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Article *in* Fresenius Environmental Bulletin · January 2000

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Fresenius Envir Bull 9: 314 - 321 (2000)

1018-4619/2000/5-6/314-08 DM 20 or 3.50/p

INDUSTRIAL WASTEWATER MANAGEMENT FOR RECYCLE AND REUSE - A CASE STUDY FOR THE TEXTILE INDUSTRY

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Abstract

This study provides a scientific methodology for the recycle and reuse of industrial wastewaters. Textile finishing industry has high water use and wastewater generation. Water use should be decreased by the recycle and reuse of wastewater. In this context a typical knit fabric finishing mill producing 750 m^3 wastewater per day, has been investigated to present an example for the presented methodology and it is concluded that 30% reduction of water could be possible in cotton and viscose rayon knit fabric finishing operations.

Keywords: textile finishing industry, process profile, pollution profile, reuse criteria

INTRODUCTION

Textile finishing industry is one of the major industries using wet processes in most of its production steps. Water consumption and thus wastewater generation of textile finishing industry is high due to the batch operations carried out in textile mills in addition to the need for high flotation ratios in the process baths. In the knit fabric subcategory, the unit water used per unit amount of fabric processed ranges from 20 to 100 m^3/tons [1, 2]. For the conservation of resources and protection of the receiving bodies, the amount of water used should be decreased. Furthermore, wastewater reduction is essential to alleviate the high economical burden of treatment in order to fulfil the stringent discharge requirements.

Presented at the 10th International Symposium of MESAEP in Alicante, Spain, 2 - 6 Oct. 1999

in textile finishing industry. The reusable streams are the process effluents that have less pollutant loads in terms of reuse parameters. The methodology consists of 5 steps:

i) plant survey,

ii) process profile,

iii) pollution profile,

iv) criteria determination and,

v) reuse / recycle stream determination.

Plant Survey

The detailed survey of the plant investigated is the first step for industrial wastewater management. The plant survey should include the general data about the plant, the production details, information about the use of resources, and the wastewater amount and disposal. This survey provides the necessary information for understanding the production characteristics of the textile mill as shown in Table 1.

Table 1. General outline of the plant survey

Survey	*Information*
General information	
Firm / Plant name and address	
Total number of employee	*165*
Number of shifts/Working hours	*3 shifts / 07.00-15.00, 15.00-23.00, 23.00-07.00*
Any change in manpower/Type of change	*Present / Seasonal change*
Production information	
Main production or process category	*Textile*
Subcategory	*Knit fabric finishing*
Scheme of production processes	*Batch*
Any seasonal production process changes	*Present*
Raw material type/amount	*Cotton (5 400 kg/day), polyester/polyamide (5 000 kg/day)*
Additives type/amount	*Soda (8 t/year), reactive dye (16 t/year), hydrogen peroxide (25 t/year), disperse dye (9 t/year), pigment dye (10 t/year), salt (175 t/year)*
Energy use	*Electricity 3 852 MW/year, natural gas 2 520 000 m^3/year*
Water use	*750 m^3/day, 72 m^3/ton fabric*
Wastewater information	
Wastewater amount	*750 m^3/day*
Control parameters	*TSS, TDS, COD, TKN, TP, alkalinity, pH, T (°C), color*
Wastewater disposal system	*Receiving body discharge*

The relevant parameters according to the reuse criteria are determined as pH, COD, TSS (total suspended solids), TDS (total dissolved solids), chloride, hardness, and color. All analysis for conventional characterization were performed as defined in *Standard Methods* [8].

Table 2. Process profile of the plant

	Process	Water use [m^3/batch]	Fabric [kg/batch]	ww/fabric [l/kg]	Fabric/day [kg/d]	ww/day [m^3/d]	ww/day [%]
Cotton & viscose knit fabric	[1]Raw fabric washing	6.0	337	17.8	100	1.8	0.24
	[2]Sugar bleaching	12.0	179	67.0	100	6.7	0.89
	[3]Optical brightening	8.0	200	40.0	1700	68.0	9.05
	[4]60°C bleached Remazol dyeing	3.0	14	214.3	300	64.3	8.56
	[5]60°C kiered Remazol dyeing	35.0	385	90.9	700	63.6	8.47
	[6]95°C bleached Procion dyeing	21.0	217	96.8	2300	222.6	29.63
	[7]95°C kiered Procion dyeing	10.0	101	99.0	100	9.9	1.32
	[8]Sugar bleaching after mercerization	16.0	316	50.6	100	5.1	0.67
	[9]Viscose 60°C Remazol dyeing	8.8	84	104.8	400	41.9	5.58
	[10]Viscose 95°C Procion dyeing	4.5	40	112.5	500	56.3	7.49
Synthetic knit fabric&blends	[11]Polyester&viscose single bath dyeing	18.0	303	59.4	400	23.8	3.16
	[12]Polyester&viscose double bath dyeing	42.0	443	94.8	400	37.9	5.05
	[13]Polyester 110°C dyeing with carrier	8.0	187	42.8	100	4.3	0.57
	[14]Polyester 130°C light color dyeing	15.4	640	24.0	800	19.2	2.56
	[15]Polyester 130°C dark color dyeing	3.2	125	25.6	800	20.5	2.73
	[16]Cotton&polyester single bath dyeing	18.0	303	59.4	400	23.8	3.16
	[17]Cotton&polyester double bath dyeing	42.0	443	94.8	400	37.9	5.05
	[18]Cotton&polyester dyeing with cleaning	20.0	367	54.5	400	21.8	2.90
	[19]Polyamide dyeing	4.0	106	37.7	300	11.3	1.51
	[20]Reactive printing	1.5	14	107.1	100	10.7	1.43
	Overall total				**10400**	**751.4**	**100**

Table 3. Conventional characterization of process [6]

Processes	pH	COD [mg/l]	TSS [mg/l]	TDS [g/l]	Cl^- [mg/l]	Hardness [mg $CaCO_3$/l]	Color [Pt-Co unit]
[6] 95°C Reactive dyeing with bleaching							
[6].1 Pre-bleaching							
[6].1.1 Pre-bleaching	11.4	2365	55	39	210	60	155
*[6].1.2 Neutralization	2.5	235	35	1.7	665	75	15
[6].2 Procion dyeing							
[6].2.1 dyeing	10.6	1500	195	55	26060	30	640
[6].2.2 First rinse	10.0	80	35	4.5	1600	16	80
**[6].2.3 Second rinse							
[6].3 Washing							
[6].3.1 Soaping	8.3	50	12	1.8	400	12	40
**[6].3.2 First rinse (95°C)							
**[6].3.3 Second rinse (95°C)							
*[6].3.4 Third rinse (60°C)	7.7	35	<10	0.8	240	25	15
*[6].3.5 Softening	6.4	440	75	0.7	185	25	30

* *Reusable streams* ***Skipped during operation*

The reusable process streams should be selected according to the reuse criteria. The selected reusable wastewaters for process [6] are shown in Table 3. Since organic and solids content of the reusable wastewater exceed the criteria, advanced pre-treatment is necessary before the reuse of wastewater as fresh process water. The oxidation studies conducted with ozone on the reusable portion of wastewater have resulted in total removal of color and about 30% reduction of COD (9).

CONCLUSION

A systematic approach is crucial for the wastewater management of any industrial plant. This approach must include a detailed plant survey which will convey to the process profile of the plant. Once the process profile is completed experimental wastewater characterization is necessary in order to prepare the pollution profile of the plant based on the reuse criteria and treatment plant operation scheme. The reuse criteria can be determined from a literature survey or by the manufacturer's demand. The wastewater streams selected for reuse should also be examined as a composite wastewater in order to identify the pre-treatment needs before reusing as fresh process water.

A typical knit fabric finishing mill is investigated to present an example for the methodology proposed for the determination of reusable wastewater. Since the most important parameters for process water were determined as color and dissolved solids to sustain the desired production quality, the reusable process effluents with low color and TDS were selected. These wastewaters were separated from the plant effluent and treated with ozone. Color was totally removed and COD decreased about 30%.

It is concluded that 127 m^3/d of 410 m^3/d (wastewater generated from cotton and viscose knit fabric finishing operations) could be reused corresponding to a 30% reduction of water and wastewater. Even if no reuse was achieved for the remaining operations, 127 m^3/d could be reused out of 750 m^3/d of total wastewater generation, which corresponded to 17% of reduction. These results show that it is possible to obtain the maximum amount of wastewater reuse with minimum treatment demand by following the proposed methodology.

An important aspect that is generally overlooked in the recycle and the reuse of wastewaters is the quality changes imposed on the wastewater stream remaining after recovery. The recovery process generally results in a stronger wastewater with different treatability characteristics involving a more complex treatment and additional cost for compliance with effluent limitations.

ACKNOWLEDGEMENT

This study was jointly supported by the *Volkswagen Stiftung Fund* and *The Research and Development Fund of Istanbul Technical University*. It was also conducted as part of the sponsored research activities of *The Environmental Biotechnology Center* of *The Scientific and Research Council of Turkey*.

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Received for publication: October 11, 1999
Accepted for publication: May 08, 2000