



Reorganization of Beaming in Ecological Perspective

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<http://dx.doi.org/10.15677/jallpa.2018.v4i1.16>

Abstract

The principal aim of the leather industry, which plays a significant role in today's global economy, is to transform animal hides/skins into a physically and chemically stable material by subjecting them to chemical and mechanical processes. Leather processings involved in isolation in beamhouse processes generate large volumes of solid wastes and high loaded wastewater which are major source of environmental pollution characterized by chemical oxygen demand (COD), biological oxygen demand (BOD), total dissolved solids (TDS), total suspended solids (TSS), chromium (III) and phenolics with high pH, strong odor and dark brown color. In our study, the best practices modelling and eco-compatible process shifts were the objectives for the decrement in high pollution load of large effluent portion for leather industry. Soaking, immunization and liming processes were carried out with reductive chemical additives and surfactants, fibre opening auxiliaries, enzyme based and enzyme assisted chemicals in the factories as an eco-friendly designed recipe. The results revealed the advantages of time saving, cost effectivity, minimized pollution load and quality enhancement in limed pelts compared to conventional process.

Introduction

The growing global concern on environmental issues has imposed to the adaptation of greener and cleaner manufacturing practices for processing industries. Due to this global agenda Leather Industry has an obligation to keep pace with ecological criteria within the scope of the use of safe and environmentally benign substances, design of energy efficient processes, avoiding the production of waste, minimization of inherently occurred wastes and exploring the safely disposal of inherently occurring wastes. Hence; it is being in motion of technological evolutions.

Conventionally; the leather manufacturing generates significant amount of solid wastes and effluents. Hence; it seems to be a serious threat to environment due to its own pollutive potential including salinity and conductivity, organic and inorganic pollutants (giving rise to high chemical oxygen demand and biological oxygen demand), dissolved and suspended solids, ammonia, total

kjeldahl nitrogen (TKN), specific pollutants (sulfide, chromium, chloride, sodium and other salt residues) and heavy metals etc. (Chowdhury et al., 2013). Due to the fact that 1 ton of wet salted hides yields in 200 kg of finished leather and requires 15-50 m³ water consumption along with the usage of 500 kg process chemicals, the production emanates the total wastes of 800 kg including tanned solid wastes of 250 kg, non-tanned wastes of 350 kg and discharged wastes of 200 kg in the discharged process water (Yang et al., 2009). However; globally emerging environmental concerns about discharge and escalating landfill costs are today's serious problem for the industry. As a general perspective all these problematic issues make the waste management alternatives as much important as treatment practices. These waste management alternatives are based on multi-spots which is a modelling from the source minimization, recovery of wastes and equalization to the optimization of CETP practices.

As a natural consequence of the leather processing,

solid and gaseous wastes are also discharged into the environment. Among the numerous phases of the tanning process, the beamhouse represents 83% of the BOD₅, 73% of the COD, 60% of the suspended solids, 68% of the salinity and overall 76% of the total polluting charge produced during the manufacturing process of hides. Besides, in the beamhouse, the traditional unhairing process with sodium sulfide and lime is responsible for both the highest pollution load and the effluent volume. Consequently, the development of an alternative unhairing process, characterized by a lower environmental impact than the traditional will have a high priority in the leather technology.

Bursa Leather Industry Park at a Glance and Regional Reorganization

Bursa Leather Industry Park, namely BIDOSB in abbreviation, is the pioneer Leather Industry cluster located in southern Marmara region in Turkey (Figure 1). In the region, average 200 tones of hides are processed daily, that is the one fifth of Turkey production annually. Once; in the first time of relocation, it was designed just for resettlement of the tanneries in Bursa Province, but later as a consequence of the loss of Tuzla Leather Park's significance with high logistic prices, majority of the biggest tanneries in Turkey moved their facilities in this region. However; the infrastructure and common treatment plant capacity which was designed by taking into consideration of the first facility layouts remained incapable of the treatment of newly need-based capacity. Hence, a reorganization of modelling of waste management from the source until the discharge to sewage involved in optimization of CETP practices.

The biggest problem is the changing regime and differing the pollution load of the effluent in BIDOSB. Due to full capacity running of the several biggest tanneries which processes raw hides to wet-blue, the increasing flow rates and changing the effluent characteristics gave rise to decrease the efficiency of infrastructure and regional facilities and also required

to take measures for adequate and efficient treatment. For this reason management of CETP practices are of main importance now and prerequisites are to be into consideration. In the regional reorganization, there set 5 points to control and compensate the characteristics before CETP entree unit and finally the last adjustment in equalization tank enables to get it to be in accordance with treatment. But above all, the cleaner processing attempts, best available techniques and eco compatible interventions were our main goals for now and so sustainable forth.



**Figure 1. Bursa Leather Park
A Shift to Ecological Alternatives**

CETP in BIDOSB has a treatment capacity of 8000 m³ effluent daily and recently a flow rate of 5000-5500 m³ is being processed which is coming from 3 different channels, namely; sulphide, chromium and household effluents. Entree unit is simply a start-up station with coarse (13 mm) and fine screens (1 mm) and grease and sand scrapers. Whole flows coming from three different chennals are being distributed in

this unit and must be functional 7/24 hours properly. The chromium channel is flowed into chromium precipitation tank and sulphide is flowed into oxidation tank, hereafter they are flowed up to equalization tank. Household channel flows are directly taken into the equalization tank. For the treatment the mixture of the three channel flows are

of main importance and must be taken the one third from the sulphide effluent and the two third from the chromium and household effluent channel. Otherwise many problematic occasions arises in the plant to diminish the efficiency and performance.



Figure 2. Entree Unit in CETP

As 50 % of the total production capacity is the ones from raw material to wet-blue stage discharging huge amount of sulphide effluents and also only one third of sulphide effluent can be taken into the equalization tank, there is only two options to do the best in treatment and for the efficiency which are the decrement of total sulphide effluent volume and enhancement the characteristics of this effluent. Consequently; we concentrated on soaking and liming to shift from accustomed practices to novelty. The aim was to decrease waste water volume to 13 m³ per tones and below until wet-blue, and besides to get its characteristics better.

Soaking and liming are the most polluting stages. Especially liming involves the use of alkaline medium (e.g. lime) to condition raw hides and skins in which

the aim is to remove the hair, flesh and splitting up of the fibre bundles by chemical and physical means (Mwinyihija, 2010; 2012). The process not only removes epidermal structures; but also brings about the removal of non-structural protein of the pelts by a certain swelling and plumping. As the term implies leather is made or marred during liming, it is so sensitive with respect to final quality. The process modifies the skin fibre for subsequent penetration of other processing chemicals such as tannins and other leather building auxiliaries. Hence; since 1880's neither the process was changed nor improved because of refraining from low quality characteristics. However, the use of this chemical combination generates large volumes of waste that constitutes major source of pollutants accounts for



more than 65-70% in combined tannery effluent (Leafe, 1999; UNIDO, 2000). Its effluents composed of both organic, inorganic matter and containing metals make the treatment very complicated and expensive.

Methods

Our work was to suggest a set of recommendations to subsidize the practitioners in implementing

initiatives promoting environmentally friendly measures to be adopted. We focused on beamhouse processes and traced back to the process parameters considering the analyses.

A process recipe was set by some preliminary trials and after some modification it was incorporated into a guideline for any private company to use their own chemicals. In this process guideline the variables and their effects are given in Table 1.

Table 1. Variables, limitations, impacts and cautions of the process

Variables	Limitations (%)	Impacts	Cautions
Water	70-150	Continous phase in dispersion, appropriate mechanical action	Volume of pollution load, wrinkles along with increasing mechanical action
Liming Auxiliaries	0.5-2	Good dispersion of primary lime and other particles	Good and appropriate sweeling, clean-up of soluble materails and epidermal deposits
Reductive surfactants	0.3-1	Improves loosening of epidermis, scud and the removal of natural pigment.	Allows a significant reduction of the sulfide and reduces pollution and alkalinity
Keratinase	0.2-1.2	Degradation of soft keratin and loosening of hair root	low COD, less sludge, reduced nitrogen
Sodium hydrosulphide	0.5-1.2	Milder effect on break- down of disulfide bonds (S-S) of cystine causing keratin degradation	Increases the pH, alkalinity. Totally destruction of keratin and thereby; increased sulphide and soluble colloids in effluent
Sodium sulphide	0.5-1.0	Stronger break- down of disulfide bonds (S-S) of cystine causing keratin degradation	Increases the pH, alkalinity with high sweeling and veinness. increased sulphide and soluble colloids in effluent
Calcium hydroxide	1.6-2.8	Opening-up and collagen hydrolysis	Relaxed leathers with loosened grain, necks'and shanks' wrinkles. Collagen fibers become finer and shorter, which allows obtaining emptier leathers.



Figure 3. Ecological applications in soaking and liming processes

Studies were performed in the factories which are active in Bursa Leather Park. After conventional and new designed processes, analyses of electrical conductivity, total suspended solids (TSS), total dissolved solids (TDS), chemical oxygen demand (COD), oil & grease and total Kjeldahl nitrogen (TKN) were applied in the wastewaters. Moreover, total sulphide and total chromium analyses were carried out in equalization tank.

Results

The results can be summarized as below;

1. Quality enhancement in limed pelts and splits:
 - Increasing yield in split practicing (with 50-55 % as per the thickness of 2.6-2.8 mm splitting)
 - Efficiency and performance in splitting and also well handling,

- Valorization of splits in gelatine production as a very good quality raw materials, increasing the productivity in gelatine production (yield approx. 17% in gelatine production),
 - Increment of 2-3% in areal yield totally,
 - A remarkable improvement in mechanical properties of leather, especially in tear strength,
 - Possibility of variations in appropriate wet-end processes for multi-purpose and universal finished leather in many end usage.
2. Beneficials in waste water and CETP Practices:
 - Decrement of water usage up to 65% for both soaking and liming,



- Better end-of-pipe waste water quality involved in some parameters of COD, TSS, TKN, Salinity, Conductivity, Total Chromium, Chloride, Sulphide, pH and alkalinity etc.,
- Rehabilitation in efficient CETP practices, sustainable and productive model of controlled management in treatment for local and internationally adopted legislations,
- Improvement of opportunities in use for established capacity involved in tanks, pits, pipes, channels and pumps etc.,
- Decrement of maintenance costs in CETP and its infrastructure,
- Better management in biological unit of treatment (optimal bacterial growth in lower nitrogen and salinity etc.),
- Lower sludge formation and improved sludge quality for disposal,
- Minimization of pollution load of wasted oils and grease for CETP and its infrastructure.

Conclusion

As a well-known fact, while removing undesired substances and ingredients out of the structure and isolation in leather processing and thereby; facilitating the reactions between chemicals and skin/hide protein, process pollution is final and highlighted agenda which needs to be overcome by adopting sustainable cleaner technologies and shifting a new model of management. Bursa case is an example for this new model which is over control and management. In this case study; mostly proven and best available techniques were carried on and adoption of the novelties depends on the enhancement of CETP efficiency. Our study provided the total betterment in effluents with reduced pollution load for leather industry by creating eco-

friendly designed process and thereby efficient treatment possibly achieved. Finally; we are moving in the path of new, more efficient approaches as per the perspective at the forefront.

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