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15851-E

DP/ID/SER.A/721

MAY 1986
ENGLISH

ASSISTANCE IN PREVENTING
ENVIRONMENTAL DEGRADATION

SI/DJI/86/050

DJIBOUTI

Technical report: Preventing environmental degradation from the wet-blue tannery project*

Prepared for the Government of Djibouti
by the United Nations Industrial Development Organization

Based on the work of David Winters,
Expert in Tannery Effluents

United Nations Industrial Development Organization

Vienna

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1 US $ = 176 D.F

I SUMMARY - BACKGROUND

A. Summary

Within a 10 day assignment the consultant has evaluated the possible environmental impact which would be caused by the establishment of a joint venture tannery in Djibouti, at a site adjacent to the existing abattoir, to process locally available sheep and goat skins to the "Wet Blue" state for exportation.

Following discussions with the potential joint venture foreign partner, Glacelader of Sweden (Glace), the consultant has prepared a scheme of treatment for the expected tannery effluent and solid wastes, to ensure that such treated effluent may be discharged to the municipal sewer and treatment plant now being installed. It is calculated that the Primary Physico-Chemical Treatment proposed would yield massive reductions in pollution :-

Possible Major Parameters of Tannery Effluent

		Initial Effluent	Pollution Reduction	Treated Effluent
SS	mg/l	2955	>95%	<148 mg/l
BOD_5	mg/l	900	60%	360 mg/l
$S^{=}$	mg/l	156		<10 mg/l
Cr^{+++}	mg/l	100	99%	<1 mg/l
Cl	mg/l	1077	NIL	1077 mg/l

As may be seen there would only be traces of Chromium (Trivalent) and Sulphides would be expected to be circa 10 mg/l. Thus the treatment system will effectively remove the risk of malodour.

The consultant feels confident that the treatment system suggested will ensure that effluent discharged causes no problem to the municipal treatment plant, and if operated according to the "Code of Conduct" and the operational guidelines established at commissioning, the tannery will have almost zero negative effect on the tannery environs.

Indeed, the consultant would suggest that a well run tannery should cause less environmental nuisance than the skin drying operation which would need to be carried out if no tannery were installed.

The scheme when costed appears to be well within the budget figure employed in the updated Teknokonsult Feasibility Study.

B Background

The reported 900 thousand live petty ruminants in Djibouti are thought to yield from 300 - 600 thousand skins p.a. (possibly augmented by animals and skins from border zones). Until now these skins have been exported in the dried state with minimal "added value".

The value of the exported skins has been depressed due to the numerous defects on the skins, many of which are due to poor flaying techniques and incorrect methods of drying.

The Government of Djibouti, anxious to increase the "added value" of one of its few domestic resources is interested in promoting a tannery to further process the skins. In addition to the advantages of further processing, the presence of tannery technical experts would allow the introduction of improved flaying techniques and further improve the skin quality and value.

A well reputed Swedish Tannery (Glace) expressed willingness to become a partner in such a tannery operation, undertaking the technical managerial and marketing responsibilities of the operation, processing the skins to the "Wet Blue" state.

A feasibility study for such wet blue tannery has been prepared by Teknokonsult of Malmo, Sweden (Construction Contractors) who, while not detailing an effluent treatment scheme, Teknokonsult budgetted 37.2 million D.F. (US $ 210 thousand) for such installation.

Three sites for the tannery have been offered by The Ministry of Public Works, Direction de l'Urbanisme et du Logement Department :

a) Adjacent to the old and new abattoir facilities;
b) On an industrial estate;
c) 12 km from the Town.

The potential promoters of the project prefer the site adjacent to the abattoir because it offers several advantages; the tannery would get fresh skins from the abattoir and therefore transport and preservation costs would be minimised. Furthermore, the municipal water and the proposed municipal sewer are also close to site whereas in the case of the other two sites offered it is necessary to drill for water and most probably to cool it since hot, geothermal water is likely to be found. However, the Government is understandably reluctant to approve the installation of the tannery within the town as it fears that it may have adverse effects on the environment.

However, today's modern technology allows the processing of hides and skins, with only negligible unfavourable impact on the environment. Correct design and operation of purification plant can certainly assist in keeping any unfavourable impact on the environment down to an acceptable level.

The Government of Djibouti rightly requested that a detailed study in this respect be made by an impartial competent organisation to ensure that the establishment of a tannery, although so desirable for the country's economy (estimated added value US $ 1.5 per each skin processed), will not have an unacceptable impact on the environment in the country.

C Current Assignment

The Government of Djibouti requested assistance in this matter and UNIDO fielded Mr David Winters, a Leather Industry Consultant, specialist in Tannery Effluent Treatment.

Mr Winters was fully cognisant of the situation in Djibouti, having taken part in a joint OPEC/UNIDO Mission in January/February 1986.

The Terms of Reference for this 10 day assignment were :-

"The consultant shall visit the potential joint venture partner in Sweden and will be specifically expected to :-

1. discuss, determine and agree on the most suitable type of system for the treatment of tannery wastes for the planned wet blue tannery at the site adjacent to the municipal abattoir in Djibouti.

At home base :

2. elaborate details of the technical system agreed upon which will ensure effluents treated so as to enter the municipal sewers as well as minimal malodour.

3. contact reputable suppliers of equipment, propose the list of equipment needed, obtain relevant quotations, terms of delivery/installation.

4. work out a "Code of Conduct" to be adhered to by the tannery staff to ensure efficient functioning of the treatment system.

The expert will be expected to prepare a technical report setting out his findings."

II TYPICAL TANNERY OPERATION AND ENVIRONMENTAL MITIGATING MEASURES

A. Typical Process

1. Introduction

It must be appreciated that leather making, even in highly developed countries, is today still much of an industrial art, with tannery managers and technologists employing their own personal processes. Similarly plant and equipment vary from tannery to tannery, as will capacity of production unit and end-product. Thus, although some basic similarity exists there can be no universal definitive or even "basic" tannery process.

Given these variations in utilized technology it is not uncommon to find variation in particular detail, thus water usage may range from <20 litres/kg hide to >100 l/kg, consequently the effluents from such process may vary equally widely in concentration of pollutants.

The discussions with "Glace" confirmed that they envisaged a fairly conventional installation with mostly drums rather than the oft employed paddles. It is visualized that the hair would be removed by painting and thus the organic load in the effluent would be greatly reduced.

2. Typical Process

Universally tanning is a batch operation requiring a series of processes, in well controlled sequence, and a typical process for skins may be :-

(Chemical Agents calculated on weight of skins)
Unless otherwise noted draining will follow each process.

TABLE I

Process	Agents	Plant	Duration
Weigh	-	Weighing m/c	-

Process	Agents	Plant	Duration
Soak	In pit/paddle 700% Wash	Paddle	2 days for dry skin
OR	In Drum 300% Wash (Water changed several times)	or Drum	OR 2/3 hrs for fresh skin
	Minute amounts bacteriacides Minute amounts organic soaking agents		
Paint	With mixture containing 150 g.p.l. Sod. Sulphide 500 g.p.l. Hydrated Lime 20 - 25° Be	By hand or Machine	-
Pile	-	-	4 - 6 hours
Unhair	-	By hand on Beam or m/c	-
Lime	200% Hydrated Lime 2% Sodium Sulphide @ 25°C	Drum	2 - 3 days
Flesh	-	Machine	-
Weigh	-	Weighing m/c	-
Wash	250% Water @ 20°C	Drum	¼ hour
Wash	250% Water @ 25°C	Drum	¼ hour
Delime	100% Water @ 30°C 1% Am. Chloride	Drum	½ hour
Bate	Add 0.5% Pancreatic Bate	Drum	2 - 4 hours
Wash	30% Water @ 30°C	Drum	¼ hour
Wash	100% Water @ 30°C		¼ hour
Degrease	1% Proprietary Agent 10% Water Miscible Solvent	Drum	½ hour
	Add 200% Water 30°C		½ hour
Wash	250% Water @ 30°C	Drum	½ hour
Pickle	70% Water @ 25°C 8% Salt 1.5% Sulphuric Acid	Drum	1 hour
Tan	Add 10% Chrome Salt (33% Basic. 25% $Cr_2 O_3$)	Drum	2 hours

Process	Agents	Plant	Duration
Basify	to pH 3.5 by adding up to 0.75% Sod. Bicarbonate	Drum	2 hours Lay overnight
Pile	-	-	24 hours
Sarm	-	Machine or Extended Duration of piling	
Measure	-	Machine	

Product is now known as Wet Blue Tanned Leather.

It should be noted that although the above "typical process" suggests total water consumption is from 2350% - 3550% (i.e. 23.5 - 35.5 litres water per Kg fresh skin), when allowance is made for tannery housekeeping (washing of drums and floor etc) and tanners traditional overuse of water, it would be safer to allow 45 litres water per Kg. skin (45 l/kg).

B Possible Effluent and Waste Production

1. Full Tanning Process with Drum Unhairing

No standard data exists regarding amounts of pollution derived from wet blue tannery processing, including depilation by painting. However, the consultant would calculate such possible pollution from basic data published in a UNEP Study[1] which gives data for salted hides processed to fully finished leather :-

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(1) "Environmental Considerations in the Leather Producing Industry" UNEP Project 0402 - 73 - 001. UNIDO/ITD 337. Vienna 1975

Typical Hide Leather Process

	Amounts of Pollution Per Ton of Salted Raw Material		Possible Composition of Effluent calculated by Consultant at 45 l/kg water usage	
Suspended Solids	Kg/T	150	mg/l	3,333
$B.O.D._5$	Kg/T	60	mg/l	1,333
Sulphide	Kg/T	7	mg/l	156
Chrome (Trivalent)	Kg/T	4.5	mg/l	100
Chloride	Kg/T	160	mg/l	3,556

2. Process Proposed by Glace (as Table I earlier)

The major differences between the process assumed in the UNEP Study[1] and the Glace type process are :-

a) Raw Skins. The raw skins would either be fresh air dried and thus not contain any salt. The only salt employed would be 8% employed in the Pickle i.e. 80 kg/ton Na Cl = 48.5 Kg/Ton Chloride which @ 45 l/Kg would yield an effluent of circa 1,077 mg/l Chlorides.

b) Paint Depilation. The process of depilation by painting gives drastic reduction of Suspended Solids (SS) and Biochemical Oxygen Demand ($B.O.D._5$) in comparison with the "classical" drum pulping of hair. A Danish Survey[2] showed that painting yielded reduction of pollutants in effluent :-

S.S. 17 Kg/T
$B.O.D._5$ 19.5 Kg/T

Thus the expected concentrations of these parameters could be expected to be :-

(i) S.S. 150 - 17 = 133 Kg/T which at 45 l/Kg water usage would yield . . . . . 2,955 mg/l S.S.

(ii) BOD_5 60 - 19.5 = 40.5 Kg/T which at 45 l/Kg water usage would yield 900 mg/l BOD_5

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(2) Frendrup W. "The Influence of Unhairing Methods upon the Amount and Degree of Water Pollution from a Tannery: A Survey of the Literature 1967 - 73". J. Soc. Leather Technol. Chem. 1974 (58) 9.

Thus the untreated effluent from a Glace type process to wet blue could have the following characteristics :-

S.S.	2,955 mg/l
BOD_5	900 mg/l
Sulphide	156 mg/l
Chrome (Trivalent)	100 mg/l
Chloride	1,077 mg/l

C Removal of Pollutants from Tannery Effluent

The systems of effluent treatment proposed by the consultant are all well proven standard techniques whose efficiency may be safely calculated at the design stage as such systems are now employed at many hundreds of tanneries. In essence the proposed treatment system entails three major elements* :-

1. Catalytic Oxidation of Sulphides

The combined effluents are given a catalytic oxidation with air employing Manganous Sulphate as catalyst. Such continuous process within 4 - 6 hours can lower Sulphide levels to <10 mg/l $S^{=}$. Technically improved results can be obtained if the Lime Bath and subsequent washes are separately catalytically oxidised. However, given the small scale of the project it would be technically difficult to operate such a small unit, and it would appear preferable to oxidise all the liquors.

2. Physico-Chemical Sedimentation

The combined effluents are mixed to achieve homogenization and mutual neutralization, the pH adjusted to range 7.5 - 8.5, flocculants and coagulants in measured quantities are added to the effluent, which causes the sedimentation of virtually all SS and significant quantity of the BOD_5. The sediment is separated from the supernatant in a vertical sedimentation tank. At the pH employed virtually all the

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* Full technical details in next chapter

Trivalent Chrome (no Hexavalent Chrome is employed) is removed with the sediment.

3. Sludge Compacting/Disposal

The sediment (sludge) which contains all of the pollutants removed from the effluent is, when removed from the sedimentation tank, in a 2 - 3% dry solids, slurry condition, and as such difficult to handle and dispose. Accordingly, the slurry is conditioned with lime and passed through a filter press. The product of the filter press operation is a 60 cm x 60 cm cake of 3 - 4 cms thick, which has some 25 - 30% dry solid content and may be easily handled. Such sludge cake, together with all other solid wastes (trimmings, screenings, fleshings and hair etc.) is removed daily to a remote location, where it may be safely buried.

D Characteristics of Treated Effluent

Following the treatment outlined above, one could expect :-

		Initial Effluent	Pollution Reduction	Treated Effluent
SS	mg/l	2,955	>95%	<148 mg/l
BOD_5	mg/l	900	60%	360 mg/l
$S^{=}$	mg/l	156		<10 mg/l
Cr^{+++}	mg/l	100	99%	< 1 mg/l
Cl	mg/l	1,077	NIL	1,077 mg/l

TREATED EFFLUENT OF SUCH CHARACTERISTICS IS UNIVERSALLY ACCEPTED INTO MUNICIPAL SEWAGE SCHEMES AND IS AMENABLE TO THE "ACTIVATED SLUDGE" PROCESS WHICH WILL BE EMPLOYED IN THE DJIBOUTI TOWN SCHEME. (INDEED IN MOST COUNTRIES EFFLUENT OF SUCH CHARACTERISTICS WOULD BE SAFELY DISCHARGED TO THE SEA.)

E Odour

Historically tanneries were reputed to produce noxious odours, these were derived from :-

(i) The putrefaction acting on the proteinaceous matters during soaking of the dry raw materials. Today bacteriacides are available to suppress such putrefaction and in the Djibouti case processing a majority of fresh skins, little soaking will be necessary, thus removing risk of malodour;

(ii) Sulphide from the liming process has a characteristic noxious odour, however the catalytic oxidation process will virtually remove all risks of this problem.

(iii) Putrefaction acting on the untanned organic waste materials (raw trimmings, fleshings etc.) is the cause of much tannery malodour. This risk in a modern tannery is easily removed by insistence on good housekeeping practice, i.e regular floor and machine washing, coupled with daily removal from the site of all solid wastes which could subsequently be removed to an approved remote location for burying;

(iv) Anaerobic conditions in effluent holding tanks has sometimes been responsible for noxious odours. In the proposed treatment scheme the effluent tanks will be aerated 24 hours/day and thus no anaerobic activity allowed.

Thus, provided the tannery and treatment plant are operated, given due consideration to the above points, as further detailed in the "Code of Conduct", the risk of malodour affecting the environs are minimal.

Note: It is possible to install an air pollution control tower to clean air emissions from catalytic oxidation/homogenization tanks. Such unit would only cost some US $5,000 but would require further civil engineering works - see next chapter.

III DETAILED TREATMENT SCHEME

A Objectives

The major objectives may be summarized :-

1. To remove and discourage the possible emission of H_2S or other fumes from the tannery, its environs and effluent.
2. To treat the tannery effluent so that it may be acceptable to the municipal sewage scheme under construction and occasion no negative environmental effect.
3. To facilitate the handling and disposal of all pollutants and wastes removed from the tannery effluent.

B Background

It is proposed to install the wet blue tannery adjacent to the existing abattoir in Djibouti Town.

Although the tannery site is to be only some 100 m from the sea it is understood that no marine discharge will be allowed.

The municipal sewage plant is being extended and collection sewers will pass close to the site. It is understood that the new municipal sewage plant is to cater for 3 - 4,000 M^3/day. Following an "extended aeration" "activated sludge" treatment the final effluent from this municipal plant is to be employed for irrigation.

The tannery effluent plant must satisfy the acceptance standards which will be imposed by the municipal scheme management. It is assumed that an efficient primary, physico-chemical sedimentation system would satisfy the authorities.

C Basic Data

1. Tannery Throughput

The capacity of the tannery is not firm at this time, but is envisaged to be 400 - 700 thousand sheep/goats p.a. to the wet blue state. Some 200 thousand of the skins may be fresh, the balance sun dried.

The tannery will operate 7 days a week (as the slaughter house) ie. 360 days p.a.

Assuming maximum 700,000 pieces p.a. = 1944 skins/day but assume for safety maximum per day = 2,500 skins, assume soaked wt. circa 1.1 kg = 2.75 mT/d. Although nominal process employs less than 35 l/Kg but allow for 45 l/kg safety margin.

Therefore volume of effluent = 124 M^3, say 120 M^3

2. Effluent Characteristics

From previous chapter accept raw untreated effluent of following characteristics:-

Assumed Characteristics

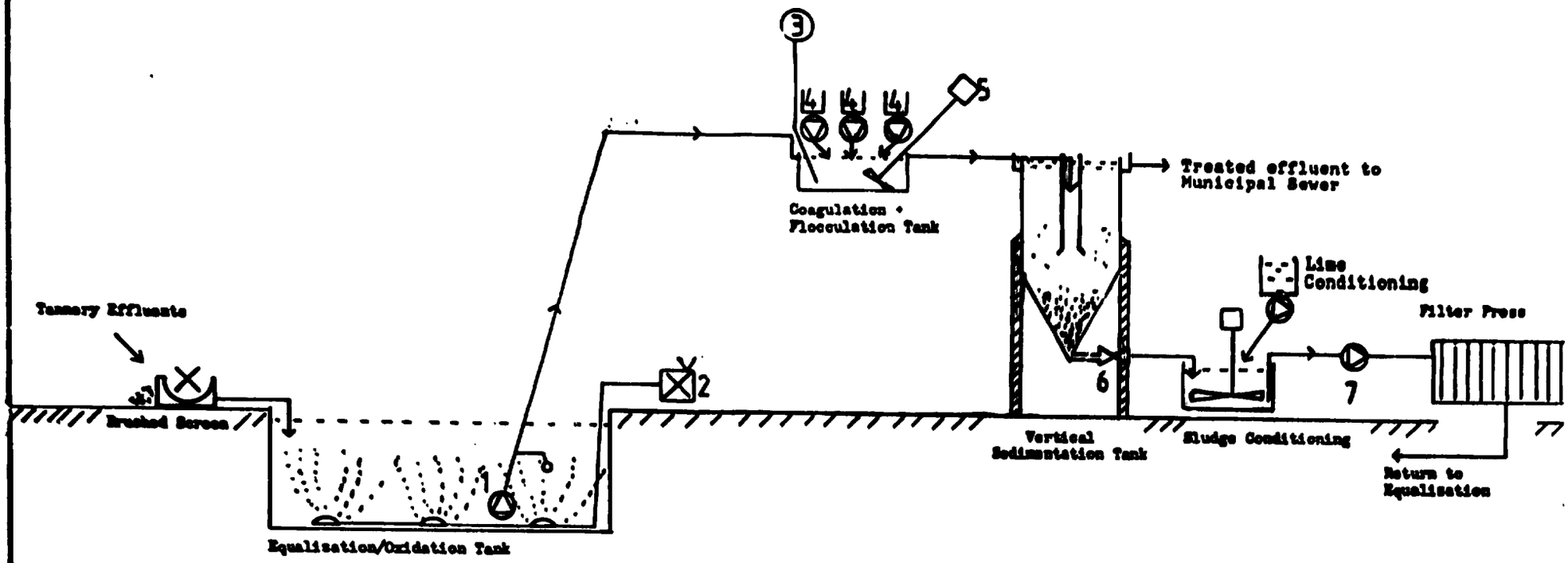
SS	mg/l	-	2,955
BOD_5	mg/l	-	900
$S^=$	mg/l	-	156
Cr^{+++}	mg/l	-	100
Cl	mg/l	-	1,077

D Possible Primary Treatment Schemes

The proposed scheme is shown on the fluxogram overleaf. The details and specifications of the plant may be seen :-

1 Screening

If daily volume V24 = 120 M^3, it may be assumed that



LEGEND:

1 Submersed Pump (controlled by float switch)
2 Air Blower with diffusers
3 pH Monitor
4 Reservoirs and Dosing Pumps
5 Agitator
6 Pneumatic Sludge Discharge Valve
7 Pump for Filter Press

FLUXOGRAM - DJIBOUTI TANNERY SCHEME

[Not to scale]

D.WINTERS. 5-86

maximum hourly flow = $\frac{4 \times V24}{20}$ = 24 m^3/hour.

A Brushed Screen (Parkwood type) or brushed rotary drum screen would appear most suitable. (Parkwood type 0.8 x 1.0m with 0.375 Kw motor has peak flow of 29 m^3/hour). Perforations 2 - 3 mm.

2. Equalization/Homogenization/Oxidation Tank

This must carry out three major functions :-

a) Equalization and mutual neutralization of the variable liquors which will be discharged throughout the working day;

b) A reservoir which will allow forward pumping throughout the remainder of the process at a controlled, regular rate, i.e. regular hourly flow of $\frac{120}{24}$ = 5 m^3/h.

Note: Such regular flow over 24 hours allows the plant to be of optimal size, whereas without such control the plant would need to be scaled up to cope with peak flows in working hours, e.g. up to 24 m^3/h.

c) The equalization tank must ensure that suspended matters are not allowed to settle.

a) Volume of Tank

This could conveniently have a utilizable capacity of 100 m^3. Possibly 3 m deep utilizable (total depth 3.3 m). Rectangular tank of 8 x 4 m would appear suitable. (Materials concrete, rendered brick or rock).

b) Blower/Diffuser

To achieve agitation and allow sufficient oxygen for catalytic oxidation some 3 m^3 air per M^2 tank/hr is usually found suitable, i.e. 32 m^2 tank = 96 m^3/hr.

Thus a blower of 1 - 200 m^3/hr capacity will be required (to allow for losses etc.) i.e. 2 - 3 H.P.

"Non Clog" Diffusers spaced as manufacturers specification. (Typically 8 Diffusers each capable of 12 - 15 m^3/air/hr discharge).

c) Pump

A submersed, non clog type pump would appear most suitable. With capacity of 10 m^3/hr at 0.8 bar (1 - 2 H.P) (lifting 5 - 6 m and pipe losses).

The exact forward flow rate of 5 m^3/hr may be achieved employing a controllable bypass to return excess volumes to the tank.

Alternatively, a helicoidal pump (Monho type) would be employed. (3 H.P., 63.5 mm pipe @ 500 R.P.M. delivers some 5 - 6 m^3/h).

The pump should be controlled by a mercury type float switch to ensure that there is always at least one-third of residual tank volume to act as equalizer for incoming liquors.

d) Catalytic Oxidation of Sulphides

The now well proven catalytic oxidation of sulphides, developed by Bailey[3] may be carried out in the equalization tank employing 20 - 40 mg/l of Mn^{++} (ex Manganous Sulphate).

(i) Air Requirement Calculation:-

Assume 2,000 skins/day = 2,200 Kg with usage of, say, 2.5% Sodium Sulphide = 55 Kg commercial Na_2S (62% pure) = 14 Kg $S^=$. Assume 50% Sulphide is utilized and 50% residual, therefore 7 Kg $S^=$ to be oxidised.

Under the reaction which occurs with oxidation to Thiosulphate state 1 Kg $S^=$ requires 0.75 Kg O_2. Therefore 7 Kg $S^=$ requires 5.25 Kg O_2.

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(3) Bailey A.D: Humphreys F.E.: "The Removal of Sulphide from Limeyard Wastes by Aeration". J. Soc. Leather Trade Chem. 1967, (51) 154.

1 M^3 Air = 0.28 Kg Oxygen. If Diffuser transfer efficiency = 10% then 1 M^3 Air = 0.028 Kg O_2. Thus to obtain the 5.25 Kg O_2 would require 188 m^3/air.

Given 120 m^2/air/hr (6 Diffusers at 20 m^3/hr) the complete operation would require less than 2 hours. Considering that the lime liquors will not be discharged simultaneously the proposed plant has more than sufficient capability.

The catalyst levels required may be proven by on-site trails at commissioning. The catalyst may be dosed by a manually adjusted valve or employing dosing pumps - see later.

The above oxidation may be expected to yield effluents with <10 mg/l $S^=$.

3. Neutralize/Coagulate/Flocculate

The necessary adjustments and chemical additions will require an agitated mixing tank of from 10 - 20 minutes retention i.e. 0.8 - 1.6 m^3. Such tank may alternatively be incorporated into the sedimentation unit.

a) Neutralize

For efficient subsequent sedimentation a pH in the range 7 - 9 is usually found acceptable. This range of pH may well be found naturally given the process assumed earlier. However, for security a pH monitor may be installed to ring an alarm if outside this range, or activate the necessary dosing pump. As the pH will, with a regular production, be either within the above range or consistently acid or alkali, only one reagent will be ever found necessary.

At the above pH virtually all of the chrome will be precipitated and will be present in the sludge.

The agent (acid or alkali as found necessary) would require a stirred reservoir of up to 1 m^3 and an adjustable dosing pump capable of discharging 0 - 30 l/hr.

b) Coagulate/Flocculate

In order to achieve efficient sedimentation it is necessary to input controlled amounts of coagulants and flocculants. The exact dosage is normally found by trials, however a typical dosage could be :-

400 mg/l	-	Aluminium Sulphate
1 mg/l	-	Polyelectrolyte

These are introduced into the mixing tank from their reservoirs via adjustable dosing pumps (0 - 30 l/hr).

Note: The dosing pumps above should be interconnected with the "forward flow" pump to ensure that chemical agents are only added when effluent is being pumped.

4 Sedimentation Vessel

A simple standard vertical sedimentation tank should prove efficient. With an upflow rate of 1.0 m/hr (i.e cross section is M^2 = M^3 flow/hr) the diameter of the tank would need to be 2.5 m (3 m tall cylindrical section = 1.5 hr holding. Base cone with 60° angles).

Given dosing as at 3 b) above, one could expect removal of >95% of SS and some 60% of the BOD_5. Thus the supernatant for discharge to a municipal sewer may have the following parameters :-

SS	mg/l	<150
BOD_5	mg/l	360
$S^=$	mg/l	< 10
Cr^{+++}	mg/l	trace
Cl	mg/l	1,077

5 Sludge

The sludge which, depending on efficiency of dosing, will occupy some 10 - 15% by volume of total effluent, will have a solids content of 2.5 - 3.0% only. In this state it is bulky and difficult to handle. The sludge discharge may be effected with a "time-clock" controlled pump or pneumatic valve (e.g. operating X seconds every Y minutes, as found by trials).

a) Conditioning

To aid subsequent filtration it is necessary to condition i.e. add some 4 Kg Lime per M^3 sludge. This is effected in a 2 m^3 tank to which is connected a controllable pump, which feeds the 10% Lime slurry from a reservoir.

b) Filter Press

The volume of sludge is at, say, 12% of effluent, to be 15 M^3/day which at some 2.5% Dry Solids = 375 Kg solids/d. (A further check is that normal sludge from a full tannery process yields 0.1 - 0.15 Kg dry material per Kg fresh skin processed, i.e. 2.75 M.T. skins/day would yield 275 - 412 Kg dry solids)

Allowing 3 cycles on the filter press per day and assuming a sludge cake of 30% solids and a specific weight of 1.2 Kg/l one may calculate that a filter press of 0.63 x 0.63 plate size, 60 plates could produce 1.080 m^3/d = 1.29 MT = 389 Kg. Dry Solids.

6 Summary

Thus from the treatment scheme proposed, one may expect a treated effluent with characteristics of SS of <150 and a BOD circa 360 mg/l with no significant quantity of other pollutants, and as such this should be acceptable for entry to the municipal treatment plant where it would subsequently undergo biological treatment.

The removed pollutants are now conveniently concentrated into 1.1 m^3 of sludge cake, which may be transported daily to an approved remote dumping site.

E. Biological Treatment ?

The consultant feels such treatment would be unnecessary at the tannery site. It would merely be an uneconomic duplication of the facilities which are due to be incorporated in the municipal scheme. Considering the small volume involved it would also be costly to operate as a specialist may be needed to control the process.

The data for the necessary biological system is given for the unlikely situation which would occur if the local authority insisted on such biological system :-

1. Concept

The extended aeration, activated sludge process would appear most suitable, with a retention time of 36 hours.

2. Biologic Load

With 120 M^3 effluent at 350 mg/l BOD a daily load of 42 Kg BOD may be assumed.

Thus a tank of 180 M^3 (4 m deep x 5 x 9 m rectangular tank) would have a daily load of 0.23 Kg BOD_5/m^3. Well within normal operating limits.

Oxygen requirements of 1 Kg O_2/Kg BOD would only require some 42 Kg O_2. However to keep the tank fully agitated and the materials in suspension would require circa 3 m^3 air/tank m^2/hr = 3 x 45 = 135 m^3/air/hr.

135 m^3/h air = 37.8 Kg/O_2/hr if diffusers are 10% efficient = 3.78 Kg/O_2/hr = 90.7 Kg/O_2/day. Thus, there would be appreciable excess oxygen available.

Equipment requirements would be :-

Tank - 180 m^3 (4 m deep x 5 x 9 m rectangular)

Diffusers - To supply greater than 135 m^3/air/hr

Air Blower - To supply greater than 135 m^3/air/hr

Sludge Recycle Pump - 6 - 8 m^3/hr

Secondary Sedimentor - Dimensioned as Primary Vessel.

Any necessary pH adjustments and neutriant additions could be made manually.

Note: It may be expected that a biological secondary treatment will achieve BOD reductions of from 75% - 90%. Thus from Primary Treatment BOD_5 of 360 mg/l was assumed - this would be brought down to only 36 - 90 mg/l BOD_5.

F. Air Pollution Control

There always exists the possibility of Hydrogen Sulphide fumes/odours being discharged from the equalization tank before the catalytic oxidation operation is completed.

There are two methods to avoid this :-

1. Akali may be added (normally Lime) to the equalization tank to raise the pH and thus reduce the possibility of gas discharge. (Has the disadvantage that it may be necessary to add acid at a later stage to obtain correct sedimentation conditions).

2. Alternatively, provision may be made to "wash" any such gases being discharged. This would entail covering the equalization tank. (Some of the other equipment could be mounted thereon and space saved). A gas washing tower, possibly of 0.5 m diameter, and 4 m high could be mounted over the equalization tank. Such tank would operate by sucking air and any gases through the tower, wherein plastic pall rings washed

by Caustic Soda solution effectively absorb any H_2S present.

Requirements: Complete Unit :-

Tower Ø 0.5 m x 4 m h
Packed Plastic Pall rings
Reservoir for Caustic Soda
Recycle Pump for Caustic Soda
Fan 200 m^3/hr air

IV POSSIBLE PROJECT COST

Skanska/Teknokonsult in their study allocated US $ 210,000 for the effluent treatment system, including design and contingencies. (Primary Treatment only). The consultant costed his proposed scheme at US $ 130,000, however, this would entail "shopping around" for individual units and would require the project operators to install and operate the plant themselves.

It may however be preferable for the tannery to ask specialist companies to design, install and commission the treatment plant. Although such may be a more expensive solution it would guarantee an efficiently operating plant and allow the tannery to concentrate on producing leather, in which field they are specialized.

The consultant sought quotations from three European companies:-

Messrs Davenport Engineering Cc. Ltd.
Effluent Treatment Division
Harris Street,
Bradford, West Yorkshire
U.K.

Messrs Idronova S.R.L
Via Valleri
10080 Salassa (To)
Italy

Messrs Italproggetti
Via Risorgimento
13 - 56024 Ponte a Egola (Pl)
Italy

To date only one quotation has been received from the experienced Italproggetti Company, this is summarized overleaf. If quotes are received from the other companies these will be forwarded to the interested parties.

	Items to be Supplied by Italproggetti	It.Lira Millions	* US $	US $	Items To Be Produced Locally	US $
	PRIMARY TREATMENT					
1	Brushed Screen 20 m^3/h					
1	Blower 100 m^3/h					
6	Non Clog Diffusers					
1	Submersed Pump 15 m^3/h					
1	Sedimentation Tank + Flocculation Tank					
1	Pneumatic Valve for Sludge					
3	Stirred 1 m^3 Fibreglass Tank					
3	Dosing Pumps	66	41,562			
1	Equalization Tank				20,000	
1	2 M^3 Stirred Conditioning Tank					
1	Lime Milk Pump					
1	Filter Press Pump 2 m^3/hr at 10 bar					
1	Filter Press 60 plate 0.63 x 0.63 m	59	37,154			
1	Set Electric Controls	15	9,446			
1	Set Pipes, Valves etc	18	11,335			
	Hydraulic + Electrical Assembling	20	12,595	112,092		
	Estimate Freight @ 15%			16,814		
				128,906	20,000	
	TOTAL PRIMARY SYSTEM INSTALLED					$148,906
	"Start Up" Technical Assistance	30	18,892			$ 18,892
	TOTAL OPERATIONAL COST					$167,798

* Exchange Rate of 1 US $ = It. Lira 1,588

Optional Extras

Odour Control Unit complete (Tower ø 0.5 m, filled plastic rings, with fan 200 m^3/h and recycle pump for wash solution	It. Lira	8,000,000	US $ 5,038
Estimated Freight 20%			1,008
TOTAL Delivered Cost - Odour Control			US $ 6,046

SECONDARY TREATMENT

Air Blower 100 m^3/hr 6 Diffusers Centrifugal Pump	It. Lira	12,000,000	US $ 7,557
Estimated Freight			US $ 1,134
Tank to be locally constructed			US $ 20,000
			US $ 28,691
Secondary Sedimentation Unit*			5,000
TOTAL Delivered Cost - Secondary Treatment			US $ 33,691

* The quotation does not appear to include this item. An estimate has been used.

V CODE OF CONDUCT

In order to achieve a tannery operation with minimal environmental degradation, it seems necessary for the tannery to agree a "Code of Conduct". It may be suggested that the following should be major points in such a Code.

A. The tannery shall install an effluent plant as agreed by the competent Djibouti Authority.

B. The tannery will operate such effluent plant in accordance with the operating instructions as detailed by the installation specialists or other competent consultant.

C. The tannery will not operate its leather production facilities when the effluent plant is not able to function due to plant fault or non-availability of necessary chemical agents.

D. The tannery will accept it s responsibility to minimise environmental degradation and, in particular, agree to:-

   (i) Wash DAILY all working areas, drains and equipment;

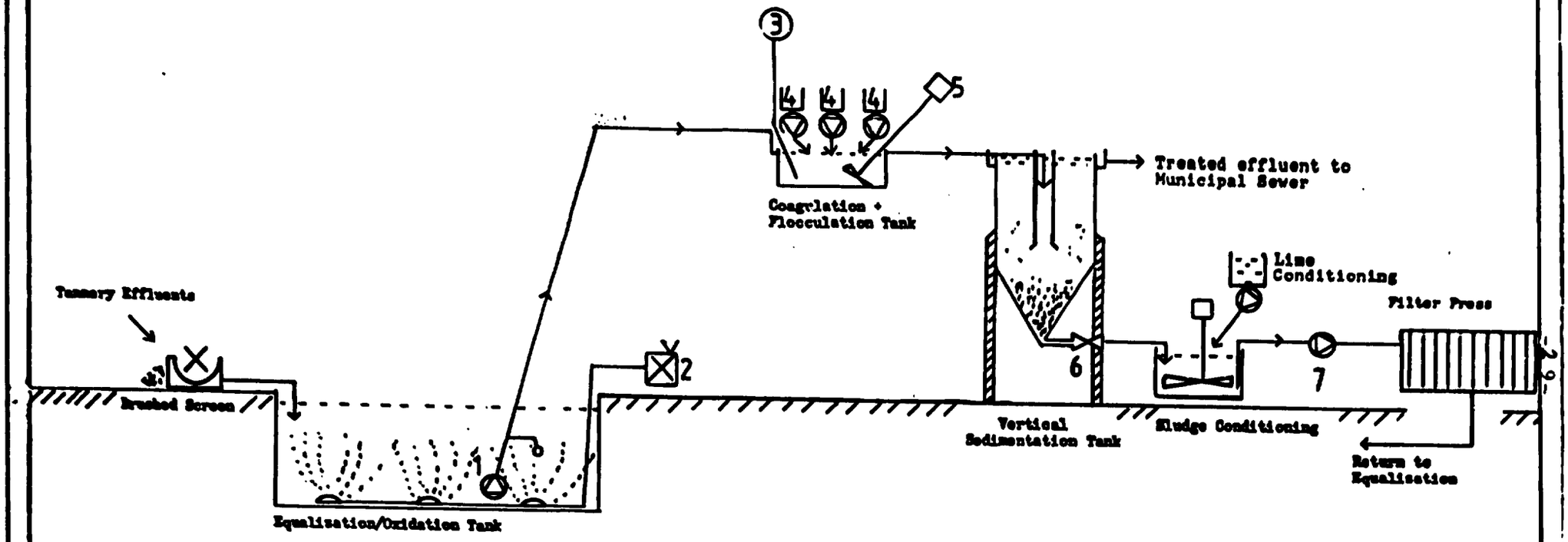
   (ii) Collect DAILY all solid waste materials, e.g. raw trimmings, fleshings, sweepings, screenings and hair and filter cake etc.

   (iii) Remove DAILY all such solid wastes to an approved dumping site and, as necessary, bury or otherwise ensure safe disposal of such materials.

E. The tannery shall agree to undertake all measures to minimise air pollution, in particular:-

   (i) Ensure that no putrescent or other mal-odorous materials are stored on the tannery site

   (ii) Take all necessary measures to minimise the release of Hydrogen Sulphide fumes.



LEGEND:

1 Submersed Pump (controlled by float switch)
2 Air Blower with diffusers
3 pH Monitor
4 Reservoirs and Dosing Pumps
5 Agitator
6 Pneumatic Sludge Discharge Valve
7 Pump for Filter Press

FLUXOGRAM - DJIBOUTI TANNERY SCHEME

[Not to scale]

D.WINTERS. 5-86