AUTOMATION IN LEATHER MAKING – A CLEANER PRODUCTION APPROACH

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Abstract. Leather auxiliaries, chemicals and raw materials are being handled manually in most of the tanneries. The practice give-rises to spilling over of costly chemicals and utilities causing increase in pollution load, financial loss and health hazards. In order to solve this, a computerized programmable logic controller based dosing system is designed and is installed to automate the unit operations in tanning drum. There are five modules which follow the sequences of operation to improve the working atmosphere and reduce the loss. The material handling through engineering inputs results in improved quality control and provides cleaner production.

1 Introduction

Tanning stabilizes putrescible skins/hides of animals to non-putrescible leather by establishing links between functional groups of collagen and chemicals. Almost 90% of the leather products are produced via chrome tanning. The raw hides and skins have their active binding sites which get bonded with these auxiliaries to avoid spoilage. In the process of leather making, there exist many unit operations where pH of float/hides is adjusted manually. Monitoring pH, hide to float ratio, rate of diffusion of chemicals, time of dosing, temperature and rpm of drums are few factors which need to be monitored continuously through-out the operations. Introduction of process controls at different sequences of operation yields a better consistency in leather quality. The prime important area becomes volume of water and temperature. The next priority comes to correct measurement/ weighing of chemicals followed by pH monitoring (Purushotam et al, 1990). Number of researchers (Huang & Liu, 1996; Hitchingham and Thomas, 2007; Li and Shitao, 2009) has proposed different automatic dosing systems, where the application is other than leather. There are many patents based on which commercial dosing systems are available for leather applications. Tailor made systems have also been reported. However, an integrated facility which takes care of minimizing waste (to avoid use of excess chemicals & water) through its control logic by minimizing cost function is not available. Hence the objective of this work is to develop process control techniques to implement through PLC to minimize rejects and batch-to-batch variation of wet blue quality. This will provide cleaner technology and abate pollution load

In order to achieve this, the rest of the paper is organized as follows: Section 1 gives an introduction to general unit operations in wet tanning of leather processing. Section 2 describes limitations to existing micro-processor based systems. The feature of present computer aided dosing (CAD) system is explained in section 3. Techno-economic study is presented in section 4. At the end, conclusion is drawn.

2 Leather Manufacturing: Unit operations

Leather making is an art where the layers are separated or split across the cross sections into two layers: top layer (hair side) and under layer (flesh side). The top layer is named as full grain which provides durability and malleability while the bottom layer provides stiffness. A coating is applied on it for practical use. The sequences of common operating steps are as follow.

2.1 Presoaking

Hides are soaked to remove salts (which was used for preservation) in revolving drums.

2.2 Liming

Hair and epidermis are removed by adding lime and sodium sulphide. This makes the hides softer, flexible and palpable necessary for upholstery leather. Hides are then delimed, and send for batting and pickling.

2.3 Splitting

The hides are separated into two layers: grain (smooth grains) layer and bottom (flesh side) layer.

2.4 Tanning

The hides are tanned using some leather chemicals which slowly diffuse into leather matrix through its pores. The chrome tanned hides get properties of leather.

2.5 Neutralization

After performing chroming and rechroming in acidic pH, the hides are subjected to neutralization using light alkaline media. Hides are then processed for retanning, dyeing and fatliquoring for making wet blue leather. For producing crust and finished leathers, some more steps like, piling, setting, drying, staking, toggling, trimming, buffing and de-dusting etc. may be necessary.

Most of the above operations are performed in tanning drums where water, chemical addition and pH verification of hides are done manually. This crude method of handling of raw materials give rises to waste and spill over of chemicals. These losses can be minimized by commissioning automatic dosing systems and automatic aqua systems.

3 Features of CAD System

The objective of this work is to produce consistent quality of leathers and to provide a healthy environment through automatic dosing and pollution abatement system. Therefore the entire process control operation is integrated to operate through PLCs with following five modules:

i) Water addition module
ii) Chemical preparation and dosing system
iii) pH monitoring and float recycle system
iv) Drum rotation module
v) pollution reduction module.

In the integrated system, critical and bulk chemicals are stored in bulk storage tanks and are drawn into the load cell (LC) as per process sequence or recipe for feeding into the drums through auxiliary tanks. The float-recycle system helps to remix & heat the float where a pH electrode is housed to monitor pH online. The pH monitoring system adjusts addition of critical chemicals that indicates automatic end point. 10% NaOH is dosed to remove pollution. The control parameters monitored are: hide/float ratio, pH, moisture in the pollution abatement system and uniformity of media (contaminated process liquor). The humidity and temperature of inlet air is controlled and contact time with counter-current media is 10-30 secs. Flow rate of alkali solution is controlled to maintain pollution.

4 Techno Economic Study

Cleaner production is provided through automation of dosing & pH monitoring using PLC in indegeneous way. It has been found that for a 6 drum tannery, the cost of the system comes to be about INR 80 Lakhs. Raw to wet blue process have been experimented using this module. Six batches (each 100 pcs) of hides are processed under 3 batches with conventional and other 3 batches with modified. Wet blue & crust quality assessment have been made on the product. Effluent streams are also analyzed for composition. The gross savings (amount saved through chemicals, power, time saving and reduced wastage of water) play important role in these calculations. By working 300 days per year, the gross profit is calculated to be Rs. 8.63 lakhs per one shift basis or Rs. 17.25 lakhs per two shifts basis. Based on the 4 drums connected to automation system, percent of net return on additional investment comes to be 34%. The pay back period becomes 4 years. Following benefits were achieved:

(1) Quality consistency was improved to a minimum of 3%
(2) Existing capacities can be significantly enhanced by changing over to 3 shift schedules. This is mainly due to saving in process time and hence manpower and power consumptions are reduced.
(3) Strong economic incentives exist for accepting a higher level of investment of automation system. More attractive returns can be realized on investment than hitherto possible with the conventional systems.
(4) The work culture in a tannery wet section with automation system can be changed for the better occupational health and safety. Production teams can be kept well informed of the operation sequences and drudgery can be reduced in various repetitive operations. Work procedures can be systematized to a great extent. Due to reduction in chemical loads, the waste streams from the wet processing area are carrying less chemical loads.

5 Conclusion

Tannery wet operations are automated by implementing various process control measures that will help to yield more throughput, uniform quality product and build awareness on occupational safety. Comparison of products from processes & economic benefit analysis between conventional and PAS (partially automated system with CADS) reveals that the present technique can be implemented in more tanning units throughout the country.

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