INNOVATIVE ENVIRONMENTAL TECHNOLOGIES INCLUDING WATER RECOVERY FOR REUSE FROM TANNERY AND INDUSTRIAL WASTEWATER – INDIAN AND ASIAN SCENARIO

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Wastewater discharge from world tannery sector is about 600 million m3/annum. The tanneries in Asia discharge more than 350 million m3 of wastewater per annum from the process of 8 to 10 million tons of hides and skins. The ground and surface water resources in many locations in and around tannery cluster contain high Total Dissolved Solids (TDS) and not fit for domestic and industrial use. The conventional treatment systems implemented all over the world reduce Biochemical Oxygen Demand, Chemical Oxygen Demand, Suspended Solids, Heavy Metals etc. and not TDS and salinity which are mainly contributed by chlorides, hardness and sulphates. The treatment plants are unable to meet the standards in terms of TDS, chlorides and salinity which are being enforced in India and many other countries. The pollution control authorities also insist on water recovery integrated with Zero Liquid Discharge (ZLD) system. Naval treatment systems such as special Micro Filter, Ultra Filtration, Membrane Bio-Reactor, Nano Filtration, Reverse Osmosis, etc. have been developed for recovery of water from domestic and tannery wastewater. The achievement of ZLD concept has got many technical challenges. Management of the concentrated saline stream treatment by adopting energy intensive evaporation system is one of the major sustainable issues. The innovative treatment technologies developed and adopted for water recovery, saline stream management, etc. are dealt in this paper.

Keywords: Tannery Wastewater, Treatment, Reverse Osmosis

INTRODUCTION

Annual leather process in Asian Countries is estimated at 8 to 10 million tons of hides and skins which is more than 50% of the estimated World leather production of about 16 million tons per year. Wastewater discharged from world tannery sector is about 600million m^3/annum. The tanneries in Asian countries including India, China, Vietnam, etc. discharge more than 350 million m^3 of wastewater per annum.

The conventional physiochemical and biological treatment systems are designed and implemented only to reduce Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), Heavy metals etc. and not TDS and salinity which are mainly contributed by chlorides, hardness and sulphates. Due to inherent quality of wastewater from tanning industry, the treatment plants are unable to meet the prescribed standards in terms of TDS, chlorides in salinity in the treated effluent.

There is not much scope in mixing the treated tannery effluent with domestic sewage to achieve the TDS level in many locations in Asia in the absence of organized sewage treatment plants of required capacity. Many polluting industries including tanneries are located in the land locked areas and there are constraints to discharge the treated effluent with high TDS in the Sea.

The TDS limit is being enforced in India and other parts of the World depending upon the final mode of disposal. In addition to the removal of TDS in the treated effluent, it is necessary to recover water for reuse to meet the challenge of water shortage. In many states in India, the pollution control authorities insist on water recovery integrated with Zero Liquid Discharge (ZLD) system. However, the achievement of Zero Liquid Discharge concept has got many technical challenges in addition to the application of various types of membrane systems. Management of the concentrated saline stream treatment by adopting energy intensive evaporation system seems to be one of the major issues in land locked areas.

This technical article deals with the recent developments on the environmental protection techniques in including water recovery from water discharged from tanneries and other industrial waste water treatment with focus on sludge reduction water recovery for reuse and salt recovery, marine disposal of saline reject with proper treatment and guard, etc. Case studies of major projects implemented in India, Spain, China, etc. and saline reject disposal coastal zones are covered in the novel technical paper.

NEED FOR IMPROVED TREATMENT SYSTEM FOR SLUDGE REDUCTION & WATER RECOVERY

Due to inherent quality of industrial wastewater such as textile dyeing units, tanneries etc., the conventional treatment plants are unable to meet the prescribed TDS level of 2100 mg/l in the treated effluent. In addition to TDS management the control of volatile solids in hazardous category sludge is also becoming a necessary.

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For control of sludge and recovery of quality water from wastewater, the required treatment steps are (i) Chrome recovery and other in process control including cleaner production (ii) Conventional physiochemical and biological effluent treatment systems to reduce BOD, COD, SS etc. and (iii) Tertiary treatment systems including, micro-filter, low pressure membrane units such as ultra-filtration etc., before the application of single or multiple stage Reverse Osmosis (RO) system. A special treatment process for recovery of water from waste water is given in Figure 1.

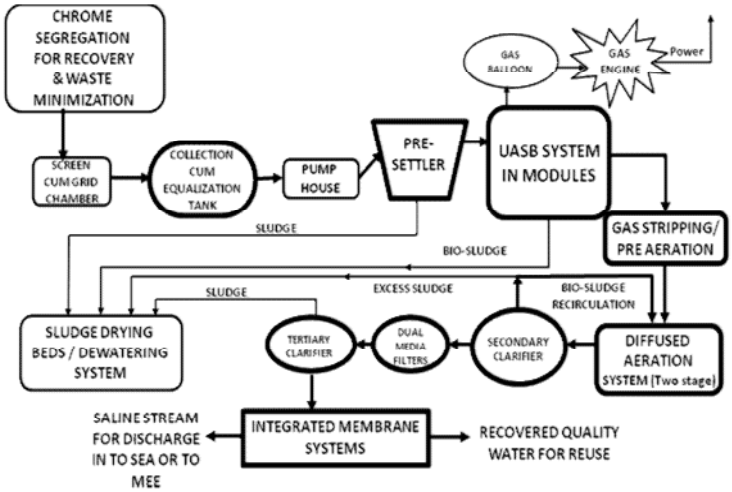

Figure 1. Process Flow Diagram for Tannery Waste Treatment & Integrated Saline Management – New and First of its kind

After primary and secondary treatment units, Reactive Clarifier, Dual Media Filter, Micro Filter, Ultra-Filter (UF) are installed prior to RO system for recovery of water.

The number of stages and types of RO system are based upon the TDS concentration in the feed water, estimated percentage of quality water recovery and reduction in volume of saline reject. High pressure Sea water membrane is adopted for handling treated effluent with TDS concentration more than 10,000 mg/l. The quality water recovery rate could be achieved to the level of 70 to 90% depending upon the feed water TDS level, type and stages of membrane system etc. In addition to recovery and reuse of quality water by the industry, the additional benefits are savings in chemical usage in the tanning process and reduction in pollution load in the effluent. The reject saline stream from RO system needs to be managed by adopting the options of forced / thermal evaporation system or disposal into Sea wherever feasible with suitable control.

Figure 2. Amiad Filter & Ultra-filter (UF)

Many full scale membrane systems have been installed for recovery of water from domestic and tannery wastewater with capacities ranging from 100 to 20000m^3/day.

MEMBRANE BIO-REACTOR (MBR) INTEGRATED WITH RO SYSTEM

Membrane Bio Reactor (MBR) system is commonly adopted in many countries to remove the residual BOD, suspended solids / coliform, etc. from the effluent. After treatment with MBR, the water is applied through RO system for removal of TDS and salinity to get drinkable quality water with TDS less than 500mg/l. A Common Effluent Treatment Plant (CETP) in Spain with MBR and RO system for water recovery was established in 2005. Recent times many CETPs in India have adopted MBR and other membrane system for water recovery and reuse from the tannery effluent. After MBR / UF treatment, the suspended solids and BOD values in the effluent are below detectable level and taken for treatment with RO system for recovery of water after the removal of TDS and salinity.

In China also water is becoming a scarce commodity in many locations. Expansion of high water consuming industries is allowed only if they are provided with water recovery system in the effluent treatment plants. To recover water from the tannery wastewater, submerged MBR linked with activated biological treatment is provided in the first stage. Following MBR system an RO plant in “Christmas Tree” configuration has been installed and operated at 12–16 bars. The RO plant produces about 70% permeate and 30% concentrate. The quality of the recovered water meets the drinking water standards. The saline water concentrate stream is further treated with Fenton process before disposal.

A view of the submersible MBR in one of the tannery effluent treatment plants in China is shown in Figure 3.

Figure 3. Submerged Membrane Bioreactor

The Nano Filtration (NF) is adopted for removal of colour and salts such as sulphates from the treated effluent after ultra filtration or MBR stage. Nano-filtration membranes are operated under low pressure with high yield of about 90%. Adopting NF will improve the efficiency of RO in water recovery and to decrease the volume of saline reject.

Multiple stage evaporators using thermal and electrical power have been installed for evaporation of the reject saline stream from RO system. However, there are many technical issues such as constrains in continuous operation of the system, meeting the required quality of the condensate water from the evaporator for reuse, management / utilization of the recovered salt with impurities etc., The capital and operational costs are also high. Further techno economical review and modified options are required on the sustainability of the system particularly in land locked areas.

NAVAL MARINE DISPOSAL OF TREATED SALINE STREAMS

A novel technological development has been made for the drawl of Seawater of 30,000 m^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 Bay of Bengal with special bio-control and dispersion system to safe guard the aquatic life. The leather complex will be using the freshwater generated by desalination plant for its process requirements and 9,000m^3/day wastewater will be treated, 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.

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) and approval has been accorded by Government of India to this unique integrated project with water recovery using desalination process, tannery 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 Environment (AIUE) Commission and IUE Commission members from various countries, IULTCS, UNIDO and European Union are acknowledged. Special efforts and inputs from Mr. Ivan Kral, UNIDO, Ms.Catherine MONEY, Ms.Patricia CASEY, Prof.Dr.Mariliz Gutterres, Ms.Katia Fernanda Streit, Mr.Chen ZHANGUANG, Mr.Su CHAOYING, Mr.Liyuzhong, Mr.Thomas Yu, Mr.Vera Radnaeva, Mr.Gokhan Zengin, Ms.Eylem Kilic, Dr.Campbell Page, Mr.Jakov BULJAN, Dr.Wolfram SCHOLZ, Mr.Elton Hurlow, Dr.Shi Bi, Dr.MaJianzhong, Dr.Volkan Candar, Prof.Altan AFSAR, Dr.Keiji Yoshimura, Mr.M.Aihara, Mr.Juan Manuel SALAZAR, Dr.Dietrich Tegtmeyer, Mr.Arnab Jha, Ms.Suliestiyah Wiryodiningrat, Dr.LuminitaAlbu, Mr.Gustavo Gonzalez, Mr.Y.K.Luthra, Mr.Goeff HOLMES, Mr.Dylan BALL, Dr.Mwinyikione Mwinyihija, Mr.Arnold Mulder, Mr.Mohammad Aslam Mia and other technical committee members are greatly acknowledged.

The support and contributions of COTANCE, European Union (EU), National Research & Development Institute for Textile and Leather (INCDTP), Division Leather & Footwear Research Institute (ICPI), Leather Research Institute by name "Asociación Española de las Industrias del Curtido y Anexas (AIICA)" located in Igualada, particularly by Dr.Agusti Marshal, Dr.Ms.Luisa F.Cabeza and Mr.Daniel Sanchez Esteve from Spanish Leather Chemists Association (SLCA) are greatly acknowledged.

The contributions of Central Leather Research Institute (CLRI), China Leather Industry Association (CLIA), Taiwanese Leather Industry Association (TLIA), Indian Leather Technology Association (ILTA), Latin American Congress Federation of Leather Industry Chemists and Technicians (FLAQTIC), Japanese Association of Leather Technology (JALT), National Research and Development Institute for Textiles and Leather (INCDTP), Krishnapatnam International Leather Complex Private Ltd. (KPILC), Nellore, Andhra Pradesh, India and Leather & Footwear Research Institute (ICPI) other Leather Industry Associations and Common Effluent Treatment Plants (CETP) are acknowledged.

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