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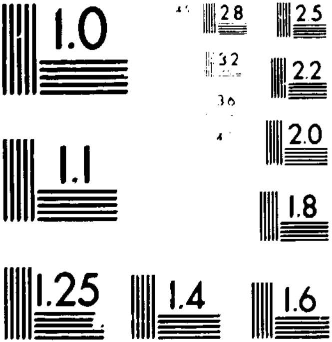

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

STANDARD REFERENCE MATERIAL 1010a

(ANSI and ISO TEST CHART No. 2)

RESTRICTED

14487

February 1985
ENGLISH

LEATHER TECHNOLOGY CENTRE

DP/CPR/83/004

THE PEOPLE'S REPUBLIC OF CHINA.

Technical Report: Tannery Effluent Treatment *

Prepared for the Government of the People's Republic of China
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of David Winters
Expert on Effluent Treatment

United Nations Industrial Development Organization
Vienna

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3564

CONTENTS

			Page
I	SUMMARY		1
II	TERMS OF REFERENCE, ARRANGEMENTS AND ACKNOWLEDGEMENTS		1
	A -	Terms of Reference	1
	B -	Arrangements	2
	C -	Acknowledgements	3
III	FINDINGS		3
	A -	Survey of Local Situation	3
	B -	Discharge Standards for Tannery Effluent	4
	C -	Course of Lectures	6
	D -	Combined Effluent Plant Da Chung Site	8
	E -	Effluent Treatment Scheme for Shanghai Leather Research Institute	11
IV	RECOMMENDATIONS		12

ANNEX	I	Tanneries Visited	i
	II	Course of Lectures/Seminars/ Discussion Groups	iii
	III A	Effluent Treatment Scheme for Shanghai Leather Research Institute	v
	III B	Technical Parameters for Effluent Treatment at Shanghai Leather Research Institute	xi

I SUMMARY

The expert's work during the six week assignment was split into three phases :-

Initially the expert presented a series of ten lectures to a group of 29 persons. The lectures covered the introduction of environmentally sounder tannery technology (reduction in quantity of water employed and recycling used liquors etc), as well as treatment technologies applicable to tannery effluent. The participants were split into three groups, one of which met each afternoon, over the ten day period, for indepth questions and discussion sessions with the expert. Plant and equipment available on the international market was discussed and illustrations examined.

The second phase of activity related to the proposed effluent treatment plant to be installed when four tanneries are relocated, adjacent to the Hong Guang Tannery, at some future date. This treatment plant had been designed by a group of specialists working for several years. The expert studied in some detail the plans for the proposed scheme and offered constructive suggestions which may allow more efficient operation of the plant when it is installed.

Finally, the expert prepared a flow chart and detailed parameters for an effluent treatment plant, suitable for the installation at the Shanghai Leather Research Institute (LRI) when its production is expanded (See Annex III).

II TERMS OF REFERENCE, ARRANGEMENTS AND ACKNOWLEDGEMENTS.

A TERMS OF REFERENCE

The purpose of the mission was :-

"To assist the Leather Technology Centre in Shanghai in setting up the effluent treatment pilot plant and to advise it in developing a viable scheme for the treatment of waste water from the tanneries in Shanghai."

However during preliminary discussion with the National Project Director it was apparent that the terms of reference for the assignment needed modification to conform to felt needs as seen by the national side. Similarly, the work programme previously submitted by the consultant was not appropriate to the situation.

The consultant attempted to speak to the SIDFA in Beijing to obtain his agreement to any change of terms of reference, however, he was out of the country, but his deputy confirmed that it was in order to modify the Job Description to satisfy local demand.

Accordingly the consultant accepted his duties as :-

Following a brief survey of some of the Shanghai Tanneries the consultant would :-

(1) Present a series of lectures, covering "better environmental tannery processing" and effluent treatment techniques and equipment. Such lectures to be further elaborated at smaller discussion groups.

(2) Analyse and evaluate the effluent treatment scheme, prepared by a group of local specialists, planned to be installed when four tanneries are relocated to the Da Chung area (adjacent to Hong Guang tannery). Where necessary advise the group on means by which their scheme's efficiency may be improved.

(3) Assess the needs for an effluent treatment plant at the Leather Research Institute (LRI) when its production is expanded. Outline a viable scheme giving such detail as may be required.

B ARRANGEMENTS

The expert arrived in Shanghai on 30th December 1984, and carried out his duties at the LRI. He subsequently travelled to Beijing for debriefing (3.2.85) and left for debriefing in Vienna on the night of 4/5 February 1985.

C ACKNOWLEDGEMENTS

The expert would wish to thank Mr Shi Xianglin, National Project Director, and all his staff at the Leather Research Institute for their generous assistance to the work programme and their hospitality and kindness.

Thanks must also be expressed to the management and staff of the Shanghai Leather Corporation, Hong Guang, Yi Min and Jiau Sin Tanneries for their hospitality and assistance.

The expert would also wish to thank Mr Liu Guanglu, Deputy Department Chief, Foreign Affairs Bureau, Ministry of Light Industry, No. 2 Department Beijing for his assistance and constructive discussions during debriefing in Beijing.

III FINDINGS

A SURVEY OF LOCAL SITUATION

1. Tanneries Visited

The consultant visited three tanneries and viewed their waste water treatment, outlined at Annex I. Their effluent treatment may be summarised :-

(a) Hong Guang Tannery - currently the waste water plant is not in use as it is being reconstructed. Their plant also includes an anaerobic digester for sludge treatment.

(b) Yi Min Tannery - the unhairing liquors are catalytically oxidized employing a fixed aerator on a batch system. The mixed liquors are coagulated employing a crude aluminium chloride reagent and sedimentation tanks (parallel). A filter press is employed for dewatering sludge. Currently a flotation unit is being installed.

(c) Jiau Sin Tannery (known previously as Zhen Yi) Tannery - due to the restricted area available three pits are employed as separate batch coagulation and sedimentation units. Residues are dewatered employing filter presses.

The consultant attempted to obtain detail as to water usage per Kg hide processed. However such relationship is not utilized by the Chinese tannery management. Simplistic calculations suggested their water usage was 70 - 90 litre water per 1 kg fresh hide (70 - 90 m^3/m.Ton); possibly almost double usage in developed countries.

Precipitation of chrome is practised, but the tanneries do not redissolve it - they sell it to other companies. No other recycling (direct or indirect) was practised.

B DISCHARGE STANDARDS FOR TANNERY EFFLUENT

There is a National Standard for discharge of pollutants from the Leather Industry - GB 3549 - 83. This established two classes of tanneries :-

Class 1 - Newly built, enlarged or reconstructed tanneries
Class 2 - Existing tanneries.

The Standards are based on weight of pollutants per ton of Raw Hides processed and the maximum allowable limits are :-

Items / Class	Maximum Allowable Discharge Amount														Index		
	pH	SS		BOD_5		S^{-}		Cl^{-}		Cr^{+++} Tanyard and Beamhouse Discharge Outlet Sampling		Cr^{+++} Central Discharge Outlet Sampling		Volume of Effluents		% of Cr^{+++} recovery
		Kg/T raw hide		Kg/T raw hide		Kg/T raw hide		Kg/T raw hide		Kg/T raw hide		mg/L		m^3/T raw hide		
		MAV*	DAV**	MAV*	DAV**	MAV*	DAV**	MAV*	DAV**	MAV*	DAV**	MAV*	DAV**	MAV*	DAV**	
1st Class	6 - 9	9 (300)	13·5	13·5 (350)	15·8	0·03 (1)	0·045	9 (300)	13·5	0·015 (0·5)	0·023	-	-	30	45	≥ 99
2nd Class	6 - 9	18 (400)	27	22·5 (500)	33·8	0·135 (3)	0·20	13·5 (300)	20·3	0·135 (3)	0·20	1·0	1·5	45·0	67·5	≥ 98·5

MAV * - Monthly Average Value DAV ** - Daily Average Value

<u>At the present time, only values included in the parentheses are used as figures for inspection (in mg/L).</u>

The notes included with the National Standards shown overleaf give local authorities permission to adapt such standards to conform to local circumstances. In Shanghai it is verbally reported that tanneries are given a less stringent discharge standard. (*It must be noted that the consultant has not seen written corroboration of this special Shanghai tannery standard). Discharge standards for effluent are reported variously :-

	Shanghai General	Shanghai Tanneries*	Tiensin	Canton	Chengdu
pH	6 - 7	6 - 9	N/A	6 - 9	6 - 9
$S^{=}$ mg/l	1	1	1	1	1
SS mg/l	500	500	300	500	500
Cr^{+++} mg/l	2	2	2	N/A	1
COD mg/l	100	300	350	300	200
BOD mg/l	60	200	250	60	60
Cl^{-} mg/l	N/A	N/A	1,000	N/A	N/A
Mn^{++} mg/l	N/A	N/A	5	N/A	N/A
Ammonia N mg/l	15	N/A	N/A	N/A	N/A

There is some measure of uncertainty as to what is the current legal status of the discharge standards. There appears to be no fixed date when the national standards, which is a more logical basis, i.e. pollutant total discharge related to hide production, will be introduced.

The "present time" basis of concentration of pollutant as standard is counterproductive leading to overlavish usage of water in order to lower concentration levels.

The expert would only wish to comment on two parameters included in GB 3549 - 83 :-

(i) The Cl^{-} levels (which are specified for areas where water may be utilized for irrigation), appear economically unobtainable. Typical Chloride levels produced by tanning are 100 - 150 Kg/Ton. Employing non-salted hides and adapting tannery technology one could possibly halve such level of Chloride effluent. However, at this time no technology exists to remove even this reduced amount, and to attain levels of 9 - 15·5 Kg/Ton appears somewhat unrealistic.

(ii) With regard to Cr^{+++} levels, it may be possible to achieve the discharge concentration standards regarding effluent. However, Cr^{+++} levels in sludge are inevitable. Of more significance are the promulgated Index of Chrome Recovery. The levels of real recovery, given today's available technology, cannot reach levels of 98·5 - 99·0%.

Bayer employing their patented materials have possibly achieved highest Chrome fixation levels. Luck (J.A.L.C.A 1980 (75.10.378) under controlled conditions obtained 98·5% fixation at the end of tanning, however, when allowance is made for subsequent bleeding during sammying, splitting and retannage, the effective fixation level was only 94·5%. If one accepts that such process is not suitable for all leathers, may not be employed utilizing chrome liquors prepared at the tannery from Bichromate (generally practised in China), and of even more importance, substitute material (of Bayer type) is not yet produced in P.R. China, the suggested recycle index appears a very long term objective.

Given normal precipitation of the residual Tan Float one could expect 85% effective recycling, if one also collected the liquors produced by piling, sammying etc. one may achieve effective recycling of 90%.

C COURSE OF LECTURES

Outline of the subjects covered in the lectures may be seen at Annex II, as may the details of the participants.

The afternoon discussion groups may be considered very fruitful, with such smaller groups (8 - 9 people), it was possible to understand their real problems and needs. Generally the discussions centered on three main areas :-

1. Plant and Machinery Utilized in the West

The expert had a selection of technical leaflets covering a wide range of equipment employed. (Brushed Screens, Racks, Pumps, Rotors, Floating Aerators, Sedimentation Units, Band Presses, etc.). The operation of such equipment was discussed and technical parameters and prices noted.

(Arrangements have been made to circularize to the participants copies of a UNIDO publication ID/WG 411/10 which at Annex IV has details of equipment available from over one hundred suppliers).

2. Efficiency of Effluent Treatment Plants

During discussion it became obvious that a number of participants were operating tannery effluent treatment schemes, but not obtaining optimum results. In general the poor performance appeared to be due to one or more of the following :

a) Attempting to operate without effective flow control. The need, especially during physico-chemical sedimentation, for regular flow control did not appear to have been included in their projects. In most cases flow = rate of discharge from tannery yielding surges at peak discharge periods and overloading of plant.

b) Non appreciation of basic philosophy accepted elsewhere, i.e. removal of maximum pollutant during primary treatment to lessen the size and load of subsequent biological treatment.

c) Overloading the biological plant, i.e. attempting to exceed the normal loading for activated sludge systems, i.e 0·2 - 0·4 Kg BOD/Kg MLVSS day. With MLSS of 1,500 - 3,000 mg/L = 0·3 - 0·6 Kg BOD/M^3 day.

d) Given the low ambient temperatures during winter and the often poor primary treatments, allowing a high inorganic loading in the biological treatment, even the loadings at c) above would be ambitious.

e) The poor primary treatments could be due to the unwillingness to employ polyelectrolytes to aid sedimentation. Originally the participants informed the expert that Chinese polyelectrolytes had not proven effective. However, at a later date when the expert was carrying out some laboratory trials with UK polyelectrolyte samples he had carried with him, a new Chinese product showed similar efficient results when employed with Alum. (Details of trials at Annex III).

3. Better Environmental Tannery Processing

Little appreciation was given to lowering of volumes of water employed, recycling and other techniques now in common use elsewhere. Possibly the situation will alter when the standards at GB 3549 come into effect, forcing lower water usage. The present management structure, whereby engineers installing and operating effluent treatment schmes are not able to influence tannery technology, could be reappraised.

D COMBINED EFFLUENT PLANT - DA CHUNG SITE

In anticipation of the relocation of four tanneries to the site adjacent to the Hong Guang tannery in the near future, a group of engineering specialists had prepared, during several years work, detailed plans for a combined effluent treatment plant. They had calculated that following Sulphide, Fat and Chrome pretreatments at the individual tanneries, they would have some 9,700 m^3/day, with pollution levels of circa :-

BOD_5	1168 mg/L
COD	2252 mg/L
SS	1037 mg/L

and they were hoping that after treatment they would be within the following discharge standard :

pH	6 - 9
SS	500 mg/L
BOD_5	60 mg/L
COD	300 mg/L
$S^=$	1·0 mg/L

----

1. Consultant's Approach

Originally the consultant was asked to give his outline of a treatment plant to process the above effluent. He outlined the treatment plant installed at Ponte a Egola, Northern Italy, which is a combined plant for many tanneries and handles 8,000 m^3 but with higher concentration of pollutants (lower water usage ratios). The system is a classical plant following the accepted principles, i.e. equalized flow - pump forward over 24 hours at regular rate - coagulate and flocculate - primary sedimentation - activated sludge treatment - sludge thickening - dewatering on belt press.

Fig. I shows layout and flow. The sizes and technical parameters were given to the interested engineers, (too voluminous to duplicate here).

2. Analysis of the Specialist Group's Scheme

The consultant was given a three volume set of detailed plans (50 odd), detailing the group's proposed treatment plant. The annotations had been translated and the engineers further elaborated the scheme. Over a two day period the consultant somewhat superficially analysed the scheme and directly informed the concerned engineers where he felt significant improvements could be effected. The suggestions are summarized below :-

a) For efficient physico-chemical sedimentation, it is essential that a regular flow rate through the plant be established, i.e. 9700 m^3 - 24 hours = <u>400 m^3/hour.</u> This would entail larger holding capacity equalization tank and pump flow at 400 m^3/hour from such tank (not gravity surge/erratic flow visualized).

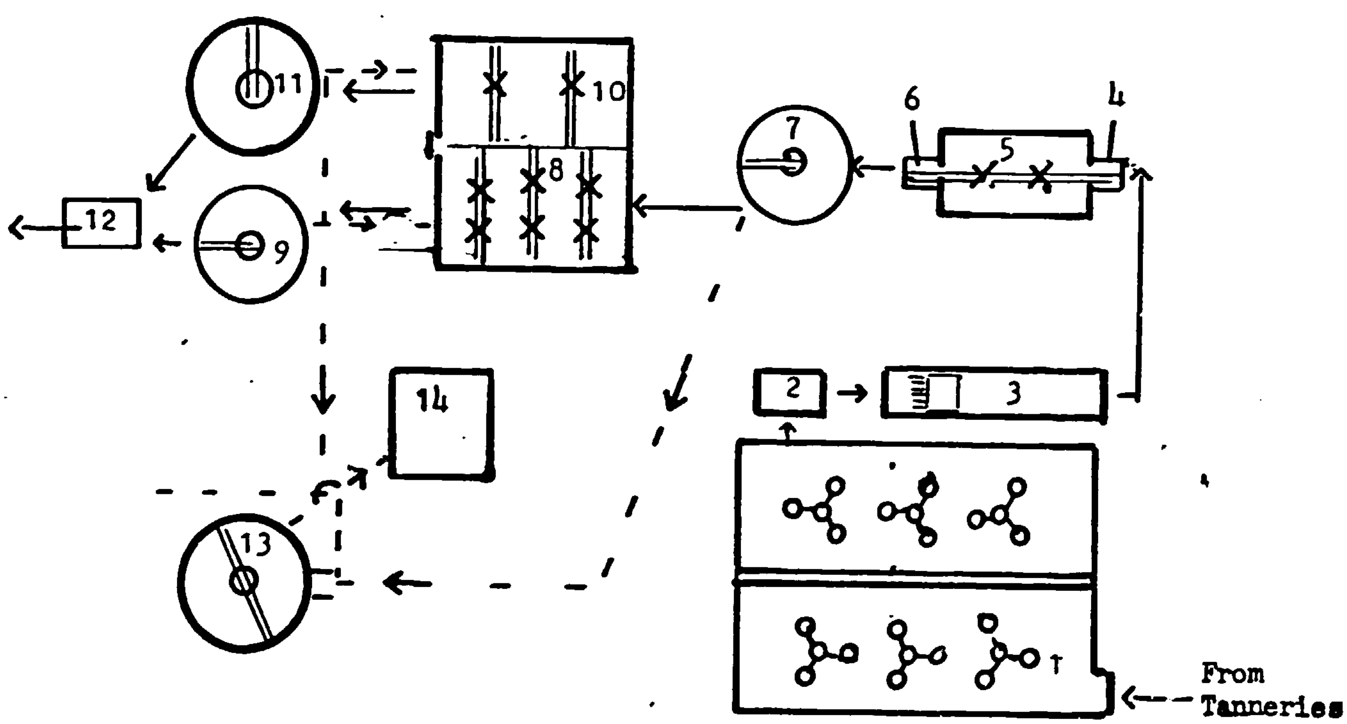
b) Seriously question the rationale of coagulation after biologic treatment. Believe coagulation/flocculation and correct sedimentation must precede biologic treatment to ensure that the biologic floc is not contaminated by unnecessary, non-active, suspended solids. The object should be to maximise removal of SS and BOD by sedimentation

FIG. I - OUTLINE PLAN - 8 - 10,000 m^3/day

EFFLUENT TREATMENT PLANT

LEGEND :

1 - Equalization and Catalytic Oxidation
2 - Pump Station
3 - Spontaneous Sedimentor
4 - pH adjustment
5 - Reserve Catalytic Oxidation Tank
6 - Flocculation
7 - Primary Sedimentation



- - - = Sludge Flow

LEGEND (continued) :

8 - 1st Stage Activated Sludge Tank
9 - 1st Stage Sedimentor
10 - 2nd Stage Activated Sludge Tank
11 - 2nd Stage Sedimentor
12 - Clean Effluent Discharge
13 - Sludge Thickener
14 - Belt Press House

to ensure subsequent biologic unit has minimum BOD to consume.

c) Even with an efficient sedimentation prior to the activated sludge treatment, the organic load appears high for the suggested volume and MLVSS levels suggested, especially in winter.

d) Find difficult to visualize treating such a large volume of sludge in Filter Presses. Would suggest Belt Press only realistic equipment (Simon-Hartley or Andritz). (This would involve relatively large amounts of polyelectrolytes, but given the volume of sludge it appears the only realistic approach).

NOTE: Sludge may be 12% of total volume (depending on efficiency of flocculation), i.e. circa 1164 m^3/day, following thickening it may occupy 600 m^3/day. A 2 metre Belt Press may handle some 20 m^3/hour = 480 m^3/day. Therefore two presses required.

e) Am uncertain of the efficiency of the scraping mechanism suggested for the horizontal sedimentation tank. Would suggest a proven design (outline drawings given directly), or alternatively feel a circular tank and scraper could prove more efficient.

E EFFLUENT TREATMENT PLANT FOR THE SHANGHAI LEATHER RESEARCH INSTITUTE.

The future production programme was discussed and a simple treatment scheme proposed. It may be found in detail at Annex III.

IV RECOMMENDATIONS

It is recommended that :-

1. When the effluent treatment plant is installed for the four new tanneries, to be relocated adjacent to Hong Guang Tannery, due consideration be given to the suggestions outlined earlier at para. 111 D.

2. When the LRI at Shanghai install an effluent plant it is suggested that the parameters and schematic flow chart at Annex III be employed as the basis.

3. The LRI investigate how the freely available and cheap local Aluminium Chloride may be utilized (with polyelectrolytes) to obtain rapid, non bulky sedimentation of pollutants in tannery effluent in order to equal the technical efficiency obtained elsewhere, employing aluminium sulphate and polyelectrolytes. (See Annex III).

ANNEX I

TANNERIES VISITED

The expert briefly viewed three tanneries and their effluent treatment schemes :-

1 HONG GUANG TANNERY (3.1.85)

Processes some 5,000 pigskins a day. Up to 40% in vegetable tan. (Balance chrome). Effluent handled together with that of an adjacent tannery - Hung Wei. Combined volume circa 2,500 m^3/day. Apparently 80 L water/kg.

Effluent treatment reportedly includes :- Screening - catalytic oxidation of sulphides - primary sedimentation and anaerobic digestion of sludge and other solid wastes. However, currently whole effluent plant under reconstruction. Did not study plans or parameters, but it appears they are attempting to construct a massive joint flocculation: sedimentation tank. The anaerobic sludge digestion tower:tank is reported not to function too efficiently (?due to low temperature?).

2 YI MIN TANNERY (4.1.85)

Processes daily some 600 domestic bovine hides (circa 2·5 m^2 each) and up to 1,000 pigskins (veg.). Total effluent circa 930 m^3/day.

The effluent treatment plant consists of :-

(i) Catalytic oxidation of unhairing liquors, employing a batch system with a fixed slow speed aerator.

(ii) Partial equalization, dosing with aluminium chloride (poor regulatable drip feed).

(iii) Sedimentation in a pair of parallel vertical flow sedimentation vessels.

(iv) Dewatering of sludge in manual type filter presses.

(v) An air flotation tank is being constructed.

(vi) Chrome in residual floats is precipitated and treated in filter press. (Chrome hydroxide is sold to others for regeneration).

3 JIAU SIN TANNERY (Previously known as Zhun Yi) (4.1.85)

Processes some 4,000 goats a day, employing approximately 350 m^3/d.

Due to the lack of space at the tannery site, treatment - physico chemical - is carried out in three elevated tanks, where batch dosing and sedimentation is practised. Sludge is dewatered in simple, crude filter presses. Chrome in residual floats is precipitated and treated in filter press. (Chrome Hydroxide is sold to others for regeneration).

Effluent samples from this tannery employed in laboratory sedimentation/jar tests at LRI (see Annex III).

ANNEX II

COURSE OF LECTURES/SEMINARS/DISCUSSIONS

The Institute had assembled a group of 29 interested parties for this short course, they represented :-

	Tanneries	Research Institute	Leather Corporation	University	Effluent Group	Total
Beijing		1				1
Chungdu	1		1	1		3
Hufei	2					2
Kwanchao	1					1
Shanghai	10	4			6	20
Tianjin	1		1			2
	15	5	2	1	6	29

The participants held the following professional levels :-

Engineers	7
Assistant Engineers	8
Technicians	12
Cadre	2
	29

The course occupied 10 working days - with a 3 hour lecture in the mornings to all participants. During the afternoons three separate groups were formed and discussions held.

The lectures covered the following areas :-

Lecture 1 :- General review - pollution levels and possible removal. Principles. Need for better environmental tannery technology. Discharge regulations etc.

Lecture 2 :- Pollution levels. Better environmental processing - reduce water - modify unhairing - recycle unhairing etc.

<u>Lecture 3</u> :- Protein precipitation. Chrome high fix - Direct recycle - precipitates etc. Liritan and rapid vegetable.

<u>Lecture 4</u> :- Outline primary (physico-chemical) schemes. Streaming.

<u>Lecture 5</u> :- Catalytic oxidation - equalization - flocculation - sedimentation etc.

<u>Lecture 6</u> :- Sedimentation, sludge dewatering, filter presses, band presses. Incineration. Anaerobic digestion.

<u>Lecture 7</u> :- Biological treatment. High and low load activated sludge. Oxygen transfer. Nutrients. Ratios BOD/MLUSS etc. Oxidation ditch parameters and equipment. Costs.

<u>Lecture 8</u> :-) Design parameters. Retention times.
<u>Lecture 9</u> :-) Flow rates. Mixing. Oxygen transfer.

<u>Lecture 10</u> :- Complete scheme of treatment review.

- - - - - - - - - - - - - - -

In addition to the above the expert also presented a $1\frac{1}{2}$ hour Paper to some 50 - 60 members of the Shanghai Leather Chemists Association : "The Interrelationship Between Tannery Technology and Tannery Effluents".

ANNEX III A

EFFLUENT TREATMENT PLANT AT SHANGHAI LEATHER RESEARCH CENTRE

A BASIC DATA

The expert was unable to obtain analytical data regarding characteristics of a composite effluent from the LRI. No definitive production process employed was available.

It was expected that current concentration levels would approximate those employed for the four tanneries being relocated, i.e.:-

BOD_5	1168	mg/L
COD	2252	mg/L
SS	1037	mg/L

Current water usage at LRI would appear to be circa 80 L/Kg. The expert was instructed to assume a daily flow of some 30 m^3. This would currently represent some 37 pigs a day i.e. 37 x 10 Kg x 80 litres = 29·6 m^3.

If the National Standard - GB 3549 - is introduced with its limitation on volume of water employed (45 L/Kg) such 30 m^3 would represent some 67 pigs/day. (Possibly with increased concentration of pollutants).

The LRI personnel had not decided how they would obtain such lower levels of water consumption, but felt they may have to introduce both shorter floats plus some recycling. The Director felt that the LRI would be classified as a Class 2 Tannery, and would need to obtain final effluents of :-

pH	6 - 9
SS	<400 mg/L
BOD	<500 mg/L
$S^=$	<3

B SYSTEM SELECTION

The expert felt that initially the LRI should install :-

(i) Catalytic oxidation of unhairing liquors,

(ii) Coagulation and flocculation followed by sedimentation.

Experience elsewhere suggests pollution removal levels obtainable by physico chemical primary treatment could be :-

% Removals

	High Level Dosing e.g. 800 ppm Alum + 1 ppm Polyelectrolyte	Low Level Dosing e.g. 200 ppm Alum + 0·5 ppm Poly-electrolyte	Natural Sedimentation
SS	99·5%	99·0%	96·0%
COD	77·0%	66·0%	50·0%
BOD	62·0%	58·0%	40·0%

Assuming the intial effluent characteristics expected, see above, one could expect final liquors :-

Final Pollution Levels - mg/L

	High Level Dosing	Low Level Dosing	Natural Sedimentation
SS	5	10	41
COD	518	766	1,126
BOD	444	490	700

Thus, to attain the acceptable BOD level a fairly efficient coagulation would be necessary.

C LABORATORY SEDIMENTATION TRIALS

A series of sedimentation trials were carried out in the LRI laboratories and it was shown that employing :-

200 ppm Aluminium Sulphate (added first)
plus 1 ppm Anionic Polyelectrolyte (NALFLOC A 3721 or A 3731)

the COD of a tannery effluent was reduced from 2,369 mg/L to 631 mg/L i.e. 73·3% reduction. Facilities for BOD analysis were not available, but extrapolating from the table of expectations above, this should represent a BOD of some 460 mg/L and be acceptable.

NB: It is understood that the LRI technical personnel would wish to employ a locally available cheap Aluminium Chloride as main coagulant, while agreeing that such material gave improved clarification the expert would strongly assert that it is essential to experiment with this material (additions of polyelectrolyte etc.) in order to obtain RAPID SEDIMENTATION and a DENSE FLOC.

The initial trials in the laboratory with $Al.Cl_3$ yielded a slow settling sediment with high bulk which could not be handled under normal plant conditions.

In order to be employed under normal plant conditions, it is essential that sedimentation tests obtain results similar to those achieved by the expert, employing Alum and Polyelectrolyte, i.e. employing effluent of similar characteristics and utilizing 500 ml graduated cones one must obtain a sediment of :

60 - 75 ml after ½ hour settling (i.e. 12 - 15% of original volume)
35 - 40 ml after 24 hours settling (7 - 8% of original volume).

Such sediment levels represent primary sedimentation and sludge thickening respectively.

D ALTERNATIVES

1. The expert outlines later the technical parameters for physico chemical treatment employing vertical sedimentation unit, which was explained in detail to the concerned persons at the LRI. An alternative, possibly obtaining higher levels of pollution removal, could be Dissolved Air Flotation. However, the expert feels this could only be employed if a guaranteed unit (package plant) is available from specialist manufacturers.

2. In the event that the BOD/COD standards are not achieved it may be possible to finally treat with NaOCl.

E LIMITATIONS

Due to lack of space, the design prepared at Fig II is on three levels, i.e. below ground, ground and elevated. This may incur higher installation costs than normal, but appears essential given the limited ground available.

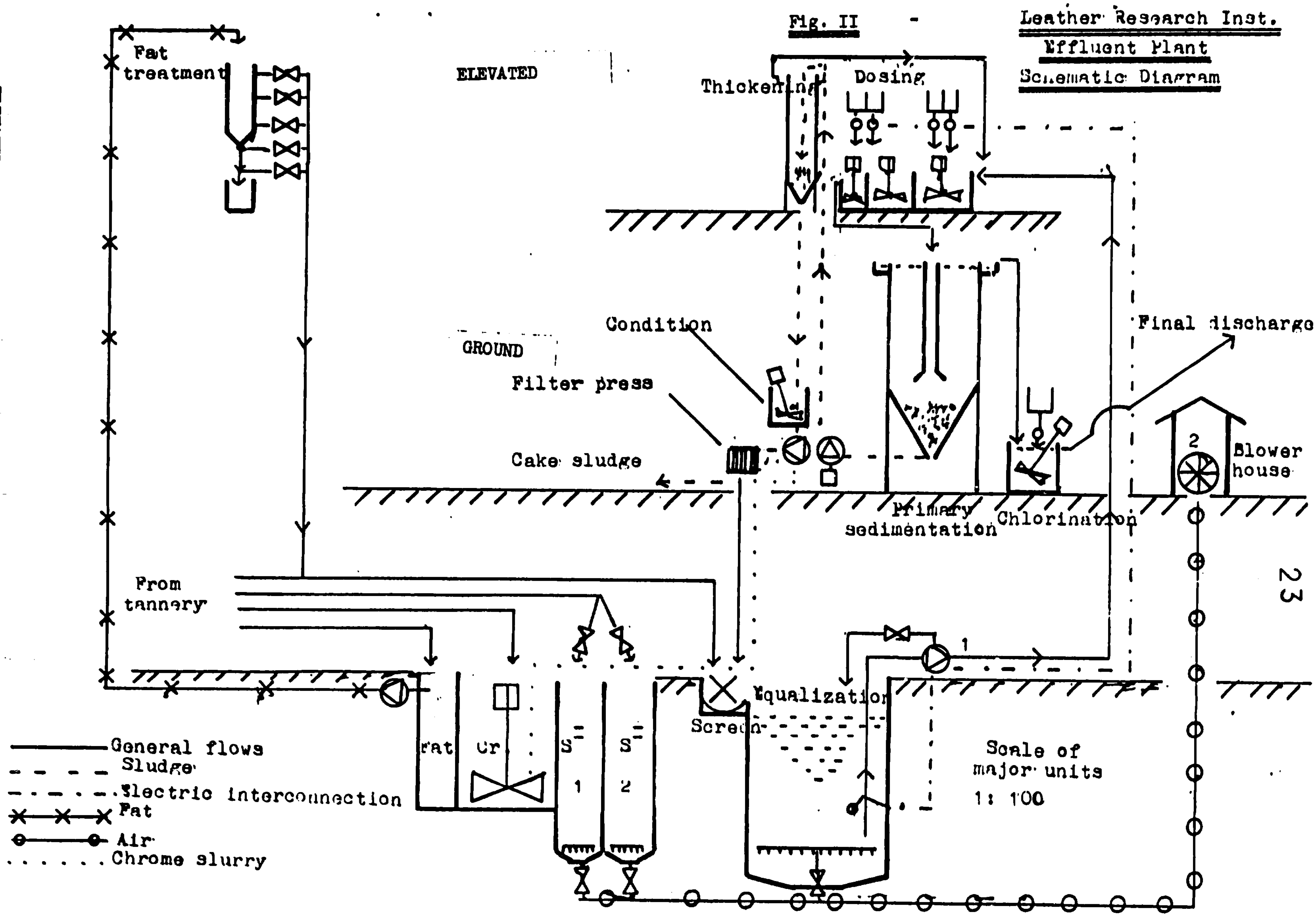
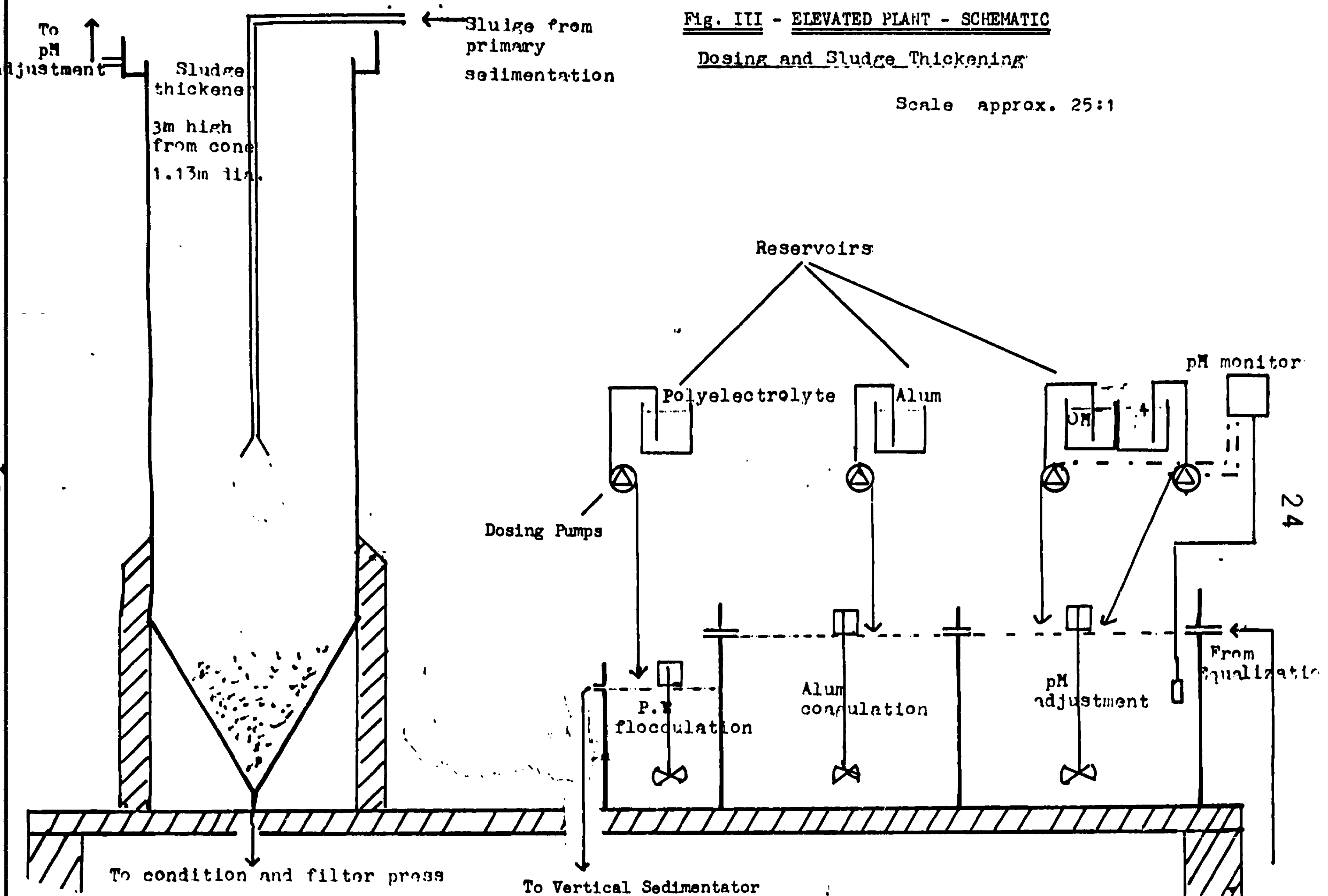


Fig. II
Leather Research Inst.
Effluent Plant
Schematic Diagram
ELEVATED
Fat treatment
Thickening
Dosing
Condition
Filter press
GROUND
Cake sludge
Primary sedimentation
Chlorination
Final discharge
Blower house
2
1
From tannery
Fat
Cr
S 1
S 2
Screen
Equalization
Scale of major units
1: 100
General flows
Sludge
Electric interconnection
Fat
Air
Chrome slurry

Fig. III - ELEVATED PLANT - SCHEMATIC

Dosing and Sludge Thickening

Scale approx. 25:1



ANNEX III B

TECHNICAL PARAMETERS FOR EFFLUENT TREATMENT AT LRI

A MAIN FLOW

1. Equalization

A minimum volume of 18 m^3 (3 m deep (effective below screen) x 3 m x 2 m).

Entry via a Brushed Screen (as Parkwood* type D.4. 0·4 m x 1·0 m. 0·25 Kw. Peak Flow 13 m^3/hour - Longwood Engineering). Such screens with 1·5 - 2·0 mm perforations are normally employed in tanneries. However the expert does not know how they will perform with the high fat levels reported from Chinese pigs.

Agitation by non-clog air diffusers (3 m^3 air/m^3/hr = 54 m^3/hr required).

Constant Flow - Essential for subsequent dosing and primary sedimentation effected employing a helicoidal pump. Assume operates 10 hours a day. Therefore flow rate must be 3 m^3/hour. (Depends on manufacturers specification, could be 2" outlet. 2 H.P. running at 600 RPM). Fine balance of flow utilizing a bypass circuit.

Float Valve. Fitted to ensure minimum of 6 m^3 always residual to act as equalizer, and avoid dry run of pump. (Actual level as high as possible found by practical trials).

2. Dosing See Separate Drawing

a) pH Control - Retention = 30 minutes = Tank 1·25 x 1·25 m x 1 m deep. (1·56 m^3).
Agitated. High Speed Stirrer. 1 HP. 100 mm blades
pH control effected with monitor controlling acid/alkali dosing pumps (0 - 100 L/Hr controllable - Possible supplier - Messrs Bran & Lubbe). pH Monitor usually set so that a pump is activated outside range pH 6·5 - 8·5.

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* Names and addresses of potential suppliers of equipment may be found at Annex IV of ID/WG 411/10. (Copy submitted with this Report).

b) Coagulation - Alum addition - Retention 30 minutes.
Tank, Agitator and Dosing Pump as 2 a) above.

c) Flocculation - Polyelectrolyte - Retention 5 minutes
$= 0{\cdot}25\ m^3$ ($0{\cdot}65 \times 0{\cdot}65 \times 0{\cdot}65$ m).
Slow Speed Agitator 0·05 HP. 100 mm blade
Dosing Pump as above at 2 a).

Flow through dosing units by gravity.

NB ALL DOSING PUMPS AND AGITATORS CONTROLLED BY MAIN FLOW PUMP (1)

NO FLOW = NO DOSING ETC.

(Suggested Dosing Rates :

$Al_2(SO_4)_3\ 18\ H_2O$ -	200 - 400 mg/L
Polyelectrolyte	0·5 - 1·0 mg/L)

Reservoirs usually Alum at 10% P/E at 0·1% Soln.

3. Primary Sedimentation

Employing vertical flow tank. Up flow rate to be circa 1 m/hr. With input of 3 m^3/hr require surface area of 3 m^2 i.e. diameter circa 2 m. Height above cone = circa 2·5 m. 60° Cone. Overflow via notched weirs adjusted to be horizontal.

4. Chlorination

If felt necessary. Could also be used for NaOCl to oxidise some COD. Equipment same as Alum dosing.

5. Discharge

By gravity to sewer

B SLUDGE

Provided correct coagulation:flocculation would expect sludge to occupy some 12% or less of original volume of effluent at minimum of 2·5% D.S.

With effluent flow of 3 m^3/hr maximum sludge = 0·36 m^3/hour. A 2" helicoidal pump at 600 RPM discharges 3·0 m^3/hour. (Pipes of less than 2" diameter may clog). Therefore will need to install timeclocks/relay system to run the pump, say, 75 sec every 15 mins. (Rate found by trials). Pass to thickener (as drawing). Position/height of inlet pipe on thickener should be adjustable. Will be dependant on mode of operation - i.e. continuous or 18 hour batch holding system.

After primary sedimentation may have 3 m^3/day of sludge at circa 2·5% D.S. i.e. 75 Kg Dry Solids day.

After thickening may be 1·5 m^3/day at 5% D.S.

Employing an efficient filter press one should arrive at circa 30% Dry Solids and a cake of 1·2 Kg/L density. Such cake would occupy 0·25 m^3 (250 litres).

An efficient Filter Press of 20 plates 0·63 m x 0·63 m with 25 mm thick cake (Possible supplier - Padovan), can produce some 110 litres of cake per cycle. As cycle time is approximately 4 hours it is possible to carry out 2 - 3 cycles per day.

C CHROME RECOVERY

a) The calculation of expected chrome recovered may be simplistically calculated :-

(i) If one assumes maximum production = 80 pigs day at 5 Kg each split = 400 kg. If one offers 2·2% Cr_2O_3 and 33% is in the residual liquor, we have daily : 2·9 Kg Cr_2O_3/day in used liquor. If in 100% float = 0·4 m^3 at 7·25 g.p.l. Cr_2O_3

b) The Filter Press quoted earlier could produce some 110 litres of cake per cycle. With density of circa 1·1 Kg/L = 120 Kg. Cr_2O_3 content of such cake is 10 - 12% i.e. 12 - 14 Kg Cr_2O_3. Therefore once a week a batch of Chrome could be processed.

c) The chrome holding tank could have a 1 week capacity i.e. 0·4 x 6 = 2·4 m^3.

Alternatively, a smaller tank could be utilized and the $Cr(OH)_3$ precipitated daily, the next day some virtually chrome free supernatant may be pumped to the equalization tank, allowing room for fresh chrome to enter.

(If MgO is employed it gives good sedimentation with chrome bearing liquor at 50 g/L Cr_2O_3)

D CATALYTIC OXIDATION OF SULPHIDES

The consultant would suggest "in situ" catalytic oxidation. This would require two pits, one being treated, one collecting that day's flow. If Lime liquor is circa 10% of daily flow each pit would need to be 1 m x 1 m x 3 m deep. (Could collect lime liquors during day, oxidise during evening and discharge by pump gradually over 4 - 5 hours to equalizing tank.)

Air Requirement

If the tannery was using 2·0% $S^=$ as its unhairing basis, and if 30% was unutilized would have :-

80 hides @ 7 Kg Raw = 560 Kg. at 0·6% residual $S^=$ = 3·36 Kg $S^=$. If in 200% Float = 1,120 litres @ 3,000 mg/L.

	1 Kg $S^=$	requires	0·75 Kg O_2
Therefore	3·36 Kg $S^=$	requires	2·52 Kg O_2

If Air Diffusers (Coarse bubble) are only 6% efficient will require 60 m^3/air per Kg O_2 i.e. daily will require 150 m^3/air.

To process the sulphide in three hour batches would require 50 m^3/hour. Allow 50% safety margin (often 50% of sulphide offered is unutilized), i.e. 75 m^3/hr. Number of diffusers to be calculated with 3 m head.

Catalyst dose to be found by trial. $MnSO_4$. Usually 150 ppm Mn^{++} sufficient.

E BLOWER HOUSE

Maximum total air required -	Equalization	54 m^3/hour
	Sulphide	75
		129 m^3/hour

This could easily be produced by a 2 KW rotary vane blower.

F PUMP

Will require also several mobile pumps for transfer of fat, chrome and lime liquors. Possibly submersible type (e.g. as Flygt - "Unchokable".)

G NOTE: To obtain maximum smooth running of the plant it would be preferable to have screens at the entry to fat, chrome and lime catchpits. However LRI personnel felt the cost may be excessive. In such circumstances at minimum crude bar screens - 1·5 cm apertures should be fixed to ensure no large matters enter the pits. The "Unchokable" pump can normally handle solids up to 2 cm diameter.