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24 January 1979

ENGLISH

United Nations Industrial Development Organization

Second Leather and Leather Products
Industry Panel Meeting

Vienna, 5-7 February 1979

MEANS OF ACHIEVING IMPROVEMENTS IN ENVIRONMENTAL STANDARDS IN THE TANNING INDUSTRY: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT *

prepared by

the International Centre for Industrial Studies
UNIDO Secretariat

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id.79-412

Introduction

This presentation is designed to give an overview of environmental problems in the tanning industry and their effective management. This report presents a description of waste characteristics, current waste treatment and control practices in the industry, and information from several countries on the economics of pollution control systems. Pollution regulations and the importance of maintaining pollution control standards are discussed. An environmental impact evaluation procedure raises the key environmental issues that should be dealt with in the initial stages of planning a tannery.

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MEANS OF ACHIEVING IMPROVEMENTS IN ENVIRONMENTAL STANDARDS IN THE TANNING INDUSTRY: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT *

SUMMARY *

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Pollution problems from the leather industry arise from tanned and untanned solid waste, waste waters (as well as the sludge separated therefrom), and some air pollutants.

Solid wastes from the leather industry include cuttings of untanned hides with hair, cuttings of limed, untanned hides without hair and leather shavings, as well as splits and cuttings, both chrome-tanned and vegetable tanned.

The particular characteristics of effluent from leather factories which start with the green, or fresh, hides are sulphides (from the liming), high alkalinity, a high concentration of dissolved organic compounds (mainly partially decomposed protein from the liming and bating processes, but also unbound tanning materials, dyestuffs and fatliquoring oils) and, in the case of chrome leather factories, chromium (III) compounds. The effluent also contains organic and inorganic suspended solids. These form as a result of co-precipitation when the effluents from the various processing stages are mixed.

In tanneries, the problem of air pollution is a minor one and is limited almost exclusively to the waste air from the finishing process. This waste air may contain solvent vapours and formaldehyde, depending on the finishing process used in the particular tannery concerned.

The effluent resulting from the manufacture of side leather in central European tanneries with a water consumption of 40-50 liters/kg raw hides has the following average composition:

Chrome (III)	100 mgCr/1
Chrome (VI)	0 mgCr/1
$SO4^{--}$	1,500 mg/1
NaC1	4,000 mg/1
Sulphide (S^{--})	150-200 mg/1
BOD	1,000-1,500 mg/1
COD	3,000-4,500 mg/1
Suspended solids	2,000-3,000 mg/1

If the practice of sulphide oxidation and chromium precipitation have been followed, the resultant effluents can be mixed with those from the tanning, dyeing, and fatliquoring processes to form an overall plant mixed effluent. After this effluent is allowed to undergo primary sedimentation and the sludge is separated for separate disposal, the resultant effluent is generally suitable for secondary treatment utilising biological purification plants. In the case of a tannery operating in an urban area with little available space, the treatment may be via an activated sludge plant or the effluent may be discharged to a municipal treatment plant. For the case of a tannery in an area with much land available, say a rural area of a developing country, the preferred method of treatment may be ponds or an oxidation ditch. On the average, primary treatment will remove about 40% of the BOD whereas primary plus secondary treatment will remove 85-95% of the effluent BOD.

The savings which can be obtained by recycling the liming and chrome liquors can reach US$18 (1974 dollars) per ton of hides, according to Centre Technique du Cuir. This represents approximately one per cent of the price of the finished leather. In the case of the application of these recycling measures in a French tannery, an additional US$4.5 credit would be obtained from the reduced amount of pollution taxes required to be paid by the firm for effluent discharges.

In the EEC countries effluent treatment incorporating sulphide removal, primary sedimentation, and pH adjustment is reported to cost $0.016/sq.ft. or 2.1 per cent of the leather selling price. Effluent treatment incorporating primary sedimentation, chromium recovery, and biological oxidation is reported to cost $0.025/sq.ft. or 3.2 per cent of the leather selling price.

A problem specific to the developing countries when endeavoring to protect the environment through regulations is a lack of experience. Never previously having had to face environmental problems due to industrial pollution, a large number of the developing countries have no specific regulations at hand. Such regulations, however, are indispensable to the contractor for the design of pollution control systems and should be in effect at the time the tender documents are sent out.

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Organisation des Nations Unies pour le développement industriel

Deuxème réunion du Groupe de l'industrie du cuir et des articles en cuir

Vienne (Autriche), 5-7 février 1979

MOYENS DE RELEVER LES NORMES DE PROTECTION DE L'ENVIRONNEMENT DANS LES TANNERIES : EVALUATION ET SOLUTION DES PROBLEMES D'ENVIRONNEMENT

RESUME*

Document établi
par
le Centre international d'études industrielles
Secrétariat de l'ONUDI

* Traduction d'un document n'ayant pas fait l'objet d'une mise au point rédactionnelle.

id.79-414

La pollution engendrée par l'industrie du cuir est imputable aux déchets solides, tannés ou non, aux eaux usées (ainsi qu'aux boues qu'elles déposent) et à certains polluants atmosphériques.

Les déchets solides de l'industrie du cuir comprennent les chutes de peaux en poil et de peaux chaulées et ébourrées (non tannées), les raclures de cuir ainsi que les croûtes et les chutes de peaux tannées au chrome ou au végétal.

Les effluents des tanneries qui traitent des peaux dites "vertes" ou "fraîches", se caractérisent par leur teneur en sulfures (provenant du chaulage), une forte alcalinité, une importante concentration de corps organiques en solution (pour la plupart des protéines décomposées résultant du chaulage et du déchaulage, mais aussi des substances tannantes, des teintures et des huiles utilisées pour le corroyage) et, dans le cas des usines qui tannent le cuir au chrome, par leur teneur en composés de chrome (III). Les effluents contiennent également des corps organiques et minéraux en suspension, qui se forment par coprécipitation lors du mélange des eaux servant au tannage.

Dans les tanneries, le problème de la pollution atmosphérique revêt une importance secondaire et ne se pose pratiquement que pour le finissage du cuir. L'air peut alors été vicié par des vapeurs de solvants et du formaldéhyde, selon la méthode de finissage utilisée.

Voici la composition moyenne des effluents des tanneries d'Europe centrale produisant du cuir scié et consommant 40 à 50 litres d'eau par kilo de peau brute :

Chrome (III)	100 mgCr/l
Chrome (VI)	0 mgCr/l
SO_4^{--}	1 500 mg/l
NaCl	4 000 mg/l
Sulfure (S^{--})	150-200 mg/l
BOD (demande biochimique en oxygène)	1 000-1 500 mg/l
COD (demande chimique en oxygène)	3 000-4 500 mg/l
Corps en suspension	2 000-3 000 mg/l

Si l'on a employé la méthode de l'oxydation des sulfures et de la précipitation du chrome, on peut mélanger les eaux résiduelles avec les eaux utilisées pour le tannage, la teinture et le corroyage des peaux de façon à n'avoir qu'un seul effluent. On laisse d'abord les eaux usées se décanter (sédimentation primaire) et on élimine les boues qu'elles ont déposées. On peut généralement ensuite procéder à l'épuration secondaire dans des usines d'épuration biologique. Pour les tanneries implantées dans des zones urbaines où l'espace est limité, l'effluent peut être traité dans une usine produisant des boues activées ou canalisé vers une usine municipale de traitement des eaux usées. Pour les tanneries installées dans des endroits où la place ne manque pas, par exemple les zones rurales des pays en développement, on peut préférer traiter les eaux dans des étangs de stabilisation ou des fossés d'oxydation. En moyenne, l'épuration primaire permettra de réduire la demande biochimique en oxygène (BOD) d'environ 40 % et l'épuration primaire suivie d'une épuration secondaire de 85 à 95 %.

D'après le Centre technique du cuir, on peut économiser jusqu'à 10 dollars des Etats-Unis (au taux de 1974) par tonne de peaux en recyclant les solutions ayant servi pour le chaulage et le tannage au chrome, soit environ 1 % du prix du cuir fini. Les tanneries françaises économiseraient 4,5 dollars de plus du fait qu'elles acquitteraient des taxes de pollution moins élevées.

Dans les pays de la CEE, le traitement des effluents par l'élimination des sulfures, la sédimentation primaire et la modification du pH reviendrait à environ 0,17 dollar par mètre carré, soit 2,1 % du prix de vente du cuir. Le traitement des effluents par la sédimentation primaire, la récupération du chrome et l'oxydation biologique coûterait environ 0,025 dollar par mètre carré, soit 3,2 % de plus que le prix de vente du cuir.

Les pays en développement sont gênés par leur manque d'expérience dans le domaine de la protection de l'environnement par la loi : n'ayant encore jamais eu à résoudre des problèmes écologiques dus à la pollution industrielle, nombre de ces pays n'ont adopté aucune réglementation spéciale en la matière. Il est toutefois indispensable de prendre de telles dispositions avant même de lancer des appels d'offres afin que les industriels puissent prévoir des dispositifs anti-pollution.

- - - - -

A. Environmental Assessment

1. Environmental problems resulting from the leather industry: General Considerations [1]

Pollution problems from the leather industry arise from tanned and untanned solid waste, waste waters (as well as the sludge separated therefrom), and some air pollutants.

a. Solid waste

Solid wastes from the leather industry include cuttings of untanned hides with hair, cuttings of limed, untanned hides without hair and leather shavings, as well as splits and cuttings, both chrome-tanned and vegetable tanned.

Within Europe the practice is to send some of the untanned waste to hide glue and gelatine factories for further processing and also to carcass disposal plants. Sometimes it is disposed in special dumps, in which each day's wastes are covered with a layer of earth (sanitary land fill).

Chrome-tanned and vegetable-tanned wastes can be used for making leather board (leather fibres bonded together with glues) or disposed in sanitary land fills.

b. Waste waters

The composition of the liquid effluent from leather factories is very complex and depends upon the manufacturing procedure used in the particular factory concerned and on the starting materials. The particular characteristics of effluent from leather factories which start with the green, or fresh, hides are sulfides (from the liming), high alkalinity, a high concentration of dissolved organic compounds (mainly partially decomposed protein from the liming and bating processes, but also unbound tanning materials, dyestuffs and fatliquoring oils) and, in the case of chrome leather factories, chromium (III) compounds.

The effluent also contains certain amounts of organic and inorganic suspended solids. These form as a result of co-precipitation when the effluents from the various processing stages are mixed.

In Europe, official regulations, which vary from country to country, generally require that before any effluent is discharged into public waters (rivers, lakes, the sea), it must be purified sufficiently to ensure that there is no risk of major disturbances to the biological equilibrium or damage to the public health. Where effluents are to be treated in public waste water treatment plants, any constituents which might impair the functioning of these plants must first be removed prior to discharge of the effluents into the public sewers. Often times a charge is levied by the public authority. This charge is typically assessed according to both the strength and volume of the waste water discharged.

c. Air pollution

In tanneries, the problem of air pollution is a minor one and is limited almost exclusively to the waste air from the finishing process. This waste air may contain solvent vapours and formaldehyde, depending on the finishing process used in the particular tannery concerned.

The West German firm of Bayer reports that the most suitable purification process (e.g. wet scrubbing, absorption by activated charcoal, combustion of the waste stream) can only be determined after studying each individual case carefully.

2. A more detailed description of wastes which arise in different processing operations 2/

a. Beam-house wastes

The beam-house processes are designed to prepare green, or fresh, hides for tanning. Operations are designed to remove undesirable impurities and leave the collagen receptive to absorbe vegetable tannins or chrome.

(1) Washing and soaking. Hides arrive as green, or wet, salted or dry salted (dried after salting). First they are washed to remove dirt, dung and blood. Next these hides are soaked in cold water to remove salt and soften. Dirt, hair, dung, blood, salt are the pollutants.

(2) Green fleshing. Muscle and fatty tissue are cut away with revolving knives during this process. Suspended particles are the main pollutants.

(3) Liming. Hides placed in vats containing approximately 10 per cent lime based on hide weight. Liming swells the skin and loosens the hair. Some accelerators are added, such as sodium sulfide. A high alkalinity (lime) waste is produced in small volumes; sulphides are present in the waste.

(4) Unhairing. Hair is cut away via rollers with knives. Hair is collected on screens. Hair, suspended particles from the epidermal layer, and lime are the main pollutants.

(5) Lime fleshing. This is a mechanical process to remove any flesh and fatty tissue which remains after liming.

(6) Splitting. The hide is split through the middle of its thickness to produce grain and flesh side layers.

(7) Bating - an enzyme - ammonium sulphate solution is used to remove excess lime from the hides. Small amounts of organic matter and lime are the pollutants.

b. Tan-yard wastes

(1) Vegetable tanning. Tannins from certain tree barks, woods, and leaves are used. A small volume of waste is generated but this is highly coloured and heavily concentrated in organic matter.

(2) Chrome tanning. Hides are first pickled in a solution of sulphuric acid and salt. Tanning is carried out in vats with sodium dichromate and reducing agent (glucose). The hides are washed in an alkaline bath. The resultant leather is termed wet blue, after its characteristic blue colour at this stage. Waste water contains chromium ions and salts.

(3) (a) Retanning. With chrome salts, synthetic tanning chemicals, or vegetable tanning. Low percentages of chemicals. Mainly taken up by leather.

(b) Bleaching. With sodium bicarbonate and sulphuric acid.

(c) Dyeing. Carried out in drums with synthetic and natural dyes. Unbound dyestuffs are the pollutants from this process.

(d) Fat liquoring. Skins are tumbled in drums containing emulsions of oils (linseed, castor) - emulsified oils are the main pollutants. Following this step, the leather is dried and the product is termed crust leather.

A flow chart of the processes in the tanning manufacturing procedure is shown in Figure 1. Air, water, and solid wastes eminating from the various processes are shown to the left and right of the process flow diagram.

3. Composition of mixed effluent from the tannery

The effluent resulting from the manufacture of side leather in central European tanneries with a water consumption of 40-50 liters/kg raw hide has the following average composition: 1/

Chrome (III)	100 mgCr/l +)
Chrome (VI)	0 mgCr/l
SO_4^{--}	1,500 mg/l
NaCl	4,000 mg/l
Sulphide (S^{--})	150-200 mg/l
BOD	1,000-1,500 mg/l
COD	3,000-4,500 mg/l
Suspended solids	2,000-3,000 mg/l

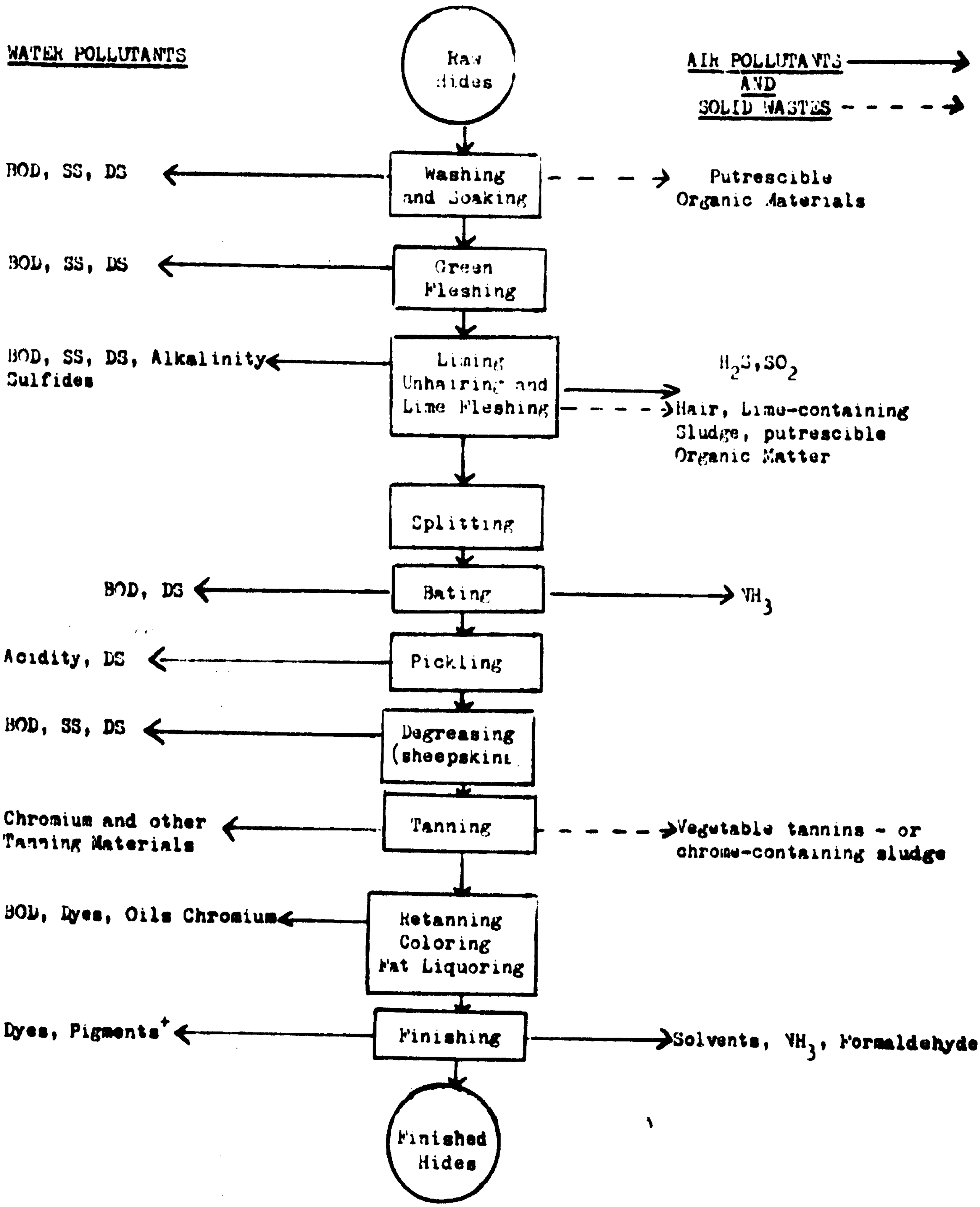
+) without previous Cr separation; with previous Cr separation approximately 40 mgCr/l.

Following catalytic oxidation of the sulphide in the hair burn effluent and separation of the primary sludge of the mixed effluent by sedimentation, the composition of the effluent is approximately as follows: 1/

BOD	600-900 mg/l
COD	2,000-2,700 mg/l
Suspended solids	400-600 mg/l
Cr (III)	10-20 mg/l

Figure I

Processes producing pollutants in the tanning industry*



* Adapted from Industrial Pollution Control, Vol. 2: Technological Strategies, Chap. 5, Fig. 5-21

BOD = biological oxygen demand
SS = suspended solids
DS = dissolved salts

B. Environmental Management

1. Effluent problems

a. Sulphide from the liming process

The best approach is to eliminate the sulphide from the alkaline liming liquors before these liquors are mixed with the rest of the effluent. The most common and technologically simplest method is oxidation with air utilizing $200 g/m^2$ manganese (II) sulphate. 1/

b. Hair burn effluent

The effluent from the unhairing can be collected in a storage tank and then pumped through an Idronova vertical settling tower. The sludge is removed daily for disposal and the supernatant liquor is collected for reuse. Only the necessary chemicals required to bring the waste up to strength are then added. 4/

c. Chromium tannery waste

All waste waters from the chromium tanning process, including wringer pressings, can be pumped through a hydrosieve to remove suspended particles. These waste waters can then be re-used as pre-tanning liquors in the pickling process. This requires the use of dry salt rather than brine in order to reduce the volumes.

Alternatively, the concentration of chromium (III) ions can be considerably reduced by precipitating the chromium through addition of alkalis. The precipitated chromium hydroxide can be filtered out, redissolved in acid and used again in the next tanning batch. The process requires careful analytical supervision. 4/

d. Treatment of the mixed effluent

If the practices of sulphide oxidation and chromium precipitation have been followed, the resultant effluents can be mixed with those from the tanning, dyeing, and fatliquoring processes to form an overall plant mixed effluent. After this effluent is allowed to undergo primary sedimentation and the sludge is separated for separate disposal, the resultant effluent is generally suitable for secondary treatment utilizing biological purification plants. In the case of a tannery operating in an urban area with little available space, the treatment may be via an activated sludge plant or the effluent may be discharged to a municipal treatment plant. For the case of a tannery in an area with much land available, say a rural area of a developing country, the preferred method of treatment may be ponds or an oxidation ditch. 1/

2. The economics of pollution control through recycling

The savings which can be obtained by recycling the liming and chrome liquors can reach US$18 (1974 dollars) per ton of hides, according to Centre Technique du Cuir. This represents approximately one per cent of the price of the finished leather. In the case of the application of these recycling measures in a French tannery, an additional US$4.5 credit would be obtained from the reduced amount of pollution taxes required to be paid by the firm for effluent discharges. 5/

3. Effluent treatment in rural areas

A three lagoon system is suggested. Waste water first enters the lagoon A which serves as a primary treatment stage. This lagoon will tend to operate under anaerobic conditions because of the high oxygen demand of the waste. Sastry 6/ has reported that reductions in effluent BOD from 1,600 mg/l to 250 mg/l can be achieved in India with a 10 day retention time.

The effluent from the primary lagoon then enters a secondary lagoon or an oxidation ditch for further biological treatment under aerobic conditions. In either case another lagoon should be available to receive waste waters when lagoon A must be closed down in order to remove accumulated sludge.

In the case of an oxidation ditch, residence time is usually two to three days, and the effluent is circulated and aerated by means of rotating steel brushes. 7/

A study in Holland showed treatment of an incoming effluent of BOD from 500-1,500 mg/l resulted in removals of 98 per cent of BOD and 88 per cent of COD. 8/

An outline of sizing and design parameters for the primary sedimentation and oxidation ditch processes can be found in reference 8, appendix II.

4. Costs of effluent treatment

Detailed cost analyses of alternative effluent treatment procedures have been presented in a recent publication covering environmental practices in the EEC countries. 8/ Effluent treatment incorporating sulphide removal, primary sedimentation, and pH adjustment is reported to cost $0.016/sq.ft. or 2.1 per cent of the leather selling price.

Effluent treatment incorporating primary sedimentation, chromium recovery, and biological oxidation is reported to cost $0.025/sq.ft. or 3.2 per cent of the leather selling price.

Calculation of effluent treatment costs for both of the above processes includes a straight line 20 per cent annual capital depreciation charge.

More detailed analyses of costs of effluent treatment in several developed countries are presented in Appendix II.

5. Solid wastes management practices

A summary of the various types of solid wastes produced in tannery operations is shown in Table 1. 9/ In each instance, environmentally sound and unsound practices for disposal of these wastes are summarized. Thus the table is intended to serve as a general guide to decision-makers in developing countries.

Unfortunately detailed economic analyses of the alternative disposal methods as well as market analyses of reuse potentials are not available at this time.

6. Pollution regulations for discharges into the air and public waterways

In recent years, more and more countries have expanded or adopted new environmental legislation. Governments have created official bodies which are responsible for the elaboration of new legislation and its application and enforcement. As a guide to present practice, a comprehensive listing of air quality* and pollutant emission+ standards from a number of countries, including Japan, USSR, the United States, and several European countries, are to be found in a recent World Bank

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* An air quality standard requires that the concentration of a pollutant in the atmosphere at the point of measurement shall not exceed a specified amount.

\+ An emission standard requires that the amount of a pollutant emitted from a specific source shall not exceed a specified concentration.

Table 1. Environmentally sound and unsound practices of disposal of solid waste from tanneries*

Solid waste	Environmentally unsound disposal	Environmentally sound utilisation
Salt dust	Storing in heaps and allowing to be washed away during rains.	Solar evaporation after dissolving in minimum amount of water and reusing in pickling etc.
Raw, green fleshings	Piling in tannery yards and allowing to putrefy.	Immediate disposal for glue manufacture, animal feed etc.
Hair	Allowing it to choke effluent drains.	Washing, drying and utilization for carpet, drugget industry etc.
Lime sludge	Allowing it to be disposed of into sewers or rivers thereby choking them.	Utilization for building construction, soil, conditioning etc.
Limed fleshings, splits and trimmings.	Piling in tannery yards and allowing to putrefy.	Utilization for glue and gelatine manufacture, animal feed, etc.
Vegetable tank bark	Dumping inside tanneries.	Use as fuel and stable ground cover.
Vegetable tan sludge	Allowing entry into effluent flow.	Fertilizer, soil conditioner.
Vegetable and chrome tanned shavings and splits	Using for agriculture.	Manufacture of leather boards, reducing chrome liquors etc. incineration along with sludge.
Effluent sludges	Drying in open yards, disposal into water course, lagooning indefinitely.	Dewatering and incineration along with other solid wastes.

* The information given in the above table is particularly relevant to developing countries.

Reference: T. Mathew, unpublished UNIDO document on pollution from tanneries, May, 1977, 66 pages. 9/

publication[10], which also refers to criteria for maximum concentrations of various water pollutants in public waterways.

A problem specific to the developing countries when endeavouring to protect the environment through regulations is a lack of experience. Never previously having had to face environmental problems due to industrial pollution, a large number of the developing countries have no specific regulations at hand. Such regulations, however, are indispensable to the contractor for the design of pollution control systems and should be in effect at the time the tender documents are sent out.

The regulations for several developed countries govering discharges of tannery effluents into public water ways or sewers are presented in Tables 2 and 3. [5] These are intended to serve as guides to decision-makers in developing countries. Each country must decide, in the context of its own development planning, the nature of the pollution control regulations best suited to allow continued industrial development while at the same time to provide safeguards for the health of its citizens and to protect the natural environment. It is recommended therefore that the ministries concerned, such as those of industry, health or development, should draw up the relevant regulations, referring as necessary to the experiences of other countries cited in the World Bank publication and in Tables 2 and 3.

7. Further references on recycling possibilities, water savings, and effluent treatment procedures

For further details on recycling possibilities, practices which can result in water savings, effluent treatment procedures, and effluent guidelines, the reader is referred to citations 11 through 16 in the list of references at the end of this paper.

Table 2

Permissible Upper Limits for Discharges of Pollutants Contained in Tannery Effluents into Surface Waters as taken from the Regulations of Eleven Developed Countries

1975 Regulations in mg/l (except Temperature and pH value)	Australia	Belgium	Denmark Sea	Denmark River	United States 1977**	United States 1983**	France	Great Britain	Nether-lands	Hungary	Italy	Poland	Switzer-land
Temperature °C		< 30 20–23 °C	< 30 °C	< 30 °C			< 30 °C	< 43 °C					< 30 °C
pH value	5–10	6,5–8,5	5–10	6,5–8,5	6–9	6–9	5,5–8,5	6–10	6,0–8,5	6,5–8,5	6,0–8,5	5–9	6,5–8,5
Dissolved oxygen in receiver downstream from discharge	-	60% Satu. surface 40% Satu. bottom	-	-			> 5 > 7					> 4	> 5
Suspended Solids	< 40	< 100	< 80	< 30	< 5,0 g/kg	1,5 g/kg	< 30	< 20	< 30		50–80	< 60	< 20–30
Settleable matter (ml/l)	-		< 1	< 0,5	-	-	-			< 5			-
Oil and grease	-		-	-	0,75 g/kg	0,53 g/kg	-	< 10		< 10	10–20		-
Dissolved salts	-		-	-	-	-				< 1 000			-
BOD_5	< 20	< 50 < 30 < 15	< 400	< 25	4,0 g/kg	1,4 g/kg	< 40	< 10 < 20	< 20		35–40	< 30	< 25
PV Permanganate value	-		-	-								< 80	< 80
COD (Dichromate)	-	-	-	-	-	-	< 120			< 75	80–120 < 2		-
N ammoniacal	-	-	-	-	-	-	< 10			< 30	< 5		< 0,1
Cr^{3+} Chromium	< 0,75	-	< 0,2	< 0,2	0,1 g/kg	0,05 g/kg	-	< 1	< 2	< 50	< 1	< 0,5	< 2,0
S^{--} Sulphides	0	< 0,05	< 5	< 2	-	< 0,005 g/kg	-	< 10		< 5	< 0,5 < 1	< 1	< 0,1
Phenols	-	-	1	< 0,2	-	-	-	-		< 3		< 1	< 0,05–20

*After dilution in the natural medium.

**Values expressed in g/kg of hides input (chrome tanning with beamhouse process).

Reproduced from Table 30, Tannerie et Pollution by permission of Centre Technique du Cuir, Lyon, France.

Table 3

Permissible Upper Limits for Discharges of Pollutants Contained in Tannery Effluents into Public Sewers (Assuming that the Mixed Domestic and Industrial Effluents Pass Subsequently into a Municipally-Owned Treatment Plant) as Taken from the Regulations of Twelve Developed Countries

1975 Regulations in mg/l except for temperature and pH value	Germany	Australia	Belgium	Denmark	France	Great Britain	Nether-lands	Hungary	Italy	Japan	Poland	Switzerland
Temperature °C	< 35		< 45	< 35	< 30	-		-			-	< 30
pH value	6,5–9,5	> 6,3	6,0–9,5	6,0–9,0	5,5–8,5	6–10		6,5–10	6–10	5,7–8,7	-	6,5–9,0
BOD_5		< 600	-	< 125	< 500 – 1000	< 750 – 1 000		-	< 500	-	< 700	-
Nitrogen		-	-	< 10	< 150			-	< 50	-		-
Chrome Cr^{3+}	< 4	-	-	< 1	-	< 5–10	< 4–10	< 50	< 2	-	< 0,2*	< 2
Sulphides S^{--}	0	-	-	< 10	-	< 5–10		< 1	< 2	-	< 3*	< 1
Phenols		-	-	< 1	-			< 30		-	< 90*	< 5
Oil and grease		-	< 500	-	-	< 500		< 60	< 50	-	-	-
Suspended Solids		< 600	< 1 000 (cut to 1 cm in size)	< 150	< 500	150 – 600		-	< 600	< 300	< 330	-

*After mixture with domestic sewage

Reproduced from Table 31, <u>Tannerie et Pollution</u> by permission of Centre Technique du Cuir, Lyon, France.

Case Study: Country X

Presently 3.1 million hides are produced annually in Country X, a developing country in Africa. The indigenous tannery industry processes only 10 per cent of these. The remaining hides are exported raw.

Serious environmental problems are already present along certain rivers which receive tannery wastes. If one considers the scenario whereby Country X meets the goals of the Lima Declaration through establishing facilities to process all hides produced within the country, a serious increase in environmental damage could result unless sound waste management practices (in-plant waste reductions, recycling practices, plus effluent treatment) are adopted.

Tannery A is located just outside the capital city of Country X. Untreated liquid effluents are discharged into the River [redacted] adjacent to the tannery. A portion of the solid wastes generated by the tannery are buried. The remainder are also disposed into the river.

Tannery B is also located near the capital along River [redacted]. This tannery, however, disposes of no solid waste to the river and only treated liquid effluent. All solid wastes are buried on the company grounds. Liquid effluents are treated by means of screening, settling for 24 hours, coagulation followed by further settling, pH adjustment, final filtration through a clinker bed, and chlorination.

River [redacted] is badly polluted for 2-3 kilometres downstream from Tannery A due to that firm's poor environmental practice. The river waters are used by the inhabitants for laundry and as a source of drinking water for cattle.

If all tanneries in Country X followed the practice of Tannery B, the pollution load on the nations rivers would be substantially reduced at relatively little cost.

Planning ahead to reduce pollution from existing and future tanneries is recommended for Country X as the government moves to implement the overall goal of industrial expansion recommended in the Lima Declaration. If this practice is not followed, the social costs concomitant with an order of magnitude increase in river pollution could offset many of the economic benefits of industrial expansion in the leather industry as Country X strives to improve the quality of life for its citizens.

Case Study: Country Y

A large industrial complex in Country Y, a developed country in eastern Europe, presently consumes 150 tons of raw hides per day and produces 460 million dm^2 per year of upper shoe-leather and some sole-leather. From this upper shoe-leather approximately 45 million pairs of shoes per year are manufactured. Another factory in the complex produces various leather treatment chemicals.

In the case of shoe-leather production portion of the complex, 13% of the capital costs are invested in environmental pollution control. The 13% is divided among 8% for effluent treatment and 5% for air pollution control. The air pollution control costs represent both in-plant control for workers' health and safety and external air pollution control. The 8% expended for effluent treatment represents mostly costs expended for a mechanical, or primary, effluent treatment plant. Included in the 8% were costs of installation of an entirely new sewer system. This was required because the old sewer system dated before world war II. The present mechanical plant removes nearly all suspended solids and about 40% of the BOD from the tannery effluent.

Over the next five to ten years a biological treatment plant will be added to the treatment process. Therefore the percentage capital cost for effluent treatment will be higher. Costs will include the installation of an activated sludge plant and the rechannelling of industrial water piping. Experience for the full scale activated sludge effluent treatment plant is already being obtained through a pilot plant activated sludge unit presently operating at the site of the mechanical plant.

The sludge from the present mechanical treatment plant is dried in sludge beds near the plant. The odour of the sludge bed in summer is eliminated by treating the surface of the sludge field with either $Ca(OH)_2$ or fly ash. The fly ash is obtained from the air pollution control cyclones of the coal-burning electricity plant.

One air pollution problem which cannot be eliminated in the plant is the smell of the raw hides. However, air pollution from the chemical production of the tanning chemicals is solved by incinerating waste gases.

From time to time H_2S occurs in the beamhouse. Worker safety in the plant is safeguarded by strict controls on the levels of H_2S and solvents from finishing operations. The mean permissible level of H_2S in a worker's shift is 10 mg/m^3. The maximum concentration allowed is 20 mg/m^3. Allowable concentrations of the solvents which are used in various finishing operations are shown in the table below:

Solvents from finishing operations

Solvent	Mean allowed concentration	Maximum allowed concentration
Toluene	200 mg/m^3	1000 mg/m^3
Acetone	800 mg/m^3	4000 mg/m^3
Ethyl acetate	400 mg/m^3	2000 mg/m^3
Formaldehyde	2 mg/m^3	5 mg/m^3

In so far as possible, solid wastes generated in the leather-producing process are utilised. About 50% of the proteins from the raw hides end up as solid waste. Solid wastes are also produced from cutting and the splitting operations as well as from the tanning operations. This industrial complex manages to utilise about 80% of all solid wastes. The experience in this complex in dealing with solid wastes is summarised below:

(i) Solids from the liming process are processed for glue and gelatine (an export item), glutin hydrolysate (a fodder for animal feed) and recovery of fat (further processed for making soap and other items);

(ii) The split leather is used for making sausage skins which are then exported to western Europe;

(iii) Scraping after chrome tanning are either used with cuttings for preparing a leather board or combined with solids from the liming process to make the glutin hydrolysate.

(iv) In the case of pig skins, dehairing is carried out in utilising special enzymes. The hair is then collected and processed for use in brushes. This also represents a good export item.

The tannery sludge is dried and utilised for soil conditioning on agricultural land. Composition of the sludge is shown in the following table:

Composition of the tannery sludge

Parameter	% (based on dry sludge)
Organic matters	45,0 - 60,0
Total nitrogen	2,0 - 4,0
P_2O_5	0,2 - 0,4
K_2O	0,1 - 0,2
CaO + MgO	15,0 - 25,0
Cr	1,5 - 3,0

Of particular interest is the study carried out on uptake of chromium in the sludge by agricultural plants. The conditions are as follows: fertilising is carried out once every four years using 30 to 50 tons of dried sludge per hectar. The resultant chromium content in the soil is increased from 10 ppm (background) to 150 ppm as result of sludge addition. The generally accepted upper limit of chromium content for soils in Europe is 400 to 1000 ppm. An analysis has been carried out of chromium content in different plants. The reader should note that the chromium concentration in plants depends on when the sample was taken and on the type of the plant. Furthermore, the chromium concentration will not be identical in all parts of the plant. In the table below based upon chromium analysis in crops grown on sludge-fertilized soils, the lower chromium contents were found in potatoe bulbs, turnip roots and tomatoe fruits. Higher chromium contents were determined to occur in the leaves.

Uptake of chromium from tannery sludge by agricultural plants

Plant	Cr content, ppm, in dry solids
Corn - leaves	1,1 - 3,0
Potatoes - edible plant	1,7 - 2,3
Potatoes - stalks and leaves	2,5 - 13,0
Turnip - edible plant	1,0 - 1,4
Turnip - leaves	3,6 - 5,8
Tomatoes - fruits	0,1 - 1,0
Tomatoes - plant	4,2 - 10,6

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Appendix I

Evaluating the environmental impact of a new tannery

An environmental impact evaluation procedure should form part of the planning procedure for any new tannery operation. The purposes of evaluating environmental impact are two-fold:

(1) To prevent the deterioration of natural resources, such as the river which is to receive plant waste waters, so that these resources can continue to provide a basis for further economic development; and

(2) To give ample warning of deleterious side-effects of the projects, which may result in economic or social costs not normally identified in the project review procedure.

The environmental impact procedure sets out a series of analytical steps applicable to environmental problems that may occur during the raw materials phase right through to the final disposal of materials produced. The definitions of these steps are:

1. Raw materials linkage: Environmental considerations beginning with production of the raw material through the manufacturing project under evaluation;
2. Site assimilative capacity: Present or baseline analysis of air, land and water carrying capacity to determine original conditions and effects of the project;
3. Project design and construction: Analysis of alternative possibilities for unit operations and energy sources;
4. Operations: Maintenance of project and monitoring (analysis of outputs, including by-products and wastes for treatment and reuse; monitoring waste discharges);
5. Social aspects: Social implications of project;
6. Health aspects: Safety and welfare of population affected by plant;
7. Place of ultimate deposit: Recycling, re-use or assimilation of products and future products;
8. Long term considerations: Plant expansions;
9. Optimization: Cost analysis of alternatives.

Appendix I (cont'd)

The environmental impact guidelines include a broad array of concerns. They are designed to assess costs that would result if the project were to impair the future productivity of a country's natural resource base or result in other adverse side effects of investments. As indicated in the nine analytical steps, the impact of investments on the human environment requires a systematic and integrated view focusing on materials flow within production processes and outside the plant.

Proceeding through the nine steps from the raw materials linkage to optimization calls attention to the interrelationship between the choice of process and recycling and/or re-use potential, between plant location and urbanization issues, between waste management and process design. These connexions are an effort to impress upon the project manager the need to design an integrated project which is sensitive to environmental needs.

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