Tanning and Leather Finishing

Industry Description and Practices

Hides and skins are sometimes preserved by drying, salting, or chilling, so that raw hides and skins will reach leather tanneries in an acceptable condition. The use of environmentally persistent toxics for preservation of raw hides and skins is to be avoided.

In the tanning process, animal hides and skins are treated to remove hair and nonstructured proteins and fats, leaving an essentially pure collagen matrix. The hides are then preserved by impregnation with tanning agents. Leather production usually involves three distinct phases: preparation (in the beamhouse); tanning (in the tanyard); and finishing, including dyeing and surface treatment. A wide range of processes and chemicals, including chrome salts, is used in the tanning and finishing processes.

The tanning and finishing process generally consists of:

- Soaking and washing to remove salt, restore the moisture content of the hides, and remove any foreign material such as dirt and manure
- Liming to open up the collagen structure by removing interstitial material
- Fleshing to remove excess tissue from the interior of the hide
- Dehairing or dewooling to remove hair or wool by mechanical or chemical means
- Bating and pickling to delime the skins and condition the hides to receive the tanning agents
- Tanning to stabilize the hide material and impart basic properties to the hides
- Retanning, dyeing, and fat-liquoring to impart special properties to the leather, increase penetration of tanning solution, replenish oils in the hides, and impart color to the leather
- Finishing to attain final product specifications.

Waste Characteristics

The potential environmental impacts of tanning are significant. Composite untreated wastewater, amounting to 20–80 cubic meters per metric ton (m^3/t) of hide or skin, is turbid, colored, and foul smelling. It consists of acidic and alkaline liquors, with chromium levels of 100–400 milligrams per liter (mg/l); sulfide levels of 200–800 mg/l; nitrogen levels of 200–1,000 mg/l; biochemical oxygen demand (BOD) levels of 900–6,000 mg/l, usually ranging from 160 to 24,000 mg/l; chemical oxygen demand (COD) ranging from 800 to 43,000 mg/l in separate streams, with combined wastewater levels of 2,400 to 14,000 mg/l; chloride ranging from 200 to 70,000 mg/l in individual streams and 5,600 to 27,000 mg/l in the combined stream; and high levels of fat. Suspended solids are usually half of chloride levels. Wastewater may also contain residues of pesticides used to preserve hides during transport, as well as significant levels of pathogens. Significant volumes of solid wastes are produced, including trimmings, degraded hide, and hair from the beamhouse processes. The solid wastes can represent up to 70% of the wet weight of the original hides. In addition, large quantities of sludges are generated. Decaying organic material produces strong odors. Hydrogen sulfide is released during dehairing, and ammonia is released in deliming. Air quality may be further degraded by release of solvent vapors from spray

application, degreasing, and finishing (for example, dye application).

Pollution Prevention and Control

The design of new plants should address the following process modifications:

- Process fresh hides or skins to reduce the quantity of salt in wastewater, where feasible.
- Reduce the quantities of salt used for preservation. When salted skins are used as raw material, pretreat the skins with salt elimination methods.
- Use salt or chilling methods to preserve hides, instead of persistent insecticides and fungicides.
- When antiseptics or biocides are necessary, avoid toxic and less degradable ones, especially those containing arsenic, mercury, lindane, or pentachlorophenol or other chlorinated substances.
- Flesh green hides instead of limed hides.
- Use sulfide and lime as a 20–50% solution to reduce sulfide levels in wastewater.
- Split limed hides to reduce the amount of chrome needed for tanning.
- Consider the use of carbon dioxide in deliming to reduce ammonia in wastewater.
- Use only trivalent chrome when required for tanning.
- Inject tanning solution in the skin using high-pressure nozzles; recover chrome from chrome-containing wastewaters, which should be kept segregated from other wastewaters. Recycle chrome after precipitation and acidification. Improve fixation of chrome by addition of dicarboxylic acids.
- Recycle spent chrome liquor to the tanning process or to the pickling vat.
- Examine alternatives to chrome in tanning, such as titanium, aluminum, iron, zirconium, and vegetable tanning agents.
- Use nonorganic solvents for dyeing and finishing.
- Recover hair by using hair-saving methods to reduce pollution loads. For example, avoid dissolving hair in chemicals by making a proper choice of chemicals and using screens to remove hair from wastewater.
- Use photocell-assisted paint-spraying techniques to avoid overspraying.
- Precondition hides before vegetable tanning.

Through good management, water use can be reduced by 30–50%, to 25 liters per kilograms (l / kg) of raw material. Recommendations for reducing water consumption include the following:

- Monitor and control process waters; reductions of up to 50% can be achieved.
- Use batch washing instead of continuous washing, for reductions of up to 50%.
- Use low-float methods (for example, use 40–80% floats). Recycle liming, pickling, and tanning floats. Recycle sulfide in spent liming liquor after screening to reduce sulfide losses (by, say, 20–50%) and lime loss (by about 40–60%).
- Use drums instead of pits for immersion of hides.
- Reuse wastewaters for washing—for example, by recycling lime wash water to the soaking stage. Reuse treated wastewaters in the process to the extent feasible (for example, in soaking and pickling).

Waste reduction measures should include the following:

- Recover hide trimmings for use in the manufacture of glue, gelatin, and similar products.
- Recover grease for rendering. Use aqueous degreasing methods.
- Recycle wastes to the extent feasible in the manufacture of fertilizer, animal feed, and tallow, provided the quality of these products is not compromised.
- Use tanned shavings in leather board manufacture.
- Control odor problems by good housekeeping methods such as minimal storage of flesh trimmings and organic material.
- Recover energy from the drying process to heat process water.

Target Pollution Loads

Implementation of cleaner production processes and pollution prevention measures can yield both economic and environmental benefits. The production-related waste load figures presented in

Table 1. Target Loads per Unit of Production
(kilogram per ton of raw material)

Parameter	*Maximum value*
BOD	40
COD	140
Nitrogen	7
Chromium	6 (aim for 1.5)
Sulfide	1
Solid waste	500
Effluent flow rate	30,000 (aim for 15,000)

Sources: Indian Standards Institution 1977; UNEP 1991.

Table 1 can be achieved by implementing measures such as those described above. The figures are for the waste loads arising from production processes before the addition of pollution control measures. These levels are derived from typical loads recorded in industry studies and should be used as maximum levels of unit pollution in the design of new plants.

Use of techniques such as water-based paint and roller coating can help achieve emissions of volatile organic compounds (VOCs) from finishing of less than 4 kg/t (aim for 2 kg/t).

Treatment Technologies

Treatment of tannery wastewaters is always required. Some streams, such as soaking liquor (which has high salinity), sulfide-rich lime liquor, and chrome wastewaters should be segregated. Preliminary screening of wastewaters is required because of the large quantities of solids present. Recovery of hair from the dehairing and liming process reduces the BOD of the process effluent. Physical-chemical treatment precipitates metals and removes a large portion of solids, BOD, and COD. Biological treatment is usually required to reduce the remaining organic loads to acceptable levels (0.3 kg BOD, 2 kg COD, and 0.004 kg chromium per metric ton of raw hide).

Good ventilation and minimization of solvent release can avoid the need to collect and treat vapors in carbon adsorption beds. VOC emissions from finishing are approximately 30 kg/t if pollution prevention measures are not adopted.

Maximum upstream pollutant reduction is essential for tanneries, but treatment is also required.

Emissions Guidelines

Emissions levels for the design and operation of each project must be established through the environmental assessment (EA) process on the basis of country legislation and the *Pollution Prevention and Abatement Handbook,* as applied to local conditions. The emissions levels selected must be justified in the EA and acceptable to the World Bank Group.

The guidelines given below present emissions levels normally acceptable to the World Bank Group in making decisions regarding provision of World Bank Group assistance. Any deviations from these levels must be described in the World Bank Group project documentation. The emissions levels given here can be consistently achieved by well-designed, well-operated, and well-maintained pollution control systems.

The guidelines are expressed as concentrations to facilitate monitoring. Dilution of air emissions or effluents to achieve these guidelines is unacceptable.

All of the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours.

Air Emissions

Odor controls should be implemented to reduce impacts on nearby residents.

Liquid Effluents

The effluent levels presented in Table 2 should be achieved.

Solid Wastes

Solid wastes and sludges must be disposed of in a secure landfill.

Ambient Noise

Noise abatement measures should achieve either the levels given below or a maximum increase in

Table 2. Effluents from Tanning and Leather-Finishing Processes

(milligrams per liter, except for pH and bacteria)

Parameter	*Maximum value*
pH	6–9
BOD	50
COD	250
TSS	50
Oil and grease	10
Sulfide	1.0
Chromium	
Hexavalent	0.1
Total	0.5
Nitrogen (NH_4–N)	10
Phosphorus (total)	2
Coliform bacteria	400 MPN/100 ml

Note: Effluent requirements are for direct discharge to surface waters. MPN, most probable number.

background levels of 3 decibels (measured on the A scale) [dB(A)]. Measurements are to be taken at noise receptors located outside the project property boundary.

	Maximum allowable log equivalent (hourly measurements), in dB(A)	
Receptor	*Day (07:00–22:00)*	*Night (22:00–07:00)*
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Monitoring and Reporting

Frequent sampling may be required during start-up and upset conditions. Once a record of consistent performance has been established, sampling for the parameters listed in this document should be conducted monthly.

Annual monitoring for pesticides should be carried out, and, if pesticides are present at levels of 0.05 mg/l and above, corrective actions should be taken.

Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Records of monitoring results should be kept in an acceptable format. The results should be reported to the responsible authorities and relevant parties, as required.

Key Issues

The key production and control practices that will lead to compliance with emissions guidelines can be summarized as follows:

- Minimize chrome use; avoid the use of hexavalent chrome and use trivalent chrome instead; recover and recycle chrome.
- Avoid the use of hides treated with persistent insecticides and fungicides.
- Use nonorganic solvents for dyeing and finishing.
- Minimize storage of flesh trimmings and organic material.
- To reduce water use, monitor and control process waters; use batch instead of continuous washing; use drums for immersion of hides; reuse wash water and recycle floats; and segregate wastewater streams to simplify treatment.
- Minimize solid waste by recovery and reuse of hide trimmings.

References and Sources

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