipped with the metering system in place. The details are given in table no. 7. For the machines as well as water-intensive areas where there is no measurement, the BTRA audit team suggests implementing a metering system for proper quantification.

Table 7:- Status of the water metering system:-

No.	Department	Machine name	Water in Flowmeter availability (Yes/no)
1	Pre-treatment	PTR 1 and 2	Yes (on the machine)
		Mercerizer 1 and 2	Yes (on the machine)
2	Dyeing	Pad-steam –1 and 2	Yes (on the machine)
		Pad-dry 1 and 2	Yes (on the machine)
		Washer -1 and 2	Yes (on the machine)
		Colour kitchen	No
3	Printing	Printing 1 and 2	Yes (on the waterline)
		Colour kitchen	No
4	Finishing	Stenters (for washing)	No
		Chemical preparation	No
5	Weaving	Sizing department	No
		Compressor cooling	Yes (on the waterline)
6	Made-ups and washing		No
7	Gardening		No
8	Boiler feed water		Yes

The above listing can be further expanded as areas other than processing are considered. It is recommended that every consumption point should have a water metering system.

8.0 Leakages and wastages

During the study of water conservation at the following point leakages and water wastages were observed by the BTRA team

- Leakage was observed in both the Pretreatment range at water line joints
- Water leakage from the water seal of both pad steam unit
- Washer machine leakages at the joint of the washing compartment
- Through leakages at the washer machine
- Jigger machine through leakages
- Mercerizer washer bearing seal leakage
- Eye washer leakage in the chemical store
- Printing colour kitchen auxiliary pipe valve leakage (continuously flowing)

9.0 Conclusion

To understand and estimate the overall processing water footprint per kg of the fabric a comparison against the proposed benchmark water conservation audit was conducted. It was a systematic attempt to find out the water wastages/ leakages areas, water consumption pattern process-wise and machines, estimation of water losses in the system, estimation of processes machines effluent generation, the water recycling possibilities in the system based on the water quality requirement, hot water generation and reuse possibilities in the process house and estimation of possible steam saving. Steam savings of at least 3 Cr were possible by implementing the suggestions in the report.

In general, depending on a plant's work culture, product mix, types of processes, process routes, machinery types and automation, Water flow rates in the washing compartment, M:L ratio, proper planning at washing machine, present water consumption level and effluent treatment plant and recycling capacity etc, the scope for water saving varies.

The BTRA Mumbai is having the required expertise for conducting water conservation and also energy audits. The mill may contact an email 'tsd@btraindia.com' for the same.

References

1. BTRA norms for chemical processing, special publication volume 08.2.40 April 2021