REVIEW ON WASTE WATER TREATMENT METHODS IN TANNERY WASTE WATER

S.Meenachi* a, Dr. S.Kandasamyb

aDepartment of Chemistry, Al-Ameen Engineering College, Erode-638002, Tamil Nadu, India.
bDepartment Of Food Technology, Kongu Engineering College, Erode, Tamil Nadu-638052, India

*Correspondence email: smeena26@gmail.com

Abstract: Manufacturing of leather products produced numerous by products, solid wastes, high amount of waste water containing different loads of pollutants and increases health risks for human beings and environmental pollution. Moreover, the process economy is as important as removal efficiency during the process evaluation task. Various direct and indirect cost items including electrical, sacrificial electrodes, labor, sludge handling, maintenance and depreciation cost have been considered in calculation of total cost. Finally the study showed that EC method was faster and more economic, consumed less material. It is possible to recycle the waste water and solid waste also used as a raw material in different industries. This article discuss the review of few tannery treatment methods in waste water.

Keywords: Tannery process, wastewater, treatment methods , efficiency

Introduction

India is the third largest leather producing country in the world. Indian tannery industries produce huge amount of waste with concentration of pollutants. The quantity and quality of the effluent can be varying industry by industry, day to day even hour to hour [1,2]. Disposal of tannery wastes and treatment methods are old in tannery industries. In tannery industry processing treatments of hides and skins produce the biggest part of the effluent load. It is possible to divide the leather industry process of transforming rawhide into leather in four main stages like beam house operations, Tanning operations, Post tanning operations and finishing operations.

Preliminary Processing

In preliminary processing, the raw material is prepared for tanning through various conditioning steps: Soaking process used for the removal dirt and impurities, blood and preservatives and creates softness. De-hairing process removes hair, wool and keratin from the hides. Deliming removes excessive lime used in de-hairing. pH of hide reduced by Pickling, which favors tanning.

Tanning

It is the process which converts animal hides into leather. The hides and skins
have ability to absorb other chemical substances, which used to resist wetting and prevent decay. During the tanning process, the leather attains resistance towards chemical, thermal and microbiological degradation. The tanning can be done in two ways, either with vegetable tanning or chemically with chrome. The waste stream, after the tanning process contain an excess tanning agent, and trace of hide residue. Generally, chrome tanning is used to process leather than the traditional vegetable tanning since it consumes less processing time.

Post Tanning: In post tanning operation, the tanned hide is washed to remove the unfixed tanning agents. Substantial amounts of water are used during this process to wash the tanned leather.

Finishing: To enhance the appearance of the leather is the overall objective of finishing and to provide the performance characteristics expected of the finished leather with respect to color, gloss, Handle. Generally, finishing operation ends with mechanical finishing and applying surface coat.

A flowchart for leather processing and pollutants of tannery shown in Figure 1.
Treatment methods

In tannery industry, hides and skins introduced various processes with variety of chemicals in each stage. It contains high concentrations of Cr (III), which could be oxidized to highly toxic and carcinogenic Cr (VI) [3, 4]. Tannery waste was creating more impacts to the environment with health hazards [5, 6]. In tanning of leather done only by chromium (III) salts [7, 8], certain conditions Cr (III) can be converted into Cr (VI). Cr (VI) compounds are responsible for most of the health problems and also the colored wastewaters released into the ecosystem from leather processing industries are toxic and even mutagenic towards living organisms in aquatic environment. These compounds are virtually non-biodegradable [9, 10].

Various chemical, physico-chemical and biological technologies were investigated for the treatment of high loaded toxic tannery effluent. Most advanced technologies were tried for maximum removal efficiency of pollutants. The higher amounts of chemicals utilization, toxic sludge production, treatment area are the problems of conventional methods [11, 12]. Based on that, the application of electrochemical methods to achieve better results for the treatment of highly concentrated wastewater was reported by authors [13, 14]. Electrochemical methods applied in oil and fat emulsion waste water [15-18], plastic and electro plating waste water [19-22], textile waste water [23-26]. Electro chemical treatment was suitable for saline waste water of tannery [27-31].

Treatment efficiency

Precipitation method is simple, more suitable for chrome waste water and metals are precipitated in form of insoluble hydroxides [32]. Removal efficiency reached maximum 37% for COD and 46% for TSS by using aluminum sulfate and ferric chloride as coagulant material [33]. Tannery waste water treated with ozone and ultra violet radiation method, but the method not adopted by industries due to the high cost of ozone.

Vegetable tannery waste water with electrochemical oxidation produce better results compare with other treatment methods [34]. Conventional tannery treatment system to improve its efficiency and prevent the alleged environmental consequence due to the toxic effluent discharge [35]. Tannery waste water treatment using electrolytic and physico-chemical systems, showed poor removal efficiencies. So a combination of electrochemical and biological processes for tannery wastewater treatment was tried [36].

When high amount of waste water can be treated by above mentioned process become cost ineffective and produced sludge very toxic, also create sludge disposal problem. Further investigations were carried out biological treatment remains the most suitable process to treat
organic waste. An up-flow anaerobic fixed biofilm reactor (UAFBR) used to treat tannery Waste water and obtained good COD and TSS removals even under conditions of temperature shock [33]. Bioremediation technique used for the effective removal of chromium, but other pollutants not removed [37, 38]. Tannery effluent treated by the method of chemical coagulation using sodium and magnesium hydroxides [39]. But the results indicate, the waste water containing high amount of chromium [40]. Available methods where up to 99% removal of chromium is possible [41-44] and usually these sorts of technologies are complicated, expensive and energy intensive and some technologies are not yet in practice widely.

There were many processes for the treatment of tannery waste water was tried nowadays, such as photo-degradation [45] and bio-degradation [46-50], electrochemical methods [51-53]. Aluminum electrodes are considered superior to ordinary steel electrodes for its disinfection properties due to its better floatability [54]. Zaroual et al. (2005) studied the removal effect of different pollution with iron electrode used as a sacrificial anode during the electro coagulation treatment of tannery waste water and several mechanisms for the pH variation in the electrolysis were suggested [55].

**Electro coagulation (EC)**

Electro coagulation (EC) has proven to be competitive and effective in the treatment water and waste water to remove metals, anions, dyes, organic matter (BOD, COD), suspended solids, colloids and even arsenic [56]. Reports on disinfection ability of EC are available [57-59]. More than 90% of COD, turbidity, Chromium, iron and nitrate were removed by using aluminum cathode, a current density of 75 A/m²in 45 minutes[60]. Two mechanisms are followed in Electro coagulation process for the removal of pollutants in waste water treatment. The first mechanism is the removal of organic matters by indirect oxidation, apparently through chlorine species formed from chloride ions. The second mechanism the organic pollutants, suspended solids, turbidity from tanning waste water were removed in colloidal form by produced metal hydroxide flocs during the reaction. The removal efficiency of pollutants increased with increasing metal hydroxide flocs. Current density or cell current plays a determining role on the floc formation rate and on the rate and size of the bubble production. At higher cell current or current density, the larger amount of metal dissolution from sacrificial anode accelerates, and brings about a greater amount of metal hydroxide flocs for the removal of pollutants. Furthermore, bubble density increases and bubble size diminishes with elevating cell current or current density, resulting
in faster removal of pollutants. Hence, a number of laboratory scale studies have been carried out to reveal the influence of this key process variable on organic matter, colour and turbidity removal performance.

Significant advantage of electro coagulation process compared with other treatments, dangerous chemicals do not need to be transported and some of them are unstable on long term storage. In this case there is no cost associated with transport of chemical products because the electrodes can be stored for long period opposed to chemical products. Electrochemical processes generally have lower temperature. Potentials can be controlled and electrodes and cells can be designed to minimize power losses. The main reagent here, the electron, is a 'clean reagent' and there often is no need for adding extra reagents.

**Advanced Oxidation Process**

Advanced oxidation process includes different oxidation process with hydrogen peroxide, ozone, Fenton oxygen, and air and UV radiation. Higher chemical concentration and less biodegradable pollutants can be removed by Advanced oxidation processes (AOPs), mainly used for the removal of organic impurities. The efficiency depends on oxidant, operating temperature and concentration of the pollutants. Different oxidation techniques can analysed using UV with TiO$_2$, H$_2$O$_2$ and O$_3$ by Schrank to reduce the pollutants in tannery waste water. The effective treatment achieved by ozone molecules activation and hydroxyl radicals formation in UV/O$_3$ process. Chromium recovered using H$_2$O$_2$ in tannery waste water. It is a suitable oxidant to recover 88% of chromium in waste water. In treatment of Fenton and Photo-Fenton processes COD removed 90% in four hours treatment time. Removal efficiency increase with increasing of hydroxyl radicals ($\cdot$OH) concentration. All the treatment methods have some drawbacks. For example, in physical treatment methods like, filtration and adsorption are not always sufficient to achieve the discharge limits; coagulation and flotation generate a large amount of sludge; chemical oxidations have low capacity rates and need transportation and storage of dangerous reactants; and advanced oxidation processes require high investment costs. In this context, oxidative electrochemical technologies offer an alternative solution to many environmental problems.

**Conclusion**

Based on literature the following points should be cleared,

- Chemical coagulation needed additional chemicals that caused secondary pollution.
  
  There were also disadvantages for the photo-degradation of tannery waste water because of the lower energy utilization efficiency.
• Although bio-degradation process was cheaper than other methods, it was less effective because of the toxicity of the tannery waste water that will affect the development of the bacteria.

• Sulfate and Cr are chemically removed, but microbial treatment processes need secondary primary or secondary treatments in analysis. If the process is too long, it becomes infeasible for treating huge amount of waste generated. Often nutrient supplements need to be added for biological processes.

• Compared with other methods, there were a few advantages for the treatment of tannery waste water by electro coagulation. Energy consumption could be decreased for the better conductivity due to the masses of salt and the reaction conditions could be easily controlled by changing the electro cell current or voltage.

• Electrochemical waste destruction shows several benefits in terms of costs and safety. The process runs at very high electrochemical efficiency and operates essentially under the same conditions for a wide variety of wastes.

• EC technology needs better reactor design, understanding and process control in future, because of its numerous advantages and changing strategic global water needs.

References


33. Z. Song, C.J. Williams, R.G.J. Edyvean: Tannery wastewater treatment using an upflow


