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Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for a Garment Manufacturer

Executive Summary

A pollution prevention assessment was done for a garment producing facility. The objectives of the assessment were: 1) to identify pollution prevention actions that would reduce the quantity of toxics, raw materials, and energy used in the manufacturing process; 2) demonstrate the environmental and economic value of a comprehensive pollution prevention assessment; 3) improve manufacturing competitiveness and product quality; and 4) improve the health and safety concerns inside the plant. The assessment team was comprised of local experts as well as experts from the US and local implementing agencies.

This assessment identified nine pollution prevention actions that will save the facility US$97,100 in the first year with a total investment of US$85,100. Seven of the actions if implemented together can result in about LE 90,000 in savings, with a cost of US$2,100. The majority of the total savings come from two recommendations costing US$60,600 and US$22,700 and having payback periods of 1 year and 4 years, respectively. Implementing the pollution prevention options will help improve environmental conditions and reduce fire hazards.

Most noteworthy are the savings on water and energy consumption. The facility could reduce its water consumption by 85,000 m³/year; equivalent to approximately US$25,800. The decrease would result from water recycling and process streamlining. Fuel consumption at the plant could be reduced by 113 tons, saving the facility US$8,220 annually.

Facility Background

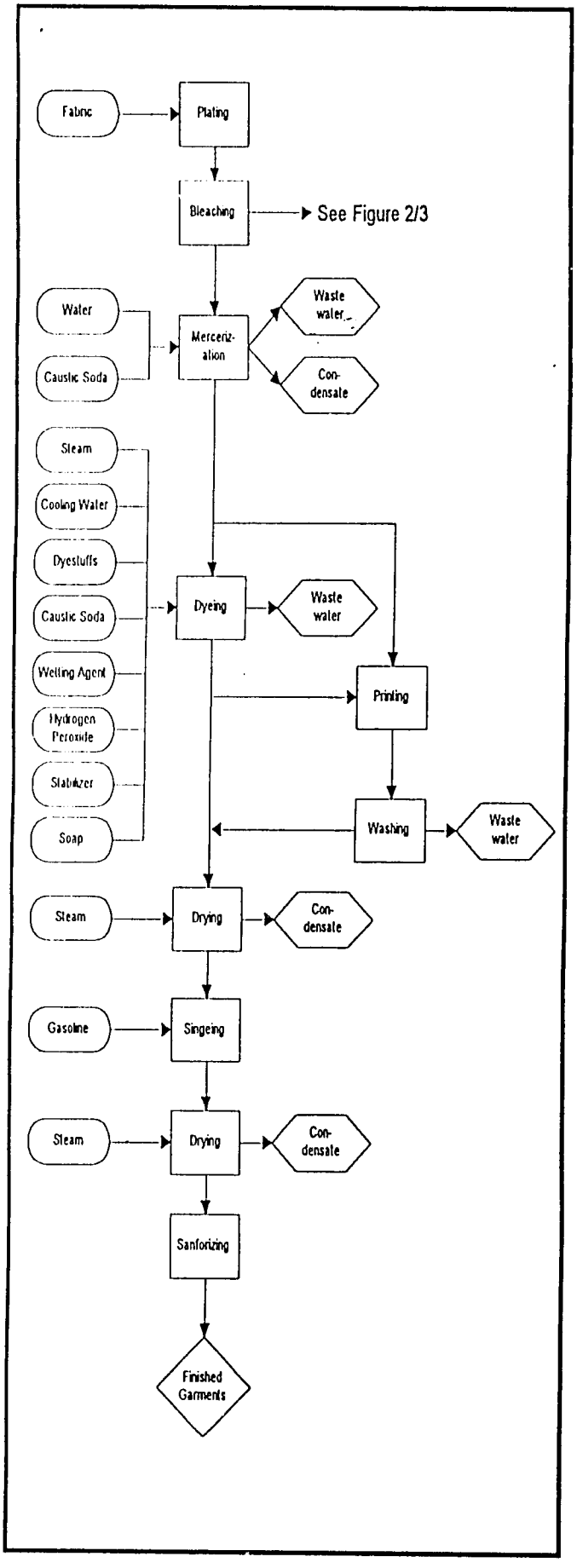
The facility produces men's and women's garments for both the domestic and international market, 75% and 25% respectively. The materials used in production are wool, cotton, cotton polyester, wool/acrylic, and rayon. The manufacturing facility operates a single shift while the dye house operates two shifts of 8 hours per day for 300 days a year. There are a total of 1,100 employees at this site.

Manufacturing Process

The manufacturing process consists of four unit operations: 1) fabric preparation; 2) printing and dyeing, 3) treatment and drying, and 4) plant services. **Figure 1** provides an overview of the fabric preparation process; **Figure 2** illustrates the present desizing-bleaching process in greater detail because of its high potential for pollution prevention opportunities; and **Figure 3** illustrates the proposed bleaching-desizing process.

There are three steps in fabric preparation: plating, bleaching and mercerization. In the plating step, griege cloth (newly woven material) is sewn together to predetermined lengths. The fabric is desized, washed, and dried, then it is bleached, washed, and dried. Subsequently, the cloth is immersed in a caustic solution for a short period of time (mercerization) and then washed. This process adds luster and deepens the color of the fabric (this is done for cotton cloth only).
The cloth can be printed, dyed, or both. The two printing processes are: 1) flat bed printing, where the fabric moves on a belt the distance of the desired pattern and stops while the color is transferred from screen to

Figure I: Overview of Facility's Printing Process



the cloth; and 2) rotary screen printing, where the cloth is on a continuous belt and passed under round screens for print application. At this facility, color is introduced to the fabric using the following dyeing procedures: 1) jet dyeing; 2) jigger dyeing; and 3) pad batch dyeing.

The next step is treatment and drying. The cloth is dried using blown air, which is sometimes heated, singed to remove excess fibers, washed, dried, finished or treated with a softener, dried, and Sanforized to reduced shrinkage (cotton fabric only). The cloth is then inspected for defects before garment sewing/production.

Environmental Problems

The key environmental problems associated with this facility are: 1) condensate (wastewater at high temperature, but relatively free from contamination); 2) wastewater contaminated with high levels of dyes and chemicals; 3) high energy use; and 4) heat loss from leaking and uninsulated pipes.

Pollution Prevention Opportunities

This assessment identified nine pollution prevention opportunities, five of which have already been implemented. **Table 1** lists the recommendations and presents the environmental and financial benefit for each. The total cost of implementing these pollution prevention options is approximately US$85,400, and will result in an annual savings of US$97,100 per year.

Recycle mercerizer overflow: The mercerization line has 4 wash boxes with an overflow rate of 2 m^3/hour. At the time of the assessment, washwater was discharged as effluent. Because it is relatively clean water, the overflow can be used to make up part of the caustic solution. The cost to implement this pollution prevention option is US$30 and the savings is US$2,900 (assuming water cost of US$.30/$m^3$).

Recycle water from pad: Water, produced at the pads (rollers used to squeeze out water in the washers) can be collected and used for washing, reducing the amount of wastewater generated. Counter flow rinsing in the washers can also result in a savings in water use. These two measures reduce water consumption by more than 50%, from 20.7 m^3/hour to 6 m^3/hour. The cost of implementing this recommendation is US$760 with a yearly savings of approximately US$10,700.

Table I: Summary of Recommended Pollution Prevention Opportunities

Operation	Pollution Prevention Option	Environmental and Health Benefits	Cost (US$)	Financial Benefits US$ per year	Payback Period
Fabric Preparation	Recycle mercerizer overflow	Reduction in wastewater generation and caustics use	US$30	US$2,900	4 days
Fabric Preparation	Recycle water from pad; counter flow rinsing	Reduction in wastewater generation	US$760	US$10,700	one months
Fabric Preparation	Streamline desizing and bleaching process	Reduction in process time, resource use	US$60,600	US$63,600	one year
Treatment and Drying	Install vacuum extractor	Reduction in fuel consumption	US$22,700	US$6,100	four years
Treatment and Drying	Convert singe-er to natural gas use	Increase worker safety; reduction in fuel cost	US$150	US$1,600	one month
Treatment and Drying	Insulate Dow-therm pipes	Reduction in fuel consumption	US$450	US$6,400	one month
Plant Services	Repair Steam Leaks	Reduction in fuel consumption	US$0	US$3,600	Immediate
Plant Services	Recycle Condensate	Reduction in fuel consumption; reclamation of water, heat and chemicals	US$550	US$1,970	three months
Plant Services	Insulate Steam Pipes	Reduction in fuel consumption	US$120	US$200	seven months
TOTAL			US$85,400	US$97,100	

Streamline preparation line for desizing-bleaching cloth: The preparation line has a rope washer, a saturator, J box, washer, and dry cans. At present, cloth is passed through the preparation line twice. By installing a steamer in front of the first washer, the cloth would only have to pass one time through the preparation line, resulting in a substantial savings in time and resources. **Figure 3** illustrates the proposed bleaching method. The cost of a steamer is US$60,600. Annual savings are US$63,600.

Install vacuum extractor in front of Bruckner dryer: Current procedures result in cloth that is 70% water by weight. Passing the cloth over a vacuum slot would reduce the water content in the cloth by 50%, reducing the amount of energy needed to dry the cloth. The cost to implement this recommendation is US$22,700 with a yearly savings of US$6,100, from reduced energy and water needs.

Repair steam leaks: A considerable amount of steam is lost due to leaking pipes. Repairing these leaks would reduce the amount of fuel the facility has to purchase. There is no cost associated with implementing this recommendation because it was assumed that the maintenance department would complete repairs. The yearly savings in fuel cost is estimated to be US$3,600.

Convert singe-er to natural gas: The singe-er is fired with gasoline, which presents a safety hazard from gasoline/air mixtures. Converting the singe-er to natural gas will not only reduce fuel cost, but also will improve worker health and safety. The cost of converting to a natural gas system is US$150; yearly savings are US$1,600.

Insulate Dow-therm lines: The Bruckner frames used in drying are heated with Dow-therm. The pipes carrying the Dow therm liquid are not insulated, resulting in a large amount of heat loss. Insulating the pipes would cost US$450 and result in a savings of 87 tons of fuel per year, equivalent to US$6,400.

Recycle condensate from Bruckner and Gaston County dye machines: Both of these machines are equipped with steam heat exchangers. By capturing the condensate and pumping it to the boilers, the heat and treated water can be recycled. Implementing this measure will save a total of US$1,970/year, in fuel and water costs with a capital cost of US$550.

Insulate steam pipes in the boiler room: Heat is lost in the boiler room because the the pipes that carry steam are not insulated. Insulating the pipes would result in a yearly fuel savings of 2.7 tons of fuel, equal to US$200. The total cost to insulate the pipes was not calculated because the total area needing insulation was not known, however a base estimate was calculated assuming that at least 20 m^2 of piping would have to be covered. The unit cost of insulation was estimated at US$12/$m^2$.

Implementation

Five recommendations have already been implemented with great success. The facility began to recycle the overflow from mercerization as soon as the recommendation had been made, and the facility has already experienced a savings of US$2,900/year. Subsequently, the recommendations to recycle wash water, repair steam leaks and insulate the steam pipes have also been carried out, further increasing the facility's savings.

Figure 2: Present Bleaching Method

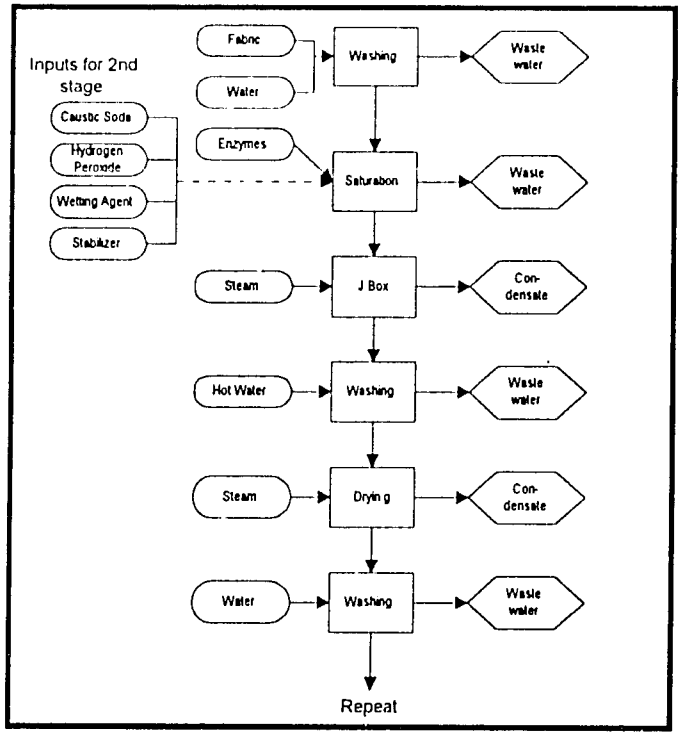
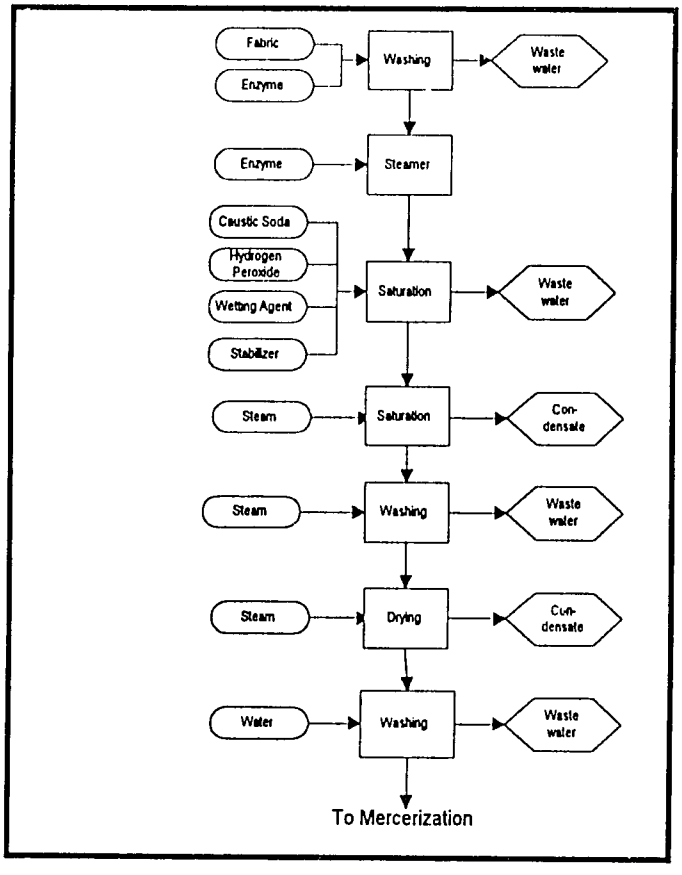


Figure 3: Proposed Bleaching Method



For Further Information

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