Effective resource management in textile industry through Cleaner Production: case study of an elastic and yarn manufacturing factory in Sri Lanka

Eng. V.R.S Peiris[1], U.Y.I.L Dharmasoma[2], L. Herath[2], N.A Gunawardana[2], S. Thudugala[2]

[1]*National Cleaner Production Centre, Sri Lanka*

[2]*Faculty of Graduate Studies, University of Colombo, Colombo 03*

a). Background

Throughout the past century, people all over the world have recognized that human activities have contributed to the deterioration of the environment and to the loss of natural resources (Aondona-Paul, 2014). Within recent decades paradigm shift from pollution control (the so called "End of Pipe" thinking) to pollution prevention strategies have been witnessed. Many pollution prevention activities make industrial processes and equipment more resource-efficient, which would simultaneously provide economic savings and environmental benefits to the industry itself and to the community. While it is true that Cleaner Production technologies do not yet exist for all industrial processes and products, it is estimated that 70% of all wastes and emissions from industrial processes can be prevented at source by the use of technically sound and economically profitable procedures (Baas *et al.,* 1992).

The textile industry is one of the most polluting industries, where it consumes large quantities of water and produces large volumes of wastewater from different steps in the production process (Ghaly *et al.,* 2014), mainly in the Dyeing process. However, lack of industry specific scientific data on resource use and effluent generation has become a constraint in implementing pollution prevention strategies. Therefore, an elastic and yarn manufacturing industry which does not have any pollution control mechanism in place was selected in order to conduct this Cleaner Production (CP) Assessment. In this Study, only the water and chemical resource management of the selected factory has been considered. By reviewing the past records and reconnaissance factory visits, it was revealed that a considerably higher amount of waste is generated in the Dyeing Section of the factory. Therefore, the study was focused on the wastewater and chemical/ dye waste generated through the ranging process at the Dyeing Section.

b). Research problem

What is the possible cost savings to the factory by reducing the wastewater, chemicals/ dye waste generated during the dyeing process and what are the suitable CP solutions that can be implemented for waste minimization is the research problem.

c). Objectives

1. To quantify the wastewater, chemicals/ dye waste generated during the dyeing process of the factory.
2. To calculate the cost savings to the factory through reducing waste.
3. To suggest most suitable CP solutions to reduce the waste generation during the dyeing process.

d). Research Methodology

Cleaner Production Assessment methodology developed by United Nations Industrial Development Organization (UNIDO) was followed in conducting the Study (UNIDO, 2014). The key steps of the production processes in the Dyeing section were identified through factory visits. Monthly resource flow i.e elastic as raw material, water supply from national supply, from own source and from contractors, chemicals/ Dye, main product output (colored elastic) were measured for a period of three months. Daily resource flow within a week was also measured and recorded. A sample material balance was conducted and all the inputs, outputs and wastewater generated during each process step were quantified separately. The Resource Productivity Indicators and Pollution Intensity were calculated by using the collected data following the equations given below.

$$\text{Resource Productivity} = \frac{\text{Production Output per annum}}{\text{Quantity of Resource consumed in same period}}$$

$$\text{Pollution Intensity} = \frac{\text{Quantity of Waste generated per annum}}{\text{Production Output in same period}}$$

A waste cause analysis was conducted and screening was done to categorize CP options suitable for direct implementation and options need further analysis.

e). Key Findings

Through the factory visits and data collected, it was revealed that steps of Dyeing process of the factory consist of (1) separating elastic, (2) feeding to range machine, (3) mixing with Dye bath (manual), (4) sending through steam machine, (5) chemical fixing, soaping and washing, (6) bonding/ softening and; (7) drying and finishing. Consequently a considerable amount of waste comprising dye, chemicals, softeners and water was generated at these steps.

The resource productivity indicators and pollution intensity are given in Table 1 below.

Table 1: Resource productivity indicators and pollution intensity of the Dyeing section of the factory

Resource Productivity Indicators		
Material Productivity		0.656
Water Productivity	kg/L	0.026
Energy Productivity	kg/MJ	0.062
Pollution Intensity		
Liquid Waste	l/kg	10.98

As depicted in Table 1, the productivity indicators are not close to '1', which indicates that the raw material, water and energy resources are not used effectively. Pollution intensity of the dyeing process i.e a measurement of how much pollution generate per unit of product output as indicated by liquid waste is 10.98 l/kg which indicates a higher level of pollution.

The amount of chemical waste generated during the process steps (1). Mixing with dye bath (Manual), (2) Chemical fixing, soaping and washing and (3) Bonding/ softening is 14515.7 liters/ year which accounts for a total cost of LKR. 21,756,000.00. Amount of wastewater generated during the above process steps plus steaming is 5,318,000 (liters/ year) which accounts for a total cost of LKR. 432,000.00. Therefore, the cleaner production potential of the dyeing process is identified as LKR. 22,185,000/ year.

The main waste causes identified through the Study are (1). skills and motivation (2). technology and machinery (3). specifications (4). process control and; (5). design/ layout of the place. Create awareness among the staff on good housekeeping practices, improve knowledge on efficient use of resources through intensive training, monitor the water usage, minimize spillage through proper handling of chemicals and dyes, maintain an up-to date inventory of chemicals and dyes, upgrade and regularly maintain the equipments use for dyeing are the recommended factory specific CP options to minimize the waste generation.

f). Conclusion

It is concluded that the Cleaner Production potential of the Dyeing section of the selected elastic and yarn manufacturing factory is LKR. 22,185,000/ year. The knowledge of the factory staff regarding cleaner production technologies should be enhanced in order to ensure that resources will not be exhausted unnecessarily and the environment will be preserved optimally.

g). Acknowledgement

Authors wish to express their sincere thanks to staff of National Cleaner Production Centre, Sri Lanka for their immense support given to conduct this study.

h) References

Aondona-Paul IHOM (2014) *Environmental Pollution Prevention and Control: The Current Perspective (A Review).* Journal of Multidisciplinary Engineering Science and Technology (JMEST) ISSN: 3159-0040 Vol. 1 Issue 5, pp 93-99.

Baas LW, Van der Belt M, Huisingh D, Neumann F (1992) *Cleaner Production: What some governments are doing and what all governments can do to promote sustainability.* European Water Pollution Control. 2 (1).

Ghaly AE, Ananthashankar R, Alhattab M, Ramakrishnan VV (2014) *Production, Characterization and Treatment of Textile Effluents: A Critical Review.* Journal of Chemical Engineering and Process Technology 5: 182. doi: 10.4172/2157-7048.1000182.

United Nations Industrial Development Organization (UNIDO), CP Toolkit available on http://www.unido.org/en/resources/publications/energy-and-environment/industrial-energy efficiency/ cp-toolkit-english.html, accessed on 1 Feb 2014.