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FINAL REPORT

for

'Training in Design and Operation of Effluent Treatment Plants for the Tanning Industry in China'

UNIDO Project No. US/CPR/92/120
UNIDO Contract No. 97/282P
BLC Contract No. RC96-7-029

BLC Leather Technology Centre
Northampton
United Kingdom

BLC
Leather Technology Centre

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March 1998

FINAL REPORT

for

'Training in Design and Operation of Effluent Treatment Plants for the Tanning Industry in China'

16-28 February 1998

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Farid Turan | Martin van Vliet | Song Ma

for

BLC Leather Technology Centre
Northampton
United Kingdom

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1. Introduction

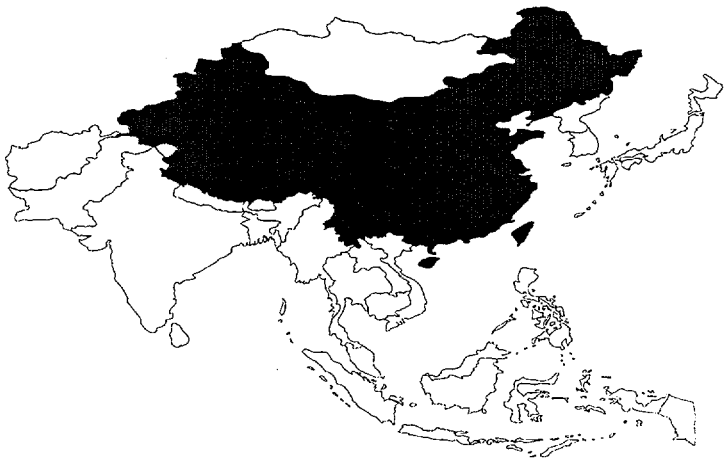
UNIDO is currently providing technical assistance to the Chinese leather industry under project US/CPR/92/120, "Assistance in Pollution Control and Treatment of Tannery Wastes in selected areas of China".

The objectives of the project are the introduction of cleaner leather processing technologies and optimisation of the operation of several existing large-scale tannery effluent treatment plants (ETPs and CETPs), and the strengthening of the national research & development establishments in dealing with pollution control.

Under the frame work of the UNIDO project, a total of 16 Chinese specialists attended a very successful one month training course at BLC Leather Technology Centre (UK) in 1995 in the field of cleaner technologies and pollution control. This report presents details of the second-leg of such technical and demonstration training programme for the Chinese leather industry, which was conducted in the field during 16-27 February 1998, in association with the China Leather Industry Association.

In order to meet the strict environmental standards most companies in China have installed or are installing effluent treatment plants. However, it is believed these plants are mostly inefficient and inadequately designed. As a result companies are often unable to meet the required standards and are faced with unnecessary high capital investment and operating costs. To address this concern, this follow-up two week training programme was specifically designed to provide both theoretical and relevant practical in-plant training of the process and plant design, operation and performance optimisation of tannery ETPs and CETPs in China.

The training course was attended by a total of 25 participants representing the leather industry from the various provinces of China and the associated consulting and contracting companies. The classroom training was based at the Shanghai Leather Research Institute, with practical training carried out at Shanghai Richina Leather Co. Ltd., and the Da-chang Common Effluent Treatment Plant.



2. Group and Course Introductions

The training course was officially initiated on Monday 16 February 1998 with the local counterparts, UNIDO experts from BLC and the participants being present at the Shanghai Leather Reserach Institute. A list of the course participants with details of their company, province and experience is presented in Appendix III.

The first introduction was by Madam Song Xian Wen (Vice National Project Director) who introduced the presenters, the UNIDO support for the training course and explained the main objectives, structure and programme for the next two weeks. The next speaker was Mr Su Chaoying (Vice Secretary General) of China Leather Industry Association who presented further information on the overall UNIDO project in China and indicated the importance of this training programme to disseminate practical information on pollution control to the actual tanneries in China. He also presented further information from the China leather sector and news from Beijing.

The official welcome introduction to the Shanghai Leather Research Institute was made by Mr Li (Director of Shanghai Leather Technology Centre) to both the UNIDO presenters and training course participants. The role of the Institute was explained and the group was given a tour of the facilities at the Shanghai Leather Research Institute including the leather processing areas, testing facilities, laboratories, library, and offices.

Mr Song Ma introduced the role of BLC in the UNIDO training programme, a brief description of the BLC activities and presenters. Further information was provided on the specific course structure and proposed agenda for the course (see Appendix II). Individual introductions were made by Mr Jean-Marie Gigante and Mr Farid Turan of BLC providing details of their past experience and the expected objectives from the training course.

The course participants individually introduced themselves with information on their backgrounds, experience, details of their Company and treatment facilities. Each of the participants indicated the specific information they expected from the training course as summarised in the Pre-course Questionnaire in Appendix IV.

A detailed course manual prepared by BLC was provided to each of the participants as well a detailed booklet in Chinese which was provided by the Shanghai Leather Research Institute on the subject of cleaner technologies and effluent treatment. All information was presented using overheads (partly translated in Chinese) along with videos to demonstrate the various technologies. The Computer Aided Technology Training (CATT) software on cleaner technologies and effluent treatment programme was also demonstrated to the group for use as reference during the group case study.

3. Training Course Presentations

3.1. Environmental Impact of Tanneries

The first technical presentation was focused on the environmental impact of leather processing, in terms of effluent, gaseous pollution and solid wastes. Figures were provided on the sources, characteristics and quantities of the pollution from each of the stages of leather production and for the various types of raw materials processed, namely: bovine, sheepskins, goatskins and pig skins.

A more detailed presentation was provided on tannery wastewater characterisation and the specific effluent pollution parameters (suspended solids, dissolved salts, BOD, COD, sulphide, chromium, etc.) and the consequences of their release into the environment. The discharge consent limits for various countries (particularly China) was presented, together with information on typical treatment levels achievable and the problem areas such as the effective treatment of persistent (non-degradable) COD, ammonia and dissolved salts.

An introduction into cleaner technologies was presented in terms of reducing the pollution load from each stage of leather manufacture. Typical guidelines was provided in terms of practicality and relevance for the main environmental issues of concern in China. Specific aspects of cleaner technologies, such as chrome recovery and water management, were later presented in greater detail and the presentation on cleaner technologies was repeated in request by the participants.

3.2. Technical Presentations on Effluent Treatment Technologies

The introduction to effluent treatment technologies covered the definitions, terminology and sequence of treatment operations associated with preliminary, primary, secondary and tertiary treatment stages. Various process flowsheets were used to illustrate the alternative process configurations for tannery ETPs and CETPs with focus on the specific requirements such as sulphide oxidation, equalisation, chrome removal/recovery and sludge management.

3.2.1. Module I - Preliminary and Primary Treatment Operations

During the remainder of day one of the training course the introduction, objectives and details of the individual facilities, equipment and processes associated with preliminary and primary treatment operations was covered. These included:

- pre-treatment processes of screening, grit removal, oil & fat removal
- sulphide oxidation (by aeration and/or chemical reaction)
- chrome removal and recovery methods
- flow balancing and equalisation

The presentation included information on the design of the facilities, comparison of the various types of equipment available (pumping, mixing, screens, aeration),

and typical operational performances and problems. The presentations were supported by video demonstrations and group discussions of the subject.

Day two of the training course continued on the subject of primary treatment with details and choice of chemical treatment operations for pH control, coagulation and flocculation with typical dosage and control of chemical additions. The training presentation focused on the comparison of different facilities used for primary treatment of suspended solids removal by settlement and flotation. Information was provided on principles of settling tank design, operational performance and control of the process. Common problems associated with preliminary and primary treatment operations was discussed by the group to determine possible solutions.

3.2.2. Module 2 - Secondary Biological Treatment Operations

Day two of the training course continued with the introduction and process details of technologies associated with secondary biological treatment of wastewater. The basic principles and operation of different types of biological treatment, for both fixed film and suspended growth processes, was presented. These included: activated sludge, bio filters, oxidation ditches, lagoons, and advanced systems.

The presentation provided information on the basic design and typical operational parameters and control of common biological oxidation processes. In particular, comparison of different types of biological treatment plant was presented, highlighting the practicalities and attributes of common aerobic systems in the leather industry such as the extended aeration 'oxidation ditch' systems.

The presentation also included important factors and environmental implications to be considered with new biological plant installations and relative cost for capital investment and operation of such biological plant. Information was also presented on the basic design principles, operational control and common problems for different types of aeration systems and secondary settlement clarifiers.

Day three of the training course continued with the presentation of secondary biological processes based on enhanced treatment technologies such as oxygen enriched activated sludge process and combined biofilter systems. Also, the principles of further biological treatment to remove problem nutrients (nitrification and denitrification) was also presented with details of the process and operational requirements. The group discussed the common problems and possible solutions.

The basic principles of anaerobic biological treatment was also presented in this module. Examples of the technologies available and the expected performance of appropriate anaerobic technologies associated with the leather processing sector was presented including UASB and anaerobic lagoon systems.

3.2.3. Module 3 - Tertiary Treatment and Water Recycling

Tertiary treatment operations for further treatment (polishing) of wastewater was presented during the first half of day three of the training course. The subjects covered included:

- Residual suspended solids removal: sand filtration, screening, lagoons
- Disinfection technologies
- Membrane recycling technologies

A more detailed presentation was provided on the subject of water recycling. These included the options for reuse of treated wastewater and the more practical approach of general management of water usage in the tannery operations and the recycling of spent process liquors. The requirements for adequate quality control and the issue of dissolved salts build-up and salinity were highlighted.

A video of a comprehensive tannery effluent treatment plant was presented to demonstrate the complete range of technologies covered in the training course. The video was of particular relevance as it presented a suitable scale of treatment plant (3000 m^3/day) from a large European tannery processing sheep and goat skins and demonstrated the potential for the recycle of treated wastewater.

It was noted that many tanneries in China processed with an excess of water (typical usage at 100 m^3/tonne rawhide). Therefore, there exists a major potential for wastewater minimisation by improved process control to reduce both capital and operating costs of ETPs and CETPs.

3.2.4. Module 4 - Tannery Sludge Handling and Disposal

The second half of day three of the training course covered the important subject of treatment technologies for tannery sludge. The presentation included the general introduction and initial considerations associated with effective sludge management to reduce the overall environmental impact and cost of disposal.

The presentation topics included:

- Sources, quantities and characteristics of tannery sludge
- Effective segregation of inert and hazardous (chrome) sludge
- Chemical treatment (lime stabilisation) and conditioning
- Options for volume reduction by thickening and dewatering technologies
- Anaerobic digestion and composting for stabilisation and land application
- Drying, thermal incineration and brick making

The training course focused in promoting practical and low-cost options to separate chrome containing sludge and other solids wastes for possible re-use and by-product recovery and the safe disposal of the remainder tannery sludge.

3.3. Process Design of Effluent Treatment Facilities

Day four of the training course presentations focused specifically on process design, installation and operation of tannery effluent treatment facilities. Initially, a brief presentation was made on the overall ETP design procedure listing the necessary stages and important factors to be taken into consideration. This broadly covered the following areas:

- wastewater characterisation, individual effluent parameters
- pre-treatment study and definition of design basis
- choice of treatment processes, treatment stages and unit operations
- individual process design, selection of equipment and facilities
- installation and commissioning
- trouble shooting and process performance optimisation
- monitoring, control, sampling and analysis

Information was provided on typical process flow schemes, design parameters, and important guidelines for each of the main unit operations with examples of calculations and sizing. These included: screens, grit chambers, equalisation tanks, pumping, sulphide oxidation, chemical conditioning, primary treatment by settlement and flotation, aerobic biological treatment, and secondary clarification.

To reinforce the information on process design, examples of a number of case studies were presented on the design of preliminary, primary and secondary treatment facilities. The training focused on design outlines of typical, low cost methods and practical examples of wastewater treatment and sludge disposal. Furthermore, common operational problems as experienced with the various main stages of treatment was presented. The group was encouraged to discuss own experiences of ETP operational problems (such as effects of extremes of climate) and advice on the possible causes and solutions to these problems.

3.4. Group Site Visits

The group visited the large tannery complex at Shanghai Richina Leather Co. Ltd. on day five of the training course. The one day visit was originally proposed to provide demonstration of the treatment technologies of the comprehensive common effluent treatment facilities at Da-chang and for the group evaluation of the treatment plant performance. However, in request by many of the participants, a two day visit was arranged with the first visit focused to provide further practical information on cleaner technologies in leather processing. A return visit was arranged for the next week (day six) to inspect the Da-chang Tannery complex and CETP facilities and to evaluate its design and performance.

A very in depth and practical approach to cleaner technologies was presented by Mr Hagen (President of Shanghai Richina Leather Ltd.) during the first day visit. The thorough presentation covered all the main cleaner technologies of rawstock preservation, hair-save unhairing, CO_2 and low nitrogen deliming, chrome recovery

and recycling to low emission finishing operations and low water usage. The subject of practical chrome recovery was presented and discussed in some detail as this was of particular relevance to many of the participants.

A return visit was made to Shanghai Richina Leather Co. Ltd. on day six of the training course to inspect the very large CETP facilities and to evaluate its design and performance. A detailed tour of the three tannery complexes (processing bovine, goat and pig skins) was also provided by Mr Hagen. The individual chrome recovery and pre-treatment facilities for each of the tanneries was also inspected by the training course participants. Pictures of the tannery visit is included in Appendix V.

The inspection of the CETP was undertaken in conjunction with the effluent plant managers and was focused to evaluate and trouble shoot any technical problems which needed to be resolved. The CETP, which was originally designed for 10,000 m^3/d, was being operated at a much reduced capacity of 3000 m^3/d but this was expected to increase in-line with growth in tannery production. The group was encouraged to evaluate the present plant performance and provide relevant practical assistance and technical advice to optimise treatment performance and reduce the high operating costs. Much of the limitations was attributed to the excess design capacity of the treatment plant and design of some of the key facilities, such as the primary and secondary settlement tanks and the high energy demand associated with the aeration system.

3.5. Group Case Study

The remainder of week two of the training course was specifically focused towards the group case study design project. The participants were split into two teams of mixed disciplines to participate in the real life case study based on the requirements by two course participants for a new ETP for their tannery.

The target for the ETP design was based on a plant to treat a mixed production of goat skins and bovine from raw to finish leather with a daily capacity of 2000 m3. The influent quality was based on the average figures, as provided by the participants and listed below, and the objective was to treat up to the river discharge consent limit for China:

Parameter	*Beamhouse*	*Tan Yard*	*Discharge Consent*
pH	11.5	4.5	pH 6 to 9
BOD_5 (mg/l)	1800	1000	100
COD (mg/l)	3800	3000	300
S.S. (mg/l)	1200	800	150
Cr^{3+} (mg/l)	0	260	1.5 (total)
S^{2-} (mg/l)	250	0	1
Flow (m^3/d)	1400	600	-

Prior to the group case study, a detailed example of the process design for a tannery ETP processing upto 5000 m^3/d was presented to the participants to provide the structure and guidance as necessary for the project. The presentation included full design calculations of the unit operations, design assumptions, equipment sizing and selection, expected treatment performance and financial evaluation for capital investment and operating costs. A hard copy of the example case study was provided for each of the groups. However, full freedom of design was encouraged as was the application of cleaner technologies to minimise pollution load at source.

The individual case studies were presented by the two groups on the final day of the training course. The overall outcome of the case study was considered to be very useful to the participants in combining the technical information presented during the course together with the documented information provided in the detailed course manuals and text books made available. Furthermore, much benefit was gained from the participants working together in groups and learning from each others practical experience and diverse backgrounds as was encouraged during the second week.

The group case study was considered to be of particular value to the two participants who were in the stage of considering an ETP upgrade for their tannery. Their company was in the process of evaluating a design contractors proposal for a treatment plant based on sequencing batch reactor (SBR) technology. The case study provided the information necessary to critically evaluate their given proposal and two alternative design options for the treatment plant as proposed by the group. In addition to the group case study, the BLC experts provided the additional service of evaluating the SBR design proposal, on a confidential basis, at the request of the two participants.

During the course of the second week, additional presentations were made by local experts. Prof. Zhang of Tongji University gave a detailed discussion on the principles of tannery wastewater treatment which was very useful for the less experienced participants. Mr Wu, an engineer from Xing Yuan Machinery Ltd., also gave a detailed presentation about the principles, operation and trouble shooting of the new generation of filter press unit as supplied by his company.

Ms Song also presented on the method to predict the running costs of ETP operation with practical example and calculations to illustrate for use during the group case study.

3.6. - Course Evaluation

The case study presentations by the two groups was evaluated (informally) by the UNIDO experts, local counterparts and other participants on the basis of technical and commercial viability.

Following the group presentations, the participants were each awarded signed course certificates both from the Director of the Shanghai Leather Research Institute and from the BLC Leather Technology Centre. All participants were also awarded a token gift (and a prize for the winning team) compliments of the UNIDO presenters, for taking active part in the group case study and training workshop.

The participants were asked to provide (anonymous) feedback of their comments on the training programme, contents and presentation by the UNIDO experts. Their feedback, directly translated, is included in Appendix IV.

In summary, the two week training course was considered to be very successful and of great value to the course participants representing the leather sector. The course, which covered a very broad range of subjects, provided a balance of the fundamentals, theory and practical guidance to the design, equipment selection, operation, optimisation and trouble-shooting of tannery effluent treatment plants.

A compromise had to be achieved between the detail and extend of coverage of certain topics, such as detailed process design, since the participants were mostly comprised of tannery ETP operators and environmental managers with a wide range of backgrounds and often practical experience. Therefore, a thorough introduction into the treatment technologies was made during the first three days to provide a common basis prior to the process design and case study exercises.

The flexibility offered by the presenters and the large amount of prepared course material enabled the adaptation of the training course to suit the actual needs of the participants. In particular, the group requested focus on cleaner technologies and leather specific new technologies which was presented in a number of occasions despite this being not included in the original course programme. Furthermore, the group were presented with the basic design information and process schemes for a number of international tannery ETPs to provide examples of the wider choice of technologies and treatment options as applied in both developed and developing countries.

In addition to the group presentations, the UNIDO experts also provided technical advice and support on an individual basis to many of the course participants on specific matters. This included the detailed design evaluation of a contractors' ETP proposal which was used as the basis of the group case study.

APPENDICES

Appendix I - Terms of Reference for the Sub-contractor

Appendix II - Course Programme & Contents of Training Manual

Appendix III - List of Participants and UNIDO Team

Appendix IV - Course Questionnaire and Evaluation

Appendix V - Pictures from the Training Course

20.10.1997

US/CPR/92/120
Terms of Reference for the sub-contractor to organize and carry out Training in Design and Operation of Effluent treatment plants for the Tanning Industry in the People's Republic of China

A) Background information:

The main targets of the project US/CPR/92/120, Assistance in Pollution Control and Treatment of Tannery Wastes in selected areas of China, are the introduction of cleaner leather processing technologies in tanneries, optimization of the operation of several existing large-scale tannery effluent treatment plants (ETPs and CETPs), and the strengthening of the national research and development establishments in dealing with pollution control.

Extensive specialized upgrading of the knowledge of the Chinese counterparts at the four projects sites forms an essential part of project activities, including training courses abroad. A total of 16 Chinese specialists attended a very successful one month training course in cleaner leather technologies and pollution control at BLC Leather Technology Centre, Northampton, UK in 1995.

The present training course constitutes the second leg of such training, to be conducted in the field and including practical demonstrations of actual operations of industrial tannery ETPs and CETPs.

Services to be provided:

In order to achieve the aims of the project the sub-contractor shall provide the following services:

Conduct a practical training programme on design and operation of tannery effluent treatment plants for selected participants from the leather industry and associated consulting/contracting companies in China.

This training course is scheduled for the period 24 November to 5 December 1997, and will involve both theoretical and practical in-plant training. The classroom (theoretical) training will take place at Shanghai Leather Research Institute, in Shanghai, whilst the practical in-plant training will be carried out at Shanghai Richina Leather Co. Ltd., and Dachang Effluent Treatment Plant.

1. Content of the training course:
Days 1-4: Effluent Treatment Technologies

Module I - Preliminary and *Primary Treatment Operations*

Introduction and initial considerations

- Pre-treatment processes: screening, grit & fats removal, balancing
- Chemical additions for pH control, coagulation and flocculation
- Sulphide oxidation and chrome removal methods
- Primary treatment processes for suspended solids removal by settlement and flotation, settling tank design and practical operation
- Design and selection of treatment equipment
- Common problems associated with preliminary and primary treatment

Module 2 - Secondary Biological Treatment Operations

Introduction and initial considerations

- Types of biological treatment plant (fixed film arid suspended growth)
- Design and parameters for common biological oxidation processes (activated sludge, trickling filters, oxidation ditches, lagoons, etc.)
- New biological installations and plant implication
- Operating practicalities of biological oxidation plant
- Enhanced biological treatment technologies including N & P removal

Module 3 - Tertiary Treatment Operations

Introduction and initial considerations

- Residual suspended solids removal: filtration, screening, etc.
- Disinfection technologies
- Membrane recycling technologies
- Water recycling

Module 4- Tannery Sludge Handling and Disposal

Introduction and initial considerations

- Sources, quantities and characteristics of tannery sludges
- Options for treatment, stabilization and disposal
- Thickening and dewatering technologies

Practical demonstrations: Coagulation, flocculation and chrome removal, settlement & sludge dewatering efficiency, control of biological oxidation plant.

Video presentations: Combined tannery effluent treatment plant, advanced biological processes, membrane recovery systems and water recycling.

Daily Workshops: Questions presented to delegates on topics covered

Day 5: Site Visit

Group visit to a large tannery with comprehensive effluent treatment facilities for demonstration of treatment technologies and to evaluate the plant performance. The demonstration will be undertaken in conjunction with the effluent plant managers and will be focused to any technical problems which need to be resolved. The group will be encouraged to provide relevant practical assistance and technical advice and investigate suitable options to optimize and upgrade the treatment plant.

Day 6-10: Case Studies on design and Operation of Effluent Treatment Plant

The group will be split into two equal teams of mixed disciplines to participate in the real life case studies based on two small-medium sized tanneries requiring either new or upgrade effluent treatment plants. The case studies will aim to provide full design and operational information including all calculations of the necessary unit operations, selection of equipment, P&I and general layout drawings, capital and operating cost estimations, anticipated operating performance and future options to optimize and upgrade the facilities.

The designs on each case study will be presented by the relevant team members and evaluated by the sub-contractor staff, participating tannery management and the local counterparts. It is envisaged that the information provided by these case studies will be of substantial value to the participating tanneries in obtaining a choice of design information supported by the extensive practical experience of the sub-contractor's consultants in this field.

B) The sub-contractor's team

The sub-contractor's team should be composed of the following experts:

1. Team Leader -environmental protection specialists;
2. Effluent treatment technologist; and
3. Leather Technologist with extensive experience in tannery pollution prevention and treatment (Chinese speaking an asset).

C) Time schedule

Estimated time input, for each of the team members will be as follows:

Two weeks at project area in China.
Five days, preparatory work and finalization of final report, at home base.
Total: Approxiamately two work-months.

Final report

Submission of final report, which will also include (self) evaluation of the training imparted: two weeks after completion of training course.

Appendix II -

Course Programme and Contents of Training Manual

RCE96-7-29

United Nations Industrial Development Organisation
UNIDO

February 1998

TRAINING IN DESIGN AND OPERATION OF EFFLUENT TREATMENT PLANTS FOR THE TANNING INDUSTRY IN CHINA A TWO WEEK TRAINING COURSE

TRAINING IN DESIGN AND OPERATION OF EFFLUENT TREATMENT PLANTS FOR THE TANNING INDUSTRY IN CHINA

COURSE PROGRAMME

DAY 1 :

PART A) TANNERY EFFLUENTS

Environmental Impact of Tanneries
Main Pollutants in Tannery Effluents
Pollution Limits for Discharge of Effluents

PART B) EFFLUENT TREATMENT TECHNOLOGIES

Preliminary Treatment
Primary Treatment

DAY 2 : Secondary (Biological) Treatment
Aerobic Treatment
Anaerobic Treatment
Advanced (High Rate) Processes

DAY 3 : Tertiary Treatment
Wastewater Reclamation & Re-use

Sludge Treatment and Disposal
Options for Sludge Utilisation

DAY 4 : Design of Effluent Treatment Plant and Facilities

DAY 5 : Site Visit To Tannery Effluent Treatment Plant
Performance Evaluation
Options to Optimise and Upgrade

DAYS 6-9 : Group Case Study
Effluent Treatment Plant Design and Operation

DAY 10 : Group Presentations/Evaluation

EFFLUENT TREATMENT TECHNOLOGIES AND SOLID WASTE MANAGEMENT

CONTENTS

Section 3: Tertiary Treatment Processes and Wastewater Reuse

Tertiary Treatment Processes:
- Prolonged settlement, irrigation, fine screening, sand filtration
- Disinfection
- Membrane Filtration

Wastewater Reclamation and Re-use
- Global Wastewater Reclamation Technologies
- Planning Considerations & Economics
- Tannery Wastewater Recycling

Section 4: Sludge Treatment and Disposal

Sources & Classification of Tannery Sludge

Sludge Handling & Volume Reduction
- Sludge Pumping
- Thickening
- Mechanical & Thermal Sludge Dewatering

Sludge Stabilisation
- Heat and Chemical Stabilisation
- Anaerobic & Aerobic Digestion
- Composting
- Other Options for Sludge Disposal/Re-use

Section 5: Design & Operation of Effluent Treatment Plant

Process Design Methodology

Main Facilities Design Parameters & Guidelines

Appendix III - List of Participants and UNIDO Team

Name	*Company*	*Province*	*Experience*
Ms Cui Xiu-hua	3515 Tannery	He-nan	14 years
Ms. Ding Xia	Huaxin Leather Industry Ltd.	XinJiang	8 years
Ms. Ma Yun-zhi	3513 Tannery	Shaanxi	7 years
Mr. Xu Ye-tian	Fubang Group	Zhejiang	--
Ms. Li Qing	Dachang Tannery	Shanghai	4 years
Mr. Xu Shanxing	Detaishun Tannery	Zhejiang	6 years
Mr. Dong Xusheng	Dachang Tannery	Shanghai	30 years
Ms. Zhou Jinti	Dachang Tannery	Shanghai	30 years
Ms. Ye Bingyan	Shanghai Leather Research Inst.	Shanghai	--
Mr. Song Guoyu	Jieli Tannery	Hebei	--
Mr. Yu Baoxing	Shuangjie Tannery	Zhejiang	--
Mr. Zeng Dejin	Tianyi Tannery	Zhejiang	--
Mr. Feng Yifei	Tianyi Tannery	Zhejiang	--
Mr. Li Zhengcong	Fusun County Tannery	Sichuan	--
Mr. Xie Mingcong	Fusun County Tannery	Sichuan	--
Mr. He Mingzhong	Shuangle Chemicals Ltd	Jiangsu	--
Mr. Mao Sunming	Shuangle Chemicals Ltd	Jiangsu	--
Mr. Xie Shiwei	Nanjing Tannery	Jiangsu	--
Ms. Luo Ruxin	Fudan University	Shanghai	--
Dr. Chen Xiaoyin	Fudan University	Shanghai	--
Mr. Cao Cuncang	3512 Tannery	Gansu	--
Mr. Zhang Lihui	Shanghai Leather Research Inst.	Shanghai	--
Ms. Song Xianwen	Shanghai Leather Research Inst.	Shanghai	--
Mr. Su Chaoying	China Leather Industry Assoc.	Beijing	--

UNIDO Experts :
Mr Farid Turan, Mr Jean-Marie Gigante and Mr Song Ma
(All from BLC Leather Technology Centre, Northampton, UK)

Appendix IV - Course Questionnaire and Evaluation

A: Pre-Course Questionnaire

In the first day introduction to the training course the participants were requested to list their main subject areas and topics of interest which could be incorporated during the two week training programme. The questionnaire response is as follows:

1. **Mr Xie**
   a - Tannery waste treatment technologies - sections and integrated.
   b - Discussions based on practical examples of design and operation.
   c - Combination of cleaner technologies with effluent treatment.
   d - Equipment selection and operation trouble shooting

2. **Mr Xu**
   a - Mature and new technologies on waste treatment technologies.

3. **Mr Feng**
   a - The financial implications ((investment and running costs) of operating more advanced technologies.

4. **Mr Yu**
   a - Selecting suitable ways to reduce operating costs.
   b - New and more advanced ETP technologies.

5. **Ms. Ma**
   a - Characteristics of tannery wastes.
   b - General effluent treatment technologies.
   c - Air pollution in tanneries.
   d - Reduction of water usage.
   e - Advanced (especially cleaner) tannery technologies.

6. **Ms. Ding**
   a - Recycle of lime liquors and recycle of tan liquors.
   b - Use of solid wastes from the 'wet-white' processing.
   c - Design of tannery ETPs.

7. **Ms. Luo**
   a - Recent developments of ETP.
   b - Biological treatment of tannery wastewaters.
   c - Recovery and re-use of chromium.

8. **Mr Chen**
   a - Information on design and of ETPs for tanning industry.
   b - Advanced wastewater treatment technologies.
   c - Project to design a suitable ETP for tanning industry.

B: Course Evaluation and Comments

In the final day of the training course the participants were requested to provide their critical comments on the contents, relevance and presentation method of the two week training programme. Their directly translated comments is as follows:

1) "Got more knowledge on international cleaner technologies and environmental protection technologies for tanneries. " Learned more about the design of ETPs operated overseas. (The course) enabled me to compare the design parameters used in China and internationally".

2) "I wish for a bit more of practical study."

3) "Lecturing methods very good. Presenters have excellent art for lecturing - complicated materials are presented in simple language."

4) "You encouraged our interest for studying and increased our knowledge and capability to understand."

5) "This training course is a very rare chance for me and people with knowledge about ETP to further understand ETP design and operation. The results of training are excellent. Also, it is very helpful for people without any knowledge of ETP as after only 2 weeks the trainees can now design a simple ETP."

6) "Of the many training courses I have attended, this one is the best because in this course the theories are correlated with practical situations. I have learned a lot of new things as the contents of the course are closely related to my work - many thanks."

7) "Very interested in training course of this style! - Learned a lot of new knowledge. Hope that in the future introducing of more advanced technologies in ETPs including their advantages and disadvantages."

8) "You might be able to make it even more successful if more detailed cost materials in Chinese are available - Many thanks to you three."

9) "Hoped to discuss secondary treatments in greater details in Chinese."

10) "Thanks from the bottom of my heart for the professionalism of you three and your efforts during the training course."

11) "The training course is excellent, I learned a lot of new knowledge from nothing. I hope for more similar training courses about ETP to improve for a better environment - Many thanks to experts from BLC and the Shanghai Leather Research Institute."

12) "The training course is excellent. You three are most welcome to our plant in Sichuan province."

13) "Through this training course on ETP technologies, I got the basic knowledge and processes for the treatment of leather effluents. But reaction mechanisms in different stages and the possible operational problems has been a bit less than I expected - many thanks."

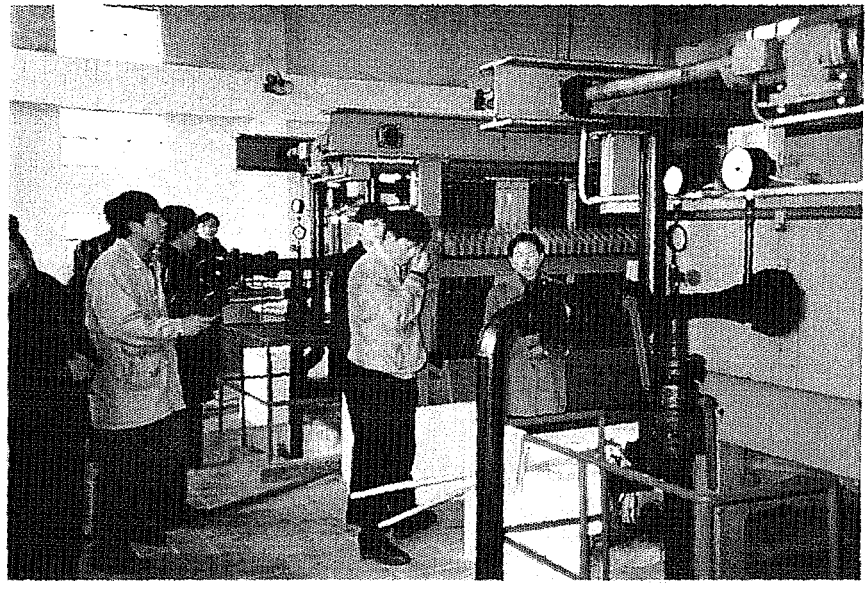
14) "I hope the clean technologies could be incorporated in tanneries because it can minimise quantity of effluent and reduce the treatment costs."

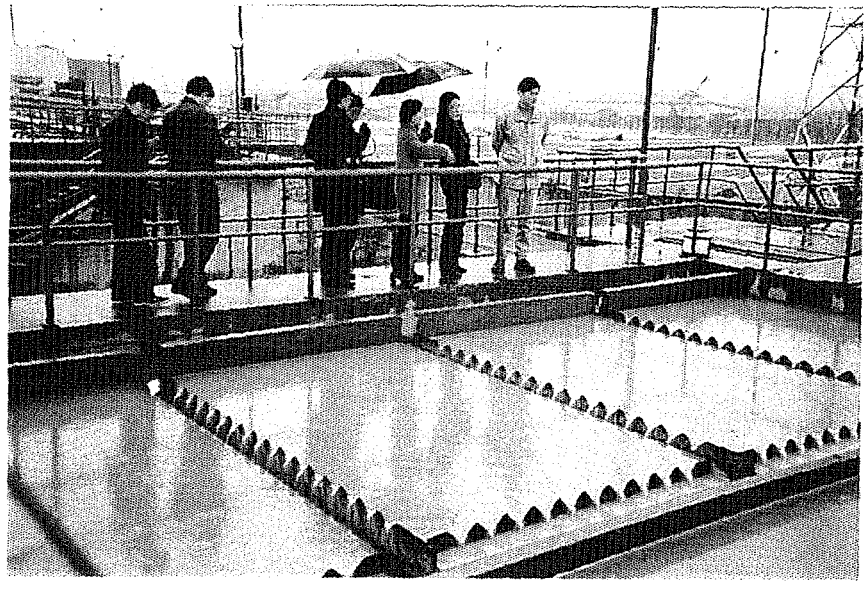
15) "This type of training course gathers colleagues from all over China - let's all work harder for a cleaner sky and cleaner water."

16) "Through the training course, I have learned a lot of new things. I was impressed by the three experts from BLC who communicated their knowledge to us without any reserve."
"Because I have benefited a lot, I hope more training course's like this will be created- This style of the training will benefit a lot of people."

Appendix V -

Pictures from the Training Course



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