Water Efficiency in Textile Factories

Promotion for Sustainability in the Textile and Garment Industry in Asia-FABRIC

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

Water Efficiency in Textile Factories

11:00 – 11:45

Prof. Dr. Florian Schindler,

Director, Institute of Distance Learning,

Berlin University of Applied Sciences and Technology, Berlin Germany

on behalf of giz FABRIC and adelphi consult GmbH Berlin

Water Efficiency Issues

i. **Lack of knowledge and awareness (skills and training)**
ii. **Nonrealization of importance of water (knowledge)**
iii. **WATER IS FREE - resource consciousness (wasteful attitude)**
iv. **No metering, No monitoring, No management (management system)**
v. **Old and inefficient machines (investment)**
vi. **Lack of maintenance (operation and maintenance)**

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

Water Scarcity - Water Footprint

The Asian Development Bank (ADB) has pinpointed many countries as water-stressed countries

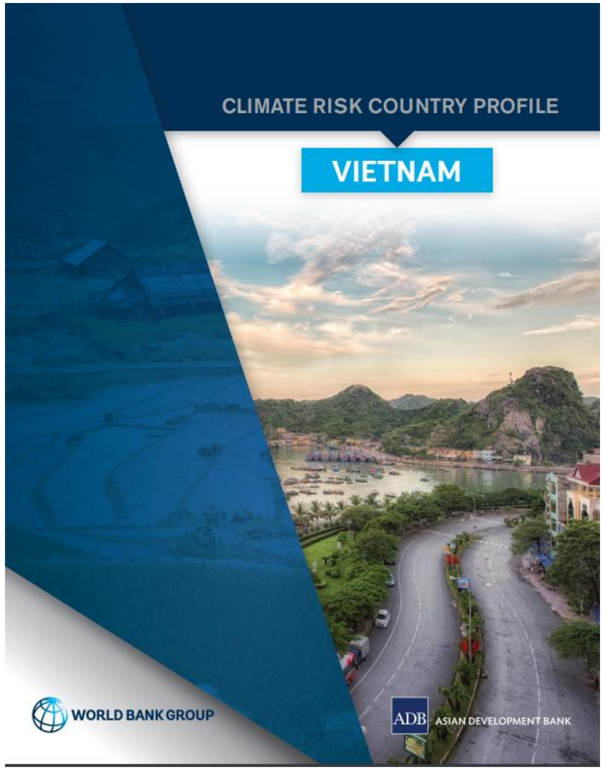
Vietnam's water resources already experience significant pressures from human development processes.

Key issues

- over-utilization of groundwater,
- land-use changes (notably to aquaculture)
- Rapid urban development

Research has focused on the development of systems for more efficient water management and ensuring water security.

- Strategies need to be devised to **Reduce, Reuse and Recycle (RRR)** water for industrial and domestic use.
- **Increasing water-use efficiency** and productivity will be made possible if the stakeholders are made knowledgeable about the urgency of the deteriorating water scarcity situation,
- **Capacity building to conserve and maximize reuse water** at all levels incentivizing to recover the used water

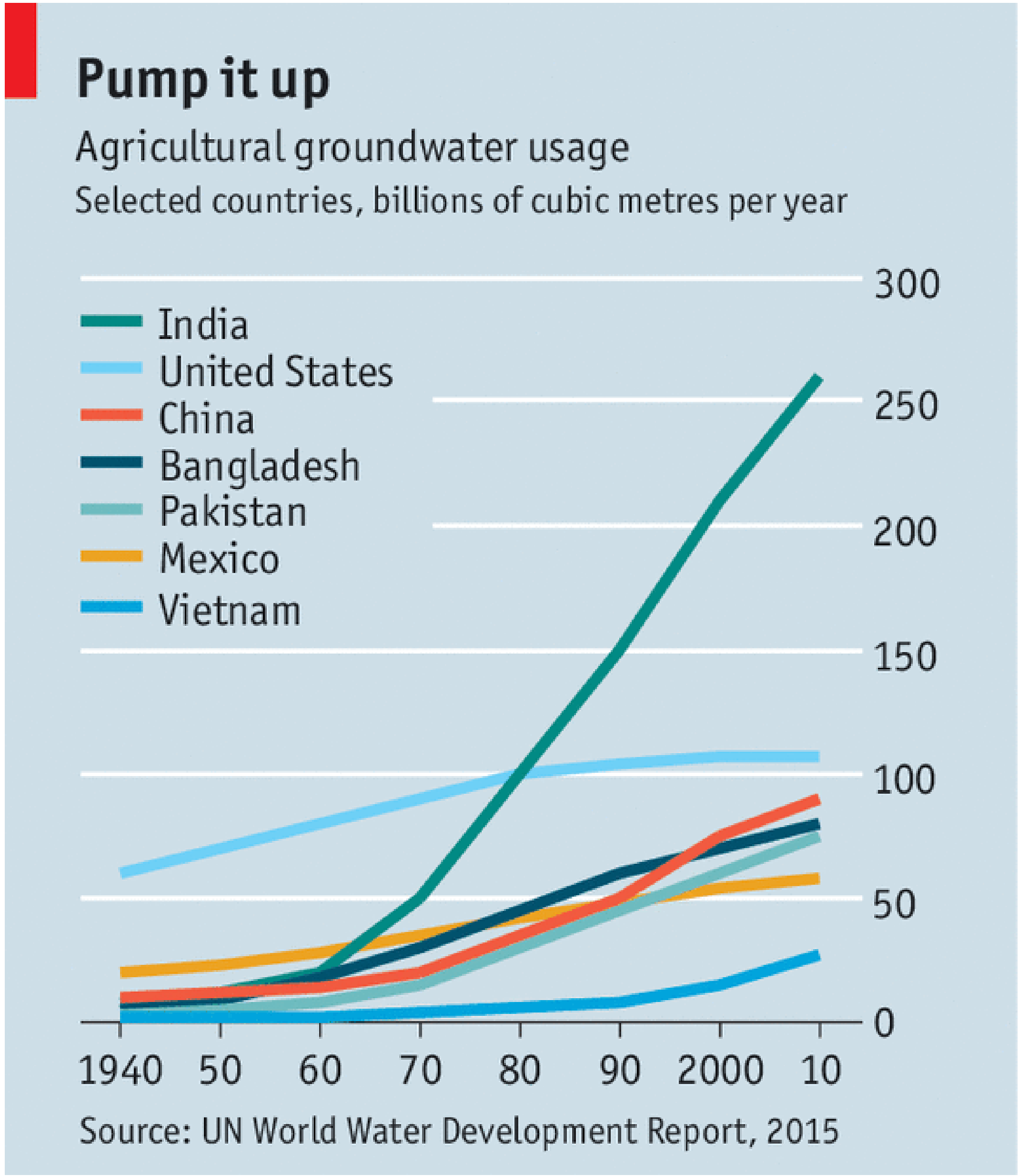


2021, ADB / WB World Bank Group, Washington

https://climateknowledgeportal.worldbank.org/sites/default/files/2021-04/15077-Vietnam%20Country%20Profile-WEB.pdf

last review: 07.06.2022

giz



Economist.com

Menu « Previous Next »

1.5.1 Typical Non-Revenue Water Rates

Non-revenue water is water which is produced however not billed due to several reasons like leakage and illegal connections. In most countries, especially in the developing world, non-revenue water rates of water utilities typically lie in the range of 40%-70% (SWAN 2011). Germany is at the other end of the range: Water losses here are on average 6.5% (VEWA 2010).

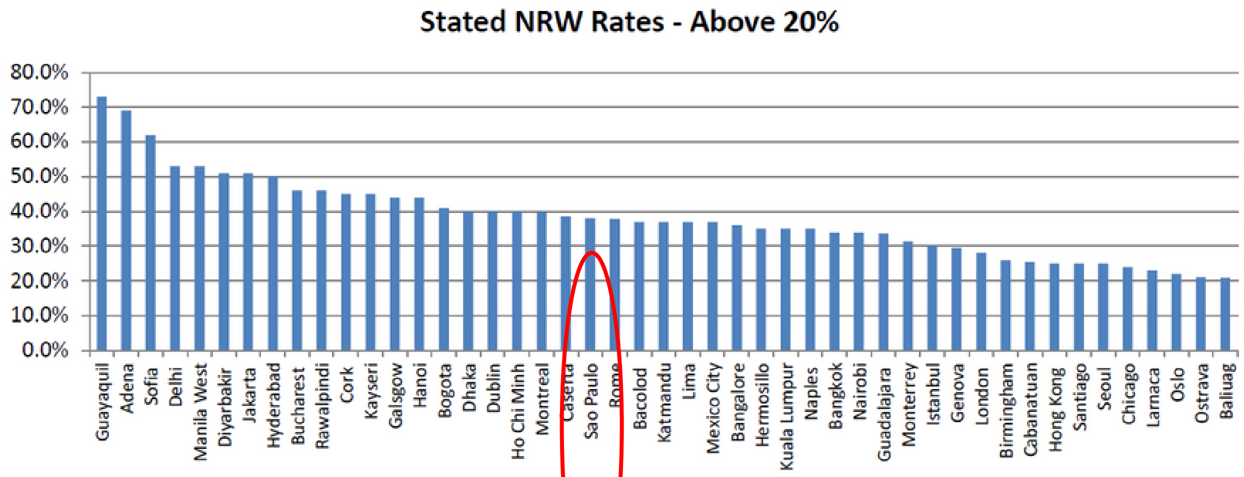


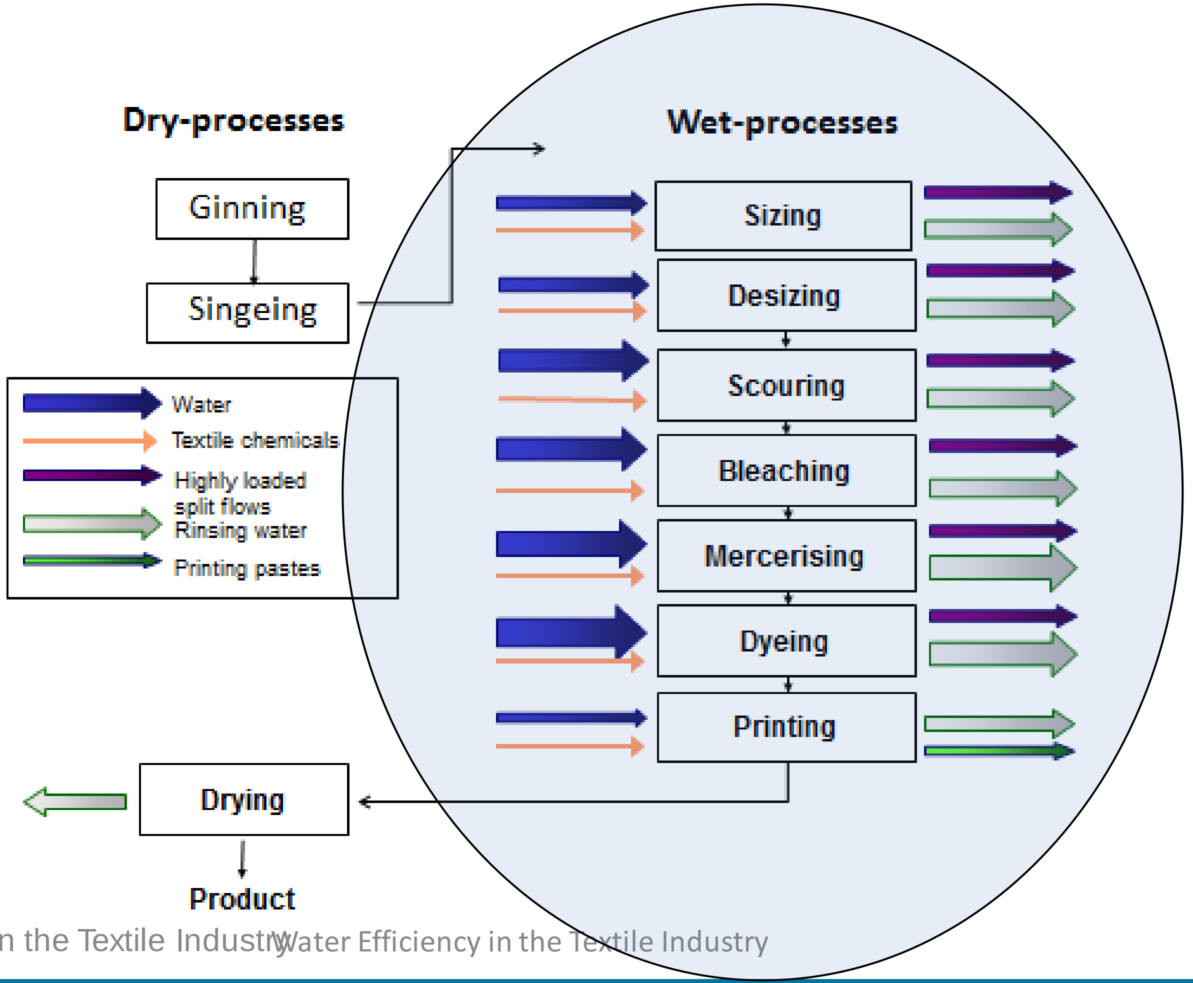
Figure 1.4: Stated NRW Rates – Above 20%

With a conservative average level of non-revenue water of 35%, the World Bank estimates the annual volume of NRW in developing countries to be in the range of 26.7 BCM, representing approximately $5.9 billion lost by water utilities every year. Halving this amount of water loss would generate considerable earnings and enough water to supply an additional 90 million people in developing countries.[15]
The share of non-revenue water (NRW) in Pakistan varies between an estimated 25% in Multan and an estimated 75% in Gujranwala. It is difficult to accurately measure NRW, because customer metering is uncommon. For example, in Punjab only 3% of connections of the five largest utilities have functioning meters and are read. Officials from major Pakistani cities reported a share of NRW ranging from 40%-50%.
In irrigation networks, water losses can also be high, depending on the state of the infrastructure. Reported losses from Central Asia can be as high as 50% – the water becomes lost through eva-poration, infiltration and leakages.

giz

The Wet Processes of Textile Finishing

Main steps involved in the finishing of clothing textiles. Processing cotton fabrics, for example, usually encompasses the following operations:



Water Efficiency in the Textile Industry

Water Use in Textile Processing

The water use can vary widely between similar operations as well. For example, knit mills require an average of 83 litres of water per kg of production, yet water use ranges from a low of 21 litres to a high of 377 litres. The data summarized in the table serve as a benchmark for determining whether water use in a particular mill is excessive.

Processing Subcategory	Min. Water Usage in Production l/kg	Med. Water Usage in Production l/kg	Max. Water Usage in Production l/kg
Wool	111	285	658
Woven	5	113	508
Knit	20	83	377
Carpet	8	47	163
Stock/Yarn	3	100	558
Non-Woven	3	40	83
Felted Fabrics	33	213	933

Ref. Textile North Carolina Division of Pollution Prevention and Environmental Assistance, 2009, May, Water Efficiency Fact Sheet, Industry Specific Processes, p. 2 based on excerpts from "Best Management Practices for Pollution Prevention in the Textile Industry," EPA, 1996

Water Efficiency in the Textile Industry

Areas of Improvement

i. **Pipes and Taps keeps on wasting water (maintenance)**
ii. **Water hoses lying on floor and keep on running water (handling)**
iii. **Large diameter water hoses/pipes are used (equipment)**
iv. **Floor and vessels washing with amounts huge water (workers)**
v. **Water keeps on running while machines are stopped (usage)**
vi. **Overflow from storage tanks (pump / overflow control)**
vii. **Rainwater collection facilities missing (Rainwater Harvesting)**

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

Areas of Improvement

vii. Extensive and uncontrolled fabric washes
viii. Leakages (Non-revenue Water)
ix. Wastage of clean streams
x. Wastage of cooling water
xi. No REUSE/RECYCLING of waste streams
xii. Wastage of RO reject /Softener’s regeneration water

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

Why water is important for the textile industry?

- **No textile production process is possible without water**
- **Textile is consuming 75% of industrial water.**
- **Water quality affects fabric quality, chemical & energy consumption and machine life**
- **MORE water means**
    - MORE chemical consumption
    - MORE electrical energy
    - MORE thermal energy
    - MORE pollution and hydraulic load of the wastewater
    - MORE treatment cost

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

giz

Cost of water

For every 1000 L = 1 m^3

Example for Pakistan

- **Pumping Cost** **3 – 4/m^3**
- **Transportation Cost** **3 – 5/m^3**
- **Water Treatment Cost (Softener)** **Rs. 10 – 12/m^3**
- **Water Treatment Cost (RO)** **Rs. 25 - 30/m^3**
- **Wastewater Treatment Cost** **Rs. 20 – 30/m^3**
- **Hot Water (80^{o}C) Cost** **Rs. 160/m^3**

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

Desizing

- In a classical finishing sequence, singeing is usually combined with enzymatic de-sizing. In the initial washing operation, desizing, the additives used to facilitate spinning and weaving, e.g., spinning preparations and sizes, as well as any impurities adhering to the material are extensively washed out.

- Acids or enzymes are used for the removal of starch, cellulose derivatives - the de-sizing process itself is usually carried out by acid or enzymatic de-sizing.

- With other sizing agents such as polyvinyl alcohol (PVA) the process is different:
- Modern plants recover the PVA by using ultra filtration (UF) membrane technologies.

Desizing

- **Modern plants in Europe recover the polyvinyl alcohol (PVA) by using ultra filtration (UF) membrane technologies.**
- **The concentrate contains the PVA and the filtered water can be recycled.**

PVA Recovery Plant

Apart from PVA, which is costly, starch-derivatives or cellulose-derivatives are still common.

In the case of knitwear, the paraffin can be removed with detergents separately or within the scouring process.

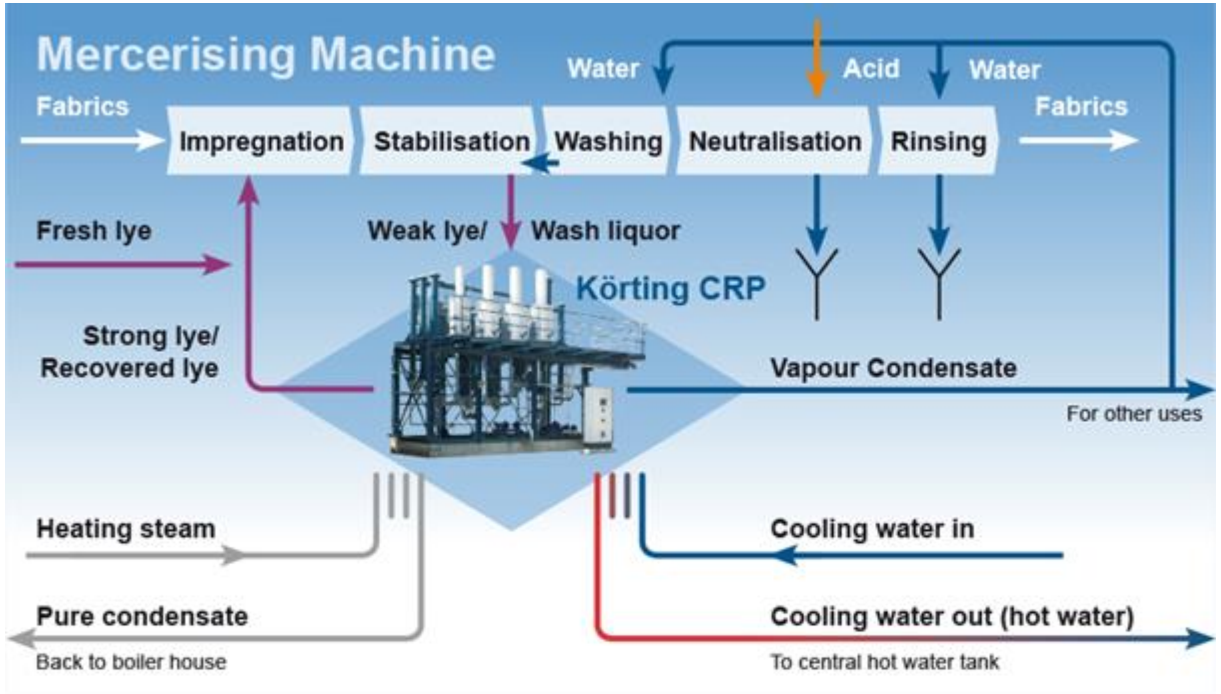
Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

- **Scouring, Kiering is the process of removing impurities such as greases, waxes and/or fats from the fiber.**
- **This can either be done through conventional methods (kier boiling) or through modern continuous processes known as scouring. The process of fabric scouring is performed under highly alkaline conditions at high temperatures.**
- **Souring and Kiering liquor is an alkaline solution containing caustic soda, soda ash, sodium silicate and sodium peroxide with small quantities of detergents (surfactants).**
- **When applied to raw/grey textile goods, scouring removes substances that have adhered to the fibres during production of the yarn or fabric, such as oils, grease, dirt and any sizing or lint applied to warp yarns to facilitate weaving.**
- **Combined scouring and bleaching process is called solomatic bleaching.**
- **The water required for the unit process varies from 20-45 l/kg of knitted fabric.**

Recycling of mercerizing wash water to bleaching plant

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

Caustic Recovery Plant



A caustic soda recovery plant is an industrial solution which turns large proportions of this weak lye (caustic soda dilution) into reusable concentrated caustic soda, thereby saving on water and caustic soda

Installation of new mercerizing machine

Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

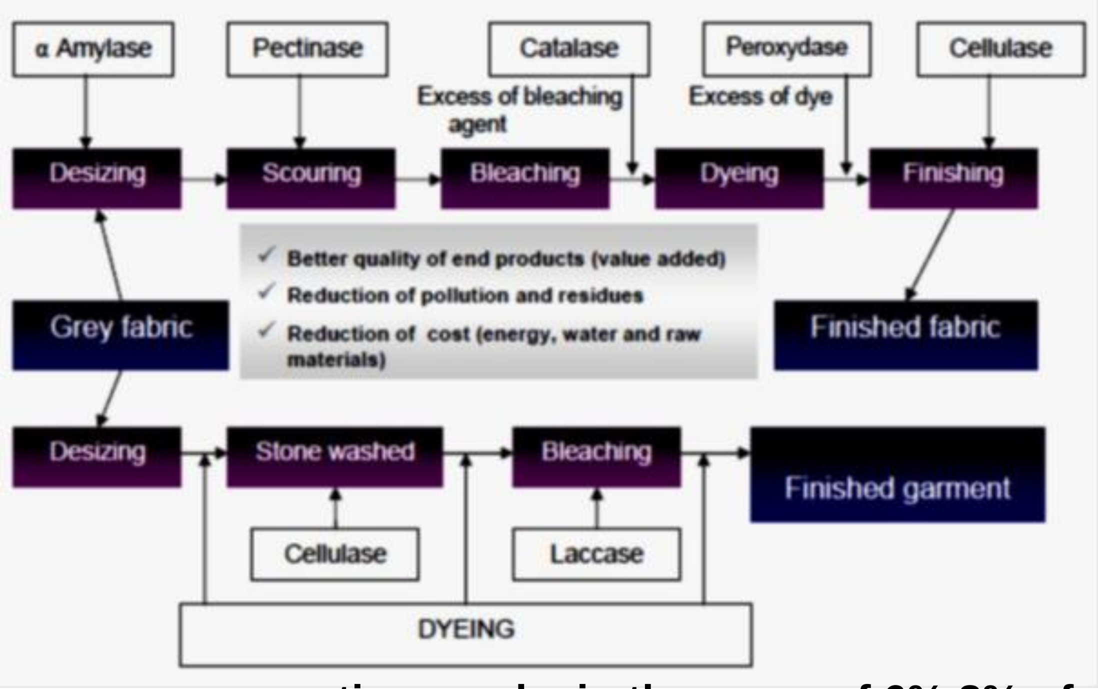
Bleaching

- For removing the natural color and render the textile white, a unit process called bleaching is applied.
- Bleaching means oxidizing the tan of linen.
- Chemical bleaching is usually accomplished by oxidation, destroying colour by the application of auxiliary chemicals, according to the chemical composition of the fiber.

- Cotton and other cellulose fibers are usually treated with:
- Heated alkaline hydrogen peroxide (H_2O_2) / or Sodium hypochlorite (NaOCl)
- Cottons can be scoured and bleached in a continuous process.
- Modern industrial units are using hydrogen peroxide for fabric bleaching to avoid Chlorites.
- The same amount of water of 24 –32 l/kg is required for bleaching yarn through either hydrogen peroxide or hypochlorite
- For cloth bleaching the water required fluctuates between 40-48 l/kg of textile.

Bleaching

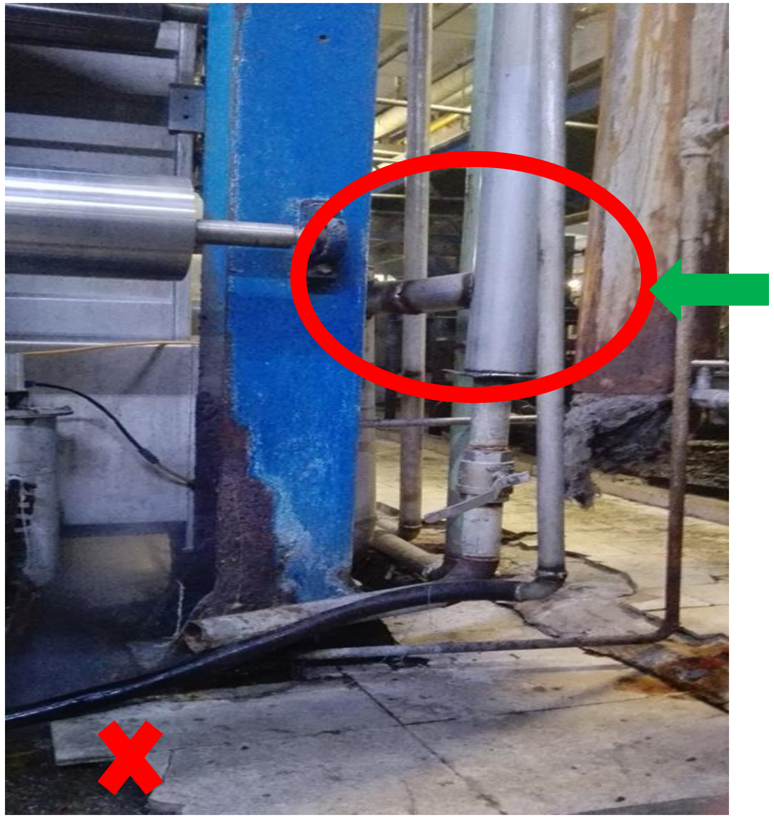
- **Enzymatic peroxide removal is possible in a discontinuous, semi-continuous, and continuous production method. The method is applicable both in new and existing installations**



- **Savings in water and energy consumption can be in the range of 6%-8% of production costs. A textile plant in Denmark called Skjern Tricotage -Farveri implemented this measure and achieved 13,500 m3/year water savings" [40]**

giz

Recycling of water lock in a bleaching plant



Ref. Best Management Practices, Presentation, GIZ Cluster Office, Bernhard Hartleitner, www.giz.de

Scouring, Kiering

- Scouring, Kiering is the process of removing impurities such as greases, waxes and/or fats from the fiber.
- This can either be done through conventional methods (kier boiling) or through modern continuous processes known as scouring. The process of fabric scouring is performed under highly alkaline conditions at high temperatures.
- Souring and Kiering liquor is an alkaline solution containing caustic soda, soda ash, sodium silicate and sodium peroxide with small quantities of detergents (surfactants).
- When applied to raw/grey textile goods, scouring removes substances that have adhered to the fibers during production of the yarn or fabric, such as oils, grease, dirt and any sizing or lint applied to warp yarns to facilitate weaving.
- Combined scouring and bleaching process is called solomatic bleaching.
- The water required for the unit process varies from 20-45 l/kg of knitted fabric.

Avoid, reuse or recycle water

Rinsing and washing operations are very common in the textile finishing processes. These operations require large amounts of water and often involve chemicals (textile auxiliaries) as well.

Within this processes of washing and rinsing a significant amount of water and chemicals can be saved.

Washing and rinsing operations include the following activities:

- Continuous washing
- Counter-current washing
- Drop and fill batch washing
- Overflow batch washing

In order to optimize processes one of the preconditions is that a proper monitoring (control) of the water and material flows is functioning.

Bleaching Process Water Consumption

Washing processes are often excessively long to ensure completeness. The processes are often designed to remove even the darkest shades, so that even for lighter shades (that do not require extended washing), the same excessive water use is often applied.

Example:

Stage	Water in m^3/h	Percentage
Saturators	145	5.0
Steamer and J Boxes	13	0.5
Washers		
Deseize	977	33.8
Scour	819	28.3
Bleach	819	28.3
Dry Cans	119	4.1
Total	2892	100

Source: Textiles, North Carolina Division of Pollution Prevention and Environmental Assistance, 2009, May, Water Efficiency Fact Sheet, Industry Specific Processes.

Water requirements for washing

The washing processes are optimized with continuous washing machines.

Typical water requirements for washing after different processes:

Process after washing	Washing Machine Type	Typical Specific Energy Consumption (GJ/ton)	Typical Specific Water Consumption (m^3/tonne)
Bleaching	5 hot standing tanks	7.5	10.4
Bleaching	4 tanks, fully counter flow, with heat exchanger	2.8	4.3
Scouring/Bleaching	5 tanks, fully counter flow, with heat exchanger	3.0	5.5

Ref. Carbon Trust, 1997, Cutting your energy costs -A guide for the textile dyeing and finishing industry, website https://www.carbontrust.com

Water requirements for washing

- **Typically washing machines are applied after scouring, bleaching or mercerizing (preparatory processes) and of course after the dyeing process as well .**

Process after washing	Washing Machine Type	Typical Specific Energy Consumption (GJ/ton)	Typical Specific Water Consumption (m^3/tonne)
Dyeing	4 tanks counter flow and 1 cold standing tank	6.6	8.2
Printing	4 hot counter flow and 3 cold individual flow	10.5	35.0
Printing	4 hot counter flow with heat exchanger and 3 cold individual flow	5.5	35.0

Ref. Carbon Trust, 1997, Cutting your energy costs -A guide for the textile dyeing and finishing industry, website https://www.carbontrust.com

giz

Dyebath Segregation and Reuse

Dyebath reuse:

Dyebath reuse is the process by which exhausted hot dyebaths are analyzed for residual colorant concentrations, replenished and reused for dying or rinsing additional batches of material.

Advantages:

- **reduces effluent volume**
- **reduces pollutant concentrations in the effluent**
- **dyebath reuse for 15 or more cycles (ranging from 5-25 cycles)**

Risks:

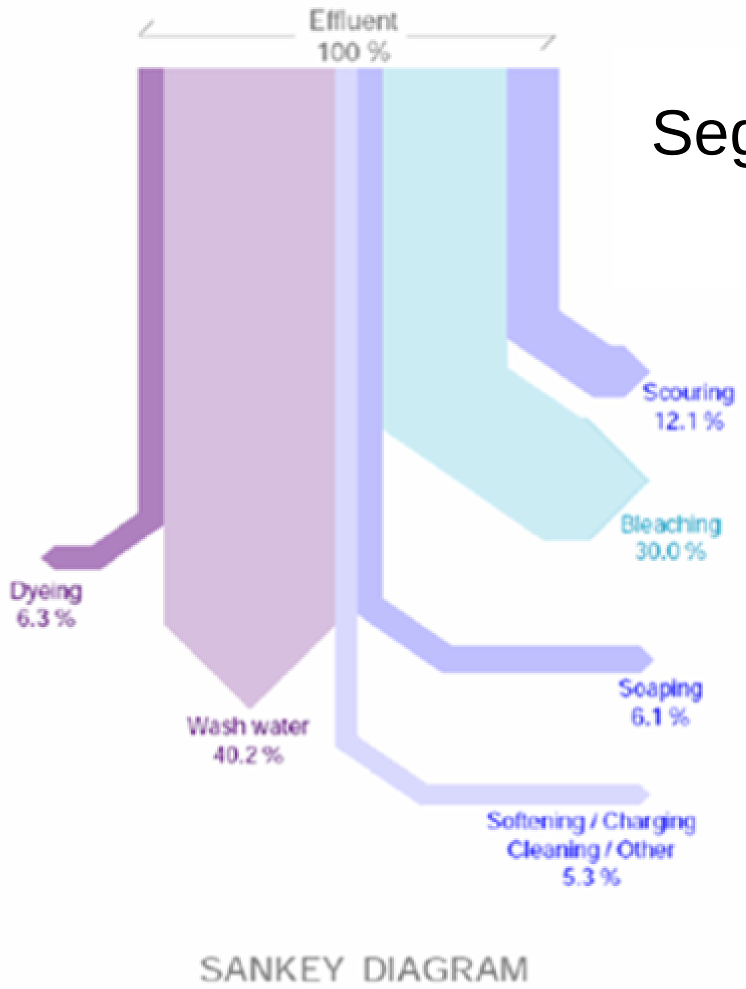
- **shade variation**
- **impurities build up in the dyebath**
- **decrease the reliability of the process**
- **depending on the individual unit processes for each finishing step a tailor made solution must be found.**

Ref. United States Environmental Protection Agency -U.S. EPA/SEMARNAP, 1996. Pollution prevention in the textile industry. http://infohouse.p2ric.org/ref/20/19041.pdf

giz

Dyebath Segregation and Reuse

A precondition for the success of dyebath and/or process water reclamation / reuse depends on the segregation of the process and/or waste water streams:



Segregation of different effluent streams

break-up of the wastewater streams in a textile finishing unit.

Appropriate Systems for Dyebath Reuse

Final Product	Fibre	Dye Class	Machine
	•Polyester	•Disperse	•Jet
Knit Fabric	•Cotton	•Reactive or direct	•Beck/Winch
	•Polyester/Cotton	•Disperse/Reactive or direct	•Beck/Winch
	•Polyester	•Disperse	•Package
Yarn Package	•Polyester/Cotton	•Disperse/Reactive or direct	•Package
	•Acrylic	•Basic	•Package
Socks	•Nylon/Spandex	•Acid	•Paddle
Pantyhose	•Nylon/Spandex	•Disperse/Acid	•Beck/Winch
		•Disperse	•Paddle/Drum
Carpet	•Nylon	•Disperse/Acid	•Beck/Winch
	•Polyester	•Disperse	•Beck/Winch
	•Aramid/Momex	•Basic	•Jet
Woven Fabric	•Cotton	•Direct	•Reel
	•Cotton	•Vat/Sulphur	•Jig
Skein	•Acrylic	•Basic	•Skein

Ref. United States Environmental Protection Agency -U.S. EPA/SEMARNAP, 1996. Pollution prevention in the textile industry. Available at: http://infohouse.p2ric.org/ref/20/19041.pdf last visited on 11/8/2016

giz

Dyebath Segregation and Reuse

- Dyebath segregation and reuse saves water, dyes, chemicals, and energy as well as it reduces wastewater and the subsequent cost of waste-water treatment.
- Some dye classes that undergo minimal changes during the dyeing process should be used (see table below) for maximum dyebath reuse benefits.
- -acid dyes for nylon and wool
- -basic dyes for acrylic and some copolymers
- -direct dyes for cotton
- -disperse dyes for synthetic polymers

- <u>By contrast, vat, sulphur, and fibre reactive dyes are very difficult to reuse.</u>

Processing Machinery

Different types of processing machinery use various amounts of water, particularly in relation to the bath ratio in dyeing processes.

Water consumption of a batch processing machine depends on:

- Bath ratio
- Mechanical factors:
    - agitation
    - mixing
    - fabric-turnover rate -also called "contact"
- Turbulence / Physical flow characteristics

- **Low liquor ratio dyeing equipment not only conserves water but also chemicals and energy in addition to reducing steam use as well as air pollution from boilers.**

Processing Machinery

Advantages of low bath-ratio dyeing equipment:

- water conservation

- chemicals reduction

- energy savings

- steam reduction

- less air pollution

- higher fixation efficiency.

- The washing efficiency of some types of low-bath-ratio dyeing machines, such as jigs, is inherently poor; therefore, a correlation between bath ratio and total water use is not always exact.

Dyeing Technology / Principles

Dyeing is mainly conducted in watery media, which has dissolving and carrying functions for the dye (Fries et al 1990). Three applied processes can be distinguished from each other:

- I Stagnating material and moving dye bath
- II Moving material stagnating dye bath
- III Moving material moving dye bath

The first principle is generally applied for yarn and synthetic fibre/textile dyeing. The second principle concerns one of moving material and stagnating dye bath. This principle is applied in jiggers (used for mixed textile which tend to wrinkle) and open winches, which are normally batch procedures.

SME textile finishing units might still use discontinuous exhaust dyeing, but semi continuous pad-batch and continuous procedures are gaining significance.

Dyeing - Liquor Ratio

- Dyeing methods are characterised by the liquor ratio (LR), i.e. the ratio between the textile substrate and the liquid phase.
- A liquor ratio of LR = 1:10 signifies that 1 kg textile is dyed within 10 litres of water.
- The higher the liquor ratio, the higher is the specific effluent volume (referring to the amount of substrate).
- Equipment manufactures often provide a range repesenting the nominal liquor ratio foir each type of machine.
- The nominal liquor ratio is defined as the range of liquor ratios at which the machines can be operated at maximum capacity.
- In each range the lowest values often refer for synthetic fibres and the highest apply for cotton knittwear.

Winch Dyeing / Soft Flow Machine

Difference of conventional winch dyeing and a modern soft flow machine:

Conventional Open Winch

Soft Flow Machine

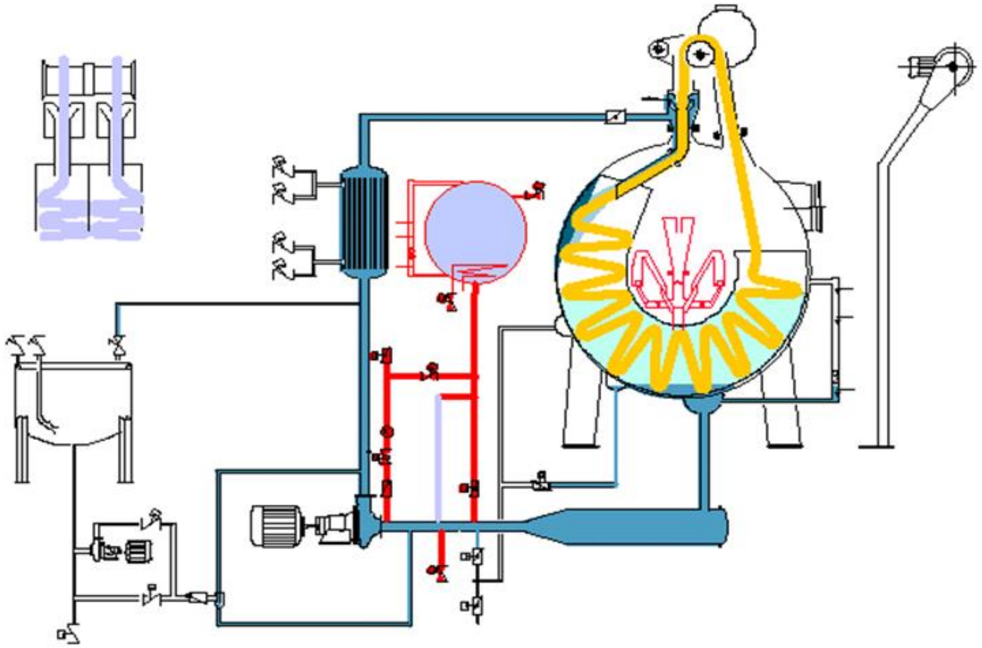
- Non-continuous process
- Process water can evaporate
- Liquor ratio range from 1:15 - 1:40.
- Poor mixing qualities
- Workers are directly exposed to the hot dye bath
- Regular reproduciability

- Continous process
- Non evaporation of process water
- Liquor ratio 1:8
- Optimised mixing properties
- Less health risks for workers
- Automized operation
- High reproducibility

giz

Over/Soft-Flow Machines

- Material moving and dye bath moving techniques belong to the group of overflow, soft-flow, roto-stream or soft-stream processes. In these machines the textile fabric is transported through the pumped dye bath with speeds of 300 up to 600 m/min. They are often fully automated, providing control of temperature, time, flow rate and other processes, which enhances the reproducibility and increases the quality of the dyeing process.



The liquor ratio is generally lower than in winches ranging from 1:3 up to 1:15.

Investment, operational cost vs plant size

- The table below shows the capital cost and annual operating cost saving for low liquor ratio jet dyeing machines in various size plants.

Cost Item		Plant Size	
	Small (10,00 kg/week)	Medium (60,000 kg/week)	Large (120,000 kg /week)
Capital cost (average per plant)	$928,000	$3,370,000	$4,900,000
Net annual operating savings (average per plant)	$298,000	$1,790,000	$3,580,000
Simple payback period	3.1 years	1.9 years	1.4 years

Note: Costs and savings are associated with the amount of production for each plant size and not just for one machine.

Ref. Marbek Resource Consultants, 2001.Identification and Evaluation of BAT-Economically Achievable (BATEA) for Textile Mill Effluents. Available at: http://infohouse.p2ric.org/ref/41/40651.pdf

Air jet dyeing vs soft flow machines

- The table shows specific input data ranges for cotton dyeing with reactive dyestuffs in a conventional jet operating at a liquor ratio of 1:8 to 1:12 and compared to an airflow machine.

Comparison of Specific Input Data for Cotton Dyeing with Reactive Dyestuff in Conventional Jet (LR 1:8-1:12) and in the Airflow Jet Machine

Input	Unit	Conventional Jet Operating at LR. 1:8-1:12	Airflow Jet Operating at LR. 1:2-1:3 (Polyester)/ 1:4.5 (Cotton)
Water*	l/kg	Polyester: 100 Cotton: 150	Polyester: 120 Cotton: 80
Auxiliaries	g/kg	12-72	4-24
Salt	g/kg	80-960	20-320
Dyestuffs	g/kg	5-80	5-80
Steam	kg/kg	3.6-4.8	1.8-2.4
Electricity	kWh/kg	0.24-0.35	0.36-0.42

The data are derived from measurements taken at different production sites in Europe.

2001, Marbek Resource Consultants, Identification and Evaluation of BAT Economically Achievable (BATEA) for Textile Mill Effluents. Available at: http://infohouse.p2ric.org/ref/41/40651.pdf

The investment costs for this type of new machinery is around **one third higher** than for conventional jets; **High savings on the resource consumption** side shortens the payback period..

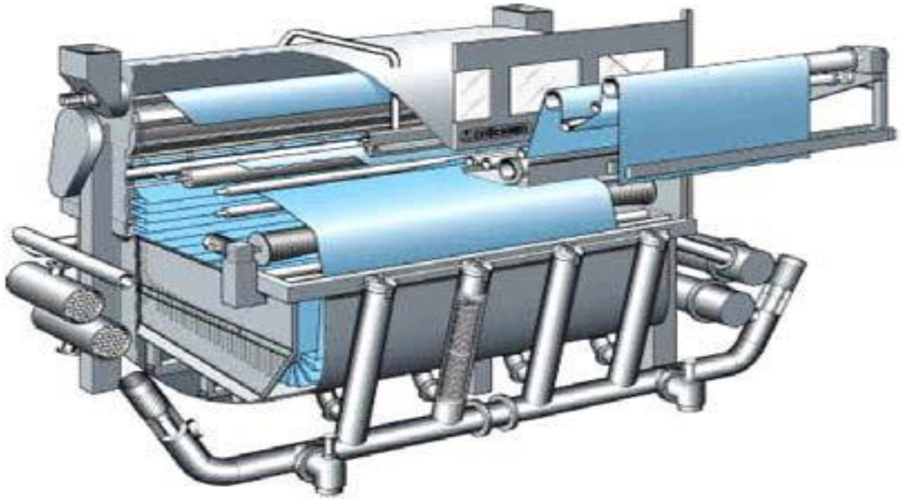
Case study, economic and ecologic benefits

- Alamac Knit North Carolina upgraded their jet dyeing machinery to state-of-the-art low liquor-ratio enclosed jet dyeing machines with shorter cycles. This modification reduce dye chemicals by 60%-70%.
- Operation data of a U.K.-based commission dyer and finisher of knitted fabrics showed that the water consumption of the new machine (64 m^3/tonne of fabric) was less than half that of conventional machines (142 m^3/tonne of fabric)
- The average steam demand for the new machine was 980 kg/batch compared with 1,480 kg/batch for the conventional machines.
- The new machine takes about 20% less time to process a single batch than the conventional machine.
- The new machine was installed at a cost of $221,000 (in the year 1996) with an return on investment (ROI) of 1.6 years.

Marbek Resource Consultants, 2001.Identification and Evaluation of BAT Economically Achievable (BATEA) for Textile Mill Effluents. Available at: http://infohouse.p2ric.org/ref/41/40651.pdf

Winch Beck Dyeing Machines

Technological improvements in winch-beck dyeing machines:



Modern Carpet Winch

- **Heating: Direct steam injection was replaced by indirect heating/cooling (to overcome dilution and water spillage)**
- **Liquor ratio: Smaller batches can be dyed with lower liquor ratios**

Winch Beck Dyeing Machines (cont.)

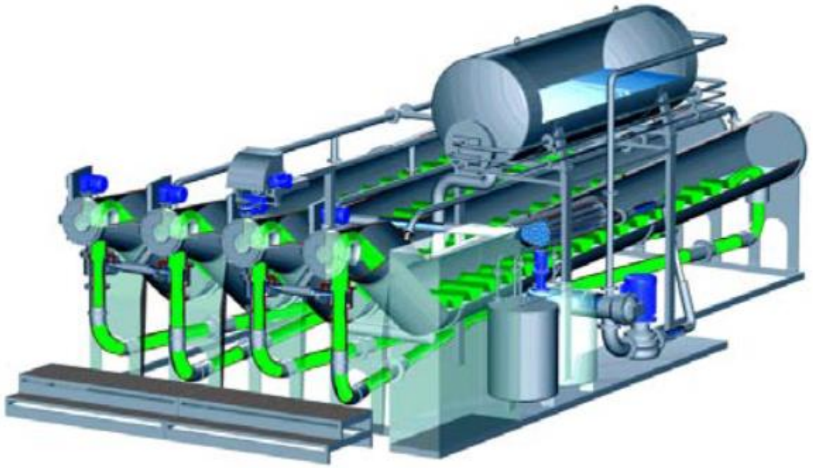
- Rinsing: Removing carpets without draining, cooling or diluting the bath "hot-drawing-out system" - automatic removal and vacuum extraction
- Recycling: Non-bound water y recycled and the recovered liquor is diverted back to the dye bath
- Covers in form of hoods to maintain temperature and minimize losses
- Automated dosing and process-control system

Substantial savings in terms of water, chemicals and energy consumption. Reductions of 40-50% in fresh water for the total dyeing process (up to 94% of these savings occurring in rinsing water reductions) are claimed by the machines' manufacturers

Ref. European Integrated Pollution Prevention and Control Bureau (EIPPCB). 2003. Ref. Document on BAT for the Textiles Industry. http://eippcb.jrc.ec.europa.eu/reference/BREF/txt_bref_0703.pdf

Single-Rope Flow Dyeing Machines

Only one fabric rope passes through all flow groups and compartments, returning to the first compartment after the lap is complete. The single rope approach ensures both optimum uniformity of the system and repeatability of the results.



Single-Rope Dyeing Machine

Single-rope machine are used for knit, woven fabrics and almost all types of fibres. Investment cost are 20%-30% higher but the ROI can be less than a year.

Single-Rope Flow Dyeing Machines (cont.)

Comparison of the Performance of Cotton Dyeing with Reactive Dyestuffs in a Conventional Jet Machine, a Jet optimized Machine, and the Single-Rope Machine

Input	Unit	Conventional Jet Machine	New Generation Jet Machine	Single-Rope Jet Machine
Water [a]	l/kg	100-130	50-90	30-70
Auxiliaries	g/kg	15-75	8-40	5-25
Dyestuffs	g/kg	10-80	10-80	10-80
Steam	kg/kg	4-5	2-3	1.5-2.5
Electricity	kWh/kg	0.34-0.42	0.26-0.32	0.18-0.22
Time [b]	min	510-570	330-390	210-220

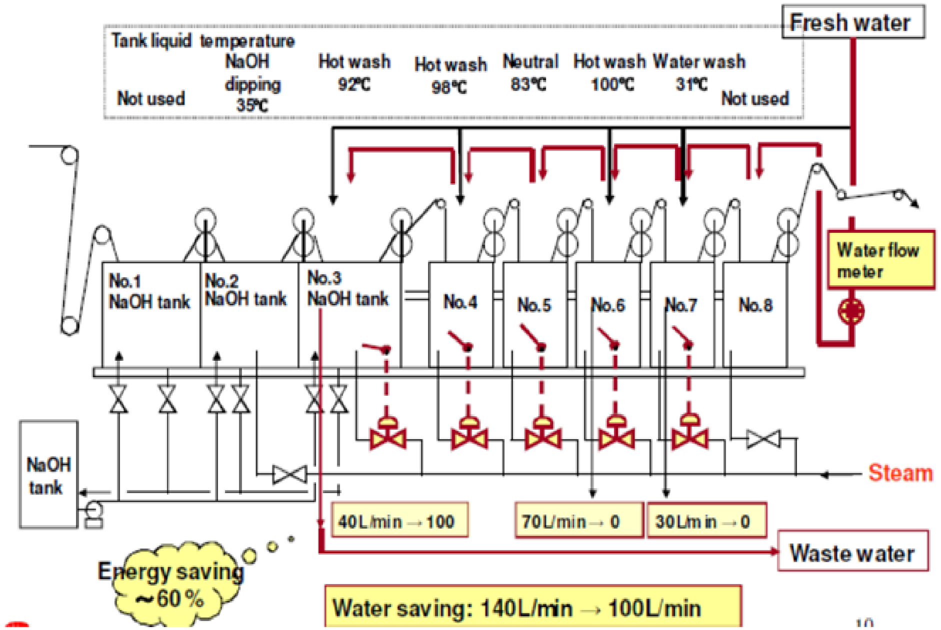
[a]: Including rinsing
[b]: Including loading/unloading

Ref. European Integrated Pollution Prevention and Control Bureau (EIPPCB). 2003. BAT for the Textiles Industry. Available at http://eippcb.jrc.ec.europa.eu/reference/BREF/txt_bref_0703.pdf

giz

Counter Current Washing

- In the counter current washing the fabric runs through the washing elements from entry to exit of the washing process and fresh water is passed through in “counter current” to the process i.e. in a counter-flow system “from the back to the front”.



Schematic of counter -flow current washing process

Counter current washing equipments are often composed of several washing elements, a rinsing/washing and dehydration mechanism, filters, sensors and pumps.

giz

Counter Current Washing (cont.)

- The cleaner the fabrics gets in the process the more diluted becomes the wash water.

Washing Bath	η (eta) or efficiency with one element	η (efficiency) with two elements	η (efficiency) with three elements
1	0.50	0.67	0.75
2	0.50	0.67	0.75
3	0.67	0.86	0.93
4	0.75	0.92	0.98
5	0.80	0.95	0.99
6	0.83	0.97	0.99
7	0.86	0.98	1.00
8	0.89	0.98	1.00
9	0.90	0.99	1.00
10	0.91	0.99	1.00

- Often sensors such as conductivity meters or colorimeters are used to detect water impurity to adjust automatically the fresh water feed rate.

giz

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH