OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

19911

UNITED
NATIONS
INDUSTRIAL
DEVELOPMENT
ORGANIZATION

REGIONAL AFRICA

HIDES & SKINS, LEATHER AND LEATHER PRODUCTS IMPROVEMENT SCHEME

US/RAF/88/100/11-10

TECHNICAL REPORT (*)

on a mission in
KENYA, TANZANIA and ZAMBIA

JUNE 1992

Based on the work of

Mr. Giuseppe Clonfero, Expert in Effluent Treatment

Backstopping officers: Juhani Berg, Aurelia Calabrò
Agro-Based Industries Branch

* *This report has been reproduced without formal editing*

LIST OF CONTENTS

MOST RELEVANT ACTIVITIES

o o o o o o

This paper reports the activity carried out by Mr. Giuseppe Clonfero, UNIDO's consultant in tannery effluent, during his mission in Kenya, Tanzania and Zambia (01 - 22 June 1992) for the Project US/RAF/88/100.

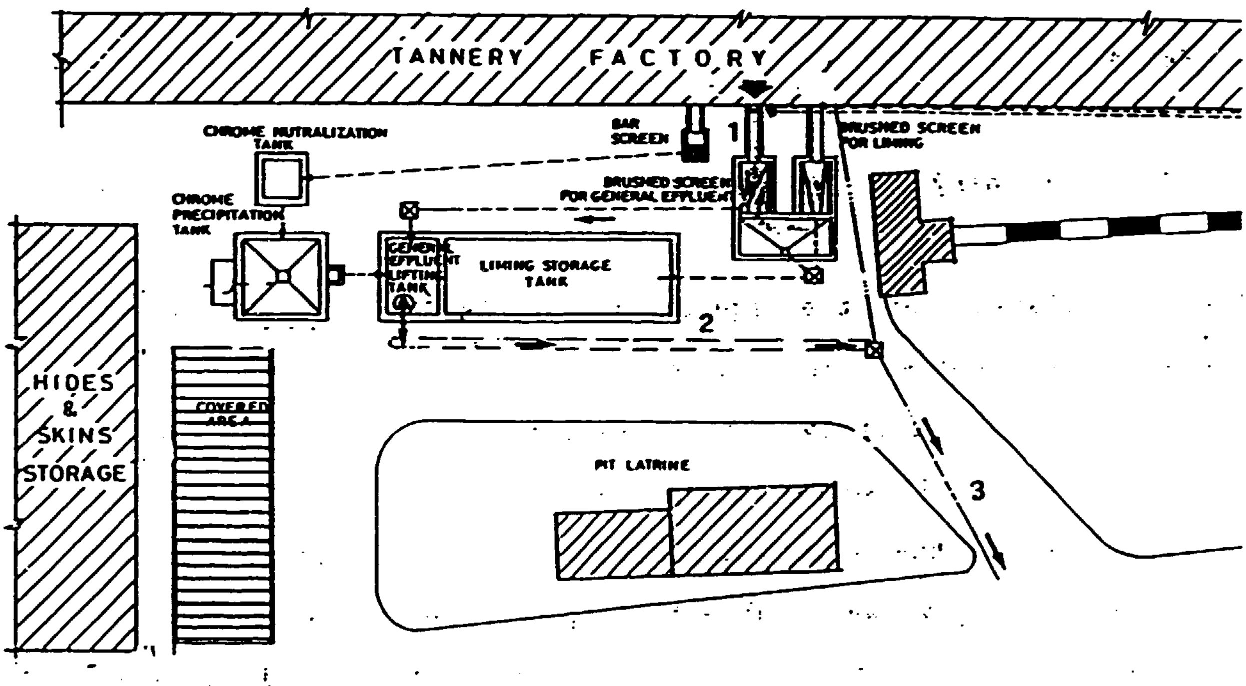
MOST RELEVANT ACTIVITIES

A. KENYA

A.1 Sagana tannery

The installation of the equipment purchased by UNIDO for the effluent treatment was planned for May.
Unfortunately the factory did not respect its obligations and did not finish the civil works within that date.
For this reason the mechanical engineer of the supplier company (Italprogetti-Italy) was unable to complete the installation.
The existing concrete works are satisfactory and properly executed.
The new discharge gullies inside the tannery have been realized.
The few missing concrete works should be done within July; possibly, the residual equipment may be installed in September and the primary treatment commissioned in October.

In the meantime, Sagana tannery must work and discharge effluents. The slope of the new gullies does not allow the disposal by gravity directly to Tana river and, so, the effluent flows into the new installed tanks. In order to avoid deposits and a general dirtiness of the plant, the following provisional solution may be adopted untill the equipment installation and commissioning is completed:



Legend:

1. Line for general effluent (all the tannery's discharges must be collected in this gully).

2. Temporary connection channel (ground excavated) between the pumping station and the existing channel 3 to Sagana river.

The three discharge lines must be jointed in the same gully and, after screening, sent by gravity into the lifting tank. Using one of the two new submersible pumps, the wastes may be transferred into a narrow ground trench communicating with the cld discharge channel to Tana river. In this way, the lifting tank will be the one part of the plant contaminated by waste waters: all the other tanks, dry and clean, remain prompt for the equipment installation.

A.2 Alpharama tannery

The ETP rehabilitation is almost completed: only few facultative lagoons require further improvements.

The efficiency of the plant is still far from the expected one: the residual BOD_5 in the effluent from the oxidation ditch is still too high for a final polishing by facultative lagooning.

Unfortunately, the commissioning of the rehabilitated plant has been mainly carried out by the same factory's personnel with a very little and random (desultory) technical support of the same expert. The analytical controls done at KIRDI LDC (few, not always well planned and, sometimes, unreliable) are not useful for trying any conjecture on the possible causes of these poor performances.

In the expert's opinion, the main problem is the encountered difficulty in developing a suitable biological activity in the oxidation ditch. This fact can be caused by several different factors alone or together:

i. The effluent from the primary treatment sometime contains products (sulphide, alkalinity, biocides, etc.) at concentrations that negatively affect the biological activity. This is due to the lack of an equalization basin.

ii. the suspended solids in the oxidation ditch are very low. This may be an effect of the previous cause or the cause itself of the poor plant's efficiency: an extended aeration process cannot work correctly without a proper loading/biomass rate.

We started the recycling of the sludge from the secondary sedimentation tank but its settleability is very poor. The influent from the ditch looks as a very stable emulsion: perhaps this is the cost paid by the tannery for having greatly reduced the consumption of water and increased that of surfactants.
For overcoming this difficulty in solid sedimentation, the expert suggested to add some Alum in the influent to the secondary sedimentation. The test is still running.
iii. The high level of biocides, required especially in hot regions,for the production of wet-blue may reach in the effluent toxic concentrations for the aerobic bacteria. This possibility has been verified with a simple (and not decisive) test and the results seem to esclude this eventuality. The expert has done a rapid investigation of the mixed liquor of the ditch with a microscope borrowed from KIRDI. The analysis showed the presence of some protozoa characteristic of still polluted waters and not prosper aerobic environments. In any case, this presence should indicate that a biological activity is possible. This fact is also confirmed by the evident facultative/anerobic activity in the successive lagoons. Sulphides, quantitatively absent in the oxidation ditch, return in the first lagoon, despite the floating aerator.
From an analysis done by the expert at LDC a sulphide content of 16 mg/litre as S^{2-} resulted at the out-let of this lagoon.

A.3 Seminar on Effluent Treatment

The expert participated to the seminar on effluents held in Nairobi on 8 - 11 June.

The expert's lecture referred to the criteria adopted in the design of some more relevant cases of ETPs implemented and/or rehabilitated with the technical and economical support of the Project US/RAF/88/100.

A.4 Bulleys tannery

In a previous mission, the expert visited this factory and drafted a proposal for the rehabilitation of the existing ETP.

During the seminar, the factory's general manager , Mr. Awale, asked the expert to define his proposal and prepare a detailed project of interventions.

In fact Mr. Awale is not satisfied with the first interventions done for the plant's rehabilitation with the technical assistance of a national consultant for effluents.

The expert is available but declared himself unable to offer to Bulleys an effective service without the support of a local engineer. The first phase of the Project US/RAF/88/100 is nearly expired: the expert does not know if and when there will be a next mission for effluents.

In any case,the expert has prepared at his home base and submitted to Bulleys a more detailed techno-economical proposal(see Annex 2) that may be discussed during the next expert mission in Kenya for the ETP commissioning at Sagana. It is advisable that for that period Bulleys have selected a new national consultant or re-confirmed the previous one.

In a visit to the ETP, the expert collected up-to-date information and a copy of the project of the plant's rehabilitation prepared by the national consultant of the factory.

B. TANZANIA

B.1 Afro-leather Tannery

The ETP has been commissioned by the same expert in March 1992. At that time, due to the current low tannery production and the subsequent scarce effluent volume,it was impossible to put into operation the entire plant and in particular the final aerated lagoon.

A re-commissioning of the plant was originally programmed in this mission. Unfortunately the expert has been informed in Nairobi by, Mr.A.Zink, UNIDO consultant for tannery equipment that recently visited Afro Leather, that the situation was still the same. The tannery is implementing its capacity with some new equipment and the production has been temporarly stopped.

For this reason, the expert's activity in Tanzania has been limited to a meeting with the factory general manager, Mr.Salim Mawji, in which the expert has consigned the final ETP's operation and maintenance manual prepared in Italy after the plant's commissioning.

The re-commissioning of the plant should be eventually planned inside the activities of a second phase of the Project.

C. ZAMBIA

C.1 Asaria Tannery

This ETP has also been commissioned by the expert in March.
In the succeeding period, the plant has been operated by the tannery personnel according to the treatment procedures without big problems. A minor damage to the air-blower transmission has been repared by the same factory's fitter. The stator of the screw sludge pump must now be replaced using one of the two spare pieces.
The damage to the blower was casual and the problem has been overcome. In any case, the expert has modified the night operation programme of the blower on the timer in order to limit the number of on-off strokes. The original programme (30 min. operation and 20 min. stop) has been modified to 60 min. and 30 min. respectively.
The consumption of the rubber stator deserves more attention.
These stators are expensive (500 U.S.$ per piece ca.) and must be imported. Two months represent too short a duration time!
The expert has investigated the cause of the damage and, from the factory' fitter, received the confirmation that the pump ran at dry (the same rotor was "brass-colored" by the heat).
The operator must follow with maximum care the pump instructions and keep under visual control the pump during the entire operation period.

Furthermore, the two stolen submersible pumps must be replaced as soon as possible: at the moment only one pump is available for both the chrome and the other sludges.

The use of the pump for the discharge of the sludge from the primary sedimentation must be limited to those cases in which the discharge by gravity is unachievable (too thickened solids).

The definitive plant operation and maintenance manual, prepared by the expert in Italy, has been consigned and discussed in detail with those in charge.

During a general re-commisioning, the expert could verificate that the factory personnnel has reached sufficient autonomy and skill in the operating of the plant.

The sludge drying beds is the one part of the plant to be still implemented. The first two beds (1 for chrome and 1 for the other sludge) will be ready shortly but they are still insufficient.

C.2 Kembe Tannery

Mr.A.Lesuisse, UNIDO consultant, recommended for this factory a primary treatment similar to that installed at Sagana tannery (separation and pre-treatment of the chrome liquors, sulphide oxidation, flocculation with chemicals and primary sedimentation).

The expert does not believe this proposal suitable for Kembe. The local conditions greatly differ from the Sagana ones:

i. the factory is located in a rural area where there are neither surface waters nor sewers in which to discharge the pre-treated effluent.

ii. the real (and sole) problem encountered by Kembe is the effluent salinity and the proposed treatment does not affect the salt content.

Currently, after a simple sedimentation (m. 10 x 5 x 2 H), the tannery effluents are disposed of into a large pond (90 x 90 m.). The pond bottom is unlined and some water infiltrates the soil. The evaporation, that occurs especially in the dry season, does not give any benefit: it reduces the volume but increases the salt content of the leachate water.

The pond has been excavated two years ago. But, because of its large surface and the little volume of the tannery effluent, the soil is not completely sealed by deposits.
As a result a nearby well that supplied water to the tannery should be abandoned because of its eccessive salinity.

The tannery is located in a farm of 3500 acres belonging to the same company. Thirty hectares are cultivated (wheat and soybean cyclically) and in the dry season the crop must be irrigated with subsoil water. The use of the effluent for irrigation would be the most appropriate and less expensive solution.
This possibility was also indicated auspicious in the report of Mr.Lesuisse.

BOD and Suspended Solids are removed by bacterial action and by filtration as applied wastewater percolates through the soil. BOD and SS are normally reduced to concentrations of less than 2 mg/l and 1 mg/l, respectively, after 1.5 m of percolation.

Nitrogen removal mechanisms include crop uptake, nitrification-denitrification, ammonia volatilization and storage in the soil.

A model describing the removal of fecal coliforms in pond systems has been developed [Bowles, D.S. et al. Coliform Decay Rates in Waste Stabilization Ponds, Journal WPCF, 51 (1):87-99, January 1979]. Based on this model, actual detention time necessary to reduce the coliform level of a typical domestic wastewater to 200/100 ml ca. is about 20 days at 20 °C.

Thus, pond treated effluents, in many cases, meet the EPA coliform recommendations for irrigation without disinfection.

Removal of viruses in ponds is also quite rapid at warm temperatures. (essentially complete after 20 days at 20 °C.

The retention time in the existing lagoon (12000 m^3 ca.) is about 80 days.

Without a previous practical experience, the expert has tried a theoretical approach to the problem and from his calculations the alternative seems technically possible in the situation existing ar Kembe tannery (see Annex 3).

<u>Description of the proposed effluent treatment (in alternative to the classical one)</u>

(see also the following sketch)

<u>Foreward</u>

In the following proposal it has been taken into consideration that in this tannery, which processes green (not salted) hides, most of the discharged salts are concentrated in the spent tanning liquors (the tanning is done in the same pickling floats).

These liquors also contain the trivalent Chrome that must be eliminated before their disposal into the enviroment.

If in the dry season the spent tanning liquors are evaporated, the remaining effluents (after lagooning and dilution with fresh water) can be used for irrigation without problems.

In the wet season, the salinity is not a problem: the rain will dilute and flush the salt. Of course, the trivalent chrome must have been previously removed.

Treatment of the chrome containing waters

The spent tanning liquors must be separately discharged (line 1) and, after screening (bar screen BS), collected in the precipitation tank.

The chrome precipitation will be done in batch: the liquor is mixed (mechanical mixer) and treated with lime-milk (final pH 8 ca.). The pH is measured with pH-indicator paper.

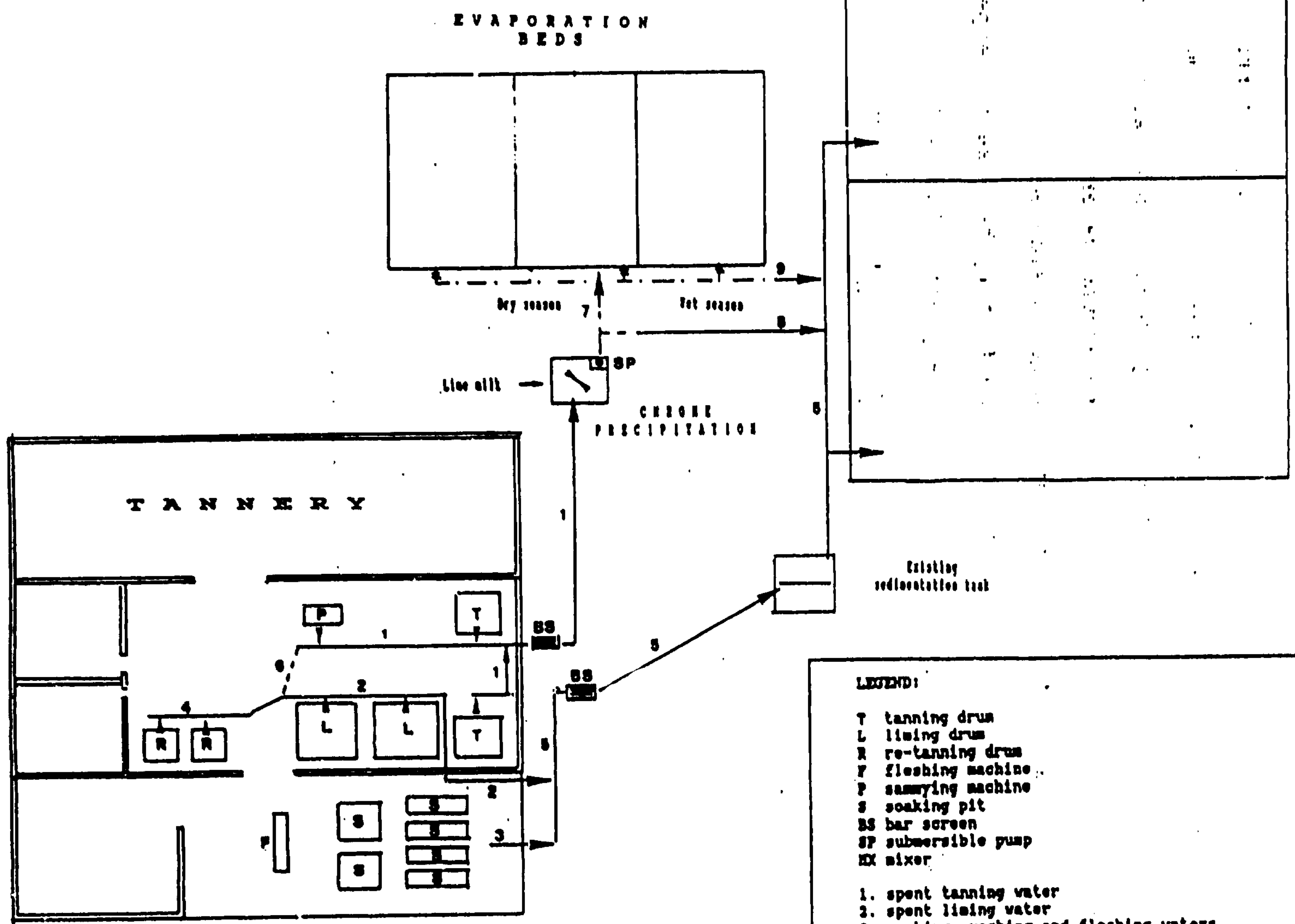
Case a (dry season)

The mixed liquor (water and suspended solids) are pumped with the submersible pump P to the evaporation beds (line 7).

In the dry season the bottom discharge holes of the drying beds are close: the beds are operating only as evaporation tanks.

K E M B E   T A N N E R Y

Z A M B I A



LEGEND:

T tanning drum
L liming drum
R re-tanning drum
F fleshing machine
P sammying machine
S soaking pit
BS bar screen
SP submersible pump
MX mixer

1. spent tanning water
2. spent liming water
3. soaking, washing and fleshing waters
4. re-tanning water
5. channel to the pond
6. by-pass of chrome containing water (optional)
7. mixed liquor (after chrome precipitation) to evaporating beds
8. supernatant from chrome precipitation (wet season)
9. [illegible]

NOT TO SCALE

When the residue is dry (20% ca. of dry matter), the solids are taken off and transported to the final disposal area.

The bed cleaning operation is manual with shovels and/or forks.

Due to the lack of municipal landfills, the disposal area must be selected with care (far from the factory wells) in order to limit the risk of a secondary pollution of the ground water.

The possible aesthetic impact must also be considered.

This aspect must be studied by the same factory because the expert has not the necessary information to give precise indications.

Note: this difficulty is common in Countries in which there are no defined government policies and rules for sludge disposal.

Case b (wet season)

After the chrome precipitation, the liquor is settled and the supernatant pumped to the pond (line 8).

After various cycles of precipitations and supernatant discharges, the residual deposit of the chrome sludge is pumped by P1 to the drying beds.

In this period the bottom discharge holes of the beds must be opened and the possible filtration water sent to the pond (line 9).

In the wet season the beds must operate as common drying beds.

Treatment of the other effluents

The washing, soaking, liming and re-tanning waters,after screening (bar screen),are discharged by gravity into the pond (line 5)

The expert does not see serious problems in the little chrome present in the re-tanning effluents. In the future, if necessary, these waters may be mixed with the spent tanning liquors (by-pass dotted line 6). At the moment, to treat even the re-tanning water would represent an increase of the total water to be evaporated.
The existing pond will be divided in two equal parts with a ground embankment. This will increase the soil clogging and simplify future cleaning of the pond from deposits.
The retention time of each part is still respectable: 40 days ca. at the maximum tannery capacity.
A periodic dosage of phosphate can be tested for facilitating the development of algae in the pond; the presence of algae will improve the soil clogging and also reduce the Ammonia nitrogen content in the infiltration and irrigation waters.
In the dry season the supernatant water of the pond will be pumped with a mobile submersible pump, mixed with the underground water and used for irrigation.
To avoid the risk of contamination (the ground water is used for domestic scopes as well) a new separate tank must be installed in which the two waters are mixed before the spry irrigation.

In the wet season (no irrigation) the effluent of the pond will be discharged (over-flow) and disposed of on land.

The rain will dilute and flush away any residue.

Design of the evaporating beds

The tannery's max. production is about 7,500 kg of hides (pelt weight). Assuming a water consumption for the tanning of 60% on the pelt weight, we obtain 4,500 litres of spent liquors per day. This figure is amply precautionary: in the reality the tannery is currently using shorter floats for the tanning.

The average loss due to the evaporation of a flat water surface is 7 mm ca. per day in the dry season. This value is reduced to 1.2 mm per day in the wet season.

Ref. "Les Eaux Usées dans les Agglomérations Urbaines ou Rurales" C.Gomella and H.Guerrée, Ed. Eyrolles, Paris 1978, pag.283.

Note
These values have been measured at the Côte Azur, France, we could expect higher values in Zambia but, in our case, the progessive increase of the salinity and the consequent decrease of the surface tension of the liquid to be evaporated must also be considered.

According with these data, for evaporating the daily spent tanning effluent, say 4 m^3/day, 570 m^2 ca. are necessary in the dry season.

The monthly production (20 work days) is (4.5 x 20) = 90 m^3.

It is necessary to adopt a liquid height in the beds of m. 0.2, 450 m^2(90 : 0.2)

The time for a complete evaporation results (200 : 7) 28.6 days (i.e. 1 month ca.).

The expert suggests the installation of three beds m. 30 x 10.

The beds must have the lateral walls with a height of 40 cm. and a slightly sloped bottom to facilitate the drainage of the filtration water during the wet season.

On the bottom of the beds a layer of 10 cm. ca. of fine sand must be collocated.

The lateral wall can be realized with concrete blocks, the bottom can be in concrete or in ground, sealed with well compacted clay or plastic lining.

List and indicative price of the necessary equipment

n.2 Bar screens sloped 60° and 1 rake for manual cleaning.
Material: stainless steel AISI 304.
Space between bars: 10 mm.
Capacity: 30 m^3/h ca.

Indicative total price: 2,200 U.S.$

n.3 Submersible pumps (2 in operation + 1 spare unit) mobile version.
Pump body and propeller in cast iron,
shaft, studs and nuts in stainless steel AISI 304.
Vortex impeller free passage: 50 mm.
Capacity: 24 m3/h at 4 m. head,
Installed power: 1.1 kW Classe F

Indicative total price: 4,200 U.S.$

n.1 Mixer (chrome precipitation)
Shaft and paddles in stainless steel AISI 304.
Speed reducer and motor of 2.2 kW IP 55.
The mixer is complete with a support frame for the installation.

Indicative price: 3,500 U.S.$

n.200 metres of flexible pipe (piping of chrome sludge)
Material: polypropylene with internal reinforcing plastic spring.
Complete with quick connections in stainless steel AISI 304.

Indicative price: 3,000 U.S.$

C.3 Meeting at the Ministry of Environment and Natural Resources

During his stay in Lusaka the expert has met Mr. Chipungu, Director of National Environmental Council of Zambia, and some collaborators. The aim was to be informed about the current environmental legislation and policy in Zambia.
The Council has been recently created and its participants must define the future government actions. They are subdivided in three branches: water, soil and air. At the moment the Council is still in a preparatory phase. A proper legislation with definite standards does not exist in Zambia.
They are studying the local situation in order to prepare a programme for the most urgent interventions.

Mr. Chipungu has demonstrated a great interest for the UNIDO's project and he looks forward to a future cooperation.

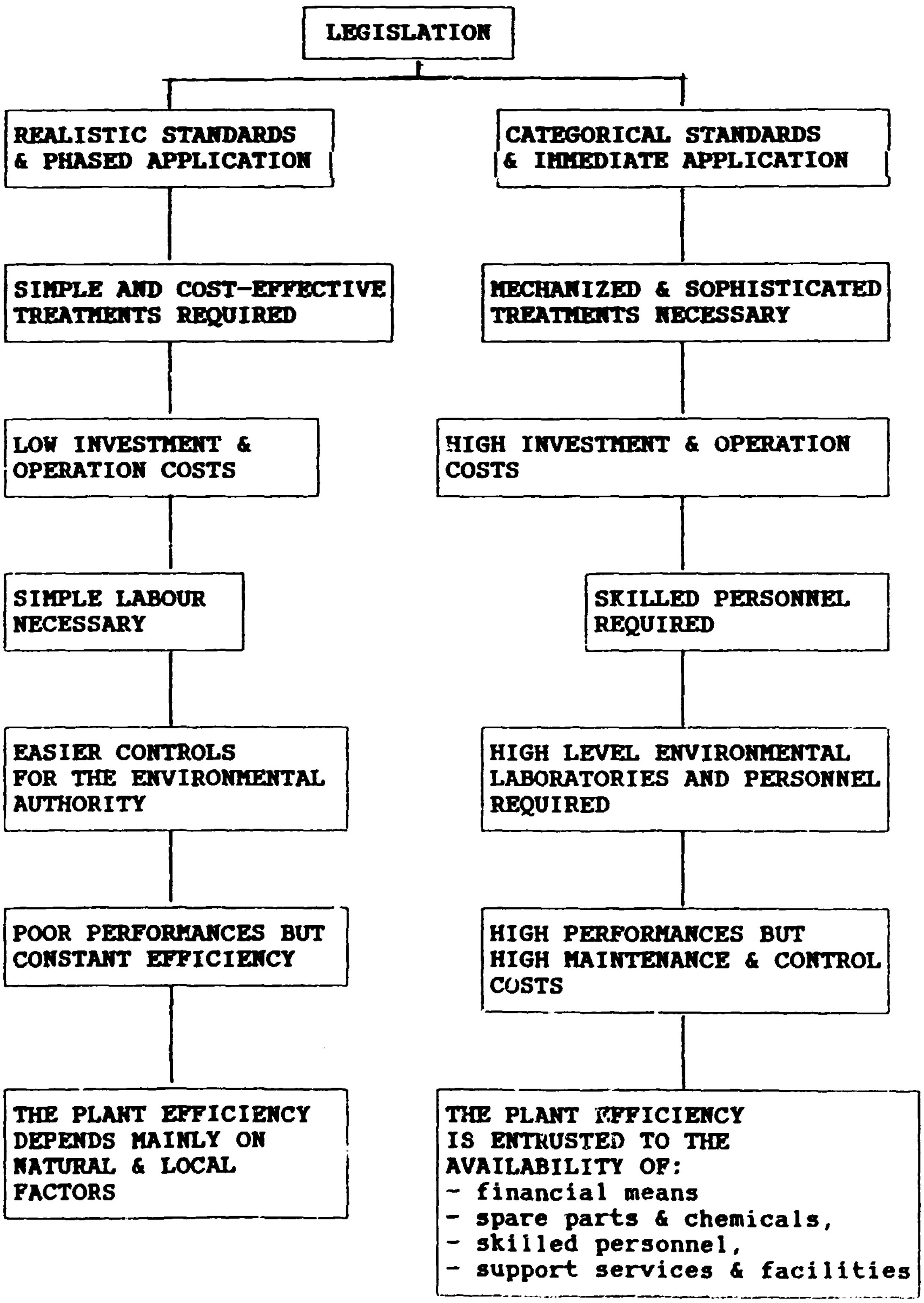
FINAL RECOMMENDATIONS

The expert's advice on the technical aspects of his trip is contained in the specific chapters regarding each tannery. His personal views on the more general aspects, regarding the Government's and UNIDO's policy, are here exposed, as requested.

a. Government

The Government of a developing Country should adopt a progressive and realistic environmental policy and in particular:

1. require a phased (progressive) reaching of the standards (limits) required.
2. impose realistic standards, i.e. ones really necessary for the environment and technically achievable at reasonable costs.
3. in the preparation of the environmental legislation, distinguish between the final (best according to the common criteria) and the immediate (more necessary or urgent in the local conditions) standards.
4. give fiscal and import facilitations to the industries that implement pollution control facilities. This will facilitate the Industry for the equipment, chemicals and spare parts that must be imported.
5. develop guide-lines of the treatment processes for effluents and solid wastes disposal most suitable in the local economical and geographic conditions.
6. increase the number and equipment of the governmental effluent laboratories in order to both have a more incisive instrument of control and fournish a concrete service of assistance to the Industry.


LEGISLATION
REALISTIC STANDARDS & PHASED APPLICATION
CATEGORICAL STANDARDS & IMMEDIATE APPLICATION
SIMPLE AND COST-EFFECTIVE TREATMENTS REQUIRED
MECHANIZED & SOPHISTICATED TREATMENTS NECESSARY
LOW INVESTMENT & OPERATION COSTS
HIGH INVESTMENT & OPERATION COSTS
SIMPLE LABOUR NECESSARY
SKILLED PERSONNEL REQUIRED
EASIER CONTROLS FOR THE ENVIRONMENTAL AUTHORITY
HIGH LEVEL ENVIRONMENTAL LABORATORIES AND PERSONNEL REQUIRED
POOR PERFORMANCES BUT CONSTANT EFFICIENCY
HIGH PERFORMANCES BUT HIGH MAINTENANCE & CONTROL COSTS
THE PLANT EFFICIENCY DEPENDS MAINLY ON NATURAL & LOCAL FACTORS
THE PLANT EFFICIENCY IS ENTRUSTED TO THE AVAILABILITY OF:
- financial means
- spare parts & chemicals,
- skilled personnel,
- support services & facilities

b. UNIDO/UNDP

Instead of supporting the importation of technologies (even if simplified) used in more developed Countries, UNIDO/UNDP should start projects in which alternatives of low technology are tested in the local conditions. It is mandatory in many developing Countries to install very simple not mechanized ETPs. Most of the installed plants are often out of order for the lack of spare parts that must be imported.

Some examples:

- pilot scale facultative lagoons;
- pilot scale sand beds (covered and un-covered) for the sludge dewatering;
- tests on the use of the sludge or other by-products as fertilizers;
- treatment tests with local aquatic plants;
- tests of soil irrigation and other effluent treatments of land disposal;
- tests of sun evaporation of concentrated liquors: in particular of high salinity wastes.

These tests can be carried out by local engineers with the desultory support of international specialists expert not only in effluents (e.g. biologist, geologist, agronomist, chemist, etc.). The function of these specialists should be to prepare the programme of the tests and to evaluate the final results.

The day-by-day operation and control of the tests must be ensured by the local engineers.

****

ANNEX 1

<u>Letter sent to Alpharama Tannery - Athi River - Kenya</u>

Att. Mr. SAMBASIVA RAO, Production Manager

As discussed in my last visit, I'm sending you some technical advice/suggestions for the rehabilitated E.T.P..

1. <u>Pumping of sludges from primary sedimentation tanks</u>:
after the problems with the rubber stator of the helicoidal pump, you have replaced this pump with three submersible units that seem to work satisfactorily. I do not want now to enter again in the merits of the cause of these damages and I agree with this solution. In the operation conditions of your ETP a submersible pump is more reliable.
Therefore, I suggest to maintain definitive the current solution and to use the helicoidal pump (eventually installed on a mobile frame on wheels) for the drainage of the excess supernatant water from the sludge drying beds.
In this way you can obtain a more thickened sludge (i.e. a higher efficiency compared to the existing drying beds) as originally thought when an helicoidal pump has been chosen for these sludges. Furthermore, in these conditions, the pump will not cause further problems.

2. <u>E.T.P.'s performances operative conditions</u>.

2.1 Sulphide oxidation:
on the basis of our brief controls the current situation is the following:
i. the sulphide oxidation process of the spent liming baths is unsatisfactory;
ii. there are no residual sulphides at the out-let of the oxidation ditch;
iii.sulphide is again present in the effluent after the aerated lagoon.

For a better understanding of the point i., I need the following additional information:
- the daily quantity and titre of the sodium sulphide used in the hide and skin unhairing;
- the quantity of air supplied by the blower.
I suggest to installe a pressure gauge on the blower out-let pipe and to measure the motor absorption. With these data we can calculate the quantity of the pumped air.

Note: the manufacturer ot the ATURIA blowers stopped the production and closed the factory years ago, so to get the technical data of the blower is difficult. In addition, the equipment has been locally restored and, so, its performances may be changed.

To explain the fact at point iii. is rather difficult:
I hope that the floating aerator is continuously operating (no stops at the night or during the week-ends)!

I would like that you start a systematic programme of plant controls:

Sulphide
(qualitative, using $FeSO_4$ as indicator)

1. at the out-let of the sulphide oxidation tanks
   3 controls per day (8 a.m., 12 a.m. and 6 p.m.)
2. at the out-let of the oxidation ditch
   3 controls per day (8 a.m., 12 a.m. and 6 p.m.)
3. at the out-let of the aerated lagoon
   3 controls per day (8 a.m., 12 a.m. and 6 p.m.).

pH
(pH indicator paper)
1. at the inlet and at the out-let of the oxidation ditch
   3 controls per day (8 a.m., 12 a.m. and 6 p.m.).

Setteable solids
(volumetric, ml/1 of sludge after 1 hour sedimentation)
1. mixed effluent of the oxidation ditch
   2 controls per week (Monday and Friday).

These controls must be carried out during a minimum period of 15 days and the daily data recorded.

As discussed, there are two possible treatment modifications:
- to try the oxidation in batch of the concentrated sulphide liquors. The diluted water will be by-passed directly to the primary sedimentation tanks and the oxidation ditch. The end of the oxidation process can be controlled with $FeSO_4$.
At the end of the process (no or little sulfide) the effluent must be pumped to the primary sedimentation tanks and, by gravity will flow into the oxidation ditch.
- to do the chemical flocculation after the oxidation ditch (i.e. before the secondary sedimentation tank).
The Alum must be dosed into the out-let channel (over-flow) of the ditch and the Polyelectrolyte in the influent well of the sedimentation tank. It is important that the two products be added successively (first the Alum).
The quantities may be the same used actually.

For the moment, I suggest you to try only the second alternative, controlling if the pH in the oxidation ditch remains near 7.

Please send me a.s.a.p. the requested information and let me know the results of the over-indicated controls.
Regards

Giuseppe Clonfero

ANNEX 2

BULLEYS TANNERY - Thika

PROPOSAL OF E.T.P. REHABILITATION

Foreward

The existing E.T.P. and its operation problems have been already described in the Technical report prepared by the expert on March 1991 for the Project US/RAF/88/100.(for details please see that paper.

In the meantime the factory with the assistance of a local engineering company, Surtech, has done some interventions on the plant. These interventions, essentially finalised to improve the pre-treatment of the trivalent Chrome effluents, resulted not properly designed and are causing some operating problems.

After screening (brushed screen) the Chrome effluent of the new tannery is treated with lime milk and settled into two 200 m^3 tanks with pyramidal bottom. Each tank has a capacity almost equal to the daily volume of the Chrome effluent. When a tank is full the effluent is by-passed to the adjacent tank. After an overnight sedimentation the supernatant is discharged by gravity and the Chrome hydroxide sludge sent to two drying beds newly constructed.

Unfortunately some operative problems exist:

- the lime milk dosage is done by dropping the product directly into the incoming effluent and mixing the liquor in a labyrint channel.

The control of the flocculation pH results very difficult.

- the slope of the bottom wall is inadequate (less than 30°) and, furthermore, due to an error in the calculation of the relative levels, the Chrome sludge cannot be discharged by gravity in the new sand beds.

Difficulty in the discharge of the settled solids.

In January 1992, Surtech prepared a design and cost estimates for upgrading the plant: phase I -improvment of the existing facilities- and phase II -implementation of new facilities (biological treatment) in order to satisfy the pollution control requirements-.

The factory managers estimated very expensive the proposed solution if compared with the cost of the E.T.P. istalled by UNIDO at Sagana tannery.

Furthermore, the poor results of the first plant's modifications done by Surtech have greately reduced the tannery reliance in this company.

For these reasons they turned to UNIDO for technical assistance.

Tannery data

- work days: 6 per week.
- capacity: 18,500 kg/day dry weight
  (11,000 + 7,500 -hides and skins respectively)
  i.e. 42,000-43,000 kg/day soaked weight.
- production: hides 80% wet-blue or crust,
  skins 100% wet-blue.
- process: standard process with pulp-unhairing (lime and sulphide) and Chrome tanning.
- effluent volume: 700 m^3/day (400 m^3/day from beamhouse and 280 m^3/day from tanning departments).
  See Note 1.
- recipient body: surface water (Thika river).
  See Note 2.

Note 1

These figures have been calculated by the factory production manager, Mr. R.Kinya. The water consumption results about 16-17 litres per kg of soaked weight (700,000:42,500=16.5).

The expert believes a minimal figure of 1,000 m^3/day ca. (20-25 l/kg) more prudent.

The conventional water consumption of 30 l/kg gives an effluent volume of 1,300 m^3 ca. (which was considered by Surtech in its project).

Note 2

The standards imposed by the Kenyan W.D.M.for the discharge in the Thika river are very strict (see the expert's previous report).

Proposed upgrading of the E.T.P.

In his design the expert has followed the one criterion of obtaining the maximum results with the existing facilities. The new interventions are limited to those facilities which,in his opinion, are strictly necessary to obtain this scope.
The full compliance with the standards requested by the Kenyan authorities is not the aim of this rehabilitation.At this stage the expert could hardly design a rehabilitation of the plant able to meet such strict standards.

The tannery effluents (both in the new and in the old departments) are divided in two separate lines: beamhouse and tanning. A third line can be obtained by by-passing part of the effluents that do not contain Chrome nor sulphide directly into the general pumping station.
The Chrome and sulphide pre-treatments are already designed with capacities nearly equal to the daily effluent volumes so that, in practice, we have two equalization tanks (beamhouse and tanning effluents). In these conditions, we must only obtain a regular mixing and distribution of these two lines to the general treatment.

Beamhouse effluent

The existing facilities consist of:

- n.1 grit trap.
- n.2 brushed screen working in parallel.
- n.3 pyramidal bottom tanks of 250 m^3 capacity each.
  Two tanks are equipped with n.2 floating aerators of 60 HP each and the third with a floating aerator of 15 HP.

The beamhouse effluents of the two tannery sections (new and old) are collected in one gully. After a simple treatment of grit removal the effluent is filtered (brushed screens) and discharged always by gravity into the sulphide oxidation tanks.
The three tanks are working in parallel, when a tank is full the operator manually by-passes the effluent into the successive.
The sulphide oxidation is done in batch without any catalyst: the aeration continues untill the sulphide are almost completely oxidised (no or little black color when the liquor is tested with Lead acetate or Iron sulphate)
The process runs well with the 60 HP aerators (the oxidation is ultimate in about 6-10 hours), whereas there are some problems with the 15 HP aerator (24 hours or more are required).

When the sulphide oxidation is completed, the aerator is switched off and the liquor settled for 2-3 hours.

Then the sludge is discharged into the drying beds and the supernatant tranferred to the pumping station.

Even in this case, because of too slight a slope of the bottom walls, big problems are encountered in the sludge discharge.

Furthermore, with the current system, these still highly polluted liquors are transferred to the general treatment all at once (all in one hour's time).

In these periods the general treatment receives high peaks of loading (BOD, COD, SS, etc.).

Suggested modifications

Note: a simple flow-sheet of the proposed modified treatment process is annexed.

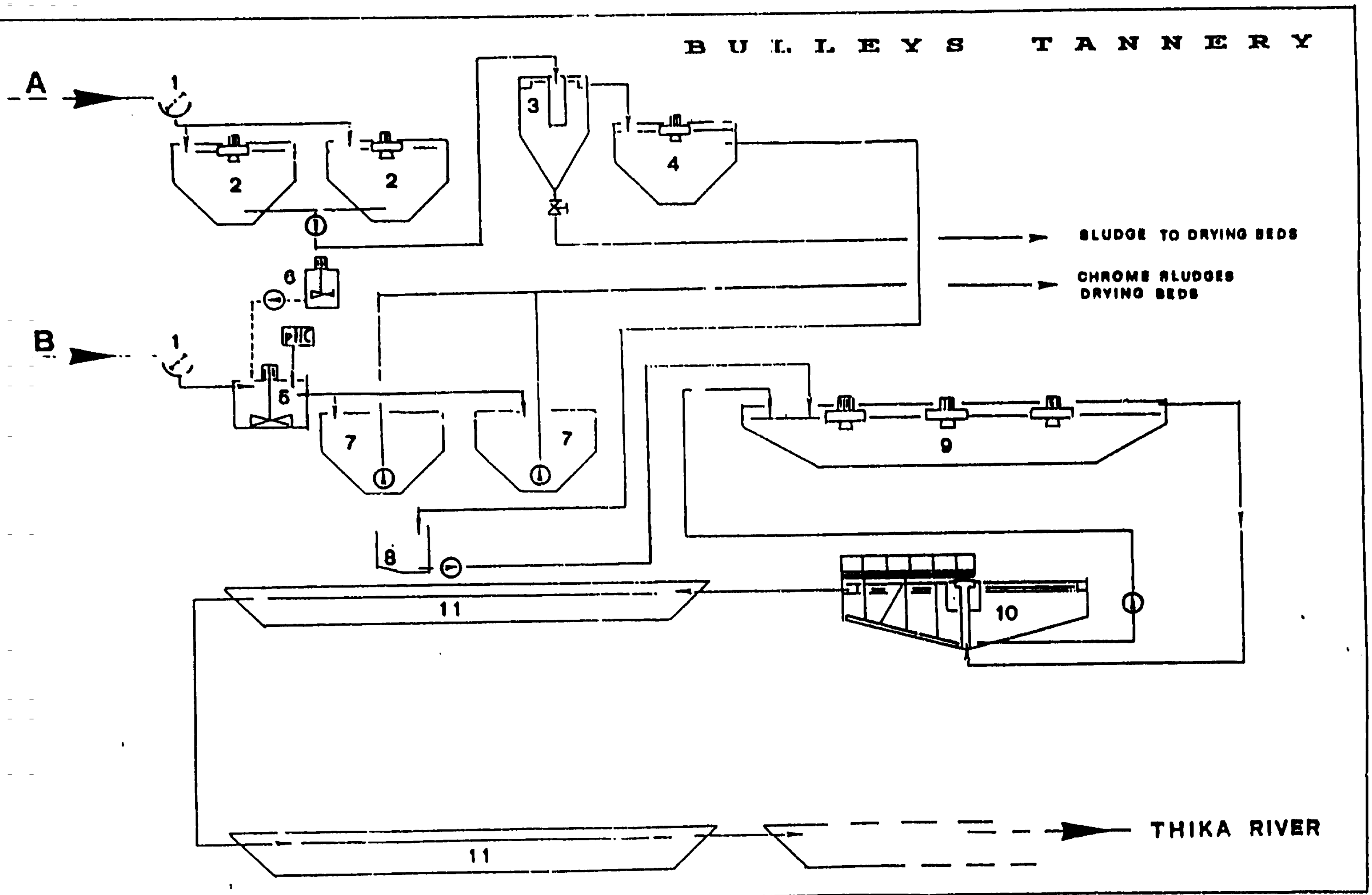
Currently there are two main discharge lines:

- the beamhouse wastes (A);
- the other department wastes (B);

Note that,currently, even effluents without sulphide nor chrome are discharged into these two lines. In the future, the manual by-pass of part of these effluents directly to the lifting tank may be advisable for reducing the volumes of the wastes that must undergo the pre-treatments.

Pre-treatment of liming liquors

After grit removal and screening (brushed screen) the liming wastes are collected in the two existing tanks (2) for undergoing the sulphide oxidation.


BULLEYS TANNERY
A
B
1
2
3
4
5
6
7
8
9
10
11
P/C
SLUDGE TO DRYING BEDS
CHROME SLUDGES
DRYING BEDS
THIKA RIVER

Two aerators of 60 HP each are installed in these tanks.

A dosage system for the catalyst, manganese sulphate, (not indicated in the flow-sheet) may be installed in the future if necessary.

The aerated liquor is successively pumped at costant flow to a static sedimentation tank type Dortmund(3) to be installed.

The settled sludge is periodically discharged and sent, by gravity or by using the existing sludge pump, to the drying beds.

The supernatant flows by gravity to the third existing tank (4) fitted with a 15 HP floating aerator.

The treated effluent is then pumped at constant flow to the pump sump (8) and to the successive biological treatment.

Pre-treatment of chrome wastes

The chrome wastes, after screening (brushed screen) are sent into a neutralization tank (5) in which lime milk is dosed by means of a pump driven by a pH-meter.

The mixed liquor cointaining flocks of chrome hydroxide flows into two sedimentation tanks (7) working in parallel.

When a tank is full, the incomimg effluent is by-passed to the adjacent tank and the first is maintained quiet to allow the chrome hydroxide's precipitation.

The chrome-free supernatant will be sent to the lifting tank (8) by gravity. The opening of the draw-off valves must be regulated for a slow and uniform discharge.

The settled chrome deposits are periodically discharged (by a submersible pump) into the new installed drying beds.

Pumping

The sulphide and chrome wastes, after pre-treatment, and the by-passed effluents are collected in the pump sump and lifted to the biological treatment.

Biological treatment

The entire existing tank (9) will be used as an aeration basin for the biological treatment.

The existing internal baffle will be removed.

The three installed floating aerators of 20 HP each will supply the oxygen necessary for the biological process.

The mixed liquor (water and biological sludge) will flow by gravity in the secondary sedimentation tank (10).

Due to the size of this plant, the expert has proposed a circular tank (type Dorr) with a mechanical scraping facility for the sludge.

The settled sludge will be continuously recycled (cetrifugal pump) in the aeration basin.

The excess of the biological sludge will be periodically discharged in the adjacent drying beds.

In the future, it is foreseen that the supernatant from the biological treatment will flow by gravity into a series of facultative lagoons (11) for the final polishing. The number and dimensions of these lagoons will be defined in the second phase of the plant's rehabilitation, when the first is in operation and its efficiency known.

Indicative list of the civil works and equipment:

Pre-treatment of liming wastes

n.2 (1+1 standby) horizontal centrifugal pumps, capacity 600 l/min.ca.; **indicative price: 4,200 U.S.Dollars**

n.1 sedimentation tank (type Dortmund) in concrete, useful volume 60 m^3 ca., indicative dimensions m 5x5x2 H + tronco-pyramidal bottom sloped at 60°. The tank will be constructed with the vertical wall above ground level. **Indicative price: 5.000 U.S.Dollars**

n.1 dosing unit for manganese sulphate (optional), constituted by 500 l vessel in polythene, fast stirrer with shaft and paddles in stainless steel and dosing pumps (1+1) in stainless steel or PVC, capacity 0-50 l/h. **Indicative price: 5,000 U.S. Dollars**

Pre-treatment of chrome wastes

n.1 fast mixer for the neutralization tank, shaft and paddles in stainless steel AISI 304. INDICATIVE PRICE : 2,000 U.S. DOLLARS

n.1 pH-meter on-off action with probe holder and glass/calomel electrode; indicative price: 2,200 U.S. Dollars

n.1 fast mixer for the preparation of the lime milk, shaft and paddles in stainless steel AISI 304; indicative price: 2,800 U.S. Dollars

n.1 tank for the preparation of the lime milk; this tank may be in concrete or other material;

n.2 (1+1 standby) centrifugal pumps for the dosage of lime milk, capacity 50 l/min. ca. Indicative price: 2,400 U.S. Dollars

n.2 (1+1 standby) submersible pumps, capacity 600 l/min.ca.; Indicative price: 4,000 U.S. Dollars

Biological treatment

n.1 circular sedimentation tank in concrete (Dorr type),300 m^3 ca useful volume, indicative dimensions : 18 m diameter and 1,5 m height . The tank will be partially underground.

n.1 sludge scraping devices, half bridge with peripherical driving, for circular secondary sedimentation tank of 18 m. diameter. Peripherical speed 2,5 m/min. ca.; installed power 0,5 kW ca.

Structure in hot galvanized steel. Complete of influent wheel, overflow weir and other accessoires.

Indicative price: 20,000 U.S. Dollars

n.2 (1+1 standby) centrifugal pumps for the recycling of the biological sludge, capacity 1000 l/min. ca.

Indicative price: 5,200 U.S. Dollars

ANNEX 3

CALCULATION OF THE SALINITY CONTENT IN THE EFFLUENT OF KEMBE TANNERY

TANNERY DATA

- capacity:	200 (max. 300) hides 20 kg/p green
- production:	currently 100% wet-blue, in future also finished for local market
- process:	fleshing in green, soaking, pulp-unhairing (lime and sulphide), pickling (6% NaCl on the pelt weight), chrome tanning, etc.
- effluent volume:	100 (max. 150) m^3/day

Note: currently about 60 hides per day, coming from the adjacent slaughterhouse, are green and the remaining are wet salted. To avoid the high cost of the salting (NaCl is imported), the tannery started (seemingly with success) an alternative short term curing test using biocides and boric acid. The aim is to give the distant slaughterhouses the chemicals to have a less expensive way of curing and storaging the hides and to reduce the transport costs.
At the moment an important part of the hides produced in distant villages are lost because their conservation and transport to the tannery result uneconomical.

CALCULATION OF THE TOTAL DISCHARGED SALT

The max. future production is 300 hides per day that gives 8000 kg ca. of pelt weight.

The quantity of NaCl used in picking results (8000 x 6 : 100) 480 kg per day, i.e. (480 : 58.5 x 35.5) 290 kg/day ca. of Cl^-.

290000 : 150 = 1930 mg/l of Cl^- in the mixed effluent (say 2000 mg/l ca. considering some salinity in the underground water).

This chloride content is too high to make the undiluted effluent usable for irrigation. Excessive salinity reduces a plant's osmotic activity and so prevents its absorption of both water and nutrients from the soil (salinity hazard to the crop).

Furthermore sprinkler application of salty water can cause leaf burning.

Quality of water for irrigation (Ayers, R.S.)

	No problem	Increasing problems	Severe problems
Chloride, mg/l	< 142	142 - 355	> 355

Ayers indicates a tolerance (no yield decrement expected) to salinity in irrigation water of 3.1 and 2.5 mmho/cm for wheat and soybean respectively. I.e. 3.1 x 640 = 1984 and 2.5 x 640 = 1600 mg/l of TDS.

Note: Salinity is generally measured by the water conductivity in micromhos per cm. The electrical conductivity may be approximately conversed to mg/l of Total Dissolved Solids, TDS, by multiplying mmho by 640.

The UNEP Technical Report n.4 "Tanning and Environment" reports the following maximum levels as a very general guide:

- Total dissolved salts 500 mg/l (*)
- Sodium Absorption Ratio 5
- pH 4.5 - 9
- Chromium 0.1 mg/l or 50 g/ha total mass
- Toxicants (e.g. fungicides) absent.

(*) This value seems very low.
Drinking water standards recommend that finished potable water contain less than 500 mg/l TDS but more saline waters have been used with no negative effects.
Salinity effects are generally a concern only in the arid regions where accumulated salts are not flushed from the soil profile by natural precipitation.

In the case of Kembe tannery, we have calculated 2000 mg/l of chloride and we can assume 1200 mg/l of sulphate (this is the normal content in the tannery effluent).

So we obtain [(2000 : 35.5 x 58.5)+(1200 :96 x 142)] = 5070 mg/l of TDS (sodium chloride + sodium sulphate).

Note: 35.5 and 96 are the atomic and molecular weights of Cl and SO_4 respectively and 58.5 and 142 are the molecolar weights of NaCl and Na_2SO_4.

According with the strict UNEP standards, the theoretical necessary dilution is about 1:10.

During the wet season in Zambia about 780 mm of rain fall.

This quantity on the pond surface represents 6300 m^3 ca. of water.

Considering 4 months we can expect (150 x 25 x 4) 15000 m3 of effluent at the max. tannery production.

So in the wet season (no irrigation) the chloride content of the pond or in the leachate water is about 1360 mg/l very close to the common limits for discharge adopted in many Countries (1000-1500 mg/l).

The adjacent slaughterhouse discharge ca. 60 m^3/day of effluents which, after sedimentation in an anaerobic pond, are evaporated/soil-infiltrated in a second pond. At the moment no water is discharged from the last pond but if this water will be mixed with the tannery effluent the chloride content can be further reduced to about 1500 and 1100 mg/l, dry and wet season respectively.

In the dry season the crops are irrigated with underground water. According to the received information, the irrigation hydraulic rate is 0.9 cm/h and n.2 sprinkler distribution systems are used (irrigating 0.6 hectares each) with one week cycles. In total 40 m^3/h of water per hectare are required therefore 1200 m^3/day are needed to irrigate the 30 hectares of the farm.
When 300 kg ca. of chloride are diluted in this volume of water (300000 : 1200) 250 mg/l ca. of Cl^- are obtained.
The calculated TDS, i.e. 760 kg/day ca. (5070 mg/l x 150 m^3 : 1000) will be diluted to 633 mg/l ca. (760000 : 1200).
This value results reasonably close to the tolerance data of both Ayer and EPA.
The expert's opinion is that in the Kembe situation the use of the tannery effluent for irrigation is possible.
In the wet season, the natural precipitation (234000 m3/y of rain) will flush off any residual salinity from the 30 cultivated hectares.
In any case the here proposed pre-treatment of evaporation of the tanning liquors will further reduce the discharged salinity.

REFERENCE

Process Design Manual for Land Treatment of Municipal Wastewater

Published by U.S. Environmental Protection Agency (EPA)

- October 1981 -.