WATER AND ENERGY EFFICIENCY POTENTIAL IN THE TEXTILE SECTOR WITH BEST WATER MANAGEMENT PRACTICES (BWMPS) IN PAKISTAN

By

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Abstract

Textile processing sector is one of the major water intensive sector in Pakistan. It consumes more water than spinning, weaving and garment manufacturing, so processing is the major contributor of the industrial pollution in Pakistan. There are total 1545 Textile processing units in Pakistan out of which 1395 lies in Punjab[1]. The effluents from the textile processing sector are directly discharged into the water bodies without any treatment. Each Individual industry couldn't afford the treatment plant. The pollution of the industrial processes can be controlled in house or off house by some treatment. WWF-Pakistan in partnership with WWF-UK and Cleaner Production Institute (CPI) launched a project funded by European Union for the water efficiency and pollution reduction in the 4 industrial sectors[2]. This paper will share the potential of the textile processing SMEs for the reduction of water consumption, pollution reduction and energy efficiency by the adoption of Best Water Management Practices (BWMPs) in Pakistan.

Introduction

Textile is the largest industrial sector of Pakistan with respect to production, export and labor force employment. Pakistan is the 8th largest exporter of textile products among Asian countries and 12th globally. There are about 1545 Textile processing units in Pakistan out of which 1395 lies in Punjab. The textile sector has existing established capacities of 1,550 million kg of yarn spinning, 4,368 million square meters of fabric weaving and 4,000 million square meters of fabric finishing. It contributes 8.5% of the country's GDP and 52% in the export. Major textile export products include cotton fabrics, knitwear (hosiery), cotton yarn, bed wares, readymade garments, towels, synthetic textile and raw cotton. The textile industries could be categorized in terms of small, medium, and large units on the basis of annual production. The small units process below 10 million meters of fabric annually, medium units annually process between 10 and 20 million meters of fabric while large units process in excess of 20 million meters of fabric annually[3].

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1. Pakistan EPA, "Draft Textile Sector Report", prepared by Activity Based Capacity Development Project.
2. Press Releases , WWF-Pakistan monthly news letter March 2013
3. Baseline Data of Target SMEs, WWF-Pakistan and CPI 2013

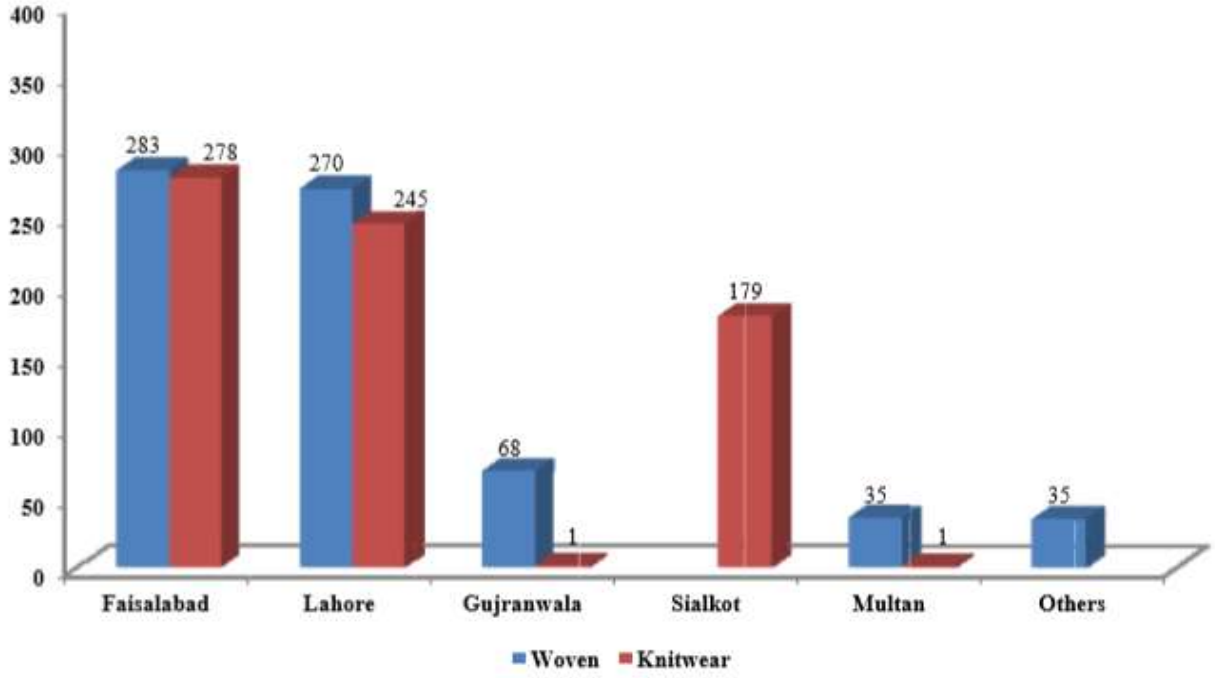

Fig.1 Number of Textile processing industries in Punjab

Utilities in the Textile Processing

Water : Water is an important utility in the wet processing of textile units. Most of the industries abstract ground water except the industries residing in the Karachi because of the deteriorating quality of the groundwater as well as more cost on deep well boring. Although the water in Punjab is going down due to over abstraction and lack of water policy, but still the groundwater is used in the industries as a common practice. The industrial demand was expected to increase to 2.268 BCM by 2025. Most of the industrial establishments use ground water and abstract it at their own expense. It was estimated by Ministry of Water and Power that until 2011 about 23,500 AF (29 MCM)[1] of water is provided to industries through municipal water supplies.

Water consumption in medium industry is comparatively higher than large and small industries. Large industries have latest high tech machinery with proper process control instrumentation to produce very good quality of the fabric. Generally, low to medium quality fabric is processed in small industry. So the small industry has limited number of machinery and conduct only selected unit processes while the medium industry processes medium to very high finished quality (export quality) fabric with the old conventional machinery. On an average, 1 kg of fabric processing requires 70—400 litres of water for the processing in Punjab province.

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1. Pakistan Water Sector Strategy ; Vol : 5 ; October 2002 ; Ministry of Water and Power of the Chief Engineering Advisor / ; / Chairman Federal Flood Commission.

Energy: Energy is another important utility in textile mills. Mostly self generation of electricity is the source in large and medium textile mills because of the shortfall or the energy crisis in the country. So the industries prefer to use some alternative resource for the continuous supply of the electricity to their industries for the production and timely delivery of the orders. Although the government's electric supply is not reliable in these days but still small textile units use government's electricity connections as primary source and diesel generators as back up facility. Electricity consumption varies from unit to unit and largely depends on the number and size of machines in operations. Electricity consumption also depends on the age and state-of-the art of machines being used in the mills.

Natural Gas / Fuel

Natural gas is an important source of energy for the textile sector. It is mostly utilized as fuel in generators, machines such as boiler, singeing, thermal oil heaters, and dryers. For large and medium units, natural gas has the key role in fulfilling energy demand because electricity is also generated from natural gas generators from which all machines, boilers and compressors are operated. Smaller units commonly rely on diesel generators and WAPDA as source of electricity. However due to high unit cost in diesel generation, units are shifting towards cheaper fuels. The supply of natural gas for generation is declining and there is little supply of gas for the power generation for 3 months of winter season. Although the gas reserves have increased from 26 TCF (2000) to 30 TCF (2007[1]) but because of more demand, the energy requirements are not fulfilled by the gas supply.

Steam is the main heating source in processing and steam boilers are used for steam generation. Their number, capacity, and running time differ, depending upon the amount of production and the types of process employed. Boilers are usually run on natural gas, though furnace oil, rice husk and wood are also used in some cases. In some industries, waste heat recovery boilers are also present which generate steam using the flue gases heat of power generators. Some anti-scaling chemicals are invariably used in boiler feed water.

Table.1 Rates of the Electricity generation and water from different sources

Source	**Rate**
Electricity from WAPDA	13—16 Rs. / KWh 6.5 (Self Generation on Gas) 26 (Self Generation on Diesel)
Natural Gas Steam	1,500--1,600 (Rs. / Ton)
Coal steam	2,000--2,500 (Rs. / ton)
Fresh Ground Water	3--4.50 (Rs. / m^3 of Fresh Ground Water)

1. Pakistan Energy Yearbook 2007.

Waste water Pollution

The total annual quantity of waste water produced in Pakistan is 4,369 MCM including 1,309 MCM from industrial use. The total waste water discharged to the major rivers is 1782 MCM (about 1/3rd of all waste water), which includes 344 MCM of industrial effluents.[1] Textile processing being a big shareholder of the water consumption produces waste water and discharges directly into the water bodies without any treatment.

Following processes are the main sources of waste water generation in the textile processing as

a) Desizing

b) Bleaching / scouring

c) Mercerizing

d) Dyeing

e) Printing

f) Color Kitchen

g) Boiler

h) Cooling water wastage

i) Screen Development Section

j) Screen Stripping Area

k) Laboratory

Fig.2. Waste water discharge from the processing of fabrics

Fig.3 Water wastage and contamination at printing process

The waste water pollution comes in terms of BOD, COD, TSS, TDS and metal contamination which are directly or indirectly discharged into the water bodies. This waste water is having high organic load and contributes the pollution into the water bodies and deteriorates the Dissolved Oxygen of water which affects the aquatic life. The main process of the waste water creation is mercerization process.

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1. CPI data base 2010. *Implementation mechanisms of environmental protection regulation by A.F. Furguson and Co.*

Characteristics of process waste water vary from industry to industry depending on the technology in use and in-house operational practices.

Table.2 Characteristics of Woven Textile Processing waste water

Parameters	Dyeing (mg/l)	Dyeing-Printing (mg/l)	NEQS of Inland water bodies (mg/l)
pH	8.3—11.7	6.3—12.0	6—9
BOD (Biochemical Oxygen Demand)	200-570	300—480	80
COD (Chemical Oxygen Demand)	640—1,200	880—1130	150
Total Suspended Solids (TSS)	320—940	200—440	200
Total Dissolved Solids (TDS)	1280—1540	1000—1900	3500
Chlorides (Cl^{-1})	400-750	90—1100	1000
Chromium (Cr)	0.5—3.6	1.5—12.6	1
Copper (Cu)	0.4—0.5	0.10	1

Note: All parameters are in mg/l except pH.

Table.3: Characteristics of knitwear processing waste water[1]

Parameters	Values (mg/l)	NEQS into inland water bodies (mg/l)
BOD (Biochemical Oxygen Demand)	100—300	80
COD (Chemical Oxygen Demand)	300—800	150
Total Suspended Solids (TSS)	200—440	200
Total Dissolved Solids (TDS)	1000—1900	3500
Copper (Cu)	0.1	1

Initiatives for the water conservation

WWF-Pakistan in partnership with WWF-UK and Cleaner Production Institute (CPI) launched a project entitled **"City wide partnership for sustainable water use and water stewardship in SMEs in Lahore, Pakistan"** funded by **European Union.** This is a three years project (from 2013—15) with a major focus on the urban based SMEs which are water intensive and contribute major pollution into the vicinity. The project has a particular focus on water use and water management in cross-sectoral, urban based high water using industrial sectors (Textile processing, Sugar, pulp and paper and leather sectors) by the adoption of Best Water Management Practices (BWMPs). This

1. Cleaner Production Institute Database 2013.

project also involves the capacity building of the workers as 30 % water and energy is lost by the ignorance of workers and mismanagement within the production processes.

Best Water Management Practices (BWMPs) in the Textile processing

A number of industries were audited under this project and it was observed that the average water consumption per industry varies regarding to the production and the raw material. There are a number of Best Water Management Practices (BWMPs) in practice in the world but here are the few ones on the basis of the surveys of the industries. By the adoption of these BWMPs, the industry can reduce roughly their energy water consumption upto 30% easily per unit production of the final product.

1. Installation of Automatic Water Shutoff Valves and flow meters

It is generally observed that water inlets to machines are not shut off and remain open, while the machines are not in use. During process disruptions, especially, workers are inclined to keep the water running. The water wastage and, consequently, unnecessary increases in the waste water quantities, are particularly significant in the water-intensive machines like pad steam dyeing, rotaries and rope washing machines. This water wastage can be controlled, by installing automatic shutoff valves on the water inlets. Also the flow meters should be installed at the water and gas flow so that the quantity of the water could be observed during the working. Two types of automatic valves can be employed, depending upon the nature of the machine and whether the water filling operation is to be manual or automatic:

i. Spring-operated Nozzles on Water Hoses

ii. Automatic Motor-operated Control Valves

Fig.4 Water Flow meter

Fig.5 RO water flow meter

2. Improvements in Working Practices in Chemical Use & Storage Areas

In order to minimize the soil and waste water pollution, owing to leakages and accidental spillages of the chemicals in chemical use and storage areas, following recommendations are made:

i. Chemical Storage with Catch Pans: A raised metallic mesh platform; with an underneath metallic tray (containment) to act as catch pan, can be used for storing the chemical vessels.

ii. Plugging of Floor Drains in Chemical Use & Storage Areas: Floor drains, lying in the chemical use and storage areas, shall be plugged, so that any chemical spilled on the floor, do not get into the waste water streams.

iii. Use of Dry Cleaning Methods: In order to reduce the quantity and pollution load of the waste water stream, the chemicals, spilled on floors, shall be cleaned by employing some dry cleaning method and not by direct water washing. Washing of floors with water, when required, should only be carried out, after ensuring that floor is practically free of any liquid or powder chemical contents.

3. Proper showering of Water at Coal Fired Boiler Exhaust Flue Gases Treatment System

It was observed that around 4-5% of total water consumption is used for showering in cyclones to capture fly ash from the exhaust flue gases. In cyclone type scrubber one basically require proper size of droplets at showering point instead of heavy flows of water. It is suggested that first industry should optimize the consumption then use Reverse Osmosis (RO) rejected water for shower instead of using fresh ground water.

Most of the contamination is in suspended form so industry should make a settling pit for the water so that fly ash or contaminants are settled down and do not go to the main drain.

4. Monitoring of Water, Chemicals and Energy Consumption

Consumption of water, chemicals and energy shall be continuously monitored and a record should be maintained thereof. These data and information can then be used for the following purposes:

1. Establishing losses and wastages of resources, including water, chemicals and energy, in the processes.

2. Identification, planning and designing of effective resource conservation measures.

3. Establishing the effectiveness and efficacies of various adopted measures for controlling the consumption of water, chemicals and energy.

5. Reuse of Mercerization 2nd and 3rd Wash Water Streams for Preparing Scouring Bath

Both scouring and mercerization processes use caustic soda, in high dosages. Scouring bath generally contains 8-10% of caustic soda by weight. Savings in chemical consumption, of the order 5-10 % of the caustic soda used in the scouring process, can be made, if the 2nd and 3rd wash-water streams of mercerization, which still contain some amounts of caustic soda, are used for the preparation of the scouring bath.

6. Use of RO Rejected Water

Most of the industries discharge the RO rejected water into the drains. The RO water requires a lot of energy for purifying the water so probably 4% of the total water consumption is used for the RO consumption. This water is used in very fine processes of solution making, blanket washes etc. Although these rejected water is rich in TDS but could be used in different processes such as for the floor washing and showering of water in scrubber at exhaust flue gases treatment, in blanket washing and for the flushing system, and for the flushing etc.

7. Heat Recovery from Waste water by Heat Exchangers

The Heat energy can be recovered from the hot waste water streams originating from different processes by the installation of heat exchangers. This energy can be recovered from scouring, bleaching, dyeing and washing, between the waste water and fresh water to be used for different washing process. The capacity of the heat exchanger will vary with the discharge of the machine. The temperature rise would be in the range of 50-60^{0}C. This measure will reduce steam consumption for heating the baths. The heat exchange system shall comprise the following components:

~ Buffer tanks for storage of hot waste water and heated water

~ Pumps

~ Heat exchanger (tube type)

~ Piping

~ Process control equipment

Industry should install heat exchangers on hot washings of bleaching plant before and after steamer. Similarly heat exchangers are required on hot washings of Printing Table (PAD) steam dyeing and mercerizer.

8. <u>Reuse of Oil Heater Cooling Water Streams</u>

Industry uses around 2% of fresh ground water in thermal oil recirculation pump cooling. This is slightly warm and clean water at around 37^{o}C temperature. Industry should store this water in a pit and reuse in utility area. It can be used in showering at cyclones of coal fired boilers placed nearby.

In order to avoid the accidents, the flow of the cooling water should always be visible prior to storage/reuse.

9. <u>Use of Counter-current Washing Method</u>

Counter-current washing process is a continuous washing process, in contrast with the conventional batch washing processes, carried out in rope washing machines, winches and jets. Counter-current washing technique should be applied on bleaching plant, PAD steam dyeing and mercerizer washings. Conceptually the counter-current washing is a multi-stage washing process, in which the least contaminated water from the final stage

of washing is reused for the next-to-last wash and so on, until the water reaches the first wash stage, where it is then discharged. This can be achieved by placing a number of washing basins in series. The water saving of the order of 50-60 %, of that consumed in conventional washing technique, can thus be achieved. Although counter-current washing equipment has low operating costs and offers water and energy savings, it has a relatively high capital cost.

Fig.6 Counter Current or solomatic washing

10. Pressurized Nozzles

About 10-15% of the industrial fresh water is used for screen washings, rotary printing machine solution pipes washings, machine washings, floor washings throughout the plant. The amount of water could be reduced by the usage of pressurized nozzles for washing the screens provided with reduced diameters of the pipes.

Conclusions and Recommendations

There is much potential in the textile sector for the water and energy conservation. From the above discussion, it is concluded that the major portion of the water is wasted by the ignorance and unawareness of the workers. The summary of the above techniques is as under:

- The industry usually uses around 5% of total water consumption for showering of fly ash from the exhaust flue gases. This water could be conserved by reusing of RO rejected water.

- The progressive Industry uses around 1.5—1.8% of fresh ground water in thermal oil recirculation pump cooling. Industry should store this water in a pit and reuse in utility area.

- Properly handling the chemicals could save the chemical consumption as well as the water consumption by separating the chemical drains from the other drains.

- By the installation of counter current flow washing, industry can save about 50-60% of water used in the conventional system.

- By the installation of heat exchangers and reuse of heat recovered in different processes.

- Reuse of Mercerization 2nd and 3rd Wash Water Streams for Preparing Scouring Bath could save 8-10% of the caustic soda consumption as well as reduction of the water and energy.

If we implement all the above techniques for water saving, so roughly about 30% water could be saved in each industry by only small amount of capital cost.

There are many other Best Water Management Practices (BWMPs) practices which could be adopted by the industry and it could save its water and energy by simple techniques. Some of these techniques are as below:

- Installation of water dye tray in the printing table

- Use of soft water in the dyeing

- Use of Hydrogen Peroxide for Bleaching instead of Sodium Hypochlorite

- Reuse of Jigger Dyeing Last Rinse Water for Makeup of Dye Bath

- Use of Solomatic Bleaching