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ASSISTANCE TO THE LEATHER INDUSTRY

DP/SRL/83/003/11-51

SRI LANKA

Technical report: Advice on the Tannery Effluent Treatment Plant*

Prepared for the Government of Sri Lanka
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Martin van Vliet
Consultant in tannery effluent treatment and plant design

Backstopping officer: J. Buljan, Agro-based Industries Branch

United Nations Industrial Development Organization
Vienna

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Explanatory Notes

Dfl 1.00	=	Rs 14.00
CLPC	=	Ceylon Leather Products Corporation
CISIR	=	Ceylon Institute of Scientific and Industrial Research
COD	=	Chemical Oxygen Demand
BOD	=	Biochemical Oxygen Demand

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1. SUMMARY

At the request of UNIDO the consultant visited the Ceylon Leather Products Corporation in Colombo, Sri Lanka from 10-06 till 25-06-1987.

During this period, information was gathered on the environmental problems of the tannery. The basis of information from several persons, a survey of the tannery effluent by CISIR, a screening of the production processes, the sewer system and the location and taking into account the local circumstances, it is advised that a chemical-physical treatment system is a suitable, reliable and not too sophisticated system for the purification of the tannery effluent.

Beside a primary sedimentation, aided by chemical flocculants, the system also includes a chromium separation system with the possibility of re-using the chromium.

Although this system cannot completely meet the Sri Lanka interim standards, it will be accepted by the local authorities.

The consultant had no meeting with the engineer from the Dutch consultancy company (BKH).

2. CONCLUSIONS AND RECOMMENDATIONS

In the following chapters, the processes and the environmental impact of the CLPC tannery are described in detail.

The most suitable effluent treatment system for solving the environmental problems of the tannery is also described.

Based on this survey, several conclusions can be drawn:

- The effluent problems of the tannery can be solved to a great extent by introducing a chemical-physical treatment system. The system will remove suspended solids, 50-60% of the organic polluting compounds and the toxic substances, chromium and sulphide.
- Although the system cannot completely meet the Sri Lanka interim standards acceptation by the local authorities is expected.
- A chrome seperation/recovery system is introduced to concentrate the chromium into a smaller amount of sludge and to create the possiblity of re-using the precipitated chromium as a tanning agent. Re-using means a reduction of the costs for chrom-tanning salts.
- There is no need for a pre-oxidation of the sulphide containing liquors from the beamhouse.
- By putting an aerator in the equalization pit, the sulphide is oxidized without the need for extra mixers. This is a first step of the biological purification.
- The chemical-physical treatment plant is designed for the treatment of the effluents of the tannery. It is therefore necessary to have a separate sewer system for rainwater.
- Better housekeeping (reduction of water and chemicals, including solid waste) as well as the application of a chrome tanning process, with a high uptake of chromium have to be considered.

- Before dumping on a location of the Municipality the chromium-bearing sludge has to be treated on drying beds.
- The land between the tannery and the Kelani river is large enough for building the effluent treatment plant and the sludge drying beds.
- Based on a rough estimation the total investment costs for the chemical-physical treatment plant with the sludge drying beds and a chrome recovery system are approximately Dfl. 390.000,-- or Rs 5,5 million. The yearly operating costs will be about Dfl. 90.000,-- or Rs 1,3 million.
- For starting up of the effluent treatment plant, a chromium re-using system, and/or introducing recipees for a high uptake of chromium extra costs have to be considered for specific consultancy, inspection after installation and during the first year of operation and for training of employees both on the job and outside.

3. INTRODUCTON

At the request of the United Nations Industrial Development Organization (UNIDO), Ing. Martin van Vliet , waste water expert of the TNO Leather and Shoe Research Institute visited the Ceylon Leather Products Corporation (CLPC) in Colombo, Sri Lanka, from 10-06 till 25-06-1987. The aim of the mission was to investigate the present situation with regard to the most suitable effluent treatment system for the CLPC tannery. The terms of reference are given in the job description, Annex 1.
The leather industry in Sri Lanka is small in scale and up till now of minor importance to the economy of the country. It consists of one tannery in the public sector (CLPC) and eight registered private tanneries. Most of them are located in the Colombo area, with only two in the Central Province.
Besides the vetegable tanning of the hides and skins, three tanneries have mechanized chrome tanning facilities.

The Ceylon Leather Products Corporation (CLPC) is a conglomerate of a tannery, a shoe factory, a leather goods factory and a rubber factory. In 1986, the tannery's production amounted to 155,000 hides, with a total weight of 1 800 tons of this amount, 85% are cattle and 15% are buffalo hides. Recently the tannery also started processing goatskins. At this time a total amount of 10 tons per day (800 hides) of cattle and buffalo hides are 1 ton per day of goatskins are processed. All the soaking and liming processes take place in the chrome tannery. After these processes the goatskins and about 15% of the hides are transported to the vegetable tannery.

In this department, the goat skins are chrome tanned and the hides are vegetable tanned.
In the chrome tannery the hides are processed to different types of leather. The leather is then transfered to the shoe and leather goods factories or sold to the local market.
The extension and modernization of the CLPC leather production facilities brought about a proportional increase in water pollution.
Up till now, the tannery has been discharging the highly polluted effluent into the Kelani river approximately 1.2 km from the river mounth.
A report on effeluents from industries situated along the Kelani river showed extensive pollution, caused by the CLPC tannery and a few other industries.
For this reason, a sedimentation tank was built and efforts were made to obtain internal and external funds in order to finance a tannery effluent treatment plant.
At the end of 1985, the Dutch Governement indicated their interest in providing assistance through a Dutch based engineering and consultancy company (BKH).
Allthough mentioned in the terms of reference, it was however not possible to arrange a combined meeting in Sri Lanka with the Dutch engineer responsible.
The consultant wishes to acknowledge his gratitude for the effective and pleasant assistance received from the staff of UNIDO, UNDP and CLPC (see Annex 2).

4. THE ENVIRONMENTAL ASPECTS OF THE CLPC TANNERY

Solving tannery effluents problems can be very complicated. Although local aspects are very important, the mosts important aspects are the different processes which take place in a tannery.
In a tannery, large amounts of chemicals are used for the processing of hides and skins. Of these chemicals, a certain amount is being charged with the process water, which depends entirely on the specific production processes and recipees used. Roughly 50% of the raw materials can be transferred into organic or inorganic, dissolved or suspended solids.
For this reason, UNIDO has attached a tannery effluent consultant to the Ceylon Leather Products Corporation to advise on the most suitable tannery effluent treatment system.

Effluent

The effluent from the CLPC tannery is discharged from two different buildings (see Annex 3). About 270 m^3 per day is discharged from the chrome tannery. This amount consists of process water from the lime-yard (180 m^3), from the deliming/tanning processes (40 m^3) and from the retanning/dyeing processes (50 m^3). The second flow (80 m^3 per day) is discharged from the vegetable tannery, where, besides chrome tanning of goatskins, mainly vegetable tanning processes are carried out. Both flows are mixed with rainwater. Sometimes a third flow, coming from the bark tannery, occurs. This is, however, a very small amount and will be even less in future.

After screening, the effluent from the chrome tannery, flows through a sedimentation tank. This system however is not working properly and causes clogging throughout the whole drainage system. The efffluent from the vegetable tannery is, after screening, directly mixed with the other flow.

In tannery waste water, the greater part of the organic pollution stems from the beamhouse liquors or more specifically from the soaking, de-hairing and liming processes. In the chromium-emitting part, a waste water flow rich in chromium, leather fibres and salt and poor in organic pollution is produced by classical chrome tanning. On the basis of given figures and the specific processes, a rough estimate of the composition of the effluent from the CLPC tannery is given in table 1.
In this table, a comparison is made with the summarized results of the study from the Ceylon Institute of Scientific and Industrial Research (CISIR). This study was done at the request of the Dutch engineering and consultancy company and included the measuring of the flow, sampling the effluent and analysis of the collected samples. The results of this study are given in Annex 4.

Table 1 Composition of the CLPC tannery effluent

Parameter	Effluent composite (as mg/l	Effluent composite CISIR study (as mg/l)
pH	6 - 10	9,5
Suspended solids	500 - 1 000	960
BOD_5	1 000 - 1 500	1 920
COD	2 000 - 3 000	2 960
Chlorides	2 000 - 3 000	-
Sulphates	1 000 - 2 000	-
Total chromium	50 - 200	400
Sulphides	50 - 100	3
Flow (m^3)	350	225

From this table it appears that a few notable differences exist. Some of these differences can be explained by the fact that measuring and sampling was carried out for 8 hours per day. The discharging of waste water will, however, take place for 10-12 hours per day and during this period the amount and composition of the waste water can differ every hours. This leads to the conclusion that the figures from the CISIR study are not fully representative. The differences in the flow and the concentration of sulphide can, however, not be fully explained by the short measuring period. A calculation on the basis of the production processes gives much higher figures.

Bisides the organic compounds, the suspended solids and the salts, the waste water contains two main substances, chromium and sulphide, which require special attention with regard to their toxic properties.

Solid Wastes

Tanning involves the production of solid wastes. The untanned waste that is formed consists of fleshings and trimmings. This chromium-free waste is sometimes used for the manufacturing of glue. Chromium-free proteïns can also be used as animal fodder or as a fertilizer.
Chromium - bearing solid waste - like shavings,splittings and sludge - has to be dumped on a specially - designated piece of land.
Up till March 1987, all the solid waste (chromium-free and chromium-bearing) was dumped on the land (CLPC property) near the Kelani river. Since March, the solid waste has been transported to a special piece of land owned by the Municipolity.

Air pollution

An important source of air pollution at the tannery is the smell of putrifying flesh. At this moment all the solid waste is removed regularly and therefore causes no severe smell problems.

5. THE TANNERY EFFLUENT TREATMENT PLANT

Generally speaking it is always important to reduce the quantity of water used for the production processes. In this way a more concentrated effluent is obtained and the treatment plant can be smaller, resulting in a higher purification rate. Reduction of water achieved by means of a critical view of the working methods and applied processes and a charge of these methods and proceeses. In this case, it is also important to separate the rainwater drain from the waste water.
An important aspect can be the use of an alternative chrome tanning method. The usage of such a chrome tanning method, with a high uptake of chromium, causes a remarkable reduction in the amount of dissolved chromium in the waste water.

For purification of the effluent from the CLPC tannery, it is advised to use a chemical-physical treatment system in combination with a chromium-separation system for the highly concentrated chromium containing liquors.
The system can be described as follows (see also Annex 5).
The chrome tanning liquors from both the chrome tannery and the vegetable tannery are collected seperately in the pit under the drum. The liquors are then pumped into the sedimentation tanks (Imhoff tank) and at the end of the day the pH is raised with lime until pH = 9. While adding the lime, the liquor should be mixed for at least 1 hour. After mixing, the liquor should stand overnight and in the morning the percipitated chromium-hydroxide sludge is removed through a valve in the sludge drying bed. The effluent has to be discharged in the waste water sewerage.

In the event that the chromium is to be re-used the effluent has to be discharged first and sulphuric acid added to the chromium hydroxide precipitate. This liquid can then be re-used as a chrome tanning agent.

The waste water from the different departments is, after screening, collected in an equalization pit. The pit has a capacity of 500 m^3 and has an aerator in the centre. This has the advantage that the effluent is mixed, the toxic sulphide is removed by oxidation and the biological purification process is started The pH in the pit should be kept at 9. From this pit, the waste water is pumped into a sedimentation tank (Imhoff tank).

In order to maintain a constant flow to the sedimentation tank (350 m^3/24 h = 15 m^3 per hour) an overflow tank is installed.

Before the effluent enters the sedimentation tank, the flocculants are added to obtain correct sedimentation in the tank. The purified water leaves the tank at the top and the chromium bearing sludge is collected at the bottom of the tank. The sludge is drained off from time to time in the sludge drying beds. A flowchart of this system is given in Annex 6.

As to this chemical-physical treatment system, the following remarks can be made.

- The system is designed for the treatment of the process water of the tannery. It is therefore necessary to have a separate sewer system for rainwater.
- A chrome seperation system is introduced to concentrate the chromium in a smaller amount of sludge and to provide the possibility of re-using the precipitated chromium as a tanning agent.
- When the alkaline sulphide liquor form the lime yard is miced with the acidic tanning liquors there is a possibility that the toxic hydrogensulphide gas is formed.

Because the beamhouse liquors are mainly discharged in the morning and the tanning liquors in the afternoon, there is no need for preoxidation of the beamhouse liquors.

Oxidation is now effectuated in the equalization pit.

- The waste water in the equalization pit has to be mixed by one or two mixers. The same effect will now be achieved by the aerator.
- In Annex 5 a rough estimate of the effluent figures are given. Based on these figures, one can see that the effluent treatment system cannot meet the Sri Lanka interim standards. Allthough the toxic substances, chromium and sulphide are removed together with the suspended solids, some organic pollution will still remain (purification rate 50-60%).

  It is however expected that the authorities will accept this treatment system.
- Before dumping on the location of the Municipality the sludge from the sedimentation tanks has to be dried on sludge drying beds. Although the sludge will still contain chromium, the concentration will be much lower than without a chrome seperation system.
- The tannery effluent treatment system is planned in the piece of land between the tannery and the Kelami river. A lay out of the tannery and the treatment plant is given in Annex 3.

In Annex 7, the financial aspects and a list of necessary equipment are given for the described treatment plant.
Although the total costs for such a system cannot be estimated exactly at this moment, the investment costs will be approximately Dfl. 390.000,-- or Rs 5,5 million.
The greater part of the costs are rough estimations based on information from local suppliers.

Dutch prices are given for the equipment which is not available in Sri Lanka.

Any costs for being present at, or kelpump with, the starting up of the treatment system are not given in Annex 7. Investing in a treatment system does not garantee that this system will work at an optimum level. With any type of treatment system, it is necessary to train the people who are in charge of this system. To reach a maximum result with the effluent treatment system, "on the job" training for two persons (operator and assistent) is necessary. To make sure that after starting up, the plant will work for a long period, it is advised that an effluent treatment expert should inspect the system after 6-12 months.
By introducing an effluent treatment plant, effluent control becomes very important. Regular chemical analysis of influent and effluent in different parameters will be necessary.

At this time, there is no need to extend this system with a secondary treatment system. Although secondary treatment of the effluent will remove the residual organic pollution, the system includes higher investment costs, will give more sludge and needs more monitoring and maintenance.
An effluent treatment plant is new for the country and should therefore be built up step by step. A too sophisticated treatment system will reduce the chance of successful operation.

UNITED NATIONS

Annex 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO 27 October 1986

Project in the Democratic Socialist Republic of Sri Lanka

JOB DESCRIPTION

DP/SRL/83/003/11-51/J 13 104

Post title Consultant in Tannery Effluent Treatment and Plant Design.

Duration 20 days

Date required

Duty station Colombo

Purpose of project To assist and advise in the planning of the Tannery Effluent Treatment Plant for the Ceylon Leather Products Corporation.

Duties The Consultant will be attached to the Ceylon Leather Products Corporation (C.L.P.C.) a parastatal organisation under the Ministry of Industries & Scientific Affairs and will in co-operation with the Experts of the contracted engineering company work out the most suitable design for the Tannery Effluent Treatment Plant expected to be constructed at the C.L.P.C. complex. In particular the Consultant is expected to:

(1). Recommend and advise on the most suitable system to be selected under which the envisaged Tannery Effluent Treatment Plant is expected to function considering the area available and the volume of pollutants discharged by the Tannery.

(2). Provide technical assistance and transfer of know-how to the involved engineering consultancy company contracted for the planning, design and costing of Tannery Effluent Treatment Plant.

The Consultant will also be expected to prepare a short technical report setting out the findings and recommendations to the Government on further actions which might be taken.

Applications and communications regarding this Job Description should be sent to:

Project Personnel Recruitment Section, Industrial Operations Division

UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

Qualifications Expert in Tannery pollution treatment and Tannery Effluent Treatment Plan design with intensive experience in this field perticular in developing countries.

Language English

Background information Sri Lanka has a fairly rich livestock population, based on the census of 1983, there are 1,699,800 cattle, 910,000 buffalo, 519,300 goats, 28,600 sheep and 77,000 pigs in the country. The off take rate for 1983 were for cattle 11% (191,824), for buffalo 12% (75,000 estimated) and for goat and sheep 24% (134,091). There is no production of pig skins. Inadequate hide and skin collection as well as poor conservation is causing substantial loss in volume and value for the country's Leather Industry.

In Sri Lanka there are nine Tanneries of which three have functioning chrome tanning facilities, the combined production capacity is some 35,000 bovine hides per month. Vegetable tanned leather is produced by all Tanneries but exclusively only in six establishments mainly due to the lack of suitable processing equipment required for chrome tanning. The local Tanning Industry provides employment for about 550 people. A substantial part of the cattle hides are processed into vegetable (bark) tanned leather known as kips and exported. During 1983 1,193,225 kg of leather valued Rs.29.3 million was exported. Most of the buffalo hides are exported in the wet salted condition however the share of hides turned into leather locally is increasing. Goat and sheep skins are predominately processed into vegetable or chrome crust for export. The Ceylon Leather Products Corporation (C.L.P.C.) a parastatal organisation founded in 1956 consists of:

- One Tannery located in Colombo, Mattakkuliya, having a present annual production capacity of 3 million square feet of upper leather, 100 ton of sole leather and 0.5 million square feet of various types of fine leather made from goat/sheep skins.
- One Shoe Factory in proximity of the Tannery having a production capacityof 550,000 pairs of Footwear per year.
- One Leather Goods Factory situated in the Ekala Industrial Estate with production facilities to manufacture leather goods on an industrial basis.

The C.L.P.C. employs in total about 1,200 people.

Under the ongoing project DP/SRL/83/003 entitled "Assistance to the Leathe Industry in Sri Lanka" and in co-operation with a Dutch based engineering consultancy firm a pre-feasibility study on the setting up of Tannery Effluent Treatment Plant at the C.L.P.C. was carried out at the beginning of 1986. Three different treatment systems have been elaborated. In the following Dutch Government assistance was sought to fund a complete feasibility study on the setting up of the Effluent Treatment Plant, which is expected to be carried out in November/December 1986. Since this envisage plant shall also function as an effluent demonstration plant for the country's Tanning Industry additional expertise in Tannery Effluent Plant design is required to assist the contracted engineering firm in their planing.

The Tannery daily input is around 7 - 9 ton, resulting in an effluent discharge of around 400 m^3/d.

Annex 2

LIST OF PERSONS CONSULTED DURING THE MISSION

UNDP/UNIDO

Mr. L. Buljan, Back-Stopping officer
Mr. T. Schroll, Sidfa
Mr. S. Ericson, JPO
Mr. G. Felsner, CTA

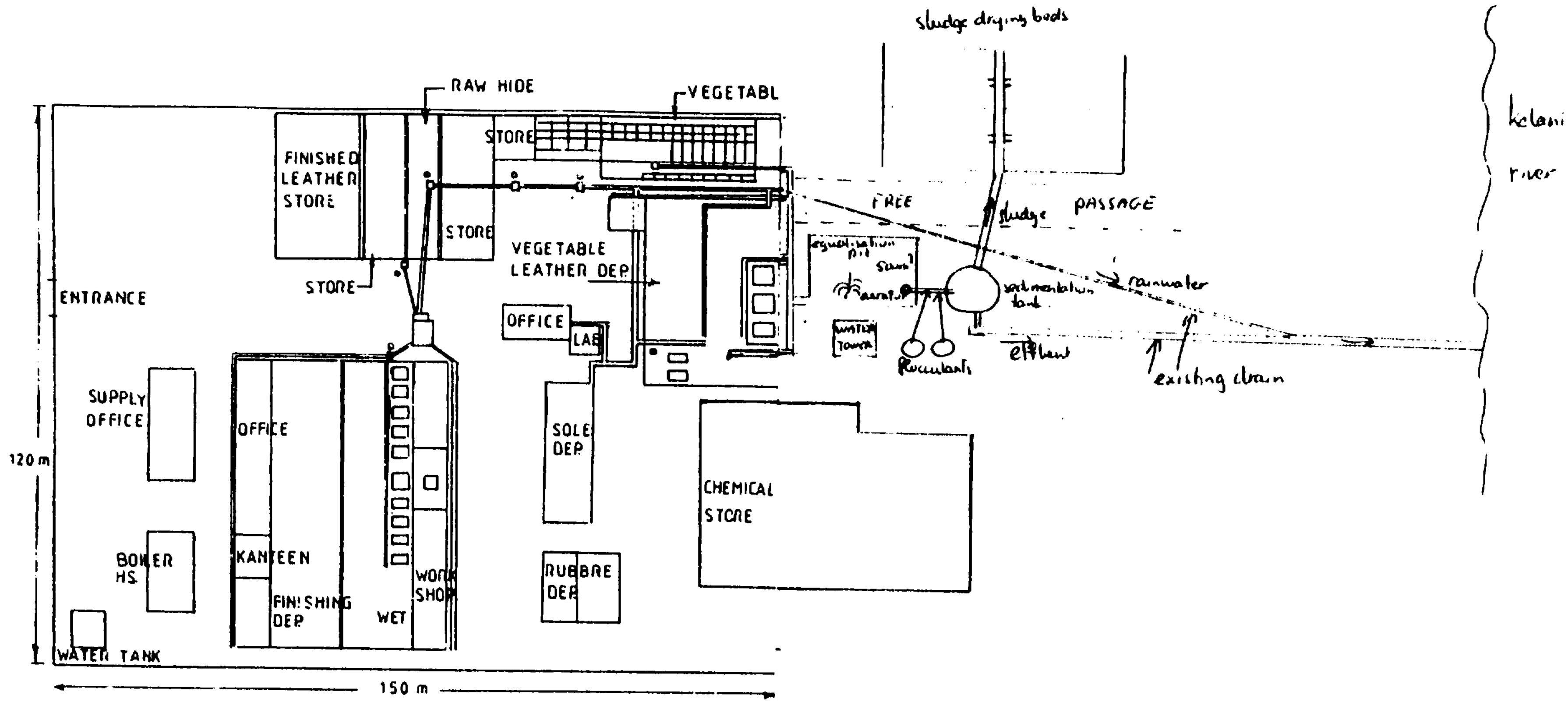
CLPC

Mr. C.R. Dias Desinghe, Chairman/Managing Director
Mr. D.G.H. Sirimanne, Assistant General Manager
Mr. R. Rajakarona, Secretary/Export Manager
Mr. W.K. Wickramasinghe, Factory Manager/Tannery

Private Industry

Mr. C. Batuwangala, General Manager Nedlanka
Mr. D.J. Percy Silva, General Manager S.A. Perrera & Co. Ltd.

LAY-OUT OF THE CLPC TANNERY AND THE EFFLUENT PLANT



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Annex 4

இலங்கை விஞ்ஞான கைத்தொழில் ஆராய்ச்சி நிலையம்

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Telex 21248 MININD CE Attention C. I. S. I. R.

REPORT ON ANALYSIS OF TANNERY EFFLUENT

Report No. NR/TS 0155

Report to :

Mr. Hans Bruins,
No. 112, Airport Road,
Ratmalana.

09th April 1987.

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REPORT ON ANALYSIS OF TANNERY EFFLUENT

Report No. NR/TS 0155

1. **Client** : Mr. Hans Bruins, No. 112, Airport Road, Ratmalana.

2. **Reference** : Clients request on 19th February 1987. (Ceylon Leather Products Corporation, Mattakkuliya.)

3. **Purpose of the study** : To determine the parameters on composite samples of tannery effluent.

4. **Visits** : The tannery was visited on 23rd, 24th, 25th, 26th, 27th of February and 02nd March 1987 by the officers from the Environmental Science and Technology Section of the CISIR. The work was done by Rajendram W.G., Attanayake K.D., Silva H.L.P., Siritunge T.L.Y.S., Alwis K and Weerasinghe K.D.N.

5. **Sampling Procedure** : Sampling was carried out using an apparatus (Aqua Sampler - HCV 21) coupled with a flow meter and 8 hours flow proportional composite samples were collected. Sampling was started at 8.00 - 8.30 a.m. and completed at 16.00 - 16.30 hours daily. Flow rate was measured using a flow meter (Aquaproper) connected to

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a sensor electrode partly immersed in the effluent in front of square weir put across the waste water channel. Flow rates were recorded at 15 minute intervals.

Samples were collected in bottles kept in a cooling chamber. Grab samples for Chromium analysis were collected in separate bottles. These samples were collected from the drums immediately before the chrome liquor was discharged.

6. Analysis : The samples were preserved and analysed according to the methods described in the "Standard Methods for the Examination of Water and Waste Water", 14th edition 1975. (APHA, AWWA, WPCF) The Biological Oxygen Demand was determined using "HACH" BOD apparatus. The BOD tests were started as soon as the samples were transported to the laboratory daily.

7. Measurements : Flow rates recorded at 15 minute intervals are given in Table I, II, III, IV and V. Cumulative flow values are also given in these tables. The total volume of effluent discharged varied daily due to the operational changes within the factory. The total volume of effluent discharged from 8 hourly operations are given in Table VI, including the first 4 hourly and the final 4 hourly discharges.

Fluctuations in volumetric flow rates vary more than ± 10% when the average is calculated on hourly and 2 hourly basis. If the volumetric flow rate is calculated on a 4 hourly basis, then except for day, 24.02.87 these values fluctuate ± 5% most of the time and at times deviation from the grand mean (08 hour operation time) is around ± 12%. Rate and the pattern of discharge of waste water determines flow equivalising criteria. A According to the present operations in the factory, the occurence of high flow rates are low (eg.>40 m^3/hr) and also time of such discharges are low. However, occurence of flow rates greater than 40 m^3/hr tends to increase the flow equivalizing time period significantly. This Fig 1a shows that 4 hour equivalization

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Table VI - Total volume of tannery effluent for shortly and 4 hourly operations.

(a) Cumulative flow

Sampling date	Cumulative flow m^3/8 hr	Cumulative flow	
		1st half m^3/4 hr	2nd half m^3/4 hr.
24.02.87	181.2	105.7	75.5
25.02.87	192.6	101.4	91.2
26.02.87	100.0	50.7	49.3
27.02.87	200.4	99.1	101.3
02.03.87	166.9	88.4	78.5

(b) Average flow rate

Average flow rate m^3/8 hr.	Average flow rate (1st)m^3/4 hr	Average flow rate (2nd)m^3/4 hr	% deviation of 4 hourly average to 8 hourly average
22.7	26.4	18.9	16.3
24.1	25.3	22.8	5.0
12.5	12.7	12.3	1.6
25.1	24.8	25.3	1.2
20.9	22.1	19.6	5.7

Table 1: Flow rate (m^3/h) and cumulative flow (m^3) determined on 24.02.87

No	Time	Flow rate (m^3/h)	Cumulative flow (m^3)
01	8.15	-	-
02	8.30	28.2	4.5
03	8.45	49.0	7.0
04	9.00	36	12.4
05	9.15	32.00	29.5
06	9.30	23.4	36.9
07	9.45	17.8	41.4
08	10.00	22.1	46.8
09	10.15	17	51.8
10	10.30	17	55.7
11	10.45	22.0	60.4
12	10.55	46.5	64.0
13	11.15	30.8	75.6
14	11.30	26.8	81.9
15	11.45	26.6	88.5
16	12.00	41.0	97.2
17	12.15	43	105.7
18	12.30	25.5	112.5
19	12.45	23.6	118.7
20	1.00	21.4	124.9
21	1.15	18.7	128.4
22	1.30	17.3	134.0
23	1.45	17.4	137.7
24	2.00	17.0	142
25	2.15	17.2	146.3
26	2.30	17.3	151
27	2.45	13.4	153.9
28	3.00	19.5	158.2
29	3.15	20.0	162.9
30	3.30	21.5	168.9
31	3.45	19.0	173.8
32	4.00	19.0	178.1
33	4.15	19.8	181.2

Table 2: Flow rate (m^3/h) and cumulative flow (m^3) determined on 25.02.87

No	Time	Flow rate (m^3/h)	Cumulative flow (m^3)
01	8.00	7	-
02	8.15	13.9	2.3
03	8.30	17.2	6.5
04	8.45	36.6	14.0
05	9.	29.1	21.2
06	9.15	28.[illegible]	2 .5
07	9.30	30.2	36.2
08	9.45	29.9	43.7
09	10.00	30.2	50.7
10	10.15	29.6	58.7
11	10.30	27.8	64.5
12	10.45	27.8	72.7
13	11.00	27.2	79.8
14	11.15	21.4	85.[illegible]
15	11.30	17.6	90.1
16	11.45	26.0	95.4
17	12.00	23.6	101.4
18	12.15	20.5	108.5
19	12.30	16.9	113.3
20	12.45	17.2	117.3
21	1.00	17.4	121.1
22	1.15	19.5	125.5
23	1.30	22.0	130.6
24	1.45	22.5	136.6
25	2.00	24.0	142.6
26	2.15	23.3	148.2
27	2.30	23.5	153.7
28	2.45	25.9	159.5
29	3.00	26.8	166.1
30	3.15	25.9	173.1
31	3.30	26.2	179.2
32	3.45	26.6	185.8
33	4.00	26.5	192.6

Table 3: Flow rate (m^3/h) and cumulative flow (m^3) determined on 26.02.87

No	Time	Flow rate (m^3/h)	Cumulative flow (m^3)
01	8.15	4.5	-
02	8.30	5.3	1.1
03	8.45	5.4	2.4
04	9.00	9.7	6.0
05	9.15	7.1	8.6
06	9.30	7.7	10.5
07	9.45	8.0	13.0
08	10.00	19.0	15.7
09	10.15	21.6	20.8
10	10.30	19.2	25.6
11	10.45	13.3	29.3
12	11.00	16.7	32.8
13	11.15	15.6	36.6
14	11.30	13.8	40.1
15	11.45	13.9	43.6
16	12.00	14.3	47.2
17	12.15	13.9	50.7
18	12.30	12.7	54.2
19	12.45	10.0	56.7
20	1.00	10.8	59.4
21	1.15	11.4	62.6
22	1.30	11.0	65.5
23	1.45	11.4	68.2
24	2.00	12.2	71.3
25	2.30	11.5	76.8
26	2.45	9.2	79.5
27	3.00	9.3	81.9
30	3.15	10	84.2
31	3.30	10.4	89.4
32	3.45	10.9	92.2
32	4.00	17.4	95.4
33	4.15	20.5	100.0

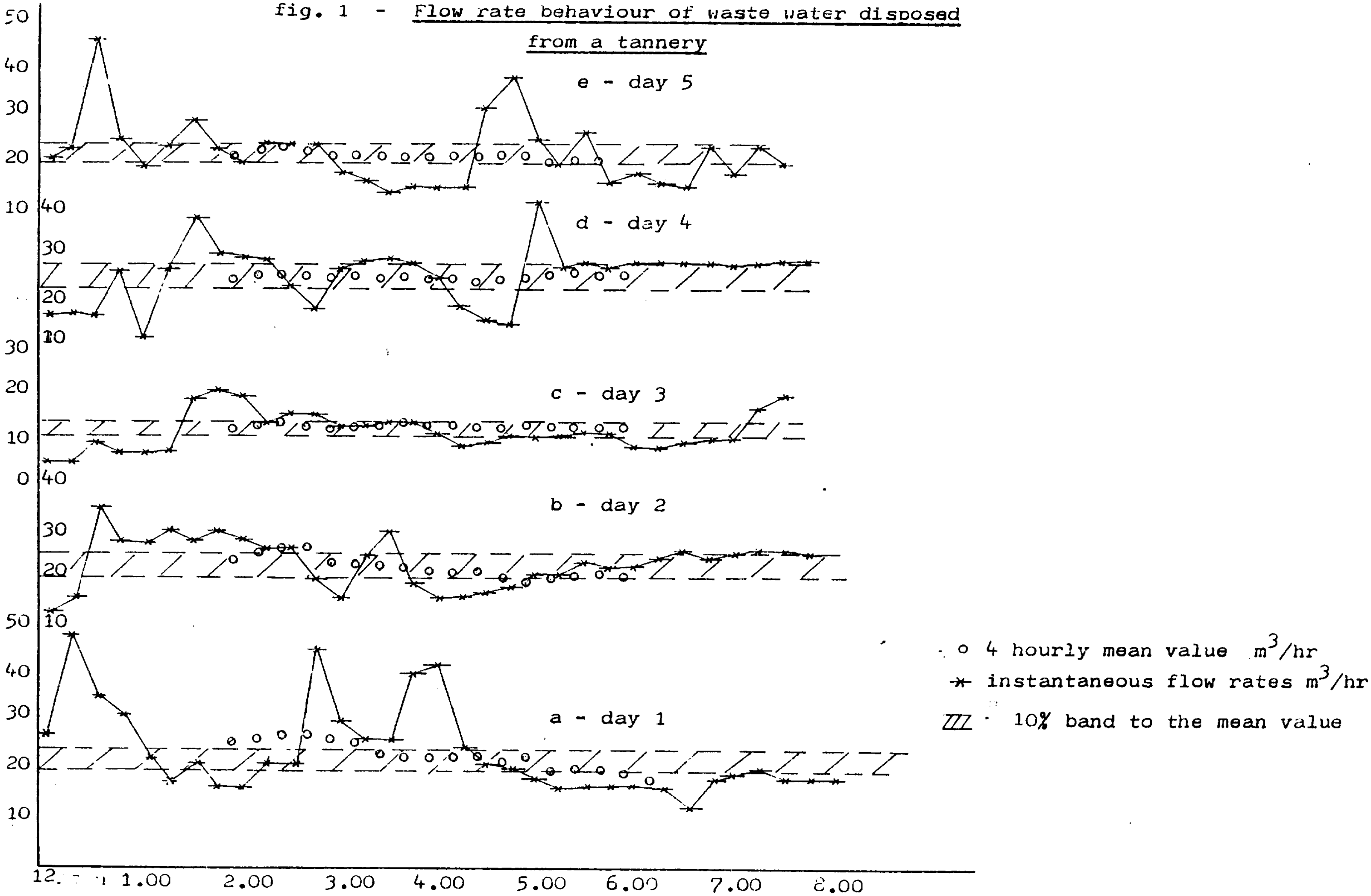
Table 4: Flow rate (m^3/h) and cumulative flow (m^3) determined on 27.02.87

No	Time	Flow rate (m^3/h)	Cumulative flow (m^3)
01	8.00	11.9	-
02	8.15	16.2	3.9
03	8.30	16.6	7.7
04	8.45	16.5	11.6
05	9.00	26.3	18.6
06	9.15	12.36	24.6
07	9.30	26.6	30.7
08	9.45	37.5	38.9
09	10.00	30.0	47.3
10	10.15	29.3	54.7
11	10.30	28.9	62.1
12	10.45	23.3	68.8
13	11.00	17.7	72.8
14	11.15	24.6	79.1
15	11.30	28.3	84.2
16	11.45	28.9	91.3
17	12.00	28.1	99.1
18	12.15	25.4	105.4
19	12.30	18.8	111.6
20	12.45	15.5	116.0
21	1.00	14.9	118.5
22	1.15	41.3	126.7
23	1.30	27.0	131.2
24	1.45	27.4	138.3
25	2.00	27.5	144.5
26	2.15	28.4	151.7
27	2.30	28.4	158.3
28	2.45	28.4	165.3
29	3.00	28.4	172.9
30	3.15	28.3	180.1
31	3.30	28.3	186.6
32	3.45	28.3	193.4
33	4.00	28.6	200.4

Table 5: Flow rate (m^3/h) and cumulative flow (m^3) determined on 02.03.87

No	Time	Flow rate (m^3/h)	Cumulative flow (m^3)
01	8.30	20	0
02	8.45	20	3.5
03	9.00	21.9	8.0
04	9.15	45	13.4
05	9.30	23.8	21.5
06	9.45	17.5	26.8
07	10.00	22.1	32.00
08	10.15	28.4	40.00
09	10.30	22	45.9
10	10.45	19.4	50.8
11	11.00	22.9	55.9
12	11.15	23	61.9
13	11.30	23.2	67.2
14	11.45	23.4	73.3
15	12.00	23.4	79.1
16	12.15	17.5	84.1
17	12.30	15.6	88.4
18	12.45	13.3	91.9
19	1.00	14.6	95.1
20	1.15	14.8	9[illegible].7
21	1.30	14.5	104.4
22	1.45	31.6	109.7
23	2.00	37.4	116.8
24	2.15	24.7	123.1
25	2.30	18.8	128.4
26	2.45	25.6	135.5
27	3.00	15.3	140.6
28	3.15	17.3	144.8
29	3.30	14.8	149.0
30	3.45	14.6	152.7
31	4.00	21.6	157.1
32	4.15	16.6	161.9
33	4.30	22.6	166.9

fig. 1 - Flow rate behaviour of waste water disposed from a tannery



is insufficient where as Fig 1b, 1c, and 1d justify the above prediction. Cumulative flow is plotted as against the time (Fig 2) and these measurements of different days (except day 3, 26.02.87 where the normal operations did not take place) are collectively taken as cumulative flow. Fig 2 shows that it is possible to estimate a reasonably good average flow rate in the following manner.

From Fig 2

Average flow rate $\approxeq \frac{750 - 0}{32 - 0}$ $m^3/hr.$

$= 23.44$ $m^3/hr.$

This average flow rate can be estimated as 23.44 $m^3/hr.$ So with an operational time of 10 hours per day, the total discharge is about 225 m^3.

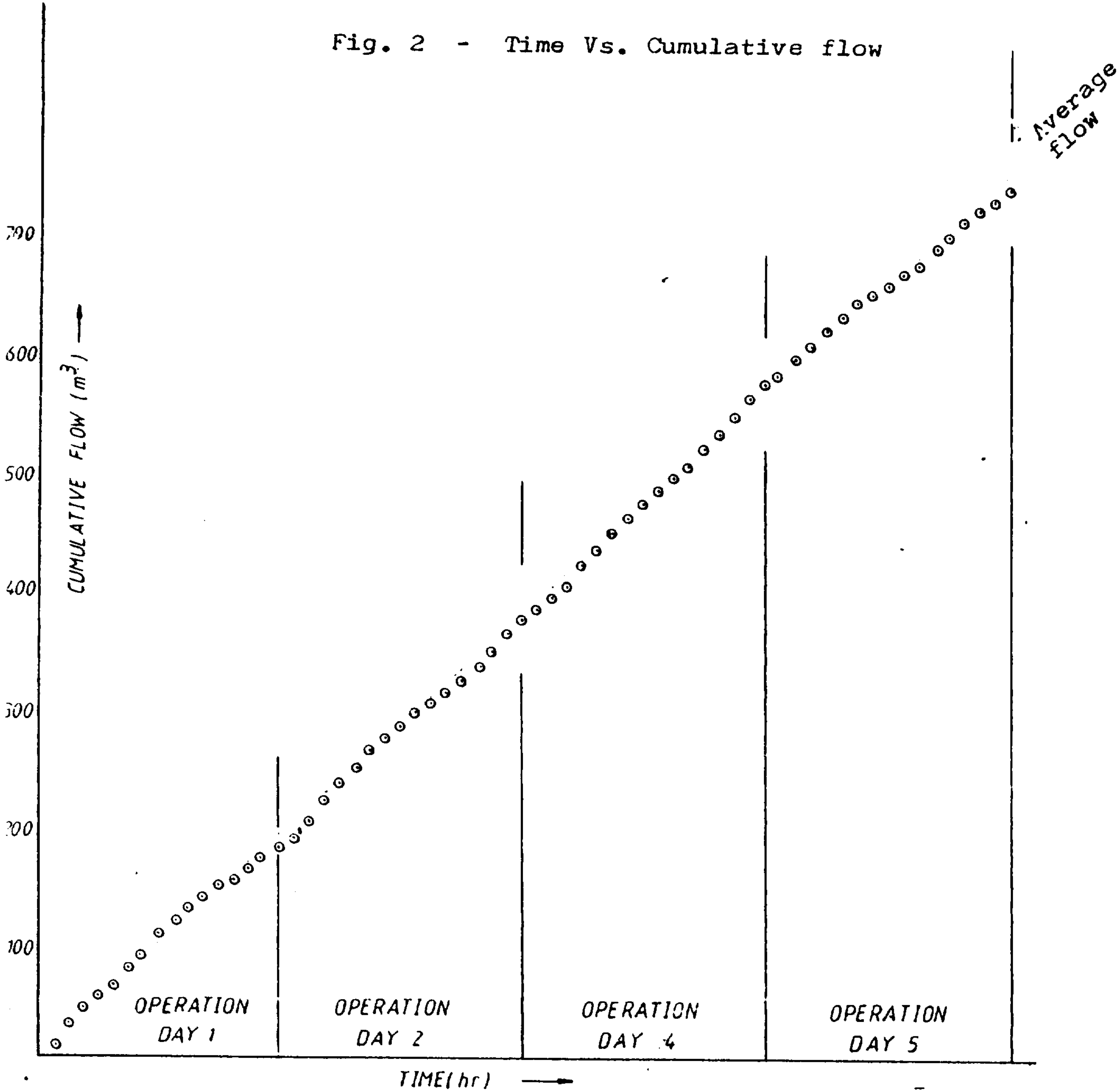
8. Analytical Results: Table VII - Analysis of Composite Samples (Tannery effluent (mg/l)

Sampling Date	pH	BOD mg/l	COD mg/l	T.S. mg/l	TDS mg/l	S.S. mg/l	T-N_2 mg/l	S^{2-} mg/l
24th	9.60	2500	2852	11560	1860	1072	405	3.73
25th	9.64	1600	2880	16545	7835	639	403	3.2
26th	8.89	2000	2400	8170	1840	1148	329.10	3.63
27th	9.36	2000	2512	15767	4317	621	519	3.2
02nd	10.09	1500	3660	15610	2500	1318	389.39	3.2

Note : The Biological Oxygen Demand values are questionable due to the presence of chromium in the samples. The values of Chemical Oxygen Demands are more reliable than BOD values.

Contd/...... 4.

Fig. 2 - Time Vs. Cumulative flow



The determinations of Chromium in all forms such as Total Cr, Cr(iii) and Cr(vi) are given in Table VIII.

Table VIII - Concentration of Cr(iii) and Cr(vi) in the composite sample and the samples taken from the drum.

Date	Composite sample		Sample taken from the drum	
	Cr(iii) mg/l	Cr(vi) mg/l	Cr(iii) mg/l	Cr(vi) mg/l
24th	532	28	-	-
25th	352	7.8	4200	100
26th	457	14.5	4914	86
27th	416	14.5	-	-
02nd	1235	21.5	5320	280

5. Conclusions :

1. Flow measurements, including flow rates and cumulative discharges of tannery effluent, indicates that a minimum retention time of 4 hours is sufficient to equivalize the flow.

   Thus the construction of a retention tank for the flow equivalisation is not necessary.

2. Readily settleable suspended solids are present in large amounts and so a presettler which should be slightly bigger than the grit chamber is appropriate.

3. Alum coagulation is possible to eliminate the high levels of chromium and to reduce the BOD and COD as well. Since the sludge formed in this process is bulky it is advisable to to select a polyelectrolytic coagulant to obtain a reasonably good hydrophobic type sludge in the dry settling chamber.

Contd/....... 5.

4. Since the pH of the composite sample is well above 9.5 lime addition is not required for the coagulation process.

5. The above chromium containing sludge should be dried and disposed of carefully.

6. A biological treatment, for the 2ry treatment unit is sufficient to remove biodegradable organic matter prior to discharge into Kelani river. If necessary provisions be given to reduce Nitrogen and Sulphur.

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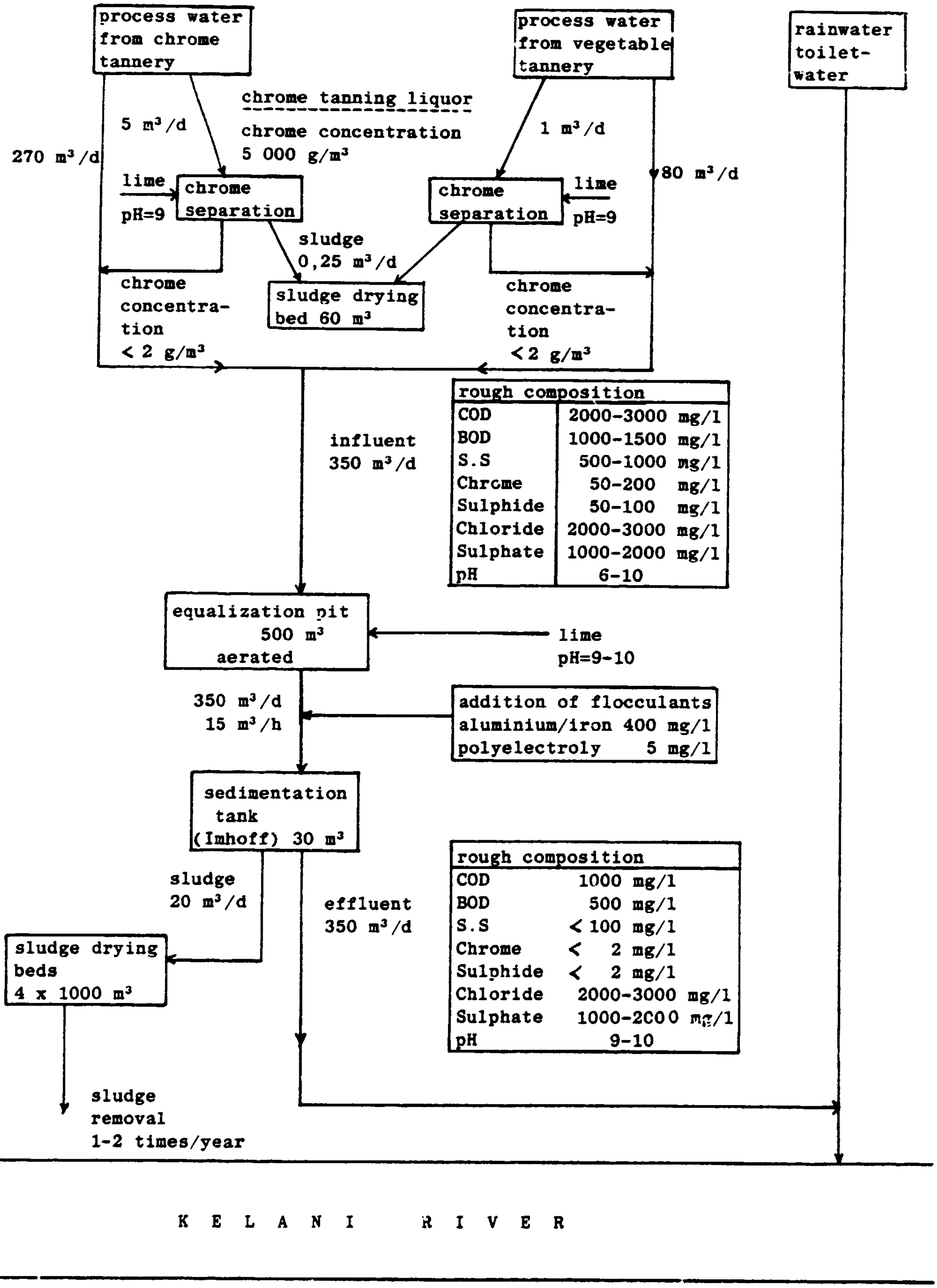
09th April 1987
APM/cs.

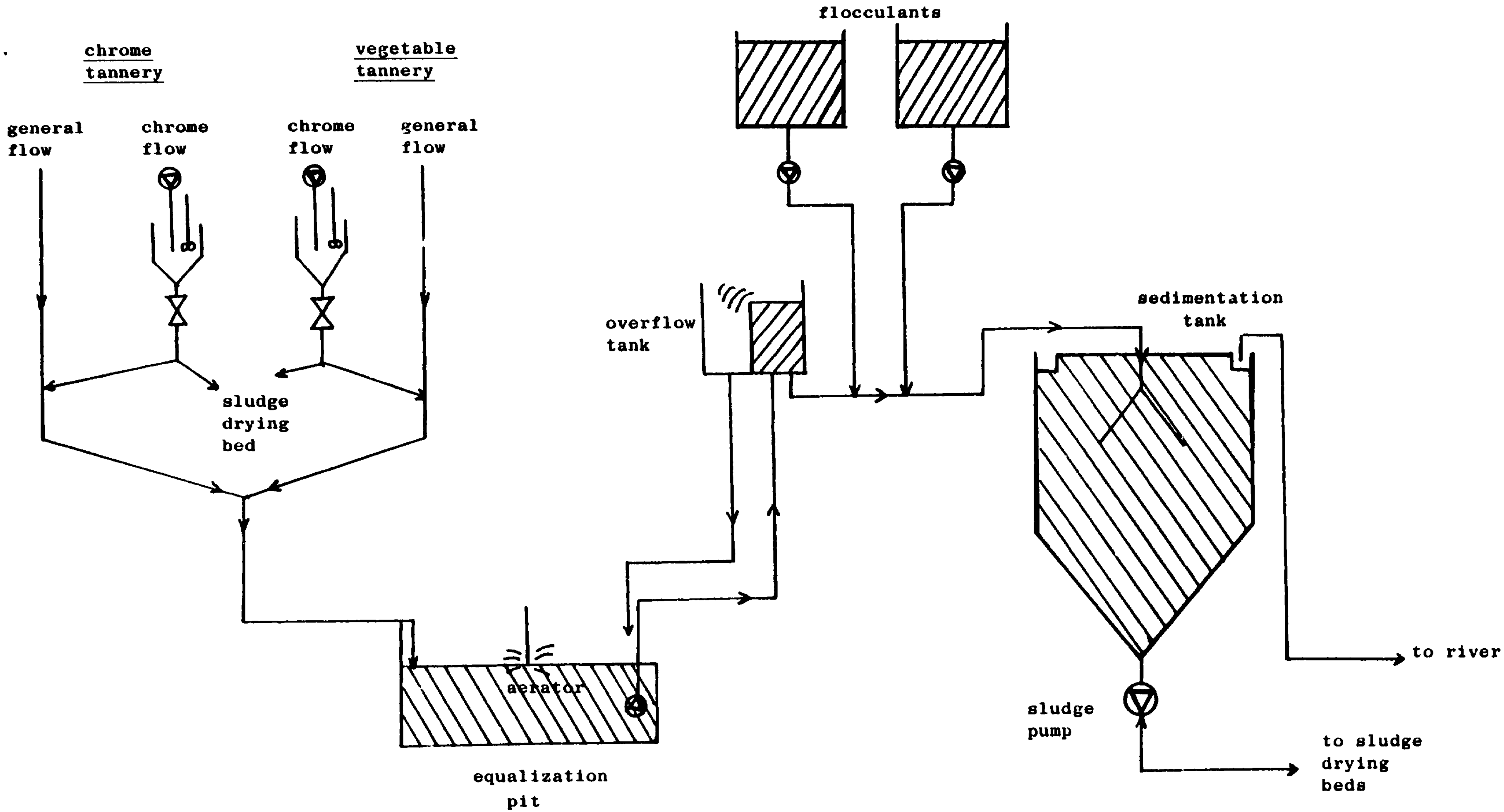
EFFLUENT TREATMENT PROCESS CLPC TANNERY



rough composition	
COD	2000-3000 mg/l
BOD	1000-1500 mg/l
S.S	500-1000 mg/l
Chrcme	50-200 mg/l
Sulphide	50-100 mg/l
Chloride	2000-3000 mg/l
Sulphate	1000-2000 mg/l
pH	6-10

rough composition	
COD	1000 mg/l
BOD	500 mg/l
S.S	< 100 mg/l
Chrome	< 2 mg/l
Sulphide	< 2 mg/l
Chloride	2000-3000 mg/l
Sulphate	1000-2000 mg/l
pH	9-10

SCHEMATIC FLOW CHART EFFLUENT TREATMENT SYSTEM CLPC TANNERY



FINANCIAL ASPECTS AND EQUIPMENT OF THE TREATMENT PLANT

Chromium separation systems (for vegetable and chromium tannery)

2 pumps (25 m^3/h) x 1 spare	Dfl.	9 000,--
1 sedimentation tank (7 m^3) like Imhoff tank/Fiberglass	-	15 000,--
1 sedimentation tank (3 m^3) like Imhoff tank/Fiberglass	-	12 000,--
2 mixers	-	6 000,--
2 valves (manual operating)	-	2 000,--
1 sludge drying bed (content 60 m^3)	-	18 000,--
engineering and construction work	-	10 000,--
piping etc.	-	5 000,--
electrical work	-	5 000,--
extra	-	10 000,--
Total (Rs 1,2 million)	Dfl.	84 000,--

Chemical-physical treatment of mixed effluent

1 pit (500 m^3)	Dfl.	40 000,--
1 aerator (submersable) + 1 spare	-	20 000,--
1 pump (40 m^3/h) + 1 spare	-	6 500,--
1 sedimentation tank 30 m^3 or 2 tanks 15 m^3 fiberglass/s.s.	-	40 000,--
1 sludge pump (automatic) + 1 spare	-	15 000,--
2 tanks (flocculants)	-	9 000,--
1 dosingpump (2 head) + 1 spare	-	11 000,--
4 sludge drying beds (1 000 m^3)	-	30 000,--
engineering and conmstruction (rearranging sewerage)	-	20 000,--
piping etc.	-	15 000,--
electrical work	-	10 000,--
extra	-	10 000,--
(Rs 4,3 million)	Dfl.	307 500,--

Total investment costs (Rs 5,5 million) Dfl. 391 500,--

Yearly costs

labour 2 x	Dfl.	10 000,--
chemicals	-	15 000,--
energy	-	10 000,--
maintenance	-	8 000,--
depreciation + interest	-	47 000,--
(Rs 1,3 million)	Dfl.	90 000,--