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Efficient water utilization in knit dyeing factory of Bangladesh

Abstract

Water is the vital fact for the world. Day by day water level goes down due to overuse of underground water. Huge amount of underground water used in the textile sector. It's high time to think "how to ensure underground water proper utilization". This article focuses on wastewater minimization options and techniques that are available for the textile industry specially knit dyeing sector. In this research, researchers established a developed process for knit dyeing then experiment was done on this process. Water consumption was calculated for both processes; conventional and developed process. Developed process consumes less water compare to existing process. Proper implementation of this developed process can save 20.85-28.75% water consumption at the knit dyeing industry. At the same time, performed the cost analysis and developed process shows lower cost than existing processes. Developed process is more efficient and profitable than existing knit dyeing process.

Keywords: knit dying, process development, water saving, water treatment plant, effluent treatment plant, cost analysis

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Introduction

Access to water for life is a basic human need and a fundamental human right. But leading experts now predict that as early as 2025, large parts of the world could experience perennial water shortages.[1] Even now, around two billion people live in a situation where they don't have enough and suitable water for drinking, generating electricity, agriculture and so on.[2] Natural sources of fresh water, especially rivers, are becoming highly contaminated with industrial effluents and human waste, causing serious hazards to public health and ecological system. The rivers around the capital city Dhaka in particular are polluted due to mindless dumping of untreated waste and effluents that contain heavy metals and residues of toxic chemical. The toxic water of the river also slowly sips through the earth's layer into the groundwater. Consequently, water extracted through tube wells for drinking is often stinky and undrinkable.

River water is turning unsafe for drinking because of rampant release of untreated human waste and industrial effluents that contain heavy metals like chromium, cadmium, lead and mercury, and toxic chemicals. More than 300 rivers in Bangladesh are polluting the same way.[3] Such pollution makes river waters unsuitable for agriculture, fishing, household chores, and bathing. The four rivers around the capital have become virtual dumping grounds for all kinds of solid, liquid and chemical waste, as hundreds of tanneries and textile factories are situated by these water bodies.[4]

There are 72 dyeing factories on the banks of the Old Brahmaputra River and these have been dumping untreated industrial waste into the river for the last 15 years.[5] About 98 percent of drinking water and 80 percent of dry season irrigation water comes from the 21 billion cubic meters of groundwater reserve.[6] The over-extraction of groundwater would lower its level and increase salinity in coastal areas. When the groundwater level goes below the sea level, saline water flows inwards during tidal surge in rivers. In the 70s, a depth of 350-450 feet was enough for WASA [Water Supply and Sewage Authority] to install tube wells. But the required depth is now 500-1,000 feet now.[6] Besides, the properties of the aquifer, the soil that holds the water, are being damaged. The soil might become compact and its capacity to hold water in the future might be lost. The modern knit dyeing machine provides 1:3 or 1:4 liquor ratio dyeing process. In Bangladesh, most of the knit dyeing factory have 1:7 liquor ratio machine; such as- Fongs, Tong Geng, Dilmenler is the most popular brand.[7]

Another important point is that classical reactive dyes exhaustion rate 60-70% and rest of 30-40% dye flows with wastewater.[8] Huge number of wash and rinsing is needed for improve fabric fastness properties. Water consumption goes high due to these wash requirements. New generation dyes are now available in the market. This new generation dyes exhaustion rates more than 85%.[9] Unfixed dyes are lower amount compare to classical reactive dyes. Lower number of wash requirement for new generation dyes compare to classical reactive dyes. As a result water consumption goes down compare to classical dyes. But till now in market classical dyes are most popular in the market due to availability and high cost of new generation dyes.

In this study, a new dyeing method presented for knit fabric dyeing that will increase the profit percentage by minimizing the water consumption and waste water treatment as well.

Methodology

Type of the research

It's an experimental type of research. This study was conducted based on knit dyeing process with its proper water utilization and economic production process development. Contribution area of this study ensures efficient water utilization in knit dyeing. This study is conducted in 1:7 liquor ratio dyeing machine and classical low exhaustion rate 60-70% reactive dyes.

Type of the data

The research is based on the primary data which collected from dyeing floor, WTP, and ETP plant. Two colors of knit dyeing were performed in dyeing industry of Bangladesh, i.e., light pink and navy blue color. In this study, researcher considered only coloration part. Because white part consumes less amount of water which cannot possible to reduce easily. Water consumes depends on the color depth of specific shade.

Data collection

Data collected for this study by observation method. Water flow meter was adjusted with dyeing machine. Water flow meter shows the amount of water passing through its water line according to dyeing program. Every bath of water can be calculated by this meter. Finally, calculate the amount of water needed for the whole dyeing process. Water consumption calculation per kg fabric was defined by the following formula:

$$\text{Water consumption per Kg fabric} = \frac{\text{(Total amount of water needed for this batch in liter)}}{\text{(Batch weight in Kg)}}$$

Process development

In this research, dyeing process explained that how to minimize water consumption of knit dyeing with reactive dye. Process development performed on the basis of process minimization and rinsing (wash) minimization. Rinsing wash is a continues wash process for 5-10 minutes. For process development, dyeing divided into two categories in color depth, up to 1% as light color whilst above 1% considered for deep color. An experiment was performed into 4 batches in a dying machine which capacity 1200kg; 2 for light and 2 for deep color. Existing knit dyeing process and developed process placed juxtaposition for visual comparison (Tables 1–3).

Table 1 Flow chart of conventional and developed knit dyeing process for light colour

Light color				
Conventional knit dying			**Developed knit dying**	
Step	**Process name**		**Step**	**Process name**
1	Fabric load Scouring + Bleaching (98˚C×50min.)		1	Fabric load scouring + Bleaching (98˚C×50min.)
2	Bath Drop & Fill again		2	Bath Drop & Fill again
	Hot wash (90˚C×10min.)			Hot wash (90˚C×10min.)
3	Bath Drop & Fill again		3	Bath Drop & Fill again
	Peroxide Killing (65˚C×20min.)			Peroxide Killing + Enzyme (55˚C×60min.)
4	Bath Drop & Fill again		4	Bath Drop & Fill again
	Enzyme (55˚C×60min.)			Normal Wash (40˚C x 10min.)
5	Bath Drop & Fill again		5	Bath Drop & Fill again
	Normal Wash (40˚C×10min.)			Dyeing
6	Bath Drop & Fill again		6	Bath Drop & Fill again
	Dyeing			Wash (40˚C×10min.)
7	Bath Drop & Fill again (Overflow/Rinsing-5min.)	Rinsing process- 1	7	Bath Drop & Fill again
				Acid (40˚C×10min.)
8	Bath Drop & Fill again		8	Bath Drop & Fill again
	Acid (40˚C×10min.)			Hot wash (70˚C×10min.) (Depend on shade)
9	Bath Drop & Fill again		9,10	Wash (2 time)
	Hot wash (70˚C×10min.)			
	Wash (Overflow/Rinsing–5min.)	Rinsing process- 2		Unload
	Unload			

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Table 2 Flow chart of conventional and developed knit dyeing process for deep color

Deep color				
Conventional knit dying			**Developed knit dying**	
Step	**Process name**		**Step**	**Process name**
1	Fabric load		1	Fabric load
	Scouring + Bleaching (98˚C×50min.)			Scouring + Bleaching (98˚C×50min.)
2	Bath Drop & Fill again		2	Bath Drop & Fill again
	Hot wash (90˚C×10min.)			Hot wash (90˚C×10min.)
3	Bath Drop & Fill again		3	Bath Drop & Fill again
	Peroxide Killing (65˚C×20min.)			Peroxide Killing + Enzyme (55˚×60min.)
4	Bath Drop & Fill again		4	Bath Drop & Fill again
	Enzyme (55˚C×60min.)			Normal Wash (40˚C×10min.)
5	Bath Drop & Fill again		5	Bath Drop & Fill again
	Normal Wash (40˚C×10min.)			Dyeing
6	Bath Drop & Fill again		6	Bath Drop & Fill again
	Dyeing			
7	Bath Drop & Fill again (Overflow/Rinsing- 10min.)	Rinse process- 1	7 & 8	Wash (40˚C×10min.) 2 times
8	Bath Drop & Fill again		9	Bath Drop & Fill again
	Ho wash (90˚C×10min.)			Hot wash (70˚C×10min.)
9	Bath Drop & Fill again		10	Bath Drop & Fill again
	Acid wash (40˚C×10min.) (Depend on shade)			Acid (40˚C×10min.)
10	Hot wash (70˚C×10min.) (Depend on shade)		11	Bath Drop & Fill again
				Hot wash (90˚C×0min.)
	Wash (Overflow/Rinsing–10min.)	Rinse process- 2	12	Bath Drop & Fill again
	Unload		13,14,15, & 16	Wash (4 time)
				Unload

Table 3 Summarize of water requirement for light and deep color on the basis of these two processes

Conventional process	**Developed process**
Light color	
Total bath required: 9	Total bath required: 10
Total overflow required: 2	Total overflow required: 0
Deep color	
Total bath required: 10	Total bath required: 16
Total overflow required: 2	Total overflow required: 0

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Research data

After completion of the dyeing process, consumption of water was collected and listed in Table 4 and Table 5.

Table 4 Water consumption of conventional and developed process for light color

Conventional Process (1000 kg batch)	Developed Process (1035 kg batch)
1st bath= 7000 liters	1st bath= 7245 liters
2nd bath= 3955 liters	2nd bath= 4141 liters
3rd bath= 3895 liters	3rd bath= 4090 liters
4th bath= 3966 liters	4th bath= 4135 liters
5th bath= 3990 liters	5th bath= 4158 liters
6th bath= 4010 liters	6th bath= 4105 liters
7th bath= 3920 liters	7th bath= 4125 liters
8th bath= 4008 liters	8th bath= 4098 liters
9th bath= 3920 liters	9th bath= 4122 liters
1st Rinsing/Overflow= 10600 liters (5 Minute)	10th bath= 4116 liters
2nd Rinsing/Overflow= 10855 liters (5 Minute)	
Total = 60,119 liters	Total = 44,335 liters
Water consumption per kg fabric=60119/1000 =60.12 liters	Water consumption per kg fabric=44335/1035 =42.83 liters
Water Saving 28.75%	

Table 5 Water consumption of conventional and developed process for deep color

Conventional process (1060 kg batch)	Developed process (1045 kg batch)
1st bath= 7420 liters	1st bath= 7315 liters
2nd bath= 4250 liters	2nd bath= 4180 liters
3rd bath= 4209 liters	3rd bath= 4200 liters
4th bath= 4235liters	4th bath= 4210 liters
5th bath= 4195 liters	5th bath= 4165 liters
6th bath= 4198 liters	6th bath= 4189 liters
7th bath= 4220 liters	7th bath= 4210 liters
8th bath= 4238 liters	8th bath= 4208 liters
9th bath= 4225 liters	9th bath= 4168 liters
10th bath= 4215 liters	10th bath= 4200 liters
1st Rinsing/Overflow= 20055 liters (10 Minute)	11th bath= 4220 liters
2nd Rinsing/Overflow= 20100 liters (10 Minute)	12th bath= 4195 liters
	13th bath= 4225 liters
	14th bath= 4235 liters
	15th bath= 4218 liters
	16th bath= 4210 liters
Total = 85,560 liters	Total = 66,138 liters
Water consumption per kg fabric= 85560/1060 =80.72 liters	Water consumption per kg fabric = 66138/1045 =63.89 liters
Water saving 20.85%	

Discussions, analysis and findings

In knit dyeing, water is treated before dyeing in water treatment plant (WTP) and after dyeing in effluent treatment plant (ETP). Generally, knit dyeing factory spends 0.023 taka per liter water softening process and 0.02 taka per liter waste water bio-chemical treatment in ETP. Total spend for water treatment in knit dyeing factory 0.043 taka per liter in Bangladesh.

Cost analysis for one batch

For light color

Waste water treatment cost (Conventional process)=0.043×60119=2585 taka

Waste water treatment cost (Developed process)=0.043×44335=1906 taka

Cost save due to implement developed process=(2585-1906)=679taka

For deep color

Waste water treatment cost (Conventional process)=0.043×85560=3679 taka

Waste water treatment cost (Developed process)=0.043×66138=2844 taka

Cost save due to implement this new process=(3679-2844)=835 taka

Quality analysis

Quality is the main fact for any manufacturing industry. The textile manufacturing sector also has some quality parameter for ensuring proper product quality. These quality parameters for both conventional and developed processes discussed as bellow:

Table 6 and Table 7 show quality report and it can be said that "the development process is fully effective in practice". This experimented result can assist any knit dyeing factory whose are not so aware about "Efficient water utilization in knit dyeing".

Table 6 Quality parameters for light color

Quality parameter	Light color		
	Conventional	Developed	Comments
Color fastness to rubbing (Dry)	4-5	4-5	Both are acceptable
Color fastness to rubbing (Wet)	4-5	4-5	Both are acceptable
Color fastness to washing (Change in color)	4-5	4-5	Both are acceptable
Color fastness to washing (Staining)	4-5	4-5	Both are acceptable
Color fastness to water	4-5	4-5	Both are acceptable
Color fastness to perspiration	4-5	4-5	Both are acceptable
Color fastness to Saliva	4-5	4-5	Both are acceptable
Pilling (ICI)	4	4	Both are acceptable
pH	6.41	6.52	Both are acceptable

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Table 7 Quality parameters for deep Color

Quality parameters	Deep color		
	Conventional	**Developed**	**Comments**
Color fastness to rubbing (Dry)	4-5	4-5	Both are acceptable
Color fastness to rubbing (Wet)	3	2-3	Both are acceptable
Color fastness to washing (Change in color)	4-5	4-5	Both are acceptable
Color fastness to washing (Staining)	4-5	4-5	Both are acceptable
Color fastness to water	4-5	4-5	Both are acceptable
Color fastness to perspiration	4-5	4-5	Both are acceptable
Color fastness to Saliva	4-5	4-5	Both are acceptable
Pilling (ICI)	4	4	Both are acceptable
pH	6.54	6.63	Both are acceptable

Some suggestions for proper utilization of water in knit dyeing

More steps consume more water and most of the cases; one extra process needs minimum one extra bath. Knit dyeing need a huge amount of water only for cool down machine or dye bath. It's approximately 25-30 % of total water used.

Conclusion

Textile is the most raising sectors of Bangladesh and water is the heart of textile processing. It's an alarm for Bangladesh by over use of underground water in textile processing water layer go down day by day. Waste water processing causes environment pollution and processing cost. Admittedly, water minimization in textile processing is the main focus of this study. Developed process reduces the consumption of water per kg knit dying. From this research, researcher minimized the process step for the light and deep color in the knit dying process. Developed process for an average size batch, in case of light color reduces the cost of dying 679 taka and in case of deep color cost saving 835 taka. Moreover, dyed fabric in developed process provides the same test report. This process helps knit dyeing sector to minimize the amount of wastewater.

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Conflicts of interest

Authors have declared no conflicts of interest.

References

1. Islam A. Sink or swim: The need for water guardian. The Daily Star; 2015.
2. WITZE A. More than 2 billion people lack safe drinking water. That number will only grow. Science News; 2018.
3. Precious yet we pollute. The Daily Star; 2015.
4. Manik SRH. Managing fresh water: crying need of the hour. Daily sun; 2018.
5. Shaon AI. Brahmaputra no more beckons people. Dhaka Tribune; 2014.
6. Call to save groundwater. Ittefaq; 2015.
7. Recent developments in dyeing. Textile World; 2010.
8. Daniela C, Barjoveanu G, Petronela MC, et al. Reactive dyes removal from wastewater by combined advanced treatment. *Environmental engineering and management journal*. 2009;8(3):503–512.
9. Hamdaoui M, Turki S, Romdhani Z, et al. Effect of reactive dye mixtures on exhaustion values. *Indian Journal of Fibre & Textile Research*. 2013;38:405–409.