Studies on theWaste Management System of a Tannery: An overview

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Abstract
Solid waste management is a challenge for the tanneries authorities in developing countries mainly due tothe increasing generation of waste, the burden posed on the budget as a result of the highcostsassociated to its management, the lack of understanding over a diversity of factors that affect thedifferentstages of waste management and linkages necessary to enable the entire handling systemfunctioning.From the very beginning of industrialization in Bangladesh, tanning industries have been playing a significant role in the country's economy. Due to its importance as a labor-based export-oriented industry the full flourish of this industrial sector is essential. But due to the absence of proper waste management, using inferior technologies, lack of facilities for treating industrial wastes; the tanning industries are aggravating environmental problems day by day. This research study investigated ways ofrationalizing chemical, water and energy consumption usage andreducing wastedischarge & waste management in a tannery. The work was motivatedby the need to achieve sustainable development goals (SDGs) through the useof best practices to achieve compliance with environmentalregulations.

Keywords: Leather, Tannery, Waste, Resource, Waste Management
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Introduction
The process of converting hides and skins into leather iscarried out in aqueous medium. The process its self ischaracterized by a high demand and extensive use ofchemicals to treat and soften hides. Over twenty differentchemicals are employed to convert hides and skin intocommercial leather. The resulting discharge from tanningdrums and paddles contain numerous soluble and insolublematerials from hides as well as process chemicals to make upthe effluent and waste water [1]. A ton of hides yields about200kg of finished leather and the rest of the material, blood,manure, hair, proteins, greases and fats make up waste [2].Among all the industrial wastestannery effluents are ranked as the highest pollutants [3]. The highconcentration of chromium sites in South Asia is primarilydue to the abundance of tanneries in the region. Many of the tanneries have poor environmental controls [4]. Tanneries are isolated as for their characteristics, odors and mode of pollution since a tannery deals with tanning raw hides where a series of chemical operations are done to convert putrefying raw hides into non-putrefying leather[5].As the leather production contains of various stages of chemical operations, it emanates different wastes as per the operation procedure. It also creates different possibilities for reuse or conversion of residues throughthe waste management systems.Leather Manufacture is a byproduct industry, depending on the slaughter of animals primarily for other uses[6].Leather is the skin or hide of the animals, cured by tanning to prevent decay and to impart flexibility and toughness. Prehistoric and primitive peoples preserved pelts with grease and smoke and used them for shoes, garments, coverings, tents and containers. Today pelts are prepared for tanning by various procedures which include unhairing, fleshing, and then treating with lime and so on with other processes[7].The first tannery in Bangladesh territory was set up at Narayanganj by RP Saha sometime in the 1940s. It was later shifted to Hazaribagh area of Dhaka, which turned into a location that now accommodates a large number of tannery units. Leather Industry developed in Bangladesh on a large-scale basis from the 1970s[8]. About 95% of leather and leather products of Bangladesh are marketed abroad, mostly in the form of crushed leather, finished leather, leather garments, and footwear.The relocation of tanneries from Hazaribagh on the bank of the River Buriganga, which has so far been polluted as because of the industrial and chemical discharge since the establishment of the tanneries in the 1960s,took place after the relevant authorities on a court order of early March severed electric and gas supply connections in the first week of April. The welcome bold move, delayed though, for the relocation of the tanneries which has taken place since 2003 when the BSCIC on a High Court order of 2001 took up a two-year

project for their relocation to the Savar Leather Estate spanning 200 acres of land on the outskirts of the capital city. As it was a vital reason to saveBuriganga and protect the environment of the Buriganga banks along a long stretch[9].The potential environmental impact of tannery effluents is widely acknowledged. It has a long-term negative impact on the growth potential of a country[10]. From an economic viewpoint the discharge of residues is a waste of scarce resources, whether it's chemical, energy or raw material. But with the proper use of waste management system and the compliances, the detrimental effect of the waste and pollutants can be neutralized to a moderate level[11]. It can be also helpful in some cases if the wastes are reusable as byproducts which can be used for further processes or in related fields by keeping the cost in an advantage zone.The historical development of waste treatment and disposal has been motivated by concern for public health.To deal with this potential threat to human health, legislation was introduced on a local and national basis in many countries[12].

Leather Manufacturing Process

The leather manufacturing process is done in tanneries. In tanneries these raw materials go through different chemical and mechanical operations and finally come out as finished leathers[13]. These tannery operations can be broadly divided into three sections:

i. Pre-tanning or beamhouse operations
ii. Tanning operations
iii. Post-tanning or finishing operations

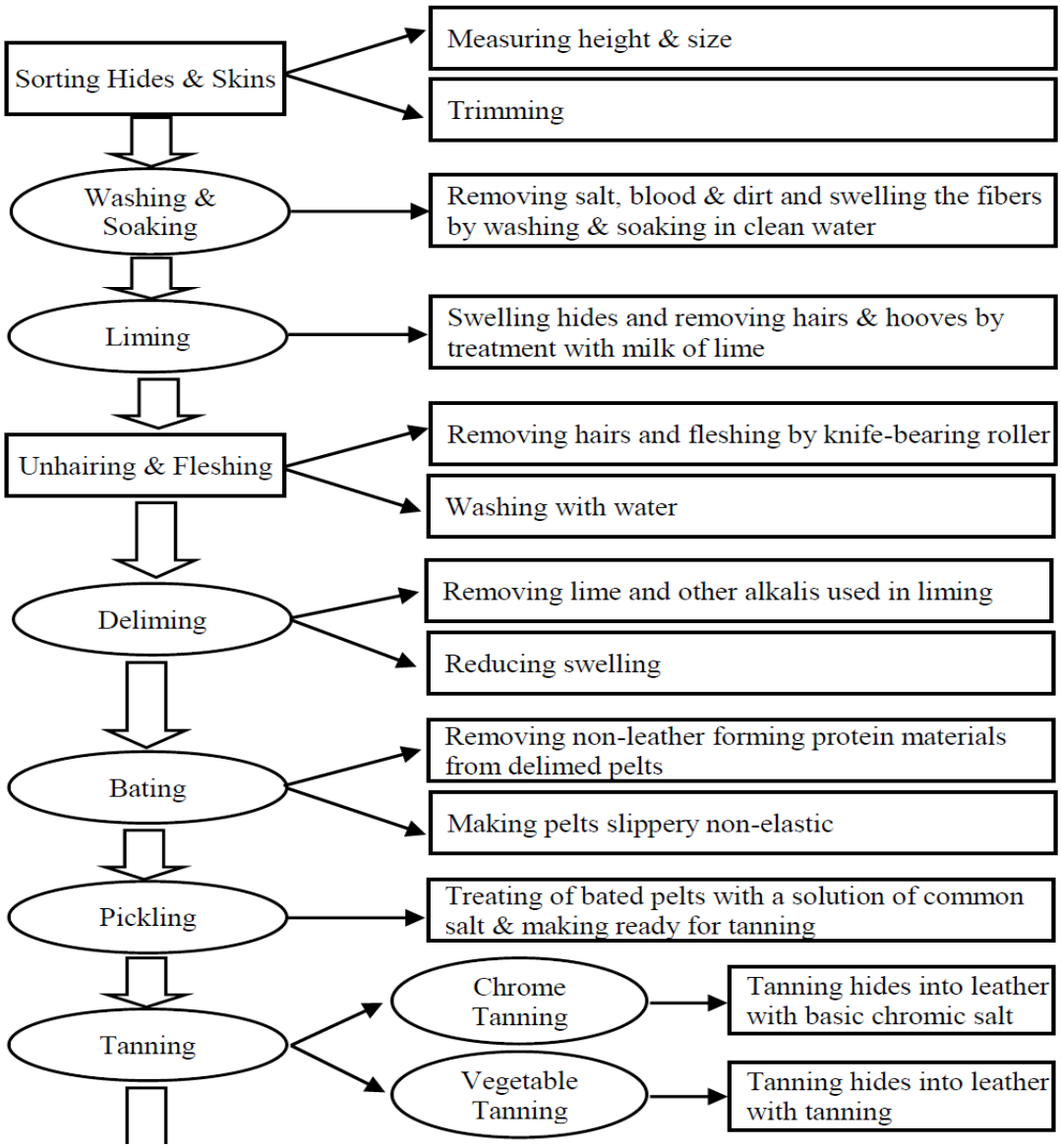

Figure 1**:** Flow chart of beam house and tanning operations

In the post-tanning operations, the tanned semi-finished leathers are dyed to give a color determined by the fashion demand and fatliquored to impart the degree of softness which is needed in the final leather and retanned to impart the filling, grain tightening and improve the uniformity in substance. Before doing these basic post-tanning operations, it might become necessary especially in the case of mineral tanned leathers to condition them by adjusting the pH to suitable level in neutralization process to get uniform results in dyeing, retanning and fatliquoring. Each process under these three distinct sets of unit operations consists of several processes also.

Finishing operations

Finishing of leather consists in the application of a film formingmaterial to the grain to provide aesthetic appeal and to improve the salevalue of the leather. It also provides surface protection against rubbing, abrasion and staining[14]. The defects of the grain are covered by theprotective coat and hence the cutting value is also very much enhanced.Finishing can be Mechanical or Chemical.Chemicals used in leather processing are classified as bulk and performance chemicals. Bulk chemicals are sodium chloride, lime, sodium sulphide, ammonium salts, formic acid, sulphuric acid, sodium formate, sodium bicarbonate, ammonia etc. which are used in many other industries as well.On the other hand, tanning materials, formulations of fatliquors, retanning, finishing agents etc., are performance chemicals[15]. These are used to add to the performance of leather in usage and limited to use in leather sector alone.The consumption pattern of chemicals in leather processing kg per ton of hides or skins is presented in Table 1.

Table1: Consumption pattern of chemicals in leather processing

Sl. No.	Name of Chemical	In kg/ton of Hides or Skin Process
1	Soaking Aids	1.0-2.5
2	Preservatives	2.5-5.0
3	Lime	80-200
4	Sodium Sulphide	20-30
5	Sodium Chloride	80-100
6	Ammonium Salts	10-15
7	Sulphuric Acid	12-20
8	Sodium formate	5-12.5
9	Basic Chromium Sulphate	60-120
10	A1 ($A1_2O_3$)	1-20
11	Zr (ZrO_2)	0-15
12	Vegetable Tanning	10-220
13	Synthetic Tanning Agents	20-60
14	Fatliquores	25-100
15	Dyes	2.5-20
16	Binders	20-45
17	Pigments	10-25
18	Top Coats	20-45
19	Wax Emulsions	2.5-5.0
20	Feel Modifier	1.0-2.0

In terms of toxicity and potential to cause a hazard it is a relatively straight forward task to divide a typical list of chemicals used in tanning into three groups representing major, moderate, and minor potential hazards[16] that are given in Table 2.

Table 2: Major, Moderate and Minor Potential Hazard in Leather Industry

High Potential Hazard Group					
Acetic Acid	Ammonia	Calcium Hydroxide	Formaldehyde	Formic acid	Glutaraldehyde hydrocloric acid
Hydrogen peroxide	Oxalic acid	Sodium chlorite	Sodium hydroxide (caustic soda)	Sulphuric acid	Sulfides and Hydrosulfides
Moderate Potential Hazard Group					
Aluminium sulphate (as lacquer constituents)	Amyl alcohol (as lacquer constituents)	Benzyl alcohol (lacquer solvent) carbon black	Chromium salts (trivalent) enzymes	Isoproply alcohol perchloroethtlene toluene	White spirit
Low Potential Hazard Group					
Alums	Acetone	Anbumen	Ammonium chloride	Ammonium sulphate	Borax, boric acid
Casein	Calcium Chloride	Castor oil china clay	Ethanol (ethyl alcohol)	Fat liquors	Fats
Ferrous acetate	Ferrous sulphate	Gelatine	Glues	Lactic acid	Lanoline
Lecithin	Oils	Parafin	Pigment dispersions	Sequestering agents	Silicones
Sodium acetate	Sodium bicarbonate	Sodium citrate	Sodium carbonate	Sodium formate	Sodium metabisulphate
Sodium nitrite	Sodium phthalate	Sodium sulphite	Sodium thiosulphate	Synthetic tannins	Tragacanth
Titanium salts	Vegetable tanning extracts		Waves	Wetting agents	

The whole process of leather manufacturing consists of huge amount of chemicals which is the main source of waste and pollution[17]. Thus, the sources of the wastes are mainly generated from the use of chemicals during the leather processing as it reacts with the leather and emanates waste materials and pollution (Figure 2).

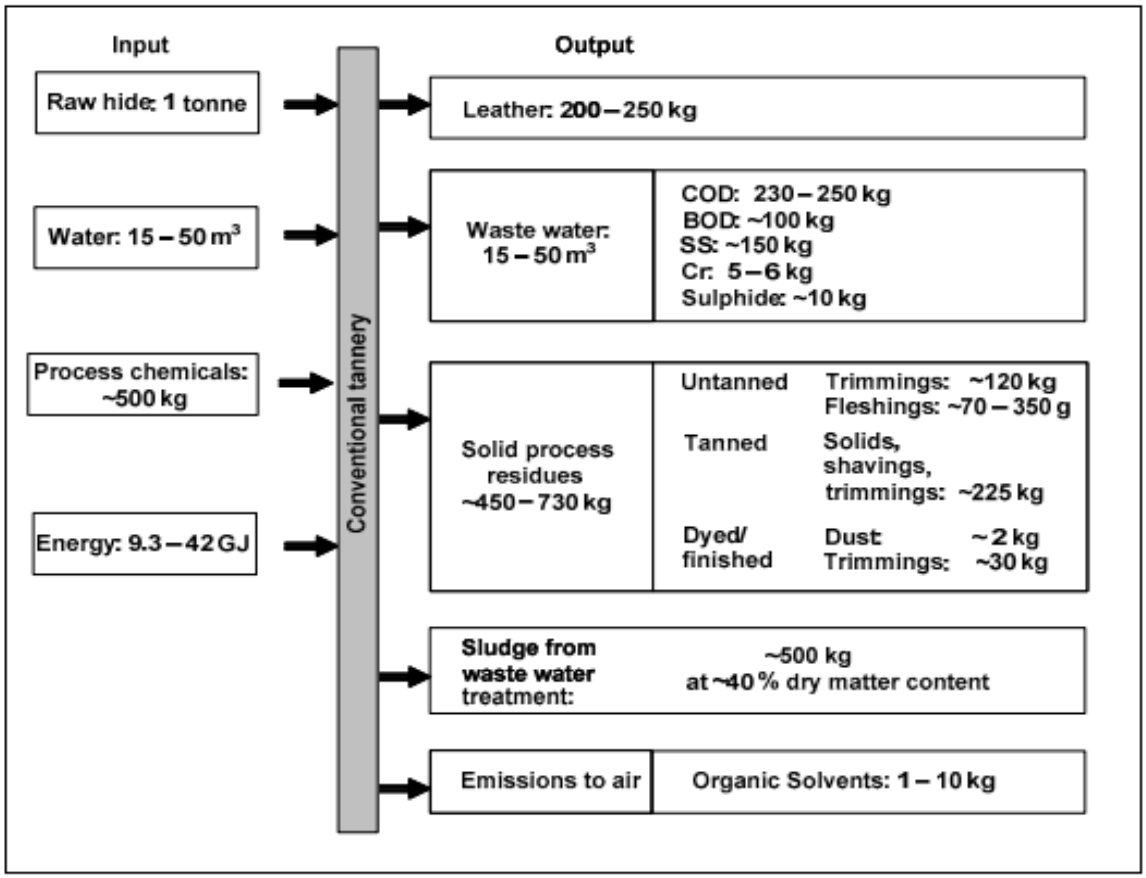

Figure 2: Input/output overview for a conventional (chrome-tanning) process up to finishing

Operations during the manufacturing of leather releases different types of pollutants[18] which are showed below by the flow chart in figure 3.

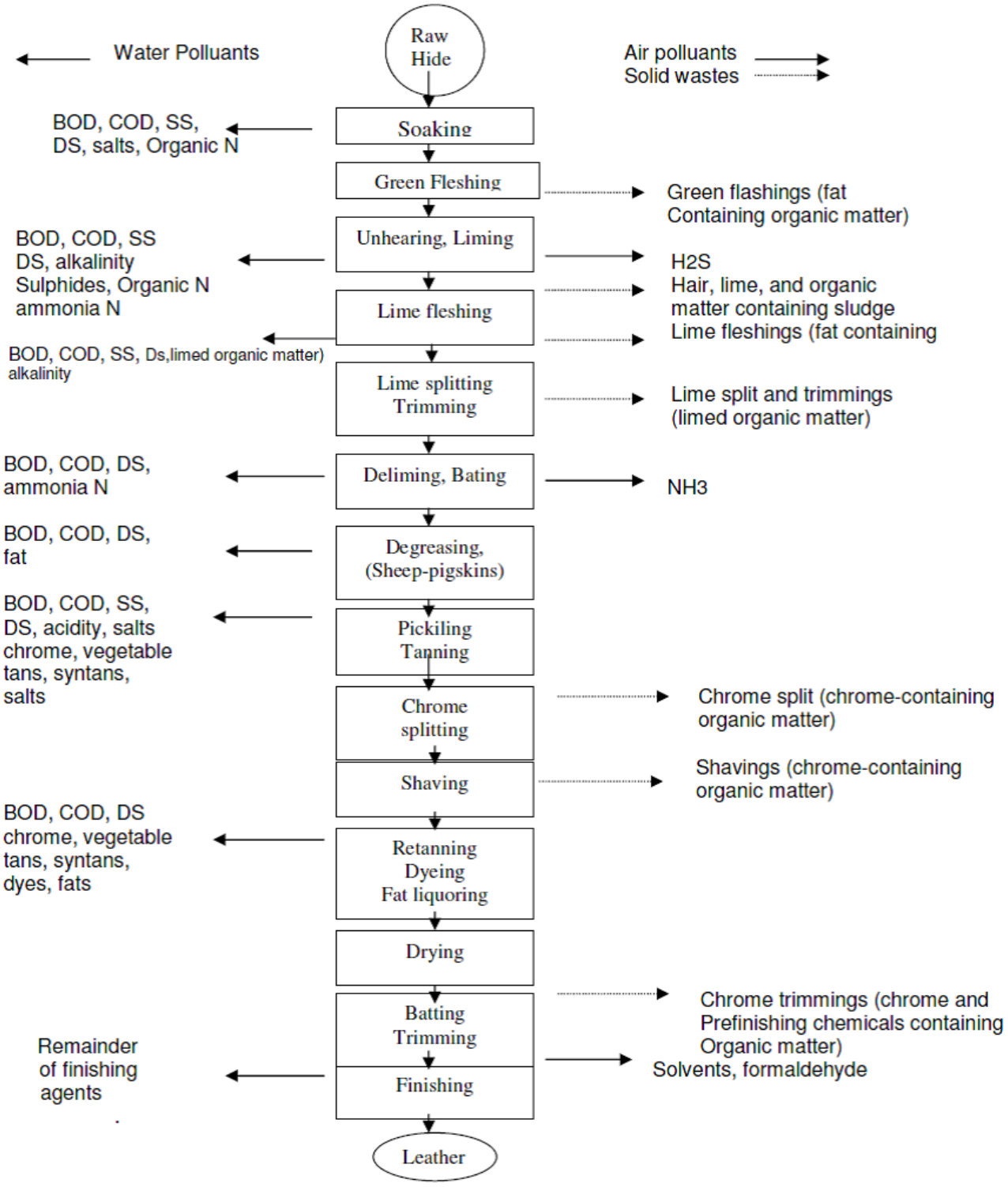

Figure 3: Stepwise produced pollutants during leather manufacturing

In beamhouse operations[19], solid waste kg per ton of raw hides is shown in below table 3.

Table 3: Amount of waste at beamhouse operations

Name of wastes	kg/ton
Raw Trimmings	80-120
Wet limed Fleshing's	250-300
Hair / Wool	40-50

During the tanning process at least 300 kg of chemicals (lime, salt etc.) are added per ton of hides. Excess of non-used salts appearin the wastewater[20]. This wastewater contains-Salts (Cl), fat, protein, preservatives (soaking), Lime and ammonium salts, ammonia, protein (hair), and sulphides (fleshing, trimming, bating), Chromium(salts) and polyphenolic compounds (tanning), dye and solvent chemicals (wet-finishing).The air polluting gases produced during beamhouse operations are shown in below table 4.

Table 4: Air polluting gases produced during beam house operations

Process-step	Air pollutants
Unhairing/liming	H_2S
Deliming/Bating	NH_3

Different types of waste with their saline features

A typical pollution load of soaking effluents is given in table5**.**Estimated volume 3-7M^3/1000kg[21].

Table 5: Soaking waste saline features

Parameter	mg/L	Kg
Total solids (TS)	40,000-50,000	200-250
Total suspended solids (TSS)	5,000-10 ,000	25-50
Total dissolved solids (TDS)	30,000-40,000	50-200
Biochemical oxygen demand (BOD)	1,200-2,000	6-10
Chemical oxygen demand (COD)	3,000-5,000	15-20
Oil and Grease	200-400	1-2
Alkalinity	1,000-1,500	5-7.5
Chromium	None	None
Sulphide	None	None
pH	7.5-9.0	-

A typical pollution load in liming effluents is presented in table 6**.** Estimated volume 3-5m^3/1000kg[22].

Table 6: Liming waste saline features

Parameter	mg/L
PH	10.0-12.8
BOD_5 at 20'C	5,000-10,000
COD	10,000-25,000
Sulphides	200-500
Total Solids (TS)	24,000-48,000
Total Dissolved Solids (TDS)	18,000-30,000
Suspended Solids (SS)	6,000-18,000
Chlorides	4,000-8,000
Sulphate	600-1,200

A typical pollution load of deliming effluents is given in table 7**.** Estimated volume 1.5-2 m^3/1000kg[22].

Table7: Deliming waste saline features

Parameter	mg/L
PH	7.0-9.0
BOD_5 at 20'C	1,000-3,000
COD	2,500-7,000
Sulphides	30-60
Total Solids (TS)	5,000-12,000
Total Dissolved Solids (TDS	3,000-8,000
Suspended Solids (SS)	2,000-4,000
Chlorides	1,000-2,000
Sulphate	2,000-4,000

A typical pollution load of pickling effluents is given in table 8. Estimated volume 0.5-1 m^3/1000kg[22].

Table 8: Pickling waste saline features

Parameter	mg/L
PH	2.0-3.0
BOD_5at 20'C	400-700
COD	1,000-3,000
Sulphides	-
Total Solids (TS)	35,000-70,000
Total Dissolved Solids (TDS	34,000-67,000
Suspended Solids (SS)	1,000-3,000
Chlorides	20,000-30000
Sulphate	12,000-18,000

A typical pollution load of chrome tanning effluents is given in table 9**.** Estimated volume 3-7M^3/1000kg[21].

Table9: Chrome tanning waste saline features

Parameter	mg/L	Kg
Total solids (TS)	30,000-60,000	150-300
Total suspended solids (TSS)	1,000-25 ,00	5-12.5
Total dissolved solids (TDS)	9,000-57,500	145-287
Biochemical oxygen demand (BOD)	4 00-800	2-4
Chemical oxygen demand (COD)	1,000-2,000	5-10
Oil and Grease	600-1,200	3-6
Acidity	2,000-5,000	10-25
Chromium	2,000-5,000	10-25
Sulphide	None	None
pH	2.5-4.5	-

A typical pollution load of effluents from vegetable tanning operations is given in table 10. Estimated volume 3-6M^3/1000kg[22].

Table 10: Vegetable tanning waste saline features

Parameter	mg/L	Kg
Total solids (TS)	25,000-60,000	125-300
Total suspended solids (TSS)	5,000-10 ,000	25-50
Total dissolved solids (TDS)	20,000-50,000	100-250
Biochemical oxygen demand (BOD)	6,000-18,000	30-90
Chemical oxygen demand (COD)	15,000-40,000	75-200
Oil and Grease	200-400	1-2
Acidity	2,000-4,000	10-20
Chromium	none	none
Sulphide	none	none
pH	3.5-5.0	-

A typical pollution load of effluents from beam house operations is given in table 11.Estimated volume 7-15M^3/1000kg[21].

Table 11: Beamhouse waste saline features

Parameter	mg/L	Kg
Total solids (TS)	30,000-50,000	300-500
Total suspended solids (TSS)	6,000-20 ,000	60-200
Total dissolved solids (TDS)	24,000-30,000	240-300
Biochemical Oxygen Demand(BOD)	5,000-10,000	50-100
Chemical Oxygen Demand (COD)	10,000-25,000	100-250
Oil and Grease	400-500	4-5
Alkalinity	12,000-20,000	120-200
Chromium	none	none
Sulphide	300-500	3-5
pH	10.0-13,0	-
Ammonia	500-1,000	5-10

In table 12the consumption of water and main effluent parameters for liquors from chrometanning[17] are summarized and shown-

Table12: Water consumption and emissions to wastewater from pickling and chrome tanning

Parameter	kg/ton of Raw Hide
Salts (Cl^-)	30-100
BOD	~3
COD	~14
SS	~5
TDS	~175
NH4-H	~0.5
TKN	~1
Cr^{+3} salts in spent liquors	5-10

Table 13Shows emissions to waste water from post-tanning operations, processing salted cow hides[17].

Table 13: Emissions to waste water from post-tanning operations

Parameter	Kg/ Ton
TS	~65
COD	20-30
Chromium	2-5
BOD	~14
SS	7
NH_4^+	0.6-0.8
Cr	1
Cl^-	2-5

Although Finishing operations discharges waste and pollutants but it is being smaller of amount fromthe previous stages.The following table 14 consist of the waste and pollutants of finishing operation[17].

Table 14: Waste and pollutants of finishing operations

Process unit	Inputs	Waste water	Waste	Air emissions
Finishing Operation				
Staking/other mechanical operations			• Particulate matter	
Drying	• Energy • Biocides			• Heat • Acid fumes
Milling/buffing			• Particulate matter	• Particulate matter
Coating	• Lacquers (solvent based) • Lacquers (water based) • Binders and cross-linking agents • Auxiliaries • Water	• Finishing agents in water or in aqueous solutions (organic solvents, heavy metals) • Auxiliaries	• Residues from chemicals, • Sludges from finishing agents (over-spray, etc.)	• organic solvent use and release: aerosols • Formaldehyde as fixing agent
Trimming			• final trimmings	

Effects of waste discharged from tannery on environment

Pollution of environment by tannery waste is one of the most horrible ecological crisis to which we are subjected today. Due to lack of proper management facilities the tannery waste creates environmental pollution day by day. About 95% of the tannery industries have been built in unplanned way[23]. These unplanned tanneries caused environmental pollution very much. These wastes affect the main elements of environment such as air, water and soil and the animal or plants living depending on these elements are harmed drastically. It was showed that the most harmful environmental effect was bad smell to the surrounding areas which caused environmental pollution[24].Thenegative effect of tannery

waste on environment are effect on land, effects on surface water, effects on ground water, effects on sewers, effects on air quality, waste dumps, effect on fisheries sector, effect on livestock production, effect on the agricultural production, effect on human health, etc.More than 250 different chemicals are used in the production of leather. Workers in the tannery are exposed to these chemicals in various ways[18].The impact of such exposure can range from temporary effects such as-Dizziness, Headache, Irritation of eyes,skin or lungs, Allergic reactions,collapse due to lack of oxygen, Poisoning of liver,kidney, nerve system to long term impairments such as bronchitis, ulcer, Genetic defects and in some rare cases, even instantaneous death[25].The following table 15shows the health hazards and safety risks of tannery operations.

Table 15: Health risk of tannery wastes

Inputs	Process	Emissions	Occupational hazards/risks
Water **Biocides** **Surfactants** **Enzymes** **Electricity**	**Soaking**	(1) Effluent (dirt, dung, salt, insecticide, biocide) (2) Noise (drum/paddle)	Anthrax Skin allergies Hearing impairment Electrical shocks Accident/injuries/Fall
Water **Sodium sulphide** **Lime** **Electricity**	**Liming** **Unhairing**	(1) Solid waste (hair, sludge) (2) Effluent (lime, sulphide) (3) Noise (drum/paddle)	Anthrax Skin irritation Eye diseases Accident/injuries/Fall
Water **Electricity**	**Fleshing**	(1) Solid waste (fleshing) (2) Effluent (wash water, lime) (3)Noise(fleshing machine)	Accident/Injuries -^ Skin Irritation Hearing impairment
Water **Ammonium sulphate/chloride** **Carbon di-oxide** **Electricity**	**Deliming**	(1) Effluent (lime, nitrogen) (2) Noise (drum/paddle) (3) Airborne pollutants (carbon dioxide, hydrogen sulphide gas, ammonia vapor)	Accident/Injuries Hearing Impairment, Respiratory problems, Gas poisoning
Water **Enzyme** **Electricity**	**Bating**	(1) Effluent (2) Noise	Skin Irritation Hearing Impairment
Water **Salt** **Acid** **Masking agents** **Electricity**	**Pickling**	(1)Acidic effluent -> (2) Acid vapors (3) Noise	Acid bums Skin irritation Respiratory problems Hearing impairment
Water **Salts** **Solvents** **Surfactants** **Electricity**	**Degreasing**	(1) Effluent (2) Solvent vapors (3) Greasy residues with solvents	Skin irritation Respiratory problems
Water **Chromium sulphate** **Electricity**	**Tanning**	(1) Effluent (chrome floats) (2) Chrome dust (3) Noise	Skin irritation, Chrome ulcer (hands, nasal septum) Occupational asthma, Injuries, Chromosomal aberration, Hearing impairment etc.

Waste Management Process

In order to minimize the negative impacts emanates from tanning industry,fundamental pollution control practices have to be implemented[18]. The generally accepted waste management hierarchy include waste:

a. Prevention and reduction
b. Recycling and reuse
c. Treatment and
d. Disposal

The total management system will be discussed here by breaking up it into three major parts

- By using cleaner technology
- By treating the Effluent with ETP
- By sludge management and disposal

Cleaner technology in Leather Processing

Cleaner technology in leather processing can significantly reduce the costs of environmental compliance by reducing effluent loadings and chemical costs in leather manufacture.The pressure to adopt cleaner technologies normally emanates from environmental imperatives such as the need to meet specific discharge norms, reduce treatment costs or comply with occupational safety and health standards[26]. The typical primary targets are:

- lower water consumption,
- improved uptake of chemicals,
- better quality/re-usability of solid waste, and
- reduced content of specific pollutants such as heavy metalsand electrolytes.

The minimization of pollution load due to leather processing can be summarized by prevention, reduction, recovery, reuse and regeneration. The first approach is to address the source of generation by using or developing cleaner process. In leather industry, the use of some sorts of recycling systems has already begun especially for economic reasons. Nowadays, nearly every part of the tanning process has several cleaner and waste water management systems[27].Some Possible technological solutions for cleaner technologies are shown at table 16.

Table16: Some possible clean technologies in leather production

Process	Technological options
Preservation	⇒ Green processing ⇒ Drying ⇒ Dry pickling ⇒ Chilling
Green fleshing	⇒ best when fleshing rendered at abattoir
Soaking	⇒ mechanical desalting to reduce salt content in waste water ⇒ recovery and reuse of salt by solar evaporation
Unhairing	⇒ Hair save unhairing ⇒ Enzyme unhairing ⇒ Lime splitting ⇒ Reuse direct liming float
Deliming	⇒ Carbon dioxide deliming ⇒ Ammonia free deliming
Bating	⇒ Ammonia free deliming agent
Pickling	⇒ Salt free pickling ⇒ No pickle ⇒ Recycle of pickle liquor
Chrome tanning	⇒ Reduction in chrome wastage by direct liquor recycle process

	⇒ Precipitation and reuse process ⇒ High exhaust system ⇒ Use short float ⇒ The use of special self-basifying agent and masked chrome tanning salts.

Effluent Treatment Technology

The choice of treatment system depends on the location of the plant with respect to neighboring land uses. If several tanneries exist closely, a co-operative treatment operation will lower the cost of treatment of each tannery. The final choice depends on the tannery and discharge standards[28].The following table 17 summarizes the basic procedure of effluent treatment technology.

Table17: Technological choices for treatment of tannery effluents

Process	Procedure
Pre-treatment settling	Mechanical screening to remove coarsematerial Flow equalization (balancing)
Primary treatment	Sulphide removal from beamhouse effluents Chromium removal from tanning effluents Physical-chemical treatment for BOD removal and neutralization
Secondary treatment	Biological treatment Activated sludge (oxidation ditch) Activated sludge (conventional) Lagooning (aerated, facultative or anaerobic
Tertiary treatment	Nitrification and denitrification
Sedimentation and Sludge handling	Different shapes and dimensions of tanksand basins

Sludge Management and Disposal

The main purpose of sludge management is not only to reduce the volume and weight of material to be transported but also to attain the dry matter content. Sludge from primary clarification, secondary clarification and tertiary clarification are transferred to sludge thickener through pump. Then it is dewatered by drying of. Then it is transferred from sludge thickener to sludge drying beds[28]. In case of bad weather, it is transferred to centrifuge for mechanical dewatering. Then solid matter is obtained.

Utilization and disposal of sludge

Tannery sludge has greater inorganic matter content, greater heavy metal content, especiallychromium and greater sulfur compound content[26]. However, the main stumbling block is the chromium content, with legislation and practice varying a lot from country to country.A number of solutions for utilization and/or safe disposal of tannery sludge have been proposed, practiced, tested, and applied at pilot and industrial scale-

- Landfill
- Vitrification
- Composting
- Brick Manufacture
- Anaerobic digestion,
- Stabilization

None of them proves satisfactory enough. There is certainly no universal solution for sludge utilization/application. Each ETP produces sludge of specific characteristics and different regions and countries have quite different regulations regarding sludge utilization. Therefore, prior to any ETP

construction, a detailed assessment of options should be prepared and the most suitable application proposed.

Some developed techniques of the effluent treatment process:

1) Using Low cost adsorbent for mitigation of water pollution caused by tannery effluents [29]
2) Simple Effective treatment of tannery effluents [30]
3) Exhausted chrome tanning solution regeneration method[31]
4) Characterization of tannery (beamhouse) effluents and study of water hyacinth in chromium recovery [32]
5) Nonconventional use of Basic Chromium Sulphate for Wet Blue Production [33]
6) Treatment of waste water from leather industry using Gamma Radiation [34]
7) Treatment of waste water from leather industry using Membrane Bio Reactor (MBR)[35]

Tannery by-products

By-products are something produced in a usually industrial or biological process in addition to the principal product. In case of tannery, during hides/skins processing solid wastes as well as fleshing, trimming etc. are produced[36, 37]. These types of solid waste are known as tannery by-products. Best available technique for waste management[18]are shown in following table 18.

Table 18: Best available technique for waste management

Reuse/recycling/recovery and treatment	Types of waste
Leather production	Splits
Leather fibre board production	Tanned wastes in general, e.g., splits, shavings, trimmings
Small leather goods	Splits and tanned trimmings
Filling material, wool	Hair and wool
Gelatine and/or hide glue	Raw trimmings, green and limed fleshings and splits
Sausage casings	Untanned splits
Fat recovery	Raw trimmings, green and limed fleshings
Protein hydrolysate	Hair, raw and limed trimmings, green and limed fleshings, green limed and tanned splits and shavings
Collagen	Limed trimmings and splits
Agriculture and fertilizer	Hair for the nitrogen content, residues from composting and anaerobic digestion, sludges from wastewater treatment
Composition	Hair, green and limed fleshings, tanned splits and shavings, fats grease and oil, sludges from wastewater treatment
Anaerobic digestion	Hair, green and limed fleshings, tanned splits and shavings, fats grease and oil, sludges from wastewater treatment
Thermal treatment	Fats, grease, mixture of non-halogenated organic solvents and oil
Recycling of organic solvents	Organic solvents (no mixtures)
Regeneration of air abatement filters	Activated carbon filters
Reuse and recycling of packaging material by feeding it back to the supplier via an appropriate recycling system	Container, pallets, plastic, cardboard

Conclusion

Tannery operations are the most important factors for the production of quality full leather. On the other hand, during these operations huge amount of hazardous waste is being produced on daily basis which is very harmful for our environment. But considering the waste only, it cannot be said that leather production processes in tanneries should be stopped for the sake of our environment. As it is possible to manage the produced waste into a marginal level, which reduces the rate of pollution and keeps the environment safe. Also, the produced waste can be used for making valuable by products and can be used for further proceedings. Nowadays, through advanced technologies, recycling of the chemicals whichare necessary in the facility itself and will be burden for the environment, and therecovery of which is costly, is the path should be taken. Although the initialinvestment cost is considerably high, in the long run the benefits will recover theinitial investment cost and minimize theharmful environmental effects.

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