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INNOVATIVE CLEANER LEATHER PRODUCTION PROCESS AND ENVIRONMENTAL PROTECTION

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Abstract : *Environmental challenges in treatment and disposal of tannery effluent with high salinity, stringent environmental regulations including Total Dissolved Solids (TDS), etc. resulted in development of new appropriate cleaner production process to reduce the volume of water usage, pollutional discharges, segregation of streams such as saline soak liquor, spent chrome liquor enable to adopt advanced aerobic oxidation process, membrane system, recovery of chromium, purified salt and water for reuse.*
The achievements of the innovative cleaner production and effluent treatment are : (i) Reduction in water usage in soaking process from 6000-8000 liters to less than 3000 liters/ton of hides, (ii) Segregation of high saline streams from soaking operations and spent chrome liquor for separate treatment and recovery of quality salt, chromium in form of cake/powder, (iii) Conversion of physiochemical treatment into biological treatment with reduced chemical usage and sludge generation by about 70% and (iv) Advanced oxidation treatment using ozone for achieving COD, colour and turbidity.
Viable cleaner production and sustainable treatment technologies had been engineered and are being implemented in a major leather cluster with more than 200 new tanneries, a Common Effluent Treatment Plant. This would become a biggest leather cluster development during this century in World Leather Sector.

Key Words: *Segregation, Soaking, Effluent, Chrome Recovery, Advanced Oxidation, Ozone Treatment.*

1. INTRODUCTION

The treatment and disposal of tannery effluent with high salinity and Total Dissolved Solids (TDS) is a major challenge in most of the land locked tannery clusters. This resulted in development of appropriate cleaner production process to reduce the volume of water usage and pollution discharges. The segregation of streams such as saline soak liquor, spent chrome liquor enable to adopt advanced aerobic oxidation process, membrane system, recovery of quality chromium in the form of cake/powder, purified salt (sodium chloride) and water for reuse [1].

The merits of the developed cleaner production and effluent treatment are : (i) Reduction in water usage in soaking process from 7000 liters to less than 3000 liters/ton of hides, (ii) Segregation of high saline streams from soaking operations and spent chrome liquor for separate treatment and recovery of quality salt, chromium in form of cake/powder, water for reuse under ZLD concept, (iii) Upgradation of physiochemical treatment into biological treatment process with reduction in chemical usage to reduce sludge generation by 60-70%, (iv) Advanced oxidation treatment using ozone for achieving COD reduction, colour and turbidity removal to the required level in the composite effluent and (v) Integration of treated tannery effluent with treated domestic sewage for achieving TDS norms and use of the entire treated effluent for irrigation.

Viable cleaner production and sustainable treatment technologies had been engineered and are being implemented in a Mega Leather Cluster (MLC) with more than 200 new tanneries, a Common Effluent Treatment Plant (CETP) of 20 MLD in modules. This would likely be the biggest leather cluster with adoption of new and innovative cleaner productions by all the cluster member tanneries and first of its kind in World Leather Sector.

1.1.Viable Cleaner Technology for Reduction of TDS at Source

The raw hides & skins available in the market for leather tanning contains 30-50% of salt (Sodium Chloride) on total weight basis. These hides & skins are taken for soaking operations without proper salt dusting. The volume of water usage is 6000-8000 liters per ton of hides and TDS concentration ranges from 40000 to 60000mg/l. The entire soak liquor is mixed with other sectional streams and discharged as a composite stream and the TDS level is in the range of 20000-25000mg/l. This high TDS level in the effluent affects the performance of biological treatment system and inability to achieve discharge parameters particularly TDS which is being enforced in many Indian States and other countries as well.

In order to meet the challenges in achieving the environmental regulations and to improve the in effluent treatment system with recovery of quality chemicals, salt and water for reuse the following cleaner productions have been developed for implementation.

- Improved mechanism for desalting of skins by using simple system such as DODECA by tanneries at source and centralized mechanical desalting of hides by adopting proven equipments which are portable as well.
- Sulphide reduced liming process by the use of suitable enzymes to extent feasible for reduction of Sulphide load by 60-70% in the effluent.
- Safe and sustainable disposal of waste fleshing by conversion into fertilizer, composting by using with dewatered bio-sludge and other degradable organic matter.
- Segregation of Chrome stream and adoption of improved Common Chrome Recovery System (CCRS) and recovery of Chromium in the form of cake. The supernatant also further processed and converted into reusable chemical and quality water.
- Reduction in sludge generation by biological treatment with minimum chemical usage, anaerobic digestion of sludge with bio-energy generation and conversion into composting.

1.2. Segregation of Streams in individual Tanneries

All the individual tanneries in addition to the adoption of suitable cleaner productions, the streams are segregated as follows for separate treatment.

- Saline soak liquor from pre-soaking, main soaking and washing.
- Spent chrome liquor from chrome tanning operations.
- All other streams starting from liming, deliming, washing and all remaining wet finishing operations are collected as a composite stream.

The concept of the innovative cleaner production process in cluster of tanneries, improved chrome recovery system, sustainable TDS management and disposal of treated effluent is shown in figure-1.

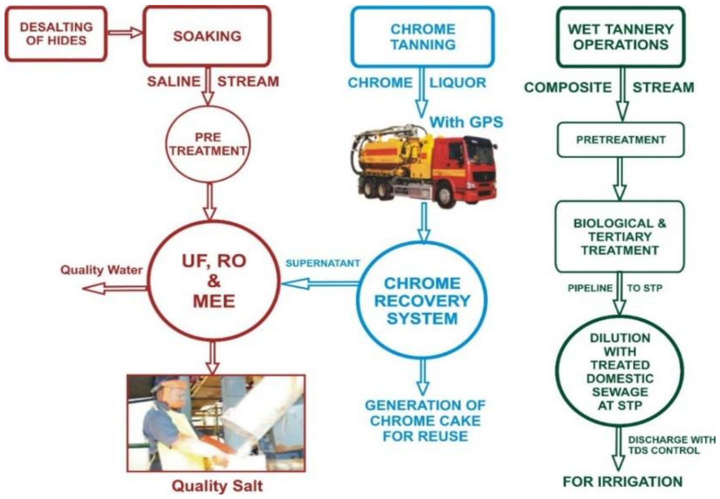

***Fig 1**: Innovative Cleaner Production for Sustainable Treatment with TDS Control*

1.3. Saline Soak Liquor

Saline Soak Liquor is generated from the three stage operations of namely (i) Pre or Dirt soaking (soaking I), (ii) Main soaking (soaking II) and (iii) Wash after main soaking (soaking III). During the conventional three stages of soaking using pits and paddles more than 6-8m3 of effluent is discharged per ton of raw material process. By the use of drums for soaking after viable desalting and cleaner production process, the volume of water usage and effluent discharge is reduced to less than 4m3/ton of raw hides and skins.

The saline soak effluent from each tannery is discharged into the exclusive conveyance system to CETP for separate treatment under ZLD concept with recovery of quality water and reusable salt [2]. The treated saline stream is partly reused in pickling / soaking and balance is evaporated for generation of reusable salt (mainly sodium chloride) and water. The salt is having more than 99% purity and has got market demand for industrial and other uses in land locked areas. The overall TDS level in the other composited stream is reduced by about 60% (i.e. from more than 20000mg/l to less than 10000mg/l). Due to this reduction, the environmental authorities permit the sustainable option of mixing the treated composite effluent with treated domestic sewage available near the tannery cluster and enable meet all the discharge parameters including TDS.

1.4. Manual / Mechanical Desalting Process

The tanneries processing salted goat, sheep, cow & buff calf skins in small scale can adopt desalting frames and rotary drums. DODECA wooden frames can be adopted for small size skins weighing upto 4-5kgs. For medium size hides weighing upto 10kg can be desalted using rotary drums with perforated holes.

Majority of tanneries in the cluster are in small & medium scale, they are not having the capability and land space to have mechanical desalting system required for big size hides. Hence, it is necessary to adopt mechanical desalting as a centralized facility. It is proposed to provide two centralized desalting facility for a capacity of about 80-100 tons per day during the first phase implementation. The desalting process, clarification of the dusted salt solution, reuse in pickling, etc. are shown in following process flow diagram.

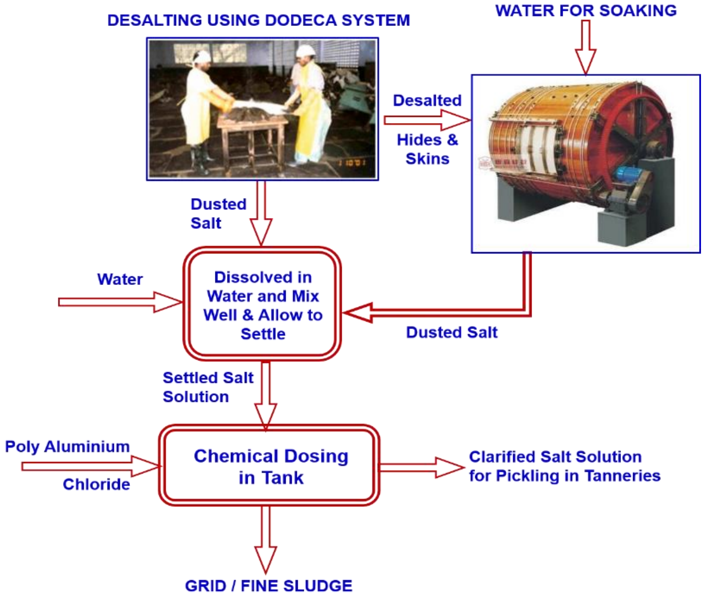

Fig.-2: *Desalting Process and TDS Management*

The salt collected from desalting process would contain grit and organic ingredients. This can be clarified by adding 200 liters of water for 20kg dusted of salt and grit will settle in bottom of the tank. The supernatant can be collected in a separate tank and added with Poly Aluminium Chloride (PAC) dosing. The suspended and organic settleable matter settles in the bottom as a sludge. This can be disposed in the sludge dewatering system installed in individual tanneries. The clarified supernatant which contains 7-8% salt solution can be used for pickling by adding required balance salt, sulphuric acid and water. The desalting process would reduce the TDS content in the saline soak liquor from the range of 40000-50000 to 20000-30000mg/l [5].

1.5. Improved Chrome Recovery System

The effluent discharge from chrome tanning operation is about 4-6% of total volume of wastewater from chrome tanneries. Conventionally, the tanneries provide individual chrome recovery system by using MgO (Magnesium Oxide) as alkali and the recovered chrome slurry is regenerated as Basic Chromium Sulphate (BCS) by mixing with Sulphuric Acid (H_2SO_4). BCS is in the form of liquid is reused in the tanning process [3, 4]. In this conventional process, there are limitation and management and reuse of Chromium. The discharge of entire supernatant from chrome system with high TDS (25000-40000mg/l), Chlorides (8000-15000mg/l), Sulphate (4000-8000mg/l), etc. to the CETP along with other streams results in increase of overall TDS in composite stream, constraints in adopting biological treatment system particularly anaerobic system achieving TDS level in the treated effluent is not feasible.

The concept of the improved CCRS (i) Collection of spent chrome liquor from individual tanneries through tankers fitted with GPS, (ii) Screening, pretreatment, separation of Chromium as a slurry in the reactor by using suitable alkali, (iii) Dewatering of chrome slurry using Chamber Filter Press and recovery of Chromium in the form of cake and (iv) The supernatant with high TDS of more than 30000mg/l is taken for further treatment integrated with saline soak stream treatment system for recovery of quality salt and water by adopting membrane system.

2. CENTRALIZED FACILITIES FOR SUSTAINABLE SOLID WASTE MANAGEMENT

The tanneries during beam house operation generate large amount of fleshing. It is estimated 20-30kg of fleshing generated during the process of 1000kg of hides & skins. Only part of fleshing is taken for commercial process and about 50% of fleshing mainly from skins and small hides are becoming waste. The waste fleshings are proposed to be disposed by adopting the following options: (i) Conversion into composting using other organic degradable waste and bio-sludge, (ii) Conversion into biological liquefaction and feed to anaerobic reactor for bio-energy generation and bio-sludge, (iii) Mixing with dewatered bio-sludge from digester and converting into bio-fertilizer.

The centralized solid waste management comprises of biological liquefaction of fleshings, anaerobic digestion, composting, etc [6]. A separate RCC industrial type building in an area of 500m2 within the CETP in a land space of 1200m2 is proposed to be implemented for solid waste management in the CETP area during the Phase-1.

3. COMPOSTING AND GENERATION OF BIO-FERTILIZER

It is estimated that about 5-10 tons of partly dewatered bio-degradable sludge would be generated from soak liquor treatment, composite treatment and anaerobic digester [7]. This bio-degradable sludge can be processed further by adding waste fleshing and degradable organic waste available in the local area. The ratio of the mix would be generally 1:1:1 and the composting process would take about 15-20 days. Proper bio-seeding generated from STP / bio-spray would be periodically applied for accelerating the composting process.

4. RESULTS AND DISCUSSION

- Improved desalting using DODECA mechanism removes the salt content from 60% to 30% on weight basis.
- Modified and improved soaking process reduces the water usage and effluent discharge from the level of 600-800% to 300-400%.
- Improved chrome recovery system generates chromium in the form of cake / powder.
- Entire supernatant is further process and recovered in the form of quality salt and water for reuse.
- Segregation & treatment of saline soak liquor under ZLD system generates quality water and salt.
- TDS level in the composite stream reduced from about 20000mg/l to less than 10000mg/l.
- Improved cleaner production and segregated treatment enable to comply the environmental regulations and discharge norms.
- Scope for replicability in many tannery clusters.

5. CONCLUSION

This unique and sustainable technological developments in cleaner production and effluent treatment will reduce the level of TDS in the effluent discharge by 50%, hazardous category sludge generation by 60% and meets the environmental norms [8,9]. Based on the pilot scale development, commercial scale systems are being implemented in Effluent Treatment Plants (ETPs) and CETPs in India and other countries.

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