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REDUCING OF THE ENVIRONMENTAL IMPACT OF UNHAIRING PROCESS IN COLOMBIAN TANNERIES

REDUCCIÓN DEL IMPACTO AMBIENTAL DEL PROCESO DE DEPILACIÓN EN CURTIEMBRES COLOMBIANAS

Diana Marcela Fúquene [1], Jorge Orlando Manrique [2], Leonardo Emilio Calle [3], Andrea Viviana Yate [4]

[1] Magíster en ingeniería ambiental, candidato a Doctor en proyectos, Universidad Nacional de Colombia, Bogotá – Colombia,

[2] Especialista en ingeniería ambiental, Universidad Nacional de Colombia, Bogotá – Colombia,

[3] Magíster en ingeniería ambiental, Universidad Nacional de Colombia, Bogotá – Colombia,

[4] Magíster en ingeniería química, Universidad Nacional Abierta y a Distancia, Bogotá – Colombia,

[1] dimafuya@yahoo.com

[2] jomanriquep@unal.edu.co

[3] leonardocallep@yahoo.com

[4] anviyase1@hotmail.com

Abstract

In Colombia, the largest percentage of tanneries is located in Cundinamarca, exactly in the municipality of Villapinzon, which is the focus of study because it uses the upper basin of the Bogotá River as receiver source of wastewater discharge. The tanneries are one of the productive sectors that have the greatest negative impact on the water resource, specifically, the unhairing process that uses 1:1 mass ratio (skin-water). Based on this, the aim of this study was the evaluation of the impact of reusing the residual liquors generated in the unhairing process without altering the quality of the final product, through tests at pilot plant level of the process without sulfur and mixed to salted hides. The discharges generated by the process without sulfur were recirculated directly, while the mixed hire discharges had a pre-treatment of oxidation, coagulation and sedimentation, both discharges were monitored by measuring four physicochemical parameters of sanitary interest. The obtained results showed that the recirculation of the water on unhairing process did not increase the costs, by contrast, it represents savings and diminishes the negative environmental impact generated in the upper basin of the Bogotá River, considering that the approximate volume of reuse of water is 50%, confirming the proposed hypothesis about the recirculation of effluents from this process.

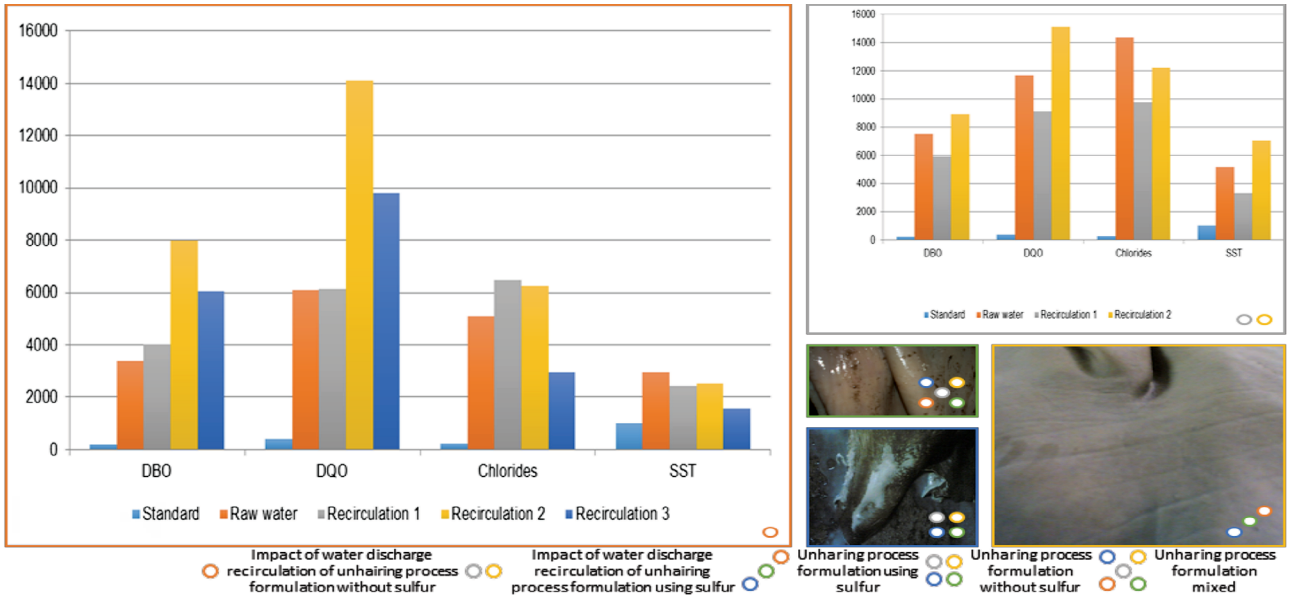
Keywords: Reduction of the environmental impact, reuse of hide discharges, leather quality, unhairing process, tannery.

Resument

En Colombia, el mayor porcentaje de empresas curtidoras se ubican en Cundinamarca específicamente en el municipio de Villapinzón, que es el eje de estudio, debido a que utiliza la cuenca alta del río Bogotá como fuente receptora de los vertimientos que genera. Las curtiembres son uno de los sectores productivos que mayor impacto negativo tienen sobre el recurso hídrico, específicamente, la etapa de pelambre que emplea una relación másica 1:1 (piel – agua). En función de esto, el objetivo de este proyecto fue la evaluación del impacto de reutilizar los licores residuales generados en el proceso de pelambre sin alterar la calidad del producto final, mediante la realización de ensayos a nivel de planta piloto del proceso de pelambre sin sulfuro y pelambre mixto a cueros vacunos salados. Los vertimientos generados por el proceso sin sulfuro fueron recirculados directamente, mientras que a los vertimientos del pelambre mixto se les realizó un tratamiento de oxidación, coagulación y sedimentación, ambos vertimientos fueron monitoreados mediante la medición de cuatro parámetros fisicoquímicos de interés sanitario. Los resultados obtenidos permiten establecer que, la recirculación de las aguas de pelambre no incrementa los costos, por el contrario, presenta un ahorro y disminuye el impacto ambiental negativo generado en la cuenca alta del río Bogotá, teniendo en cuenta que el volumen aproximado de reutilización del agua es del 50%, confirmando la hipótesis planteada sobre la recirculación de los efluentes de este proceso.

Palabras clave: Minimización del impacto ambiental, reutilización de vertimientos de pelambre, calidad del cuero, curtiembre.

Graphical abstract



Introducion

Tanning is a process of transforming animal skins into leather through a sequence process that include chemical and mechanical steps in order to obtain a product resistant to microbial degradation, heat and moisture stress (Alibardi & Cossu, 2016). All over the

world, tannery industry generates high environmental impacts, associated to air and water pollution problems, causing emissions with high biological and chemical oxygen demand and total suspended solids. (Alibardi & Cossu, 2016; Sivagami, Sakthivel, & Nambi, 2017; Martínez & Romero, 2018). In this way, propose alternatives to reduce polution is needed, as including an unhairing mixte or ecological process that allow the reduction of sodium sulphide quantities commonly used in the chemical formulation.

Europe has high production of leather and maintain strict controls for the preservation of the environment through clean and efficient production programs. In contrast, latin america has spend large amounts of money to repair the damages caused by tanneries (Martínez & Romero, 2018; Dettmer, Cavalli, Ayub, & Gutterres, 2013). In Colombia, around 80% of the total tanneries industries are in Bogotá and Cundinamarca, being Villapinzón one of the leading producers of leather nationwide (export type, webs and tulas). However, due to the proximity to Bogotá River watershed, it is used as a receiver source of waste liquor without any previous treatment (Numpaque & Viteri, 2016). In the leather industry, the major consumption of water occurs during the unhairing process with at least a mass ratio of 1:1. Villapinzón tanneries frequently use two types of unhairing methods given by a chemical supply, a mixture that contain chemical and enzymatic compounds with Sulphur, and a mixture without Sulphur.

Although, some tanneries in Villapinzón in order to reduce the negative impact in the river, reuse the wastewater on tanning process for about 16 months. Tanneries that produce exportation type leather, disagree with this technique, arguming that this practice damage the leather's quality (Fuquene, 2011).

The aim of this study was to evaluate the discharges generated by each unhairing method in order to establish a methodology for assessing the effect of the reuse of these effluents on the tanning process and the possibility of discharge effluents in the Bogota River.

Carrillo Neira & Muñoz Labrador (2014) stated that unhairing liquor could be reused twice for the next unhairing processes with or without depleted. When unhairing liquor is used twice, water consumption decreases in 32%, sodium sulfur 5% and lime 56,1%, with a cost benefit ratio upper one. In another study carried out by Gomez Bustamante & Echeverry Giraldo (2010) the characteristics of the liquor at the laboratory level are stabilized after ten or more reuses of unhairing wastewater.

Materials and methods

Materials

Tests were conducted using salted cattle hides sampled randomly from a local tannery. A mini drum (cylindrical rotating reactor, used for hide and leather processing) was used. Two different unhairing agents were used; sulphur formulation (0,5% anti winkle, 6% CaO, 2,2% Na_2S, 100% H_2O and 0,15% NaOH), and sulphur free formulation (0,25% Koramin EKO, 1,8% Depilamin GS, 3,8% CaO and 100% H_2O), both were recommended by chemical supplier house of Villapinzón (PROCUR S.A). All chemicals used for the proposed physicochemical treatment of wastewater were analytical grade.

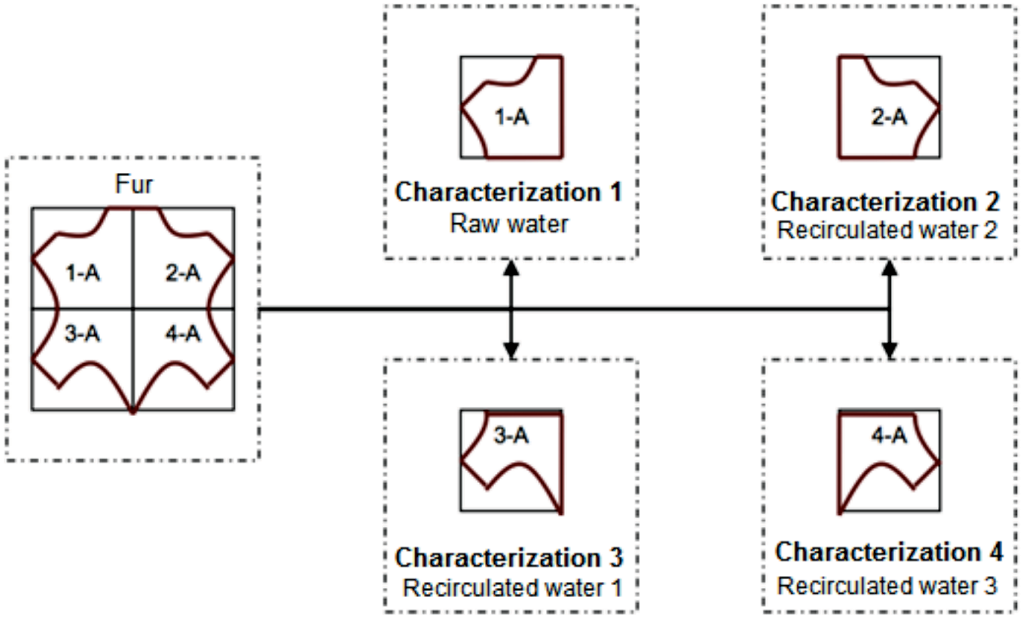
Method

Preparation of the unhairing hide:

For the scaling up, a hide was divided into four equal pieces as show in Fig. 1, to compare the effect of recirculated water in the unhairing hide evaluated. Piece 1-A was washed and soaked with raw water, the wastewater

obtained was used to wash and soak piece 2-A, section 3-A was treated with water discharge from 2-A, and section 4-A was performed with water discharge from the 3-A process. This procedure was conducted with both chemical formulations. Due to the water lost in each procedure, the volume required was fill up (according to the formulations) with raw water.

Fig 1. Bovine hide splitting for scale up test.



Unhairing test

Salted hides were thoroughly washed to remove salt, blood residues, debris, soil and manure. After that, hide went through a process of soaking that aims to restore the hides moisture loss by addition of chemicals such as surfactants (Andrioli, Petry, & Guterres, 2015). At the end of this process, the hides were washed again and drip dried until they reached between 1.0 and 2.0 Degrees Baume (°Be).

Wastewater was collected at the end of each unhairing tests and evaluated by analyzing biological oxygen demand (DBO), chemical oxygen demand (DQO), chlorides and total suspended solid (TSS). Characteristics of the unhairing hide (output of hide and finished product) were evaluated according to method based of Sectorial Chamber of Leather – ANDI (2010)

Wastewater treatment

According to the recommendations of the chemical supplier house of Villapinzon, water discharge using sulphur free formulation does not require any additional treatment, just removal of the hair one hour prior to the end of dosing.

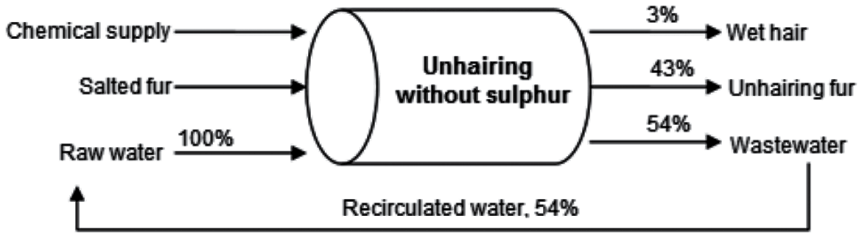
However, a screening step was necessary for wastewater obtained from treated mixed formulation with Sulphur (Agudelo, 2007), followed by a sulfide oxidation and coagulation–sedimentation step, in order to remove contaminants present in water by the addition of chemical products, and removal of non-useful components from the hide, such as hair, fat and meat. The proposed treatment design was based on Romero (2010)

Results and discussion

Sulphur free formulation

According with the flow balance shown in Fig. 2, salty hide requires 100% by weight water in the unhairing process, 43% of this is absorbed by the hide, 54% is left as industrial wastewater or effluent, which needs treatment and can be recirculated, and the remaining 3% is water combined with hair.

Fig 2. Water flow balance

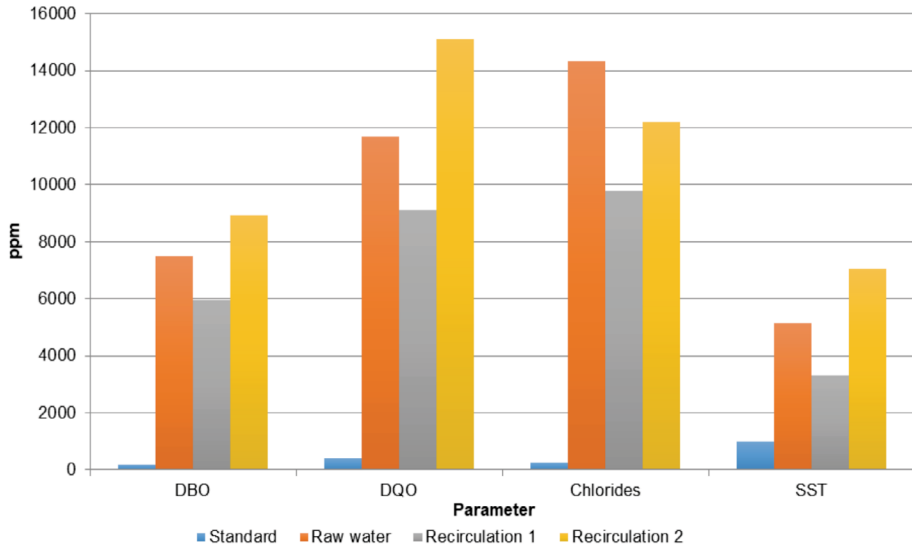


Regarding the unhairing process using Sulfur free formulation, hide sections 2-A and 3-A presented similar hair removal from the unhairing process without recirculation of water. However, hair from section 4-A remained intact, indicating that unhairing process did not work after three recirculation of water.

Figure 3 presents four quality parameters measured to each water discharge, and its comparison with the standard required for tanning wastewater. The obtained results indicate that the recommendation by the home provider of chemical inputs respect the formulation without Sulphur, only applies to one discharge of recirculated water, since the second recirculation is affected negatively by unhairing process, leaving hair on the hide.

According to figure 3, physicochemical analysis presented an increment up to 64% from the first water discharge recirculation to the second one.

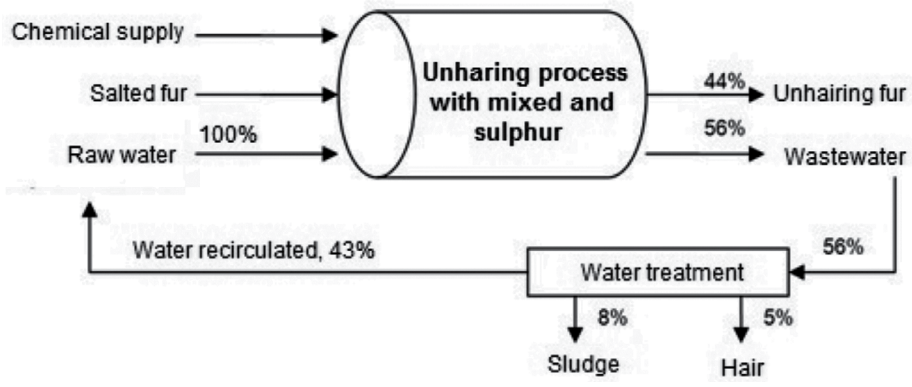
Fig 3. Effect of four quality parameter in the wastewater recirculation of Sulphur free formulation



Sulphur mixed formulation

Figure 4 shows the flow balance of Sulphur mixed formulation. The water discharge is 56% of the inlet water, however, though the removing hair and sludge step, the water discharge is reduced to 43%, being the total water to recirculate.

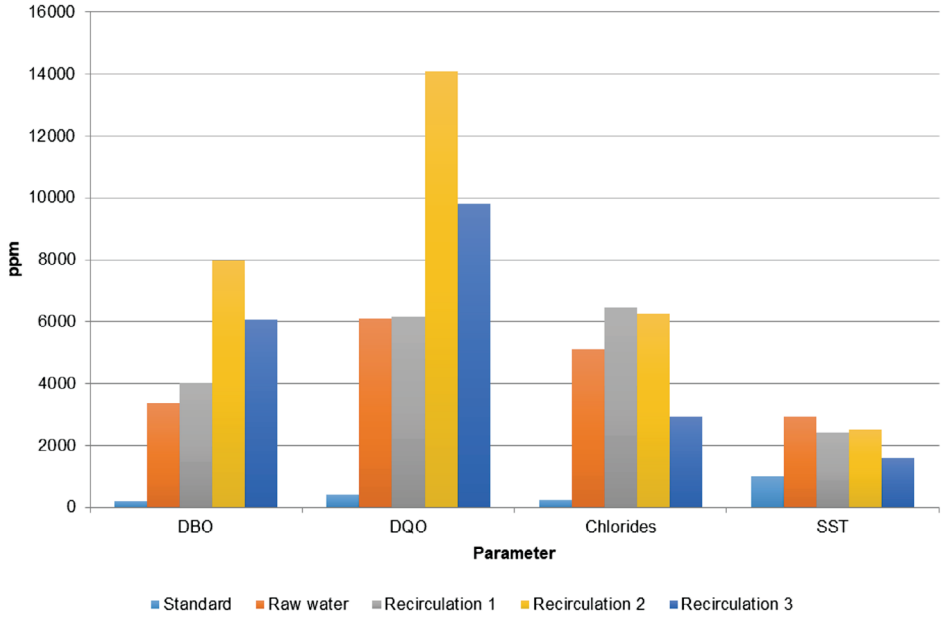
Fig 4. Water flow balance



According to figure 5, this formulation showed low level in all physicochemical parameters measured regarding unhairing process Sulphur free formulation.

Additionally, unhairing process using mixed Sulphur formulation had satisfactory results in hide aspect for the formulation with raw water and the first water recirculation. In both cases, hide was without hair or hide debris, with homogeneous color, good size and open lines.

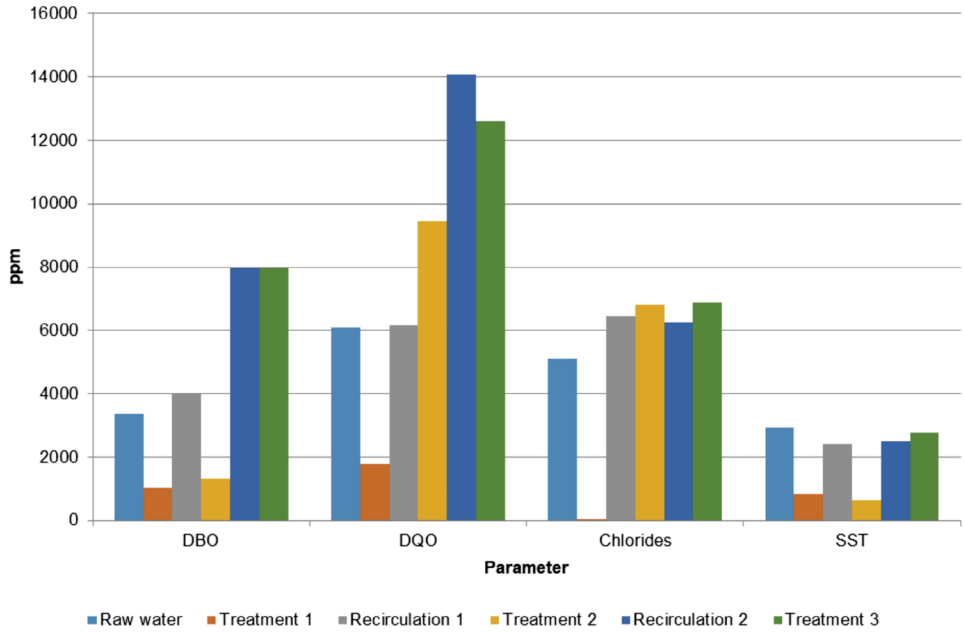
Fig 5. Effect of four quality parameter in the wastewater recirculation of Sulphur free formulation of sulphur mixed formulation



Using this formulation, it was observed that as the number of recirculation was increased, hairless skin was cleaned without traces of skin, which improved the quality of the appalled skin. The first recirculation showed a high quantity of hair removal, leaving a remanence of 2%, while the second recirculation, 1% of the hair remained, and on the third water discharge recirculation, the hide was completely free of hair.

Figure 6 shows the effect of treatment (screening step, followed by a sulfide oxidation and coagulation–sedimentation step) on water discharge carried after the unhairing process.

Fig 6. Effect of four quality parameter of the wastewater treated



Importantly, in the third recirculation, the proposed wastewater treatment was adversely affected, which could be caused by the remnants of pollutants in the wastewater from previous recirculation, which is due to the requiring of various dosages of reagents for treating water.

Conclusions

The recirculation of wastewater from the unhairing process with a previous physicochemical treatment is successful, considering that the unhairing process is performed by tanneries once a week on average.

Untreated water is not recommended to store due to the high content of organic matter, which begins to decompose, generating problems of odors and gases causing harmful to health and the environment. In addition, water decomposition precludes its reuse in the unhairing process because the nature of the contaminants is unknown and when the hide absorbs the amount required for hydration, will adversely affect the quality characteristics of the final leather.

This study evaluated a maximum of three recirculation using a mixed Sulphur formula for the unhairing process. However, further experiments are recommended to determine the maximum quantity of recirculations that would not affect the final product. Moreover, to identify

when the water will be saturated, and the physico-chemical treatment will not be effective.

The wastewater recirculation from unhairing process does not increase costs to the operation process, instead, it represents savings and reduces the negative environmental impact generated by each discharge of wastewater in the Bogota River. Moreover, water reuse promises the reduction in the use of clean water by approximately 50%.

Acknowledgements

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Conflicto de Intereses
Los autores declaran no tener ningún conflicto de intereses