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 a US expert in hide tanning, a US pollution prevention specialist, in-country EP3 staff, and local consultants.

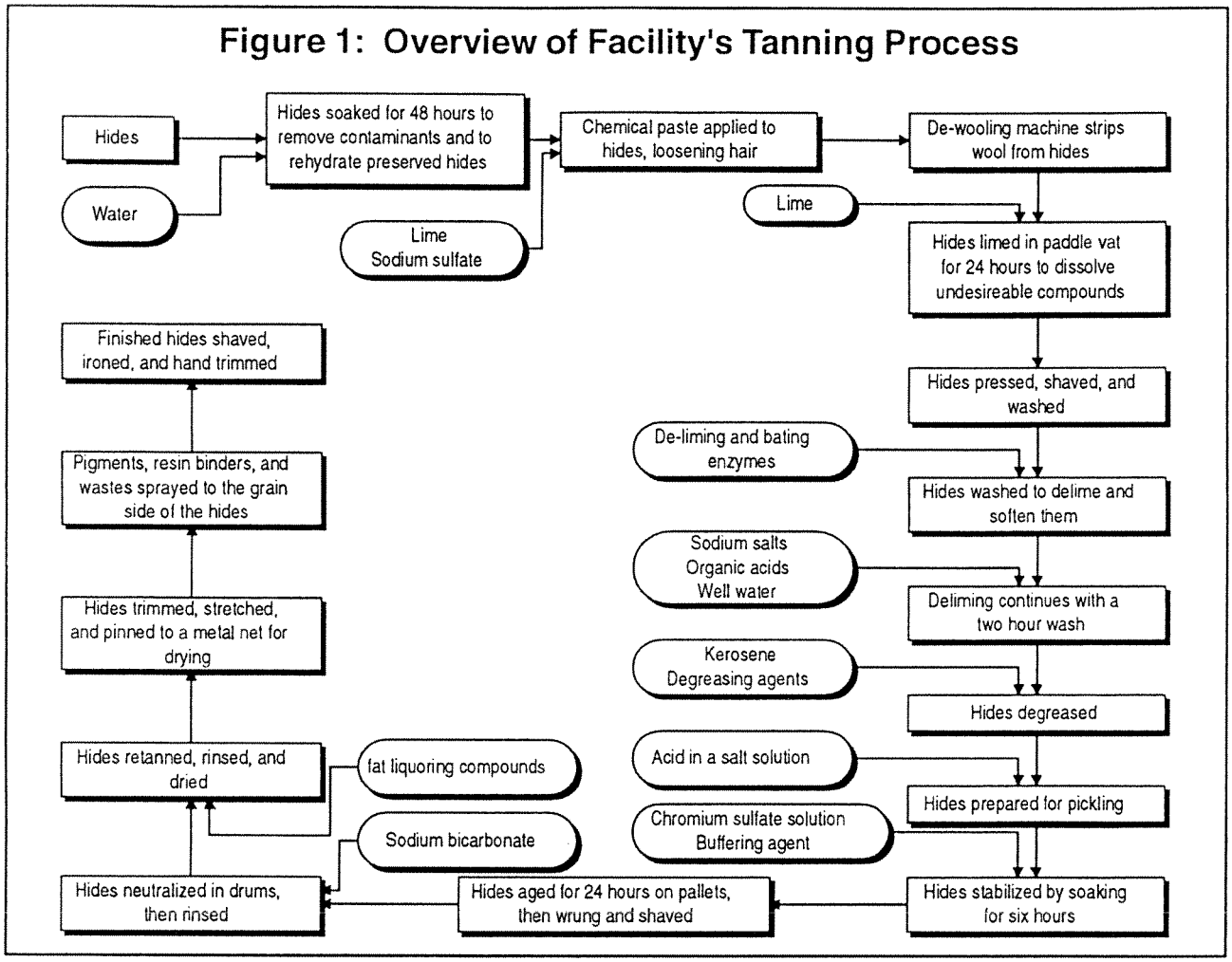
Overall, the assessment identified five pollution prevention opportunities at this facility that can save as much as $7,000 in the first year after implementation for an overall investment of $7,000. All five options identified can be quickly and easily implemented by the plant's staff. None require complicated, expensive, or new technologies. Four of the options are low-cost with payback periods ranging from five months to two years. A sixth opportunity -- recycling -- requires a significant upfront investment. If implemented, these pollution prevention changes will reduce the use of toxic raw materials, reduce the amount of waste water generated, reduce the chemicals needed to treat waste water, and significantly reduce the amount of chromium used in the facility and discharged to the waste water.

Facility Background

This facility is a tannery producing leather from sheep and goat hides. The facility tans approximately 400 sheep hides per day, for a total of 120,000 hides per year. Between 90 and 95 percent of the annual production are sheep hides tanned for clothing, while the rest are goat hides tanned for shoes. The wastes generated by the tannery come from the hides and the chemicals used in the production process.

The tannery operates one 8-hour shift, and employs

Figure 1: Overview of Facility's Tanning Process



20 permanent and 5 seasonal workers with peak activity during the first five months of the calendar year. Each employee works a 40-hour week.

Process water comes from a 50 meter deep well on the premises, while the municipal water supply provides sanitary and housekeeping needs. There is no municipal sewer system or treatment plant near the tannery. The facility has a primary solids treatment system, and a secondary system that has an aerated lagoon and an evaporation and percolation pond. During the summer months, the evaporation is considerable.

Manufacturing Process

The leather making process at this facility begins with delivery of sheep or goat hides by truck. Between 75 and 80 percent of the tannery's hides are dried; the rest are equal amounts of fresh and salted hides.

First, the hides are soaked. The soaking paddle vat typically uses 25 cubic meters of ambient temperature well water. The purpose of the soak is to remove blood, manure and dirt, and to dissolve the salt from and rehydrate the preserved hides. After 48 hours of soaking, the hides are removed from the vat and moved to the adjacent lime painting operation.

A paste of lime and sodium sulfate is applied to the flesh side of the hides. The hides sit for three hours to allow the chemicals to react and loosen the wool. Next, a mechanical de-wooling machine strips the wool from the hides. The de-wooled hides, with most of the green lime painting paste still on the flesh side of the skin, move to a paddle vat for liming. The liming process 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.

After liming and a subsequent wash step, the hides move to the fleshing operation where they are pressed by a roller and shaved (fleshed) by a blade adjacent to the roller. The daily fleshing waste aver-

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: Soaking	Recycle improved secondary treatment waste effluent - yields a 30 percent reduction in water consumption.	$17,000	To be determined	Unknown
Pre-tanning: Liming	Segregate from other waste streams and oxidize separately - eliminates the generation of H2S.	None	None	Immediate
Pre-tanning: Liming Wash Water	Reuse effluent from liming wash - reduces waste water.	$1,000	$1,000 per year	1 year
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.	$2,000	$5,000 per year	5 months
Tanning: Chromium Recovery	Precipitate chromium wastes with hydroxide, settle, and re-dissolve with acid and reuse - reduces chromium in waste water.	$2,000	$1,000 per year	2 years
TOTALS		$24,000	$7,000 per year, plus 1 unquantified opportunity.	

ages 250 kilograms. The hides next move into a revolving drum to wash the liming solution from the hide. De-liming and bating enzymes are employed to reduce hide swelling, remove unwanted non-leather making materials, and lower pH.

Sodium salts, organic acids, and well water are then mixed with the hides for about two hours. Kerosene and other degreasing agents are also added to degrease the hides. Acid in a salt solution and sulfuric acid are employed to lower the pH of the hides for pickling.

The next step is chromium tanning. Chromium sulfate solution is added with a slowly dissolving buffering agent to stabilize the collagen in the hide by reacting with the hide protein to block further undesirable reactions. At the end of this six-hour batch process, the wet hides age for 24 hours on pallets.

After tanning and aging, the hides are wrung and shaved. The hides are then placed in another drum for neutralization with sodium bicarbonate. After another rinse, the hides are re-tanned by adding fat liquoring compounds that give the leather its feel and suppleness. After rinsing and air drying, the hides are trimmed, stretched, and pinned to a metal net for drying to a predetermined moisture level. An automated process sprays pigments, resin binders, and waxes to the grain side of the hides. Finally, the finished hides are shaved to a uniform thickness, ironed, and hand-trimmed to final size.

See **Figure 1** for a graphic depiction of the facility's manufacturing process (a more detailed process flow is available from the EP3 Clearinghouse).

Existing Pollution Problems

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

Pollution Prevention Opportunities

The assessment identified five pollution prevention opportunities that could address the problems identified above, 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 chromium emissions by 45 percent and reduce production costs by $6,300 per year.

The major environmental issue for the tannery is the extensive use of chromium tanning salts, and the workers' direct contact with these toxic materials. Successful implementation of the recommendations would cut chromium purchases by 2 metric tons per year. Unlike the majority of tanning operations that use trivalent chromium, the tannery begins with hexavalent chromium and converts it to trivalent chromium. Hexavalent chromium is extremely toxic and the tannery should discontinue its use.

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 washed	0	0.08
Parts per million of trivalent chromium in the waste water effluent	2	5
Kilograms of purchased chromium sulfate per metric ton of raw, wet hides	40	64
Kilograms of solvent per kilogram of finished hides	0	0.08
Cubic meters of water per metric ton of raw, wet hides	40	67

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..