Guidelines for Environmental Improvement in Leather Tannery Sector

Central Pollution Control Board
Parivesh Bhawan, East Arjun Nagar
Delhi - 110 032

March 2019

Blank page

Contents

Blank page

1. Preamble

Central Pollution Control Board (CPCB) proposes to issue following guidelines for environmental improvement in leather tannery sector for providing guidance to the industries, industrial associations, State Pollution Control Board (SPCBs) and Pollution Control Committee (PCCs) for effective prevention and control of pollution and safeguarding the environment.

Present draft guidelines are being issued for seeking comments and suggestions for improving the guidelines before they are finalised by CPCB and released for application from March 01, 2019.

Any person interested in making any objection or suggestions on the proposals contained in the draft guidelines may forward the same in writing, for consideration of CPCB within 30 days from the date of placing the guidelines on CPCB website, to the Divisional Head, Pollution Control Implementation Division IV, Central Pollution Control Board, Parivesh Bhawan, East Arjun Nagar, Delhi 110032.

2. Introduction

Leather tannery sector has been categorised as one of the 17 categories of highly polluting industries by Central Pollution Control Board. There are a large number of small, micro and medium sized tannery units operating in India. The process operations in these units are highly polluting in nature.

In Schedule-I of the Environment (Protection) Rules, 1986, at serial number (16), standards for discharge of effluents from leather tannery sector have been specified. Further, the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, vide notification No. G.S.R. 730(E), dated 1st August 2018 issued revised standards for discharge of effluents from tannery industry under the Environment (Protection) Amendment Rules, 2018.

The Government of India launched the Charter on "Corporate Responsibility for Environmental Protection (CREP)" in March 2003 for tannery sector with the purpose of going beyond the compliance of regulatory norms for prevention & control of pollution through various measures including waste minimisation, in-plant process control & adoption of clean technologies. The Charter has set targets concerning conservation of water, energy, recovery of chemicals, reduction in pollution, elimination of toxic pollutants, process & management of residues that are required to be disposed off in an environmentally sound manner.

To address the pollution problems in the leather tanning sector, MoEFCC comprehended the concept of pollution prevention through cleaner production and waste minimisation and promoted the establishment of waste minimization circles in clusters of small and medium sized tannery units located in different parts of the country. These circles facilitated the tannery units in conducting a detailed waste audit of the process operations both with the available expertise within the unit as also with the help of the external facilitators provided by the Government of India. This has led to the identification of measures and options for waste minimization that are implementable in an economically viable manner. The implementation of these measures by the respective units has resulted in quantifiable economic and environmental benefits.

Due to pollution potential by leather tannery industries and negative impacts that may or likely to be caused on riverine systems, water bodies and the receiving environment, it has become imperative to make guidelines for prevention and control of pollution. In addition to compliance with the stipulated standards for waste water discharge and air emissions from leather tannery sector, there is a need to have a holistic approach for containing environmental pollution.

Now, therefore, CPCB has developed these draft guidelines for environmental improvement in leather tannery sector.

3. Applicability of the Guidelines

a) General applicability

These guidelines are applicable to all categories of leather tannery industry, including micro, small, medium and large-scale industries.

b) Legal status

These guidelines are not part of the Schedule I of the Environment (Protection) Rules, 1986 or amendments made thereunder. These guidelines are prepared by CPCB as a part of its functions under the Water Act, 1974 for publishing measures for effective prevention and control of pollution, and preparation of guides and providing technical assistance to SPCBs / PCCs.

c) Relevance to CPCB

CPCB will use these guidelines for conducting awareness and training programmes to industries, SPCBs/PCCs etc. so as to promote improved environmental performance in the tannery sector.

CPCB will monitor progress of the application of the guidelines with regard to reduced pollution levels and risks/impacts to environment.

d) Relevance to SPCBs/PCCs

SPCBs/PCCs may widely disseminate the guidelines to tannery industries and encourage them to adopt these guidelines voluntarily so as to attain improved environmental performance.

While issuing consent to establish or consent to operate, the SPCBs/PCCs may discuss with the applicant (leather tannery) industry and bring some or all of the conditions into such a consent for implementation in a phased manner based on a mutual agreement between the industry and the SPCB/PCC. The minutes of such discussions and decisions should be kept in record by the SPCB/PCC. Prescription of any points from these guidelines will be purely on mutual agreement between the leather tannery industry and the SPCB/PCC.

The SPCBs/PCCs may bring in incentive mechanisms for the leather tannery industry that are applying the present guidelines and have progressively achieved environmental improvements. The incentives could be for example in the form of extending the validity of the consent duration.

The SPCBs/PCCs may also advise the State Governments/Union Territories to introduce funding schemes for implementation of measures by the industry beyond the statutory requirements and for introducing award/recognition system for best performing industries including some tax holidays.

e) Relevance to the industry

The leather tannery industry may use the present guidelines for achieving environmental improvement to ensure better compliance with the statutory requirements as well to go well beyond statutory requirements so as to benefit from resource efficiency, reduced pollution and negative impacts and the ensuing reduced litigation risks, and from improved house-keeping as well as health & safety of its employees.

f) Relevance to the industrial associations

The industrial associations of the leather tannery industry could use these guidelines to promote their usage and application for the benefit of the industry. The guidelines will also be helpful for defining criteria for introducing awards for best performing industries.

4. Definitions

i) Beamhouse/Limeyard: That portion of the tannery where the hides are soaked, limed, fleshed, and unhaired, when necessary, prior to the tanning process.

ii) Existing plant: A plant existing at the time of release of these guidelines.

iii) Existing processing vessel: A processing vessel that is not a new processing vessel.

iv) New plant: A plant first operated at the installation following the publication of rules or a complete replacement of a plant on the existing foundations of the installation following the publication of these rules.

v) New processing vessel: A processing vessel first operated at the plant following the publication of these rules or a complete rebuild of a processing vessel following the publication of these rules.

vi) Tannery: An installation that carries out the activity 'Tanning of hides and skins'.

vii) Tanyard: The part of the tannery where the processes of pickling and tanning are carried out.

viii) Intermediate product: All kinds of semi-finished products, produced in a tannery, with the intended use for leather production. For example: Wet-Blue, Wet-White, Crust, Split etc.

5. Environmental Management System

To improve the overall environmental performance, the leather tannery industries shall develop and implement a comprehensive Environmental Management System (EMS) that incorporates all of the following features:

a) Establish a clearly defined environmental management system that includes the organisational structure, plans and resources for developing, implementing and maintaining measures or environmental protection. Plan and establish the necessary procedures, objectives and targets for environmental management, in conjunction with financial planning and investment. The industries are encouraged to apply an environmental management system such as ISO 14001, which is an internationally accepted standard designed to help businesses remain commercially successful without overlooking environmental responsibilities and impacts and to help grow sustainably while reducing the environmental impact of this growth by adopting cleaner technologies.

b) Bring out an environmental policy that clearly demonstrates the commitment of the industry, its senior management and personnel for compliance with environmental laws and regulations, ensuring prevention and control of pollution, and ensuring that there are no negative impacts to the environment and its resources.

c) Implement environmental management procedures paying particular attention to:

   i) Organisational structure for environmental management and responsibilities.
   ii) Capacity building of the environmental management personnel, including training and awareness development.
   iii) Prevention and control of pollution, waste management, wastewater management, efficient product ion processes and resource (energy, water, materials) efficiency.
   iv) Emergency preparedness and response.
   v) Maintenance programmes.
   vi) Monitoring, documentation and reporting.
   vii) Compliance with environmental laws and regulations.

d) Check the environmental performance of the industry regularly and take necessary corrective actions in time. The industries shall pay particular attention to the following:

   i) Monitoring and measurement for verification of environmental compliance and any negative environmental impacts.
   ii) Corrective and preventive actions.
   iii) Maintenance of records.
   iv) Where practicable, independent internal and external auditing to determine whether or not the EMS conforms to the planned arrangements and has been properly implemented and maintained.

e) The senior management of the industry shall on a half yearly basis review the EMS and its continuing suitability, adequacy and effectiveness, and if necessary, make changes to the EMS.

f) Preparation of annual environmental statements in Form V of the Environment Audit Notification 1992 [issued on 13th March 1992; amended vide notification GSR 386 (E), dated 22 April 1993] and its submission to the concerned state pollution control boards/pollution control committees and evolve and apply intra-sectoral bench marking on a regular basis.

g) If decommissioning is undertaken in the plant, maintain records of the locations of the sites and of the process steps that were carried out for site restoration.

The industry shall make available its EMS for inspection by the regulatory agencies.

6. Good Housekeeping

The principles of good housekeeping shall be practised by applying the following techniques in combination:

a) Careful selection and control of substances and raw materials including quality of raw hides/skins and quality of chemicals used.
b) Input-output analysis with a chemical inventory including quantities and toxicological parameters.
c) Minimisation of the use of chemicals to the minimum level required by the quality specifications of the final product.
d) Careful handling and storage of raw materials and finished products to reduce spills, accidents and water wastage.
e) Segregation of waste streams, where practicable, to allow for the recycling of certain waste streams.
f) Monitoring of critical process parameters to ensure the stability of the production process.
g) Regular maintenance of the pollution control systems for the treatment of effluents.
h) Review of options for the reuse of process/washing water and their application.
i) Review of waste disposal options and their application.
j) Traffic rules inside the tannery (for pedestrians, forklifts, trucks etc.).
k) Maintenance of machines/equipment.
l) Process control for temperature, pH and water quantities.
m) Calibration of equipment used in production and laboratory.
n) Clean and tidy working area in the factory premises including the production areas and wastewater treatment plant.

7. Waste Minimisation Measures

Systematic implementation of the waste minimisation measures in tannery sector can provide a viable solution to the environmental problems faced by the tanners as well as assist the tanners in improving their profitability. The following measures should be taken:

a) All the tanneries shall install water meters and flow meters to measure actual consumption and waste water discharged. Water consumption rates shall be brought down to less than the prescribed limits per tonne of hides by taking water conservation measures.

b) Process-wise, some of the waste minimisation measures to be adopted by the tannery units include the following:

i) Soaking: The waste minimisation measures for reducing water consumption inter-alia include:

- Use of counter current system of washing to concentrate the salt and other soluble materials such as dirt and blood.
- Reuse of the 2nd main soak for dirt soak: Soaking consists of dirt soak and main soak. The main soak is retained and used for dirt soak for the following batch.
- Reuse of dirt soak: The dirt soak liquor may be collected and added polyelectrolyte to flocculate and settle the suspended solids. Soak liquor thus treated and filtered can be reused partially in liming, deliming washes and pickling.
- Drum soaking instead of pit soaking: This will not only reduce water consumption but will also bring down the soaking time from 12 hrs to 3 hrs. This will enable the tanners to construct solar evaporation pond in less area thereby using the open land for more productive use.
- Addition of soaking enzymes: Soaking enzymes are added to achieve uniform and thorough soaking. Further, to improve the treatability of waste water, regular wetting agent should be substituted with biodegradable wetting agents.
- Stop "open washing systems" in drum washing. Use batch systems only. Batch washing involves washing of hides and skins during processing by introducing the required quantity of clean water into the processing vessel and using the action of the vessel to achieve the required agitation as opposed to running water washes which use the inflow and outflow of large quantities of water.

ii) Liming: The following measures shall be adopted to optimise chemical consumption in this process step. These include:

- Substitution of paste lime by 85% pure calcium hydroxide [Ca(OH)!]: This will bring down the quantity of consumption of powdered lime to one third of its original quantity. lt will also reduce the frequency of cleaning the primary settling tanks which consisted mainly of the lime sludge.
- Use of liming enzymes: Use of liming enzymes will reduce Sodium sulphide (NaS) consumption by 40%.
- Provision of a slight slope in the pasting area: By providing a slight slope in the pasting area the excess liming paste can be effectively collected and used which is otherwise washed away in the drain by lime yard workers.
- Reuse of relime liquor: 50% of relime liquor can be retained and reused for liming of subsequent batches. This will also reduce water consumption in liming.

In addition to optimisation of the chemical consumption in liming section, fleshings can be used to produce biogas, gelatine, glue and also high-grade protein. This will solve the problem of solid waste disposal from the liming section.

iii) Deliming: Efforts should be made to reduce the water consumption in this section process by implementing the following measures:

- Use of deliming agents such as ammonium chloride/ ammonium sulphide.
- Use of 2nd delime wash for liming.
- Reduce the use of ammonium by the injection of carbon dioxide gas (mainly applicable for large tanneries and /or the use of other substitutes deliming agents

iv) Pickling: In this process, the following measures should be adopted to reduce salt consumption:

a. Use of drained float for next batch or go directly to tanning.
b. Controlling pickle liquor to 6° - 7° to optimise use of sodium chloride (NaCl).

v) Chrome tanning: The following measures should be adopted to recover chrome from chrome tanning process, if it is applicable for the tannery. It may be restricted by the need to produce leather properties which meat the customer requirement in particular related to dyeing (reduced fastnesss and less brightness of colours) and fogging.

a. Collection of spent chrome liquor after basification and recovery of chrome from the same. The recovered chrome can be used along with regular Basic Chrome Sulphate (BCS) for chrome tanning.

vi) Dyeing: The waste minimization measures under this process include the following:

a. Use of soft water for dyeing process to reduce the dye consumption as well as syntans consumption, in case, the fresh water quantity is not good enough (hardness).
b. Use of automated water dosing systems.

8. Clean Technologies

Clean technologies refer to any technique/process/ method of producing a product or rendering of a service that reduces negative environmental impact and engenders reduction in energy requirement or efficient use of the resources. These are associated with alternative process inputs or methods or recycling and reuse methods resulting in reduced environmental impact and enhanced process efficiency. Clean technologies should be adopted such as the following:

a) Soaking: Salt free preservation and soak liquor management

As much as 40% w/w of common salt is used for preservation of hides and skins. In India, about 1 million kg of salt is used every day for preservation of animal hides and skins. Conventionally, the hides and skins are applied with salt as soon as they are removed from the animals. Re-salting is done after couple of days. The hides and skins contain about 8% w/w of surface salt and about 15% of salt within the skin/hide matrix. The surface salt is generally removed through desalting. The salt that is present in the skin/hide matrix is removed during dirt soaking and main soaking. Because of the removal of common salt during soaking, the soak liquor has high levels of Total Dissolved Solids (TDS) and Chloride (Cl^-). Salting method of preservation is one of the major contributors for the TDS load in tannery wastewater, more than 40% of TDS load come only from the salt used for preservation. Hence it is important to resort to preservation methods that are not associated with the use of salt.

- **Preservation through chilling: Outline of the technology and environmental benefits**

There are many salt-free techniques reported. Chilling is one of the salt-free techniques, which was validated at semi-commercial scale. According to this technology, the hides are blast chilled at 5^0C within an hour of flaying. The chilled hides may be transported to tannery in mobile chiller or chiller trucks. In tanneries, either the raw hides can be processed after thawing or can be stored for a week in cold storage. The chilled hides are easily amenable for soaking. The quality of the leathers produced was found to be similar to the leathers made conventionally. Soak liquor may be treated easily and will not contain significant level of TDS and Cl^-. This technology necessitates chiller, chiller truck and cold storage.

The capital cost of chilling facility for 5 tons/day) is about Rs 60 lakhs and the operating cost for energy is about Rs 1,500 pr day. Chilling is suitable for all kinds of skins and hides. Nevertheless, the capital cost of the technology is prohibiting its wide spread usage.

- **Preservation using an eco-benign formulation: Outline of the technology and environmental benefits**

An eco-benign chemical formulation developed by CSIR-CLRI has been found to be efficacious in preservation of skins for about a month and hides for about ten days. The hides and skins are dipped for about 30 minutes, folded and transported to tanneries. The preservation is carried out under ambient conditions and the moisture level of the hides or skins is not reduced. Soaking and rehydration of the preserved hides and skins is not difficult. The quality of the leathers is comparable to that of the conventionally preserved hides and skins. Salt can be eliminated totally. Therefore, the soak liquor will not contain salt. There is no or negligible capital requirement for practicing this technology.

The cost of chemical and labor for application for 5 tons of hides is about Rs. 24,500 per day. The eco-benign chemical formulation is suitable for all kinds of skins and hides. For hides, a mechanical intervention may be required for effective preservation leading to a small investment cost. Further, the chemical cost of the technology is prohibiting its wide spread usage.

- **Recovery of salt from soak liquor: Outline of the technology and environmental benefits**

If salt-free preservation could not be opted, then the soak liquor needs to be treated and recovery of salt has to be done. The chloride bearing soak liquor may be treated by employing electro-oxidation for the removal of organics. Once all the organic matter present in the soak liquor is degraded through electro-oxidation, the remaining TDS component will be primarily salt, which could be recovered by evaporation of the treated soak liquor using multiple-effect evaporator.

The capital cost for 5 tons of hide/day or 30 m^3/day of soak liquor is about Rs 44 lakhs. The operating cost for evaporating 30 m^3 of soak liquor/day is Rs. 48, 000 per day. This technology is suitable for individual tanning industries processing all kinds of skins and hides. However, the cost of the technology is one of the limiting factor for its wide spread usage.

b) Liming: Sulfide minimization and lime liquor management

Liming is carried out to remove the epidermis and hair from the hides and skins and to remove the adipose layer and fat. Liming also brings about the requisite degree of opening up of the fiber network of hides and skins. The conventional liming process employs 3-4% sodium sulfide and the hair is destroyed leading to significant BOD, COD and sulphide emission. The presence of sulphide in effluent treatment plant poses a threat of liberation of hydrogen sulphide (H_2S) gas.

Enzyme assisted unhairing may be practiced to minimize the sulfide load in wastewater. According to the recommended process, liming may be carried out in drums or following the dip and pile method. About 0.1 to 1% of enzyme (depending on the activity of enzyme), 2% lime and 1% sulfide may be used for complete hair removal. For drum liming, about 40% water and for dip and pile method about 40% of water may be used. Therefore, the wastewater will be very less from the liming. The loosened hair is removed manually or using a machine in the case of dip and pile method and recovered using a hair filtration/screen in drum method. The collected waste stream may be mixed along with the subsequent bath for reliming, in which the float may be 200 to 300%. To this, about 3% of lime and 0.5% of sodium carbonate may be added. This wastewater may be recycled continuously after aging the same for 2 days. During aging, the proteins and lipids present in the stored lime liquor will be degraded and this waste stream can be reused continuously without discharging the wastewater. Hair can be collected as solid. Thus, the waste streams from liming and reliming will not be discharged. The quality of the pelts processed using the proposed method would result in the leathers that are comparable to the conventionally processed leathers.

Cost of the enzyme assisted less lime and sulfide based unhairing and reuse of old lime liquor technology depends on the cost and activity of the enzyme product. Most of the enzyme products are fairly expensive and exceeds the cost of the conventional chemical based unhairing technology. Normally, it is offset by the increased area and value realization of the final leather. However, there

are enzyme products which can lead to comparable cost to that of conventional chemical based unhairing technique.

The cost of enzyme based low lime and sulfide unhairing for 5 tons of hides/day is about Rs. 8875/day. The cost of conventional lime-sulfide unhairing for 5 tons of hides/day is about Rs. 8500/day. This technology is suitable for all kinds of skins and hides. Requirement of strict process control is one of the limiting factor for its wide spread usage.

c) Deliming: Management of deliming liquor

Deliming is carried out to remove the alkali present in the pelt that was used during liming. Deliming is a three-step process comprised of initial washing to remove free alkali, deliming to remove the combined alkali and final washing to remove the products of deliming. Commonly ammonium sulfate or ammonium chloride is used. The waste streams of deliming contain calcium chloride or calcium sulfate having TDS between 1500 to 4000 mg/L. It does not contain any dangerous pollutant. The BOD of deliming streams is about 3000 mg/L indicating the presence of proteins and lipids emanated from the pelt. Therefore, if the organic matters are removed from the deliming streams, it can be safely reused for soaking. The deliming streams including the washing wastewater may be subjected to electro-oxidation and reused for soaking. Through this technique, the deliming streams will not be discharged. The quality of leathers is not affected negatively.

The capital cost for 5 tons of hide/day or 22 m^3/day of delime liquor for Electro-oxidation (EO) plant is about Rs. 12 lakhs. The operating cost per day including maintenance is about Rs. 2,600. This technology is suitable for individual tanneries processing all kinds of skins and hides. There are no major limiting factors for adopting this technology.

d) Pickling and chrome tanning: Management of pickling liquor and chrome liquor

Waste streams from pickling and chrome tanning may be managed through (a) recycling of pickling liquor and chrome recovery and reuse or (b) waterless chrome tanning. If waterless chrome tanning is opted, then pickling is not carried out and no wastewater is generated from chrome tanning. If conventional pickling and chrome tanning is resorted to, then recycling of pickling liquor and chrome recovery and reuse may be practiced.

- **Waterless chrome tanning: Outline of the technology and environmental benefits**

Waterless chrome tanning is the new technology developed by CSIR-CLRI. This technology provides comprehensive solution to the environmental issues caused by pickling, chrome tanning and basification. According to this technology, pickling is not carried out. And therefore, salt and sulfuric acid are not used. Chrome tanning is carried out without water. Although the penetration of chromium may take slightly more duration than it is needed during conventional tanning, the total duration of conventional pickling, chrome tanning and basification is reduced by at least 10%. The leathers are found to be of better fullness. Chromium content of the wetblue is more. As maximum chromium uptake is possible, offer of chromium can be reduced. And there is no necessity to carry out rechroming. And as there is no discharge from chrome tanning, therefore chromium recovery and reuse need not be followed. As the physico-chemical characteristics of the wetblue are different from the conventional wetblue, the wet-finishing process needs to be modified accordingly. As stated, no waste streams of pickling and chrome tanning will be discharged if waterless chrome tanning is practiced. As an outcome, the overall TDS load could be reduced by 25% and no discharge of chrome wastewater and savings due to the reduction in the use of chrome tanning agents. This technology has been commercially demonstrated and the technology is licensed to about 60 units in India.

The operational cost of waterless chrome tanning for 5 tons of hides/day is about Rs. 22,250 per day, while the operational cost of conventional picking and Cr tanning process for 5 tons of hides/day is about Rs 32,700 per day. The cost saving due to waterless chrome tanning is about Rs. 10,450 per day. This technology is suitable for individual tanning units processing all kinds of skins and hides.

There are no major limiting factors for adopting this technology.

- **Reuse of pickling liquor, Chrome recovery and reuse: Outline of the technology and environmental benefits**

If waterless chrome tanning is not opted, then conventional pickling followed by conventional chrome tanning needs to be carried out. The pickling wastewater may be managed through continuous reuse. Pickling wastewater contains common salt, little amount of sulfuric acid, unwanted protein matters and fat. Presence of proteins and fat deters the reuse of pickling liquor. Pickling liquor may be subjected to electro-oxidation and the treated wastewater will not contain protein and fat. Therefore, it can be reused. This recycling can be carried out continuously. The chrome liquor generated from the conventional chrome tanning process needs to be managed through chromium recovery and reuse. About 2000 to 5000 mg/L of Cr is present in the chrome liquor. Chromium is precipitated using magnesium oxide and the precipitate (chromium hydroxide) is dissolved in sulfuric acid to regenerate basic chromium sulfate, which can be used for chrome tanning process along with fresh chromium salt.

For reuse of pickling liquor, the capital cost for 5 tons of hide/day or 5 m^3/day of pickle liquor through electro-oxidation (EO) plant is about Rs. 6 lakhs. The operating cost of EO plant and maintenance is about Rs. 500 per day.

For chrome recovery and reuse, the capital cost for 5 tons of hide/day or 5 m^3/day of pickle liquor through Cr recovery plant is about Rs. 6 lakhs. The operating cost for 5 m^3 of pickling **liquor/day is about** Rs. 2,000, while the value of Cr recovered is about Rs. 1,250. This technology is suitable for all kinds of skins and hides. Requirement of strict process control is one of the limiting factor for its wide spread usage. Another major limitation of chrome recovery and reuse is the presence of magnesium salt in the recovered chromium, which may cause quality non-conformance. Also, the high-TDS supernatant from chromium recovery needs to be disposed securely.

e) Post tanning: Management of post tanning liquor containing dyes, syntans and fatliquor

In post-tanning, bulk properties such as fullness, softness and color are imparted to the tanned leathers using syntans/re-tanning agents, fatliquors and dyes, respectively. The waste streams of post tanning contain un-utilized syntans, fatliquors, dyes and neutral salts thereby having COD between 3000 to 7000 mg/L. Therefore, if the organic matters are removed from the post tanning streams, it can be safely reused for next cycle of post tanning. Hence, the post tanning streams including the washing wastewater may be subjected to electro-oxidation and reused for the next batch of post tanning. Through this technique, the post tanning streams will not be discharged. The quality of leathers is not affected negatively.

The capital cost for 5 tons of hide/day or 20 m^3/day of wet finishing liquor through Electro-oxidation (EO) plant is about Rs. 12 lakhs. The operating cost for treating 20 m^3 of wet finishing liquor/day is about Rs. 1,500. This technology is suitable for individual tanning units processing all kinds of skins and hides. There are no major limiting factors for adopting this technology.

f) Other generic measures

Apart from the aforesaid technologies, other generic measures that may be followed for reducing pollution load and hydraulic volume are:

- desalting (in the case of salted hides),
- segregation of hair after hair-saving unhairing using hair filtration unit,
- use of high purity lime,
- drum unhairing over pit method,
- high exhaust and restricted substances free post-tanning chemicals,
- replacing the toxic organic solvent with water or low toxic solvent,

- replacement of toxic cross-linkers like formaldehyde with polyaziridines,
- employment of improved coating techniques like High Volume Low Pressure (HVLP) where the material waste is less than 30%,
- use of water flow meters, and
- Low salt or liquid syntas and dyes.

9. Chemical Storage & Handling and Restricted Substances

- The following measures shall be taken for chemicals storage and handling, and for restricted substances as per the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 as amended to date:

- Study and identify chemical hazards using material safety data sheets (MSDS).

- A written chemicals management policy shall be prepared. Safety data sheets shall be available in English and local language for all chemicals.

- The chemical management policy shall be communicated effectively to the facility staff and to the suppliers.

- All of the process chemicals, which are used and stored within the tannery shall be listed in an inventory list, and hazardous and flammable chemicals shall be clearly marked.

- Chemical suppliers shall be registered based on declarations that no restricted substances as per the applicable Indian laws are in their supplies/chemicals.

- A formal set of procedures, addressing chemical emergencies, shall be made available.

- Incoming part processed raw material (wet-blue, wet-white, crust) hall be obtained from tanneries that have documented commitments to compliance.

- A risk assessment of incoming chemicals shall be done to identify potential contamination prior to storage.

- A written chemical safe handling/storage plan shall be made available to ensure that storage and handling of chemicals is in accordance with the applicable laws.

- Storage of all chemicals shall be done as per safety rules, for example: no acid beside an alkali; no Na2S or NaHS beside or below any acid chemicals; no storage of flammable chemicals with hazardous chemicals in the same room; flammable chemicals should be stored in a separate sate room (fan, explosive protection measures; special fire-fighting equipment etc.).

- Safety training for all employees that store and handle chemicals shall be given from external consultants/chemical suppliers or a dedicated internal environmental and/or safety manager.

10. Cr-recovery

a) Recovery of chromium for reuse in the tannery: All the chrome tanning units will install chrome recovery plant either on an individual basis or on a collective basis in the form of chrome recovery plant and use the recovered chrome in the tanning process. Re-solution of the chromium precipitated from the tanning float, using sulphuric acid for use as a partial substitute for fresh chromium salts.

   Applicability is restricted by the need to produce leather properties which meet customers specification, in particular, related to dyeing (reduced fastness and less brightness of colours) and fogging.

b) Recovery of chromium for reuse in another industry: Use of the chromium sludge as a raw material by another industry. Applies only where an industrial user for the recovered waste can be found.

11. Management of Chromium VI

The measures as given below shall be taken by the leather tannery industry for the management of Chromium VI. The elimination or avoidance of Cr (VI) formation in leathers exposed to heat and/or UV radiation must be an overall concept rather than a one-step remedy. All measures during the post-tanning operations must be considered together and the overall process must be controlled to achieve satisfactory results.

a) Incoming chemicals:

i) Ensure that all relevant incoming chromium containing chemicals (chrome tanning salts, dyes and pigments) contain less than 10 ppm Cr (VI) (chemical industry standard of ISO 19071:2016).

ii) The use of pigments mainly yellow, orange and red colours that may contain Cr (VI) shall be avoided and undertake risk analysis before using.

b) In-house tanning and preparation processes:

i) Strong oxidising agents such as peroxides and permanganates (if used) are unlikely to contribute to the formation of Cr (VI) (Simple tests for oxidising agents are starch-iodide papers and ferrous chloride solution).

ii) pH at the end of the in-house chrome tanning process shall be between 3.5 to 4.5.

iii) If oxidising agents are used prior to application of chrome tanning agent: they shall be reduced prior to addition of chrome tanning agents.

c) Re-tanning:

i) Wash the re-tanned leather with a suitable complex active surfactant. Hydrophobic leather production presents a problem by using surfactants. After fixation of the special hydrophobing fat-liquor, the recommended pH is 4.0-4.2.

ii) Homogeneous neutralisation to pH levels not higher than 5.0 is recommended. Using a 'reducing' neutralisation agent will also reduce Cr (VI) formation.

iii) 'Free radical capturing' is suitable to reduce the potential of the oxidation reaction in fat liquors for reducing Cr (VI) formation.

iv) Avoid especially unprotected sulphited fish oils which means, fat liquors should be produced using the concept of free radical capturing.

- pH should never exceed 6.5 al any part of the process following chrome tanning (retanning).

- Use scavenging agents (anti-oxidants; veg. retanning agent) as a precautionary measure to prevent the formation of Cr (Vl): At least 2% pyrogallic based mimosa or tara (based on the shaved weight (45 min.). In case of garment or upholstery leathers such an addition adversely influences the final characteristics of the finished leather. This can be worsening for double face production.

- A final washing with reducing salts, especially with Na2S20s or Na2S03, decreases the

likelihood of Cr (VI) formation, but have a limited reduction potential in case they are washed out too much. Use 2% Na S20s/30 min. just after the acid fixation.

- Finishing: monitor/control temperature at key stages (embossing, plating, drying tunnels, vacuum driers) to ensure excessive heat is not a contributory factor to possible Cr (VI) formation.

12. Solid Waste Management

a) The practice of reuse - recycling - disposal shall be followed and documented.

b) Guidelines regarding the identification, collection, storage and disposal of hazardous and non-hazardous waste shall be followed.

c) Yearly records of the type and quantity of hazardous, non-hazardous waste, by-product and part-product for collection and disposal shall be prepared and made available.

d) Manifests/receipts of the collection, transport, disposal of waste shall be kept for record.

e) Cr-containing waste should not be incinerated on site.

f) On-site storage arrangements for waste shall be: correctly marked,
   - adequately segregated,
   - bounded and soil-protected locations of storage areas, and
   - good condition sealed containers, with no spillage (e.g. in jacketed tanks).

g) Use of residues as by-product: To limit the quantities of wastes sent for disposal, take necessary actions to dispose the process residues as by-products which include the following:

Process Residue	Uses as a By-product
Hair and wool	• Filling material • Wool textiles
Limed trimmings	• Collagen production
Untanned splits	• Processed to leather • Production of sausage casings • Collagen production • Dog chews
Tanned splits and trimmings	• Finished for use in patchwork, small leather goods, etc. • Collagen production

h) Waste re-use, recycle and recovery: To limit the quantities of wastes sent for disposal, organize operations on the site to facilitate waste reuse, or failing that, waste recycling, or failing that, 'other recovery' which include the following:

Waste	Reuse After Preparation	Recycling	Other Recovery
Hair and wool	• Manufacture of protein	• Fertiliser	• Energy recovery
Raw trimmings	-	• Hide glue	• Energy recovery
Limed trimmings	• Tallow • Manufacture of technical gelatine	• Hide glue	-
Fleshings	• Manufacture of protein hydrolysate • Tallow	• Hide glue	• Production of substitute fuel • Energy recovery

Untanned splits	• Manufacture of technical gelatine • Manufacture of protein hydrolysate	• Hide glue	• Energy recovery
Tanned splits and trimmings	• Leather fibreboard production from non-finished trimmings • Manufacture of protein hydrolysate	-	• Energy recovery
Tanned shavings	• Leather fibreboard production • Manufacture of protein hydrolysate	-	• Energy recovery
Sludges from waste water treatment	-	-	• Energy recovery
Salts from solar evaporation	Reuse of recovered salts	-	-

i) Lime spliting: To reduce the chemical consumption and reduce the amount of leather waste containing chromium-tanning agents sent for disposal, use lime splitting.

- Description: Carrying out the splitting operation at an earlier stage of processing, to produce an untanned by-product.
- Applicability: Applies only to plants using chromium tanning.
- Not applicable:
  - when hides or skins are being processed for full substance (i.e. unsplit) products,
  - when a firmer leather must be produced (e.g. shoe leather),
  - when a more unifom1 thickness is needed in the final product, and
  - where tanned splits are produced as product or co-product.

j) Chrome recovery: To reduce the amount of chromium in sludge sent for disposal, use one or a combination of the techniques given below.

Technique		**Description**	**Applicability**
1	Recovery of chromium for reuse in the tannery	Re-solution of the chromium precipitated from the tanning float, using sulphuric acid for use as a partial substitute for fresh chromium salts.	Applicability is restricted by the need to produce leather properties which meet customers' specification related to dyeing (reduced fastness and less brightness of colours) and fogging.
2	Recovery of chromium for reuse in another	Use of the chromium sludge as a raw material by another industry.	Applies only where an industrial user for the recovered waste can be found.

k) ln order to reduce energy, chemical and handling capacity requirements of sludge for its subsequent treatment, reduce the water content of sludge by using sludge dewatering.

- Applicability: Applies to all plants carrying out wet processing.

l) Proven processes for utilization of process solid wastes and waste generated during treatment of tannery wastewater are given in table below.

Treatment Process/ Technology	Environmental benefits	Limitations
Co-digestion for biogas generation	Biogas, wealth from waste	Best suited for tropical conditions

13. Air Emission Treatment - Preventive Maintenance Programmes for All Air Emission Treatments Need to be Available

a) Boiler dust emission especially for wood, renewables or coal fired boilers need dust treatment emissions like cyclones or similar.

b) Spray machine need to be equipped with water wash and I or activated carbon treatment or equal. Ensure that protection windows in the spray nozzle cabin are closed to protect the staff from VOC emission.

c) List all liquid finishing chemicals with the percentage of the organic solvent content (VOC) of each chemical and counted per unit of leather produced.

d) Hand spray booth is equipped with water-wash or activated carbon system or equal.

e) Weighing of powder dyestuff on a scale-weight with an exhaust system.

f) Buffing/De-dusting machines with dust exhausting systems, dust bag filters and dust cake pressing.

g) To reduce air-borne emissions of VOCs from finishing, use one or a combination of the techniques given below:

- The use of water-borne coating in combination with an efficient application system.
- The use of extractive ventilation and abatement systems.
- PU coating systems need special air treatment like internal incineration system or activated carbon filter.The activated carbon filters must be maintained and changed in time.

h) H2S emission in beam house (liming/de-liming) and chemical storage/handling of NaHS and Na2S need special H2S monitoring systems (online or moveable metering systems with alarm function).

- Applicability: applies to all plants carrying out raw to finished leather processing.

14. **Control of odour and gaseous emission in tannery**

Gaseous emissions such as H_2S, NH_3 and VOC are released during the pre-tanning operations of leather processing, thereby causing bad odor.

The odor-causing gas stream can be collected through piping and ventilation system and made available for treatment. An array of treatment technologies is available for control of odor from gas streams collected through process ventilation systems. These include:

- Mist filtration
- Chemical scrubbing
- Catalytic oxidation
- Thermal oxidation/ Incineration
- Regenerative incineration

- Activated sludge diffusion tank
- Adsorption
- Bio-scrubbing
- Bio-filtration
- Green belt development etc.

15. Reduction of Emissions in Waste Water

a) Reduction of pollution load in waste water from beam-house process steps: In order to reduce the pollutant load in the waste water before effluent treatment arising from the beam- house process steps, appropriate combination of the techniques given below shall be used.

No.	Technique	Description	Applicability
1	The use of short floats	Short floats reduce amounts of process water. When less water is present, the quantity of process chemicals which are discarded unreacted, is reduced.	The technique cannot be applied for the processing of calfskins. Applicability is also limited to both new and existing processing vessels that allow the use of, or can be modified to use, short floats.
2	The use of clean hides or skins	Use of hides or skins which have less manure adhering to the exterior, possibly through a formal 'clean hides scheme'.	Applicable subject to the constraints of the availability of clean hides.
3	Processing fresh hides or skins	Unsalted hides or skins are used. Rapid post-mortem cooling combined with either short delivery times or temperature-controlled transport and storage are used to prevent their deterioration.	Applicability is limited by the availability of fresh hides or skins. Cannot be applied when a supply chain longer than two days is involved.
4	Shaking off loose salt from hides by mechanical means	Salted hides are opened out for processing in a manner which shakes or tumbles them, so that loose salt crystals fall off and are not taken into the soaking process.	Applicability is limited to tanneries processing salted hides.
5	Hair-save unhairing	Unhairing is carried out by dissolving the hair root rather than the whole hair. The remaining hair is filtered out of the effluent. The concentration of hair break down products in the effluent is reduced.	The technique is not applicable where facilities for the processing of hair for use are not available within a reasonable transport distance or when the hair use is not possible. Applicability is also limited to both new and existing processing vessels that allow the use of, or can be modified to use, the technique.
6	Using organic sulphur compounds or enzymes in the unhairing of bovine hides	The amount of inorganic sulphide used in unhairing is reduced by partially replacing it by organic sulphur compounds or by additional use of appropriate enzymes.	Additional use of enzymes is not applicable to tanneries producing leather with a visible grain (e.g. aniline leather).

b) Reduction of emissions in wastewater from tanyard process steps: To reduce the pollutant load in the waste water before effluent treatment arising from the tanyard process steps, an appropriate combination of the techniques given below shall be used.

No.	Technique	Description	Applicability
1	The use of short floats	Short floats are reduced amounts of process water. When less water is present, the quantity of process chemicals which is discarded unreacted is reduced.	This technique cannot be applied for the processing of calfskins. Applicability is also limited to both new and existing processing vessels that allow the use of, or can be modified to use, short floats.
2	Maximising the uptake of chromium tanning agents	Optimisation of the operating parameters (e.g. pH, float, temperature, time, and drum speed) and the use of chemicals to increase the proportion of the chromium- tanning agent taken up by the hides or skins.	Generally applicable
3	Optimised vegetable-tanning methods	Use of drum tanning for part of the process. Use of pretanning agents to aid penetration of vegetable tannins.	Cannot be applied in the production of vegetable-tanned sole leather.

c) Reduction of emissions in wastewater from post-tanning process steps: In order to reduce the pollutant load in the waste water before effluent treatment arising from the post- tanning process steps, an appropriate combination of the techniques given below shall be used.

No.	Technique	Description	Applicability
a	The use of short floats	Short floats are reduced amounts of process water. When less water is present, the quantity of process chemicals which is discarded unreacted is reduced.	This technique cannot be applied in the dyeing process step and for the processing of calfskins. Applicability is also limited to both new and existing processing vessels that allow the use of, or can be modified to use, short floats.
b	Optimisation of retanning, dyeing, and fat liquoring	Optimisation of process parameters to ensure the maximum uptake of process chemicals.	Generally applicable.

16. Treatment of Wastewater

In Common Effluent Treatment Plants / Effluent Treatment Plants, to reduce pollution load in receiving waters, waste water treatment comprising an appropriate on- site and/or off-site combination of the following technique shall be applied for all the techniques design guidelines and appropriate statuary/norms/rules/guidelines have to be followed:

a) mechanical treatment;
b) physico-chemical treatment;
c) biological treatment;
d) biological nitrogen elimination; and
e) exceptional for strong water scarcity: membrane technologies and evaporation systems.

The applicability on site and/or off site, of an appropriate combination of the above techniques are described in the table below.

No.	Technique	Description	Applicability
1	Mechanical treatment	Screening of gross solids, skimming of fats, oils, and greases and removal of solids by sedimentation.	Generally applicable for on-site and/or off-site treatment
2	Physico-chemical	Sulphide oxidation and/or precipitation, COD and suspended solids removal by, e.g.,	Generally applicable for on-site and/or off-site treatment

	treatment	coagulation and flocculation. Chromium precipitation by increasing pH to 8.0 or above using an alkali (e.g. calcium hydroxide, magnesium oxide, sodium carbonate, sodium hydroxide, sodium aluminate). The main limitation of this technology is management of sludge which has to be dewatered and disposed of in secured landfill facilities only.	
3	Biological treatment	Aerobic biological waste water treatment using aeration, including the removal of suspended solids by, e.g., sedimentation, secondary flotation.	Generally applicable for on-site and/or off-site treatment
4	Biological sulphide oxidation	Together with a pre-denitrification and nitrification, a simultaneous sulphide oxidation can be done biologically. Some special requirement for safety in case of nitrification-problems need to be installed	Applicable to plants with direct discharge to receiving water. Difficult for implementation into existing plants where there are space limitations.
5	Membrane technique and reverse-osmosis with evaporation systems (for exceptional circumstances only)	After biological treatment and elimination of dissolved solids by micro-, nano and ultrafiltration, reverse osmosis/ evaporation systems can be used in such exceptional circumstances for challenge of strong water scarcity and if the waste water need to be used for irrigation and no other recycled waste water (i.e. after municipal treatment) is available or not available in sufficient quantity	Applicable to plants in areas with extremely shortage of water (strong water scarcity) and no energy shortage. Difficult for implementation into existing plants where there are space limitations. A solution for the final residues (salt, nonbiodegradable substances) must be available.

For TDS management the following methods could be adopted:

- Manual /mechanical desalting
- Use of cleaner technologies for less use of salt
- High rate transpiration system for effluent treatment
- Treated waste water will be mixed with the sewage wherever feasible and further treated and the treated combined effluent will be used on land for irrigation.

17. Water Consumption Limits

The water consumption levels shall be within the prescribed limits in the consent to establish/operate issued to the industry by the concerned SPCB/PCC. However, in no case these limits shall exceed those specified under the Schedule-I of the Environment (Protection) Rules, 1986, at serial number (16), standards for discharge of effluents from leather tannery sector or any amendments made thereafter.

18. Wastewater Discharge Limits

The wastewater discharge levels shall be within the prescribed limits in the consent establish/operate issued to the industry by the concerned SPCB/PCC. However, in no case these limits shall exceed those specified under the Schedule-I of the Environment (Protection) Rules, 1986, at serial number (16), standards for discharge of effluents from leather tannery sector or any amendments made thereafter.

19. Sludge Dewatering

To reduce energy, chemical and handling capacity requirements of sludge for its subsequent treatment, industry should reduce the water content of sludge by using sludge dewatering systems. Mainly mechanical systems should be used.

20. Monitoring of Effluents

Monitor emissions and other relevant process parameters, including those indicated below, with the given associated frequency and applicability.

No.	Parameter	Frequency	Applicability
1	Measurement of water consumption in the two process stages: upto tanning and post-tanning and recording of production in the same period.	At least monthly.	Applicable to plants carrying out wet processing.
2	Recording of the quantities of process chemicals used in each process step and recording of production in the same period.	At least yearly.	Generally applicable.
3	Monitoring of the sulphide concentration and total chromium concentration in the final effluent after treatment for direct discharge to receiving water, by using flow proportional 24 hr composite samples. Monitoring of the sulphide concentration and total chromium concentration after chromium precipitation for indirect discharge by using flow proportional 24 hr composite samples.	On a daily basis.	The monitoring of chromium concentration is applicable to on-site or off-site plants which undertake chromium precipitation. Where economically viable, the monitoring of sulphide concentration is applicable to plants carrying out some part of effluent treatment on site or off site for treating waste waters from tanneries. In case, the risk assessment for H_2S shows risk of H_2S gaseous emissions (sludge storage, sludge dewatering, anaerobic tanks), the staff need to wear moveable H_2S-meters all the time.
4	Monitoring of chemical oxygen demand (COD), biochemical oxygen demand (BOD) and ammonical nitrogen after on-site or off-site effluent treatment for direct discharges to receiving water, by using flow proportional 24 hrs composite samples. Monitoring of total suspended solids after on-site or off-site effluent treatment for direct discharges to receiving water.	COD - On a daily basis, and BOD- on weekly basis. .	Applicable to plants carrying out some part of effluent treatment on-site or off-site for treating waste waters from tanneries.
5	Monitoring of halogenated organic compounds after on-site or off-site effluent treatment for direct discharges to receiving water.	On a regular basis, minimum every six months.	Applicable to plants where halogenated organic compounds are used in the production process and are susceptible to being released into receiving water.
6	Measurement of pH or redox potential at the liquid outlet of wet scrubbers.	Continuously.	Applicable to plants using wet scrubbing to abate hydrogen sulphide or ammonia emissions to the air.
7	The keeping of a solvent inventory on an annual basis and recording of production in the same period.	On an annual basis.	Applicable to plants carrying out finishing using solvents and using water-borne coatings or similar materials to limit the solvent input.

8	Monitoring of volatile organic compound emissions at the outlet of abatement equipment and recording of production.	Periodically	Applicable to plants carrying out finishing using solvents and employing abatement.
9	Testing of the capture efficiency of wet scrubbing systems.	Annually.	Applicable to plants using wet scrubbing to abate particulate matter emissions, where there is a direct discharge to the atmosphere.
10	Recording of the quantities of process residues sent for recovery, reuse, recycling, and disposal.	On a monthly basis but minimum yearly	Generally applicable.
11	Recording of all forms of energy use and of production in the same period.	On a monthly basis but minimum yearly.	Generally applicable.
12	Ground water quality monitoring	Twice in a year.	wherever the treated effluents are applied on land for irrigation

21. Emergency Plans

The emergency plans should be prepared and should include the following:

a) Fire and environmental protection plan addressing all kinds of emergencies and evacuation procedures.
b) Emergency contacts.
c) Provision of spill-kits.
d) Personal protective equipment.
e) First aid measures, key personnel.
f) Training for emergency response team members.
g) Emergency practice drill.
h) Induction programme for new employees.
i) Exit signs and exit areas clearly marked and accessible.
j) Evacuation routes and destinations clearly marked and accessible.
k) Guidelines for handling emergencies during natural calamities like cyclone / earthquake / tsunami.

22. Health and Safety

The health and safety measures as given below shall be undertaken by the leather tannery industry:

a) Personal Protective Equipment (PPE): Necessary PPE shall be provided for all staff. The staff shall have to wear PPE as may be required in different areas of the industrial plant. Examples for PPE (not complete, may differ in different sections and tanneries):

   i) Earplugs (for process operations areas of buffing, shaving, staking). Gloves (for wet processes, chemical handling, padding, hot plate areas}. Safety goggles (in all areas where chemicals are used).

   ii) Protective masks (chemical storage and handling, dusty areas like buffing, organic solvents handling areas in finishing (spray machines, roller-coaters, hand-spray booth, PU-coating, padding), degreasing areas; areas with spraying wastewater like wastewater treatment or sludge dewatering; waste handling (mainly hazardous waste).

iii) Shoes (principally no barefoot working should be allowed in a tannery. To avoid accidents, closed shoes are necessary. Especially in all wet-areas and chemical areas, applicable to all the people that are handling chemicals, waste and wastewater, salt shaking area from rawhides).

iv) Aprons (mainly in soaking/liming/fleshing, including handling of fleshings).

b) Provide clear labels on the requirements of PPE visibly on the machines, operating rooms and other areas (e.g., buffing room, milling room, colour kitchen).

c) Electrical control boards need closed doors and have to be clean, dry and if necessary equipped with fans to cool the equipment.

d) Electrical wires must be dry and safely installed.

e) No repairing for any electrical wires, pipelines and other electrical installations by wrapping tape.

f) Drainages and pits on the floor need to be closed safe without gaps.

g) Platforms and stairs should have handrails.

h) Install safety protections on motor cooling impellers and belt driven motors.

i) Install safety barriers (doors, chains, light barriers) in front of rotating drums.

j) Close gaps between drums and platforms to prevent danger during manual loading of the drums or sample taking or chemical adding.

k) Protect rotating mixer shafts mainly in colour-kitchen to avoid wrapping hairs or clothes of operators around the shafts.

l) Safety showers and eye showers shall be provided in the areas, where chemicals are stored and handled.

m) The risk assessment shall be undertaken for:
   i) Beam house (liming and deliming areas), for the drainage areas inside/outside the tanneries, where acid/sulphide water is mixed or can be mixed in case of an accident.
   ii) H_2S in wastewater treatment and sludge treatment.
   iii) H_2S in chemical storage areas where Na_2S and NaHS are stored and handled.

n) Monitoring of H_2S in all risk areas such as chemical storage areas, wastewater treatment etc. (minimum requirement: usage of mobile HS meters; online H_2S meters for medium/large sized tanneries).

o) Rack storage for chemicals shall be done in such a way that liquids are not stored on top of powders.

p) Racks are clearly labelled with maximum load permit information.

q) Fire-fighting equipment shall be provided in different areas.

r) Safety training, emergency training and exercises, and first aid training shall be provided regularly, at least 4 times per year for all staff.

s) Emergency exits and emergency meeting points shall be clearly marked and accessible.


IN PURSUIT OF CLEAN ENVIRONMENT
cpcb
Central Pollution Control Board
Ministry of Environment, Forest & Climate Change
(Govt of India)