Challenges in World Leather Sector and Sustainable Options

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Abstract

Annual World leather process is estimated at 14 million tons of hides and skins, with a gradual reduction of about 20% during the recent years, due to the conversion of raw hides and skins into the low-grade protein, gelatin, as well as even landfill, etc. because of declining of leather market. More than 55% of world leather production is done in Asian countries such as India, China, Vietnam, Bangladesh, etc. They process 7 million tons per annum using 3 million tons of chemicals and salts. They generate more than 2 million tons of solid wastes such as hair, raw hide trimmings, fleshing, wet blue trimmings and shavings per annum.

Out of 3 million tons of chemicals used for the raw to semi-finishing operations only less than 25% of chemicals are fixed in the semi-finished leather and balance 75% is used as an aided chemicals and discharged as waste with effluent and sludge. Sustainable conversion of solid waste from tanneries and sludge from the effluent treatment plants are major challenges.

Effective disposal of large volume of chrome containing sludge which is about 4 million tons per annum from World Leather Sector is one of major unresolved issues. The cleaner productions and nonchrome tanning agent and re-tanning agent which are a trend in the past few years and will be much more popular and mandatory in future due to the market

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demand and new regulations. This paper deals with new technological development on cleaner production, innovative R&D on the quality byproducts such as gelatin, collagen, etc. and corresponding effluent treatment process and future sustainable options for leather sector.

Key words: Sustainability, Non-chrome tanning, Cleaner production

1. Introduction

As per the year 2025 estimation, about 14 million tons of hides and skins were used for leather making by the world tanneries, a gradual reduction of more than 20% from the level of about 18 million tons during the pre-covid period.

Currently about 7 million tons of hides and skins are processed in Asian countries such as India, China, Vietnam, Bangladesh, etc. They use about 3 million tons of chemicals and salts. During the leather process, the industrial units generate more than 2 million tons of solid wastes such as hair, raw hide trimmings, fleshing, wet blue trimmings and shavings per annum.

Out of 3 million tons of chemicals such as lime, sulphide, etc. used for beamhouse operations only minor percentage of chemicals is fixed and the balance more than 90% of chemicals discharged along with solid waste and effluent. This discharge causes major challenge in occupational health and effluent treatment. Viable conversion of solid waste and sludge from the effluent treatment plants are major challenges for the survival of tannery units and to control the declining trend of leather production.

Effective disposal of large volume of chrome containing sludge which is about 4 million tons per annum from World Leather Sector is one of major challenge. Cleaner productions and non-chrome tanning and re-tanning agent which are a trend in the past few years and will be much more popular and mandatory in future due to the market demand and new regulations. The challenges faced by

Fig.1: Major Leather Producing Countries China, India, Vietnam, Russian Federation & Location of Leather

Research Institutions

2. Management of Environmental Challenges

The environmental pollution control standards and regulations followed in United States, European Union and other developed countries are similar to the norms followed in Asian countries such as India and China. It has become necessary to modify the leather process to reduce the pollutional discharge and upgrade the treatment systems in ETP/CETP's with huge investments to comply the stringent environmental regulations. The relocation and resettlement of tanneries from urban towns to designated industrial areas, sustainable management of Total Dissolved Solids (TDS) are the recent developments in India, China, Turkey, etc. In addition to the challenges in meeting the stringent environmental regulations with high cost, the declining trend for the leather market, increase in alternative market demand for other products such as gelatin, collagen, etc. the conversion of hides and skins into other products will continue to grow. The gradual

the World Leather Sector, new technological development

on cleaner production, innovative treatment process such

as adoption of jet aeration, ozone treatment, etc. and

sustainable solid waste management taking into account

of conversion of raw hides and skins into other products

such as gelatin, collagen, etc.

reduction in leather process in the tannery clusters and change in the product line, results in the characteristics of the effluent discharged to the CETPs. This is also another challenge in the operation and maintenance. The cluster of urban tanneries in many locations are forced to relocate from the cities to new industrial zones with CETPs integrated with sewage treatment systems. In India, China and in other countries new tanneries or expansion of the existing tanneries are permitted only in authorized industrial zones with CETPs.

3. Trend of Leather Production and R&D in India

Total average processing capacity in Indian tanneries is about 3000 tons of raw material in terms of salted hides and skins per day. Prior to 2010, leather production share in different states are as follows: Tamilnadu - 50%, Kolkata - 20%, Kanpur & Unnao region - 20%, Jalandhar

– 5% and balance 5% in other states. During the past 15 years, owing to the market sluggishness and enforcement Management of high chlorides, salinity and sulphide in the tannery effluent has become a serious environmental threat particularly land locked tannery clusters. The tannery clusters mainly in South India have adopted

Fig.2: Process flow diagram of Treating Chrome Tanning Wastewater

4. Techniological Development & Leather Production Trend in China

4.1 Pollution Treatment Technology

The waste water from tanneries has high concentration of organic materials, while in organics especially including chrome and common salt. In order to reduce the load of sewage treatment and recover useful materials, the chrome wastewater is treated separately from other sectional waste streams.

4.2 Treatment of chrome-containing wastewater

The spent chrome liquor is precipitated by alkali with the final pH at 8.0 ~ 8.5, then the chrome sludge is processed into chrome cakes, and the chrome cakes can be reused or stored independently. The chrome recoveries achieved upto 99% and the total chrome content in supernatant less than 1 mg/L.

4.3 Treatment of No-chrome Wastewater

There are three kinds of treatment method for no-chrome wastewater including physical, chemical and biological

membrane system for water recovery and high-cost treatment of the saline rejects from the membrane system. The capacity of leather process has been reduced in South India due to the declining of leather market demand as well as the increase in cost for environmental management particularly for the tannery clusters having ZLD system.

method. The physical method includes screening, gravity and centrifugal separation. The chemical method includes coagulation, neutralization. The biological method includes activated sludge process (oxidation ditch, SBR), biomembrane method (biological aerated filter, rotating biological contactor, bio-contact oxidation, fluidized bed), anaerobic and aerobic methods.

The above three kinds of methods are usually used in combination in one tannery. Typical treatment process and treatment effect is shown in Table 2.

4.4 Cleaning technology of leather making

Cleaner technology of leather making is the important guarantee of effective governance of wastewater. In recent years, much effort has been made in the field of R&D of cleaning technology in Chinese tanning industry, and there has been a lot of achievements. For instance, technologies of cleaner unhairing Liming, recycling of waste lime liquor and waste chrome liquor, high exhaustion of chromium tanning, utilization of scrap leather has been very well developed and have been used widely in Chinese tanning industry.

Table 2: Typical treatment process and treatment effect

Method Main process Removal rate

Wastewater → Regulating Tank → Primary Sedimentation Tank → Flotation Tank → Oxidation Ditch → Secondary Sedimentation Tank → Flotation Tank → Emission

Wastewater → Coagulation Sedimentation → Bio-contact Oxidation tank → Secondary sedimentation tank → Emission >90% 5565%

SBR Wastewater → Gritting tank → Regulating tank → Flotation tank → SBR → emission >90% 5570%

Oxidation Ditch

Bio-contact Oxidation

Bio-contact Oxidation + SBR

Wastewater → Screening → Precipitation tank → Regulating tank → Primary sedimentation tank → Bio-contact oxidation tank → Secondary sedimentation tank → SBR → Emission

Wastewater → Regulating tank → Primary sedimentation tank → Oxidation ditch → Secondary sedimentation tank → BAF → Final sedimentation tank → Emission

Oxidation Ditch + BAF

Wastewater → Regulating tank → Primary sedimentation tank → Flotation tank → A/O → Secondary sedimentation tank

A/O

Wastewater → Precipitation tank → Regulating tank → Primary sedimentation → Secondary sedimentation tank → A/O → A/O → Final sedimentation tank → Emission

Secondary A/O

Wastewater→ Gritting tank → Regulating tank → Coagulation sedimentation → A/O tank → Secondary sedimentation tank → BAF tank → Emission

A/O+BAF

4.5 Application of cleaning technologies

Cleaner technologies are closely related with leather chemicals and leather machinery, but also relates to the balance of leather processing, otherwise it will affect the quality of finished leather, so cleaner technology application needs time. Table 3 shows the application of cleaner production technology of Chinese leather industry.

4.6 The leather chemicals and machineries are playing an important role for the development promotion of cleaning technology in leather industry

In the past, the foreign brands of leather chemicals and machineries have occupied the market of China leather industry and have made big contribution for the development of China leather industry. At the same time, quantity of domestic chemical and machinery companies have been growing up during the past decade.

COD NH3-N

>90% 5060%

>90% 6070%

>90% 8090%

>90% 7080%

>90% 8090%

>90% 90%

Domestic Leather Chemical Companies manufacture series of cleaning chemicals such as liming agent, deliming agent without ammonia, pickling agent without salt, enzyme agent, chrome-free tanning agent, biomass retanning agent and so on, which have been developed successfully and used widely in tanneries, can substantially reduce the content of pollutants in the wastewater, e.g., COD, ammonia, salt, chrome, etc.

Domestic Leather Machinery Companies are helpful in technology upgradation. More and more attention has been paid on the research and development of machineries on automated and high precision leather processing, which can prominently reduce the usage of water and increase the absorption of chemicals, as well as decrease the outcome of waste water and solid waste.

Table 3 : Application of cleaning technologies in Chinese leather industry

Name of technology Effect of discharge reduction

No Sulfur or Low sulfur unhairing technology

Recycling of waste liming liquor

Less ammonia or Ammonia free deliming and softening

Salt-free pickling technology 18.5% reduction of Cl-

High exhaustion chrome tanning technology

Chrome free tanning 100% reduction of chrome discharge

Recycling ratio of Waste chrome liquor reach about 60%, 30%-40% reduction of chrome tanning agent
Utilization of waste wool and shavings for protein retanning materials Recycling 95% of waste wool and shavings

Recovery and recycling of chrome liquor

Utilization of wetblue shavings and scraps for electrostatic flocking materials and collagenous fiber leather

Recycling of waste water after treatment Water-saving ratio:10-30%, the water recycling ratio of tannery≥30%

5. Need to Control / Elimination of Sodium Sulphide in in Leather Process

The conventional raw to semi-finishing process, usage of chemicals and discharge of liquid and solid wastes are shown in the following process flow diagram.

The occupational health and environmental safety in the storage and use of sulphide in the tannery particularly in the beamhouse operation is continued to be a major challenge. The effluent discharged from beamhouse operations contains high concentration of Sulphide (200400 mg/l), BOD (4000-6000 mg/l), COD (6000-8000 mg/l), Suspended Solids (2000-4000 mg/l), etc. The effluent particularly in tropical condition (i.e. 25-35oC) will become

More than 50% reduction of COD discharge compare with traditional process. More than 30% reduction of S2- discharge compare with traditional discharge.

About 20% reduction of COD discharge, 50% reduction of lime discharge, more than 30% reduction of S2- discharge

About 90% reduction of ammonia in deliming and softening process, about 20% reduction of ammonia in whole leather making process

Utilization ratio of chromium to more than 90%, more than 75% reduction of total chrome

Recycling over 95% of waste wool and shavings

anaerobic condition in few hours of time and start emitting H2S in the collection tank, wastewater conveyance system to the ETP / CETP. The emission of H2S is higher, when the pH level in the effluent is decreases less than 7.

Major accidents and deaths occurred due to the emission of H2S during the cleaning and maintenance of the collection wells and conveyance system. One of the highrisk factors is the human being can sense the odour of H2S emission if it is within the low limit and cannot sense if it exceeds 300 ppm and the death will be fatal. The oxidation of sulphide in the beamhouse effluent is a difficult task and if the sulphide level is not reduced below 10ppm in the primary treatment it will affect the operational efficiency of the biological treatment system.

Fig.3 : Sectional operations, usage of chemicals, discharges in the form of liquid and solid waste

The high risk and major environmental challenges of sulphide usage are: health corrosion issues & safety issues during the storage and usage in tannery premises, sulphide containing fleshing become unfit for conversion into useful by-products, emission of H2S and toxic fumes beyond the permissible limits, high cost and energy to reduce sulphide in the effluent. In addition, oxidation of sulphide into sulphate in aerobic condition and reversal of sulphate into

Fig.4 : Ozone Treatment for Removal of Sulphide & Colour

sulphide/H2S in anaerobic condition in sewer line, failures in treatment systems are some of the major issues. To address this major issue of sulphide oxidation, the CETPs and ETPs have adopted liquid oxygen treatment and introduced ozone treatment system for the first time in Asian leather sector with huge investments. The process flow diagram of the ozone treatment introduced in one of the CETPs in Tamilnadu is shown below:

6. Results and Discussion on Sustainability

The leather production activities especially raw to semifinishing process are being shifted from the countries such as United States, West European countries, to Asian, North African and Latin American countries. Asian tanneries mainly from India, China, Turkey, etc. Now, the leather industry is facing challenges due to declining market demand, enforcement of stringent environmental regulations. The sustainability of the small-scale units is becoming a serious issue. Major investment is being made for environmental protection and resettlement of tanneries from the urban areas to the industrial parks with common effluent treatment plants. The viable option for salinity and TDS management for land locked areas, segregation of saline streams such as soak, pickle and chromium for separate process and recovery of quality reusable chemical and salt. The other sectional streams with low TDS can be treated adopting conventional physiochemical treatment and the treated effluent may be mixed with treated domestic sewage, similar to the CETP projects in Uttar Pradesh, Pallavaram & Madhavaram in Tamilnadu. The modified / improved processes such as converting part of raw hides and trimmings into protein matter, gelatin and collagen are being adopted in many Asian countries including Turkey, East Europe, etc. in addition to the normal leather processing in the same tannery units. The upgraded treatment systems adopted in South Indian CETPs such as Pallavaram CETP by introducing of advance oxidation systems using jet aspiration, ozone treatment, ceramic UF membrane and discharge of treated effluent through pipeline to the Sewage Treatment Plant (STP) for mixing / dilution with treated domestic sewage for TDS management would likely be followed in many other industry clusters.

New regulations and restrictions such as REACH on the use of certain chemicals such as Sodium Sulphide, Bisphenols, restrictions in the presence of Hexavalent

chromium in the finished leather, salinity and water re-

covery under zero discharge concept, sustainable and safe

disposal / management of solid waste chrome containing

sludge, etc. envisaged continued applied Research &

Development activity. In addition, upgradation of tech-

nologies for conversion of low-grade hides & skins and

waste trimmings, etc. to products such as gelatin, col-

lagen, etc. for getting better demand and market value

under circular economy.

7. Conclusion

The application of cleaner production using improved clean

chemicals with upgraded process equipment are becoming mandatory in India, China and other leather producing countries. The conversion percentage of raw hides and skins into other products such as low-grade protein for human consumption, gelatin, collagen, etc. are increasing year by year due to the diminishing market demand for finished leather and leather products in addition to other challenges such as environment, economy in leather production, etc. It is estimated, that the finished leather production will be reduced further during the year 2030 and more leather producing tanneries are gradually changing their product line depending upon the market demand. Many leather research institutions in Europe, India, China and other countries are focusing their applied research and development in conversion of raw hides and skins into different value-added products, minimizing the waste generated from tanned leather in tanneries. The research and development to improve the finished leather quality required for high value products with minimum generation of liquid and solid waste are essential for the sustainability of the world leather sector. The upgradation of treatment technologies for the effluent generated from the byproduct industrial units such as gelatin, collagen, etc. along with the effluent generated from leather process are considered necessary.

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