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EPP Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for a Textile Manufacturer

Executive Summary

A pollution prevention assessment was done for a textile manufacturing facility. The objectives of this assessment were to: 1) identify pollution prevention options that would reduce the quantity of raw materials, toxics, energy, and water used in the manufacturing process; 2) demonstrate the environmental and economic value of a focused pollution prevention assessment; 3) improve manufacturing competitiveness and product quality; and 4) provide the foundation for a sustainable pollution prevention program at the facility. The assessment team was comprised of 2 U.S. process experts, a U.S. pollution prevention specialist, a local expert, and local implementing agency staff.

This assessment identified 12 pollution prevention actions that can save the facility as much as US$333,300 in the first year with an investment of approximately US$227,100. If implemented, the facility can reduce fuel consumption by about 26% while reducing carbon dioxide emissions by about 4,680 tons per year and sulfur dioxide emissions by 94 tons per year; reduce the consumption of treated water by about 30%; eliminate the treatment of about 60,000 m^3 of water per year; and reduce the consumption of colors, dyes and chemicals by about 26%.

In addition to fuel and water savings, through some basic housekeeping measures the facility can improve its product quality. Currently, about 300,000 meters per year of fabric is downgraded to Grade 2 fabric due to defects. By reducing these defects, the facility can sell this fabric as Grade 1, increasing revenues and attracting new external customers.

Facility Background

The facility weaves and finishes cotton and blend fabrics. The facility houses a weaving factory which produces about 6 million meters of fabric per year from about 3,000 tons of yarn and a finishing and preparation factory which finishes about 9 million meters of fabric (6 million produced internally and 3 million for external customers). The current volume of production represents only about 50% of the facility capacity due to the high competition in the local market. The facility was established in 1949 and underwent a renovation process in 1988. It has about 2,000 workers and operates 3 shifts/day for 300 days/year.

Two Artesian wells are the only source of water in the plant. There is a water treatment plant which produces about 400 m^3/day of demineralized water for boilers use as well as about 1,000 m^3/day of soft water for the industrial purposes. Currently, the wastewater coming from all the processes is collected together and drained to a drain channel, but the facility has plans to drain its effluent to a municipal sewage system.

Process Description

In the weaving operation, length-wise yarns form the basic structure of the fabric (the warp) and the cross-wise yarns are the filling (the weft). The yarns used for the warp pass through 3 operations to prepare them for the strain of the weaving process. The first is spooling where the yarn is wound on spools which are placed on a rack called a creal. The yarn from the creal is then wound on a wrap beam. Finally, the yarns are unwound

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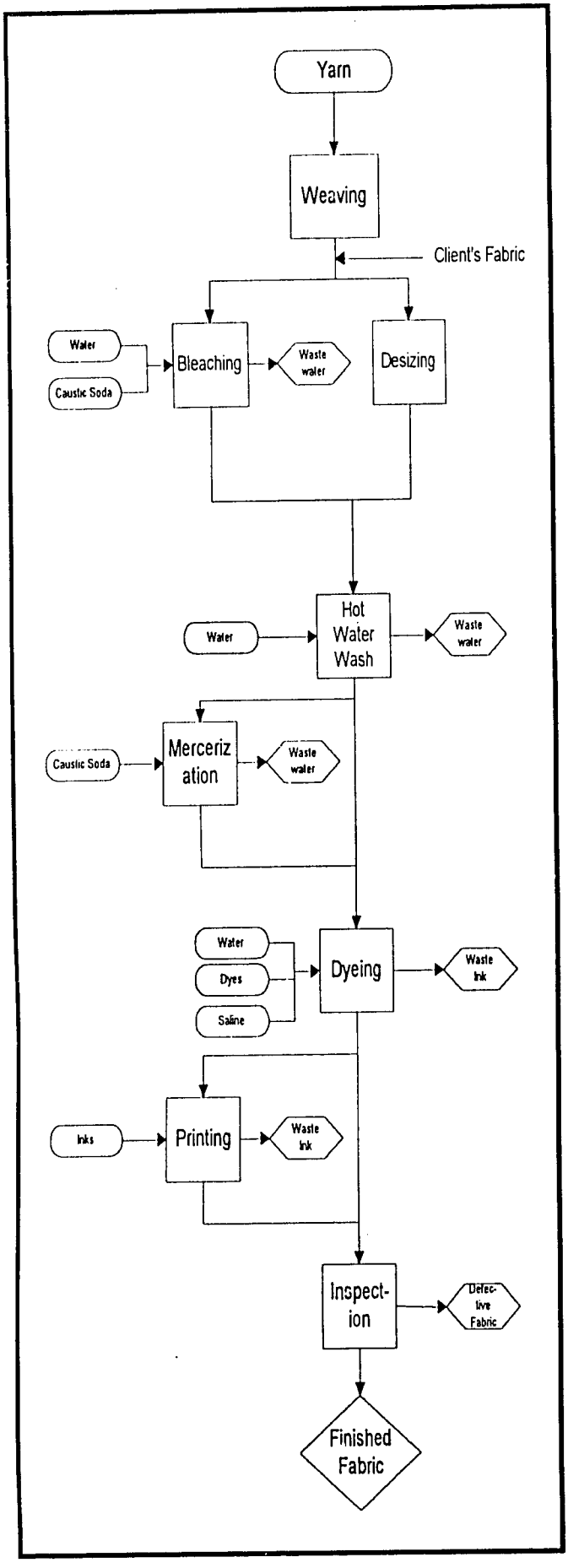
Figure I: Overview of Facility's Printing Process



and put through a sizing bath. The sizing operation covers the yarn with a coating to prevent breaking or chafing during the weaving process. The sized yarn is wound onto a final warp beam to be ready for the looms. The facility has 712 looms of several types where the yarn is woven into fabric.

The raw fabrics contain warp sizing, oils, other additives, dirt and soil and must be cleaned before they can be finished. If the fabric is to be finished white, all natural color must be removed by bleaching. For this the fabric is put through a desizing steamer, washed, soaked in caustic soda, and heated. After this process, the fabric is given a hot wash. Some of the fabric also goes through a mercerization process which increases the luster and strength of the fabric and increases its affinity for dyes. For this process, the fabric passes through a cold solution of caustic soda, stretched out on a tenter frame where hot-water sprays remove most of the caustic, and washed.

The fabrics are dyed using several methods. These are beck dyeing where long lengths of fabric pass repeatedly through the dye bath until reaching the desired intensity; jig dyeing which is similar to beck dyeing except that the fabric is held at full width; and jet dyeing in which synthetic fibers are placed in a heated container and jets of dye solution are forced through at high pressure. After dyeing, the fabric is immersed in hot saline solution to fix the colors. Finally, some of the fabric is printed using a rotary screen printer which uses engraved rollers. After application, the ink is dried in two successive dryers. The fabric is then dried and inspected. These processes are presented in **Figure 1.**

Environmental Problems

The key environmental problems associated with the weaving and finishing of fabrics are the inefficient use of water and energy resources; large amount of wastewater ladened with organic material, chemicals, and dyes; water condensate; and air emissions from fossil fuel combustion.

Pollution Prevention Opportunities

The assessment identified 12 pollution prevention opportunities. These are summarized in **Table 1**.

Recover the bleaching liquor: The drain liquor from the bleaching process can be recovered and reused. The

Table I: Summary of Recommended Pollution Prevention Opportuntities

Operation	Pollution Prevention Action	Environmental and Health Benefits	Implementation Cost (US$)	Financial Benefits (US$ per year)	Payback Period
Bleaching	Recover bleaching liquor	Reduce the amount of wastewater; save water and chemicals	US$18,200	US$46,400	5 months
Dyeing	Recover dye liquor	Reduce wastewater; reduce use of dyes	US$18,200	US$59,100	4 months
Utilities	Recover steam condensate	Reduce treated water consumption; reduce fuel consumption	US$3,000	US$59,100	1.5 months
Printing	Use untreated water	Reduce treated water consumption	US$600	US$3,600	2 months
Utilities	Tune-up boilers	Reduce fuel consumption and air emissions	US$0	US$5,500	immediate
Utilities	Convert to natural gas	Reduce fuel consumption; reduce emissions	US$72,700	US$56,400	16 months
Utilities	Insulate pipes	Reduce fuel consumption	US$9,100	US$11,200	10 months
Color Mixing	Use ladle to recover residual ink	Reduce ink use by 1 ton/year; reduce oil and grease content in wastewater	US$150	US$8,600	.2 months
Color Mixing	Use computers for color matching	Reduce colors consumption; reduce defective fabrics	US$72,100	US$52,100	17 months
Overall	Improve housekeeping measures	Reduce chemical, water and energy use	US$32,400	US$54,500	7 months
Overall	Sell scrap	Reduce waste; improve worker safety	US$600	US$14,500	.5 months
Printing	Change from solvent to aqueous system	Eliminate kerosene emissions and effluent	Not quantified	Not quantified	Not quantified
TOTAL			**US$227,100**	**US$58,900 US$/per year US$15,200 (one-time)**	

cost of installing a recycling bleaching-liquor tank is US$18,200. This will save water (which needs to be softened), chemicals, and fuel used in steam generation and will reduce the amount of wastewater generated. By reusing 50% of the materials, annual savings in materials will be US$46,400 per year.

Recover the dye liquor: By capturing the spent dye, renovating it by adding make-up chemicals, dyes, and water, it can be used for another dyeing. This will reduce wastewater flow and BOD and COD loadings and require a smaller investment than a pretreatment system. Implementation costs are US$18,200; annual savings are US$59,100.

Recover steam condensate: The steam from the heat exchangers can be returned back to the boilers as feed water rather than disposed down the drain. About 144 tons of condensate are lost each day. Reusing the condensate steam reduces fuel consumption and demineralized water consumption saving US$24,200 per year. Implementation cost is US$3,000.

Use untreated water in print shop: Currently, soft (treated) water is used to wash the cylinders of the printing machines. Untreated water can be used as effectively. Implementation cost is US$600; annual savings are US$3,600.

Tune-Up boilers: Use a microprocessor-based exhaust gas analyzer to determine the optimum air/fuel ratio for the boilers. Based on these readings, the boiler operator can adjust the excess air to maximize the boiler efficiency and save fuel. Implementation cost is US$12,100; annual fuel savings are US$15,500.

Convert to natural gas: The boilers currently use about 6,000 tons of mazout (#6 oil) and 516 tons of solar energy per year. By using natural gas, the facility will reduce the cost of fuel due to the lower price of natural gas, reduce corrosion problems due to the sulfur content in the mazout, and reduce air emissions. Implementation costs are US$72,700 for the natural gas burners; annual savings are US$56,400.

Insulate steam pipes: Covering the steam distribution system with an appropriate type and thickness of durable insulation material will reduce energy consumption. Implementation cost is US$9,100; annual savings are US$11,200.

Use ladle to remove residual ink: The wastewater in the facility has a high oil and grease content, much of which is due to the color left in the bottom of the container and rinsed into the drain. This ink can be captured and used for future black ink. Savings in ink and dyes is 1.03 tons/year, or about US$8,600 per year. Implementation cost is US$150.

Use computers for color preparation and matching: A computer system can be used to identify the colors and pigments required to prepare a certain color and shade. This will reduce the number and cost of trials to achieve the desired color and increase product quality (Grade 2 fabric represents about 5% of the total). Implementation cost is US$72,100; annual savings are US$52,100 per year.

Improve housekeeping throughout the plant: There are number of opportunities to improve the functioning of the processes at the facility that will significantly improve product quality. These include improving the light intensity at the weaving plant to enable quality control staff to identify defect fabrics; cleaning the looms and weaving machines regularly to reduce fiber build-up; and covering the dyeing machines to reduce dust contamination and increase energy efficiency. Implementation cost for these measures is US$32,400; annual savings (as increased revenue) is US$54,500.

Sell scrap metal and machinery parts: The scrap can be sold to earn revenues, clean out areas to improve transportation within the plant, and reduce fire hazard. This scrap includes metallic scrap such as steel, cast iron and aluminum alloys (barrels, dismantled machines, used spare parts and electric cables) and defective screens and cylinders in the printing shop. Revenues will be about US$14,500.

Change from kerosene print system to an aqueous system: Due to the air solvent emissions of kerosene, its use will be eliminated due to upcoming environmental regulations. An aqueous system can be used to replace the current system. Implementing this system will involve higher costs and some experimentation to find a system that works for this facility.

Conclusion

Implementing the recommended pollution prevention measures will result in a number of benefits for the facility: 1) It will improve product quality. Several of the recommendations will reduce fabric contamination and defects and improve color matching and preparation which will overall enable the facility to produce a better product. 2) It will reduce end-of-pipe investment. It is likely that future environmental regulations will impose stricter controls on wastewater discharges. To meet these requirements, the facility will need to install a wastewater treatment system to meet the standards of the city sewage system. While it is not practical to totally eliminate the need for some wastewater treatment, these pollution prevention measures will significantly reduce wastewater volume and pollution load which will save the facility money overall. 3) It will improve health and safety at the facility.

For Further Information

For futher information on this assessment or other activities sponsored by EP3, call the EP3 Clearinghouse at (703) 351-4004, send a fax to (703) 351-6166, or on Internet: ep3clear@habaco.com