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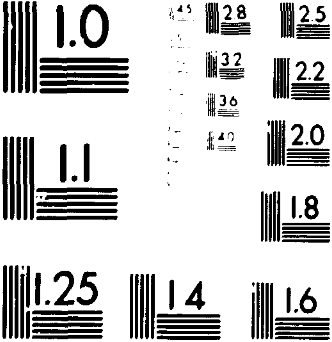

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

14085

STUDIO TECNICO
Dr. GIUSEPPE CLONFERO
Florence (Italy)

Project US/BRA/80/166
Contract N. 82/105/MK

United Nations Industrial Development Organization
U.N.I.D.O.

Officier-in-Charge, Purchase and Contract Service
Industrial Operations Division

Vienna International Centre
A-1400 VIENNA (Austria)

Brazil.

ASSISTANCE IN THE ESTABLISHMENT AND OPERATION OF A PILOT AND DEMONSTRATION PLANT FOR TANNERY EFFLUENTS TREATMENT AT ESTANCIA VELHA, RS BRAZIL

Final Report

Notice :
Based on work of Messrs. G.Clonfero, P.Nini and E.Rietti

July 1984

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English

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SUMMARY

Project

This Report contains the most significant results of the activity undertaken in accordance with UNIDO Contract No. 80/166/MK carried out during the period from February 1983 to June 1984 by our team in strict collaboration with Mr David Winters UNIDO Chief Technical Adviser (C.T.A.) and the Brazilian Counterparts.

The goals achieved according to the aims of the Project can be summarised as follows:

i) From the tests carried out at the pilot plant at Estancia Velha it has been proved that the limitations imposed on tannery effluents by the Departamento do Meio Ambiente (D.M.A.) in Rio Grande do Sul can be reasonably obtained using primary treatment followed by secondary treatment.

These limitations are:

- BOD_5	=	60 mg/1
- Sulphide	=	1 mg/1
- Cr III°	=	1 mg/1
- Oil and Grease	=	20 mg/1

In fact, with reference to the data obtained from the biological treatment which operated for a longer period of time (extended aeration with oxidation ditch), the following average values were obtained:

- BOD_5	< 30 mg/1
- Sulphide	absent or traces
- Cr III°	< 0.2 mg/1
- Oil and Grease	non determinable (^)
- Settleable solids	< 1 ml/1

Note (^): This analysis when applied to tannery waste waters gives imprecise and unreproducible data (see our Interim Report).

With regard to the biological treatment, it must be pointed out that the various experimental techniques are given, expecially in BOD reduction, efficiencies better than those obtained in similar plants in Italy. This is due, very probably, to the better climatic conditions (temperature) existing.

ii) During this time we had the possibility of offering substantial consulting services to tanneries in .R.S. and other States.

We must underline that after the "open week" in March 1984 the Project's activity in this field has increased remarkably due to the number and frequency of the requests for technical assistance from tanneries located often very far from Estancia Velha. This means that the Project not only is wellknown but also has obtained the trust of the tanneries.

iii) The collaboration between D.M.A. and the Project was very good and useful for both.

iv) We undertook a series of practical theoretical courses for the counterpart, D.M.A. and other Government bodies.

v) The training of the Brazilian Counterpart Staff assigned to the Project was completed, obtaining a high level of competence.

vi) An information and dissemination programme was established so that the results of the pilot plant and the treatment technologies utilized could be available to most of the Brazilian leather industry.

This was achieved by direct contacts, lectures and practical demonstrations.

Main aims

We believe that the major objectives of the Project have been achieved and that we have fulfilled our assignment. However, due to some external factors the programme was slightly delayed (see our preceding reports) and some important areas (joint plant at Estancia Velha, final sludge disposal etc.) still require further inputs.

1. BACKGROUND INFORMATION AND CONTRACTUAL DUTIES

1.1 Background information

The project US/BRA/80/166, "Assistance in the establishment and operation of a pilot demonstration plant for tannery effluents treatment" at Estancia Welha, RS, was proposed based on the findings and recommendations of Mr David Winters, UNIDO C.T.A. and afterwards Project Coordinator. The project was approved for financing from UNIDF funds under a special purpose donor contribution by the Italian Government.

The immediate objective was to establish a pilot demonstration plant for tannery effluent treatment in Brazil which is capable of:

- assisting the Brazilian tanning and allied industries to obtain reduction in the levels of pollutants of their effluent; to achieve the "norms" promulgated by the competent local authorities;
- assisting both the local authorities and the tanning industry in the preparation and evaluation of the technically feasible projects necessary to achieve such lessened pollution at minimal economic cost;
- evaluating, under local conditions, the cost effectiveness of a variety of effluent treatment techniques;
- conducting a systematic programme of training to develop a cadre of qualified personnel in this field;
- carrying out a programme of applied research in the treatment of tannery wastes and the economic recovery of materials from such wastes;
- initiating a programme of demonstration, extension services and dissemination to ensure that all sectors of the leather industry in Brazil (and the entire Latin American region) are able to obtain up-dated technical and economic information relating to the introduction of better environmental processes (recycling and other means) and the treatment of tannery

wastes (aqueous and solid);

- liaising between local authorities and tanners to ensure that the Government's ultimate objectives are understood by the industry.

UNIDO confirmed the selection of The Studio Tecnico Dr. G. Clonfeto, Florence, Italy on 25.1.83 to furnish an expert staff who would give technical and organizational assistance to this project during the course of 16 months from February 1983 to June 1984.

The team consisted of 3 Italian technicians, specialized in treatment of tannery effluents:

- Mr. Giuseppe Clonfero : Chemist (Team Leader)
- Mr. Piero Nini : Chemist
- Mr. Eugenio Rietti : Chemist

1.2. Contractual duties

In accordance with the UNIDO contract N. 80/166/MK, in order to achieve the Project objectives, our studio supplied the following services:

Project Area Services

Eighteen and a half (18.5) man-months of service were carried out in the Project Area by the Italian team as follows:

- Mr. G. Clonfero 4.5 months
- Mr. E. Rietti 8.0 months
- Mr. P. Nini 6.0 months

Home Office Service and Support Service

Further three and a half (3.5) months were spent at Home Office preparing the work, back-stopping support to the Subcontractors personnel in the Project Area and the preparation of the Reports.

Reports

The Studio has submitted to UNIDO, before this Final Report, the reports which are listed below:

a) Work Plan and Interim Report dated May 1983

b) First Progress Report dated August 1983

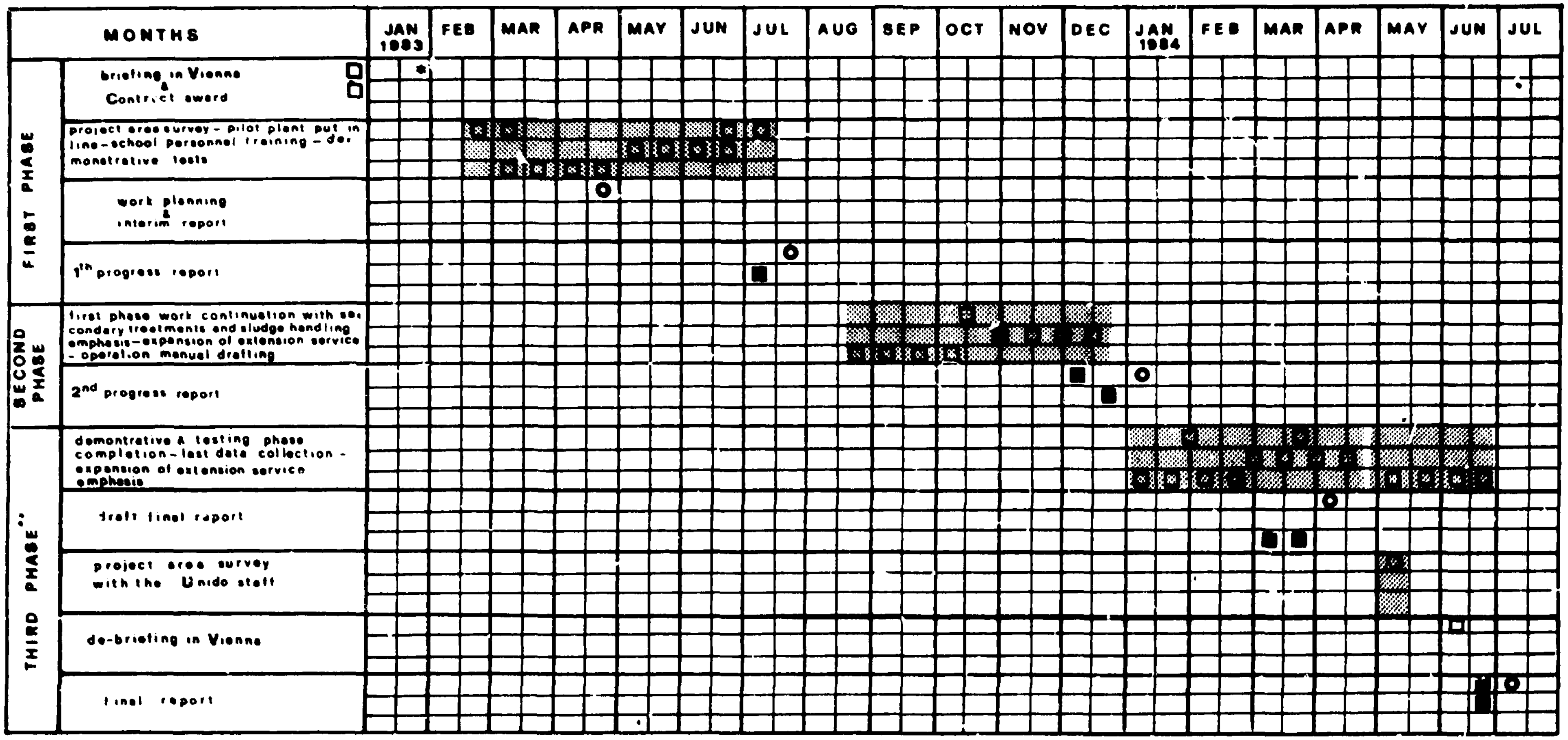
c) Second Progress Report dated January 1984

d) Draft Final Report dated May 1984.

The most significant and important parts of these Reports are al so reported herein.

(The work plan is reported at Annex 1/I)

WORK PLAN



**to be defined

- team leader
- technician A
- technician B
- project area service
- report
- home office service

date MAY 1983

UNIDO-VIENNA

CONTRACT N°82/105/MK

PROJECT N°US/BRA/80/166

STUDIO TECNICO DR. CLONFERO
(FLORENCE ITALY)

2. PILOT PLANT

2. PILOT PLANT

2.A. Pilot Plant Commissioning

- Introduction

A project was devised for a pilot and demonstration plant to be installed at the Escola de Curtimento SENAI (Tannery School) at Estancia Velha. The main operative lines were implemented after examination of data on the various techniques of treatment and after investigation of the varying technologies used mainly in Europe.

This part of the Project, together with the choice and type of equipment and the necessary facilities was made before the intervention of our Studio, by other UNIDO Specialists.

This method was adopted by UNIDO so that technicians who were specialists in the treatment of tannery wastes would not be influenced unwittingly in the design layout on the plant by their personal experience and previous methods of working.

In fact the pilot plant demonstrates various treatment techniques so that the Brazilian counterparts can evaluate the differences in the functioning of these varying methods and their adaptability to suit the local situation.

The Tannery School could not produce for the tests a constant and representative supply of tannery waste due to their erratic and diverse workload, and the modest volume of effluents produced.

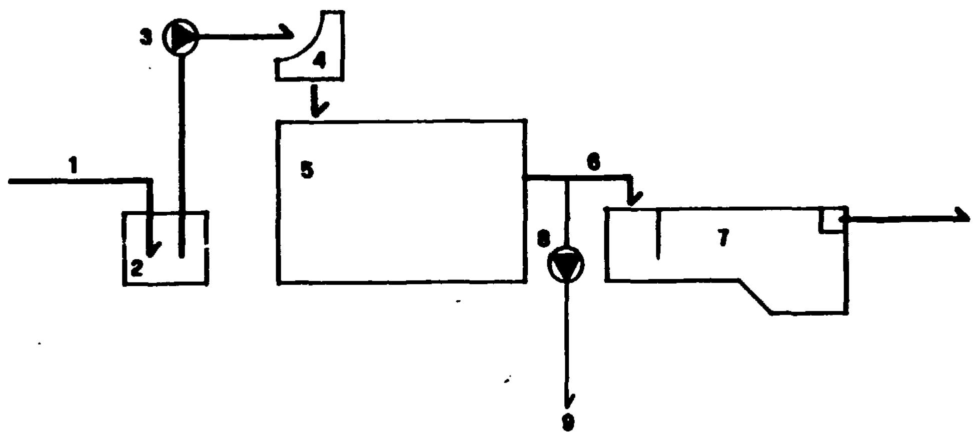
This difficulty was solved by using part of the wastes of a tannery situated near the School; the water was collected by installing a pump on the outflow of the tannery equalization tank (the system of collection is indicated in Figure 1).

2.A.1 - Pilot Plant Facilities

The layout of the pilot plant is reported in Figure 2.

The pilot plant is equipped with the following systems:

WASTE WATER FROM THE EXTERNAL TANNERY COLLECTION SYSTEM



Legend :

1 : tannery waste waters
2 : lifting tank
3 : lifting pump
4 : screen
5 : equalization tank
6 : equalization tank outlet
7 : horizontal sedimentation tank
8 : feeding pump
9 : Pilot Plant at Estancia Velha

FIGURE 1

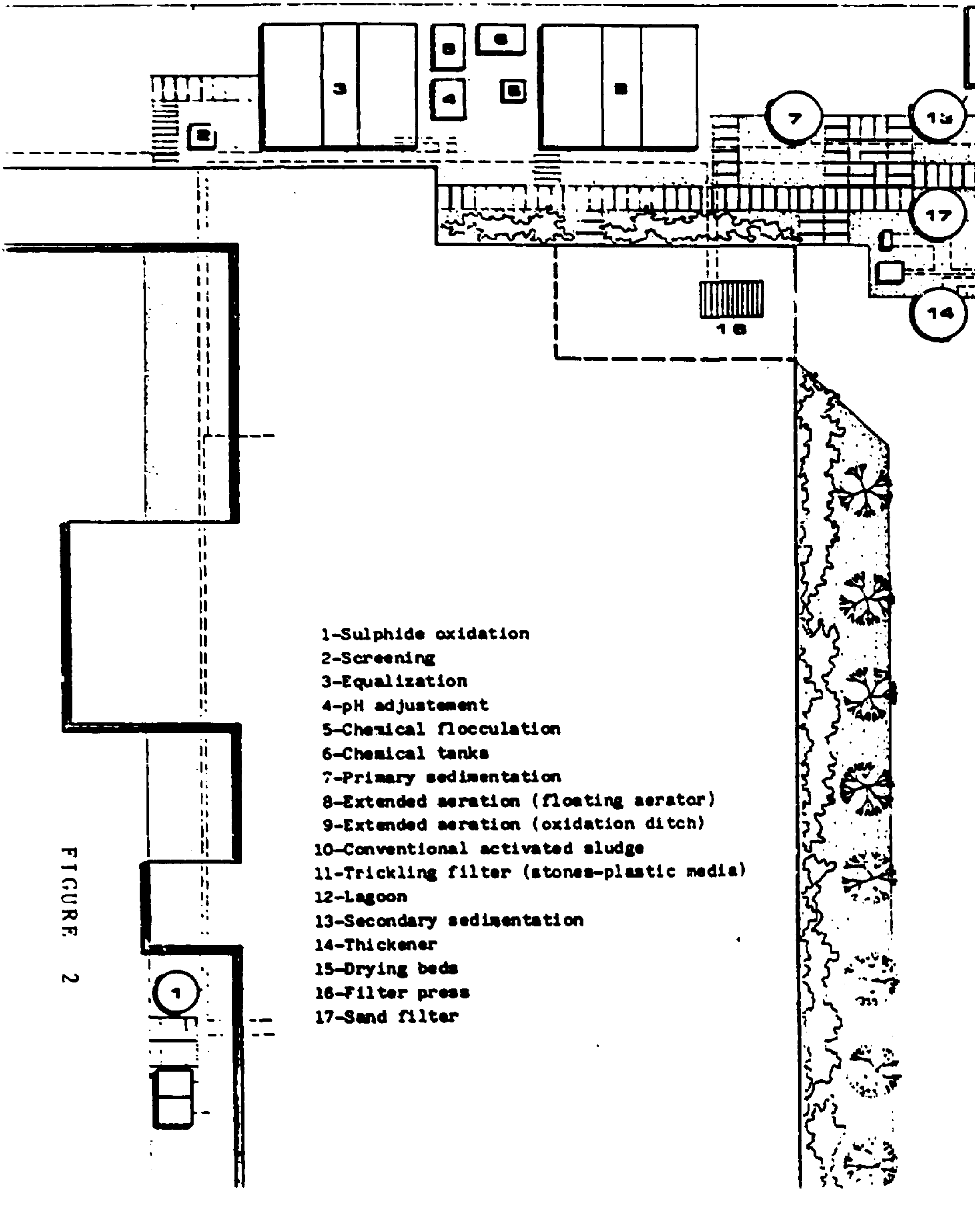
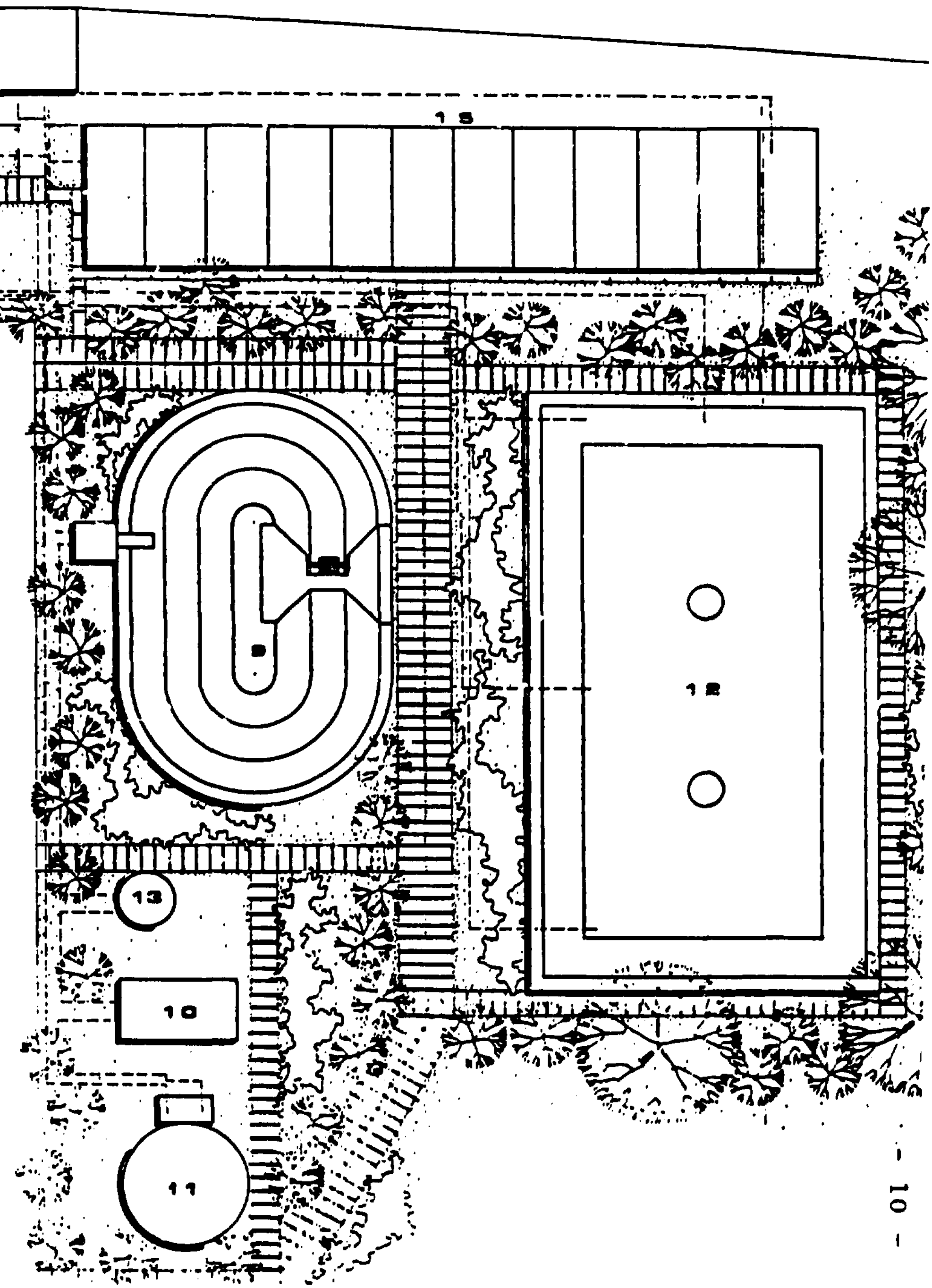

1-Sulphide oxidation
2-Screening
3-Equalization
4-pH adjustement
5-Chemical flocculation
6-Chemical tanks
7-Primary sedimentation
8-Extended aeration (floating aerator)
9-Extended aeration (oxidation ditch)
10-Conventional activated sludge
11-Trickling filter (stones-plastic media)
12-Lagoon
13-Secondary sedimentation
14-Thickener
15-Drying beds
16-Filter press
17-Sand filter

FIGURE 2


15
12
13
10
11

a. Catalytic oxidation of lime baths and protein precipitation.

b. Chrome recovery and recycle.

c. Primary Treatment (Physico-chemical treatment):
   - Screening
   - Equalization
   - PH adjustment
   - Chemical coagulation and flocculation
   - Primary sedimentation.

d. Secondary Treatment (Biological treatment):
   - Extended aeration (oxidation ditch-floating aerator)
   - Trickling filter (stones-plastic media)
   - Lagoon (aerated-falcultative)
   - Conventional activated sludge
   - Secondary sedimentation (2 tanks).

e. Sludge Treatment:
   - Thickener
   - Drying beds
   - Filter press.

The possible alternative treatments that can be operated are described in the annex flow charts.
Furthermore some tertiary treatments (chlorination and sand filtering) are foreseen for the next stage of operations.

- 2.A.2 - Pilot Plant Operative Steps

Period from February to July 1983

During this initial period, as reported in the Interim Report dated May 1983, the Italian staff was occupied in rendering the plant operative and also in overcoming some problems and external delaying factors such as:
- non availability of some of the imported equipment;
- lack of qualified Brazilian personnel for electrical and hydraulic assembly and connection;
- the need to augment the School influent waste flow to suit test requirements;

- the need to organize the chemical laboratory and to establish the various methods of analysis.

At the end of this period the functional systems were as follows:

a. Primary Treatment (including sulphide oxidation in homogenization);
b. Secondary Treatment (oxidation ditch and extended aeration with floating aerator);
c. Sludge Treatment (filter-press and drying beds).

Additionally, the laboratory was in a position to carry out the required chemical analysis.

Period from August 1983 to February 1984

In this second period, as well as testing the treatments previously functioning, the following systems were made operational:

a. Trickling filter (plastic media);
b. Biological Treatment without primary sedimentation (batch system);
c. Chrome recovery and re-use;
d. Elimination of sulphide from unhairing effluents and protein precipitation.

Period from March to June 1984

During the latter period, as well as continuing the control of some treatment tests already operational, the following treatments will be studied:

a. Trickling filter (crushed stones);
b. Conventional activated sludge;
c. Aerated lagooning.

Further tests were also effected on several of the systems at different hydraulic and organic loads.

2.B. Pilot Plant Experimental Results

- Introduction

To ensure that the waste on which we were to operate would be representative, an investigation was made inside the tannery itself to evaluate the production cycles and analytical data of these wastes compared with those of other Brazilian tanneries. The proces cycles of the tannery under examination and the comparison with data of other tanneries and with the literature data are indicated in Annexes 2/VI and 2/VII.

In comparing this data, agreement in the values is noted and, therefore, we have concluded that the characteristics of the waste water entering the pilot plant are sufficiently representative of the local situation. Some of the differences noted can be imputed to the collection system which is obviously not proportional to the tannery effluent flow and in the inability of the tannery equalization tank to ensure complete homogenization of wastes.

In particular the lower than normal COD and settled solids values are in our opinion due to the partial sedimentation of the effluent in the tannery equalization tank which does not have an efficient mixing system.

Analytical control of the influent waste water have been carried out periodically during the whole test period and the results have been constant.

2.B. Pilot Plant Experimental Performances

- 2.B.1 - Sulphide Oxidation

Introduction

The treatment of residual sulphides in the lime baths can be effected by precipitation or oxidation.

After an initial period of extensive use, the use of iron salts is today being abandoned due to the inconvenience caused by the presence of tannins and the high quantity of sludge produced.

Although it is possible to use chemical oxidants, such as NaClO or H_2O_2, due to high treatment costs, in general, they do not have a practical application.

The catalytic oxidation of sulphides with air in the presence of Mn^{++} salts is today the type of treatment most widely used.

It was therefore decided to effect a series of tests using catalytic oxidation, and two alternative methods were investigated:

a. by operating on the total effluent and on the equalized wastes also containing the lime baths;

b. by operating directly on the lime baths collected in a separate tank.

Both conditions were tested in the pilot plant.

Another system of eliminating the bulk of sulphide from waste water is that of re-cycling the lime baths.

This technique is already used by the School and other tanneries of Rio Grande do Sul with good results; for this reason we did not think necessary to make this type of test.

Sulphide removal in the equalization tank

- Description of the treatment (see Figure 3)

For these tests we used the effluent from the external tannery which does not effect any pre-treatment or separation of the lime baths. The waste water, after screening, flows into the equalization tank where aeration is carried out. The wastes are agitated and aerated by blowing air through twelve sintered alundum candle

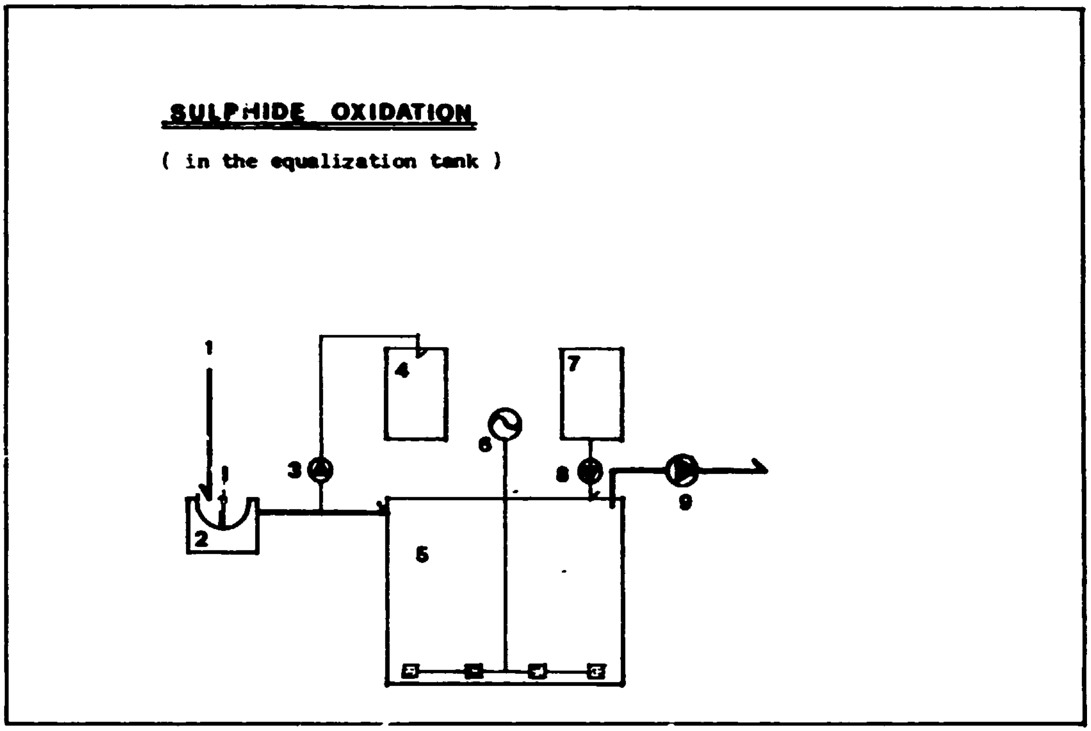


FIGURE 3

Legend :

1	: tannery waste water
2	: self-cleaning screen
3	: pump for influent sampling
4	: sample collection tank
5	: equalization tank
6	: air blower
7	: $MnSO_4$ solution storage tank
8	: dosing pump
9	: lifting pump

- - - - - - - - -

diffusers arranged on the bottom of the tank.
The characteristics of the blower and the diffuser are described in the attached Annexes, 2/VIII and 2/IX.
The oxidation catalyst, manganese sulphate, was added by means of a dosing pump directly into the equalization tank. The product was added continuously as the water to be treated was collected continually from the tannery with a constant flow pump.
Another pump then continuously transferred the treated water from this tank to the successive treatments.

- Operational performance of the test

All test were carried out in the same conditions, i.e.:

- Total air flow	: 170 Nm^3/h
- No. of candles installed	: 12
- Flow rate	: 14 m^3/candle per hour
- Average depth of liquid in the tank	: 1.2 m
- Average volume of the liquid in the tank	: 30 m^3
- Specific air flow	: 6.8 m^3/h per m^2 of tank 5.6 m^3/h per m^3 of tank (average)
- Raw influent flow	: 6 m^3/h (8 h per day)
- Treated effluent flow	: 2 m^3/h (24 h per day)
- Average retention time during the oxidation tests	: 7 h
- Catalyst employed	: commercial manganous sulphate monohydrate (titre 99%) (i.e. 32% Mn^{++} weight)
- Quantity of catalyst added	: 20 mg/l as Mn^{++} on the influent flow (i.e. 120 grams of Mn^{++} per hour).

- General procedure

Two different series of tests have been carried out.
In test I we compared the values of the sulphide concentration in the aerated equalization tank with the values we would have had

in the same condition without aeration. To obtain this we installed a pump which continually collected a constant portion of the incoming raw water and sent it to a collection tank. An analysis of the homogenized water in the collection tank was made every hour and compared with that of the aerated equalization tank.
In test II we compared the values of the sulphide concentration in the aerated equalization tank with the average hourly sulphide values in the influent.
After the sample for analysis had been taken, i.e. every hour, the remaining waste water was discharged.

- Test results

The results obtained from the twelve experiments are summarized in TABLE 1 (test I) and TABLE 2 (test II).

- Comments

i) In the test conditions the addition of 20 mg/l of Mn^{++} in the aerated equalization tank has shown an ability to reduce sulphide concentration:
- in the test I the reduction was 89%, from an average input value of 44 mg/l to an average output value of 4.8 mg/l (with values in output higher than 10 mg/l on a total of 36);
- in the test II the reduction was 88%, from an average input value of 70 mg/l to an average output value of 8.4 mg/l (with 11 values in output higher than 10 mg/l on a total of 36).

ii) In any case the residual concentration of sulphide does not seem to have affected the biological treatments (see the chapter on Secondary Treatments).

iii) In the test conditions about 3 Kg of O_2 were supplied per hour with a theoretical transfer efficiency for the diffusers of 7%. The ratio O_2 supplied treated sulphides was therefore of 11 kg O_2/Kg $S^=$ (test I) and of 7 Kg O_2/Kg $S^=$ (test II) against the theoretic 0.75 Kg O_2/Kg $S^=$ according to the reaction:

TABLE 1

Test I series : the data of the effluent treated are compared with those of the non aerated homogenised influent (simulated with sampler);see also attached graph.

Test N.1	Sample time	Influent		Effluent	
		pH	$S^=$mg/l	pH	$S^=$mg/l
	9 a.m.	8.8	58	8.4	1.6
	10 "	9.3	77	8.4	-
	11 "	9.4	109	8.3	-
	2 p.m.	9.6	49	9.2	3.2
	3 "	9.4	37	9.3	3.2
	4 "	9.3	26	9.0	1.6

Test N.2	Sample time	Influent		Effluent	
		pH	$S^=$mg/l	pH	$S^=$mg/l
	9 a.m.	8.8	26	8.3	1.6
	10 "	8.8	29	8.3	3.2
	11 "	9.2	38	8.5	3.0
	2 p.m.	9.3	25	8.6	-
	3 "	9.1	32	8.7	-
	4 "	9.1	24	8.8	1.6

Test N.3	Sample time	Influent		Effluent	
		pH	$S^=$mg/l	pH	$S^=$mg/l
	9 a.m.	9.1	32	9.2	6.4
	10 "	9.2	48	9.3	24.0
	11 "	9.3	38	9.3	19.2
	2 p.m.	9.2	34	9.4	12.8
	3 "	9.5	32	9.5	-
	4 "	9.4	20	9.6	-

Test N.4	Sample time	Influent		Effluent	
		pH	$S^=$mg/l	pH	$S^=$mg/l
	9 a.m.	9.0	58	8.3	3.2
	10 "	9.3	53	6.8	-
	11 "	9.2	26	6.9	-
	2 p.m.	9.0	16	8.0	-
	3 "	9.0	29	8.1	-
	4 "	8.7	13	8.2	-

Test N.5	Sample time	Influent		Effluent	
		pH	$S^=$mg/l	pH	$S^=$mg/l
	9 a.m.	8.9	67	8.5	-
	10 "	8.9	59	8.7	-
	11 "	9.0	66	8.8	-
	2 p.m.	9.1	43	8.9	-
	3 "	9.0	45	8.9	4.8
	4 "	8.9	35	8.8	2.9

Test N.6	Sample time	Influent		Effluent	
		pH	$S^=$mg/l	pH	$S^=$mg/l
	9 a.m.	9.2	83	9.2	11.0
	10 "	9.4	78	8.5	17.5
	11 "	9.3	69	8.3	15.9
	2 p.m.	9.4	62	8.2	13.0
	3 "	9.2	49	8.0	11.8
	4 "	8.9	28	8.0	8.8

note: - means traces

Test I Series - graphical representation

---------- influent
———— effluent

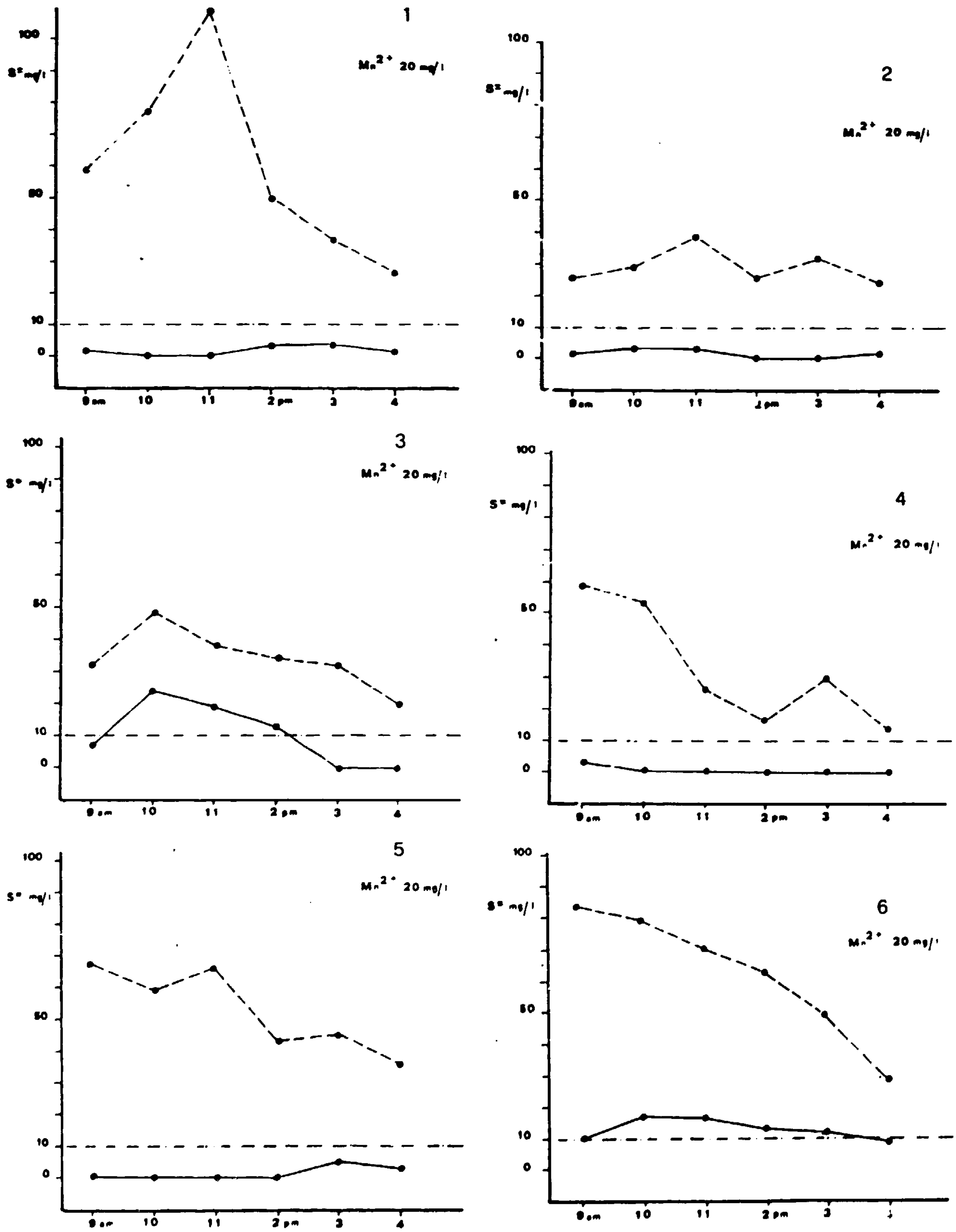


TABLE 2

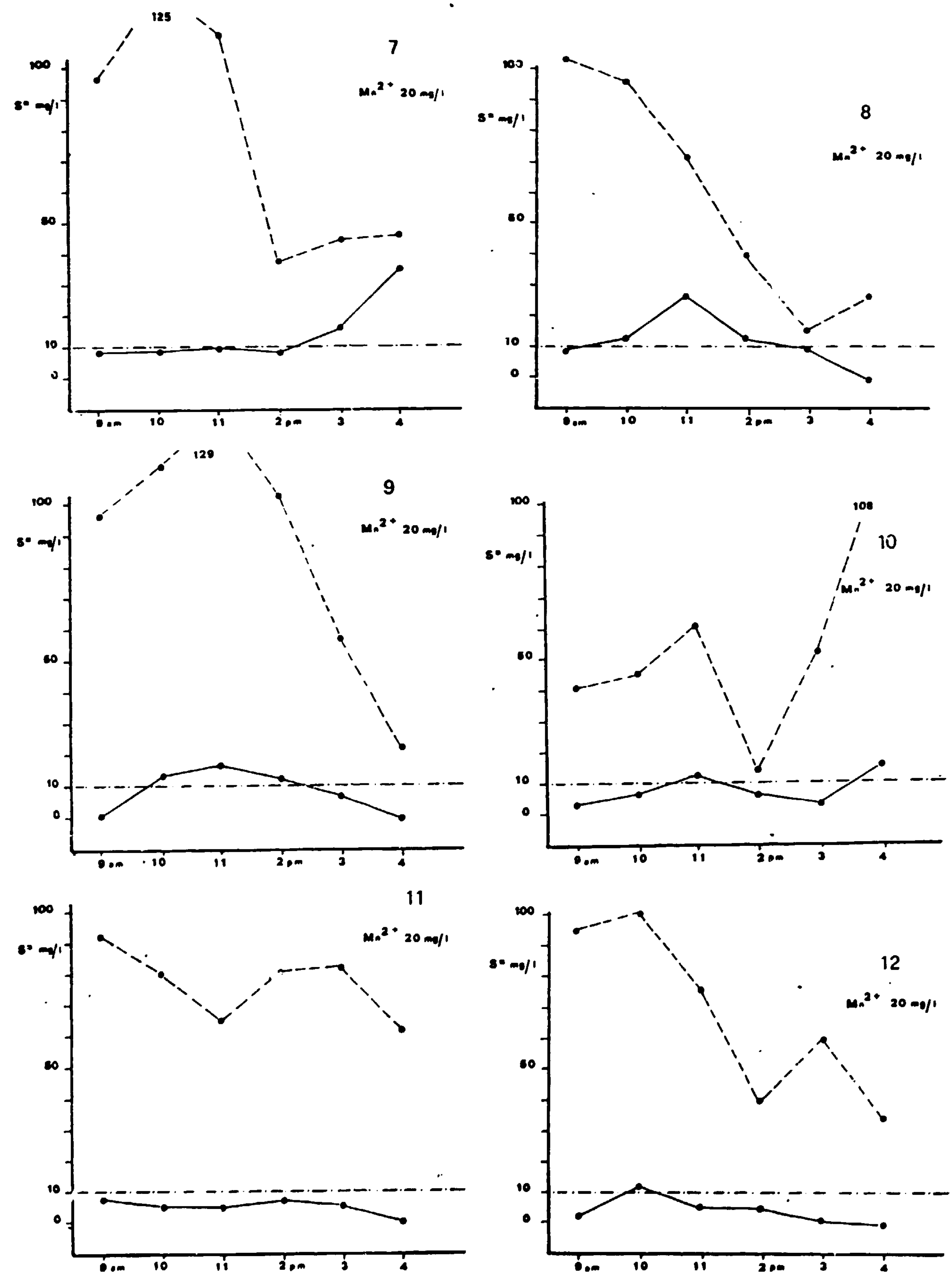
Test II series : the data of the treated effluent are compared with average hourly values of the raw influent ; see also attached graph.

Test	Sample Time	Influent pH	Influent $S^{=}$ mg/l	Effluent pH	Effluent $S^{=}$ mg/l
Test N.7	9 a.m.	8.9	96	8.2	8.0
	10 "	9.2	125	8.5	8.5
	11 "	9.0	110	7.4	9.6
	2 p.m.	8.0	38	8.5	8.0
	3 "	9.0	45	6.6	16.0
	4 "	9.4	46	6.6	36.0
Test N.8	9 a.m.	8.3	103	8.0	8.8
	10 "	8.8	96	8.2	12.8
	11 "	8.7	72	8.1	27.0
	2 p.m.	9.0	40	8.2	13.0
	3 "	8.3	16	8.1	9.7
	4 "	8.7	27	8.3	-
Test N.9	9 a.m.	8.4	96	7.9	-
	10 "	8.4	112	8.1	12.8
	11 "	8.5	129	8.3	16.4
	2 p.m.	8.0	103	8.6	11.9
	3 "	8.8	58	8.8	6.9
	4 "	7.5	23	8.5	-
Test N.10	9 a.m.	8.7	40	8.2	2.3
	10 "	8.5	44	8.7	5.7
	11 "	8.9	60	8.7	10.2
	2 p.m.	8.3	17	8.5	5.6
	3 "	9.2	53	8.7	3.2
	4 "	9.1	108	8.8	15.0
Test N.11	9 a.m.	8.8	92	8.7	7.2
	10 "	8.8	80	8.5	5.0
	11 "	8.9	65	8.5	5.0
	2 p.m.	8.9	81	8.5	7.0
	3 "	8.9	82	8.7	5.0
	4 "	8.5	62	8.7	-
Test N.12	9 a.m.	9.7	95	8.8	2.0
	10 "	8.3	102	8.6	12.0
	11 "	8.9	76	8.6	5.0
	2 p.m.	8.0	40	8.0	5.0
	3 "	8.0	60	7.7	2.0
	4 "	6.9	35	7.8	-

note : - means traces

Test II Series - graphical representation

---------- influent
―――――― effluent



$$4\,S^{=} + 3\,O_2 \longrightarrow 2\,S_2O_3^{=}$$

This is due to the necessity of supplying a major quantity of air to guarantee a sufficient homogenization of the liquor.

Sulphide removal in separate unhairing bath and protein precipitation

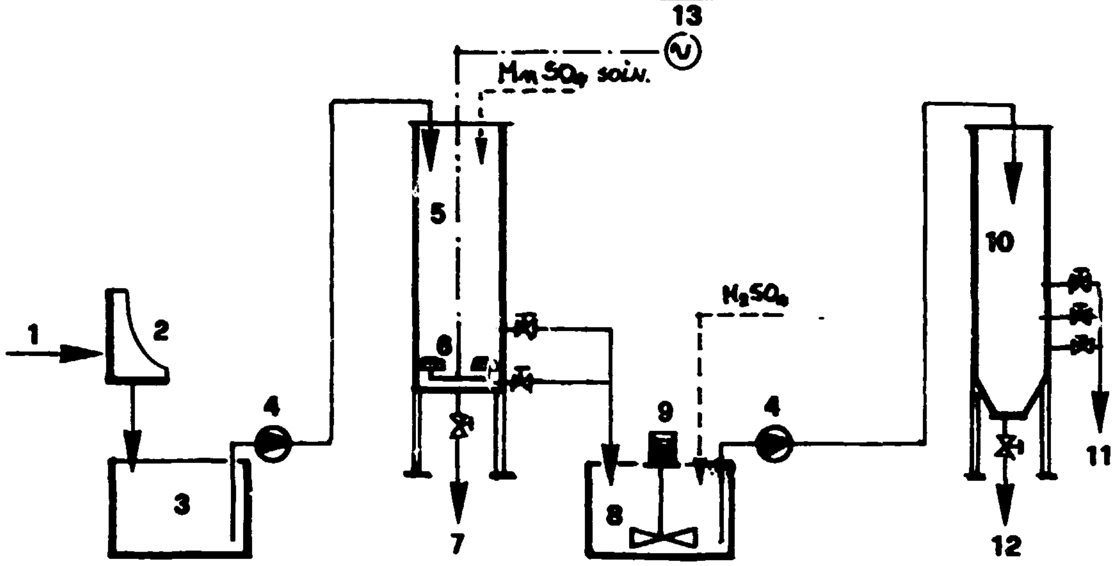
Summary

A series of tests employing sulphide oxidation with diffused air in the presence of manganous sulphate was carried out and, afterwards, the reduction of the waste loads by acidification of the residual unhairing bath and protein precipitation was investigated.

Description of the treatment (see Figure 4)

For these tests we used the unhairing bath of the School, pumped into the oxidation tower so as to reach a volume of 1 m^3. The tank was agitated and aerated by blowing air through four Sintered Alundun Dome diffusers arranged on the bottom of the tank. The diffused air supplied was ca. 15 m^3 per hour. Before starting the aeration of the tank, a manganese sulphate solution was added so as to reach a concentration of 100 mg/l as Mn^{++} in the bath.
Every hour an analysis of the residual sulphide was made and the test continued until reaching a sulphide concentration below ca. 30 mg/l.
After this phase, the air supply was stopped and the sedimentation phase began. After an hour the sludge was discharged and the supernatant sent to the acidification tank where the pH of the solution was adjusted at about 3.8 so as to allow residual protein precipitation. After sedimentation an analysis of residual COD and T.K.N. (Total Kjeldahl Nitrogen) was made.

SULPHIDE REMOVAL IN UNHAIRING BATH & PROTEIN PRECIPITATION



Alternatives L.B.b. & L.B.c.

Legend :

1	:	spent bath from the school
2	:	screen
3	:	holding tank
4	:	lifting pump
5	:	oxidation tower
6	:	dome diffusers
7	:	sludge draw-off
8	:	reaction tank (acid precipitation of protein)
9	:	stirrer
10	:	protein precipitation tower
11	:	clarified liquid phase draw-off
12	:	solid phase (protein) draw-off
13	:	air blower

FIGURE 4

Operational performance of the test

- Screen:

  self cleaning screen (Hydrasieve type) wedge wire construction in AISI 304;

  openings = 1 mm

  flow capacity = 2-3 m^3/h

- Holding tank:

  volume = ca. 1.5 m^3

- Catalytic oxidation tower:

  diameter = 0.95 m

  total height = 3 m

  total volume = 2 m^3 (useful 1 m^3 for foaming problems)

- Catalyst employed:

  commercial manganous sulphate monohydrate (32% Mn^{++} weight)

  quantity added = 100 mg/l as Mn^{++}

- Air diffuser system (fine bubbles):

  n.4 Sintered Alundun Dome diffusers

  immersion depth = ca. 1.3 m

  operational air flow = ca. 15 m^3/hour

  air flow rate = ca. 3.8 m^3/dome per hour

  oxygen transfer efficiency = ca. 10%

  volume of the bath in the tower = ca. 1 m^3

  specific air flow = 21.4 m^3/h per m^2 of tank
  i.e. = 15 m^3/h per m^3 of tank

  oxygen transferred (4 diffusers) = ca. 0.4 Kg/hour

- Acidification tank:

  volume = ca. 1.5 m^3

  stirrer = 1 HP 1.400 r.p.m.

- Acid employed:

  sulphuric acid 10% soln.

  precipitation final pH value = 3.8

- Protein precipitation tower:

(Fiberglass cylinder with truncated 60° cone base)

diameter = 0.8 m
total height = 3 m
total volume = ca. 1.5 m^3

- Analytical procedure

In this test, the high sulphite and thiosulphite concentration present in the bath required some modifications to the classic APHA Standard Method (see below).

- Test results and comments

  - Sulphide oxidation

  The results obtained are summarized in TABLE 3.
  From the analysis of these results we can draw the following conclusions:

  a) In test conditions, the addition of 100 mg/l of Mn^{++} in the aeration tank has shown capable of reducing sulphide concentration to average values lower than 20 mg/l, in a very short time (about 6 hours).
  b) The air supplied (15 m^3/h per m^3 tank) was excessive but necessary in order to guarantee good agitation of the tank (^)
  c) The mean quantity of oxygen supplied during these tests was ca. four times the theoretical quantity required according to the reaction: $4\ S^{=} + 3O_2 = 2\ S_2O_3^{=}$.

(^) Note: In our opinion a good agitation of the liquor during the oxidation treatment is required to obtain an intimate contact between the catalyst and the reactives (sulphide and oxygen). In fact, in certain cases in which due to the clogging of the diffusers the quantity of diffused air was below normal, it took much longer (even 5 times) to complete the oxidation reaction. Once the diffusers were cleaned and the air flow was normal, the test times returned to the initial values.

TABLE 3

Sulphide removal in separate unhairing bath (100 mg/l Mn^{++})

Test N.	Sample time	Sulphide concentration $S^=$ mg/l
1	9 a.m.	912
	10 "	788
	11 "	592
	12 "	224
	1 p.m.	117
	2 "	67
	3 "	21
2	9 a.m.	184
	10 "	91
	11 "	24
3	9 a.m.	405
	10 "	272
	11 "	174
	12 "	120
	1 p.m.	18
4	9 a.m.	156
	10 "	65
	11 "	57
	12 "	24
	1 p.m.	18
5	9 a.m.	294
	10 "	219
	11 "	120
	12 "	80
	1 p.m.	21
6	9 a.m.	504
	10 "	360
	11 "	270
	12 "	158
	1 p.m.	60
	2 "	20
7 (note)	9 a.m.	533
	10 "	289
	11 "	55
	12 "	23
	1 p.m.	-
8	9 a.m.	594
	10 "	450
	11 "	285
	12 "	187
	1 p.m.	108
	2 "	88
	3 "	45

Table 3 cont.

Test N.	Sample time	Sulphide concentration $S^{=}$ mg/l
9	9 a.m.	395
	10 "	304
	11 "	256
	12 "	120
	1 p.m.	60
	2 "	16
10	9 a.m.	248
	10 "	131
	11 "	85
	12 "	40
	1 p.m.	12
11	9 a.m.	284
	10 "	120
	11 "	75
	12 "	30
	1 p.m.	12

note : test N.7 with 150 mg/l of Mn^{++}

ANALYTICAL PROCEDURE FOR SULPHIDE DETERMINATION IN THE SPENT LIME BATHS

In case of sulphide determination in lime baths, some modification to the standard methods analysis were necessary, due to the high concentration of sulphite and thiosulphates present.

Sample pretreatment

Add to 150 ml of well-mixed sample 5 ml of a 10% soln. of $BaCl_2 \cdot 2H_2O$ in excess of the amount necessary to react with the sulphite present. After centrifugation, test the solution with another small amount of $BaCl_2$ soln. and if no more barium sulphite precipitates start with the sulphide determination as follows.

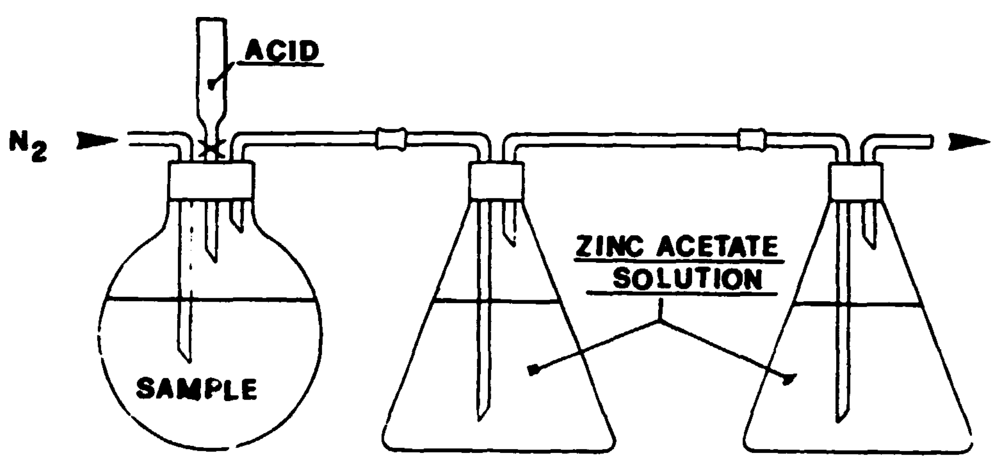


FIGURE 4a

Procedure

Measure 100 ml of a solution containing 12 gr/l of Zn $(CH_3COO)_2 \cdot 2H_2O$ into each of the two absorbtion flasks. Connect the reaction flask and two absorbtion flasks in series as shown in Figure 4a and purge the system with N_2 for 2 minutes.
Put 100 ml of the pretreated sample into the reaction flask and replace the 3 hole stoppers tightly.
Acidify the sample with 10 ml conc. HCl and pass N_2 through the apparatus for 1 hr. Filter the contents of the absorbtion flasks, wash with H_2O and put the filter and its contents into a 500 ml flask. Add 50 ml of iodine solution 0.25 N, 5 ml conc. HCl, stopper and shake to mix thoroughly. Then back titrate with 0.25N sodium thiosulphate soln. using starch solution as indicator.

Calculation

$S^{=}$ (mg/l) = (50 - C) x 40, where C is the ml of 0.25N sodium thio sulphate employed.

Protein precipitation

The average quantity of acid added to reach the final pH value of 3.8 was ca. 10 Kg of H_2SO_4 96% for 1 m^3 of unsettled unhairing bath; when the majority of suspended solids (hair and lime) was removed beforehand by sedimentation the acid consumption was ca. 6.5 Kg of H_2SO_4 96% for 1 m^3 of pre-settled bath.
The acid economy between the two alternatives was of about 35%.
The results obtained working both with fresh unhairing baths (used once) and old ones (reused several times) are reported in Table 4. From this data we can see that the protein precipitation produced an average reduction of ca. 80% of COD and of 75% of TKN present in the unhairing bath.

Observations

As already mentioned, in these tests we used the unhairing baths of the Tannery School which carries out quite frequently but in a non uniform way and without excessive analytical controls the lime bath recycles after simple screening (the process cycle is reported below).
This is the cause of the wide variations in the COD and TKN values which can be seen in Table 4. The unusually low values of sulphide in the spent unhairing baths depend, in our opinion, both on natural oxidation of the baths due to contact with air (this phenomenon is quantitatively more important in baths of small volume such as the School one) and on the dilution due to the amount of washing waters added.

TABLE 4

Test	Lime-sulphide raw effluent	After sulphide oxidation		After protein precipitation	
	COD (mg/l)	COD (mg/l)	TKN (mg/l)	COD (mg/l)	TKN (mg/l)
N.1 (fresh bath)	25,000	18,600	1,000	3,600	335
N.2 (fresh bath)	17,400	13,200	-	3,400	-
N.3 (11 times recycled bath)	44,900	34,700	3,600	5,600	660
N.4 (8 times recycled bath)	42,000	39,800	3,000	5,200	600
N.5 (fresh bath)	17,400	13,200	1,860	3,400	465
N.6 (recycled bath)	63,700	58,400	3,200	10,800	900
N.7 (recycled bath)	27,000	15,500	-	-	-
N.8 (fresh bath)	11,400	9,920	-	2,470	-
N.9 (fresh bath)	36,500	33,800	1,800	2,300	280
N.10 (recycled bath)	-	33,400	2,990	5,200	610

Note :

Process employed at the tannery School

fresh bath process	recycled bath process (*)
- 100% fresh water	- 50% spent unhairing bath
- 2.3% sodium sulphide (ca.50% Na_2S)	- 1.3% sodium sulphide (ca.50% Na_2S)
rotation 30 m'	rotation 30 m'
- 100% fresh water	- 150% spent unhairing bath
- 3.5% lime	- 3.3% lime

(*) the spent unhairing bath contains also a portion (20-30%) of the first washing

2.B.2 - Chrome Recovery

Summary

During this period some demonstrations of chrome recovery and reuse have been carried out according to the alternative C.R.c. as follows:

- screening of tanning baths
- chrome flocculation with NaOH
- chrome hydroxide filtration with filter-press
- chrome hydroxide cake redissolving with H_2SO_4
- analytical control and chrome reuse.

Note: Chrome recovery tests by direct recycling of the bath itself after screening (alternative C.R.a.) have been considered superfluous because this process is in normal use at the Tannery School at Estancia Velha.

Procedure

To carry out these tests the spent chrome bath from the School was used. The spent chrome was pumped through a screen and collected in a 1,000 litres tank equipped with a stirring device. The tests were carried out in a batch system: the solution was stirred and NaOH solution added until pH8 was achieved. Next the chromium hydroxide slurry was pumped to the filter-press. The cake of chrome hydroxide thus obtained was removed from the filter, weighed and re-dissolved with sulphuric acid.

After the acid addition the mixture was stirred for 8-10 hrs.(overnight). The next day the analytical controls were effected and, after having added the required acid to correct the basicity, the product was given to the School technicians for tannery tests.

These tests were carried out with pickled sides. The right sides were tanned with regular chrome salts and the left sides exclusively with recovered chrome liquor.

At the end of tanning the skins were again put together to undergo successive treatments. At the end of the processing a comparison was made of the two sides and the usual chemical and physical tests were made.

Plant facilities

- Screen:

  self cleaning screen (Hydrasieve type) wedge wire construction in AISI 304.

  openings = 1 mm.

  flow capacity = 1-2 m^3/h

- Flocculation tank:

  (fiber-cement tank with a capacity of 1,000 l)

  stirring device = 1 HP

- Filter-press:

  plates dimensions: 500 x 500 mm

  number of plates: 12

  total filtering surface area: 3.65 sqm.

  average cake thickness: 23 mm

  total volume of cake: 37.4 litres

  max. working pressure: 12 Kg/cm^2

- Feeding pump (one single piston pump)

  capacity: 1.2 m^3/h

  total head: 12 Kg/cm^2

  installed power: 1.47 KW

- Dissolution tank:

  (the same tank used for flocculation)

Operational Performances and Test Results

Spent chrome bath characteristics:

- Chrome content (as Cr_2O_3) = ca. 4 g/l
- pH = 3.5-4

Flocculation:

- Alkali employed = NaOH 50% soln.

- Flocculation end point = pH 8

Filtration:

- Maximum working pressure = 3 Kg/cm^2
- Time required for one filtration cycle = 3-3.5 hours
- Specific filtration rate = 70-80 litres per m^2 of filtering surface per hour
- Dry material in the chrome hydroxide cake = 20-25%
- Cake weight = 38-42 Kg for each filtration
- Chrome content of the cake (as Cr_2O_3) = 10-12%
- NaOH consumption (Kg NaOH/Kg Cr_2O_3) = 0.5-1.0

Redissolving of the hydroxide cake:

- H_2SO_4 (circa 96% consumption (Kg H_2SO_4/Kg Cr_2O_3) = 0.7-1.0
- Time required for the total cake redissolving = 6-10 hrs.
- Chromium content in the recovered liquor (as Cr_2O_3) = ca.10% weight
- Schorlemmer Basicity of recovered liquor (after correction) = within 30-35%

Observations

The chrome liquor thus recovered was given to the School technicians for a tanning test.
In this demonstration the total quantity of tan chrome was substituted by the recovered chrome.
This is unusual as it is preferable to use only a part of this chrome together with normal chrome.
However, no evident differences were noted in the tanning capacity of the chrome and the leathers obtained, apart from a slightly darker colour, showed an aspect and characteristics similar to those of leather produced normally.
The results of some physical tests on leather are reported in the following Table 5.
Further tests according to the alternative C.R.b. (screening-flocculation-sedimentation-redissolving and reuse) are still running.
These tests, employing MgO as chrome flocculation agent, are carried out, as Project external service, in strict collaboration

with a tannery in Estancia Velha area. The first results are very interesting for the high chrome content of the recovered liquor (ca. 50 g/l as Cr_2O_3) that we can obtain by this simple and economic way.

At the same time, because of the demonstrated variations in the effects of various alkalis on chrome recovery efficiencies, additional alkali studies including calcium hydroxide, calcium carbonate, sodium carbonate etc. are investigated on laboratory scale.

TABLE 5

PHYSICAL LEATHER TESTING

SENAI Tanning School Physical Laboratory of Estancia Velha
Date: 20.12.1983

	Leather tanned with "normal chrome"	Leather tanned with "recovered chrome"
I.U.P. /6 MEASUREMENT OF TENSILE STRENGTH AND ELONGATION		
- thickness mm	1.57-1.58	1.61-1.60
- cracking load Kgf	63.4-38.5	57.6-32.8
- tensile strength Kgf/mm^2	4.0-2.4	3.6-2.0
- elongation %	66-67	61-71
I.U.P./8 MEASUREMENT OF TEARING LOAD		
- thickness mm	1.53-1.57	1.65-1.68
- max. load Kgf	18.9-24.7	16.0-20.9
- tearing load Kgf/cm	124-158	97-125
I.U.P./9 MEASUREMENT OF DISTENSION AND STRENGTH OF GRAIN BY BALL BURST TEST (LASTOMETER)		
- grain cracking load Kg	39.6	33.3
- elongation at grain cracking mm	9.3	8.8
- leather cracking load Kg	75.3	67.7
- elongation at leather cracking mm	13.3	13.1

I.U.P. = Methods of Physical Leather Testing by the International Union of Leather Chemists Associations.

2.B.3 - Primary Treatment

Summary

In order to verify the efficiency of the clari-flocculation treatment of the tannery waste-waters and determine the best dosage of reactives, a series of tests were performed using a decreasing amount of coagulants and comparing the results with those obtained without chemicals.

The tests are reported in the following Table:

Test	Test period	Chemical use & dosage
P.T.a.1	22/6/83 - 16/9/83	Alum 800 mg/l + Polyelectr. 1 mg/l
P.T.a.2	19/9/83 - 7/11/83	Alum 400 mg/l + Polyelectr. 1 mg/l
P.T.a.3	8/11/83 - 2/12/83	Alum 200 mg/l + Polyelectr. 0.5 mg/l
P.T.c.	5/12/83 - 30/6/84	None

With regard to the P.T.c. test, this has enabled us to evaluate the contribution of the chemicals in the primary treatment as well as to evaluate the depurative capacities of a secondary treatment fed by such effluent which has received a treatment of homogenization, sulphide oxidation, sedimentation and pH regulation (see the Secondary Treatment section).

For practical during this period the P.T.b. test (P.T. alternative without sulphide oxidation in the equalization tank) was not carried out. In fact, although the substitution of the floating aerator with a mechanical stirrer was possible (this facility is available in the Pilot Plant), we preferred to keep the primary treatment uniform so as to be able to make a better comparison among the various secondary treatments which were progressively tested.

SCHEDULE AND CHARACTERISTICS OF THE EQUIPMENT AND FACILITIES UTILIZED IN THE PRIMARY TREATMENT TESTS

No. 1 Brushed Screen (Parkwood Type)

- perforations = Ø 1.6 mm
- flow = 10 m^3/hr
- power = 0.75 HP

No. 1 Equalization Tank

- Dimensions:
  5.6 x 4.5 m total height 2.5 m (useful c .2.0 m)
- Volume max. useful = ca. 50 m^3
- Surface = ca. 25 m^2

No. 1 Air Blower (Rotary vane centrifugal blower)

- air flow = 170 Nm^3/hr
- power = 4.5 HP

No. 12 Sintered Alundum Candle Diffusers

- air flow = 15 Nm^3/h each
- porosity = 100 micron
- theoretical O_2 transfer efficiency = ca. 7%

No. 1 Lifting Pump (Type Mohno)
(helicoidal pump)

- flow = 2 m^3/hr
- power = 1 HP

No. 1 Self Cleaning Screen (Bauer Hydrasieve Type)
(Wedge Wire Construction in AISI 304)

- spacing = 1 mm.
- flow = 2 m^3/hr

No. 1 pH-Control Unit
comprising:

No. 1 pH-Meter with two threshold points (minimum pH = 7, maximum pH = 9)

No. 1 acid dosing pump and polypropylene vessel, capacity 200 litres

No. 1 lime milk dosing pump and fiber-cement vessel, capacity 200 litres with stirring device.

No. 1 pH-adjustment tank (fiber-cement, capacity 1,000 litres) with fast stirring device (1.0 HP)

No. 1 coagulation and flocculation tank (fiber-cement, capacity 1,000 litres) with slow stirring device (1.0 HP).

Aluminium Sulphate Dosing Unit
comprising:

No. 1 Aluminium sulphate solution at 8% storage vessel (fiber-ce ment, capacity 1,000 litres) with fast stirring device (1.0 HP)

No. 1 Aluminium sulphate solution dosing pump

- flow = 20 litres/hr
- power = 0.35 HP

Polyelectrolyte solution dosing unit
comprising:

No. 1 Polyelectrolyte solution at 0.1% storage vessel (fiber-cement, capacity 200 litres) with stirring device (0.5 HP)

No. 1 Polyelectrolyte solution dosing pump:

- flow = 20 litres/hr
- power = 0.35 HP

No. 1 Lifting Pump (Type Mohno) helicoidal pump

- flow = 2 m^3/hr
- power = 1 HP

No. 1 Vertical sedimentation tank
Steel construction with lacquer finishing

Dimensions:

Ø = 1.5 m. height cylindrical part
1.5 m. height of cone (60° = 1.8 m.)
Total volume = 3.7 m^3
Surface = 1.76 m^2

No. 1 Sludge removal pump (type Mohno) helicoidal pump

- flow = 6 m^3/hr
- power = 0.75 HP

with automatic intervention of 20 seconds every 20 minutes by time switch.

OPERATION OF THE TEST

(see figure 5)

During the test period the volume of discharge water treated was about 50 m^3/day with a flow of 6 m^3/hr for 8 hours per day before equalization and a flow of 2 m^3/hr for 24 hours per day after equalization. (See in Figure 6 the operation of the equalization tank).

Tests P.T.a.

- screening (^)
- equalization and sulphide oxidation
- pH adjustment
- coagulation and flocculation
- sedimentation
- sludge discharge

Tests P.T.c.

- screening (^)
- equalization and sulphide oxidation
- pH adjustment
- sedimentation
- sludge discharge

(^) Note: a second screening has been installed after the equalization tank because the small volume of effluent to be treated undergoes a system of flow regulation (valves) and pumping with narrow free passage and therefore they can be easily blocked. In a larger plant this second screening unit would not be necessary.

All these tests were carried out under the following operative conditions:

Equalization: retention time: ca. 24 hours
air flow (blower): 170 Nm^3/hr
quantity of catalyst added: 20 mg/l as Mn^{++}

pH adjustment: within 7 and 9

Coagulation (if any): retention time 30 m'

Flocculation (if any): retention time 30 m'

Sedimentation: retention time ca. 2 hours
superficial load 1.0 m^3/m^2.hr

The chemicals used are:

- ALUM (as coagulant):
  solid aluminium sulphate $Al_2(SO_4)_3.18\ H_2O$
  type: industrial grade (Al_2O_3 content ca. 15%)
  solution strength applied: 8% (P.T.a.1)
  4% (P.T.a.2)
  2% (P.T.a.3)

- **POLYELECTROLYTE** (as coagulant aid):

  type: polyacrylamide

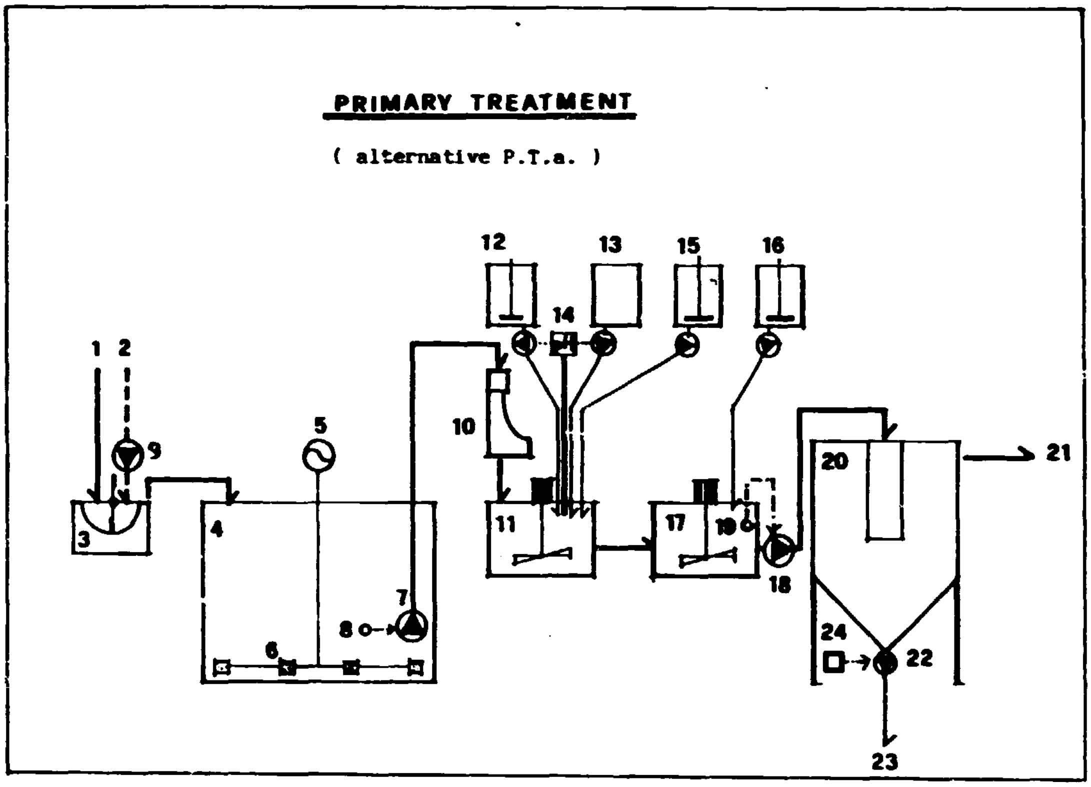
  physical form: power

  ionic charge: anionic

  molecular weight: several millions

  pH of 0.25% solution: about 10

  solution strength applied: 0.1% (P.T.a.1 & P.T.a.2)
  0.05% (P.T.a.3)



Legend :

1	: school waste waters
2	: tannery waste waters
3	: self-cleaning screen
4	: equalization tank
5	: air blower
6	: alundum diffusers
7	: lifting pump
8 - 19	: float switch
9	: pump
10	: wedge wire self cleaning screen
11	: pH-adjustment tank (fast stirred)
12	: lime milk dosing unit
13	: acid dosing unit
14	: pH control unit
15	: aluminium sulphate dosing unit
16	: polyelectrolyte dosing unit
17	: coagulation and flocculation tank (slow stirred)
18	: pump
20	: sedimentation tank
21	: clarified effluent discharge
22	: sludge removal pump
23	: sludge discharge
24	: automatic intervention time switch

FIGURE 5

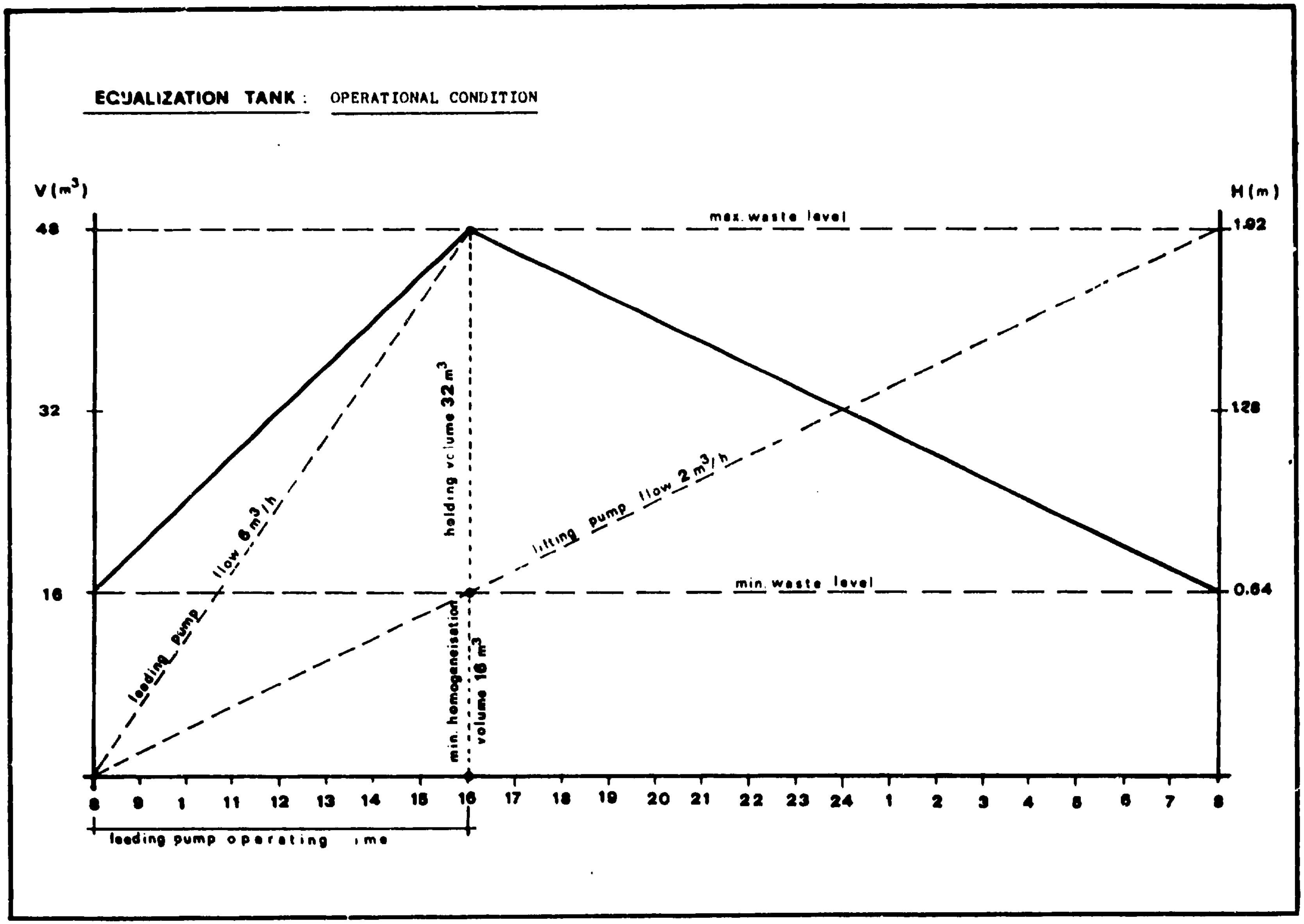

ECUALIZATION TANK : OPERATIONAL CONDITION
V(m³)
H(m)
48
32
16
1.92
128
0.64
max. waste level
min. waste level
holding volume 32 m³
min. homogeneisation volume 16 m³
feeding pump flow 6 m³/h
lifting pump flow 2 m³/h
8 9 1 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1 2 3 4 5 6 7 8
feeding pump operating ime

FIGURE 6

Test Results

The analytical data of the effluent from the equalization tank and those of the clarified effluent from the primary sedimentation tank are summarized in Tables 6, 7, 8 and 9 (average values during the test period).

TABLE 6 - Test P.T.a.1 (800 mg/l Alum + 1 mg/l Polyelectrolyte)

EQUALIZATION TANK EFFLUENT				CLARIFIED EFFLUENT			
pH	Settled Solids ml/l	COD mg/l	BCD mg/l	pH	Settled Solids ml/l	COD mg/l	BOD mg/l
8.0	70	2,560	480	7.0	0.1	590	185

TABLE 7 - Test P.T.a.2 (400 mg/l Alum + 1 mg/l Polyelectrolyte)

EQUALIZATION TANK EFFLUENT				CLARIFIED EFFLUENT			
pH	Settled Solids ml/l	COD mg/l	BOD mg/l	pH	Settled Solids ml/l	COD mg/l	BOD mg/l
8.4	32	2,000	370	7.4	0.3	525	140

TABLE 8 - Test. P.T.a.3 (200 mg/l Alum + 0.5 mg/l Polyelectrolyte)

EQUALIZATION TANK EFFLUENT				CLARIFIED EFFLUENT			
pH	Settled Solids ml/l	COD mg/l	BOD mg/l	pH	Settled Solids ml/l	COD mg/l	BOD mg/l
8.4	43	1,720	400	7.7	0.3	570	165

TABLE 9 - Test P.T.c. (No Chemicals)

EQUALIZATION TANK EFFLUENT				CLARIFIED EFFLUENT			
pH	Settled Solids ml/l	COD mg/l	BOD mg/l	pH	Settled Solids ml/l	COD mg/l	BOD mg/l
7.8	77	3,060	890	7.7	2.5	1,560	540

The average reduction found for each treatment is:

	P.T.a.1	P.T.a.2	P.T.a.3	P.T.c.
Settled Solids	99.8%	99.0%	99.3%	96.7%
COD	76.9%	73.7%	66.8%	49.0%
BOD	61.5%	62.1%	58.7%	39.3%

The detailed analytical results of the tests are reported at Annexes 2/X, 2/XI, 2/XII and 2/XIII.

Discussion of Results

The high reduction percentage found indicate that the Pilot Plant has reached a high standard of efficiency.

In fact, beyond the average values indicated above, we must underline the fact that during the whole test period the characteristics of the effluent from primary sedimentation remained within a narrow range of values as it may be seen from the annexed analytical data. This is also due to the fact that some initial problems were solved, i.e.:

- the correct and constant regulation of the hydraulic flow of the plant (this regulation has given a few difficulties at the start which were later overcome by modifying the capacities of some of the installed pumps).
- The availability of an efficient polyelectrolyte (at first we worked with different polyelectrolytes which were obtained as samples from various suppliers in order to verify their efficiency).
- The installation of an automatic drawoff system of the primary sludges (during the first phase this drainage was effected manually and in an erratic manner only during working hours).

Principally the excellent results obtained were due to the care and high professional level attained by the Brazilian counterparts assigned to the operation and maintenance of the plant.

The prolonged test period and the uniformity in the results obtained allow one to draw the following conclusions:

1. A treatment employing minimal chemical levels (200 mg/l Alum + 0.5 mg/l Polyelectrolyte) has shown the most suitable efficiency/cost ratio in the tests with chemicals P.T.a.).
2. Test without chemicals (P.T.c.) produced a settled effluent that could be treated in a secondary phase without great difficulty (see secondary treatment)).

In our opinion the choice between the two treatments (clarifloc culation with chemicals and spontaneous sedimentation) must be evaluated in relation to the following factors:

a) a treatment type P.T.a. necessitates extra installation costs which are quite insignificant with respect to the total cost but on the other hand confers big advantages to the plant reliability;

b) the absence of coagulation treatment on the other hand means a higher organic loading onto the secondary treatment system and therefore an economic evaluation must be made between the chemical costs saved and the extra energy costs which are required for the biological treatment;

c) it can be dangerous to allow raw effluents to be treated mainly by biological methods, as very few tanneries have technicians trained in the corrent functioning of this type of depuration, on the other hand operation of physical-chemical treatment is very simple;

d) chemical consumption can always be reduced in relation to the needs of the biological treatment, and can be increased if efficiency deteriorates.

2.B.4 - Secondary Treatment

The following biological systems were tested with the aim of evaluating the best performance and reliability of secondary treatment under the local conditions:

- Extended aeration with oxidation ditch
- Extended aeration with floating aerator
- Conventional activated sludge
- Facultative/aerated lagoon
- Trickling filter with plastic media
- Trickling filter with crushed stones
- Biological treatment without primary sedimentation.

The tests carried out led to the identification of the biological treatments suitable for secondary treatment which can be chosen according to the particular requirements of the relevant tannery.

- Extended aeration with oxidation ditch

According to the scheme reported in Figure 7, a secondary treatment (extended aeration) with Oxidation Ditch (Alternative S.T.a/1) was carried out.
The process facilities and the operative conditions of the test are reported below.
The detailed results are reported as Annexes 2/XIV, 2/XV, 2/XVI and 2/XVII.
The results (average), divided in four groups, depending on the different Primary Treatment employed are as follows:

I. Secondary Treatment after Test P.T.a.1(Alum 800mg/l+1 mg/l Polyel.	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	7.2	7
Settled solids (ml/l)	0.1	0.9
C O D (mg/l)	590	193
B O D (mg/l)	185	29

II.Secondary Treatment after Test P.T.a.2(Alum 400mg/l+1 mg/l Polyel.	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	7.4	6.2
Settled solids (ml/l)	0.3	0.4
C O D (mg/l)	525	270
B O D (mg/l)	140	12

III.Secondary Treatment after Test P.T.a.3(Alum 200mg/l+0.5mg/l Polyel.	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	7.7	6.5
Settled solids (ml/l)	0.3	0.2
C O D (mg/l)	570	244
B O D (mg/l)	165	14

IV.Secondary Treatment after Test P.T.c. (No chemicals)	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	8.5	7.4
Settled solids (ml/l)	4	2.5
C O D (mg/l)	1550	297
B O D (mg/l)-	520	36

The average reduction for each treatment is:

	I	II	III	IV
C O D	67.2%	48.5%	57.2%	80.8%
B O D	84.3%	9'.4%	91.5%	93.0%

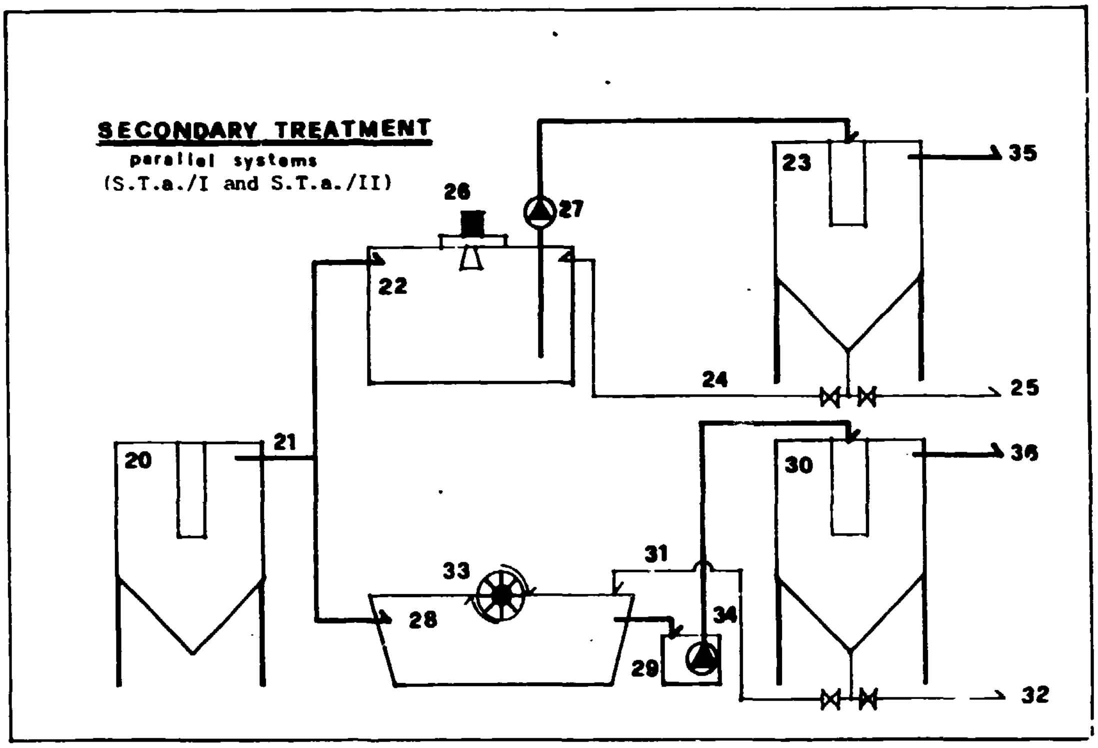


FIGURE 7

Legend :

20 : primary sedimentation tank

21 : clarified effluent discharge

22 : extended aeration tank

23 - 30 : secondary sedimentation tank

24 - 31 : sludge return

25 - 32 : sludge drainoff

26 : floating aerator

27 - 34 : lifting pump

28 : oxidation ditch

29 : lifting tank with adjustable weir

33 : aeration rotor

35 - 36 : final effluent discharge

Note:

From a superficial study of the above data, one can conclude that the test IV is preferable as it consents a higher abatement of the influent load. In reality the higher the influent load the easier it is to obtain a higher percentage of abatement but the total treated by the secondary treatment is in any case superior than that treated by the other tests.
This naturally occurs, as in this case, when the treatment capacity of the secondary plant is abundant.
Therefore for a complete evaluation of the various tests one must also consider the different energy costs and final effluent characteristics.

Discussion of the result

Analyzing the results reported above, we can draw the following conclusions:

a) an extended aeration Secondary Treatment with Oxidation Ditch was able to give a very good reduction of the organic load and produce a water with characteristics in accordance with the limits imposed by the Local Authorities.
b) Very good results were also obtained by treating the water after Primary Treatment without chemical flocculation.
c) From a mechanical point of view, this type of treatment showed high reliability.
d) These good performances can also be attributed to the climatic conditions. In fact, during the whole test period, the water temperature never fell below 15°C.

Further investigations

We are now testing the Oxidation Ditch with a higher influent flow.
The new operational conditions are the following:

- Influent flow (m^3/hr)	2
- Retention time (hr)	30
- Organic load (Kg BOD/day)	7-11
- Volumetric load (Kg BOD/m^3 of tank per day	0.12-0.2
- Recycle sludge (%)	100

The detailed results are reported as Annex 2/XVII-bis.
The short period in which the test was carried out does not allow any definitive evaluation. The high BOD values of the effluents can be attributed to the fact that the system is still adapting to the new operative conditions.
The average reduction is:
COD = 75.8%
BOD = 87.1%

- Extended Aeration with floating aerator

According to the scheme reported in Figure 7, a secondary treatment (extended aeration), using a floating aerator as oxygenator (Alternative S.T.a/2) was carried out. The detailed results are reported as Annexes 2/XVIII and 2/XIX.
The operative conditions are reported below.
The results (average), divided in two groups, depending on the different Primary Treatments employed, are as follows:

I-Secondary Treatment after Test P.T.a 1(Alum 800mg/l+1 mg/l Polyel.

	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	7.2	7.0
Settled Solids ml/l	0.15	0.8
C O D mg/l	590	284
B O D mg/l	181	22

II-Secondary Treatmentafter Test P.T.a 2(Alum. 400mg/l+1 mg/l Polyel.

	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	7.7	6.4
Settled Solids ml/l	0.3	1
C O D mg/l	554	484
B O D mg/l	120	27

The average reduction found for each treatment is:

	I	II
B O D	87.8%	77.5%
C O D	51.8%	12.6%

TABLE 10 - PARALLEL SYSTEM FACILITIES

Oxydation Ditch

- tank volume	:	ca. 60 m^3
- rotor length	:	0.75 m
- depth of immersion	:	150 mm
- theoretical oxygen transfer	:	2.2 Kg/hr
- power	:	3 HP

Floating Aerator

- motor size	:	2 HP
- motor rev/min	:	1,400
- theoretical oxygen transfer	:	2.0 Kg/hr

TABLE 11 - OPERATION OF BOTH OXYDATION DITCH AND FLOATING AERATOR

	S.T.a./I (oxydation ditch)	S.T.a./II (floating aerator)
- aeration tank volume (m^3)	ca. 60	ca. 50
- feeding flow (m^3/hr)	1	1
- total organic load (Kg BOD/day)	3.5-5.5	3.5-5.5
- volumetric loading (Kg BOD/m^3 of tank per day)	0.06-0.1	0.07-0.11
- aeration retention time (hr)	60	50
- recycle sludge (%)	100	100
- mixed liquor suspended solids M.L.S.S. (mg/l)	1,150-4,000 (average ca.2,100)	1,150-3,200 (average ca.2,300)
- volatile sludge content (%)	50-75	50-75
- Sludge Volume Index SVI	50-120	60-100
- dissolved oxygen in the aeration tank OD (mg/l)	from minimum 5 to saturation	from minimum 5 to saturation

- Comparative evaluation

In order to check the performance and reliability of the two extended aeration systems (Alternative S.T.a./I and S.T.a./II), their results were compared:

- Average percentage reduction found in each period (^)

	Oxydation Ditch	Floating Aerator	Oxydation Ditch	Floating Aerator
B O D	84.3%	87.8%	91.4%	77.5%
C O D	67.2%	51.8%	48.5%	12.6%

(^) Note: These reductions were calculated on the basis of influent values from primary treatment with two different primary treatments: 1st period (Alum 800 mg/l + 1 mg/l Polyelectrolyte) - 2nd period (Alum 400 mg/l + 1 mg/l Polyelectrolyte) and effluent from secondary sedimentation.

From the analysis of the results, we can draw the following conclusions:

a) Under test conditions both systems were proved to be a valid mean of treating tannery effluents.

b) The characteristics of the final effluent of the two systems do not differ substantially and are well within the limits imposed by the Local Authorities.

c) Perhaps the oxidation ditch seems to be more reliable.

A detailed comparative table of the two extended aeration systems is reported as Annex 2/XX.

Conventional activated sludge

As the waste water available was not sufficient to carry out all the biological systems at the same time,a timetable of the various tests was agreed and the secondary treatment, using a conventional activated sludge system (Alternative S.T.d.), started in June 1984. For this reason the short period of operation does not allow any definitive evaluation of the results. However the test is still running under the supervision of the Brazilian staff and the discussion of results will be contained in an informative paper which will be prepared for the Latin-American Annual Congress of Chemists and Technologists of the Leather Industry which will be held in Gramado in November 1984.

The operational performances of the tests are the following:

- aeration tank volume (m^3)	19
- feeding flow (m^3/hr)	1.4
- total organic load (Kg. BOD/day)	19
- volumetric loading (Kg. BOD/m^3 of tank per day)	1.0
- aeration detention time (hr)	10 ÷ 13.5
- recycle sludge (%)	100
- mixed liquor suspended solids M.L.S.S. (mg/l)	3000
- sludge volume index	120
- dissolved oxygen in the aeration tank OD(mg/l)	4
- organic load (kg BOD/kg MLSS per day)	0.35

- **AERATED LAGOON**

Among the wide variety of lagooning techniques, the aerated lagoon was chosen and tested (Alternative S.T.f.). A floating aerator was employed as stirring device and aeration source.

Operational performances of the test

- tank dimensions	- of the upper side:	22 x 12 m.
	of the bottom:	18.6 x 8.6
	total height:	1.4 m. (useful 1.1 m.)
- tank volume (m^3)		288 (useful 215)
- feeding flow (m^3/hr)		1
- retention time (days)		9
- total organic load (Kg.BOD/day)		13.5
- volumetric load (Kg.BOD/m^3 of tank per day)		0.063
- floating aerator power (Hp)		1.0
- specific power (w/m^3)		3.5

Test results and comments

The average results are the following:

	Influent from Primary Sedimentation	Effluent from Lagoon
pH	8.1	7.8
Settled solids (ml)	8.6	5
COD (mg/1)	1463	305
BOD (mg/1)	564	54

The average reduction is:

BOD	90%
COD	79%

From the analysis of these results, we can come to the following conclusions:

a) the results obtained are characteristic of this type of treatment;

b) the parameters of the effluent flow respect the limits imposed by the Local Authorities, except for the settled solids, whose high value can be due both to the corresponding high value of the influent flow and to the small dimensions of the lagoon in which it is difficult to create an area of oxygenation and an other of sedimentation;

c) the favourable climatic conditions and the availability of the soil make of an aerated lagoon, preceded by a physical-chemical treatment including screening, homogenization, sulphide oxidation, pH control, primary sedimentation, one of the possible alternatives in the tannery waste water treatment in Brazil.

TRICKLING FILTER

- Introduction

Description of treatment cycle (see Figure 8)

The effluent from primary treatment is sent to a small tank and then pumped to the filter.

Through a water-jet rotary distributor the water descends on the top of the filter.

The trickling filter is divided into two parts by a perpendicular masonry wall (half volume has been filled with plastic media and the other with crushed rocks).

In this way, it will be possible, once one test is finished, to effect a second test with the same equipment but employing alternate media.

A plastic cover has been arranged to collect and divert water on the filter half not in operation, so that the rotary arm can only feed the test media in use.

The water which passes through the plastic bed is collected on the base of the filter and recycled into the lifting tank. This tank is equipped with a dividing baffle to avoid flow short circuits i.e. a direct passage of the raw water to the second lifting tank. It is thereby guaranteed that the tank always has the quantity of water required for keeping the biological bed wet.

The treated water overflows into the second tank and then is pumped to the secondary clarifier.

Operational data

- Trickling filter
  - Influent flow: 1 m^3/hr
  - Plastic media volume: 9.5 m^3
  - Recycle flow: 37 m^3/hr total (18.5 m^3/hr on the half surface involved in the treatment)
    i.e. 3 m^3/hr recycle per m^2 of filter surface

SECONDARY TREATMENT WITH TRICKLING FILTER

(Alternative S.T.b.)

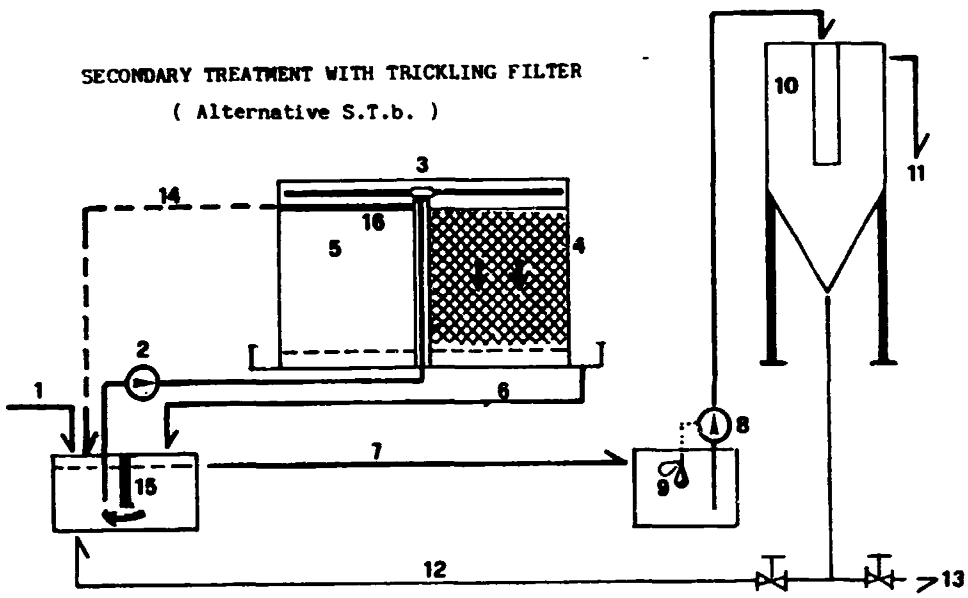


FIGURE 8

Legend :

1 : effluent from primary sedimentation

2 : lifting and recycling pump

3 : rotatory distributor arm

4 : plastic media bed

5 : crushed rock

6 : filter effluent

7 : over flow

8 : lifting pump

9 : float switch

10 : secondary clarifier

11 : effluent

12 : recycle

13 : sludge draw-off

14 : not treated water recycle

15 : baffle

16 : plastic cap

- Secondary sedimentation

  - Retention time: 3-4 hr
  - Superficial load: 0.8 m^3/m^2hr

- Biological sludge recycle : 100%

  (note: the volume of the recycled sludge is the minimum required to avoid the clogging of the clarifier sludge drawoff).

Characteristics of the facilities utilized

(in the test operational conditions)

- Recycling and lifting pump

  - Centrifugal pump flow 37 m^3/hr
  - Power 2 HP

- Recycling collection and lifting tank

  - Fiber-cement tank 1000 litres capacity

- Trickling filter (cylindrical structure with central wall)

  - Dimensions:

    total height: 2.30 m (utilizable 1.50 m)
    diameter: 4 m
  - Total volume: 18.8 m^3 (two sections of 9.4 m^3 each)
  - Rotary distribution system (hydraulic propelled)

- Filter media (pall rings in polypropylene)

  - Diameter: 90 mm
  - Weight Kg/m^3 of rings: 56
  - Free volume: 93%
  - Specific surface: 86 m^2/m^3 of rings

- Second lifting tank

  - Fiber-cement tank capacity: 1000 litres

- Clarifier feeding pump

  - Helicoidal pump (mohno type)
  - Flow: 1.5 m^3/hr
  - Power: 1 HP

- Secondary sedimentation tank

    - Cylindrical-vertical clarifier with 60° cone
    - Diameter: 1.25 m
    - Total Capacity: 3.5 m^3

- Test Results and Comments (plastic media)

The detailed results are reported at Annex 2/XXI.

The average results are as follows:

	Influent from Primary Sedimentation	Influent from Secondary Sedimentation
pH	7.6	7.9
Settled Solids (ml/l)	1.7	2.4
COD (mg/l)	1521	803
BOD (mg/l)	481	119

The average reduction is:

BOD 75.2%

COD 47.2%

From the analysis of these results, we can draw the following conclusions:

a) The results obtained are characteristics of this type of treatment.

b) The use of a trickling filter only does not result in water with the characteristics required by the limits imposed by the local Authorities and therefore must be followed by a second biological treatment. Only in cases where the influent water has a very high BOD content this system can be suitable.

c) This system is not appropriate generally for tannery waste water treatment, due to its low efficiency, and the difficulty in obtaining suitable filling materials on site.

With regard to the use of a trickling filter filled with crushed stones, the test is still running and the short period of operation does not allow any definitive evaluation of the results, however, the first results showed ahead behaviour similar to the tests effected with plastic media.

- Test Results (crushed stones)

The average results are as follows:

	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	8.7	8.0
Settled Solids (ml/l)	4.1	1.0
COD (mg/l)	1590	778
BOD (mg/l)	517	175

The average reduction is:

BOD 66.1%

COD 51.0%

Secondary treatment without primary sedimentation

- Introduction

Once the parallel tests S.T.a/I and II were completed the equipment and the tank used for the extended aeration with floating aerator were available; it was then decided to operate an unprogrammed test of secondary treatment without primary sedimentation.
This test was undertaken as we had doubts as to whether this technique was appropriate for the treatment of effluents with high inorganic suspended solids.
The test was operated as follows:
- screening
- equalization and sulphide oxidation
- pH adjustment
- biological treatment.

- Performance of the test

As a secondary clarifier was not available, the test was made in batch, according to Figure 9.
A batch system involves aeration, settling and decantation in a single tank.
The sequence adopted is shown in Figure 10.
In this test the daily volume of treated water was only about 6 m^3.
The floating aerator employed is the same utilized for extended aeration:

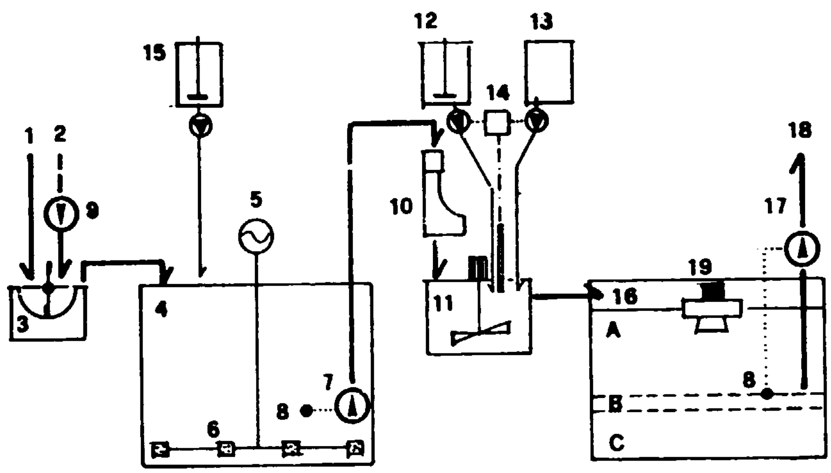
- motor size = 2 HP 1.400 R.P.M.
- theoretical O_2 transfer = 2.0 Kg/hr

- Test results

The analytical data of this period of test are reported at Annex 2/XXII. The average data are the following :

SECONDARY TREATMENT WITHOUT PRIMARY SEDIMENTATION

(Alternative S.T.h. batch treatment)



Legend :

1	: school waste waters	A	: daily waste volume
2	: tannery waste waters	B	: sludge free board
3	: self-cleaning screen	C	: sludge volume
4	: equalisation tank		
5	: air-blower		
6	: alundum diffusers		
7	: lifting pump		
8	: float switch		
9	: pump		
10	: self-cleaning screen		
11	: pH-adjustment tank		
12	: lime milk dosing unit		
13	: acid dosing unit		
14	: pH control unit		
15	: $MnSO_4$ dosing unit		
16	: biological batch system		
17	: draw off pump		
18	: final discharge		
19	: floating aerator		

FIGURE 9

BATCH TREATMENT

SEQUENCE OF DAILY OPERATIONS

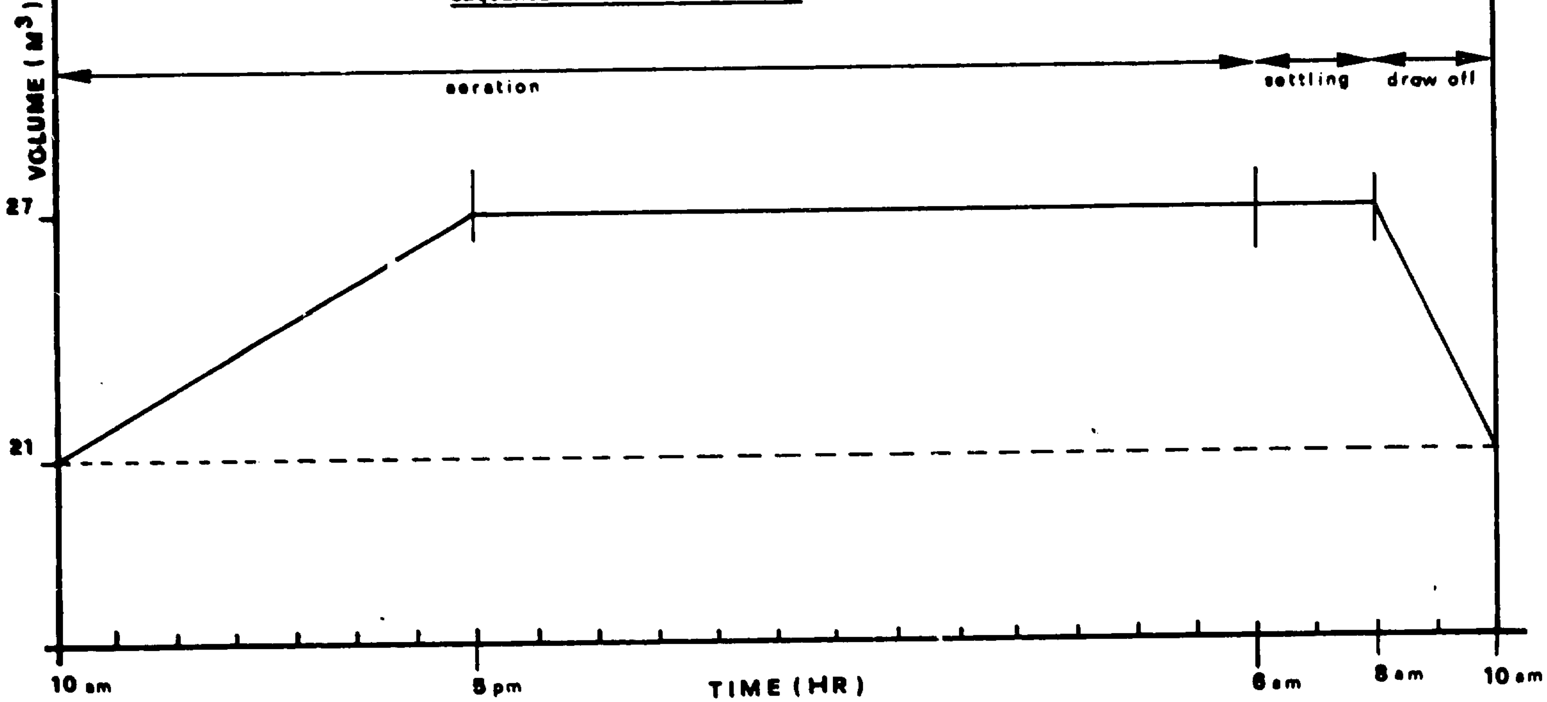


FIGURE 10

	Influent from Primary Sedimentation	Effluent from Secondary Sedimentation
pH	8.0	7.1
Settled solids (ml/l)	72	1.7
COD (mg/l)	3,040	558
BOD (mg/l)	678	25

The average reduction is:

Settled solids	97.6%
COD	81.6%
BOD	96.3 %

- Comments

If the system is able to guarantee a water with characteristics in accordance with the limits imposed by the Local Authorities, we believe that this particular treatment can be used only for small tanneries.

In fact, if one wants to reproduce the test conditions an aeration tank with a volume of ca. 5 times the tannery daily waste effluent should be used and the energy consumption would be 5-6 times higher than required by the biological process.

The oxygen supplied in the test was ca. 10 Kg/Kg of treated BOD against the 2-3 Kg/Kg of BOD which are maximum values generally used in the biological treatment (extended aeration). Furthermore, during the test period several problems arose due to the large amount of sludge produced . In fact, not only the biological sludge,but also the primary sludge are accumulated in the aeration tank,therefore, in order to maintain the contents of suspended solids within acceptable limits, abundant sludge draw-offs have to be effected daily. It is clear that such a process risks being difficult to control as it is not possible to differentiate between the "active" sludge and the inorganic sludge. That is, the operator cannot have a good control of the volatile (active) fraction of the biological sludge.

2.B.5 - Sludge Treatment

Sludge treatment by filter press

During the latter period of the Project, filtration by filter press, was operated daily.

The primary clarifier sludges and the same sludges after thickening were dewatered in accordance with scheme SL.T.e and SL.T.d (see Figure 11).

Average results of the tests are reported in the following table:

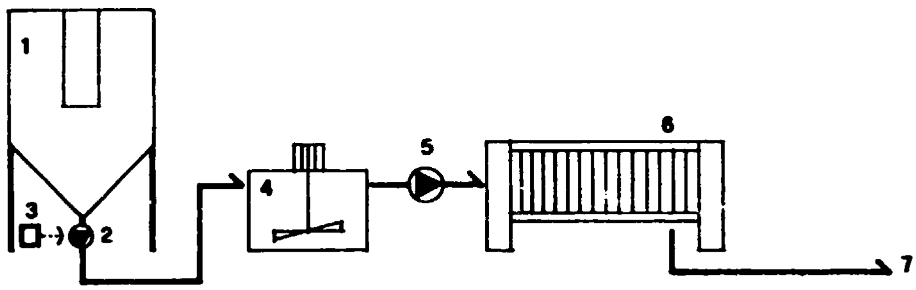
Average test results

Type of sludge	Primary	Primary thickened
- Dose of lime used Kg per m^3 of sludge	4	4
- Working pressure Atmospheres	10	10
- Specific filtration rate l/m^2 per hr	40	36
- Feed solid %	2.3	3.5 (*)
- Total filtration time hr	6.6	4.0
- Total cake production Kg	40.5	45
- Cake solids %	25	28.6
- Cake specific weight Kg/l	1.12	1.20

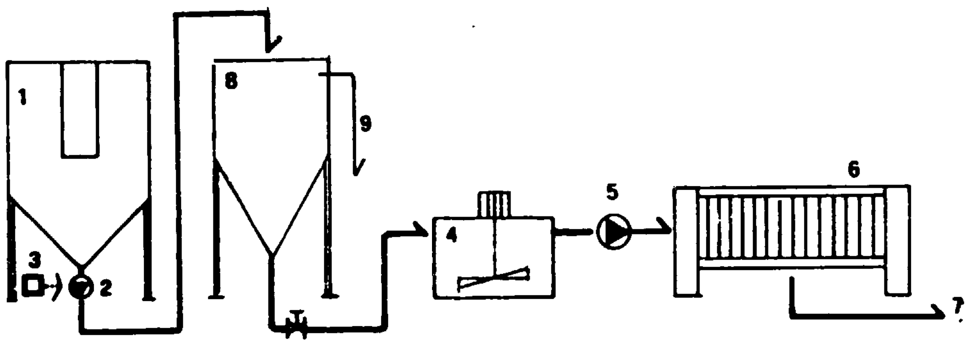
For technical characteristics of the filter press and thickener, see annex Table 11.

(*) Note: This means a reduction of the sludge volume by thickening of ca. 34%.

SLUDGE TREATMENT



(alternative SL.T.e.)



(alternative SL.T.d.)

Legend :

1	: primary sedimentation tank
2	: sludge removal pump
3	: automatic intervention time switch
4	: sludge conditioning tank
5	: filter feeding pump
6	: filterpress
7	: sludge final disposal
8	: gravity thickener
9	: supernatant

FIGURE 11

TABLE 11

a. FILTRATION DEVICE

Filter press

Technical data:

- plates dimensions	500 x 500 mm
- number of plates	12
- total filtering surface area	3.85 m^2
- average cake thickness	23 mm
- total volume of cake	37.4 litres
- max. working pressure	12 Kg/cm^2

Feeding unit (one single piston pump)

Technical data:

- flow	1.2 m^3/hr
- total head	12 ate
- power	1.47 Kw

THICKENER

- type :	gravity thickener (without scraper); open topped cylinder with 60° conic base
- volume :	4.2 m^3
- surface:	1.45 m^2

Other dewatering tests employing a mixture of biological and primary sludges or biological sludge alone were carried out.
In the first tests we obtained the same results as in the tests with the primary sludge alone. In the second test we met some problems and found it was necessary to add a little iron sulphate besides the lime, in order to obtain a good filtration performance.

Sludge Treatment By Sand Beds

The pilot plant is provided with 12 rectangular sand drying beds, 5 x 2 m each of surface, with drainage piping for water return to the equalization tank.

During this test period, these beds were not extensively used as they might cause some air pollution problems (odours).

(The Project SENAI School is in the centre of Estancia Velha).

In the few tests carried out we obtained the following average results:

- sludge filling depth = 40 - 50 cm
- drying time = 25 - 35 days
- final sludge dry content = 25 - 30 %
- load = 60-80 Kg of sludge (dry material)/m^2/of bed per year (^)

(^) Seven cycles per year for each bed is considered viable.

The dewatering time is dependant on seasonal fluctuations (especially rain and humidity).

Rainfall in Rio Grande do Sul is high, therefore we took the opportunity to carry out a test with a covered bed but no specific data could be obtained on how covers effect or improve bed loading rates.

During the first 1-2 weeks the bulk of dewatering takes place by filtration through the sand and after this time water is eliminated almost exclusively by evaporation.

In our opinion dewatering sand beds may only be used in small tanneries established in zones which are sparsely populated; in all other cases it is preferable to employ mechanical dewatering equipment.

2.B.6 - Solid Waste Disposal

Solid waste from tanneries and tannery waste - water treatment plants include the following:

1. Fleshings (raw and limed)
2. Raw hide trimmings
3. Tanned hide trimmings
4. Sanding and buffing dust
5. Primary sludge
6. Biological sludge
7. Office and general plant waste.

Many tanneries in Brazil have their own plant for grease recovery from fleshings, other collect these fleshings and raw hide trimmings for sale to rendering plants or for conversion into glue.

Tanned hide trimmings are often sold as by-products.

Office and general plant waste is either hauled away by a local refuse disposal service or disposed of on site.

The big problem is represented by the sludge.

The processing of 1 Kg of raw hide will in fact produce from a minimum of 0.05 to a maximum of 0.1 Kg of sludge dry solids.

This means a production of liquid sludge (ca. 3% of dry solids) of 1.5-3 litres of sludge/kg of processed hide. This shows the significance of sludge production even for a small tannery which, for example, may process 5,000 Kg/day of hides which could yield 7.5-15 m^3/day of liquid sludge.

The use of mechanical dewatering equipment produces a sludge cake of about 30% of dry solids, thus reducing the quantity of sludges to 0.15-0.30 litres/Kg of processed hide. Despite this the quantity of residual sludge is always high.

Incineration is not economic and not recommended for sludges containing chrome, since chrome may be oxidized from the trivalent to the hexavalent state.

Sanitary landfills appear to be the most utilized solution for the disposal of tannery sludge.

The selection of a proper site for landfill operations is of prime consideration. Requirements in the selection include: sufficient area; reasonable transport distance; remote location relative to residential; commercial and recreational development; soil conditions and rock formations; accessibility to existing transportation networks; and proximity to existing groundwater supplies.
The soil cover should be sloped so that rainfall will run off rather than percolate and pollute groundwater sources. Other factors to be considered include provision to prevent the obstruction of natural drainage channels, location to avoid flood waters, and the consideration of possible fire hazards.

Conclusions:
We are convinced that the only economical and technical solution possible in Brazil must be practical research investigation into methods of utilizing these materials as agricultural fertilizers after a significant abatment of Cr III content (by recycle or other).

2.C. Cost Aspects

- Introduction

A detailed economic analysis of the alternatives for tannery effluent treatment in the prevailing local situation is not easy for the following reasons:

i) the projection of the pilot plant costs onto an industrial plant is not realistic because of the great difference in economy of scale;

ii) land and building costs are variable, depending on special site conditions;

iii) it is difficult for an European to evaluate the investment and capital costs (interest) in Brazil due to the excessive inflation which exists (more than 200% per annum).

iv) the equipment costs are very high and variable; caused by the fact that at present there are few Brazilian companies which specialize in the production of this equipment which is, therefore, mainly imported from abroad.

For this reason we are only detailing some cost indications with particular reference to the differences with European costs.

1. Land Costs

Land costs in Brazil are generally much lower than those existing in Europe and therefore solutions that foresee the employment of large areas of land for the establishment of plant, with lower use of concrete (lagoons, oxidation ditches etc.) appear more economic, where no other limitations apply.

2. Energy Costs

Electric power in Brazil at 31.12.1983 was 0.035 US dollars/Kw.hr; this cost is lower than European standards, whereas chemical costs are higher (see below) and therefore in dimensioning a plant one must decide if it is more economic to use conventional treatments or a poor primary followed by a larger secondary treatment.

3. Chemical costs

The chemical costs at 31.12.1983 were:

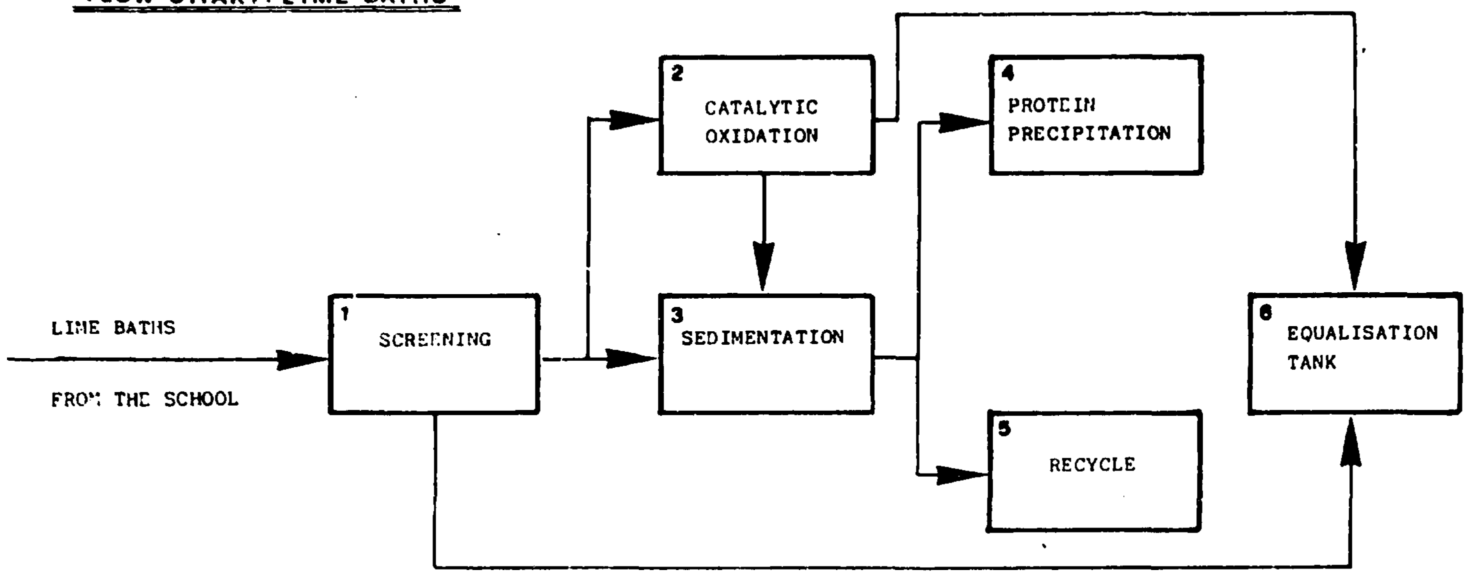
		Brazilian Costs	Typical Italian Costs
- Alum $Al_2(SO_4)_3.18\ H_2O$	US.$ /Kg =	0.21	0.18
- Lime $Ca(OH)_2$	US.$ /Kg =	0.15	0.06
- Sulphuric acid 94/96%	US.$ /Kg =	0.15	0.09
- Polyelectrolyte powder form	US.$ /Kg =	22.00	2.60
- Manganous sulphate $MnSO_4.H_2O$	US.$ /Kg.=	0.65	0.40
- Soda ash Na_2CO_3	US.$ /Kg.=	0.45	0.20
- Sodium hydroxide flakes	US.$ /Kg.=	0.50	0.35
- Sodium sulphide Na_2S (50/60%)	US.$ /Kg =	0.53	0.50
- Chromium basic sulphate (25% Cr_2O_3)	US.$ /Kg =	0.96	0.88

4. Operation and Maintenance (Labour costs)

The average labour rates in the tanning industry at 1.1.1984 was about 1300 US.$ per year (including fringe benefits).
These costs which are much lower than in Europe may justify a higher use of non-automated equipment and manual labour.

Note: The costs are estimated on an official exchange rate of 1 US.$ = 950 Cruzeiros at 1.1.1984.

FLOW CHART: LIME BATHS



TREATMENT ALTERNATIVES :

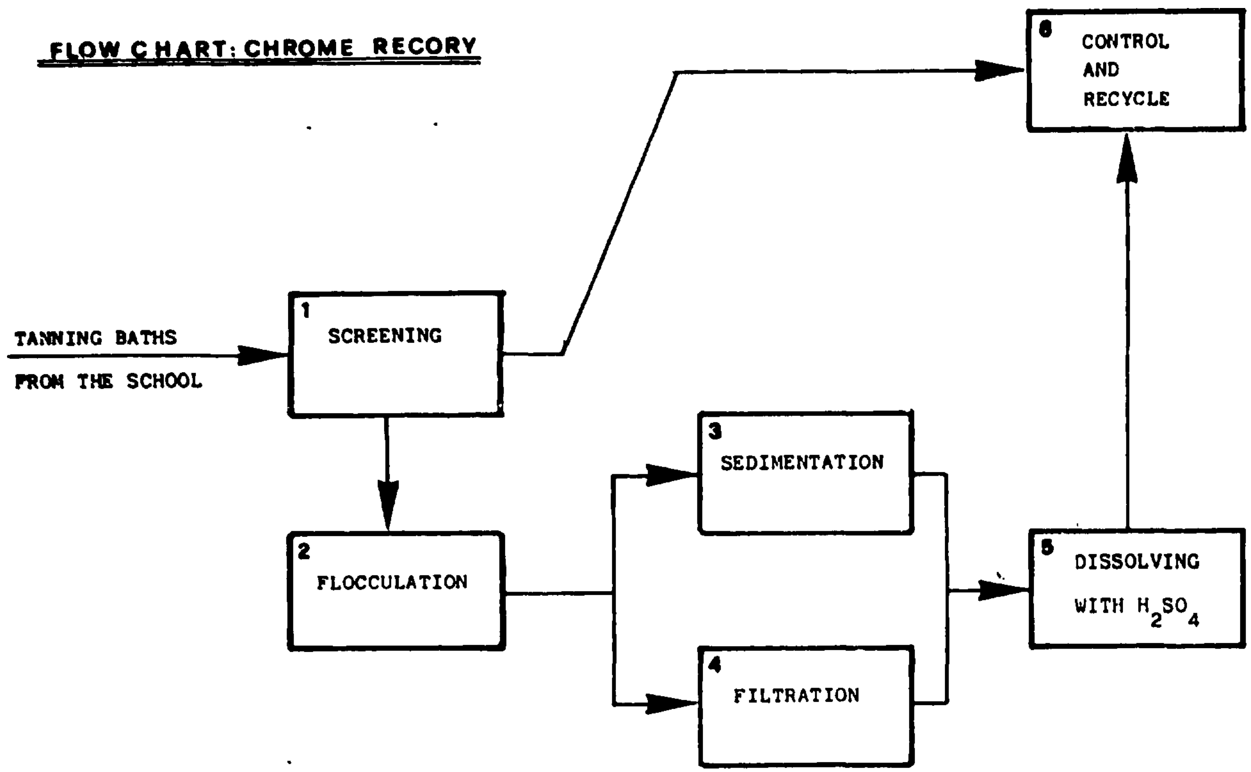
L.B.a. : 1 - 6

L.B.b. : 1 - 2 - 6

L.B.c. : 1 - 2 - 3 - 4

L.B.d. : 1 - 3 - 5

FLOW CHART: CHROME RECORY



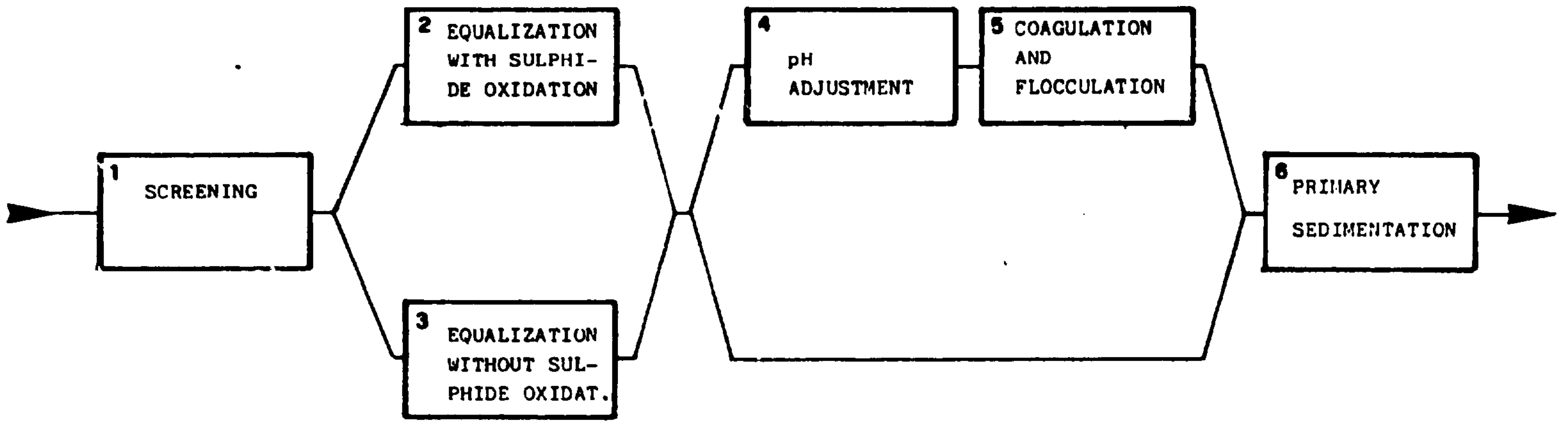
TREATMENT ALTERNATIVES :

C.R.a. : 1 - 6

C.R.b. : 1 - 2 - 3 - 5 - 6

C.R.c. : 1 - 2 - 4 - 5 - 6

FLOW CHART: PRIMARY TREATMENT



TREATMENT ALTERNATIVES :

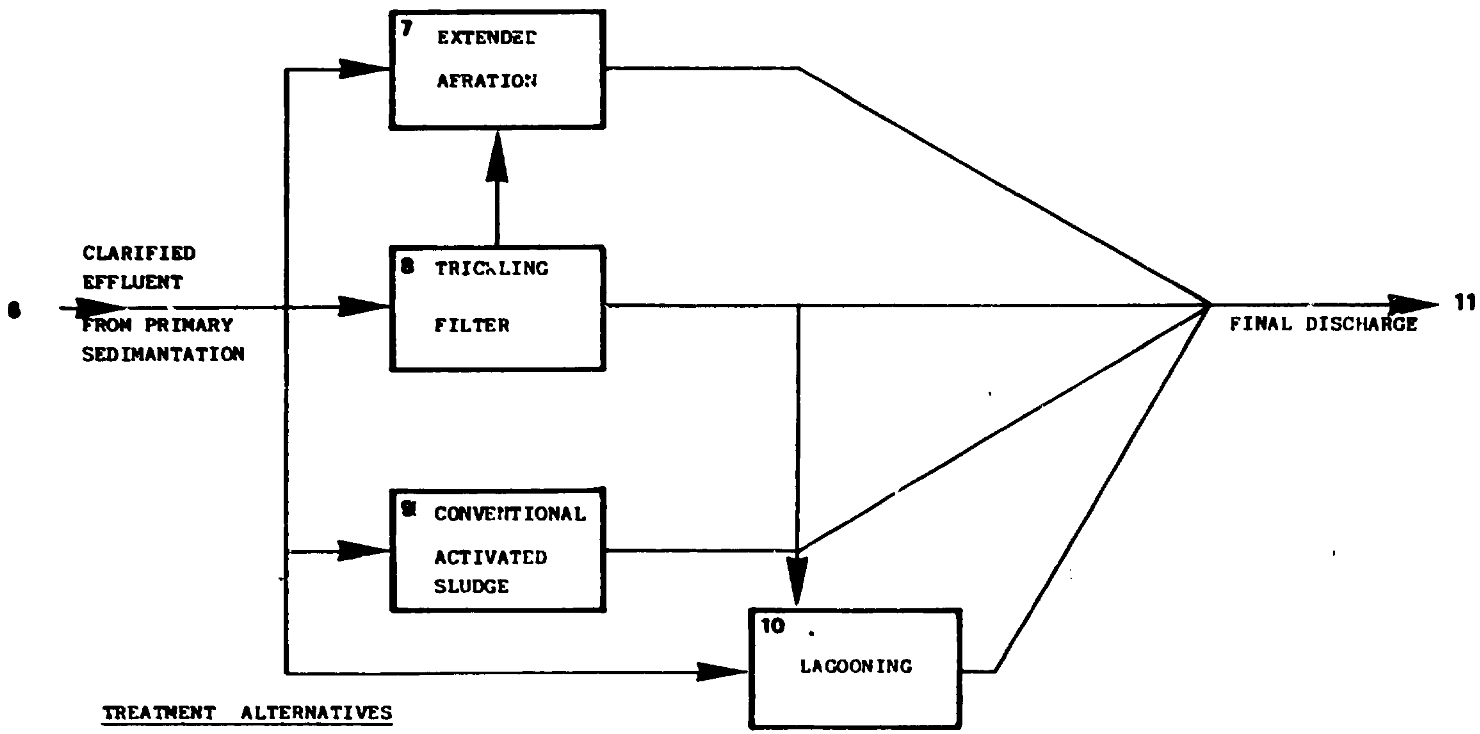
P.T.a. : 1 - 2 - 4 - 5 - 6

P.T.b. : 1 - 3 - 4 - 5 - 6

P.T.c. : 1 - 2 - 6

P.T.d. : 1 - 3 - 6

FLOW CHART: SECONDARY TREATMENT

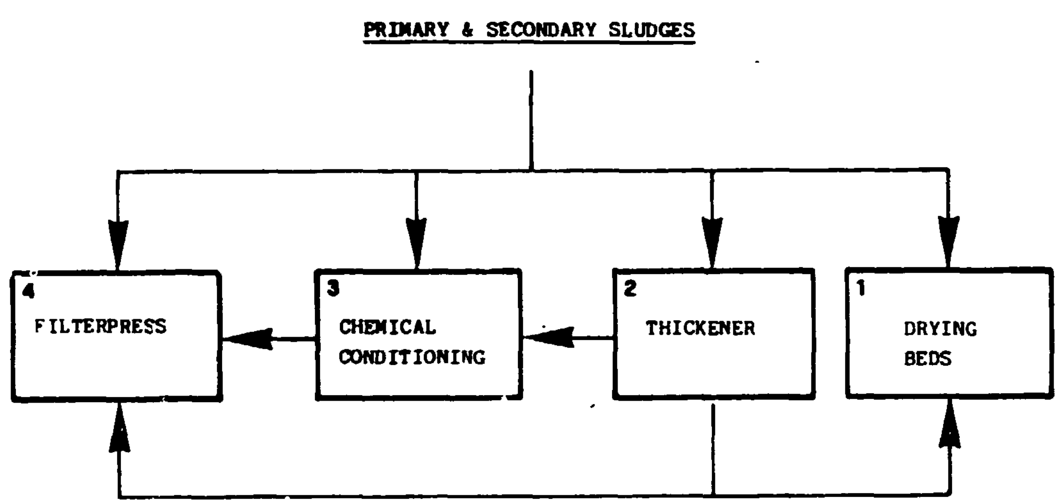


TREATMENT ALTERNATIVES

S.T.a.: 6-7-11
S.T.b.: 6-8-11
S.T.c : 6-8-10-11
S.t.d.: 6-9-11
S.T.e.: 6-8-7-11
S.T.f.: 6-10-11
S.T.g.: 6-9-10-11

ANNEX 2/V

FLOW CHART: SLUDGE TREATMENT



TREATMENT ALTERNATIVES :

SL.T. a. : 1

SL.T. b. : 2 - 1

SL.T. c. : 2 - 4

SL.T. d. : 2 - 3 - 4

SL.T. e. : 3 - 4

SL.T. f. : 4

EXTERNAL TANNERY MANUFACTURING PROCESS

- raw material processed: salted cattle hides (average 25 Kg per hide)
- number of hides processed: ca. 500 per day
- water use: 40 litres per Kg salted weight.

MANUFACTURING CYCLES SCHEME :

RAW HIDES

(*) **SOAKING:**
250% water
0.3% enzymatic soaking agent

(*) **WASHING:**
continuous flow

(*) **LIMING AND UNHAIRING:**
150% water
3% sodium sulphide (60%)
3.5-4% lime

(*) **WASHING:**
continuous flow

FLESHING (in some instances is performed after soaking)

SPLITTING

GRAIN

(*) **DELIMING AND BATING :**
100% water
1.5-2.0% ammonium sulphate
0.8-1.5% sodium sulphite
0.05% bating agent (protease enzymes)

PICKLING:
60% water
8% sodium chloride
1.2% sulphuric acid
0.5-1% sodium formate

VEGETABLE TANNING

PRETANNING:
(in the same pickling bath)
1.5% synthetic tannin

Note:
the same float is used for 2-3 pretanning baths before discharge

TANNING:
150% water
25% tanning extract powder (mimosa bark)

SHAVING

(*) **DYEING AND FATLIQUORING:**
(80% of production)
200% water
0.5% dye
5% vegetable grease
0.3% formic acid

(*) **FATLIQUORING:**
(20% of production)
200% water
5% sulphonated vegetable oil

DRYING

CHROME TANNING

TANNING:
(in the same pickling bath)
10% self-basifying chrome sulphate ($25\% Cr_2O_3$)
0.2% cationic fat

Note:
this float is used for splits tanning (once)

SHAVING

(*) **NEUTRALIZATION**
200% water
1% sodium formate
0.5% sodium bicarbonate

(*) **RETANNING, DYEING AND FATLIQUORING:**
200% water
3% synthetic tannin
0.5% dye
4-5% vegetable and synthetic grease mixture
0.5% formic acid

DRYING

FINISHING

SPLITS

(*) **TANNING:**
100% pickle float from grain
10% self-basifying chrome sulphate ($25\% Cr_2O_3$)
....
....
same manufactoring process as grain (chrome tanning)

Note:
(*) means discharged after use.

Effluent characteristics of external tannery

The results of 15 days tests are indicated in TABLE A

TABLE A

Parameters:	pH	Chloride (Cl) mg/l	COD bichromate mg/l	Settled solids (2h Imhoff) ml/l	Sulphide ($S^=$) mg/l
	8.9	5,240	3,100	10	148
	9.3	2,400	2,750	28	n.e.
	9.1	4,060	3,390	70	74
	9.2	1,740	2,590	23	51
	7.4	2,715	2,430	25	13
	8.1	1,700	3,470	27	10
	8.7	5,120	2,670	10	126
	9.1	2,140	915	15	n.e.
	8.7	3,150	3,180	8	199
	9.0	3,150	4,530	22	68
	8.5	2,330	3,500	82	65
	8.3	2,250	3,280	90	28
	7.9	1,540	2,500	55	7
	7.9	1,550	3,180	37	n.e.
	7.7	2,950	3,000	n.e.	n.e.

Note: samples taken during entry to the pilot plant
n.e. means not effected.

TABLE B

Parameters:	Range	Average
pH	7.4 - 9.3	8,5
Chlorides mg/l	1,540 - 5,240	2,800
COD mg/l	915 - 4,530	2,965
Settled solids ml/l	8 - 90	36
Sulphide mg/l	7 - 199	72

From these data we obtained the average values indicated in TABLE II.

TABLE III shows the data obtained from five different tanneries in the area.

TABLE C

Tannery	I	II	III	IV	V
pH	9.7	10.5	9.0	12.5	9.3
Chlorides mg/l	3,350	2.970	2,800	5,250	5,630
COD mg/l	6,990	6,930	1,250	3,950	5,630
Settled solids ml/l	65	240	2	19	220
Sulphide mg/l	86	41	n.e.	75	n.e.

Note: samples taken after homogenization was effected in the tanneries equalization tanks.

TABLE D shows the values obtained from the "Environmental considerations in the Leather Producing Industry" Report UNIDO/ITD. 337 9th June 1975 assuming a water consumption of 45 l/Kg (salt weight).

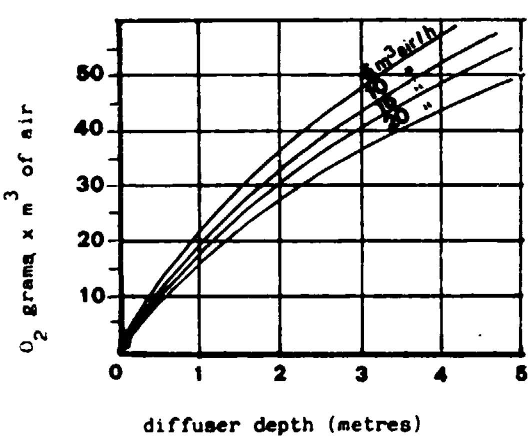
TABLE D

pH	ca. 10
Chlorides	3,500 mg/l
COD	3,500-4,500 mg/l
Settled solids	130-65 ml/l
Sulphide	160 mg/l

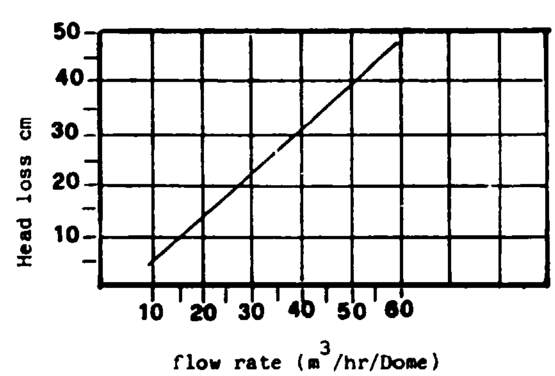
SINTERED ALUNDUM CANDLE DIFFUSERS

--- N.° pieces installed	: 12
--- Size	: Ø 50 mm 420 mm heigh
--- Porosity	: 100 micron
--- Oxygen transfer efficiency	: see diagram
--- Air Capacity	: see diagram

O_2 **TRANSFER EFFICIENCY**



AIR CAPACITY
Ø 50 x 420 mm

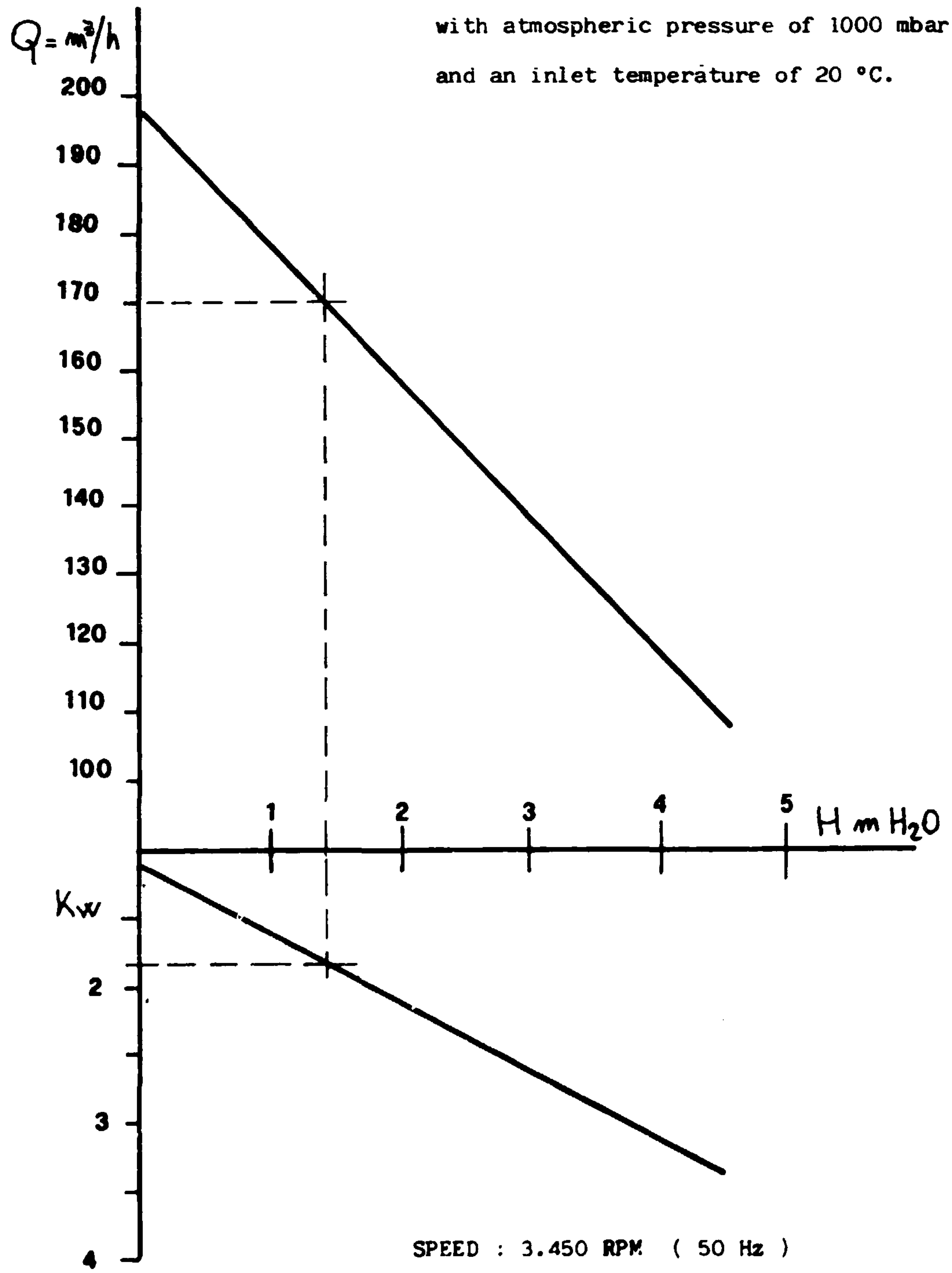


ROTARY VANE AIR BLOWER

--- INSTALLED POWER : 3.45 Kw 360 V/50 Hz triphase

--- AIR SUPPLIED : see diagram below

COMPRESSOR performances referred to air with atmospheric pressure of 1000 mbar and an inlet temperature of 20 °C.



SPEED : 3.450 RPM (50 Hz)

Tolerance on capacity and power ± 10 %

ANNEX 2/X

PRIMARY TREATMENT

ALUM 800 mg/l + 1 mg/l POLYELECTROLYTE

DATE	AIR °C TEMPERATURE	EQUALIZATION TANK EFFLUENT					CLARIFIED EFFLUENT			
		pH	Cl⁻ mg/l	C.O.D. mg/l	S.D. ml/l	B.O.D. mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l
22/6/83	8-12			2317					236	•
23/6/83	11-13	7.7	2946	1000			6.8		443	•
27/6/83	7-14	8.5	3408	3186			8.6		463	0.1
28/6/83	8-12	8.7	3976	5397	150	735	8.1		804	0.4
29/6/83	6-14	8.2	4188	7040	180		7.31	519	776	0.3
30/6/83	11-13	8.6	4260	3170	135		7.6	224	837	0.3
1/7/83	13-16	7.8	3697	4016	75		7.2	183	554	•
4/7/83	8-18	9.0	3834	2240	85		8.1		552	•
5/7/83	15-15	7.7	2875	2640	65		7.7		660	0.1
6/7/83	16-18	8.3	2236	1212	39	250	7.1		116	•
7/7/83	16-17	8.1	3301	1730	34		7.8	165	650	0.1
8/7/83	11-13		5254	1845				106	296	
11/7/83	11-11	8.4	2880	2348	54		7.6		729	•
12/7/83	11-12	7.4	4082	1689	100		6.7		474	•
13/7/83	11-16	7.7	4437	4129	190	495	7.7	300	1046	0.4
19/7/83	12-14	7.7	3555	2689	55		6.5		400	•
20/7/83	9-14	7.9	4220	3360	100		7.2	83	544	•
27/7/83	13-14.5	9.8	3555	2869	45		6		228	1
28/7/83	15-16	7.1	2982	1941	105		6.2		675	•
29/7/83	12.5-14	7.4	2733	2467	75		6	120	506	•
1/8/83	11.5-11.5	8.3	2769	1690	45	198	6.4		418	0.1
2/8/83	10.5-13	7.5	2485	1087	55		6.5		510	•
3/8/83	10-15	8.6	4011	4435	40		7.5	86	368	•
4/8/83	6.5-15	7.9	3227	2240	45		7.5		755	•
5/8/83	8-17.5	7.4	2591	1480	25		7.2		1120	2
9/8/83	11-14.5	7.5	3053	1576	35		7		622	0.5
10/8/83	14-19	8.9	3834	1752	30		7.5	263	500	•
11/8/83	20-26	7.6	3976	2944	90	535	7	130	920	•
12/8/83	17-21	7.7	3230	1392	58		7.7	320	1056	•
15/8/83	16.5-16.5	8.0	2982	2098	25		7		732	•
16/8/83	14-14	7.1	3230	1690	23		7		823	•
17/8/83	14-13.5	7.8	2982	1465	30		7.3	103	449	•
18/8/83	13-14.5	7.6	3443	2432	60	585	7.4	229	880	•
19/8/83	13-17	8.0	3086	4800	150		7.1		960	•
22/8/83	11-20	8.4	3443	2220	45					
23/8/83	15-21.5	7.4	3300	2631	60		6.6		551	•
24/8/83	16.5-17	7.8	2946	2121	55		7.3		805	•
25/8/83	18-33	8.3	3124	3019	70	610	7.3	146	677	0.5
26/8/83	24-29	8.0	2485	1314	50		7		750	•
29/8/83	24-29	7.9	3017	2764	80		7.4		523	•
30/8/83	23-23	7.6	2982	2729	75		6.9		480	•
31/8/83	15-17	8.1	2911	4034	140		7.1		335	0.2
1/9/83	12.5-23.5	8.0	2698	1287	60	320	7.1	109	463	•
2/9/83	15-23	8.0	3400	3433	140		7.5		370	•
3/9/83	9-20	8.1	3180	1000	20		6.9		318	•
5/9/82	17-20.5	8.9	2840	4641	130		8		464	0.7
8/9/83	18-22	7.1	2840	2565	70		6.9		362	•
12/9/83	14-13	8.7	2733	2036	50		7.6		581	•
13/9/8?	13-14.5	8.8	3053	1953	55		7.3		411	•
14/9/83	18-22	8.7	3783	2100	40		7.3	100	395	•
15/9/83	18-22	8.4	3621	1704	33	565	7.8	191	837	0.5
16/9/83	18-21	8.8	3514	2622	55		7.8	133	830	•
AVERAGE	13.4-17.3	8.0	3415	2580	70	480	7.2	185	590	0.1

Note: • means traces.

ANNEX 2/XI

PRIMARY TREATMENT

ALUM 400 mg/l + 1 mg/l POLYELECTROLYTE

DATE	AIR °C TEMPERA-TURE	EQUALIZATION TANK EFFLUENT					CLARIFIED EFFLUENT			
		pH	Cl^- mg/l	C.O.D. mg/l	S.D. ml/l	B.O.D. mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l
21/ 9/83	13-18	9.0		2300	33	353	7.5	132	626	4.5
22/ 9/83	16-18	9.2		3100	50	420	7.6	173	890	2.0
23/ 9/83	18-19	10.2		2197	35	340	7.4	126	703	-
27/ 9/83	22-28	7.6		4100	100		5.1		510	0.2
28/ 9/83	25-29.5	8.7		5941	65		7.4		800	-
29/ 9/83	23-18	8.8		2120	60	277	7.7	85	627	0.2
30/ 9/83	15-14	8.4		2433	30		8.2		516	-
3/10/83	20-24	8.7	2520	1840	20		7.4		393	-
4/10/83	24-28	7.3	2485	1104	20		6.8		284	-
5/10/83	24-28	9.3	3656	1473	18	237	7.9	60	577	1
7/10/83	24-30	8.3	2863	2100	60		7.7		512	-
10/10/83	17.5-15.5	8.9	2450	1657	28		8.5		418	-
11/10/83	16-17	8.5	2733	1925	40		7.4		653	-
13/10/83	21-27	8.0	2698	2016	40	440	7.5	185	611	1
14/10/83	21-27	8.2	2343	1620	60	270	7.8	80	430	-
17/10/83	21-21	8.5	2236	1469	28		7.7		408	-
18/10/83	16-17.5	8.7	3692	1828	35		7.5		506	-
19/10/83	22-28	8.3	3372	1877	28		7.3		440	-
20/10/83	23-26	8.3	2591	1501	33		7.7		538	-
21/10/83	22-19.5	8.1	2130	1632	40		7		261	-
25/10/83	19-22	7.4	1065	2016	38		6.8		1572	0.1
26/10/83	21-25	7.9	1207	2202	30		7.9		504	-
27/10/83	25-30	7.6	1065	1658	35	590	7.1	280	707	-
28/10/83	24-29	8.3	2165	1577	25	382	4.2	150	333	-
31/10/83	20-20	7.9	2236	1056	25		8.3		344	-
1/11/83	20-20	9.1	1917	1432	25		6.7		200	-
3/11/83	21-25	8.6	1917	1088	27		8		216	-
4/11/83	22-24	8.0	2059	1736	35		8		352	-
7/11/83	25-27	8.0	1917	1000	15		7.5		280	-
AVERAGE	20.7-23.2	8.4	2324	2000	32	370	7.4	140	515	0.3

ANNEX 2/XII

PRIMARY TREATMENT

ALUM 200 mg/l + 0.5 mg/l POLYELECTROLYTE

DATE	AIR °C TEMPERATURE	EQUALIZATION TANK EFFLUENT					CLARIFIED EFFLUENT				
		pH	Cl^- mg/l	C.O.D. mg/l	S.S. ml/l	B.O.D. mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	S.S. mg/l
8/11/83	24=26	8.3	2580	1305	3		8.5	162	398	•	230
9/11/83	21.5-25	8.9	2662	1368	3		7.7		438	•	350
10/11/83	24-29	8.2	2307	1195	3	472	8.1	149	532	•	
11/11/83	23-28	8.0	2627	1392	30	435	7.3	193	595	•	
16/11/83	21-21	8.5	3834	1535	35	390	7.8	171	691	2	
18/11/83		8.4	2414	1395	37	230	7.9	105	646	1.4	315
21/11/83	24-25	8.2	2485	1711	35		7.7		720	0.1	436
22/11/83	15-18	9.0	3337	1946	40		7.3		360	•	
23/11/83	17-22	8.6	3088	1387	40	420	8	160	630	•	
24/11/83	20-22.5	8.8	3017	1297	20	520	7.4	100	297	•	
25/11/83	20-24	8.3	3124	1542	35	400	7.5	225	658	0.5	
28/11/83	23-26	8.2	3124	1964	130		7		616	•	
29/11/83	22-28	8.7	3337	2875	70		8		580	•	
30/11/83	22-33	8.4	3692	2089	45	540	7.8	305	893	•	410
1/12/83	23.5-23	8.2	3124	1500	35	260	7.6	100	482	0.3	
2/12/83	20.5-21	8.4	2556	2964	30	300	7.4	110	500	0.4	
AVERAGE	21.4-24.8	8.4	2960	1720	43	400	7.7	165	570	0.3	

ANNEX 2/XIII

PRIMARY TREATMENT (ALTERNATIVE P.T.c.)

FLOW = 2 m^3/HR

No chemicals

DATE	IR °C EMPERA-TURE	EQUALIZATION TANK EFFLUENT					CLARIFIED EFFLUENT				
		pH	Cl^- mg/l	C.O.D. mg/l	S.D. ml/l	B.O.D. mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	S.S. mg/l
5/12/83	21-24	8.4	1990	1010	20		7.5		350	2.5	
6/12/83	22-26.5	8.4	1920	700	19		7.5		370	0.7	
9/12/83	2 .5-29.5	8.1	3870	2900			7.9		1640	0.5	420
12/12/83	24-28.5	8.1	3300	2040	180		8.1		2620	1.5	
13/12/83	2 .5-27	8.4	3020	2120	120		8.3		2220	0.8	
14/12/83	24-27	8.3	3585	1780	190	240	8.3	227	1780	0.1	
15/12/83	23-23.5	8.4	5150	1985	32		5.4		1810	0.1	225
19/12/83	25-25	8.0	3330	820			8.0		930	2.5	
20/12/83	23-30	8.1	3860	1185	210		7.8		950	•	12
21/12/83	23-25	7.8	3110	1640	0.5		7.9		280	•	
22/12/83	21-24.5	7.2	2850	3580	120		7.5		2300	•	
23/12/83	22-25	7.5	2560	6350	0.8		7.5		3340	0.6	
26/12/83	25-24	7.9	2400	1650	160		8.0		2120	10	
27/12/83	24-28.5	7.3	2250	4000	18		7.9		1360	2	
28/12/83	26-32	7.1	3940	12000	150		7.5	500	3640	3	
29/12/83	28-33	8.0	3430	5820	37	1270	7.5	910	4000	1	
3/ 1/84	25-24	7.0	2450	4080	14		7.6		1800	0.8	
4/ 1/84	23.5-28		3550	1080	390	1020		860	2580	•	
10/ 1/84	25-26.5	8.0	4650	1760	200	740	8.3	1000	2095	•	
11/ 1/84	29-28	8.0	4530	1120	25		7.7		1100	•	1030
12/ 1/84	26-29	8.1	3660	770	9		7.9		630	•	
13/ 1/84	27-32	8.0	4170	640		81	7.7	260	850	0.5	
30/ 1/84	23-27	8.0	4330	1350	40	330	7.6	130	570	6	
1/ 2/84	24-25	7.7	3760	1000	40	210	7.9	130	840	1	
2/ 2/84	25-25	7.7	4230	2250	50	370	7.9	90	950	4.5	
8/ 2/84	21-29	7.9	3270	1000	25	230	7.6	200	860	•	
9/ 2/84	24-28	6.6	890	4800	27	1350	7.0	380	2120	0.7	
13/ 2/84	32.5-33	7.2	2380	5200	35	2380	7.2	2250	4830	0.1	
14/ 2/84	28-35	7.5	4050	4180	50		7.2		3680	0.5	
15/ 2/84	27.5-33	7.6	3900	1960	20	680	7.9	280	1500	1	
16/ 2/84	28-33	7.5	4200	1679	40	530	7.7	430	1300	3.5	
17/ 2/84	26.5-30	7.4	3550	1870	95	380	7.5	250	710	•	360
20/ 2/84	28-31.5	7.3	3120	2690	70		7.7		635	10	
21/ 2/84		7.2	4690	3960	120		7.5		1460	4	
22/ 2/84	30-33	7.9	4190	6100	110	2000	7.4	1000	1950	0.1	
23/ 2/84	30.5-27	7.5	4730	4570	120	1300	7.8	510	1660	0.5	
24/ 2/84	27-33	7.8	4610	7120	175		7.0	400	800	•	
27/ 2/84	31	8.4	3370	4190	90		7.6		1930	1	
28/ 2/84	27.5-37.5	7.3	2870	4700			7.2		1790	0.1	
29/ 2/84	25-34	7.0	2720	5190	160		6.7		1410	24	
1/ 3/84	25-29		3940	6230	89			430	1490	4	
2/ 3/84	24-25	8.6	3340	4310	100		6.2	650	1080	•	
7/ 3/84	30-31	8.0	3800	2740	95		6.9		370	2	
23/ 3/84	20-31	8.3		2890	95		6.9		270	•	
27/ 3/84	22-38.5	7.8	2180	1500	40		7.0		590	•	
28/ 3/84	24-28	7.4		1760	40		6.6		320	•	
2/ 4/84	18.5-27	7.6	1090	3200	52		8.6		1470	5	
3/ 4/84		7.8	1120	1820	45		7.7		1280	6	
6/ 4/84	17-27	9.7		3920	75	1800	10.2	390	860	•	
9/ 4/84	19-29	8.6		3840	17		9.1		2270	10	
10/ 4/84	20-31	7.4		2660	35		8.3		1570	9.5	
11/ 4/84	20-30	8.3		2040	34	1040	8.1	520	1220	3.5	
12/ 4/84	20-29	8.2		2430	40	1200	6.2	640	1880	.5	
13/ 4/84	20-27	9.3		2970	20		9.4		2050	.5	
16/ 4/84	24-26	7.5		2400	68		8.0		1280	.5	
AVERAGE	24.5-28.8	7.8	3380	3055	77	890	7.7	540	1560	.5	410

Note: • means traces

ANNEX 2/XIV

SECONDARY TREATMENT (OXIDATION DITCH ALTERNATIVE S.T.a/I)

ALUM 500 mg/l + 1 mg POLYELECTROLYTE (P.T.a.1)

DATE	AIR °C TEMPERA-TURE	INFLUENT FROM PRIMARY SEDIMENTATION pH	B.O.D mg/l	C.O.D. mg/l	S.D. ml/l		EFFLUENT FROM SECONDARY SEDIMENTATION pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	
22/ 6/83	8-12			236	•				114		
23/ 6/83	11-13	6.8		443	•				88		
27/ 6/83	7-14	6.6		463	0.1				162		
28/ 6/83	8-12	8.[illegible]		804	0.4				121		
29/ 6/83	6-14	7.31	[illegible]	776	0.3			120	312		
30/ 6/83	11-13	7.6	224	837	0.3			41	203		
1/ 7/83	13-16	7.[illegible]	162	554	•			92	345	2.5	
4/ 7/83	8-18	8.[illegible]		552	•				128	2	
5/ 7/83	15-15	7.[illegible]		660	0.1				112		
6/ 7/83	16-16	7.[illegible]		1[illegible]6	•				180	2	
7/ 7/83	16-17	7.8	165	650	0.1				82	2.5	
8/ 7/83	11-13		106	296					181	15	
11/ 7/83	11-11	7.6		729	•				367		
12/ 7/83	11-12	6.[illegible]		424	•				86		
13/ 7/83	11-16	7.7	303	1046	0.4			27	140		
19/ 7/83	12-14	6.5		400	•		7.4		248	•	
20/ 7/83	9-14	7.2	85	544	•			38	360	•	
27/ 7/83	13-14.5	6		228	1				118	•	
28/ 7/83	15-16	6.2		675	•			24	177	•	
29/ 7/83	12.5-14	6	120	506	•			20	202	•	
1/ 8/83	11.5-11.5	6.4		418	0.[illegible]				125	•	
2/ 8/83	10.5-13	6.5		510	•				226	•	
3/ 8/83	10-15	7.5	86	368	•			12	142	•	
4/ 8/83	6.[illegible]-15.5	7.5		755	•				224	•	
5/ 8/83	8-17.5	7.2		1120	2		7.6		376		
9/ 8/83	11-14.5	7		622	0.5		6.9		439	•	
10/ 8/83	14-19	7.5	263	500	•			13	144	•	
11/ 8/83	20-26	[illegible]	130	920	•			12	136	10	
12/ 8/83	17-21	7.7	320	1056	•						
15/ 8/83	16.5-16.5	7		732	•		7.3		133	•	
16/ 8/83	14-14	7		823	•		6.6		150	•	
17/ 8/83	14-13.5	7.3	103	449	•		7.2	11	158	•	
18/ 8/83	13-14.5	7.4	229	680	•		7.3	18	158	•	
19/ 8/83	13-17	7.1		560	•		7.2		176	•	
22/ 8/83	11-20						7.1		123	•	
23/ 8/83	15-21.5	6.6		551	•		6.9		140	•	
24/ 8/83	16.5-17	7.3		605	•		7.1		296	•	
25/ 8/83	18-33	7.3	146	677	0.5		7	25	193	•	
26/ 8/83	24-29	7		750	•		6.9		310	•	
29/ 8/83	24-29	7.4		523	•		6.3		129	•	
30/ 8/83	23-32	6.9		480	•		6.6		214	•	
31/ 8/83	15-13	7.1		335	0.[illegible]		7.2		154	•	
1/ 9/83	12.5-23.5	7.1	109	463	•		7.4	10	171	•	
2/ 9/83	15-23	7.5		370	•		7		257	•	
3/ 9/83	9-20	6.9		318	-		7.2		100	•	
5/ 9/83	17-20.5	8		464	0.7		6.1		160	•	
6/ 9/83	17-19	6.9		362	•		5.9		152	•	
12/ 9/83	14-13	7.6		561	•		7.1		162	1.0	
13/ 9/83	13-14.5	7.3		411	•		7.6		311	•	
14/ 9/83	16-22	7.3	100	395	•		7.5	10	203	•	
15/ 9/83	16-22	7.6	191	837	0.5		7.2	13	270		
16/ 9/83	15-21	7.8	133	630	•		6.9	10	139		
AVERAGE	13.4-17.3	7.2	185	590	0.1		7	29	193	0.9	

Note: • means traces

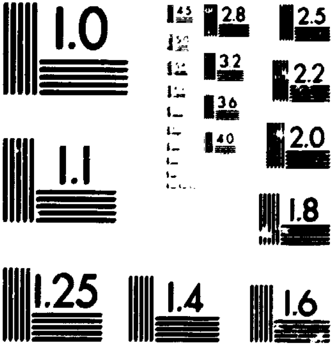
SECONDARY TREATMENT (OXIDATION DITCH ALTERNATIVE S.T.a./I)

ALUM 400 mg/l + 1 mg POLYELECTROLYTE (P.T.a.2)

DATE	AIR °C TEMPERA-TURE	INFLUENT FROM PRIMARY SEDIMENTATION					EFFLUENT FROM SECONDARY SEDIMENTATION				
		pH	B.O.D mg/l	C.O.D. mg/l	S.D. ml/l		pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	S.S. mg/l
21/ 9/83	13-18	7.5	132	626	4.5		6.4	9	274	1.5	
22/ 9/83	16-18	7.6	173	890	2.0		6.3	14	430	0.5	
23/ 9/83	18-19	7.4	126	703	•		6.4	10	301	•	
27/ 9/83	22-28	5.1		510	0.1		6.1		251	5	
28/ 9/83	25-29.5	7.4		800	•		6.2		477	1	264
29/ 9/83	23-18	7.7	85	627	0.2		5.9	9	392	•	
30/ 9/83	15-14	6.2		516	•		5.4	8	296	•	
3/10/83	20-24	7.4		393	•		6.9		125	•	
4/10/83	24-28	6.8		284	•		6.2		209	•	
5/10/83	24-28	7.9	60	577	1		5.9	9	184	•	
7/10/83	24-30	7.7		512	•		5.7		252	•	
10/10/83	17.5-15.5	8.5		418	•		7		227	•	
11/10/83	16-17	7.4		653	•		6.4		335	•	144
13/10/83	21-27	7.5	165	611	1		5.8	12	220	0.1	
14/10/83	21-27	7.8	80	430	•		5.2	10	290	•	
17/10/83	21-21	7.7		408	•		6.2		277	•	
18/10/83	16-17.5	7.5		505	•		6		508	•	
19/10/83	22-28	7.3		440	•		5.9		294		
20/10/83	23-26	7.7		538	•		5.7		318		
21/10/83	22-19.5	7		261	•		6.3		196		
25/10/83	19-22	6.8		1572	0.1		5.3		397		
26/10/83	21-25	7.9		504	•		6.5		219		
27/10/83	25-30	7.1	280	707	•		6.1	28	292		
28/10/83	24-28	4.2	150	333	•		5.3	11	160		
31/10/83	20-20	6.3		344	•		5.6		152		
1/11/83	20-20	6.7		[illegible]	•		7		220		
3/11/83	21-25	8		216	•		6.7		176		
4/11/83	22-24	8		352	•		6.2		228	•	
7/11/83	25-27	7.5		280	•		6.8		128	•	
AVERAGE	20.7-23.2	7.4	140	525	0.3		6.2	12	270	0.4	

Note: • means traces

85 01 17



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

ANNEX 3/XVI

SECONDARY TREATMENT (OXIDATION DITCH ALTERNATIVE S.T.a./I)

ALUM 200 mg/l + 0.5 mg POLYELECTROLYTE (P.T.a.3)

DATE	AIR °C TEMPERA-TURE	INFLUENT FROM PRIMARY SEDIMENTATION					EFFLUENT FROM SECONDARY SEDIMENTATION				
		pH	B.O.D mg/l	C.O.D. mg/l	S.D. ml/l		pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	S.S. mg/l
8/11/83	24-26	8.5	162	398	•		6.4		156	•	
9/11/83	21.5-25	7.7		438	•		7.7				
10/11/83	24-29	8.1	149	532	•						
11/11/83	23-28	7.3	183	595	•		6.5	22	164	•	
16/11/83	21-21	7.8	171	691	2		6	6	403	•	70
18/11/83		7.9	105	646	1.4						
21/11/83	24-25	7.7		720	0.1		6.4		171	•	
22/11/83	15-18	7.3		360	•		6.6		207	0.1	20
23/11/83	17-22	8	160	630	•		7	14	180	•	
24/11/83	20-22.5	7.4	100	297	•		6.5	18	189	•	
25/11/83	20-24	7.5	225	658	0.5		6.7	8	189	•	
28/11/83	23-26	7		616	•		6.5		339	•	
29/11/83	22-28	8		580	•		6.3		312	1.5	200
30/11/83	22-33	7.8	305	893	•		6.5	25	410	0.5	
1/12/83	23.5-23	7.6	100	482	0.3		5.9	10	232	0.5	
2/12/83	20.5-21	7.4	110	500	0.4		6.4	10	223	•	
AVERAGE	21.4-24.8	7.7	165	570	0.3		6.5	14	244	0.2	

Note: • means traces.

ANNEX 2/XVII

SECONDARY TREATMENT (OXIDATION DITCH ALTERNATIVE S.T.a./I)
No chemicals (P.T.a.) FLOW = 1 m^3/HR

DATE	AIR °C TEMPERATURE	INFLUENT FROM PRIMARY SEDIMENTATION					EFFLUENT FROM SECONDARY SEDIMENTATION				
		pH	B.O.D mg/1	C.O.D. mg/1	S.D. ml/1		pH	B.O.D. mg/1	C.O.D. mg/1	S.D. ml/1	S.S. mg/1
5/12/83	21-24	7.6		350	2.5		6.4			•	
6/12/83	22-26.5	7.5		370	0.7		6.8		359	0.7	
9/12/83	24.5-29.5	7.5		1640	0.5	420	7.2		450	0.7	
12/12/83	24-28.5	8.1		2620	1.5		7.0		540	2	4.5
13/12/83	23.5-27	8.3		2220	0.8		7.3		664	6	
14/12/83	24-27	8.3	227	1780	0/1		7.7	3	408	4	
15/12/83	23-23.5	8.4		1810	0.1	325	7.7		264	0.2	
19/12/83	25-25	8.0		930	2.5		7.5		385	0.1	
20/12/83	23-30	7.8		950	•	12	7.3		300	0.3	
21/12/83	23-25	7.9		280	•						
22/12/83	21-24.5	7.5		2300	•						
23/12/83	22-25	7.5		3840	0.6						
26/12/83	25-24	8.0		2120	10		6.3		452	3	
27/12/83	24-28.5	7.9		1360	2		6.3		315	3.5	
28/12/83	26-32	7.5	500	3640	3		6.4		860	3.2	
29/12/83	28-33	7.5	910	4000	1		6.4	12	390	1.0	
3/ 1/84	25-24	7.6		1800	0.8		7.3		640	3.5	
4/ 1/84	23.5-28		860	2580	•			30	2940	1.0	
10/ 1/84	25-28.5	8.3	1000	2096	•						
11/ 1/84	29-28	7.7		1100	•	1030					
12/ 1/84	26-29	7.9		630	•		7.7		300	0.2	
13/ 1/84	27-32	7.7	260	850	0.5		5.9		472	0.8	
30/ 1/84	23-27	7.6	130	570	6						
1/ 2/84	24-25	7.9	130	840	1		6.7	20	310	1.0	
2/ 2/84	25-25	7.9	90	950	4.5		7.0	24	580	0.3	
8/ 2/84	21-29	7.6	205	860	•		6.0	21	400	•	
9/ 2/84	24-28	7.0	380	2120	0.7						
13/ 2/84	32.5-33	7.2	2250	4830	0.1						
14/ 2/84	27.5-33	7.3	290	1500	1		7.1	20	630	1.5	
16/ 2/84	28-33	7.7	430	1300	3.5		7.5	25	470	2.0	
17/ 2/84	26.5-30	7.5	250	710	•	360	7.4	22	370	1.0	
20/ 2/84	28-31.5	7.[illegible]		635	10		7.1		310	7.0	
21/ 2/84		7.5		1460	4		7.0		270	0.2	
22/ 2/84		7.5	1000	1350	0.1		7.4		250	15	
23/ 2/84	30.5-27	7.8	510	1660	0.5		7.[illegible]	40	350	5	
24/ 2/84	27-33	7.0	400	800	•		[illegible]	40	190	•	
27/ 2/84	31	7.6		1430	1		7.8		425	1	
28/ 2/84	27.5-37.5	7.2		1730	0.1		7.7		450	2	
29/ 2/84	25-34	6.7		1410	24		7.2		210	0.2	
1/ 3/84	25-29		430	1490	4				300	0.1	
2/ 3/84	24-25	6.2	650	1080	•		7.5	230	520	5	
7/ 3/84	30	6.9		370	2		6.3		270	•	
23/ 3/84	20-31	6.9		270	•		7.1		300	•	
27/ 3/84	22-32.5	7.0		540	•		6.3		280	0.5	
28/ 3/84	24-28	6.6		320	•						
2/ 4/84	18.5-27	8.6		1470	5						
AVERAGE	24.5-28	7.8	540	1560	.5	410	7.5	40	46	-	

Note: • means traces

ANNEX 2/XVII-bis

SECONDARY TREATMENT (OXIDATION DITCH - ALTERNATIVE S.T.a/I)

No Chemicals (P.T.c..

DATE	AIR °C TEMPERATURE	INFLUENT FROM PRIMARY SEDIMENTATION					EFFLUENT FROM SECONDARY SEDIMENTATION				
		pH	B.O.D mg/l	C.O.D. mg/l	S.D. ml/l		pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	S.S. mg/l
18/ 4/84		8.1	420	1026	1.3		7.1	20	310	0.1	
10/ 5/84		7.8	500	1000	77		7.0	68	268	•	
11/ 5/84		8.1		1315	•		7.2	65	233	•	
15/ 5/84		8.0		1900	17		5.7		478	0.6	
16/ 5/84		8.2	520	1470	4.0		7.6	51	232	•	
17/ 5/84		7.6	400	2350	3.0		6.8	62	432	•	
29/ 5/84		7.6		925	10		7.3		145	•	
30/ 5/84		8.5		2120	25		7.5		218	•	230
31/ 5/84		8.4		1200	0.5		7.8		521	•	
1/ 6/84		8.2	520	1310	1.8		7.9	30	370	4.5	710
6/ 6/84		7.7	165	430	•		7.3	26	232	•	
7/ 6/84		7.6		1553	10		7.5		172	•	
8/ 6/84		7.3		1750	0.1		5.8		224	•	50
11/ 6/84		7.1		1470			6.7		375	•	
12/ 6/84		8.3	1480	1465	0.6		7.5		500	7.5	225
13/ 6/84		8.4	1000	1950	4		7.6	160	888	11	
14/ 6/84		6.9	700	1850	7.6		7.6	200	742	5.5	
15/ 6/84		6.8	1150	2880	17		7.7	340	967	11	
AVERAGE		8.0	645	1553	8.4		7.3	83	375	2.3	330

<u>Note</u>: • means traces.

SECONDARY TREATMENT (FLOATING AERATOR [illegible])

ALUM 200 mg/l + 1 mg POLYELECTROLYTE [illegible]

DATE	AIR °C TEMPERA-TURE	INFLUENT FROM PRIMARY SEDIMENTATION				EFFLUENT FROM SECONDARY SEDIMENTATION			
		pH	B.O.D. mg/l	C.O.D. mg/l	S.S. ml/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.S. ml/l
22/ 6/83	8-12			236				236	
23/ 6/83	11-13	6.6		443		[illegible]		105	
27/ 6/83	7-14	6.6		463	0			97	
28/ 6/83	8-12	8.1		804	0.			204	
29/ 6/83	6-14	7.31	519	776	0.		59	172	
30/ 6/83	11-13	7.6	224	837	0.		11	105	
1/ 7/83	13-16	7.2	183	554	•		10	56	
4/ 7/83	8-16	8.1		552	•			312	5
5/ 7/83	15-15	7.7		660	0.1			152	0.1
6/ 7/83	16-18	7.1		116	•			164	
7/ 7/85	16-17	7.6	165	650	0.1		14	62	
8/ 7/85	11-13		106	296			13	62	
11/ 7/83	11-11	7.6		729	•			490	
12/ 7/83	11-12	6.7		474	•			78	•
13/ 7/83	11-16	7.7	300	1046	0.4		24	222	0.5
19/ 7/83	12-14	6.5		400	•			400	
20/ 7/83	9-14	7.2	89	544	•		49	456	
27/ 7/83	13-14.5	6		228	[illegible]			405	0.1
28/ 7/83	15-16	6.2		575	•		16	337	•
29/ 7/83	12.5-14	6	120	506	•		21	363	•
1/ 8/83	11.5-11.5	6.4		416	0.1				•
2/ 8/83	10.5-13	6.5		510	•			284	•
3/ 8/83	10-15	7.5	86	368	•		[illegible]	251	•
4/ 8/83	6.5-15	7.5		755	•			[illegible]	•
5/ 8/83	8-17.5	7.2		1120	•	7.2		136	1
9/ 8/83	11-14.5			622	0.5				
11/ 8/83	20-26	[illegible]	130	320	•		13	352	13
12/ 8/83	17-21	7.1	320	1056	•	6.6	16	248	•
15/ 8/83	16.5-16.5	[illegible]		732	•	6.		183	•
16/ 8/83	14-14	[illegible]		923	•	[illegible]		150	•
17/ 8/83	14-13.5	7.3	103	449	•	[illegible]	22	249	•
18/ 8/83	13-14.5	7.4	223	869	•	[illegible]	19	345	•
19/ 8/83	13-17	7.1		360	•	7.4		340	•
22/ 8/83	11-20					[illegible]		345	
23/ 8/83	15-21.5	6.6		[illegible]	•	7.3		280	•
24/ 8/83	16.5-17	7.3		305	•	7.-		419	5
25/ 8/83	18-33	7.3	146	577	0.5	7.4	18	220	•
26/ 8/83	24-29	7		750	•	[illegible]		400	•
29/ 8/83	24-23	7.4		[illegible]	•	[illegible]		129	•
30/ 8/83	23-23	6.9		480	•	6.3		274	•
31/ 8/83	15-17	7.1		335	0.2	[illegible]		320	•
1/ 9/83	12.5-23.5	7.1	109	465	•	[illegible]	13	309	•
2/ 9/83	15-23	7.5		370	•			172	•
3/ 9/83	9-20	6.		318	•	[illegible]		[illegible]	•
5/ 9/83	17-20.5	8		464	0.1	6.4		486	•
6/ 9/83	18-22	6.9		362	•	[illegible]		336	•
12/ 9/83	14-13	7.6		561	•	6.6		511	•
13/ 9/83	13-14.5	7.3		411	•	.3		444	•
14/ 9/83	16-22	7.3	100	395	•	[illegible]	20	361	•
15/ 9/83	16-22	7.6	191	837	0.1	6.5	22	436	•
16/ 9/83	16-21	7.8	133	630	•	[illegible]	25	472	•
AVERAGE	13.3-17.4	7.2	181	590	0.15	[illegible]	22	284	0.8

Note: • [illegible]

ANNEX 2/XIX

SECONDARY TREATMENT (FLOATING AERATOR S.T.a/II)

ALUM 400 mg/l + 1 mg POLYELECTROLYTE (P.T.a.2)

DATE	AIR °C TEMPERATURE	INFLUENT FROM PRIMARY SEDIMENTATION				EFFLUENT FROM SECONDARY SEDIMENTATION			
		pH	B.O.D mg/l	C.O.D. mg/l	S.O. ml/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.O. ml/l
21/ 9/83	13-18	7.5	132	626	4.5	6.5	32	652	2
22/ 9/83	16-18	7.6	173	890	2.0	7	44	630	0.1
23/ 9/83	18-19	7.4	126	703	•	6.5	26	518	•
27/ 9/83	22-28	5.1		510	0.2	6.3		502	•
28/ 9/83	25-29.5	7.4		800	•	6.4		544	•
29/ 9/83	23-16	7.7	65	627	0.2	6.3	20	382	•
30/ 9/83	15-14	8.2		516	•	6		364	•
4/10/83	24-28	6.8		284	•	6		468	10
5/10/83	24-28	7.9	60	577	1	5.9	19	586	2
7/10/83	24-30	7.7		512	•	5.9		353	•
10/10/83	17.5-15.5	8.5		418	•	7.8		284	•
11/10/83	16-17	7.4		653	•	6.2		393	1.5
13/10/83	21-27	7.5	185	611	1	6.5	29	347	•
14/10/83	21-27	7.8	80	430	•	6.8	20	438	•
17/10/83	21-21	7.7		465	•	6.7		504	•
18/10/83	16-17.5	7.5		505	•	6		577	•
4/11/83	22-24	8		352	•	6.2			
AVERAGE	20-22.3	7.7	120	553	0.3	6.4	27	484	1.0

<u>Note</u>: • means traces.

ANNEX 2/XX

COMPARATIVE TABLE

OXIDATION DITCH AND FLOATING AERATOR TREATMENTS

DATE	AIR C° TEMPERATURE	EFFLUENT FROM OXIDATION DITCH pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l	EFFLUENT FROM EXTENDED AERATION (FLOATING AERATOR) pH	B.O.D. mg/l	C.O.D. mg/l	S.D. ml/l
22/ 6/83	8-12			114				236	
23/ 6/83	11-13			88		7.7		10.	
27/ 6/83	7-14			162				97	
28/ 6/83	8-12			121				204	
29/ 6/83	6-14		120	312			59	172	
30/ 6/83	11-13		41	203			11	105	
1/ 7/83	13-16		92	345	2.5		10	56	
4/ 7/83	8-18			128	2			312	9
5/ 7/83	15-15			112				152	0.1
6/ 7/83	16-18			180	2			164	
7/ 7/83	16-17			82	2.5		14	82	
8/ 7/83	11-13			181	15		13	82	
11/ 7/83	11-11			867				490	-
12/ 7/83	11-12			86				78	-
13/ 7/83	11-16		27	140			24	222	0.5
19/ 7/83	12-14	7.4		248	-	7.7		400	
20/ 7/83	9-14		38	360	-		49	456	
27/ 7/83	13-14.5			118	-			405	0.1
28/ 7/83	15-16		24	177	-		18	337	-
29/ 7/83	12.5-14		20	202	-		21	363	-
1/ 8/83	11.5-11.5			125	-				-
2/ 8/83	10.5-13			226	-			284	-
3/ 8/83	10-15		12	142	-		16	251	-
4/ 8/83	6.5-15.5			224	-			315	-
5/ 8/83	8-17.5	7.6		376		7.3		296	1
9/ 8/83	11-14.5	6.9		439	-				
10/ 8/83	14-19		13	144	-				
11/ 8/83	20-26		12	136	10		13	352	13
12/ 8/83	17-21					6.8	16	248	-
15/ 8/83	16.5-16.5	7.3		133	-	6.7		183	-
16/ 8/83	14-14	6.6		150	-	[illegible]		250	-
17/ 8/83	14-13.5	7.2	11	158	-	7.1	22	245	-
18/ 8/83	13-14.5	7.3	18	158	-	7.3	19	249	-
19/ 8/83	13-17	7.2		176	-	7.4		240	-
22/ 8/83	11-20	7.1		123	-	7		345	
23/ 8/83	15-21.5	6.9		140	-	7.3		280	-
24/ 8/83	16.5-17	7.1		295	-	7.6		419	6
25/ 8/83	18-33	7	25	193	-	7.4	18	220	-
26/ 8/83	24-29	6.9		310	-	7		400	-
29/ 8/83	24-29	6.3		129	-	6.3		129	-
30/ 8/83	23-23	6.6		214	-	6.5		274	-
31/ 8/83	15-13	7.2		154	-	6.2		320	-
1/ 9/83	12.5-23.5	7.4	10	171	-	6.9	23	309	-
2/ 9/83	15-23	7		257	-	7		370	-
3/ 9/83	9-20	7.2		130	-				
5/ 9/83	17-20.5	6.1		161	-	6.4		489	-
6/ 9/83	17-19	5.9		152	-	5.7		337	-
12/ 9/83	14-13	7.1		162	-	6.8		611	-
13/ 9/83	13-14.5	7.6		311	-	7.3		444	-
14/ 9/83	16-22	7.5	10	203		7.2	20	361	-
15/ 9/83	16-22	7.2	13	270		6.6	23	436	-
16/ 9/83	16-21	6.9	10	199		6.5	26	472	-
21/ 9/83	13-18	6 4	9	274		6.5	32	652	2
22/ 9/83	16-18	6 3	14	430		7	44	630	0.1
23/ 9/83	18-19	6 4	10	301		6.6	28	518	-
27/ 9/83	22-28	6 1		257		6.3		502	-
28/ 9/82	25-29.5	6 2		477		6.4		544	-
29/ 9/83	23-18	5 9	9	392		6.3	20	382	-
30/ 9/83	15-14	5 1		296		6		364	-
4/10/83	24-28	6		209	-	6		468	10
5/10/83	24-28	5	9	184	1	5.9	19	586	2
7/10/83	24-30	5		252	-	5.5		353	
10/10/83	17.5-15.5			227	-	7.8		284	-
11/10/83	16-17	6		335	-	6..		393	1.5
13/10/83	21-27	5	12	220	0.1	6.5	29	347	-
14/10/83	21-27	5	10	290	-	5.8	20	438	-
17/10/83	21-21	6		277	-	6.7		604	-
18/10/83	18-17.5			506	-	6		677	-
4/11/83	22-24	6		228	-	6.2			
AVERAGE	15-18.5	6.	24	220	0.7	6.7	23.5	339	0.9

TRICKLING FILTER WITH PLASTIC MEDIA

SECONDARY TREATMENT (ALTERNATIVE S.T.b./I)

(PLASTIC MEDIA)

DATE	AIR °C TEMPERATURE	INFLUENT FROM PRIMARY SEDIMENTATION					EFFLUENT FROM SECONDARY SEDIMENTATION				
		pH	B.O.D mg/l	C.O.D. mg/l	S.O. ml/l	S.S. mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.O. ml/l	S.S. mg/l
21/11/83	24-25	7.7		720	0.1	436	8.3		468	•	
23/11/83	17-22	8	160	630	•		8.4	69	490	•	
24/11/83	20-22.5	7.4	100	297	•		8.4	51	350	•	
25/11/83	20-24	7.5	225	658	0.5		8.3	50	491	•	
28/11/83	23-26	7		616	•		8.1		357	•	
29/11/83	22.5-28	8		580	•		8.4		420	•	
30/11/83	22-33	7.8	305	893	•	410	8.2	77	571	•	93
1/12/83	23.5-23	7.6	100	482	0.3		8.2	45	375	•	85
2/12/83	20.5-21	7.4	110	500	0.4		8.5	37	435	•	
5/12/83	21-24	7.6		349	2.5		8.2		312	0.5	
6/12/83	22-26.5	7.5		367	0.7		8.3		468	0.1	
9/12/83	24.5-29.5	7.9		1640	0.5	420	8.1		480	0.7	
12/12/83	24-28.5	8.1		2620	1.5		8		1240	3	
13/12/83	23.5-27	8.3		2220	0.8		8.2		1789	1.6	270
14/12/83	24-27	8.3	227	1780	0.1		8.2	61	1080	•	
15/12/83	23-23.5	8.4		1808	0.1	225	8		448	0.2	
18/12/83	25-25	8		930	2.5		7.6		479		
20/12/83	23-30	7.8		954	-	12	7.1		512		
21/12/83	23-25	7.9		280	•		8.0		476	0.3	
22/12/83	21-24.5	7.5		2300	•		7.5				
23/12/83	23-25	7.5		3340	0.6		8.1		2024	0.6	
26/12/83	25-24	8.0		2120	10		7.9		703	3.0	
27/12/83	24-28.5	7.9		1360	2		8.1		889	12	
28/12/83	26-32	7.5	500	3640	3		7.9		1860	0.8	
29/12/83	28-33	7.5	910	4000	1		8.0	[illegible]	1503	-	
3/ 1/84	25-24	7.6		1800	0.8		8.1		1600	2.5	
4/ 1/84	23.5-28		860	2580	•		8.1	200	760	0.5	
5/ 1/84	25-28.5	8.3	1000	2100	•		8.1	210	978	0.7	
11/ 1/84	24-28	7.7		1100	•	1030					
12/ 1/84	26-29	7.9		630	•		7.9		504	3.5	
13/ 1/84	27-32	7.7	260	850	0.5		7.8		452	•	
1/ 2/84	24-25	7.9	130	840	1		7.0	20	405	0.7	
2/ 2/84	25-25	7.9	90	950	4.5		7.7	160	970	0.2	
9/ 2/84	24-28	7.0	380	2120	0.7		8.6	100	1602	1.0	
10/ 2/84	23.5-27	8.2		2220			6.5	320	2320	1.0	
13/ 2/84	32.5-33	7.2	2250	4830	0.1		7.3				
14/ 2/84	28-35	7.2		3680	0.5		7.3		1372	3.5	
15/ 2/84	27.5-33	7.9	280	1500	1		7.8		1046	15	
16/ 2/84	28-33	7.7	430	1300	3.5		7.1		602	0.5	
17/ 2/84	28.5-30	7.5	250	710	•	360	7.7		586	20	
20/ 2/84	28-31.5	7.7		635	10		7.1		500	6	
21/ 2/84		7.5		1460	4		7.5		569	0.5	
22/ 2/84	30-33	7.4	1000	1950	0.1		7.8		666	0.1	
23/ 2/84	30.5-27	7.8	510	1660	0.5		7.9	147	538	0.1	
24/ 2/84	27-33	7.0	400	800	•		7.7	75	280	4.5	
28/ 2/84	27.5-37.5	7.2		1790	0.1		8.0		603	15	
29/ 2/84	25-34	6.7		1410	24		7.9		378	0.3	
1/ 3/84	25-29		430	1490	4		7.4		525	6.0	
2/ 3/84	24-25	8.2	650	1080	•		8.0	225	440	1.5	
AVERAGE	24.8-27.5	7.8	481	1521	1.7	415	7.9	119	803	2.4	149

Note: • means traces.

ANNEX 2/XXII

SECONDARY TREATMENT WITHOUT PRIMARY SEDIMENTATION

(ALTERNATIVE S.T.P.)

DATE	AIR °C TEMPERATURE	INFLUENT FROM pH REGULATION TANK					EFFLUENT AFTER SEDIMENTATION (BASE SYST.)				
		pH	B.O.D. mg/l	C.O.D. mg/l	S.S. ml/l	S.S. mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	S.S. ml/l	S.S. mg/l
11/11/83	23-24	8	435	1392	30	540	8	25	592	2	
16/11/83	21-21	8.5	388	1535	35		7.2	22	179	1.8	
17/11/83	26-26						8.3	21	425	4	245
18/11/83	26-26	8.4	230	1345	37		8.2		450	2	
21/11/83	24-25	8.2		1711	35	785	8.4		405	•	230
22/11/83	15-18	5		1946	40		6.7	15	360	•	
23/11/83	17-22	8.6	400	1387	40		[illegible]	[illegible]	405	•	
24/11/83	20-22.5	8.3	518	1297	[illegible]		6		586	•	
25/11/83	20-24	8.3	[illegible]	1542	[illegible]		5.3	24	543	1.5	
26/11/83	23-25	8.2		1964	30		5.5	35	550	•	
29/11/83	22.5-28	8.7		2875	70		5.8	35	344		570
30/11/83	22-33	8.4	[illegible]	2088	[illegible]		5.3	35	556	•	
1/12/83	23.5-23	6.2	257	1503	35	[illegible]					
13/12/83	23.5-27	8.4		2120	[illegible]	1440	7.8		1600	•	
14/12/83	24-27	8.3	240	1780	[illegible]		8.2	37	880	•	[illegible]
15/12/83	23-23.5	8.4		1384	32		7.3		[illegible]	•	
19/12/83	25-25	8		616	[illegible]		7.6		236	•	[illegible]
20/12/83	33-30	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	
22/12/83	21-24.5	7.2	[illegible]	3380	120		8.2	[illegible]	[illegible]	•	
[illegible]/12/83	22-25	7.5		[illegible]	[illegible]		[illegible]		[illegible]	•	
26/12/83	25-29	7.3		1690	[illegible]		[illegible]		[illegible]	•	
27/12/83	[illegible]	[illegible]		4000	[illegible]		[illegible]		[illegible]	0.3	
28/12/83	26-32	7.1	[illegible]	12000	[illegible]		[illegible]	[illegible]	364	•	[illegible]
29/12/83	28-33	8.0	1270	[illegible]	[illegible]		8.4		624		110
5/ 1/84	25-28.5	8.0	740	1760	[illegible]		7.8	[illegible]	[illegible]	[illegible]	
11/ 1/84	29-28	8.0		1120	[illegible]		[illegible]		[illegible]	•	
12/ 1/84	26-29	[illegible]		770	[illegible]		[illegible]		[illegible]	0.8	
13/ 2/84	32.5-33	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	
14/ 2/84	28-35	[illegible]		[illegible]	[illegible]		6.6		[illegible]	[illegible]	
23/ 2/84	30.5-27	[illegible]	1300	[illegible]	[illegible]		[illegible]	[illegible]	388	[illegible]	
27/ 2/84	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	
28/ 2/84	[illegible]	7.3		[illegible]			[illegible]	[illegible]	[illegible]		
29/ 2/84	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
[illegible] 3/84	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	•	
12/ 3/84	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]		[illegible]	•	
AVERAGE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

3. TRAINING ACTIVITY

3. TRAINING ACTIVITY

In accordance with the aims of the Project, a systematic programme of training was carried out. This programme was divided into two separate periods, depending on the personnel available and the particular requirements of the Project.

3.1. - First Phase

In the first phase (from February to October 1983) the immediate objective and priority was given to putting the installation in order and subsequently to obtain the rapid implementation of the entire plant and the first process data.

During this period the available operational personnel was a Chemist to operate the plant, a Mechanic for plant maintenance, and a Chemical Technician to undertake analytical control.

The time of these three persons was completely utilized in the management and supervision of the functioning of the pilot plant.

This is the reason the type of training was directed to preparing the personnel for their specific activity. Additionally, particular attention was paid to the operation and dissemination of knowledge relating to standard and/or routine analytical methods. The following information and knowledge was supplied in detail to each responsible operator:

Plant Operation

a. knowledge of the process cycles.
b. relevant knowledge of the various pieces of equipment.
c. general methods of sample collection and preservation.
d. stock control of the necessary chemical agents in order to establish the minimum quantities which must remain in stock together with names of suppliers and delivery times.

Plant Maintenance

a. specific maintenance norms for each piece of machinery or equipment.

b. spares and/or normal rate of utilization of parts required for each unit of equipment.

c. procurement procedures to establish availability and delivery times of the various spares and/or parts required for the operation of the equipment.

Analytical Controls

a. analytical methods.

b. sample preservation times.

c. procurement procedures for maintaining stock of chemicals - suppliers name and delivery times.

According to the STANDARD METHODS of American Public Health Association (A.P.H.A.) the following detailed analysis were prepared:

- pH Value
- Settled Solid (Imhoff cone)
- Suspended Solids
- Sulphide
- Chrome
- Ammonia Nitrogen
- C.O.D. ($K_2Cr_2O_7$)
- Chloride
- $B.O.D._5$
- Oxygen Dissolved (Winkler)
- Oil and Grease
- Súlphate
- Phosphor
- Sludge Volume Index
- Sludge Suspended Matter (total and volatile)
- T.K.N. (Total Kjeldahl Nitrogen).

In parallel with this theoretical activity, field training was carried out for each responsible operator, consisting of the following:

Responsibility for Plant Operation

- undertake flow controls at each stage of the plant.
- carry out one or two tests weekly of sludge filtrations with the filter press.
- to take daily samples for the chemical laboratory.
- inform the UNIDO coordinator of any anomaly or malfunction of the plant.
- keep a register of the plant data and itemize the chemicals consumed and any malfunction or anomalies that must be communicated to the laboratory personnel.
- check the chemical stock and re-order if necessary.

Responsibility for Analytical Laboratory

- carry out an analysis of the relevant factors in his charge and record the data, together with any observations, in the analysis register (including the analysis that will be effected by the school teachers and the other plant data).
- copy of the analytical data must also be recorded on the special cards and sent to the National Coordinator.
- keep a register of the existing chemical reagents and make an indent for replenishment when stocks go down.

Responsibility for Plant Maintenance

- every Friday to carry out the control and maintenance of all the equipment (with the sole exception of the pH meter which is under the control of the plant operative).
- prepare a list of the existing spare parts and those which have to be stocked.
- collect the necessary technical equipment documentation.

In the initial period of training activity, a course covering general information in the field of waste water treatment was given to the teaching personnel of the School (SENAI) not directly involved in the Project.

3.2. - Second Phase

After the meeting of 9.11.83 between the UNIDO C.T.A. and Drs. Borsa and Rech, Senior Officials of SENAI, three extra graduate personnel were recruited from counterpart staff so as to ensure a normal Project programme.
A definitive cadre was thus formed by a Chemical Engineer (Project National Coordinator), two Chemists and a Chemical Engineer (Graduate operating staff), a Chemical Technician (Laboratory support) and by a mechanic for plant maintenance.
This additional personnel permitted the implementation of training to develop a cadre of qualified personnel able to attend to the pilot plant operation and to constitute a specialized Brazilian staff for future assistance to the leather industry and consulting engineers.
This phase was programmed as follows:

- Theoretical session involving Tannery Effluent Treatment techniques and facilities.
- Theoretical and practical session involving analysis of waste waters and control methods with particular regard to specific problems of tannery effluents.
- Session of applied research involving treatment and recovery of tannery liquid and solid wastes.
- Session involving evaluation and testing of the appropriate techniques available to achieve the norms promulgated by the Brazilian Authorities.
- Review of possible costs/efficiency in relation to the local situation.
- Practical session concerned with the operation and maintenance of the plant.

After a few months of training, the personnel reached a satisfactory professional level which enabled the establishment of a work plan with specific duties and responsibilities.
However although the counterparts have absorbed much knowledge and gained experience in this field, it is doubtful whether after this limited period they are sufficiently competent to operate without some external assistance and supervision.

4. EXTENSION SERVICES

4. EXTENSION SERVICES

A programme of demonstration, extension services and dissemina tion was carried out with the aim of ensuring that all sectors of the leather industry were able to obtain updated technical infor mation relating to the introduction of better environmental proces ses (recycling and other means) and the treatment of tannery wastes (aqueous and solid).

This programme was carried out as follows:

1. Theoretical-practical courses.
2. "Open Week".
3. Centralised plant.
4. Extension Service.
5. Dissemination of Information.

4.1 - Theoretical-Practical Courses

A) After a meeting held between the UNIDO C.T.A. , a sen ior official of the D.M.A., the National Coordinator and Mr. P. Nini of the Italian team, a combined work programme was carried out, including:

- theoretical and practical courses for the D.M.A. personnel em bracing tannery effluent treatments. The programme of these courses is indicated in Annex 4/I. The project counterparts and other technicians from various Brazilian organisation took part in these courses;
- a joint D.M.A./UNIDO Project activity which will contribute to the establishment of the project for the realisation of a cen tralised plant for industrial and urban waste water treatment at the Estancia Velha municipality. The work schedule is specified in detail in Annex 4/II.

The theoretical practical courses were held by the Italian staff at Estancia Velha. A total of 13 technicians of the D.M.A. with specific competence in tannery waste water treatment took part in groups of three or four during the period from November 1983 to June 1984.

B) Another two courses (lasting about three days each) covering especially chemical and biological dimensioning of plant in plant tannery waste water treatment were held in June 1984.
The content of these courses were chosen with particular atten tion to the requirements of consulting engineers and tannery tech nicians, and is aimed towards satisfying the needs of those who are involved in the preparation and operation of projects for tan nery effluent treatment (see Annex 4/III).

C) In order to increase the dissemination of the Project's results a visit has been effected to SENAI School in Campinas (San Paolo State) during the period 28, 29, 30 and 31 May 1984.
In this visit in which the UNIDO C.T.A., the National Coordinator and two persons of the Italian team had taken part,the technologi es employed in the pilot plant at Estancia Velha and the results obtained had been described in a two days meeting.
At the same time the tanners had been offered a consulting serv ice and "clinic" evaluation assistance (see in Annex 4/IV the list of tanneried visited).

The Project Team also had a meeting with a Senior Official of Companhia de Tecnologia de Saneamento Ambiental (CETESB) Governa tive Body which carries out in the State of San Paolo also the same functions similar to D.M.A. in R.S., to know the anti-pollu tion strategy adopted for the tannery effluents and in particular the imposed limits and the normative concerning the final dispos al of the sludges produced.

Contrary to D.M.A. in R.S., CETESB in S.P. does not oblige the tan neries to respect limits on the discarge but requires a minimum reduction of 80% of the pollution load (BOD, COD, S.S.) of the raw effluent. Furthermore, there does not exist in S.P. any limits for the sludge disposal and their use in agriculture.

4.2. "Open Week"

In November 1983 it was agreed that a Meeting should be held at Estancia Velha, and an invitation was extended to all sectors of the Leather Industry in Brazil, whose main scope was to emphasize the Project's aims and disseminate its results by means of practical demonstrations with the Pilot Plant and technical lectures and discussions.

This "Open Week" was held from the 19th to the 23rd March 1984 and its programme was defined according to the outline proposal prepared by the UNIDO C.T.A. The "Open Week", which was organised by SENAI (under the aegis of the Regional Director of the Rio Grande do Sul Eng. LUIZ PAULO BIGNETTI) and by the UNIDO consultants, was scheduled to coincide with the official inauguration of the Pilot Plant which took place during the morning of the first day of that week.

During this important event, which was covered by the entire Brazilian press, about 400 people took part including Authorities, Industrialists in this sector, tannery technicians, journalists , etc.

About 130 people took part in the "Open Week" which was followed with great interest.

From the programme (see Annex 4/V) it can be seen how the lectures supplied a fairly complete picture of the tannery waste-water treatments environmental processes.

It must be emphasized that Brazilian counterparts in this sector also took part in this presentation.

Additionally, during the "Open Week" practical demonstrations were given (chrome recycle and sludge dewatering). Also the presentation of the pilot plant and its results was entrusted to the Brazilian counterparts who were thus able to acquire first-hand experience relating to a part of their future work. (see Annex 4/VI)

Furthermore, in the dissemination of expertise case study "clinics" were hosted by the UNIDO staff in close cooperation with the tanners and technologist associations (AICSUL and ABQTIC).

To conclude, we can emphasize the "Open Week" completely covered the aspects it wished to achieve as well as giving the Project its due emphasis.

4.3. - Centralized Plant

Since their arrival at the Project in February 1983 the UNIDO consultants have been involved in weekly meetings between the representatives of the local tanners and the municipality of Estancia Velha.

In this period the aim of installing a centralized plant for the common treatment of the sones urban and industrial waste waters developed. Unfortunately it was necessary to use the primary treatments existing in the tanneries which, in the majority of cases, was inadequate or unsatisfactory. At the same time this was complicated by the urgent need to discover a temporary solution to pollution before the expiration of the Brazilian anti-pollution.laws.

After the initial period during which a location for the plant was chosen, the best available solutions, both technical and economic were studied. In agreement with Mr D.Winters and by request of the Brazilian counterparts, he Project team declared its availability for active collabora ion. This activity was carried out in the following fields:

1. Investigation of the possible solutions regarding primary, secondary and sludge treatments.
2. The interconnection of various systems between the tanneries and town wastes and the cent alized plant.
   This research is reported in Ann x 4/VII.
3. A study, in collaboration with t e D.M.A., covering the capacity and flow of a stream pass ng through Estancia Velha, in order to evaluate its possibl use as a collection system.

The clarification of the connection between the various waste sources and the joint treatment plant, the choice of improving the primary treatments already existirg and other technical considerations have been considered in the selection of the treatment that will be adopted, including interventions in the tanneries for chrome recovery, sulphide oxidation and primary pretreatments.

In the joint plant treatment centre s foreseen primary treat ment-facilities, i.e. screening, clariflocculation, pH control, sulphide oxidation (emergency treatment) and the sedimentation followed by secondary treatment. The choice of the secondary treatment will also be based on the results obtained by the Project pilot plant.

In order to identify elements on which to base the design work the Project team started research into the various tanneries to define the volume and characteristics of the effluents and the efficiency of the existing primary treatments.

This research had anticipated an investigation of one week for each industry. At the same time the efficiency of the existing plant primary treatment was evaluated.

The industries investigated were as follows:

1. IMBRAGEL
2. CURTUME BENDER SCHUCK S.A.
3. GENUINO S.A. IND. E COMM.
4. CURTUME RIMUS S.A.
5. CURTUME LEUCK MATTES S.A.
6. CALCADOS RELIN S.A. IND. E COMM.
7. REINALDO KONRATH E CIA LTDA.
8. INTEGRAL
9. E.M. BERGMANN E CIA LTDA.
10. IRMÃOS SPENGLER E CIA LTDA.
11. FINILUX
12. VEMASO
13. BUFFALO - BEN. E ASSIST. TECN. COUROS

At the same time an investigation was carried out in order to define the flow characteristics (in rainy and dry weather) and the physical-chemical characteristics of the receiving basin.

For this investigation six different points were chosen along the route from the town to the site where the centralized plant will be installed, which were considered significant for an appropriate analysis of the basin mentioned above.

The synthesis and results of the entire work were sent on the 28th March 1984 (see Annex 4/VIII) to the Joint Plant Consortium as per their official request.

In 25th June 1984 the UNIDO/SENAI Project received from the Tanners Consortium of Estancia Velha the preliminary project for the joint plant prepared by CORSAN-MAGNA (an engineering Company of R.S.).

Before 30th September 1984 the Project Team will send to the Tanners a technical note regarding this project.

4.4. - External Services

In this period an external consulting service was operated for the other tanneries of Rio Grande do Sul and other Brazilian States regarding: treatment plant projects, rearrangement of existing plants, assistance in chrome and sulphide recycles and so on. In this way about 30 Tanneries were investigated and this service received the collaboration and was to the satisfaction of the tanners.

Furthermore this activity allowed us to comprehend the local situation of the Tanning Industry which may be thus summarized:

a. Manufacturing processes

The production cycles employed do not differ much from those used by Italian tanneries, the only difference worthy of note are:

- Water consumption generally higher: 40-50 litres per kilo of salted hide worked against the 30-35 litres or less used in Italy.
- Fleshing of the hides after soaking: non-limed fleshings give a greater possibility of commercialization of this by-product and lime baths less contaminated by greases which can be recycled more easily.
- Larger employment of vegetable re-tanning.
  However some tanneries have their own installations for the tannin extraction from mimosa bark; as such the contribution to the total pollution caused by this operation must be evaluated.

b. Antipollution treatments adopted

As already stated, in general the tanneries of the area have adopted some treatments of the primary type: these, in the great majority of the case consist of screening, homogenization and primary sedimentation.

Some factories have also implemented the separation of lime and of chromium effluents. Some details of the treatment system may be seen:

- Screening:

  self cleaning inclined screens of wedge wire construction having opening running transverse to the flow (similar to Dorr-Oliver).

- Homogenization:

  tanks of various shapes and sizes with capacities about equal to the daily discharge. These tanks generally are stirred by mechanical propellers, floating turbines or diffused air.

- Primary sedimentation:

  in the great majority of cases the sedimentation is not aided by means of chemicals and therefore the flocculation is of a spontaneous nature. In general the sedimentation tanks are horizontal-flow type with one or more hoppers for the collection of the sludge. In a few cases only they use chemical such as aluminium sulphate and polyelectrolyte and have installed mechanical scrapers for the sludge drawoff.

- Lime bath recycling:

  this technique until now has not been favoured by tanners and therefore in the great majority of case the adherence has been to a sulphide destruction by oxidation with air. These treatments are being studied and are already operational in only a few cases. However in one tannery sulphide recovery was observed, in which the recycling, effected by fine screening of the bath with additions of new lime and sodium sulphide, works extremely well for about two years in a closed cycle.

- Chromium recovery from spent tanning baths:

generally bath recycling is made employing the bath itself af ter screening with the addition of new chromium sulphate. This technique is possible, as already stated due to the fact that generally only limed splits are tanned with this product. Only one plant was found that recovered the chromium after precipita tion of the hydrate, sedimentation, removal of the supernatant and redissolving of the precipitate with sulphuric acid. In an other very interesting case the problem has been solved employ ing self basifying chromium sulphate with high exhaust charac teristics (Bayer) and working at temperatures higher than nor mal (heating the drums with steam).

In some of the tanneries seen, there existed installations for the extraction of fat from fleshings, something completely un usual in Italy; the fat obtained in this manner and the residu al solids were transferred to other industries that manufacture and commercialize these sub-products.

In another tannery, an installation was running in an experimen tal phase recovery of proteins from the lime baths.

- Biological treatment:

Only in very few cases the problem has been faced with very em piric means, in general employing natural lagoons and sometimes treatment with acquatic plants (water hyacinths etc.).

Sludge dewatering and disposal:

A few tanneries only have installed some sand beds; no mechani cal filters. In the main the liquid sludge produced is trans ported in the same form to the disposal site by means of pumps or tank trucks.

Existing problems

In many of the tanneries visited there were striking operational difficulties. These occurred due to the lack of experience of those who planned and executed the installation and also of those who operate the plant itself.

The problem linked particularly with the plants installed are as follows:

- Nil or insufficient stirring of the homogenization tanks with subsequent formation of sludge deposits.
- The horizontal sedimentation tanks not provided with mechanical scrapers show difficulty in the extraction of sludge.

  These facts - together with the absence or insufficiency of aeration of the wastes during homogenization - lead to t establishment of considerable anaerobic process which produces malodorous gases creating an unpleasant environment for the local population, also has the effect of diminishing the efficiency of the primary sedimentation (bubbling).

- The final disposal of the sludge.

  Apart from some fortunate case in which it has been possible to disperse this sludge onto soil, a satisfactory solution has not as yet been found, and this sludge (still very liquid) is stored in lagoons and left to dry in the open air, increasing the unpleasant odours.

4.5. - Dissemination

An informative summary was prepared on the aims and first results of the Project for the Latin American Annual Congress of Chemists and Technologists of the Leather industry which was held in Fortaleza in November 1983.
In fact we profites by this opportunity to give wider publicity to UNIDO's Project aims. The Summary prepared by the UNIDO C.T.A., the Italian Team Leader and the National Co-ordinator was presented and read to the Congress by Mr Luiz Leuck President of the Associacão Brasileira Dos Quimicos e Tecnicos De Industria Do Couro (ABQTIC) in which the participants showed interest.
(Appended at Annex 4/IX).
A further informative report on the results obtained with two of the biological treatment systems of the Pilot Plant (oxidation ditch and floating aerator extended aeration) is being prepared for the forthcoming IX LATIN AMERICAN CONGRESS OF CHEMISTS AND TECHNOLOGISTS OF THE LEATHER INDUSTRY which will take place in November 1984 at Gramado R.S. Brazil. The summary of this report (appendix at Annex 4/X) has been sent to the Technical Committee of the Congress for acceptance.
Furthermore, it has been established that the Brazilian team of the UNIDO/SENAI Project will periodically send some technical communications (as practical as possible) to magazines specialized in the waste water treatment and/or leather manufacturing.

ANNEX 4/I

PROGRAMME OUTLINE OF THE INSTRUCTION COURSE

1. Theoretical course on the various operations effected in the tannery

2. Survey of tannery waste-water characteristics

3. Primary treatments

   3.1. Screening - Lifting - Homogenization

   3.2. pH correction - Clariflocculation - Sedimentation

   3.3. Sulphide recycling - Sulphide oxidation - Protein precipitation

   3.4. Chrome recycle

   3.5. Practical applications and projects dimensioning

4. Secondary treatments

   4.1. Theory

   4.2. High rate activated sludges - Extended aeration

   4.3. Other treatments involving activated sludges

   4.4. Parameters dimensioning and secondary treatment

   4.5. Trickling filters - Dimensioning

   4.6. Lagoons - Dimensioning

   4.7. Sludge treatment and disposal - Dimensioning

   4.8. Tertiary treatments (ammonia removal)

   4.9. Hydraulic concepts applied to treatment plants

5. Laboratory tests

   5.1. Chlorides - BOD - COD

   5.2. Settled solids - Suspended solids (MLSS - MLVSS - SVI)

   5.3. Sulphide - Chrome - Ammonia - Phosphorus - OD.

ANNEX 4/II

JOINT WORK PROGRAMME D.M.A. - UNIDO PROJECT

1. Daily programme:

   A) Theoretical course concerning:

   - Basic information about tanning processes and pollution sources.
   - Description of various treatments alternatives.
   - Dimensioning and evaluation of practical cases of tannery effluent treatment plant (with a study of the various alternatives).

   B) Analytical control steps of the different treatment systems functioning in the pilot plant.

   C) Evaluation of the efficiency of the equipment available in the Brazilian market.

2. Participate, together with the UNIDO-SENAI team in the service activity towards individual treatment plants of Rio Grande do Sul and the joint plant at Estancia Velha.

ANNEX 4/III

COURSES HELD IN JUNE 1984 BY THE ITALIAN TEAM LEADER

1st Course 6-7-8th June "Primary Treatment of Tannery Effluents" Participants 13 persons (D.M.A. - CIENTEC - Fundacão Ciencia e Tecnologia - Governmental Engineering Company - and freelance professionals)

The arguments treated were the following:

a) chrome recovery

b) lime bath recycling

c) catalytic sulphide oxidation

d) physical-chemical treatments:

- screening
- homogenization
- flocculation
- primary sedimentation
- sludge treatment

e) equipment, machinery, material and so on.

2nd Course 11-12-13th June "Secondary Treatment of Tannery Effluents Participants 20 persons (D.M.A. - CIENTEC - Fundacão Ciencia e Tecnologia - Governmental Engineering Company - and freelance professionals)

The arguments treated were the following:

a) biological treatments:

- conventional activated sludge, extended aeration and aerated lagoons
- biological flocculation and synthesis of organic matter
- oxygen requirements
- sludge production
- nutrients requirements
- effect of temperature and pH
- causes of toxicity in biological oxidation systems.

b) biological process controls:

- dissolved oxygen (DO)
- mixed liquor volatile suspended solids (MLVSS)
- sludge volume index (SVI)
- sludge age
- sludge recycle ratio
- laboratory tests and analysis

c) secondary sedimentation

All the arguments (after some brief theoretical notes) were treated from a strictly practical and engineering point of view.
Some practical examples were made of plant design establishing the influent data and the treatment parameters, discussing the type and the characteristics of the equipment to be used, the most suitable material and everything else required for a correct dimensioning of the plant.

ANNEX 4/IV

LIST OF TANNERIES VISITED IN SAN PAOLO STATE

- **FASOLO, Fernandopolis, S.P.**
- **COSTA, Campinas, S.P.**
- **CANTUSIO, Campinas, S.P.**
- **PODBOI, Leme, S.P.**
- **S.TA GENOVEVA, Aquai, S.P.**
- **ALVORADA, Mogi Mirim, S.P.**

ANNEX 4/V

PROGRAMA

SEMANA DE DEBATES
SOBRE TRATAMENTO
DE EFLUENTES DA
INDÚSTRIA DE
PELES E COUROS
de 19 a 23 de março-84
Estância Velha-RS

Dia 19.03.84 - 2a.feira

09h30min - Solenidade de Inauguração da "ESTAÇÃO PILOTO PARA TRATAMENTO DE EFLUENTES"

12 horas - ALMOÇO COMEMORATIVO
na Sociedade Canto União de Estância Velha

14h30min - Solenidade de Abertura da SEMANA DE DEBATES SOBRE TRATAMENTO DE EFLUENTES DA INDÚSTRIA DE PELES E COUROS

15h30min - Palestra - Mr DAVID WINTERS
Coordenador Internacional do Projeto UNIDO (US/BRA/80/166)
Tema: Características e Finalidades do Projeto

16 horas - Debates

16h30min - INTERVALO

16h45min - Palestra - Técnico do Departamento do Meio Ambiente da Secretaria da Saúde e do Meio Ambiente do Estado do Rio Grande do Sul
Tema: Atuação do DMA no Controle da Poluição Ambiental

17h15min - Debates

Dia 20.03.84 - 3a.feira

08h30min - Palestra - Prof. GIUSEPPE TAPONECO
Professor Catedrático da Universidade de Pisa (Itália)
Tema: Estratégias de Saneamento Ambiental para as Indústrias de Peles e Couros da Região de Pisa (onde existe uma concentração de cerca de 1000 curtumes)

09 horas - Debates

09h30min - INTERVALO

09h45min - Palestra - Dr. MAX LOTHAR HESS
Consultor em Depuração de Efluentes Industriais em São Paulo
Tema: Depuração Primária de Efluentes de Curtumes

10h15min - Debates

10h45min - INTERVALO

11 horas - Palestra - Engº Químico HUGO SPRINGER
Técnico da Escola de Curtimento SENAI de Estância Velha

Tema: Custos de Implantação e Operação dos Sistemas Depuradores Primários de Efluentes Líquidos de Curtumes

11h30min - Debates

12 horas - ALMOÇO

14h30min - Palestra - Dr- MAX LOTHAR HESS
Consultor em Depuração de Efluentes Industriais em São Paulo

Tema: Reutilização de Banhos Residuais (Depilação-Caleiro, Curtimento ao Cromo) - Demonstração Prática

15h30min - Debates

Dia 21.03.84 - 4a.feira

08h30min - Palestra - Eng. ELLEN MARTHA PRITSCH GOETTEMS
Chefe do Departamento de Controle Técnico-Operacional do Sistema Integrado de Tratamento de Efluentes Líquidos da CORSAN, junto à COPESUL (Pólo Petroquímico do Sul)

Tema: Tratamento Depurador com Lodos Ativos

09 horas - Debates

09h30min - INTERVALO

09h45min - Palestra - Mr DAVID WINTERS
Coordenador Internacional do Projeto UNIDO

Tema: Valo de Oxidação (Carrocel)

10h15min - Debates

10h45min - INTERVALO

11 horas - Palestra - Dr. PIERO NINI
Técnico-Consultor da UNIDO

Tema: Tratamento Biológico mediante uso de Filtros Percoladores

11h30min - Debates

12 horas - ALMOÇO

14h30min - Palestra - PhD BERNARD VULLIERMET
Vice-Diretor do Centro Técnico do Couro de Lyon (França)
Consultor para a Área de Gerenciamento de Resíduos de Curtumes do mesmo Centro

Tema: Tratamento Aeróbio Facultativo em Lagoas

15h15min - Debates

Dia 22.03.84 - 5a.feira

08h30min - Palestra - Prof. SALOMÃO ANSELMO SILVA
Professor Titular do Departamento de Engenharia Civil da Universidade Federal da Paraíba

Tema: Depuração de Efluentes Urbanos em Lagoas de Estabilização Aeróbia e Anaeróbia

09 horas - Debates

09h30min - INTERVALO

09h45min - Palestra - Engº PhD URIVALD PAWLOWSKY
Responsável pelo Serviço Técnico Ambiental da Superintendência dos Recursos Hídricos e Meio Ambiente do Paraná - SUREHMA
Consultor da Organização Mundial da Saúde

Tema: Tratamentos Depuradores Anaeróbios

10h15min - Debates

10h45min - INTERVALO

11 horas - Palestra - Sr. FREDERICO EDVINO LEUCK
Prefeito Municipal de Estância Velha

Tema: Implantação da Estação Centralizada de Tratamento de Efluentes de Estância Velha

11h30min - Debates

12 horas - ALMOÇO

14h30min - Palestra - Dr. GIUSEPPE CLONFERO
Técnico-Consultor da UNIDO

Tema: Implantação Centralizada de Tratamento de Efluentes para a Região de Ponte a Egola (Itália)
- Demonstração Prática -

15h30min - Debates

Dia 23.03.84 - 6a.feira

08h30min - Palestra - Dr. BENITO DA RIN

Consultor em Depuração de Efluentes Industriais
Assessor da Fundação Estadual de Engenharia do Meio Ambiente (FEEMA/RJ)
Professor do COPPE - RJ

Tema: Tratamento e Disposição Final de Lodo produzido em Sistemas Depuradores de Efluentes

09 horas - Debates

09h30min - INTERVALO

09h45min - Conclusões dos Trabalhos

11h30min - ALMOÇO

13h30min - Visita à Estação de Tratamento de Efluentes do Pólo Petroquímico do Sul (opcional)

17 horas - Retorno

ANNEX 4/VI

LIST OF THE LECTURES NOT INCLUDED IN THE "OPEN WEEK" PROGRAM UNDERTAKEN BY THE UNIDO PROJECT TEAM

Mr. FEDERICO WEBER, Chemist, UNIDO Project Technician: "Physico-chemical treatments; Pilot Plant results illustration"

Mr. VALMOR SILVERA DOS SANTOS, SENAI Tanning School Technician: "Recycle of spent tanning chrome baths"

Mr. ANTONIO AUGUSTO AMARAL LEITÃO, Chem. Engineer, UNIDO Project Technician: "Oxidation ditch and extended aeration with floating aerator, parallel systems; Pilot Plant results illustration"

Mr. JAIR JOÃO RUARO, Chemist, UNIDO Project Technician: "Extended aeration of tannery effluents without primary sedimentation (batch system); Pilot Plant results illustration"

Mr. PAOLO DE TARSO JOST, Chem. Engineer, National UNIDO Project Coordinator: "Tannery sludges treatment: Pilot Plant results illustration"

Mr. DAVID WINTERS, UNIDO Chief Technical Adviser: "Tannery effluents treatment: economy of scale"

Mr. GIUSEPPE CLONFERO, UNIDO Project Consultant: "Chrome recovery from spent tanning baths: various systems survey, reliability and dimensioning".

CENTRALISED PLANT AT ESTANCIA VELHA - POSSIBLE ALTERNATIVES

W A T E R			S L U D G E		
TANNERIES	CONNECTION	CENTRALISED PLANT	TANNERIES	CONNECTION	CENTR. PLANT
NO TREATMENT CHROME RECYCLING PARAMETERS TO VERIFY: none	PIPE-LINE	PRIMARY TREATMENT: screening - equalisation - sulphide oxidation pre-sedimentation coagulation and flocculation - pH adjustment primary sedimentation. SECONDARY TREATMENT	NO TREATMENT	PIPE-LINE	CENTR. PLANT
PARTIAL PRIMARY TREATMENT: Chrome recycling - screening - equalisation - sulphide oxidation [illegible] sedimentation. PARAMETERS TO VERIFY: pH-S.S.- [illegible] - Cr[illegible]	PIPE-LINE OR STREAM	PARTIAL PRIMARY TREATMENT: Screening - coagulation and flocculation - pH control - sulphide oxidation - primary sedimentation SECONDARY TREATMENT	SLUDGE TREATMENT ---------------- NO TREATMENT	TRUE TRANSPORT ---------------- TRUE TRANSPORT PIPE-LINE	SLUDGE HOLDING ---------------- CENTR. PLANT
PRIMARY TREATMENT chrome recycling - screening - equalisation - sulphide oxidation - coagulation and flocculation - pH control - primary sedimentation. PARAMETERS TO VERIFY (weekly frequence): pH - S.S. - $S^{=}$ - COD - BOD - Cr^{+++}	PIPE-LINE OR STREAM	SECONDARY TREATMENT	SLUDGE TREATMENT ---------------- NO TREATMENT	TRUE TRANSPORT ---------------- TRUE TRANSPORT PIPE-LINE	SLUDGE HOLDING ---------------- CENTR. PLANT
PARAMETERS [illegible]			PARAMETERS TO VERIFY		
Total and instantaneous flow water characteristics before treatment water characteristics after treatment	Legal aspects [illegible]		Total and instantaneous flow	sludge pipe-line or other alternative	

SENAI [illegible]

c/c ESCOLA DE CURTIMENTO SENAI
Rua Gregorio Mattos, 111 - 93600 - ESTÂNCIA VELHA

ANEXO [illegible]

Estância Velha, 28 de março de 1984.

À

Diretoria do Sindicato das Indústrias de Curtimento de
Couros e Peles de Estância Velha

Prezados Senhores:

Em razão de seu ofício nº 01/84 e do ofício MSE nº 044/84 do Consórcio Magna Engenharia STE Ecoplan, e conforme tratativas efetuadas na Reunião Almoço de 21 de março de 1984, estamos enviando a V.Sªs. a presente cópia dos dados solicitados.

Tanque de Homogeneização

Tempo de Retenção Médio 24 horas

Dosagem de Manganês

Foram usadas 20 mgl do ion Mn^{2+}, em relação a vazão da água de entrada. A quantidade de ar fornecida pelo compressor foi de 5,6 m^3 de ar por metro cúbico de tanque, ou 7 metros cúbicos de ar por metro quadrado por hora. Sendo sempre em excesso mas necessário para garantir a suficiente homogeneização.

A redução de sulfetos(com tempo de retenção média de 7 horas) foi em média de 89%, com valor médio de entrada de [illegible] mg/l e o valor médio de saída de 4,8 mg/l. Em nossos testes, a concentração de saída dos sulfetos não superou nunca um valor de 10 mg/l. Esses valores nunca interferiram no tratamento biológico subsequente, mas assim contribuiram para [illegible] o sulfeto.

Tratamento [illegible]

[illegible]

Decantação: Tempo de retenção 1,6 horas e a carga hidráulica 27 m^3 d/[illegible]

A dosagem dos produtos químicos, eficiência da [illegible] e parâmetros da água de saída, veja anexo.

Tratamento Biológico

Em relação aos resultados dos processos de aeração prolongada e valo de oxidação, veja Anexo 2; para o filtro biológico veja Anexo

Em relação ao consumo de oxigênio em função da matéria orgânica, a quantidade de energia usada para garantir uma suficiente agitação da massa líquida, em todos os casos produzia uma quantidade de oxigênio em excesso. Em relação a lagoa aerada facultativa, não temos ainda resultados em números suficientes.

Nutrientes

Foi usado somente Na_2HPO_4, de modo a manter a relação entre DBO:N:P = 100:5:1 .

Filtro Prensa

Taxa Específica de Filtração:

Lodo Primário: 40 l/m^2h

Lodo Espessado: 36 l/m^2h

Percentual de Sólidos na Torta do Filtro Prensa:

Lodo Primário: 25 %

Lodo Primário Espessado: 28,8 %

Pressão Máxima de Trabalho: 11 Kg/cm^2

Condicionamento: Cal, 4 Kg/m^3 de lodo

Filtração de Cromo

Taxa Específica de Filtração: 60 l/m^2h

Percentagem Seco: 20 a 25 %

Pressão Máxima de Trabalho: 3 Kg/cm^2

Em relação as características físico-químicas dos efluentes de cada curtume e sua vazão horária, veja Anexo 4; características físico-químicas do [illegible], veja Anexo 5 e 6.

Informamos ainda que não foi feito relatório operacional da Planta Piloto, dos técnicos da [illegible] para o SENAI, mas somente relatório interno que é de propriedade da [illegible].

Em relação às cópias solicitadas referentes às palestras realizadas durante a Semana de Debates de Efluentes da Indústria de Peles e Couros, temos a informar que as mesmas serão enviadas tão logo sejam concluídas as devidas traduções.

Sendo o que se apresentava no momento, subscrevemo-nos

Atenciosamente.

p/SENAI/UNIDO PROJECT
Dr. Piero Nini

Coord.Nac.UNIDO/PROJECT-SENAI
Engº.Quím.Paulo Tarso Jost

NOME DO PROJETO:

NOMES DOS SUBPROJETOS:

TRATAMENTO PRIMÁRIO 1 (800 mg/ℓ $Al_2(SO_4)_3$ + 1 mg/ℓ Poli)

	EFLUENTE TANQUE HOMOGENEIZAÇÃO				EFLUENTE CLARIFICADO		
	MIN.	MAX	MÉDIA		MIN.	MAX.	MÉDIA
pH	7,1	9,8	8,[illegible]	pH	[illegible],0	8,6	7,0
SD	20	190	70	SD	[illegible],1	0,[illegible]	0,1
DQO	1000	7.040	2.5[illegible]0	DQO	[illegible]16	1.120	590
DBO	198	735	480	DBO	86	519	185

TRATAMENTO PRIMÁRIO 2 (400 mg/ℓ $Al_2(SO_4)_3$ + 1 mg/ℓ Poli)

	EFLUENTE TANQUE HOMOGENEIZAÇÃO				EFLUENTE CLARIFICADO		
	MIN.	MAX.	MÉDIA		MIN.	MAX.	MÉDIA
pH	[illegible],3	9,0	8,4	pH	[illegible],2	8,[illegible]	7,4
SD	15	100	32	SD	0,1	4,5	0,3
DQO	1000	5.941	2.000	DQO	200	1.572	525
DBO	237	590	370	DBO	60	280	140

TRATAMENTO PRIMÁRIO 3 (200 mg/ℓ $Al_2(SO_4)_3$ + 0,5 mg/ℓ Poli)

	EFLUENTE TANQUE HOMOGENEIZAÇÃO				EFLUENTE CLARIFICADO		
	MIN.	MAX.	MÉDIA		MIN.	MAX.	MÉDIA
pH	[illegible],4	9,8	8,4	pH	6	8,6	7,7
SD	20	190	43	SD	-	0,5	0,3
DQO	1000	5.397	1.720	DQO	116	1.120	570
DBO	198	735	400	DBO	86	519	165

TRATAMENTO PRIMÁRIO SEM USO DE PRODUTOS QUÍMICOS

	EFLUENTE TANQUE HOMOGENEIZADO				EFLUENTE CLARIFICADO		
	MIN	MAX.	MÉDIA		MIN.	MAX.	MÉDIA
pH	8.0	8.4	8,2	pH	7,5	[illegible]	7,5
SD	20	210	89	SD	-	-	1,5
DQO	[illegible]	[illegible]	[illegible]	DQO	350	[illegible]	1.410
DBO	[illegible]	[illegible]	290	DBO	[illegible]	[illegible]	227

[illegible] DE REDUÇÃO PARA CADA TRATAMENTO

[illegible]	[illegible]	T.P. 1	T.P. 2	T.P. S/QUIM.
SD	[illegible]	[illegible]	[illegible]	99,[illegible]
DQO	7[illegible],9	72.7%	6[illegible].[illegible]%	12,7%
DBO	[illegible].5%	62,1%	55.7%	21,7%

. RESULTADOS ANALÍTICOS

- Foram divididos em quatro períodos de operação.

1- Período de 22/06 a 16/09 1983; nesse período foram utilizados 800 mg/l de sulfato de alumínio + 1mg/l polieletrólito no tratamento primário.

	Efluente do decantador primário				Efluente do decant. secund (valo de oxidação)				Efluente do decantador secund.(aer. flut.)			
	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)
MIN	6,0	[illegible]	50	0,0	6,1	10	[illegible]	0,0	5,7	10	56	0,0
MAX	6,6	519	1120	0,7	7,6	120	439	10,0	7,6	59	490	9,0
MED	7,2	185	590	0,1	7,0	29	193	0,9	7,0	22	284	0,6

- Eficiências de Remoção: Valo de oxidação Aerador Flut.

	Valo de oxidação	Aerador Flut.
DBO:	84,0%	87,8%
DQO:	67,3%	51,8%

2- Período de 21/09 a 7/11 1983; onde foram utilizados 400mg/l de sulfato de alumínio + 1mg/l polieletrólito.

	Efluente do decantador primário				Efluente do decant. secund. (valo de oxidação)				Efluente do decant. secund. (aer. flut.)			
	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)
MIN	[illegible]	66	200	0,0	5,3	[illegible]	128	0,0	5,8	19	284	0,0
MAX	[illegible]	[illegible]	[illegible]	[illegible]	7,6	26	506	5,0	7,9	44	677	10
MED	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	270	0,4	6,4	27	464	1,0

- Eficiências de Remoção:

	Valo de Oxidação	Aerador Flut
DBO:	[illegible]	77,5%
DQO:	[illegible]	[illegible]

3- Período de 8/11 a 2/12 1983: foram usados 200mg/l de sulfato de alumínio + 0,5 mg/l de polieletrólito no primário.

	Efluente do decantador primário				Efluente do dec. secund.; valo oxid.				Efluente do decant. sec.; aer. flutuante.
	pH	DBO (mg/l)	DQO mg/l	S.D. (mg/l)	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	
MIN	7,6	100	297	0,0	5,9	6	156	0,0	FORA DE OPERAÇÃO
MAX	8,5	305	893	1,4	7,7	25	403	1,5	
MED	7,7	165	750	0,3	6,5	14	244	0,2	

- Eficiências de remoção:

  - Para o valo de oxidação,

    - DBO: 91,5%
    - DQO: 57,2%

4- Período de 5/12/83 a 21/o2/84; não foram adicionados produtos químicos no primário.

	Efluente do decantador primário				Efluente do dec. secund.; valo oxid.				Efluente do decant. sec.; aer. flutuante
	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	pH	DBO (mg/l)	DQO (mg/l)	S.D. (mg/l)	
MIN	7,2	84	280	0,0	5,9	3	207	0,0	FORA DE OPERAÇÃO
MAX	8,4	2250	4800	1,1	7,7	35	760	7,0	
MED	7,7	670	1600	0,3	6,9	21	440	1,6	

- Eficiências de remoção:

  - Para o valo de oxidação:

    - DBO: 9[illegible]
    - DQO: [illegible]

- COMPARAÇÃO DOS RESULTADOS.

	1º Período		2º Período		3º Período.		4º Período	
	V.Oxid.	A. Flut.	V.Oxid	A. Flut.	V.Oxid.	A.Flut.	V.Oxid.	A. Flut.
DBO.	84%	87,8%	97,4%	77,5%	91,5%	Fora de operação.	92,3%	Fora de operação
DQO:	67,3%	51,8%	48,6%	[illegible]	57,2%			

- CONDIÇÕES DE OPERAÇÃO DA PLANTA.

	VALO DE OXIDAÇÃO	AERADOR FLUTUANTE
- VOLUME TANQUE AERAÇÃO (M^3)	60	50
- VAZÃO DE ALIMENTAÇÃO (M^3/H)	1	1
- CARGA ORGÂNICA TOTAL (KG DBO/DIA)	3,5 - 5,5	3,5 - 5,5
- CARGA VOLUMÉTRICA (KG DBO/M^3DIA)	0,06 - 0,1	0,07 - 0,11
- TEMPO DE RESIDENCIA (H)	60	50
- MLSS (MIXED LIQUOR SUSPENDED SOLIDS).	1150 - 4000	11[illegible]0 - 3200
- TEOR DE VOLÁTEIS (%)	50 - 75	[illegible]
- SVI (SLUDGE VOLUME INDEX)	50 - 1[illegible]	[illegible]
- TEMPERATURA MEDIA DO TANQUE (ºC).	1[illegible] - 2[illegible]	11 - 19

FILTRO PERCOLADOR COM ENCHIMENTO PLÁSTICO

		Influent from primary sedimentation					Effluent from secondary sedimentation				
Date	Air temperat(ºC)	pH	BOD (mg/l)	COD (mg/l)	S.D (mg/l)	S.S (mg/l)	pH	BOD (mg/l)	COD (mg/l)	S.D. (mg/l)	S.S. (mg/l)
21/11/83	24-25	7,7		720	0,1	436	8,3		468	-	
23/11/83	17-22	8	160	630	-		8,4	69	490	-	
24/11/83	20-22,5	7,4	100	297	-		8,4	51	360	-	
25/11/83	20-24	7,5	225	658	0,5		8,3	50	491	-	
23/11/83	23-26	7		616	-		8,1		357	-	
29/11/83	22,5-28	8		580	-		8,4		420	-	
30/11/83	22-33	7,8	305	893	-	410	8,2	77	571	-	93
1/12/83	23,5-23	7,6	100	482	0,3		8,2	45	375	-	85
2/12/83	20,5-21	7,4	110	500	0,4		8,5	37	455	-	
5/12/83	21-24	7,6		349	2,5		8,2		312	0,5	
6/12/83	22-26,5	7,5		367	0,7		8,3		468	0,1	
9/12/83	24,5-29,5	7,9		1.640	0,5	420	8,1		480	0,1	
12/23/83	24-28,5	8,1		2.620	1,5		8		1.240	3	
13/12/83	23,5-27	8,3		2.220	0,8		8,2		1.780	1,6	270
14/12/83	24-27	8,3	227	1.780	0,1		8,2	61	1.080	-	
15/12/83	23-23,5	8,4		1.808	0,1	225	8		998	0,2	
19/12/83	15-25	8		930	2,5		7,6		979		
20/12/53	23-30	7,8		954	-		7,1		512		
3/01/84	25-24	7,6		1.800	0,8		8,1		1.600	2,5	
4/01/84	23,5-28		860	2.580	-		8,1	200	760	0,5	
5/01/84	25-28,5	8,3	1.000	2.096	-		8,3	210	978	0,7	
12/01/84	26-24	7,9		632	-		7,9		504	3,5	
13/01/84	27-32,5	7,7		856	0,5	210	7,8	456		-	
31/01/84	24-25	7,9	136	840	1,0		7	20	405	0,7	
2/02/84	25-25	7,9	86	950	4,5		7,8	80	970	0,2	
3/02/84	24-28	7,6	206	861	-		7,6	42	560	10	
9/02/84	24-28	7,0	385	2.120	0,1		7,0	100	1.602	1,0	
10/02/84	25,5-34	7,2	2.250	4.825	0,1		6,5	320	2.378	1,0	
14/02/84	28-35	7,2		3.682	0,5		7,7		1.372	3,5	
15/02/82	27,5-33	7,9	280	1.506	1,0		7,8	150	1.046	1,5	
16/02/84	28-33	7,7	430	1.305	3,5		8,0	80	602	0,5	
17/02/84	26,5-30	7,5	290	711	-	360	7,8	71		20	580
20/02/84	28-31,5	7,7		635	10		7,6		586	6	
21/02/84		7,5		1.457	4		7,5		568	0,5	
22/02/84	30-33	7,4	1.000	1.948	0,1		7,8		686	0,1	
23/02/84	30-30,5	7,8	515	1.660	0,5		7,9	147	538	0,1	
24/02/84	27-33	7,0	500	796	-		7,7	250	280	4,5	
27/02/84	31-32	7,6		1.928	1,0						
28/02/84	27,5-37,5	7,2		1.790	0,1		8,0		603	15	
29/02/84	25-34	6,7		1.411	24		7,9		376	0,3	
MÉDIA	24,6-28,4	7,6	458	1.360*	1,5	343	7,9	126	763*	2,4	257
VAL MAX.	31-37,5	8,4	2250	4.825	24	436	8,5	456	1.780	20	580
VAL MIN.	17-2[illegible]	6,7	86	297	0	210	7	20	312	0	85

RENDIMENTO MEDIO (DQO)   43,8[illegible] %

RENDIMENTO MEDIO (DBO)   72,5 %

CARGA ORGÂNICA   1, 5 kg DBOxdia/m³ de recheio

		Vazão mc/dia	DQO mg/l	DBO mg/l	pH	Cl⁻ mg/l
Curtume Bender Schnck S/A	Média	20[illegible]0	1204	750	[illegible],7	1350
	Máx.		2400	990	[illegible],2	1775
	Mín.		800	540	4,9	900
IMBRAGEL	Média	4800	-	230	8,5	-
	Máx.					
	Mín.					
Curtume Leuck Mattes	Média	00	2560	480	8,0	3415
	Máx.		5400	735	9,8	5250
	Mín.		1000	200	7,1	2240
Genuino (cola)	Média	[illegible]50	3620	1500	11,3	220
	Máx.		5770	2300	11,9	425
	Mín.		2070	820	9,5	70
Genuino (secção Acabamento)	Méd.	900	750	380	6,7	125
	Máx.	2000	860	390	6,9	180
	Mín.		640	360	6,6	90
VEMASO	Média	20	2240	810	4,3	660
	Máx.		3600	1070	7,0	890
	Mín.		1710	580	3,2	460
Curtume Spengler	Média	250	730	120	6,1	450
	Máx.		1030	120	7,2	590
	Mín.		540	115	5,1	315
Curtume Belim S/A	Média	[illegible]00	875	250	8,3	620
	Máx.		115[illegible]	340	9,8	1210
	Mín.		250	150	6,9	430
Curtume Berghan	Média	70	680	30	6,4	200
	Máx.		820	31	7,6	280
	Mín.		510	29	5,1	180
Curtume Konrath Ltda.	Média	200	1100	300	3,7	170
	Máx.		1250	-	4,1	260
	Mín.		840	-	3,4	120
Curtume Rumus S/A	Média	700	4800	280	10,3	4590
	Máx.		6300	-	11,6	6820
	Mín.		3850	-	9,1	3600

Os dados referem-se exclusivamente às amostras analisadas e possuem caráter restrito e específico, podendo não se aplicarem a uma população maior.

Assim, possíveis inferências a partir destes dados correm / por conta e risco de quem os utilizar.

O Projeto SENAI/UNIDO não se responsabiliza por danos e perdas que possam vir a resultar do emprego deste dados.

Paulo [illegible]
Piero Min[illegible]

[illegible]

Todas coletas seguiram a seguinte sequência:

Ponto 1 - Em frente ao curtume [illegible], av. 7 de setembro.

Ponto 2 - Em frente ao depósito do curtume [illegible]-Schuck.

Ponto 3 - [illegible] ponte após o arroio tributário onde o curtume [illegible]-Schuck faz sua descarga.

Ponto 4 - Primeira ponte após o arroio tributário proveniente do balneário.

Ponto 5 - Primeira ponte após a descarga do [illegible].

Ponto 6 - Em 18/01/84, a coleta foi realizada [illegible] ponto situado a, aproximadamente, 500 m do ponto de descarga da [illegible]. Para as coletas seguintes, o ponto foi deslocado para uma distância aproximada de 1 km [illegible] do ponto anterior.

DATA: 1[illegible]/0[illegible]/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	zero	zero	zero	zero	zero	zero
pH	[illegible],4	11,4	11,[illegible]	9,[illegible]	8,[illegible]	7,[illegible]
Cloretos	[illegible]	[illegible]	[illegible]	54[illegible]	55[illegible]	[illegible]9
[illegible]	[illegible]	[illegible]	[illegible]	9[illegible]	66[illegible]	93
DBO[illegible]	1[illegible]	[illegible]	[illegible]	4[illegible]	250	17
S. Sedimentáveis	1,[illegible]	[illegible]	3[illegible]	1,7	17	5

DATA: 27/01/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	zero	[illegible]	[illegible]	[illegible]	[illegible]	zero
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DATA: 06/02/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	7,1	3,4	0,4	3,2	----	----
pH	6,2	6,7	9,6	9,3	----	----
Cloretos	35	106	426	142	----	----
DQO	17	75	711	284	----	----
S. Decantáveis	0,3	1,1	3,0	2,0	----	----

Obs.: Os dias que precederam a data da coleta foram chuvosos.

DATA: 09/02/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	3,0	zero	zero	zero	zero	zero
pH	6,9	8,8	9,7	8,1	----	----
Cloretos	745	568	816	416	355	35
DQO	192	260	1322	284	2004	192
S. Decantáveis	2,0	4,0	9,0	7,0	20	1,0

DATA: 16/02/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	zero	zero	zero	zero	zero	zero
pH	7,1	9,7	10,0	9,2	9,5	8,2
Cloretos	213	284	531	352	731	320
DQO	135	450	1054	1155	1447	209
S. Decantáveis	15	11	15	13	15	0,5
Cromo Total	0,85	0,72	4,4	0,52	1,92	zero

DATA: 23/02/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	zero	zero	zero	zero	zero	zero
pH	7,1	[illegible]	[illegible]	[illegible]	[illegible]	9,1
Cloretos	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DQO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	450
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	370
S. Decantáveis	[illegible]	[illegible]	[illegible]	[illegible]	5	[illegible]
Cromo Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible],14	[illegible]

4 23/02/84

	Ponto 1	Ponto 2	Ponto 3	Ponto 4	Ponto 5	Ponto 6
O_2 Dissolvido	zero	zero	zero	zero	zero	zero
pH	8,7	5,6	9,2	9,2	7,6	8,4
Cloretos	994	674	1740	674	1350	320
DQO	564	674	3544	1300	525	643
S. Sedimentáveis	60	15	7,0	10	10	0,2

MEDIDAS DE VAZÃO DO ARROIO ESTÂNCIA VELHA

DATA: 03/02/84

Medidas efetuadas após uma precipitação pluviométrica da ordem de 10 mm, na data de 02/02/84.

Ponto 1 - Em frente ao depósito do curtume Bender-Schuck.
Vazão: 1.368 m^3/h.

Ponto 2 - Primeira ponte após o tributário onde o curtume Bender-Schuck efetua a descarga.
Vazão: 2.592 m^3/h.

Ponto 3 - Em frente à terceira casa cor de rosa após o primeiro cruzamento de ruas.
Vazão: 4.968 m^3/h.

Ponto 4 - Situado a uma distância aproximada de 2 km abaixo da firma [illegible].
Vazão: 3.208 m^3/h.

DATA: 06/02/84

Medidas efetuadas após uma precipitação pluviométrica da ordem de [illegible]5 mm, na data de 05/02/84.

Ponto 1 - Em frente ao curtume Leuck-Mattes, av. 7 de setembro.
Vazão: 1.800 m^3/h

Ponto 2 - Em frente ao depósito do curtume Bender-Schuck.
Vazão: 3.160 m^3/h

Ponto 3 - Primeira ponte após o tributário onde o curtume Bender-Schuck faz sua descarga.
Vazão: 3.744 m^3/h

Ponto 4 - Primeira ponte após o tributário [illegible] do balneário.
Vazão: 4.7[illegible] m^3/h

Data: [illegible]

Medidas efetuadas após o terceiro dia sem precipitação pluviométrica.

Ponto 1 - Em frente ao curtume Lauck-Mattes, av. 7 de setembro.

Vazão: 650 m^3/h.

Ponto 2 - Primeira ponte após o tributário onde o curtume Bender-Schuch faz sua descarga.

Vazão: 1.[illegible]20 m^3/h.

Ponto 3 - Após o tributário oriundo do balneário, primeira ponte.

Vazão: 1.90[illegible] m^3/h.

Ponto 4 - Situado a uma distância aproximada de 2 km abaixo do ponto de descarga da firma [illegible].

Vazão: 2.700 m^3/h.

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PLANTA PILOTO E DE DEMONSTRAÇÃO PARA TRATAMENTO DE EFLUENTES DE CURTUME EM ESTÂNCIA VELHA (RS)

Autores: Equipe do Projeto*

I - Resumo/Sumary

This paper briefly outlines the organisation and operation of the pilot and demonstration plant for tannery effluent treatment in Estância Velha.

The plant amongst other activities during the past 8 months has regularily pratised the catalytic oxidation of sulphides to obtain less than 10 mg/l $S^{=}$ and treated its primary sludges employing a filter press to obtain cakes of some 30% dry solids.

To date 2 secondary biological systems have been operated and monitored - conventional activated sludge (i) and oxidation ditch (carroussel) (ii) and average results over the period show average reduction of B.O.D. of 87% and 91%. Yielding final discharges of 23 mg/l and 15 mg/l B.O.D. well with in Depart. Meio Ambiente of RGS State requirements

Este texto esboça brevemente a organização e operação da planta piloto para o tratamento de efluentes de curtume em Estância Velha.

A planta entre outras atividades, durante os últimos 8 meses, praticou regularmente a oxidação catalítica dos sulfetos para obter menos que 10 mg/l $S^{=}$ e tratou o lodo primário empregando um filtro prensa para obter tortas de 30% de secos (sólidos).

Inicialmente, 2 sistemas biológicos secundários foram operados e monitorados - lodo ativado convencional (i) e valo de oxidação (carroussel) (ii) e a média dos resultados durante o período mostram uma redução média de B.O.D. de 87% e 91%, produzindo descartes finais de 23 mg/l e 15 mg/l B.O.D. adequando-se às exigências do Departamento de Meio Ambiente do RS.

* Projeto UNIDO US/BRA/80/166 - Coord. Internacional (C.T.A.): Dr. David Winters, Coordenador da Equipe de Assistência Técnica Internacional: Dr. Giuseppe Clonfero, Coord. Nacional do projeto: eng. quím./tecn. curtumes Luiz Kappenthal.

II - Introdução

Em 1981 o governo federal brasileiro assinou um acordo com as Nações Unidas (ONU) para a implantação de uma planta piloto e de demonstração para o tratamento de efluentes de curtume. O projeto seria instalado na Escola de Curtimento "SENAI" em Estância Velha e a execução técnica do projeto seria conduzida pela Organização das Nações Unidas para o Desenvolvimento Industrial (ONUDI). Este projeto deveria melhorar e complementar a estação primária de tratamento físico químico existente na Escola de Curtimento com uma série de sistemas de tratamento secundário biológicos alternativos. Durante o ano de 1982 as obras civis foram completadas e os equipamentos (estrangeiros e nacionais) instalados. Por considerações práticas a U.N.I.D.O. subcontratou a maior parte da assistência técnica internacional à uma equipe italiana com experiência neste setor, que começou suas operações em fevereiro de 1983.

Neste momento a planta encontra-se 100% operacional, mas dadas as limitações de recursos humanos julgou-se conveniente concentrar as atividades correntes na padronização do sistema primário ou físico químico seguido da operação em paralelo de dois sistemas de tratamento biológico ou secundário. Esta operação durante 6 meses foi intensamente controlada e monitorada e alguns dos dados obtidos bem como as eficiências verificadas são fornecidas abaixo.

III - A Estação - Sua Capacidade e Natureza

A - Fonte dos Efluentes

O conceito básico era de que a planta piloto deveria tratar os efluentes da Escola de Curtimento. Porém, dados os volumes de descarga relativamente pequenos e a sazonalidade desta fonte, decidiu-se complementar o volume necessário bombeando efluentes de um curtume local (Curtume Leuck, Mattes S.A.) através de uma tubulação especialmente instalada assegurando a disponibilidade de 50 m³/dia.

B - Estratégia Geral

Apesar da equipe brasileira e da U.N.I.D.O. ter se preocupado em assegurar que apenas 4 sistemas de tratamento secundário fossem instalados inicialmente, a planta piloto pode ser adaptada para outros possíveis sistemas de tratamento secundário sendo que os equipamentos instalados podem ser facilmente intercambiados. Assim, em um de nossos tanques de homogeneização a sedimentação foi evitada usando um grande agitador, após um agitador flutuante, após um aerador submerso e finalmente ar injetado por uma rede de difusores de cerâmica sinterizada.

C - A Estação

O layout esquemático da planta piloto pode ser visto no anexo I. Os parâmetros de projeto empregados se supunha que o DBO_5 do efluente seria inicialmente cerca de 2000 mg/l e seria reduzido para cerca de 500 mg/l de DBO_5 após o tratamento físico químico. Previu-se, assim, uma carga diária de 25 kg de DBO_5.

1 - Tratamento Primário

A unidade instalada é baseada em um tanque de equalização (homogeneização) que com um volume para retenção por 24 do influente do qual um fluxo controlado é passado por um ajuste de pH, tanques de floculação e coagulação e conduzido para um tanque de sedimentação vertical padrão

2 - Tratamento Secundário

A planta instalada foi dimensionada para permitir que cada unidade de tratamento secundário fosse capaz de tratar cerca de 50% do influente diário conforme os parâmetros do projeto de formas que as dimensões das unidades de tratamento secundário são:

a) Filtro de percolação

Diâmetro: 4m; altura útil: 1,5m; volume: 19m³ de recheio. A unidade é dividida em 2 metades, uma recheada com pedra britada, fração retida em peneira nº 2 e passada por peneira nº 3 e a outra recheada com anéis de polipropileno, tipo PALL. Esta unidade trata 0,3 kg DBO_5/dia/m³ (pedras) e 1,0 kg DBO_5/d/m³ nos anéis plásticos.

b) Valo de Oxidação (Carroussel)

Na forma de um anel alongado (ovalóide) com secção semitrapezoidal com um volume útil de 60m³ permitindo uma alimentação de 0,2 kg DBO/m³/dia, isto é, tempo de redução de 2,5 dias. Foi instalado um rotor com 0,7m x 0,7m com um motor de 3,0HP.

c) Lodo Ativado (Alta carga)

Constituído por um tamque de 4m x 1,85 x 3m de profundidade, isto é, 22m³ permitindo 0,56kg DBO/m³/dia ou seja, um dia de retenção

d) Lagoa Aerada

Uma lagoa aerada com 22m x 12m x 1,5m com volume útil de 300m³, com uma carga de 0,04 kg/m³/dia com retenção de 12 a 15 dias. É operada por 2 aeradores flutuantes de 1,5HP cada.

IV - O Projeto U.N.I.D.O. - US/BRA/80/166

Após um primeiro período dedicado a implantação da estação piloto e aos testes pré-operacionais, foi iniciada em março de 1983 a parte experimental do programa que compreende uma série de provas de tratamento que serão concluídas em maio de 1984.

Estas provas visam o emprego da maior parte dos sistemas de tratamento de água de descarga, seja o emprego de sistemas mecânicos, físico-químicos ou os biológicos e suas diferentes combinações, de modo a formar um quadro bastante amplo de alternativas possíveis.

Com base na análise dos resultados obtidos, é possível fazer-se a seguir uma definição dos sistemas de tratamento que são praticáveis, de um ponto de vista econômico e técnico, dentro de um contexto baseado na realidade brasileira.

No momento algumas provas podem ser consideradas como já concluídas e por outro lado o número de testes já executados são suficientes para permitir as primeiras considerações gerais.

Seguindo um esquema lógico, podemos avaliar os resultados do tratamento primário baseado em 82 dias de análise diária de tratamento útil. O tratamento primário compreende peneiramento, homogeneização e ao mesmo tempo oxidação de sulfetos, coagulação e floculação, sedimentação primária e tratamento de lodo. Os resultados obtidos podem ser resumidos nos seguintes pontos:

a) A Oxidação catalítica de sulfetos com a adição de 20mg/l de sulfato de manganês no tanque de homogeneização levou, na saída do decantador primário a uma concentração de sulfetos inferior a 10 mg/l, sendo possível, se desejado, a completa eliminação desta substância.

b) A adição de 400 mg/l de sulfato de alumínio e de 0,5 mg/l de um polieletrólito sintético permitiu a eliminação de 74,5% do DQO na entrada da estação. O DBO na saída do decantador primário se situa geralmente em torno de 180 mg/l. Um valor muito baixo de DBO, existindo um tratamento secundário posterior leva a um abatimento médio devido ao tratamento físico químico excessivo, razão pela qual se tensiona reduzir a quantidade de floculante usado até a alimentação no sistema biológico da água residual apenas com o pH corrigido e sedimentação primária.

c) A filtração direta do lodo no filtro prensa apresentou resultados não satisfatórios, enquanto que um condicionamento com 4kg/m³ de cal permitiu uma filtração normal com um torta contendo cerca de 30% de material seco e velocidade de filtração de aproximadamente 40 l/m²/h.

Passamos agora a considerar o tratamento secundário. Apesar de todos os sistemas implantados se encontrarem em situação operacional, podemos no momento fazer considerações tão somente sobre o sistema de lodo ativado e o valo de oxidação (carroussel). Nestes casos entramos no campo da"aeração prolongada", onde no tratamento de efluentes de curtume a quantidade de MLSS se situa entre 1500-2500 mg/l. No sistema tradicional de lodo ativado o tanque de oxigenação é constituído por um tanque de secção quadrada e um aerador flutuante fornece a agitação e oxigênio necessários ao processo. O líquido passa por um decantador onde o lodo é separado no fundo e retornado para o tanque de oxigenação e a água já clarificada passa para o tratamento seguinte. Os resultados referentes às análises efetuadas diàriamente durante 52 dias de"tratamento útil" mostram um abatimento de 56% do DQO e 87 % do DBO_5 com um valor médio na saída do decantador secundário de 23 mg/l.

O valo de oxidação, constituído essencialmente de um tanque de oxidação anelar alongado com seção de perfil específico, recebe a oxigenação e agitação necessárias de uma"molineta" rotante que além de manter o lodo ativo em suspensão permite ainda a transferência do oxigênio do ar para a fase líquida. Como no lodo ativado, um decantador vertical separa a água do lodo ativo que retorna para o sistema. Também neste caso os resultados até agora obtidos são mais que satisfatórios. Análises diárias efetuadas ao longo de 80 dias de tratamento útil mostram a evidência de uma eliminação de DQO da ordem de 52% e de DBO de 91% com um valor médio na saída do decantador secundário de 15 mg/l.

Em ambos os casos, valo de oxidação e lodo ativado, o valor do DBO é significativamente inferior aos 60 mg/l requeridos pelo Departamento do Meio Ambiente do Rio Grande do Sul sendo que os demais parâmetros como óleos e graxas, sulfetos, cromo, etc são amplamente satisfatórios.

V-ATIVIDADES FUTURAS

-Agora que o projeto está completamente implantado e 100 % operacional, é proposta uma rápida expansão, em particular:

a)Planta Piloto

Num futuro imediato é proposta a expansão e troca dos tipos de tratamento secundário em operação e demonstração. Em particular a operação de sistemas de tratamento secundário biológico incluindo o tratamento por lodo ativado em batelada e outros a serem realizados com um mínimo ou nenhum tratamento primário para aproximar-se mais da possível situação dos curtumes brasileiros.

b)Serviço de Estenção

Com o reforço de engenharia da contraparte brasileira do projeto a ser efetivado imediatamente, serão incrementadas as atividades de extensão e assistência com serviços técnicos a curtumes interessados bem como projetistas que atuam neste campo e espera-se exercer e contribuir com uma posição relevante na pretendida estação centralizada de tratamento de efluentes (município-curtumes) em Estância Velha.

c)Disseminação de Informações

Em adição aos serviços de extensão é proposta uma intensa e efetiva transferência de tecnologia. O projeto propõe a realização de uma " open week", uma espécie de seminário com explanações e demonstrações relativas ao tratamento de efluentes de curtume. Este evento seria realizado de 19 a 23 de março de 1984. Na preparação e execução do programa desta "semana aberta" o projeto conta a ativa colaboração de instituições técnicas brasileiras interessadas, em particular a assistência e suporte da ABQTIC

TRATAMENTOS BIOLÓGICOS PARA EFLUENTES DE CURTUMES NA AMÉRICA DO SUL
COMPARAÇÃO DAS VÁRIAS TÉCNICAS ALTERNATIVAS - 1ª PARTE

Este trabalho faz parte de uma pesquisa destinada a verificar experimentalmente os rendimentos obteníveis com várias técnicas de tratamento biológico.

Estão sendo confrontados e reportados os resultados obtidos, focalizando as vantagens e desvantagens de cada um dos diferentes processos empregados e testados na Planta Piloto para Tratamento de Efluentes de Curtumes da Escola de Curtimento SENAI em Estância Velha.

A Planta Piloto que trata 50m³ de efluente/dia dispõe de possibilidade de realizar vários testes com processos biológicos em paralelo. Nesta primeira parte serão examinados os processos.

1. Aeração Prolongada

2. Lodos Ativados

As condições operativas dos testes estão descritos na tabela abaixo:

	Aeração Prolongada	Lodo Ativado
MLVSS(mg/ℓ)	2100	3000
O.D. (mg/ℓ)	2	4
Tempo Retenção(h)	50 a 60	8 a 10
Pot. Instalada(w/m³)	19	65
SVI (índice volumétrico do lodo)	80	120
Carga Volumétrica (Kg DBO/m³.dia)	0.2	1,0
Carga Orgânica (Kg DBO/Kg MLVSS.dia)	0,09	0,35
pH	7 a 7,5	7 a 7,5
Temperatura(ºC)	15 a 28	16 a [illegible]

Estes tipos de tratamento foram conduzidos em diversas condições operativas e todas as técnicas utilizadas demonstraram um alto nível de eficiência, com redução percentual total acima de 80% de DBO_5 de ingresso.

Não foram constatados quaisquer problemas operacionais graves de modo que isto sugere a aplicabilidade destes sistemas nas condições sulamericanas, dependendo a escolha final da alternativa mais apropriada do estudo particular de cada caso.

No sentido de completar esta pesquisa testes estão sendo efetuados com outros sistemas como Filtros Biológicos e Lagoas (Aerada e Facultativa), no entanto os resultados deste trabalho serão objeto de uma próxima publicação.