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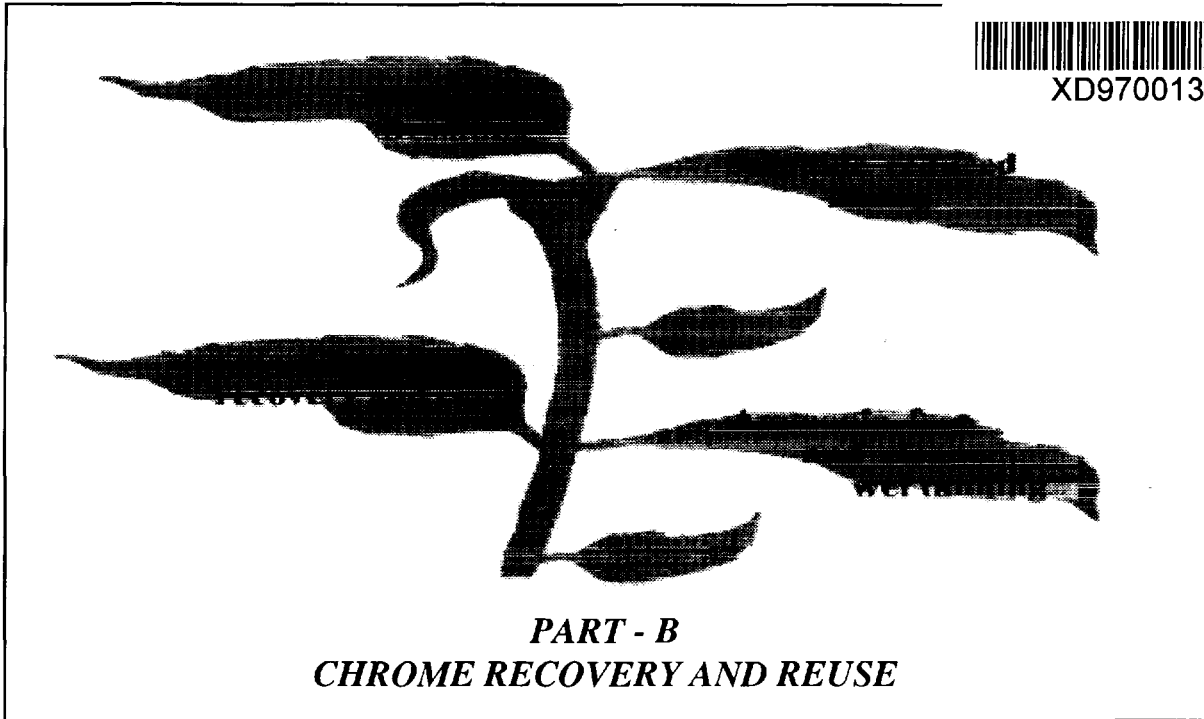
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39 p.
tables
diagrams
maps

21575 IMPLEMENTATION OF ENVIRONMENTALLY CLEANER TECHNOLOGIES (UNIDO PROJECT : US/IND/90/244/2) TERMINAL REPORT



XD9700131



*PART - B
CHROME RECOVERY AND REUSE*



A PROJECT ASSIGNED BY
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION



IMPLEMENTED BY
CENTRAL LEATHER RESEARCH INSTITUTE
(Council of Scientific & Industrial Research)
ADYAR, MADRAS - 600 020, INDIA
FEBRUARY, 1996

R

***DESIGN, IMPLEMENTATION, OPERATION
AND MAINTENANCE OF CENTRAL CHROME
RECOVERY AND REUSE SYSTEM IN
ARAFATH LEATHERS, PALLAVARAM
MADRAS, INDIA***

UNIDO PROJECT : US/IND/90/244(2)

FINAL REPORT

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**CLEANER TECHNOLOGY IN LEATHER INDUSTRY -
CHROME RECOVERY AND REUSE SYSTEM**

UNIDO PROJECT NO. US/IND/90/244(2)

EXECUTIVE SUMMARY

The United Nations Industrial Development Organisation (UNIDO) Vienna, in cooperation with the Government of India, Tamilnadu Pollution Control Board (TNPCB) Madras, Central Leather Research Institute (CLRI) Madras, Tamilnadu Leather Development Corporation (TALCO) and Tanners Associations launched a comprehensive programme in setting up Common Effluent Treatment Plants (CETPs) for tannery clusters and Effluent Treatment Plants (ETPs) for individual tanneries in the State of Tamilnadu. An important component of the project is the reduction of pollution at the source by introducing cleaner technologies like "Chrome recovery and reuse system" in individual tannery units. A fully operational chrome recovery and reuse system as a centralized facility for the benefit of 8 chrome tanneries in Pallavaram/Pammal cluster near Madras has been implemented in M/s. Arafath Leathers tannery. This system is designed and implemented under the over all co-ordination of the Environmental Technology Department of CLRI (sub contractor II) with financial support from UNIDO, contribution by M/s. Arafath Leathers and co-operation with Pallavaram Tanners Industrial Effluent Treatment Company (PTIETC) and TNPCB.

The chrome recovery system was installed operated and utilized well from the starting of the (July 1995). The entire chromium discharged in the effluent is recovered and reused. The quality of the recovered chromium and the leather processed using recovered chromium meet the standard quality requirements. The cost of recovered chromium including all financial input cost is less than 400 USD per ton where as the chromium salt (BCS) from the market is more than 800 USD per ton and the payback period of the whole chrome recovery plant will be less than three years. As an outcome of the success of the industrial scale pilot cum demonstration operation, many tanners have willingly started adopting the chrome recovery and reuse system in India and other countries.

1. INTRODUCTION

There are more than 2500 tanneries in India and their annual processing capacity is 600,000 tonnes of hides and skins. They discharge 20,000 million liters of wastewater per year. About 80% of the tanneries adopt chrome tanning process. In chrome tanning, on an average only 60% of the chromium applied in the form of Basic Chromium Sulphate (BCS) is taken by the leather and the balance is discharged as a waste in the effluent. The chromium concentration in terms of Cr in the exhaust chrome liquor ranges from 1,500 - 5,000 mg/lit. and its volume is 4 to 6% of the total volume of wastewater discharge from the tanneries. But this exhaust chrome liquor is mixed with other streams and the concentration of chromium in terms of Cr in the composite streams ranges from 100 - 300 mg/lit. In most countries, including India, Pollution Control authorities insist that the treated wastewater contains less than 2 mg of total chromium per litre. Annually 40,000 tonnes of chromium salt (BCS) is used in Indian tanneries and out of this 15,000 tonnes of chromium salt is discharged into wastewater streams. These waste discharges cause environmental pollution, wastage of large quantity of chemicals, complicate and increase the cost of effluent treatment and disposal of chromium containing sludge per year.

Sophisticated chrome recovery systems developed and adopted in Europe and other countries cannot totally be replicated in India due to small scale and traditional nature of the tanning process, technical manpower capabilities existing in tanneries, local environmental conditions, capital investment etc. Therefore it has become necessary to introduce and promote a simple and viable chrome recovery system to recover and reuse chromium from the segregated exhaust chrome liquor in small, medium and as well as large scale tanneries. The chrome recovery and reuse system designed and implemented by Central Leather Research Institute (CLRI) at M/s. Arafath leathers, Pallavaram, Madras under UNIDO assisted project (UN/IND/90/244(2)) caters the need of about 8 chrome tanneries in Pallavaram /Pammal cluster as a centralised and also serves as a demonstration unit for India and South East Asia.

2. OBJECTIVES AND FEATURES OF THE UNIDO ASSISTED PROGRAMME ON CLEANER TECHNOLOGIES

An important component of the UNIDO project (US/IND/90/244(2)) is to introduce and promote cleaner technologies in tanners. Four projects namely i. Chrome recovery and reuse ii. Ammonia free-deliming and wet process control in beam house operation iii. Mechanical desalting and iv. Sulphide reduced liming were selected for implementation with technical assistance from CLRI.

The main objectives and features of the chrome recovery and reuse system implemented in Pammal/Pallavaram tannery cluster are as follows.

- * Introduction and demonstration of cleaner and environmental friendly "Chrome Recovery and Reuse System" to reduce the chrome containing pollution generated in the process of chrome leather manufacture.
- * Implementation and commissioning of a fully operational "Chrome Recovery and Reuse System" as a central facility which is proven, cost effective and appropriate for local tannery conditions particularly chrome tanneries processing raw hides and skins into wet blue/finished leather.

3. PALLAVARAM-PAMMAL TANNERY CLUSTER IN TAMIL NADU

Tamilnadu is the leading state in Leather process with more than 1,000 tanneries located in many clusters as shown in Fig.1. Most of these units are in small scale sector processing less than 3 tons of raw hides and skins per day. The Chromepet-Pallavaram-Pammal tannery cluster is located about 20 km South of Madras on the Madras-Chenglepet National High-way, close to the International Airport, CLRI, TNPCB administrative head quarter and its technical facilities. Tanning of hides and skins at Pammal/Pallavaram has a tradition of over 50 years. At present there are more than 100 small and medium sized tanneries processing cow and buffalo hides and skins of goat and sheep.

They produce all types leather from raw stage as well from semi finished stage adopting both vegetable tanning and chrome tanning methods.

A Common Effluent Treatment (CET) Plant with a capacity of 2.8 million litres per day for the wastewater collected from Pallavaram/Pammal tanneries had been designed and implemented with UNIDO assistance. The CETP is under operation from the end of 1994.

The tanneries in Pallavaram/Pammal tannery cluster mostly process semi-finished leather in to finished leather and only 8 units have provision/plan to process raw hides and skins adopting chrome tanning. The estimated discharge from these units would be 15,000 lit/day of exhaust chrome liquor per day. M/s. Arafath Leather Ltd., one of the main chrome tanneries which is located in the centre of the cluster as shown in Fig.2. This tannery processes 4 to 5 tons of wet salted hides and skins and discharges 5,000-6,000 litres of exhaust chrome liquor per day. The other chrome tanneries process 1 to 4 tons of wet salted hides and skins per day and discharge 1000-5000 lit of exhaust chrome liquor per day. The name of the processing raw-hides/skins chrome tanneries in Pammal/Pallavaram cluster of their processing capacity, present status exhaust chrome liquor discharge are given in Table.1. The overall discharge of exhaust chrome liquor including 20% future expansion from the chrome tanneries in Pallavaram/Pammal is estimated as 18,000 litres per day.

Table 1 : Details of tanneries to utilise chrome recovery system at Arafath Leathers, Pallavaram, Madras

| NAME & ADDRESS OF THE TANNERY | OWN/ RENT | EXISTING PROCESS | RAW TO WB KG/DAY | REMARKS |
|---|--------------|--------------------------|---------------------|---|
| M/s. Marson Tanning Industries No.12 Anna Road, Madras 600 075 | OWN | RAW TO FINISH | 3500 | ARRANGEMENT IS UNDER PROGRESS TO UTILIZE CHROME RECOVERY SYSTEM |
| M/s. Izharul Huque & Co., No.35, Anna Salai, Madras 600 044. | OWN | WET BLUE TO FINISH | --- | RAW TO WET BLUE PROPOSED FOR FUTURE |
| M/s. S. Abdullah & Sons 2, Thavalai Shop Chromepet, Madras 600 044 | RENT | WET BLUE TO FINISH | --- | RAW TO WET BLUE PROPOSED IN FUTURE. QUANTITY NOT KNOWN. |
| M/s. Arafath Leathers No.2 Thiruneermalai Road Chromepet, Madras 600 044. | OWN | RAW TO WET BLUE | 5000 | UTILIZING CHROME RECOVERY SYSTEM REGULARLY |
| M/s. East Euro Leathers 38, Anna Main Road, Nagalkeni, Madras 600 044. | OWN | WET BLUE TO FINISH | 4000 | RAW TO WET BLUE 4000 KG PER DAY PROPOSED IN FUTURE |
| M/s. Graphico Leathers No.1 Anna Main Road Nagalkeni, Madras 600 044. | RENT | RAW TO FINISH | 2000 | ARRANGEMENT IS UNDER PROGRESS TO UTILIZE CHROME RECOVERY SYSTEM |
| M/s. Govindarajulu Naidu Co., Radha Nagar, Madras 600 044. | OWN | WET BLUE TO FINISH | 2000 | RAW TO WET BLUE 2000 KG PER DAY PROPOSED IN FUTURE |
| M/s. Gordon Woodroff Ltd., Darga Road Pallavaram, Madras 600 043. | OWN | --- | --- | TANNERY IS UNDER RENOVATION |

NOTE : WB = WET BLUE

12 OCT 1995

4. SELECTION OF CHROMIUM RECOVERY AND REUSE SYSTEM

In principle, chrome recovery and reuse can be realized in three different ways: direct reuse, indirect reuse and separating chromium compounds.

Direct reuse method

This method implies that spent chrome liquors are reused directly as much as possible as a tanning liquor for the next batch. Additional chromium is supplied to compensate the deficiency. The main constraint in adopting this method is that the salts and other impurities are accumulated due to repeated reuse and have a negative effect on leather quality.

Indirect reuse method

Chromium is recovered by precipitation as hydroxide using alkali which is dissolved subsequently in sulphuric acid after which the solution can be used as a tanning liquor. The advantage of this method is generation of cleaner reuseable chrome liquor which normally does not affect leather quality.

Separating chromium compounds

The recovery of chromium can be achieved by separating the chromium compounds from other salts in the wasteliquors adopting electrodialysis, ion-exchange etc. By these methods the recovered chrome liquor may be cleaner than the direct reuse method. But the techniques such as electrodialysis, membrane separation, ion-exchange etc. are rather sophisticated for small and medium scale tanneries and have limited scope for implementation.

It was therefore considered to adopt a simple indirect chromium recovery and reuse system using a suitable alkali which is technically feasible and economically viable for Indian tanneries.

All types of alkalies such as sodium hydroxide, sodium carbonate, bicarbonate, lime etc. are useful for chromium precipitation. Most of these alkalies are cheap. The highly reactive alkalies give a voluminous chromium sludge (ie. more than 25% by volume) which makes it necessary to separate the

sludge from the liquor by mechanical dewatering system like filterpress. Some alkalies like sodium hydroxide make it necessary to heat the liquor in order to obtain complete chromium precipitation. Using lime causes a simultaneous precipitation of chromium and calcium sulphate (plaster of Paris) which makes the reuse of the chromium difficult. Two indirect reuse methods were considered. One with sodium alkalies which need the use of filter presses and the other with Magnesium Oxide (MgO) which, because of its low reactivity and solubility, causes chromium to settle compactly, so that separation from the liquor is merely a question of decantation of the supernatant. Dissolving of the sludge can be done instantly with sufficient sulphuric acid to obtain a reuseable liquor.

Using MgO as alkali is considered more appropriate for all levels of tanneries because of simplicity in operation and low investment costs. Hence, the indirect reuse method using MgO as alkali was chosen for the commercial scale central chrome recovery and reuse system installed at Arafath Leathers. The process flow diagram of the full scale chrome recovery system is shown in Fig.4

5. IMPLEMENTATION OF UNIDO ASSISTED PROGRAMME

5.1 Organisational set-up

UNIDO selected the Central Leather Research Institute (CLRI) Madras for implementation of the Cleaner Technologies including a fully operational Chrome Recovery system. Based on field inventory and consultation with Pallavaram Tanners Industrial Effluent Treatment Company (PTIETC), Tamil Nadu Pollution Control Board (TNPCB), UNIDO Chief Technical Advisor (CTA) M/s. Arafath Leathers tannery premises was selected for implementation of Chrome Recovery and Reuse system as a centralised facility. CLRI had entered into an agreement with M/s. Arafath Leathers, other chrome tanneries and PTIETC Madras on 15th September 1993 for the establishment and operation of a chrome recovery plant at the premises of M/s. Arafath Leathers. A representative of TNPCB and Dr Z. Kotasek, CTA, UNIDO signed the document as witness.

The agreement covers:

- i. Basic Know-how, design engineering and technical assistance for erection, commissioning, trial run, standardisation, training on operation and maintenance of the system by the CLRI, Environmental Tech. Dept.,.
- ii. Sharing of total capital cost of the project by UNIDO (limited to US\$ 46,000) and M/s. Arafath Leathers (Indian Rs.250,000)
- iii. Land, building, chrome liquor storage and drainage facilities and other fixed capital items to be provided by M/s. Arafath Leathers. Operating cost including raw materials, chemicals, power etc will be borne by M/s. Arafath Leathers.
- iv. The chrome recovery system will also be used by the other 7 to 8 chrome tanneries in Pammal/Pallavaram identified by PTIETC in consultation with CLRI on the mutually agreed upon terms and conditions.
- v. PTIETC will ensure the construction of collection tanks in individual tanneries for the segregated exhaust chrome liquors, provide transport facilities for the exhaust chrome liquor transportation to the chrome recovery plant, and execute civil works for approach road and additional storage tanks as required at M/s. Arafath Leathers.

The locational details of the chrome recovery plant at M/s. Arafath Leathers premises is shown in Fig.3. The process flow scheme adopted for the chrome recovery facility is given in Fig.4.

5.2 Field Execution

CLRI as a consultancy cum executing agency for cleaner technologies programme (sub contractor II) to UNIDO called for tenders for the implementation of chrome recovery system based on CLRI technical know-how. After technical and financial evaluation, work orders for implementation of chrome recovery

system in M/s. Arafath Leathers Tannery were issued in Oct'93 to the following firms.

1. M/s. S.V.V Engineering Industries

Hosur, Tamilnadu, India

for fabrication and supply of main reactor, special screens as per CLRI design and drawings.

2. M/s. Enkem Engineers Pvt Ltd.,

Madras, Tamilnadu, India

for installation of the main reactor, supply and erection of pumps, platform, interconnections and other equipments as per CLRI design, trial run, standardisation with the guidance of CLRI. The specifications and drawings for all the mechanical equipments and accessories were provided by CLRI for implementation.

The main reactor is made of mild steel and lined with Fibreglass Reinforced Plastic(FRP). Over and above FRP, epoxy coating was provided. The fabrication work was inspected by CLRI Environmental Technology Dept Scientists and the main reactor was shifted from the factory to the M/s. Arafath Leathers site and erected by Jan 94.

The following civil drawings were prepared and furnished to M/s. Arafath Leathers for execution.

- * Collection sump with capacity of 12 cubic metre to receive the exhaust chrome liquor from the existing five chrome tanning drums of M/s. Arafath Leathers tannery.
- * Drainage system for the collection of segregated exhaust chrome liquor from the chrome tanning drains to the collection system
- * A new covered shed for an area of 80 sq.m for the installation of chrome recovery system.

All the civil works were completed by the end of March 94 and the approach road was improved by providing gravel. Erection of all equipments was completed by April 94. Hydraulic tests were

carried out during May 94. Initial trial tests were carried out by CLRI and training was given to the technicians of M/s. Arafath Leathers on the operation, maintenance of the chrome recovery system and reuse of recovered chromium during June - July 95. From August '95 onwards M/s. Arafath Leathers regularly started using the chrome recovery and reuse system without any discharge of exhaust chrome liquor outside the premises.

5.3 Field and Laboratory investigations

CLRI undertook the inventory and survey on the chrome tanning process (ie percentage of chromium used, float, operation time, wastewater etc) in M/s. Arafath Leathers and other chrome tanneries in Pammal/Pallavaram cluster. The field and laboratory analytical data establish that the tanneries in Pammal/Pallavaram area use 7-8% chromium as Basic Chromium Sulphate (BCS) on pelt weight basis for chrome tanning operation with a float of 100 to 150%. About 40% of the chromium used is discharged as waste in exhaust chrome liquor.

The chromium concentration as Cr in the waste liquor ranges from 3,500 to 4,500 mg/l as detailed in Table.2.

Table 2

Analysis data of chrome exhaust liquor discharged from
M/s. Arafath Leathers and other tanneries

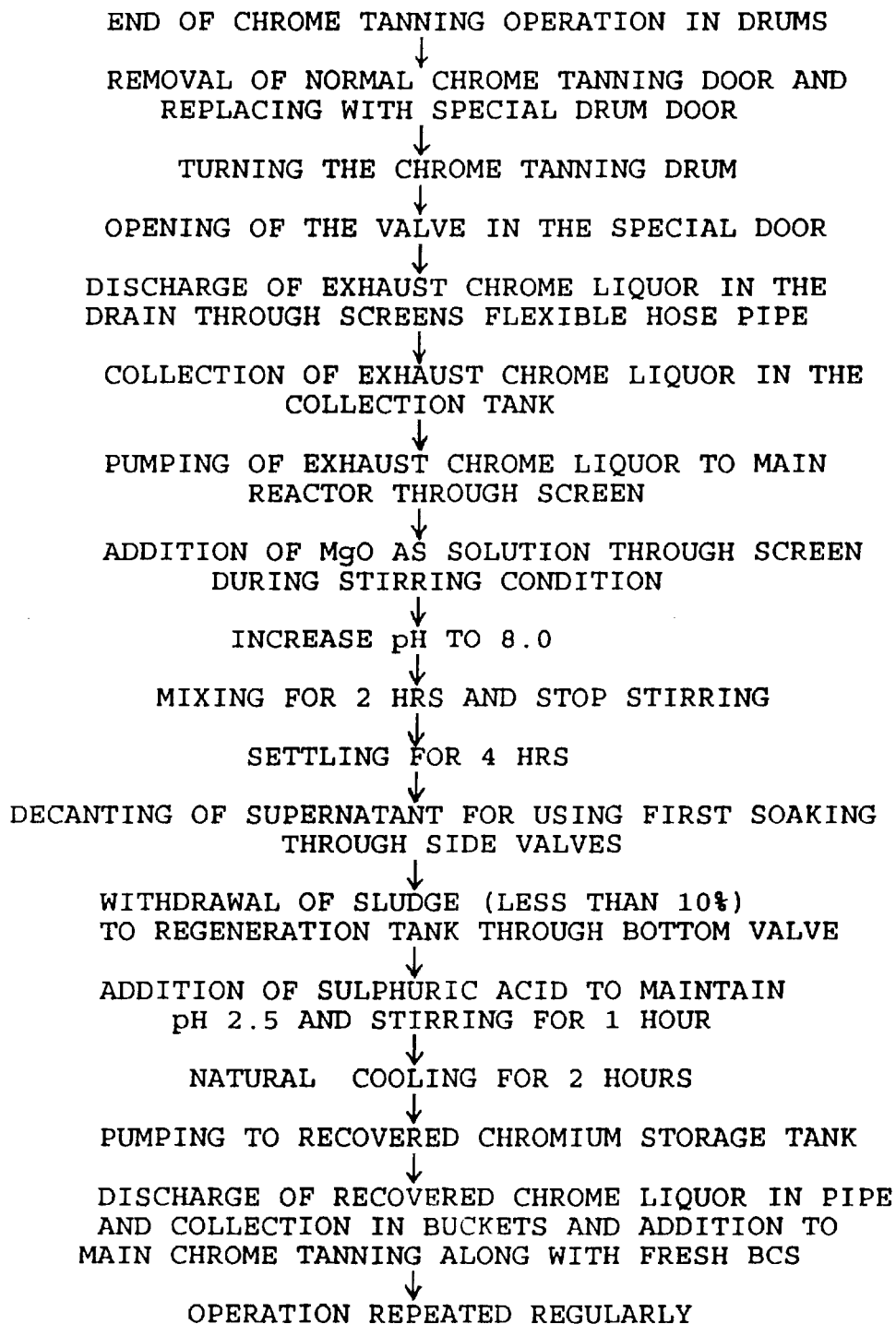
| Sample | Total chromium in mg/l | |
|--------|------------------------|-----------------------------------|
| | as Cr | as Cr ₂ O ₃ |
| 1 | 3.94 | 5.75 |
| 2 | 4.42 | 6.45 |
| 3 | 3.59 | 5.24 |
| 4 | 3.14 | 4.58 |
| 5 | 4.41 | 6.44 |

In chrome content in the exhaust chrome liquor is a variable due to variations in the chrome tanning processes. In view of this, regular pH measurement and periodical chromium estimation

is necessary to estimate the required quantity of chemicals used in the recovery process and also for the reuse along with fresh BCS.

6. OPERATION OF CHROME RECOVERY AND REUSE SYSTEM

The operation sequence of the chrome recovery and reuse system is given below



6.1 Evaluation of the experimental results

The chrome recovery plant was commissioned, operated and utilized by M/s. Arafath Leathers from the end of August 1995. The chromium content as Cr in the exhaust chrome discharge ranges from 3,500 to 5,000 mg/l. Variation in chromium content was caused by processing differences of individual lots. In view of this, regular analysis of the waste liquor is necessary to estimate the required quantity of MgO and sulphuric acid for the recovery process.

A log book is maintained in the plant with the following data

- i. Date and volume of exhaust chrome liquor processed in the main reactor : About 8000 lit/batch
- ii. Quantity of MgO used: Ranges from 30-35 kg for each batch
- iii. Vol. of sulphuric acid used: 40-45 lit per lot of about 700 lit of chrome slurry.
- iv. The basicity of recovered chromium ranges from 30-33% and 100 lit of recovered chrome liquor is equivalent to 25 kg of BCS available in the market.
- v. For one lot of chrome tanning with 1000 Kg pelt and 100% float 55 Kg of BCS (5.5%) and 100 lit of recovered chrome liquor are added which is equivalent to 8% normal BCS (ie.80 kg) on pelt weight.

The choice of MgO as alkali to precipitate chromium is found to be suitable because of the compactness of the settled chrome sludge without a filter press. The precipitated chrome slurry is less than 10% of chrome liquor and supernatant liquor which is about 90% is decanted and used for soaking operation. Therefore, a major amount of dissolved solids are removed along with the decanted supernatant liquor. The commercial scale studies during one year period from the discharge of about 1.0 million liters of exhaust chromium liquor from 1000 drum lots demonstrated that continues recycling of recovered chromium is possible without any variation. It was also established that the procedure involving chrome recovery by precipitation ensures that considerable amount of dissolved waste matter is removed along with the supernatant thereby improving the quality of recovered

chromium. M/s Arafath Leathers making use of this chrome recovery plant for their entire wet blue making with the existing facility. The tannery has used the recovered chromium for more than 1000 regular lots of each 1000-1200 kg pelt upto the end of August 95. The other chrome units are organising the transportation arrangement and will utilise the facility shortly with additional technical and financial support from UNIDO.

6.2 Leather quality

The quality of recovered chromium was tested regularly for pH, Cr₂O₃ and Basicity. The quality of wet blue leathers produced were tested regularly for boiling test, chromium content etc and met all standard requirements. The quality of finished leather processed were tested for physical, chemical, organoleptic parameters and they also met quality standards and acceptable to local and international market.

6.2.1 Organoleptic quality

In Table.3 different aspects of the organoleptic quality are given using a grading of 1 to 6, where 1 and 6 represent very bad and very good respectively. The figures in the table are average values.

Table 3 : Organoleptic quality of leather from Normal tanning (N) and leather tanned with 70% fresh chromium and 30% of Recovered chromium (R)

| | N | R | (N-R) |
|-----------------------|-----|-----|-------|
| Grain tightness | 4.4 | 4.6 | - 0.2 |
| Softness and fullness | 4.4 | 4.6 | - 0.2 |
| Tightness of bellies | 4.4 | 4.4 | - |
| Grain drawinness | 4.6 | 4.7 | - 0.1 |
| Veininess | 5.0 | 5.0 | - |
| Evenness of colour | 5.0 | 5.0 | - |

The leather tanned with recovered chromium has the same quality as the leather tanned with 100% fresh chromium. Some of the properties are even considered slightly better.

6.2.2 Physical & Chemical Properties

The main physical properties namely thickness of the leather, tensile strength, tear strength and water penetration were tested. The tests were carried out in accordance with IUP (International Union Physical) and IS (Indian Standards). Relevant chemical properties namely moisture, chromium, chlorides, sulphates and MgO contents of both types of leather in all the sides were tested. From the chemical properties it is established that the differences between the two types of leather are similar.

6.3 Technical constrains and considerations on the chrome recovery and reuse systems

Though there is no major technical constrain in adopting the chrome recovery and reuse system with MgO as alkali the following points need be considered in the operation and maintenance of the system.

i. MgO is a slow reacting alkali and the pH increases slowly after the addition of MgO for chromium precipitation. Hence time required for MgO addition is comparatively more to achieve the desired pH.

ii. The main reactor particularly the bottom slope and stirring system need to be designed carefully on case to case basis to avoid any choking or accumulation of chrome slurry in the reactor.

iii. Precaution need to be taken against fumes while adding sulphuric acid during the regeneration of chromium.

iv. Periodical testing is required on the quality of exhaust chromium, MgO and H₂SO₄ requirement and Cr₂O₃ content in the recovered chrome liquor if the chrome recovery system is used for different tanneries. This type of testing would also be required for other chrome recovery systems available in the world.

7. COST BENEFIT ANALYSIS

The entire chromium discharged in the collected effluent is recovered and used. Processing of hides and skins both before and after the main tanning operations remains the same in terms of processing time and method. Because the quality of leather is not affected, the commercial value of the leather is not changed. Hence, cost benefit analysis is restricted to the investment by Arafath Tannery operating costs and the chemical savings.

Table 4. Cost Benefit Analysis for Arafath Leathers

| | |
|---|----------------------------------|
| Leather processing capacity of Arafath Leathers | 110 tons of hides/skins per year |
| Amount of chromium salt (BCS) used in the tanning process | 90,000 kg/year |
| Quantity of chromium discharged along with wastewater | 26,000 kg/year |
| Quantity of chrome liquor collected for recovery | 1 million litres/year |
| Chromium present in the waste chrome liquor as chromium oxide (Cr_2O_3) | 5 to 6 gm/lit |
| Chromium present as Cr in the supernatant discharged from the main reactor after precipitation with MgO | less than 5 mg/lit |
| Quantity of chrome liquor regenerated in the chrome recovery system for reuse | 90,000 litres/year |
| Quantity of chromium(as Cr_2O_3) present in the recovered chrome liquor | 55-65 gm/lit |
| Efficiency of chrome recovery system on the collected exhaust liquor | 99% |
| Chromium recovery in terms of BCS from Arafath Leathers | 24,000 Kg/year |
| Cost of BCS recovered @ Rs 26000 per 1000 Kg (ie. about 800 USD per 1000 Kg) per year | Rs.6,24,000 or 19,200 USD/ |

Operational and maintenance cost per year.

| | |
|---------------------------------|-------------|
| Chemicals (MgO, Sulphuric acid) | Rs. 60,000 |
| Labour | Rs. 25,000 |
| Power | Rs. 15,000 |
| Miscellaneous & Financial cost | Rs. 78,000 |
| | ----- |
| | Rs.1,80,000 |
| | ----- |

| | | | | | |
|---|----------|---|-------|---|-------------|
| Operation and maintenance cost for recovery of 1000 Kg of BCS | 1,80,000 | = | ----- | = | Rs.7,500 or |
| | 2,400 | | | | 230 USD |

Saving per year for Arafath Leathers About Rs.4.44 lakhs (0.50 million) or 14000 USD

The following observations were made during the regular operations from August 94.

- i. Regular chrome recovery and reuse operation in Arafath Leathers started from August 1994
- ii. About 1000 lots (ie 1000-1200 Kg per lot) of wet blue worth more than Rs.500 lakhs (50 million rupees or 1.5 million USD) was produced using recovered chromium upto the end of August '95.
- iii. The quality of the chromium recovered and leather produced using recovered chromium meet the standard requirements and the tannery staff are trained to adopt the process regularly.
- iv. The recovery cost for Arafath leathers is only about Rs.7500 (230 USD) per ton of BCS comparing Rs.26,000 (800 USD) to market price of per ton.
- v. Provision on the capacity has been made in the chrome recovery system installed at M/s. Arafath leathers premises to process the exhaust chrome liquor received from other chrome tanneries (at present 4 units are adopting main chrome tanning) in Pallavaram area for recovery of chromium as a central facility (Ref Fig.4 & 5)

The other chrome tanneries are making arrangements to collect the waste chrome liquor separately and transport the chrome

liquor by tankers for recovery and reuse with the co-operation of CLRI and financial support from UNIDO. The over all cost benefit analysis of the chrome recovery system as a centralised facility is projected given Table 5.

Table 5. Overall Cost Benefit Analysis of the Chrome Recovery and Reuse System

| | |
|---|--------------------------------|
| Total processing capacity | 3,000 tons of hides/skins/year |
| Use of chromium salt (BCS) | 240 tons/year |
| Capital cost of the chrome central recovery system | 52,000 US Dollars |
| Annual operating costs | Cost in US Dollars |
| Maintenance | 1,500 |
| Labour | 1,000 |
| Chemicals | 5,000 |
| Electricity | 500 |
| Miscellaneous | 2,000 |
| Transportation cost for tanneries, other than Arafath Leathers | 3,000 |
| | ----- |
| Total annual operating cost | 13,000 |
| Financial costs | 9,300 |
| Depreciation | 5,200 |
| | ----- |
| Total annual cost | 28,500 |
| Benefits | |
| Value of chromium recovered @ about USD 800 per ton for 70 tons | 56,000 |
| | ----- |
| Net profit/year | 27,500 |

The total capital investment for the chrome recovery system is USD 52,000. The annual consumption of BCS is 240 tons. The wastage is about 80 tons. About 70 tons of chromium salt (BCS) per year can be recovered and reused. Though the chrome recovery system is more than 99% efficient in recovering chromium, we could collect only about 90% of the exhaust chrome liquor from the chrome tanning drums in the field situation.

From the cost benefit analysis it can be observed that the cost of recovered chromium including all costs is less than 400 USD/ton whereas the fresh chromium salt costs more than 800 USD/ton. Moreover, the pay back period of the whole chrome recovery plant will be less than three years. In addition to direct financial benefit, operation and maintenance cost of the CET plant in respect of chemical usage and disposal problem of

about 2,500 tons of sludge per year from CET plant will be minimized. It has also created awareness in adopting cleaner technologies, reuse of water etc in tanneries.

8. TRAINING PROGRAMME AND CONCLUSION

Regular training was given by CLRI to Arafath Leathers technicians and manager in sample collection, analysis, operation and maintenance of the system. They are able to understand utilize the system regularly. The chrome recovery system attracts many visitors from Leather Industry, Environmental pollution control Agencies, UNIDO, UNDP and other international organisation, public, media etc, In order to have better dissemination in addition to regular operation and maintenance of the system CLRI it has been decided to adopt this system for future demonstration and dissemination with UNIDO future plan. An additional training programme for the benefit of other chrome tanneries in Pammal/Pallavaram, representatives of PTIETC, TNPCB, TALCO etc is planned during the end of 95. This programme is given in Annexure.

PROJECT LINKAGE AND ACKNOWLEDGEMENT

The chrome recovery and reuse system implemented by CLRI under UNIDO project US/IND/90/244 (2) in M/s. Arafath Leathers, Madras as a centralised facility for the chrome tanneries in Pammal/ Pallavaram cluster is considered to be a great success in terms of Environmental, Economical and Social aspects. The success is due to contribution, services, co-operation of the following organisations/individuals.

1. Donor country:
Govt of Switzer land
2. Mr J Buljan, Senior Industrial Development Officer
(UNIDO)
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3. Dr K.V. Raghavan, Director,
&
Dr S. Rajamani, Project Team Leader
and Scientific Technical and supporting staff of
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Adyar, Madras 600 020.
4. Dr Z Kotazek
CTA/UNIDO consultants

5. Mr S. Selanec
TEH PROJEKT HIDRO d.d Croatia
6. Tamilnadu Pollution Control Board (TNPCB)
100, Anna Salai, Guindy
Madras 600 032
7. M/s. Arafath Leathers Ltd.,
Chromepet/Pammal/Pallavaram
Madras 600 044
8. M/s. Pallavaram Tanners Industrial
Effluent Treatment Company Ltd., (PTIETC)
Pallavaram
Madras 600 043.
9. Field Executive Agencies
 - a. M/s. S.V.V Engineering Industries
Hosur (Tamilnadu)
 - b. M/s. Enkem Engineers Pvt Ltd.,
Madras (Tamilnadu)
10. Many more direct and indirect contributors.

ANNEXURE I
TRAINING PROGRAMME

This general training activity is planned for the benefit of other chrome tanneries in addition to the training and continued interaction by CLRI with M/s. Arafath Leathers technicians on regular operation and maintenance of the chrome recovery system from July 94 onwards.

**TRAINING PROGRAMME ON CHROME RECOVERY AND REUSE SYSTEM
FUNCTIONING IN M/S ARAFATH LEATHERS, PALLAVARAM, MADRAS**

UNIDO PROJECT NO. US/IND/90/244(2)

ORGANISED BY: ENVIRONMENTAL TECHNOLOGY DEPT, CLRI, MADRAS

The training is divided into two modules and is structured as follows.

Module 1 Introduction to chrome recovery for tanneries

Objective:

Explanation and promotion of the recovery technology in such a way that the majority of chrome tannery owners in Pallavaram/Pammal area will opt for the use of the chrome recovery plant.

Target groups:

1. Owners and or plant managers of chrome tanneries.
2. Process managers.
3. Representations from PTIETC, TNPCB, CLRI, TALCO.

Remarks:

The duration of this module will be approximately 6 hours.

This module forms an introduction to the chrome recovery principle. The tanning process itself will only be very briefly dealt with, as most of the trainees are assumed to have basic knowledge in tanning methods and techniques. At the same time, this general introduction furnishes the base

Module 2 Operations and control of a chrome recovery plant

Objective : Provide staff with information and knowledge which contributes to proper operation and functioning of a chrome recovery plant.

Target groups: 1. M/s. Arafath Leather and specific tannery owners using chrome recovery plant as centralised facility.
2. Selected chrome tannery technicians
3. Other related technical staff

Remarks : * The duration of this module will be approximately one day (This is addition to the continued interaction & training to M/s. Arafath Leather technicians)
* This module is designed for tannery operational staff and will elaborate on chrome recovery techniques in more depth. The training is technical in nature but does not aim to develop skills. Additional intensive training would be required for this purpose. Some of the most important chemical analyses will be demonstrated.

* Attention will be given to the determination of chemical and leather quantities by means of calculation exercises.

* The configuration of the plant layout will be explained in more detail.

* A brief overview of operation and maintenance implications will be given.

CURRICULUM

MODULE 1

Introduction to chrome recovery for tanneries

Objectives

- * Explanation and promotion of the chrome recovery technology in such a way that the majority of chrome tannery owners will opt for the use of chrome recovery plant
- * Trainees should be able to :
 - Comprehend the background, objectives and main activities of the UNIDO assisted project on treatment of tannery effluents
- * Be aware of the environmental and commercial benefits of chrome recovery techniques in tanneries
- * Explain the basic principles of chrome recovery and reuse tanneries
- * Appreciate the requirements needed for chrome recovery and reuse in terms of chemicals, equipment and plant layout.
- * Understand the basic functioning of the chrome recovery plant installed at M/s.Arafath Leathers, Pallavaram, Madras.
- * Understand the cost benefit analysis of the technology implications
- * Be aware of the preparation and the correct procedures to install and utilize a chrome recovery plant with the involvement of CLRI.

Contents

- Unit 0.0 Opening/Introduction
1. Welcome of opening of the training
 2. Explanation of the training programme and objectives of the training
 3. Introduction of the participants of the training
- Unit 1.1 Introduction to the UNIDO sponsored project
1. Environmental problems due to the waste discharge from tannery
 2. Background, objectives and organisational set-up of the project
 3. Broad overview of project activities.
- Unit 1.2 Tannery Types and training processes in a Nutshell
1. Types and capacities of tanneries in Pammal, Pallavaram
 2. Pre-tanning and tanning processes in Pammal Pallavaram
 3. Chrome tanning and the situation in Pallavaram
- Unit 1.3 Discharge and Collection of exhaust chrome liquor
1. Discharge procedure to collect exhaust chrome liquor separately
 2. Use of special doors for discharge of chrome liquor
 3. Special screens and drainage
 4. Collection and storage of exhaust chrome liquor
- Unit 1.4 Chrome Recovery in tanning technologies
1. The chemical process in general
 2. Operation and description of the chrome recovery plant
 - 2.1 Operation of the plant
 - 2.2 Description of the plant
- Unit 1.5 Leather Quality and cost implications
1. Leather quality using recovered chromium

- 1.1 Leather quality
- 1.2 Organoleptic quality
- 1.3 Physical and chemical properties
- 1.4 observations

Unit 1.6 Over all cost benefit analysis

1. Cost and benefits
 - 1.1 Investment costs
 - 1.2 Labour costs
 - 1.3 Costs of chemicals
 - 1.4 Other costs
 - 1.5 Cost benefit analysis

Needed training

Equipment

- * Blackboard/white board plus writing pens and/or chalks plus cleaners
- * Overhead projectors plus pens, spare bulb and blank transparencies
- * Paper + Pencils (for participants)
- * Glass with tanning liquor and MgO (prepare at least 1 day in advance)
- * Three dimensional model of chrome recovery plant
- * Ten tanned hides (buffalo calf): 10 sides tanned with new BCS's the other, matching sides tanned with partly reused chromium. (prepare well in advance and arrange with the M/s. Arafath Leathers)

CURRICULUM

MODULE 2

Operations and control of a chrome recovery plant

Objectives

Provide staff with information and knowledge which contributes to proper operation and functioning of the chrome recovery plant.

(The objective is not to improve the tanning procedure as such; the starting points will be the liquor which is discharged from the drums within the existing tanning routine)

After following this module the participants should be able to:

- * recall the process as a whole
- * understand the step wise sequence of daily logistical operations
- * execute basic control operations
- * be aware of general processing conditions

Contents

- Unit 2.1 segregation, collection procedure of exhaust chrome liquor
- Unit 2.2 The process of chrome recovery
- Unit 2.3 Step wise sequence of logistical operations
1. Manual chromium recovery
 2. additional information
 3. Reuse of recovered liquor
 4. Maintenance of the plant
 5. Handling of chemicals
 6. Safety procedure in Operation and maintenance of the system
- Unit 2.4 Control of operations and calculations
1. pH control
 2. Chromium analysis
- Exercise "Quantity of recovered chrome liquor to be

reused"

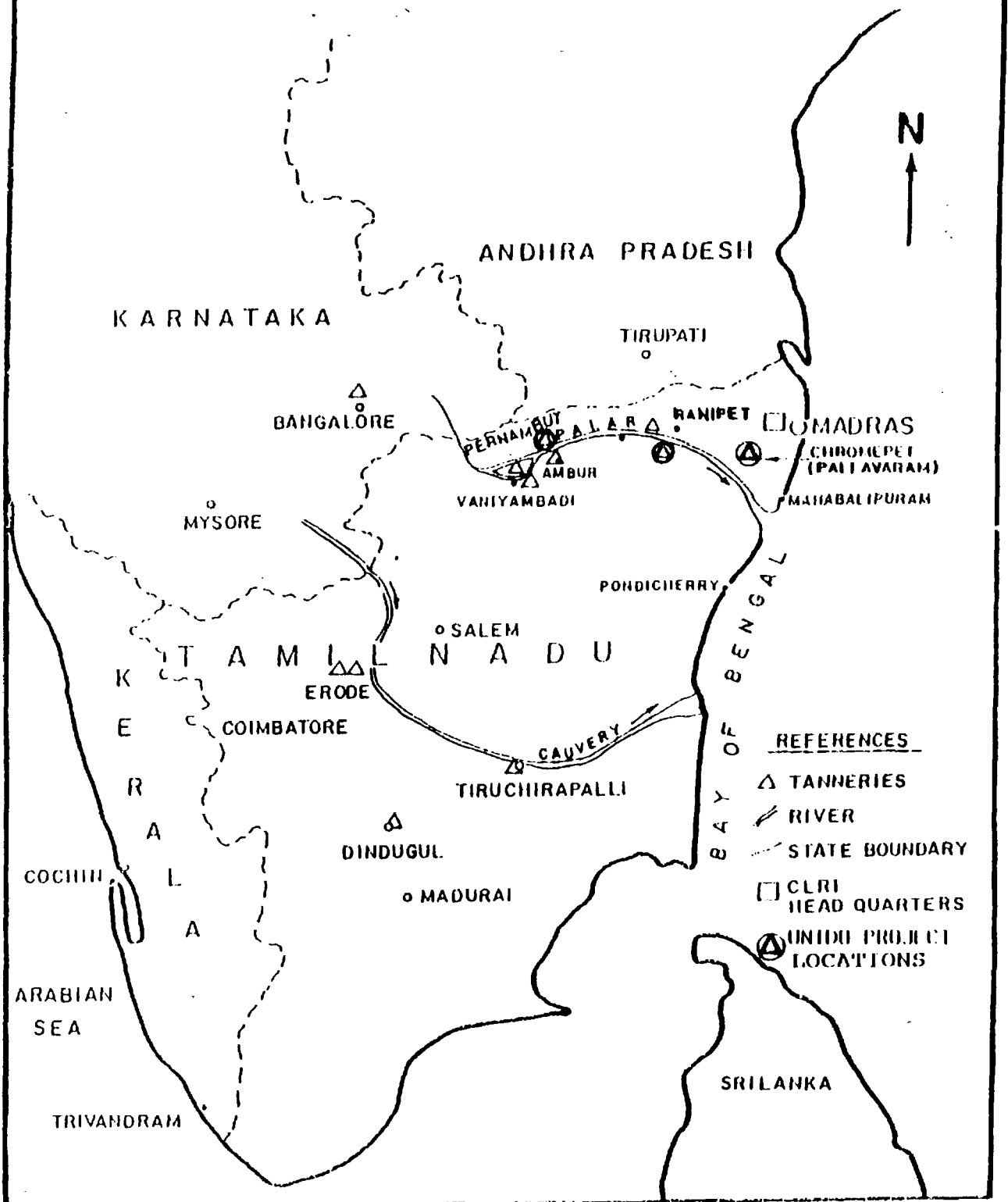
Need training

Equipment

- * Blackboard/white board plus writing pens and/or chalks plus cleaners
- * Overhead projectors plus pens, spare bulb and blank transparencies
- * Paper + Pencils (for participants)
- * Glass with tanning liquor and MgO (prepare minimal 1 day in advance)
- * Electronic device for pH measurement
- * Indicator paper
- * Equipment for chromium analysis
- * chemicals for chromium analysis

ANNEXURE II
FIGURES

FIG. 1. LOCATION OF TANNERIES IN SOUTH INDIA



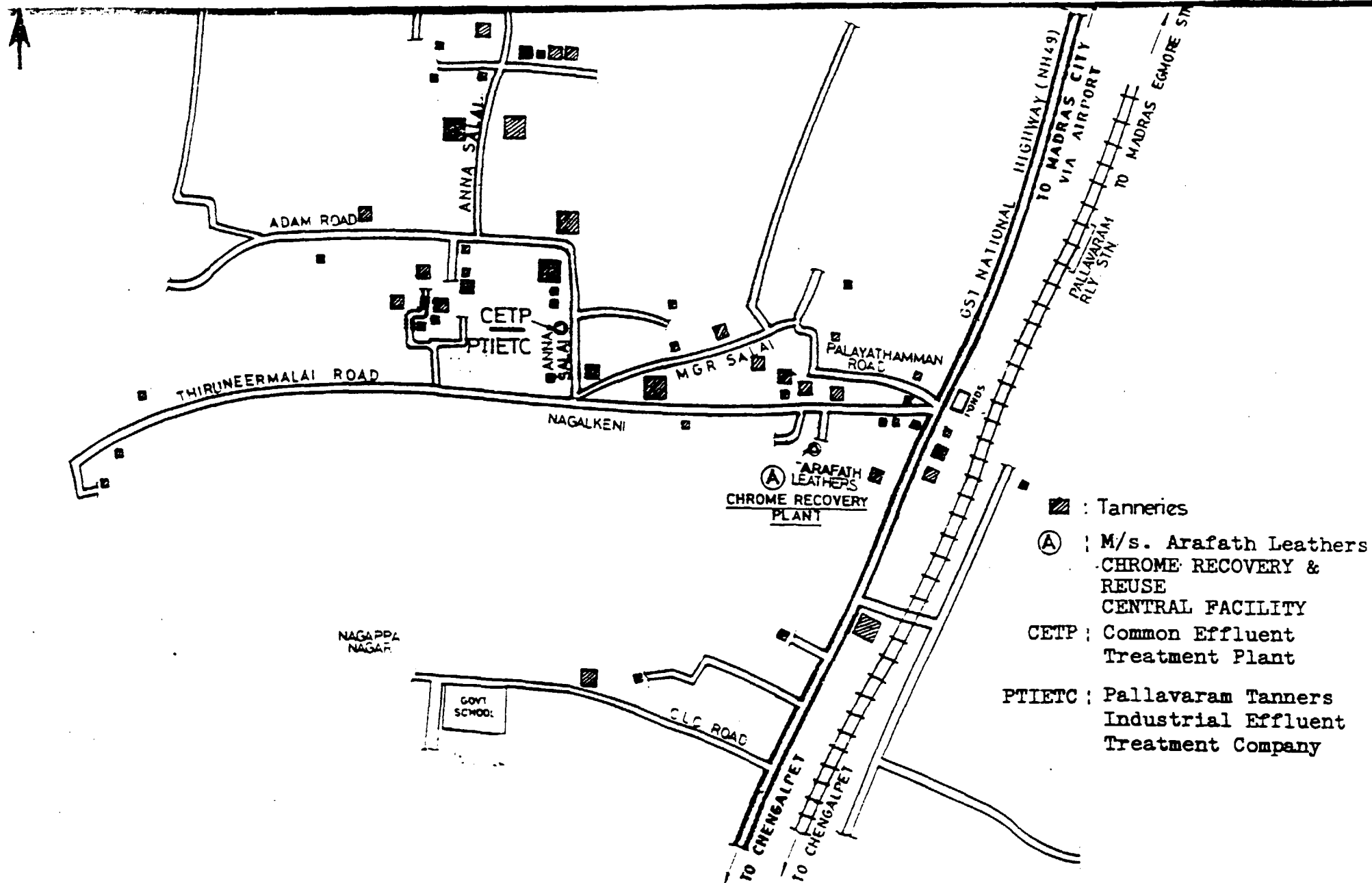


FIG.2 .LOCATION MAP OF TANNERIES IN CHROME PET (PALLAVARAM) NEAR MADRAS

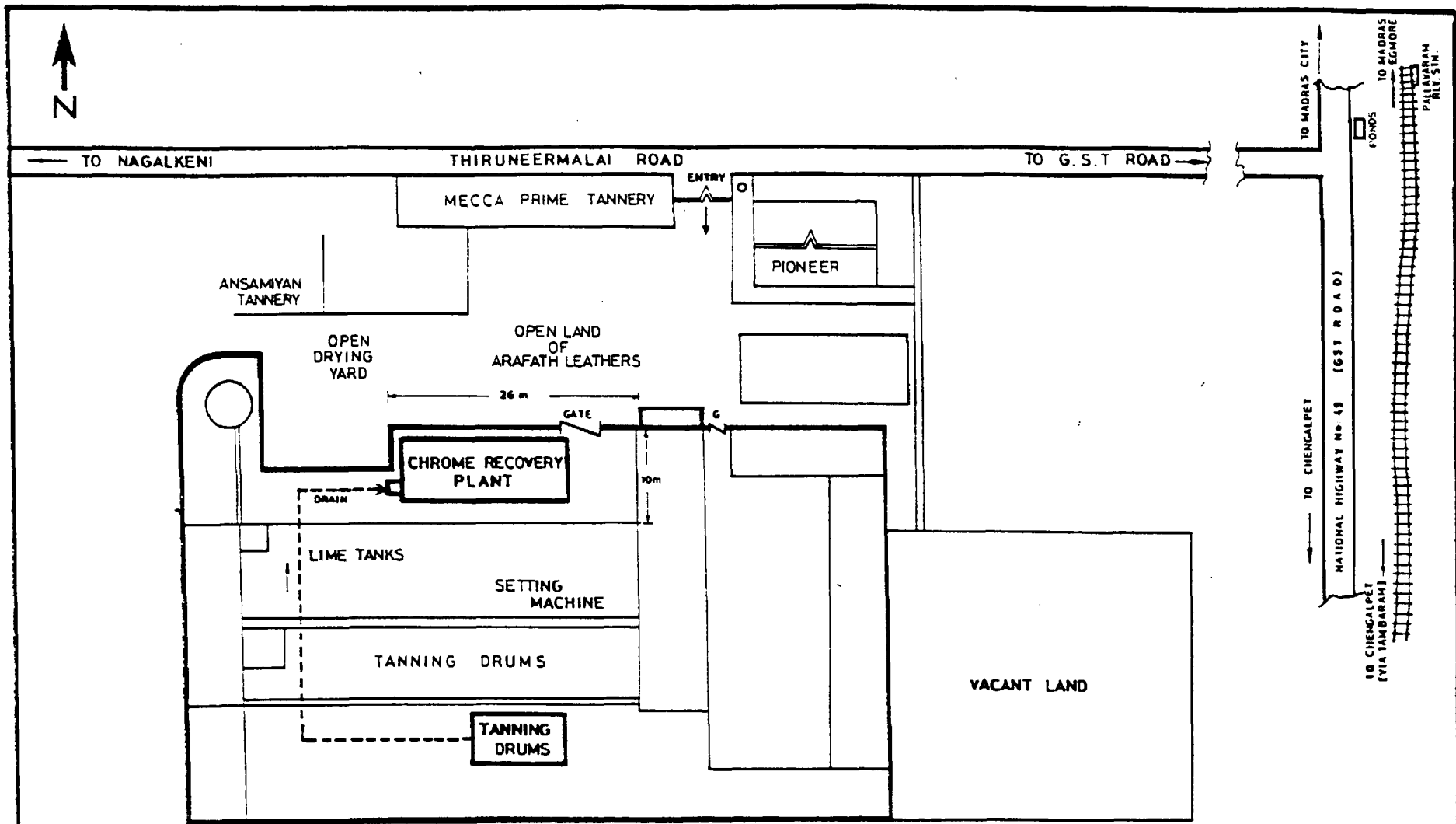


FIG. 3. LAYOUT OF M/s. ARAFATH LEATHERS (TANNERY) CHROMEPET (PALLAVARAM), MADRAS

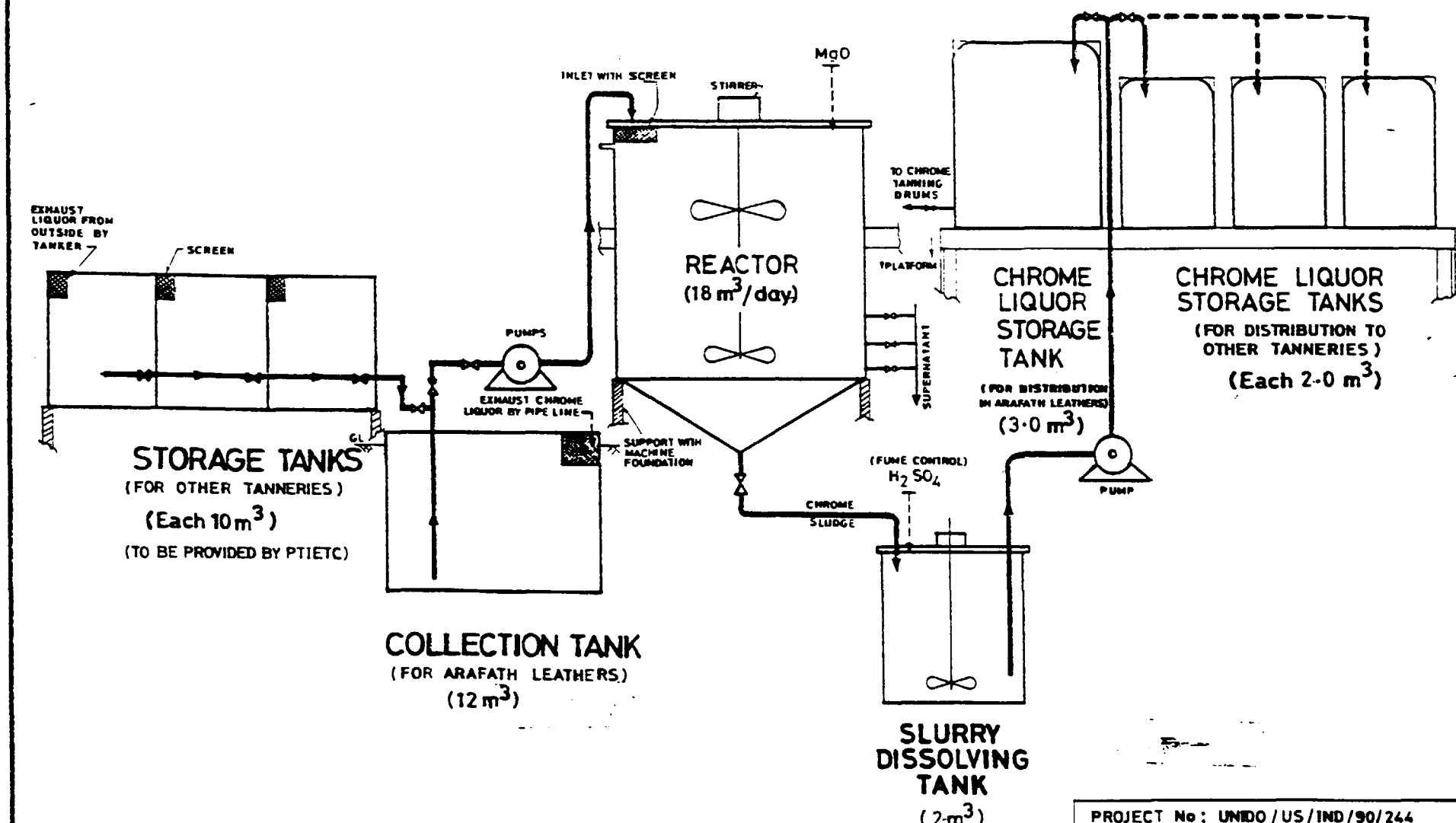
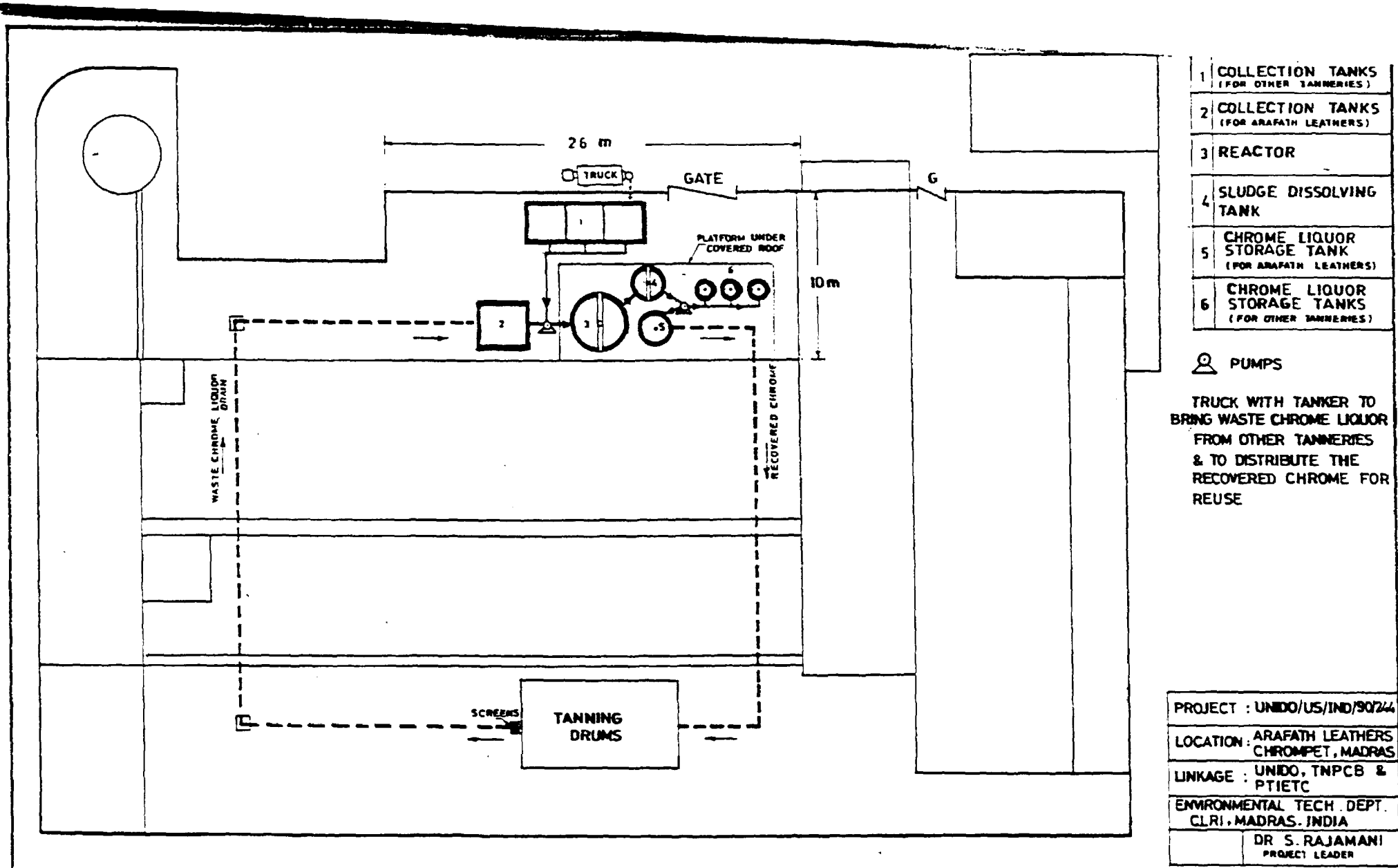


FIG 2. PROCESS FLOW DIAGRAM OF CHROME RECOVERY AND REUSE SYSTEM

NOTE
 SUBJECT TO CHANGE TO SUIT FIELD CONDITION

THIS DRAWING CONTAINS PROPRIETARY INFORMATION NOT TO BE DISCLOSED/USED WITHOUT THE WRITTEN PERMISSION OF CLRI

| | | |
|-------------------------------------|---|--------------------------------------|
| PROJECT No : | UNIDO / US / IND / 90 / 244 | |
| LOCATION : | ARAFATH LEATHERS CHROME PET (PALLAVARAM) | |
| LINKAGE : | UNIDO . TNPCB , PTIETC | |
| ENVIRONMENTAL TECHNOLOGY DEPARTMENT | CLRI , MADRAS . INDIA | |
| Dr S. RAJAMANI PROJECT LEADER | 2 | DRAWING : CLRI/UNIDO/SR/94 NUMBER |



- 1 COLLECTION TANKS (FOR OTHER TANNERIES)
- 2 COLLECTION TANKS (FOR ARAFATH LEATHERS)
- 3 REACTOR
- 4 SLUDGE DISSOLVING TANK
- 5 CHROME LIQUOR STORAGE TANK (FOR ARAFATH LEATHERS)
- 6 CHROME LIQUOR STORAGE TANKS (FOR OTHER TANNERIES)

PUMPS

TRUCK WITH TANKER TO BRING WASTE CHROME LIQUOR FROM OTHER TANNERIES & TO DISTRIBUTE THE RECOVERED CHROME FOR REUSE

PROJECT : UNIDO/US/IND/90244
 LOCATION : ARAFATH LEATHERS CHROMPET, MADRAS
 LINKAGE : UNIDO, TNPCB & PTIETC
 ENVIRONMENTAL TECH. DEPT. CLRI, MADRAS, INDIA
 DR S. RAJAMANI
 PROJECT LEADER

NOT TO SCALE

FIG.5.. LAYOUT OF CHROME RECOVERY SYSTEM IN ARAFATH LEATHERS

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