PN-ABX-749

HBI-94-008-02, Pub. 10/31/94

Pollution Prevention Assessment for a Sheep Hide Tannery CASE STUDY

What is EP3?

The amount of pollutants and waste generated by industrial facilities has become an increasingly costly problem for manufacturers and a significant stress on the environment. Companies, therefore, are looking for ways to reduce pollution at the source as a way of avoiding costly treatment and reducing environmental liability and compliance costs.

The United States Agency for International Development (USAID) is sponsoring the Environmental Pollution Prevention Project (EP3) to establish sustainable programs in developing countries, transfer urban and industrial pollution prevention expertise and information, and support efforts to improve environmental quality. These objectives are achieved through technical assistance to industry and urban institutions, development and delivery of training and outreach programs, and operation of an information clearinghouse.

EP3's Assessment Process

EP3 pollution prevention diagnostic assessments consist of three phases: *pre-assessment*, *assessment*, and *post-assessment*. During *pre-assessment*, EP3 in-country representatives determine a facility's suitability for a pollution prevention assessment, sign memoranda of agreement with each facility selected, and collect preliminary data. During *assessment*, a team comprised of U.S. and in-country experts in both pollution prevention and the facility's industrial processes gathers more detailed information on the sources of pollution, and identifies and analyzes opportunities for reducing this pollution. Finally, the team prepares a report for the facility's management detailing its findings and recommendations (including cost savings, implementation costs, and payback times). During *post-assessment*, the EP3 in-country representative works with the facility to implement the actions recommended in the report.

Summary

This assessment evaluated a sheep hide tannery. The objective of the assessment was to identify actions that would: (1) reduce the quantity of toxics, raw materials, and energy used in the manufacturing process, thereby reducing pollution and worker exposure, (2) demonstrate the environmental and economic value of pollution prevention methods to the tanning industry, and (3) improve operating efficiency and product quality.

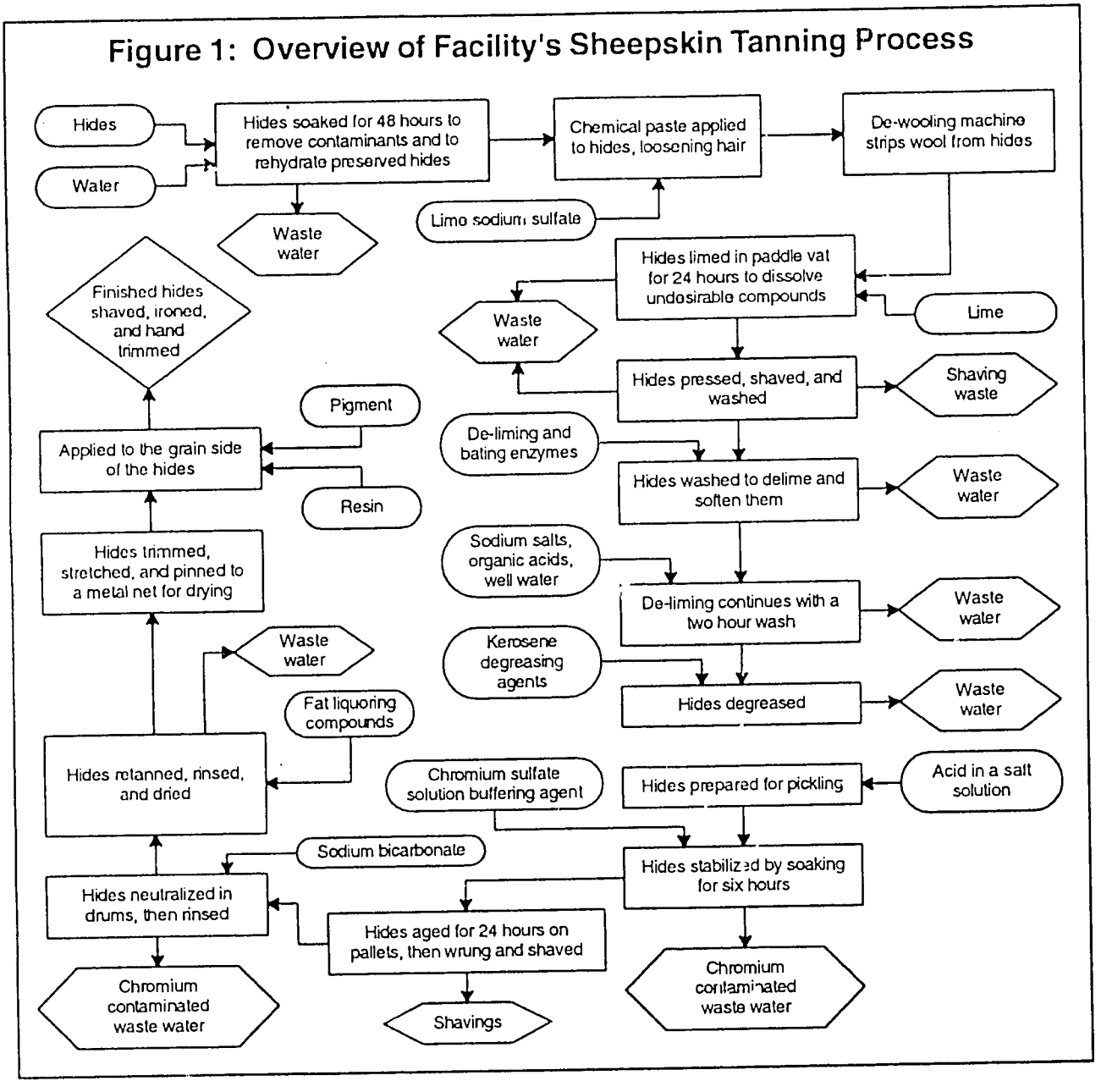
The assessment was performed by an EP3 team comprised of an expert in hide tanning and a pollution prevention specialist.

Overall, the assessment identified five pollution prevention opportunities at this facility that can save as much as $95,000 in the first year after implementation for an overall investment of at most $22,000. If implemented, these pollution prevention changes will reduce the amount of chromium sulfate used for tanning by 25 metric tons per year, eliminate the generation of H_2S, reduce the amount of waste water generated by 2,000 cubic meters per year, and reduce the chemicals needed to treat waste water. All five of the options identified can be quickly and easily implemented by the plant's staff. None require complicated, expensive, or new technologies.

Facility Background

This facility is a tannery producing leather from sheep and goat hides. The facility tans approximately 2,000 sheep hides per day, for a total of 600,000 hides per year. Between 90 and 95 percent of the annual production hides are sheep hides for clothing, while the rest are goat hides for shoes. The wastes generated by the tannery come from the hides and the chemicals used in the production process. The facility provides on-site effluent pre-treatment prior to

Figure 1: Overview of Facility's Sheepskin Tanning Process



discharging the waste water to the municipal sewer system. The tannery operates two staggered 8-hour shifts, and employs 45 permanent and 30 seasonal workers.

Manufacturing Process

The leather making process at this facility begins with delivery of sheep or goat hides by truck. Fresh hides and dried hides are sorted into piles according to size and wool color; black is separated from all other colors. The fresh hides go immediately to the paddle vat for soaking and washing; the dry hides enter the process on an as-needed basis.

The soaking paddle vat typically contains 1,000 raw hides to which ambient temperature fresh water is added. The vat mixes the hides and water for 17 to 48 hours to remove blood, manure, and dirt from the hides.

Next, the hides enter the lime painting process, which prepares the hides for wool removal. After the hides are painted with a lime and sodium sulfate solution and allowed to cure for three to seven hours, a mechanical hair-pulling machine is used to remove the wool. The hides then move to another paddle vat for liming.

Table 1: Summary of Recommended Pollution Prevention Opportunities

Unit Operation	Pollution Prevention Action and Environmental/ Product Quality Benefit	Cost	Financial Benefit	Payback Period
Pre-tanning Liming and Washing	Segregate from other waste streams - eliminates the generation of H2S.	$5,000	To be determined	N/A
Tanning: Chromium Fixation	Increase temperature and control pH - reduces chromium in waste water.	$2,000	None	N/A
Tanning: Chromium Effluent Recycling	Recycle used chromium effluent with addition of 1/3 of initial requirements - reduces chromium in waste water.	$3,000	$40,700 per year	1 month
Tanning: Chromium Recovery	Precipitate chromium wastes with hydroxide, settle, and re-dissolve with acid and reuse - reduces chromium in waste water.	$2,000	$5,800 per year	4 months
Post-tanning: Dyeing (Black Only)	Recycle used black dye solution with addition of 1/2 of initial requirements - reduces chromium in waste water.	$10,000	$48,500 per year	Less than 3 months
TOTALS		$22,000	$95,000 per year, plus 1 unquantified opportunity.	

The liming step dissolves the epidermis, any remaining hair, and any other undesirable compounds in or on the hide. The hides usually remain in the vat for 24 hours. The waste water from this step generates hydrogen sulfide when mixed with other waste water streams.

After liming and washing, the hides move to a fleshing operation where they are pressed by a roller and shaved by a blade adjacent to the roller. The fleshing waste averages 500 kilograms per batch; the tannery runs two batches per day.

Next, the hides move to a rotating, wooden drum for neutralization with a solution of fresh water, ammonium salts, enzymes, and organic acids. After neutralization, a series of steps add emulsifiers, non-solvent degreasing agents, salt, formic acid, and sulfuric acid to lower the pH to the 2.8 - 3.0 range.

The hides are then tanned. Chromium sulfate salts and sodium bicarbonate are added sequentially and mixed for two hours and six hours, respectively. This step stabilizes the collagen in the hides by blocking further chemical reactions. The waste tanning solution drains into the pre-treatment system.

After aging for about 24 hours, the hides undergo post-tanning, which consists of a rinse and degreasing. Depending on the quality of the hides and their final use, the hides may be re-tanned, neutralized and washed.

The hides are then dyed; over 80 percent are dyed black. After dyeing, fat liquoring agents which give the leather its supple feel are added. Upon completion of this step, wastes are sent to the pretreatment system, and the hides receive a final wash before moving on to an air drying area.

After drying, the hides go to the finishing steps where they are first trimmed, stretched out and pinned onto a light metal grill, and dried to the desired final moisture. Depending on the final use of the hide, an automatic system sprays pigments, resin binders, and waxes onto the grain side of the hide. The finished hides are shaved on the flesh side to produce equal thickness, and then are ironed, inspected, and hand-trimmed to their final size. Finally, each hide is measured by machine, bundled, and sent to the warehouse for shipment. See **Figure 1** for a graphic depiction of the facility's manufacturing process.

Existing Pollution Problems

At the time of the assessment, there were a number of pollution problems at the facility, including (1) excessive chromium discharge, (2) excessive effluent volume, (3) inefficient chromium fixation, (4) sulfide generation, and (5) inefficient use of dye chemicals.

Pollution Prevention Opportunities

The assessment identified five pollution prevention opportunities that could address the problems identified, with significant environmental and economic benefits to the facility. **Table 1** lists the opportunities recommended for the facility, and presents the environmental benefits and implementation costs for each.

Chromium reuse and recovery, black dye recycling, and water recycling will produce equal quality tanned hides while simultaneously reducing the quantity of chemical toxics released into the environment. Effluent from each virgin tanning bath can be reused up to five times by adding one-third the normal amount of chromium sulfate before each tanning bath. In addition, chromium recovery will reduce emissions and reduce production costs.

The recommendations can reduce the amount of waste water treated by 2,000 cubic meters per year, reduce the loading of toxic chromium salts and dye baths, and isolate incompatible waste streams for separate treatment. While it is not practical for the tannery to eliminate the need for its waste water pretreatment facility, the recommendations will enable the treatment system to operate more efficiently. Further, separation of waste waters will avoid the generation of foul smelling and toxic hydrogen sulfide gas.

Two major environmental issues for the tannery are the extensive use of chromium in the black dye and tanning salts, and direct worker contact with these toxic materials. Successful implementation of the recommendations would cut chromium sulfate purchases by 55 percent or 25 metric tons per year, and black dye purchases by 25 percent or 6 metric tons per year.

Evaluating Performance

EP3 is developing a methodology for measuring and tracking pollution prevention performance. The approach uses simple but critical ratios to compare data among facilities in the same industrial sector.

This assessment identified five critical ratios, as shown in **Table 2**. The Assessment Team developed best industrial performance (BIP) values for these ratios, and found that several of this facility's current values were significantly higher than the BIP values. The facility should be able to reduce its ratios and come closer to the BIPs by implementing the pollution prevention options listed in **Table 1**.

Table 2: Critical Performance Ratios for Leather Tanning

Ratio	BIP	Current Ratio at Facility
Kilograms of solvent per kilogram of hides	0	0
Parts per million of trivalent chromium in the waste water effluent	2	8
Kilograms of purchased chromium sulfate per metric ton of raw wet hides	40	75
Kilograms of solvent per kilogram of finished hides	0	0
Cubic meters of water per metric ton of raw, wet hides	40	43.3

For Further Information

For further 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 apenderg@habaco.com.