ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

SUSTAINABLE TANNERY EFFLUENT TREATMENT SYSTEM WITH TDS MANAGEMENT

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Abstract: *Sustainable tannery effluent treatment system in achieving required discharge standards including Total Dissolved Solids (TDS) is one of the major challenges faced by the World Leather Industry. Conventional treatment system reduces Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), heavy metals etc. and not the TDS and salinity. To achieve the TDS level, the tanneries in South India were forced to adopt Zero Liquid Discharge (ZLD) system by incorporating Reverse Osmosis (RO) system and Multiple Effect Evaporator (MEE). Though recovery of water is beneficial to certain extend in adopting ZLD system, the major challenges are high energy consumption, huge operation & maintenance cost and no safe disposal method for large quantity of mixed/contaminated salt generated from MEE. In view of the challenges faced in adoption of ZLD system, sustainable major technological developments have been made to control more than 50% of TDS in the effluent by adopting cleaner tanning process, segregation of saline streams, treatment and recovery of chromium and salt for reuse by the member units. The balance composited waste stream with low TDS is further treated and taken for mixing/dilution with treated domestic sewage to achieve all discharge standards including TDS. This development is being implemented in many tannery clusters in India such as Pallavaram in South India and Jajmau, Unnao, Banthar, etc. in North India. The Common Effluent Treatment Plants (CETPs) are being upgraded with financial support from Govt. of India and respective State Governments.*

Key words: *Tannery effluent, Chromium, ZLD, CETPs, Water recovery*

1. INTRODUCTION

Conventional treatment system reduces Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), heavy metals etc.[1] and not the Total Dissolved Solids (TDS) and salinity. The TDS limit in the discharge standard is being enforced in India and other parts of the world depending upon the final mode of disposal.

There are limitations for mixing/dilution of the treated industrial effluent with domestic sewage to achieve all discharge standards where required quantity of treated domestic sewage is not available. Hence the tanneries in land locked locations such as North Arcot in Tamilnadu were forced to adopt Zero Liquid Discharge (ZLD) system [2]. For achieving ZLD system incorporation of energy intensive membrane system for water recovery and thermal evaporation for the management of saline reject generated from the Reverse Osmosis (RO) system is required. Though the recovery of water is beneficial to certain extend in adopting ZLD system, the major challenges are high energy consumption, huge operation & maintenance cost and no safe disposal method for large quantity of mixed/contaminated salt generated from the Multiple Stage Evaporators (MEE).

The life of the membrane system, MEE and other monitoring systems are less than 3 to 5 years and require frequent replacements with huge investment.

In view of the challenges faced in adoption of ZLD system, sustainable major technological developments have been made to control more than 50% of TDS in the effluent by adopting cleaner process, segregation of saline streams, treatment and recovery of chromium and salt for reuse by the member units. The balance composited waste stream with low TDS is further treated and taken for mixing/dilution with treated domestic sewage in a feasible level to achieve all discharge standards including TDS. This development is being implemented in many tannery clusters in India. The upgradation of Common Effluent Treatment Plants (CETPs) is being implemented with a financial outlay of more than 200 million US Dollar. The Govt. of India, Department of Industry Policy and Promotion (DIPP), National Mission for Clean Ganga (NMCG) and respective State Governments provide major contributions to the tune of more than 150 million US Dollars.

2. SUSTAINABLE & ALTERNATIVE OPTION TO ZLD SYSTEM FOR TDS MANAGEMENT

In general, the treated tannery effluent is mixed/diluted with treated domestic sewage or discharged into backwaters/Sea, wherever feasible for managing the TDS aspects [3]. The Pollution Control authorities in South India insisted upon ZLD scheme incorporating membrane system for water recovery and evaporation for saline reject from RO system [4]. Accordingly, nearly 10 CETPs in Leather Sector implemented the ZLD projects incorporating membrane system and MEE with huge investment of more than Rs.600.00 crores (i.e. about 100 million USD) with financial support from DIPP, Govt. of India and respective State Government during the period 2008-2015. The major challenges in adopting ZLD system are high energy consumption, huge operation & maintenance cost which is in the range of Indian Rupees 400 to 500 per m^3 (i.e. 6 to 8 US Dollars per m^3) without the depreciation cost. There is no viable solution for safe disposal of the mixed / contaminated salt generated and accumulated in the CETPs. In addition to this within 5-6 years of the ZLD implementation, the CETPs are faced with replacement of membranes and MEE. For this purpose, the CETPs are seeking once again financial support from Govt. of India and State Govts. In technological angle, the performance of membrane system and MEE are not matching the design parameters in the field conditions. The ZLD system especially the MEE installed was not suitable in some of the CETPs where the member tanneries adopt semi-finish to finishing operations.

To overcome the technical challenges in ZLD system, disposal of large amount of hazardous category sludge from the treatement system and to achieve sustainable option for TDS management the following technological upgradations have been designed and are being implemented in the CETPs located in Pallavaram (South India), Jajmau, Banthar & Unnao (North India).

i. Adoption of cleaner production, integrated chrome tanning process, etc. to reduce the TDS and pollutional load at source [5, 6]
ii. Two stage biological treatment with improved aeration using jet aspirators
iii. Minimize the chemical usage by 60-70% which results in reduction of sludge generation
iv. Tertiary treatment including low pressure membrane system (Ultrafiltration / MBR) for removal of residual suspended solids and turbidity.

3. SEGREGATION OF STREAMS & CLEANER PRODUCTION

For sustainable TDS management, adoption of cleaner productions practices such as desalting, segregation of spent chrome liquor for chrome recovery, etc. are being practiced in tanneries. The balance composited stream with low TDS is collected separately for treatment in the

CETP and discharged the treated effluent in to public sewer or mix with treated sewage for managing the TDS are proposed to be followed in some of the locations such as Dindigul, Pallavaram & Uttarpradesh in India similar to the practices adopted in other international locations such as Italy, Spain, etc. Alternatively, the treated effluent can be discharged into sea or back water wherever feasible (i.e. Kolkata Leather Complex and Nellore Leather Complex in India, Istanbul and Izmir in Turkey, Italy etc.) for TDS management.

The limitations in the technologies to adopt ZLD concept has been taken in to account in designing and adopting future systems for TDS management in the upgradation plan of CETPs.

The following technological developments are being implemented in tanneries connected to the CETPs:

- Collection of segregated saline soak liquor as per the directions of pollution control authorities to control TDS and conveyance through separate line to CETP.
- Adoption of Cleaner production technologies such as desalting of hides and skins at individual tannery or by providing common facility with special equipments for the use of all the units.
- Improved chrome recovery system and recovery of chromium in the form of cake for reuse.

The segregated spent chrome liquor from tanneries is collected through special tankers fitted with Global Positioning System (GPS) to the Common Chrome Recovery System (CCRS) established as a central facility for the cluster of tanneries. The spent chromium is pass through screens and pH level is increased to more than 8 by adding sodium hydroxide solution in the main reactor. The chromium is precipitated in the reactor and settled as sludge in the bottom of the reactor. The supernatant with high TDS (i.e. 30000-40000mg/l) which is free from chromium is separated and further treated by using Dual Media Filter (DMF) and membrane system for reuse in the pickling process [5].

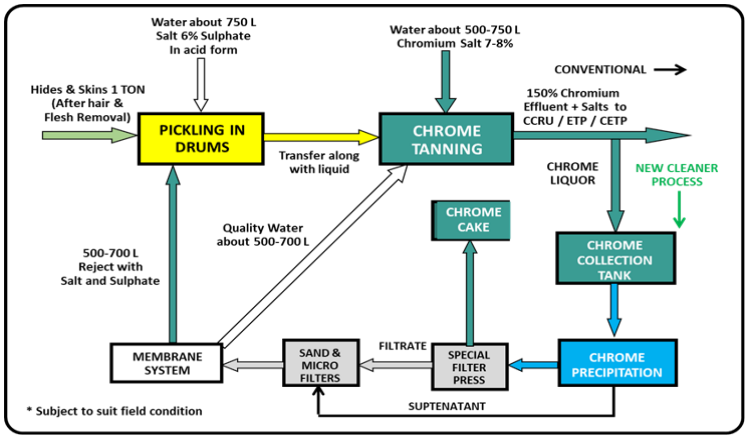

***Fig. 1**: Improved Common Chrome Recovery System (CCRS)*

The chrome slurry is collected in the bottom of the reactor and passes through chamber filter press. The chromium is recovered in the form of cake and disposed to the authorized vendors for further process and distributed in the form Basic Chromium Sulphate (BCS) to the tanneries. The CCRS is becoming popular and is being implemented in many tannery clusters in India.

4. UPGRADATION OF COMMON EFFLUENT TREATMENT PLANTS (CETPS) FOR TDS MANAGEMENT

4.1 Saline soak stream segregation, separate treatment under sustainable ZLD system

The segregation of saline soak stream, separate physiochemical and biological treatment and further adoption of membrane system, partial reuse of saline stream for pickling and separation of salt using MEE for obtaining quality salt has been successfully developed in pilot scale. The following sustainable upgradations are being implemented in many tannery clusters in India [7,8].

A separate wastewater collection line has been being provided for saline soak stream from individual tanneries to the CETP. The composited streams excluding soak and chrome are continued to be collected in the existing conveyance system.

A separate centralized treatment system is established with two stage biological treatment, membrane system and TDS management including recovery of quality salt. The quality water is recovered using RO system and reused in the tanning process. The concentrated saline stream is used partly for pickling process and the balance stream is passed through MEE to recover quality salt. The salt with 99% purity is sold for industrial uses. The process flow diagram of saline stream treatment for sustainable TDS management is shown below:

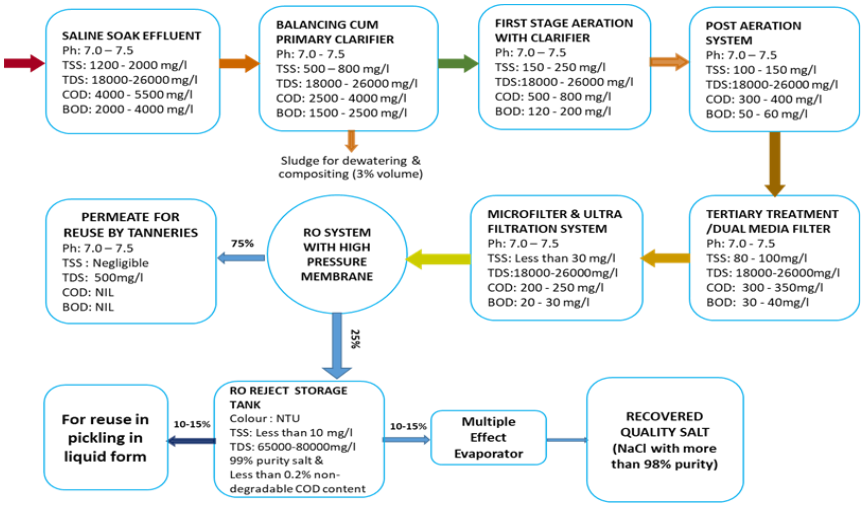

***Fig.2**: Treatment flow chart – Saline Soak Stream*

The separate treatment of saline soak stream and successful recovery of water and quality salt which is being implemented in tannery clusters of India would become a sustainable ZLD system and first of its kind in the world.

4.2 Sustainable TDS management of the composite stream excluding soak and chrome liquor

The TDS of the combined streams is reduced from about 15000mg/l to less than 8000mg/l by segregation and separate treatment of soak and chrome liquor. The upgradation of biological and tertiary treatment units for the combined stream with low TDS at the CETP is done by utilizing the existing treatment units.

The tertiary treatment systems including microfilters, UF units etc. have been incorporated for achieving the prescribed parameters except TDS. The treated effluent is being conveyed and

mixed/diluted with treated effluent from slaughter houses and treated domestic wastewater generated from the nearby area to achieve the TDS level within 2100mg/l and meeting all discharge parameters [7].

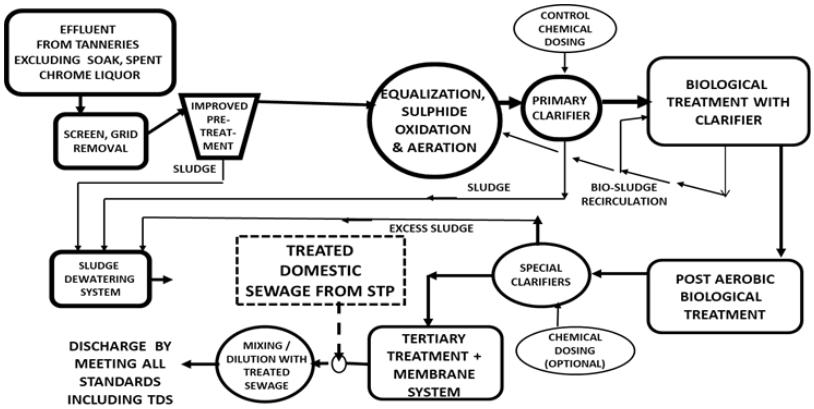

Fig.3*: Process flow diagram for upgradation of CETP – Dilution / Mixing with treated domestic sewage for TDS management and disposal*

The upgradation projects are under implementation in many tannery clusters with financial support from Govt. of India and respective State Governments.

5. IMPROVED MARINE DISPOSAL OF TREATED SALINE EFFLUENT

A novel technological development has been made for the drawl of Seawater of 30,000m^3/day from nearby Sea for the desalination plant integrated with a major leather complex in South India. Out of the total water quantity, freshwater of about 10,000m^3/day will be generated and the remaining 20,000m^3/day will be discharged into sea with special bio-control and dispersion system to safe guard the aquatic life. The leather complex will be using the quality water generated by desalination plant for its process requirements. About 9,000m^3/day wastewater generated from the tannery units will be collected and treated in the centralized treatment plant. The treated effluent is mixed with saline reject of the desalination plant, stored in a water tight pond for a capacity of about 10 days and discharged into the Sea by laying 5 km pipeline using high pressure HDPE pipe and special sprinkling system. The combined treated saline stream with a quantity of about 29,000m^3/day will be discharged once in a week under the overall control of environmental protection authorities [7,8].

Fig. 4*: Treated effluent discharge – Improved mode of disposal into Sea*

With the support of many National Institutes and other organizations, model studies were carried out in finalizing the novel marine outfall. The spreading of an effluent cloud released in a marine environment is governed by advection caused by large scale water movements and diffusion caused by comparatively small scale random and irregular movements without causing any net transport of water. Hence, the important physical properties governing the rate of dilution of an effluent cloud in coastal waters are bathymetry, tides, currents, circulation and stratification.

A five port diffuser systems with 0.18 m diameter is planned with a jet velocity of 2.5 m/sec, for the release of treated effluents and reject water from the proposed desalination plant. The Environmental Clearance (EC) has been accorded to this unique integrated project with water recovery using desalination process, industrial wastewater treatment, novel and safe saline reject disposal into Sea without affecting the marine life which is first of its kind in India.

ACKNOWLEDGEMENT

- The contributions of Asian International Union of Environment (AIUE) Commission with 30 representatives from 20 countries, UNIDO, European Union are acknowledged.
- Acknowledgment is made for technical assistance by UNIDO, Vienna and RePO, Chennai. The contributions of CSIR-CLRI Environmental Technology Dept., KPILC, IL&FS Cluster are greatly acknowledged.
- Acknowledgement is made for DIPP, NMCG for rendering assistance for implementation and upgradation of tannery sector CETPs. The contributions of Government of India, Govt. of Tamilnadu, UP, West Bengal, Punjab, CLE, CII and Industry Associations are acknowledged.

REFERENCES

[1] Alemu, T., Lemma, E., Mekonnen, A., Leta, S., 2016, Performance of pilot scale anaerobic-SBR system integrated with constructed wetlands for the treatment of tannery wastewater, Environ. Process, 3, 815–827.

[2] S. Rajamani, Recovery of water for reuse from Tannery Wastewater and other advanced environmental protection measures – Asian Scenario, IULTCS 2015 - XXXIII International Union of Leather Technologists and Chemists Societies (IULTCS) Congress, Novo Humbargo, Brazil - 2015.

[3] Zhang, C., Xiaa, F., Long, J., Penga, B., 2017, An integrated technology to minimize the pollution of chromium in wet-end process of leather manufacture, Journal of Cleaner Production, 154, 276-283.

[4] S. Rajamani, Sustainable Developments in the Global Leather Sector and Environmental Protection, 4th International Leather Engineering Congress (IAFLI 2017), Ismir, Turkey – 2017.

[5] S. Rajamani, Improved Chromium Recovery System Integrated with Water Recovery for reuse in tanneries under Zero Discharge (ZLD) Concept, Leather Age – 2016.

[6] Zhang, C., Lina, J., Jia, X., Peng, B., 2016, A salt-free and chromium discharge minimizing tanning technology: the novel cleaner integrated chrome tanning process, , Journal of Cleaner Production, 112, 1, 1055-1063.

[7] S. Rajamani, Improved Chrome & Salt Recovery System For Sustainable Effluent Treatment And Management In Leather Sector - 11th Asia International Conference of Leather Science and Technology (AICLST 2018), Xian, China – 2018.

[8] S. Rajamani, Sustainable technical alternative to Zero Liquid Discharge (ZLD) for Total Dissolved Solids (TDS) Management, Indian Leather-2018.