

008-0446

**THE LEATHER INDUSTRY AND ITS ENVIRONMENTAL IMPACT: SUBSIDIES
FOR THE IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT
ACTIONS**

Vanessa Cintra Alves, UNESP-BRAZIL, vanessinhalves_fr@yahoo.com.br

Adilson Renofio, UNESP-BRAZIL, renofio@feb.unesp.br

Agnaldo de Sousa Barbosa¹, UNIFRAN-BRAZIL, agnaldoweb@gmail.com

POMS 19th Annual Conference

La Jolla, California, U.S.A.

May 9 to May 12, 2008

Abstract: The leather industry is relevant for the Brazilian economy, considering that it represented, in 2006, 1.61% of the country's total exports. Acknowledging the growing trend of consumers opting for goods with social-environmentally responsible production processes, it is essential that companies start adapting to this new paradigm to stay in the market. This urge is stronger in the leather sector, since it embraces industries with a high potential for environmental damage. The present study aims to characterize the leather sector in Brazil and survey its environmental impacts with a wide bibliographical research. Considering that the implementation of environmental management actions requires deep knowledge of the object of study, this analysis is relevant as it gathers the main aspects of the leather sector as well as its environmental impact, specifically in Brazil.

¹ Coordinating professor of the CEDER/NEIC (Interdisciplinary Nucleus for Studies on the Footwear Industry and Production Chain) at Unifran in Franca.

Key words: Leather industry, environmental responsibility, environmental impacts of the leather sector, company sustainability.

1 – INTRODUCTION

Part of the footwear production chain, the Brazilian leather sector is considered the third largest producer and exporter of leather in the world, trailing only the United States and European Union, with an annual production of nearly 45 million hides.

In 2004, the Brazilian footwear sector was responsible for the production of 755 million pairs of footwear and it is comprised of more than seven thousand industries (CULTRI, 2005).

Leather production is characterized by large amounts of waste, which are at times disposed of in an inappropriate manner, contributing towards the rapid deterioration of natural resources and the environment.

With the emergence of “green” clients who demand ethical behavior from their suppliers and the urgent need to rationalize the use of increasingly scarcer resource, companies and industries saw themselves pressured to adopt socially and environmentally responsible attitudes in order to maintain their competitive advantage and remain in the market. In some cases, these actions aim at improvements in the environment, and consequently, bring improvements in the population's quality of life. In others, the creation of legislation that regulates productive activities was the great motivator for adaptation aimed at social-environmental protection.

It is possible to affirm that there is a real need to seek ways that contribute towards economic development, without the industry being responsible for deterioration of the environment, since according to Tachizawa (2002), there is no conflict between profitability and the environmental issue. Development should occur in a manner that meets the needs of the present and permits future generations to meet their needs.

Along these lines, the objective of this paper is to characterize the Brazilian leather sector, addressing its main aspects, such as production, the use of inputs in the production process, environmental impacts caused and some information on an important footwear and leather production center located in Franca, SP. The study methodology adopted was bibliographic research.

The elaboration of this study is justified because it gathers the main aspects of the leather sector as well as the impacts on the environment from leather production, important information for the implementation of environmental management actions that are only possible after a broad-based study of the object. The motivation to elaborate this study emerged from a study carried out by the Franca, SP, production center that contains all the leather sector problems presented herein. This study is thus a part of the dissertation work proposed to obtain a Master's Degree in Production Engineering.

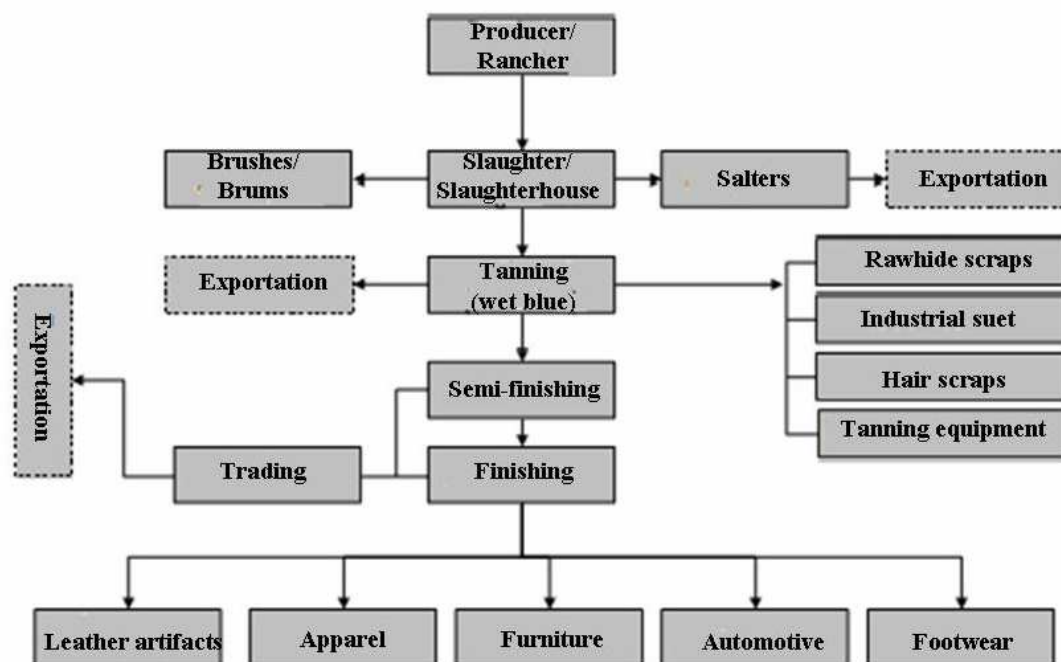
2 – LEATHER'S PRODUCTION CHAIN

Leather's production chain² has undergone some changes, according to Sacchelli (2007), because the footwear industry, once a large consumer of leather, began to use synthetic materials in its production and a growth trend in the use of leather in the automobile, furniture and artifacts industries. On the 1980s, the footwear industry consumed nearly 70% of all leather, whereas by the end of the 1990s, the sector only consumer 45%. This replacement of leather for synthetic materials in footwear manufacturing occurs in an attempt to reduce costs; however, it is a fact that the synthetic material is unable to replace some of leather's characteristics, such as breathability, perspiration absorption, comfort, adaptability to the foot's characteristics, etc.

² The production chain is understood as the series of steps, production cycles, distribution and commercialization through which an input is submitted. According to Castro *et al* (*apud* KONZEN, 2006, p.19) the production chain has a systemic focus and is defined as a set of interactive components, such as: "agricultural and forestry production, service and input providers, processing and transformation industries, distribution and commercialization, as well as the final consumers of the chain's products and byproducts."

In Brazil, the leather industry is mostly comprised of small and mid-sized companies with predominantly national capital. It is also comprised of tanneries and leather artifacts, which together with footwear and components for leather and footwear comprise the main industries in the hide dealer-footwear chain. The other segments that integrate this chain are the cattle raisers, slaughterhouses, leather and footwear machine industries and chemical industries. Figure 1 shows the leather production chain with its main components.

Figure 1 – Leather production chain



Source: Sebrae MG, 2005, p. 2.
Adapted by the author

The tanneries are classified according to their processing phases. They can thus be divided into four types:

- ✓ Integrated tannery: able to carry out all tanning operations, from raw leather (fresh or salted hide) to finished leather.
- ✓ Wet blue tannery: carries out the first phase of leather processing, in other words, it processes from raw leather to chrome tanning or resting/drying after tanning. The name wet blue stems from the leather's damp, bluish look after chrome tanning.

✓ Semi-finishing tannery: this type of tannery uses wet blue leather as a raw material and transforms it into semi-finished leather, the so-called crust.

✓ Finishing tannery: uses crust as its raw material and does the leather's final finishing. The wet blue tanneries that do the final finishing of leather can also be included in this category.

3 – CHARACTERISTICS OF THE BRAZILIAN LEATHER INDUSTRY

According to RAIS-MTE³ data from December 2006, Brazil has 815 tanneries, where only 20% are classified as mid and large-sized companies. Brazilian tanneries formally employ 46,055⁴ people; however, this sum does not include freelancers and workers at slaughterhouses that have their own tanning sector. There are also artisanal tanneries, without formal registration, which contribute with a significant number of informal jobs. AICSul statistics indicate the existence of approximately 175,000 total jobs (CAMPOS, 2006). This demonstrates that informality in the leather production chain is expressive (AZEVEDO, 2002).

The industrial complex composed of tanneries, footwear, machines, components and leather artifacts gathers more than 10,000 industries and employs more than 500,000 people⁵. The hide dealer-footwear chain is a large employer and brings in a great many foreign reserves through exports.

In 2007, Brazilian leather exports grew 17% from US\$ 1.87 billion to US\$ 2.19 billion, according to CICB data in the article "Leather exports exceed US\$ 2 billion in 2007", contributing 15% more foreign reserves than the footwear industry.

³MTE. Ministry of Labor and Employment. Available at: <http://www.mte.gov.br/PDET/Acesso/RaisOnLine.asp>. Accessed on: Jan. 10, 2008.

⁴ Op cit.

⁵ "Brazilian leather generates US\$ 21 billion, creates jobs and generates foreign reserves for the country". *CICB. Center for the Brazilian Tanning Industry*. Available at: <http://www.brazilianleather.com.br/conteudo.aspx?id=349&lingua=1>. Accessed on: Apr. 22, 2007.

According to data available of CICB's home page, in 2007, from January to October, 27,987,101 leather pieces were exported, including salted, wet blue, crust and finished leather. The main destinations for Brazilian leather were China – including Hong Kong – with 33%, Italy, with 28% and the United States, with 11%.

São Paulo is responsible for 35.44% of exports⁶, Rio Grande do Sul for 24.17%, Ceará for 6.58%, Paraná for 6.17%. The other states are Mato Grosso do Sul, Bahia, Goiás and Mato Grosso. Table 1 below shows the evolution in Brazilian exports:

Table 1 – Evolution of Brazilian leather exports from 2003 to 2007 in US\$ billion

| | |
|------|-----------|
| 2003 | US\$ 1.03 |
| 2004 | US\$ 1.29 |
| 2005 | US\$ 1.40 |
| 2006 | US\$ 1.87 |
| 2007 | US\$ 2.19 |

Source: CICB home page article “Leather exports exceed US\$ 2 billion in 2007”, 2008.

Brazil is thus considered the third largest producer and exporter of leather in the world, trailing only the United States and European Union⁷, with an annual production of nearly 45 million hides. The country also has the largest commercial cattle herd in the world, which is favored by the country's territorial extension, plus a favorable climate, providing the appropriate conditions for raising different breeds of cattle and herds of sheep and goats. The cattle herd is estimated at 204.5 million head, which gives Brazil a great international competitive advantage.

⁶ However, according to (*apud* PACHECO, 2005) there is a trend to reduce the number of tanneries in the state of São Paulo, which is mainly due to the difficulties and economic retractions, increased competition and closing of some markets, which pressured the sector to reduce costs, plus the migration of industries to other states, especially in the midwest, where there a large number of herds and slaughterhouses, fiscal incentives, cheap labor and fewer environmental demands.

⁷ Information gathered from the site for the Ministry of Development, Industry and Foreign Trade. Available at: <http://www.desenvolvimento.org.br>. Accessed on Feb. 13, 2008.

The CICB also underscores the Brazilian production of exotic hides, such as frog, ostrich, fish, alligator, chinchilla and rhea hides, and points out that Brazil is the only country with the know-how to produce frog and fish hides, which are a big success in the fashion world. It is also the only country that produces broad-nosed caiman leather, which is exported for use in luxury vehicles and motorcycles around the world.

Despite having a modern industrial park, with skilled labor, there are data that support the need for improvement in the quality of Brazilian leather, which is inferior when compared to leather produced in developed countries, thus jeopardizing competitiveness on the international market, as well as the loss of more than one billion dollars due to inferior quality.

According to Courobusiness magazine, in the article “Brazil loses US\$ 1 billion/year due to defects in leather”, on average, only 8% of Brazilian leather is of high quality, whereas 85% of American leather has that classification. Jacinto (n/d), in a document published by EMBRAPA (Brazilian Agricultural Research Company), explains that nearly 60% of the defects found in cattle leather occur in the field: 40% from ectoparasites, 10% from fire branding in appropriate places, 5% from handling trauma and 5% from accidents (pasture, corral). From shipping to slaughtering and salting, 10% of the defects are caused by transportation trauma, 10% from deficient skinning techniques and 20% from deficient conservation.

The leather production chain begins with the cattle-raising activity, where different raising systems result in different hide qualities, imposing restrictions on processing leather and its byproducts.

Jacinto (n/d) suggests some measures for ensuring hide quality:

✓ In the field: control ectoparasites; brand the herd according to ABNT NBR 10453:96 – Cattle identification brands; fence in the property, pastures and pickets with smooth wire; periodically clean the field – intent on eliminating sharp surfaces, tips of broken branches, remainders of wire, thorns, slivers; do not use the prod as a whip.

✓ In transportation: observe ABNT NBR 10452:96 – Transporting live cattle; the body of the transportation vehicle must be free of sharp edges, nails or screws; the body must be divided every 7.3 meters and the floor must be appropriate for transporting live animals, avoiding slipping;

✓ At slaughter: pre-slaughter bath – check corrals to prevent the appearance of sharp surfaces, spray water to calm the animal down and avoid veining; avoid the use of the whip prod to lead the animal to slaughter; stunning as per legislation; pre-fleshing, splitting and washing, among others.

✓ In conservation: hides must be stacked with the hair down and coarse salt must be distributed between the hides; periodic control of halophilic bacteria.

✓ In storage: must be done in a covered location, sheltered from the sun and with moderate ventilation; be careful to prevent excess dampness.

One aspect that contributes to the poor quality of the leather is that it is a byproduct of cattle raising, and represents 7% to 10% of the animal's value. The cattle rancher thus considers it without any significant commercial interest (COSTA *apud* CAMPOS, 2006). Consequently, cattle ranchers do not make investments to reduce those factors that cause defects and nor do the slaughterhouses, which could adopt a differentiated remuneration system for leather delivered by the cattle rancher. The purchasing process adopted by tanneries is called the *bica corrida*, which consists of acquiring a slaughter period from the slaughterhouse, guaranteeing the desired volume, but without carrying out a qualitative

evaluation of the raw material. This system has negative aspects because it does not permit the control and planning of raw material quality or improvements in the procedures until delivery to the tannery. These factors reveal a disregard with the quality of hides that present imperfections in the pre-slaughter as well as slaughtering phases, including fleshing and conservation (CAMPOS, 2006).

The search for competitiveness requires a systemic perspective and the understanding that the company is part of a production system and that competition standards are influenced by the company's relationship with the other chain members. Thus, intent on improving leather quality, CICB and Sebrae created the Brazilian Program for Leather Quality in October 2004. It seeks to make production chain agents aware of the importance of leather quality, reducing losses from defects in pieces produced and increasing the chain's competitiveness.

Finished leather is the result of the last phase of hide transformation into leather and it consists of the final product with the highest added value of this production process, employing large numbers of workers. According to CICB (*apud* SEBRAE MG, 2005) data, the work force used to industrialize 1000 pieces of leather/day requires 10 employees in the leather salting phase, 40 in the wet blue phase and 300 in the finishing phase.

Investments also increase, as seen in Table 2:

Table 2 – Added value according to leather produced

| | Salted | Wet Blue | Finished |
|--|--------|----------|----------|
| Investments in machines and installations (in R\$ Million) | 0.5 | 1.5 | 8 |
| Processes (# of operations) | 5 | 20 | 70 |
| Chemical inputs (R\$ million) | 0.75 | 3.2 | 15.7 |
| Environmental cost (installations/equipment – R\$ thousand) | 0 | 1000 | 1200 |
| Total cost of production (R\$ thousand) | 16 | 25.7 | 53.6 |

Source: Sebrae MG, 2005, p. 4.
Adapted by the author

Most of the leather produced in Brazil is wet blue, which has the lowest added value in the production chain and also concentrates the largest pollutant load. It is in this phase that chrome tanning is performed, which is harmful to the human being and the environment.

4 – LEATHER’S PRODUCTION PROCESS

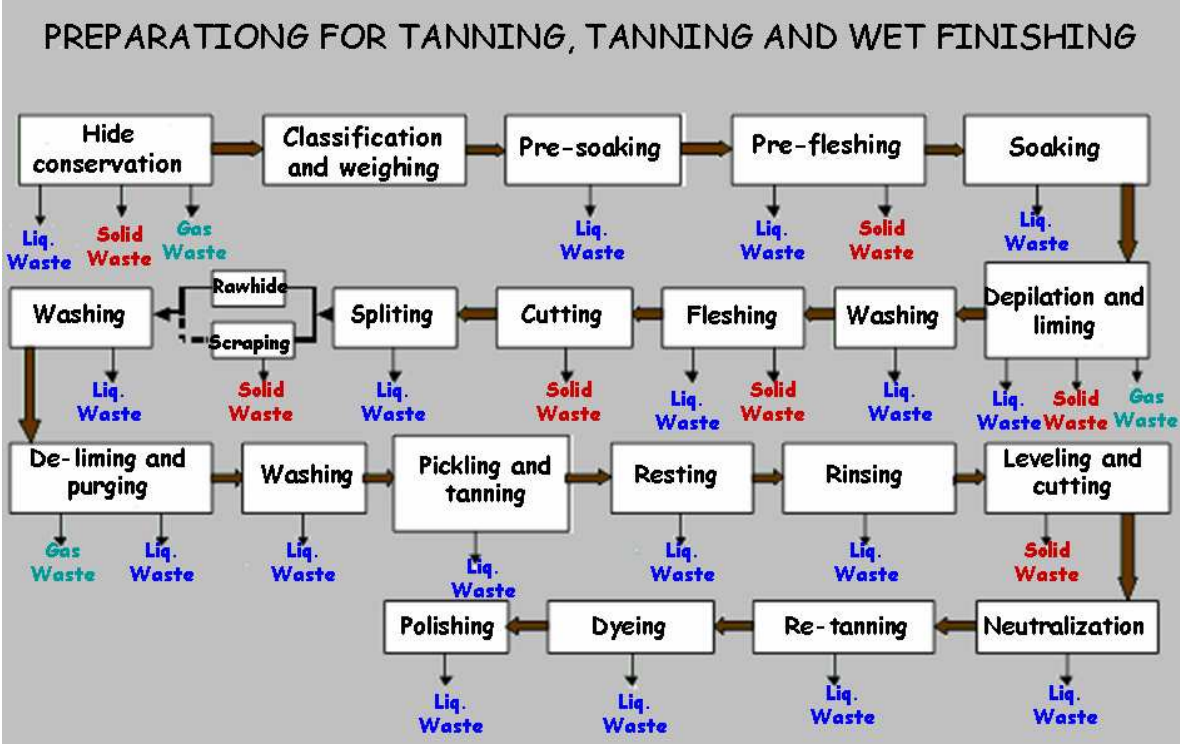
Tanning aims at transforming the hide, which is a decomposable material, into stable material, leather, preserving some of its natural characteristics such as elasticity, softness and feel.

In 2004, Brazil consumed nearly 51,500 tons of basic chrome sulfates to tan 37.6 million produced leathers. This consumption represents nearly 12% of the world’s volume of basic chrome sulfate used in the tanning industry. On a global scale, 90% of the leather processors use chrome salts as the main tanning product, because it gives the leather high quality and stability (SCHEIBE & POHREN, 2005). According to the CICB (*apud* SEBRAE MG, 2005, p. 4), in 2003, leather production by type of tanning was approximately 94% chrome, 6% tannin (extracted from the bark of the mimosa tree) and 0.1% using other methods.

Cattle hide is used in diverse segments and needs a series of cares in processing, since it is a perishable product due to its composition (water, protein, mineral salts, and fats, among others). Leather quality is determined by diverse factors, such as the animals' raising and transportation conditions, slaughtering and fleshing, hide maintenance, among other factors.

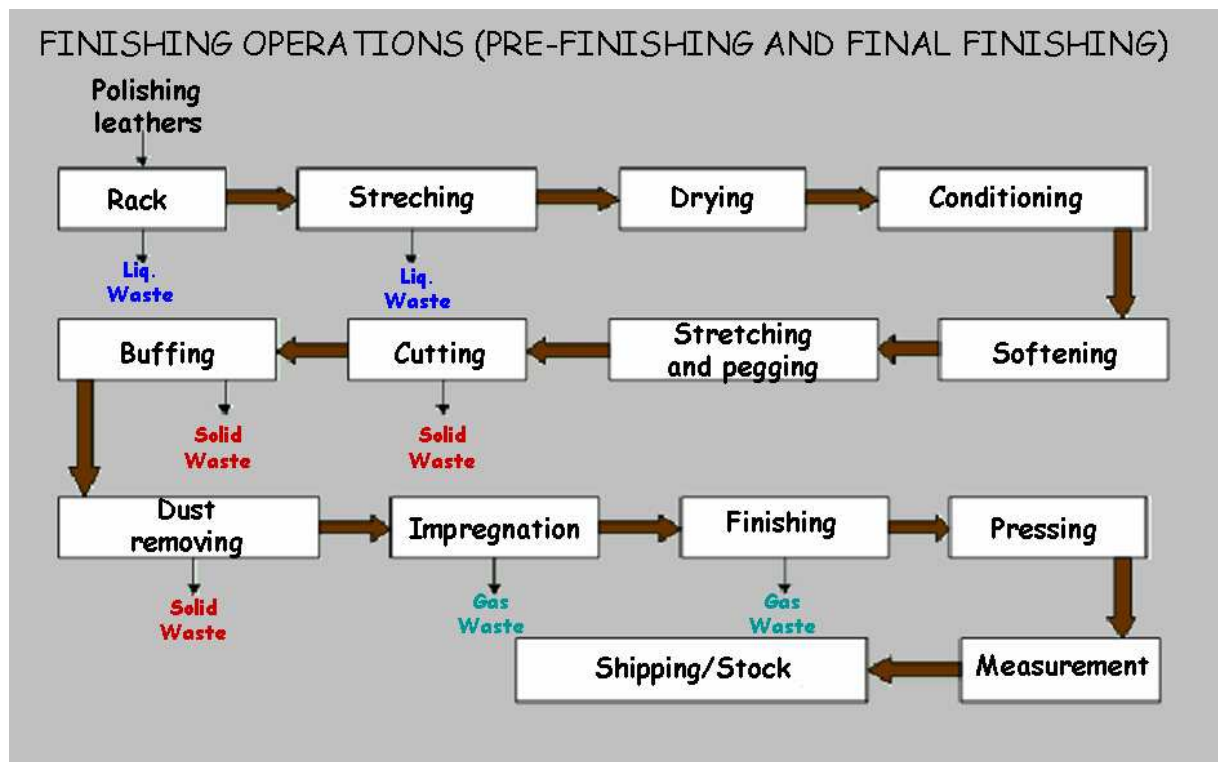
The main processes to which the hide is submitted to become leather are: preparation for tanning, tanning and finishing. The finishing process is divided into wet finishing, pre-finishing and final finishing (PACHECO, 2005). Figures 2 and 3 below show the complete leather manufacturing process, highlighting the main waste generation points.

Figure 2 – Schematic flowchart for manufacturing leather – preparation for tanning, tanning and wet finishing.



Source: Pacheco, 2005, p. 15.
Adapted by the author

Figure 3 – Schematic flowchart for manufacturing leather – finishing operations.



Source: Pacheco, 2005, p. 16.
Adapted by the author

The preparation for tanning operation involves cleaning and eliminating diverse parts and substances from the hide that do not constitute leather and also preparing the matrix of collagen fiber to react appropriately with the chemical products added in the tanning and finishing phases. The preparation for tanning includes the soaking to the pickling phases, performed before tanning (shown in Figure 2).

During the preparation for tanning operation, the hide is divided into the rawhide (which is the upper and nobler part) and the scrapings (which is the lower part with inferior characteristics). The rawhide is processed and made into leather, which is used to manufacture footwear and in the furniture and automotive industry. The scrapings are processed and used to manufacture furniture covers and suede shoes, gloves, aprons and other pieces such as IPE (Individual Protection Equipment).

After the preparation for tanning, comes the tanning, which consists of transforming the pre-treated hide into leather. There are three types of tanning: mineral, vegetal and synthetic.

Mineral tanning is done with chrome and it is the most common, since its process is short when compared to the others. Vegetal tanning, which is done with tannin, has a high cost and it is used to produce soles and some special types of leather. Synthetic tanning uses organic tanning agents such as resins and synthetic tannins. They have higher costs and are generally used as tanning aids.

The finishing phase involves three phases: wet finishing, pre-finishing and final finishing.

Wet finishing aims to complement tanning and confers some physical and mechanical properties to leather, such as basic color, traction resistance, impermeability, softness, flexibility, feel and elasticity. During this phase, chrome shaving residue is generated when leveling leather thickness.

Products are applied to the surface of the leather during the pre-finishing phase to add some physical properties to the leather.

Final finishing involves a series of steps that give the leather its definitive aspect.

5 – RESIDUE GENERATED IN LEATHER PRODUCTION

Solid residue is defined as any solid material that stems from the daily activities of humans in society and which the producer or owner does not consider to have enough importance to be preserved (CETESB *apud* RENOFIO, 2002).

Liquid effluents, solid residues and atmospheric emissions are generated in leather production. Organic and inorganic compounds are present in these pollutants. The organic compounds consist of proteic and lipid components from the animal hides that lose about 30% of organic matter during processing, according to studies. The inorganic compounds are from

chemical products that were not completely affixed to the skins during processing (CASSANO *apud* SCHRANK, 2003, p. 30).

Liquid effluents

The liquid wastes generated by the preparation for tanning operation consist of heavily alkaline and whitish water (excess lime) and contain suet, hairs, muscle tissue, fat and suspended blood. There are salts (such as sulfite, sulfate, chloride, sodium, calcium, ammonia), proteins and diverse amino acids in solution. These effluents have high concentrations of solids in suspension, dissolved proteins and acidic pH. This is the phase with the highest concentration of pollutant and toxic loads in tanning effluents. In order to have an idea of the potential environmental impact, consider that the average weight of 23 Kg/salted hide⁸ and an average organic load of domestic sewage of 54 Kg DBO⁹/inhabitant/day is the polluting potential of a biodegradable organic load of a tannery that processes 3000 hides/day, equivalent to a population of 85,600 inhabitants. The impact is thus quite significant.

The liquid effluents generated by pickling and tanning operations mainly contain salt, mineral acids, organic acids, chrome, proteins and some fungicides, with acidic pH and they may contain high concentrations of DQO and DBO, depending on the tanning agent used. Mineral tanning with chrome is still the main tanning process used in the world, because it is a relatively short process, cheaper and efficient for industrial scale operations. It also gives the leather high quality and resistance, allowing it to be stored for long periods without risk of rotting, despite its countless impacts in the environment.

⁸ These hides are preserved using salt between each of them, which allows them to be stored for months until processing. PACHECO, José Wagner Faria. *Curtimes*. São Paulo: Cetesb, 2005.p. 17.

⁹ DBO – Biochemical demand for oxygen: measures the amount of oxygen needed for oxidation or chemical and biochemical degradation, respectively, of oxidizing materials in the effluents, and therefore, the potential for deoxygenation of water bodies where they are launched. PACHECO, José Wagner Faria. *Curtimes*. São Paulo: Cetesb, 2005.p. 24.

The wet finishing or after-tanning and finishing operations have chrome, salt and dye content.

Atmospheric emissions

Besides the liquid effluents, atmospheric emissions that cause unpleasant odors are also generated by the tanneries from its various operations. These are gases and vapors, released over the production process and during effluent treatment operations. The main emissions are ammonia (which comes from the partial decomposition of hide proteins), hydrosulphuric gas, emissions of volatile compounds from organic solvents, suspended water particles called aerosols and solid particulate material (PACHECO, 2005).

Solid waste

According to Sousa (2006), Brazil generates about 1400 tons of class 1 solid waste from tanneries, footwear and artifact factories every day. Franca, which is an important industrial center, generates nearly 160 tons of these wastes every day.

Solid wastes are the most generated. They can be grouped into two categories:

✓ Non-tanning solid waste: from the rawhide and fleshing and splitting, these are the chippings, flesh, and other wastes resulting from the preparation for tanning process. These wastes are classified as non-hazardous and are rich in collagen and fats. They can be transformed into glue, gelatin, and gum, among others.

✓ Tanning solid waste: these are from the effluent treatment station (chrome-contaminated sludge), from the wet finishing phase, when the leather goes through the physical-mechanical phases of resting, leveling and cutting (comprised of: burrs, chromed shavings, chaffing, scrapings and chippings of tanned leather) and buffing dust. These wastes are classified as hazardous materials (class 1 wastes) and are rich in trivalent and hexavalent chrome (which can cause cancer and mutations in humans). For each piece of

tanned leather, 2 to 3 kg of chromed shavings is generated. In Brazil, approximately 375 tons of shavings are generated daily. In Franca, 15 tons/day are generated. Sludge with chrome is the worst waste generated by a tannery, because besides being material of difficult economic application, large volumes¹⁰ are generated daily that require special areas for disposal. For each ton of chrome processed in the tanneries, 300 to 400 kg of sludge with chrome is generated. In Brazil, 121 tons of sludge with chrome is generated daily. In Franca, this number is around 5 tons per day. With regard to re-tanning sludge, which can have large quantities of chrome, Brazil generates nearly 54 tons every day and Franca around 2 tons per day. (SOUSA, 2006).

The processing of 1000 kg of salted hide generates only 200 to 250 kg of finished leather, which is about 22.5% of the process' average yield, generating nearly 600 kg of solid waste, which demonstrates a significant polluting potential in the generation of solid waste to produce leather.

It is thus possible to see the great waste generation by the sector, and waste that can result in expressive environmental impacts. It is fundamental for the sector to invest in specific cares and treatments in the search to minimize these impacts on the environment. That's why it is so important to implement effective waste management systems, or even to prevent such waste.

6 – ENVIRONMENTAL IMPACTS CAUSED BY THE LEATHER INDUSTRY

A tannery's production process has countless environmental impacts and consumes a large amount of natural resources.

The main environmental impacts are: odor – discomfort for the public's well-being, harmful to water body quality, eventual contamination of the soil and underground waters.

¹⁰ According to Sousa (2006) approximately 4.94 m³ of sedimented sludge is generated per ton of processed hide.

These impacts can occur at every phase of the production process and they follow the emission forms and environmental aspects that can cause such impacts:

- ✓ Conservation and storage of hides: contamination of the air as a result of releasing ammonia gas, volatile organic compounds and hydrosulphuric gas; water contamination by spilling liquids released by the skins; soil contamination through pieces of hide and salt with organic matter.

- ✓ Preparation for tanning operation: contamination of the air with ammonia gas, hydrosulphuric gas and volatile organic compounds; water contamination from residual baths for hide treatment and water from intermediate washings containing organic loads and chemical products (sulfite, diverse salts and others); contamination of the soil from flesh, hairs, hide chippings and scrapings, with and without chemical products.

- ✓ Tanning process: water contamination from residual hide tanning baths, containing organic loads and chemical products such as chrome, tannin, diverse salts, among others.

- ✓ Finishing process: contamination of the air through the release of volatile organic compounds from solvents in products used; water contamination from residual leather treatment baths, containing organic loads and chemical products (such as chrome, tannin, dyes, oils and others); contamination of the soil due to inappropriate disposal of dust, chaffing, chromed shavings, semi-finished and finished tanned leather cutting, finishing product wastes, which include dyes, resins, among others.

With regard to the consumption of inputs and natural resources:

- ✓ The leather production process consumes nearly 30 to 80m³ of water per ton of processed hide (SCHRANK, 2003); however, this volume can vary as a result of the

different raw materials, processes, operational practices and management. According to Pacheco (2005), the average consumption of water for processed salted hide is 630 liters. Thus, a tannery that processes 3000 salted hides per day, consumes approximately 1900 m³, which is equivalent to the daily consumption of a population of nearly 10,500 inhabitants with an average consumption of 180 liters of water/inhabitant per day. This reveals a significant impact in the region's water source consumption.

✓ The consumption of electric energy also depends on the capacity and quantity of consumption, type and state of equipment, type of effluent treatment, efficient energy practices. Consumption varies between 2600 and 11,700 kW/h per ton of salted hide (PACHECO, 2005).

✓ A large number of chemical products are used, such as surfactants, solvents, fungicides, insecticides, acids, natural or synthetic tannin agents, chrome, titanium, magnesium, dyes, salts, sulfonated oils, etc.

The wastes generated by tanneries are rich in trivalent and hexavalent chrome (SOUSA, 2006) and their disposal is viewed as toxic by environmental legislation. Trivalent chrome is essential from a nutritional point of view, and if absorbed in small quantities by the organism, it is not toxic. Hexavalent chrome is highly toxic and has a cumulative effect on the organism, especially the body's soft tissues, such as the liver, kidneys, breasts, prostate, uterus, respiratory system, heart, among others.

Wastes that contain chrome cause significant impacts on the environment due to their high power of contamination. Chrome reaches the water table, rivers and reservoirs that supply the cities. Waste inappropriately disposed of in the soil favors chrome's permanence, which can

be absorbed by the plants that will serve as food for humans, thus contaminating the human being.

Leather industry employees are the most jeopardized because they live with chrome daily, as well as with other toxic compounds. Most of them suffer from skin allergies and have allergic rhinitis, according to Elizabeth Nascimento, professor of toxicology at the University of São Paulo (USP) College of Pharmaceutical Sciences. Prolonged stays in environments where chrome is used favors the development of lung cancer through the inhalation of large quantities of the substance. As with every heavy metal, chrome accumulates in the organism due to direct contact or the consumption of contaminated water and foods, and over the years, it can cause organ failure, such as kidneys, and eventually death. When inhaled in large doses, its hexavalent form, which is rarer and more hazardous, causes perforations in the nasal septum (CAMARGO, s/d).

One case of environmental contamination by industrial waste can be observed in Bocaina, which has an expressive leather complex and carries out the leather finishing process. According to CETESB (CAMARGO, s/d), these tanneries must treat the water, which demands high investments: a mid-sized dyeing tannery spends around R\$ 3 thousand per month to clean 20 thousand liters of water per day. The colored water from the dye is pumped by a coagulation reactor, a sort of blender, which mixes it with diverse chemical components.

The problem is that the cleaning produces another waste, chrome sludge, which must be sent to an appropriate landfill. But, these wastes are often dumped in rivers, causing enormous environmental harm. In Bocaina, the inhabitants complain about the rotten egg odor from the hydrosulphuric gas, which can be lethal in high concentrations. It enters the homes through the sewers, which use the same system to collect the effluents from the processing industries. The contamination brought by solid wastes is more subtle. Their effects cannot be seen, but they just as or more serious than those caused by liquid effluent pollution.

The rainwater removes the chemical compounds from the leather chippings deposited in the soil and carries them over time to the deepest water tables. This can contaminate water collection stations used for urban consumption as well as to supply farms. This danger has an aggravating factor: it is a reloading area for the Guarani aquifer, one of the largest underground fresh water reservoirs in the world, with an estimated volume of nearly 37 thousand cubic kilometers and encompasses the southeast and midwest of Brazil, as well as Argentina, Paraguay and Uruguay. It outcrops in the region. In other words, it has points where it is near the surface and therefore it is not protected. That's why it is sensitive to changes in the environment (CAMARGO, s/d).

Control of atmospheric emissions is another important industrial problem that must be solved by the sector due to, in some cases, occupational illness problems, depending on the tannery's installations and operational procedures, as well as the discomfort caused to the population in the surrounding area, since they are perceived beyond the industrial limits.

7 – THE LEATHER-FOOTWEAR CENTER IN FRANCA: A MICROCOSM FOR OBSERVATION

The city of Franca has a local production layout specialized in the production of men's leather shoes, which stimulated the emergence of correlated companies. According to Suzigan *et al* (*apud* BARBOSA, 2004) Franca is the perfect example of an industrial cluster since it practically concentrates the entire production link for manufacturing footwear, from the leather tannery (main raw material in making footwear) to the manufacturing of machines and components. The installation of tanneries in Franca also dates back to the end of the 19th Century, when two dozen establishments were installed by mid-century, which indicates a tradition in the city (BARBOSA, 2004).

The leather-footwear sector in Franca is considered traditional in relation to environmental problems. According to Barbosa (2004), Franca's industrial park began in the small city, that

is, most of the industries were founded by artisans and former workers. Small manufacturers thus became business people, bringing with them the culture of manual workers. In general, the business owners have restricted cultural preparation and therefore are without knowledge of new management models and have difficulties in incorporating new paradigms.

It is also necessary to take into account the importance the leather-footwear cluster has for Franca, in the context of the sector at the state and national level and the significant environmental impact caused by leather production.

Franca is the main men's footwear center in the country, and considered the second largest overall. According to Sindifranca (Franca Footwear Industry Union) data from 2005, the city has 760 footwear companies that produce nearly 27.9 million pairs, which represents about 3.85% of national production. Of these, 8.5 million pairs were exported, representing 4.5% of the national total. Export earnings reached US\$ 163.4 million in 2005, 8.7% of national earnings from footwear exports. Another interesting factor is that nearly 9.4% of the labor employed in this sector works in Franca's factories.

With regard to the tanneries, the local production layout has 31 companies that employ 1545 people (RAIS-MTE, 2006). According to the article "Leather is the highlight of Franca's growth", published on AICSUL's (Association of Leather Industries of Rio Grande do Sul) home page, in 2007, Franca's leather sector was responsible for 91% of the footwear components commercialized abroad and for 28.95% of the total exported by the city in every segment. Total sales reached US\$ 54.61 million. Exported volume was 5.9 million kilos.

8 – THE LEATHER INDUSTRY AND THE ENVIRONMENTAL ISSUE

Client demands in relation to the preservation of the environment have also reached the leather industries, which have great impacts on the environment. New technologies are thus being developed to minimize the results of the impacts from the leather production process.

One alternative that has been growing in the sector is tanning without the use of chrome. This chrome-free process can become an excellent business opportunity and it will be the future way to tan leathers. As an example, we can cite a footwear company located in Northamptonshire, England, specialized in footwear for babies that does not use chrome in leather tanning. According to the company, the use footwear with conventional leather can cause irritation and dermatitis on babies' feet. The chrome in the leather can also be ingested if the babies put the shoes in their mouths. The leather used by the company is tanned using vegetal extracts that have less impact on the environment and are biodegradable.

Another foreign company that is investing in the chrome-free process is Ecopell, located in Germany. The tanning process used by the industry employs plants and ingredients that do not harm the environment.

According to the Law of Conservation of Mass (BRAGA et al., 2002), waste generation is inherent to the transformation process of raw materials into products; however, with the adoption of tools, such as P+L and P2, the quantity of waste can be minimized and its physical-chemical characteristics altered, causing less impact on the environment. The large amount of waste generated by the leather and footwear industries therefore constitutes a management problem that needs an urgent solution for the environment to not suffer further degradation.

9 – FINAL CONSIDERATIONS

Some considerations can be made from this study. The leather sector is very expressive in the national manufacturing universe. The production of leather implies the large consumption of natural resources, especially water, and significant impacts on the environment, since large quantities of solid waste, liquid effluents and atmospheric emissions are generated. If these are not duly treated and appropriated disposed they can harm human health and water sources as well as contaminate the soil. Despite being the third largest products of leather in the

world, the Brazilian leather industry is lacking in techniques that increase the quality of the leather produced. By achieving this leather quality, it is possible to increase the country's competitiveness and also reduce the environmental impacts since wastes would also be reduced. Thus, sector growth requires investments in quality, techniques to minimize or eliminate the impacts on the environment and studies that contribute towards minimizing sector problems and towards generating jobs and foreign reserves, thus contributing towards the country's growth.

REFERENCES

AZEVEDO, Paulo Furquin de. *Competitividade da cadeia produtiva do couro e calçados*. In: Fórum de Competitividade da Cadeia Produtiva do Couro e Calçados. Brasília: Ministério do Desenvolvimento, Indústria e Comércio Exterior. Secretaria do Desenvolvimento da Produção, 2002.

BARBOSA, Agnaldo de Sousa. *Novos empreendedores na indústria do calçado: formação social e ação empresarial (Franca, 1990-2005)*. Relatório de Pesquisa. Franca: FAPESP – Unifran - NEIC, 2007.

_____. *Novos empreendedores na indústria do calçado: formação social e ação empresarial (Franca, 1990-2005)*. Projeto de Pesquisa. Franca: FAPESP – Centro Universitário de Franca - NEIC, 2004.

BRAGA, Benedito et al. *Introdução à engenharia ambiental*. São Paulo: Prentice Hall, 2002.

BRASIL perde US\$ 1 bi/ano por defeitos no couro. *Revista Courobusiness*. Disponível em: <http://www.courobusiness.com.br/convenio/33.php>. Acesso em: 21 jan. 2008.

CAMARGO, Beatriz. *À flor da pele*. Disponível em: http://www.sescsp.org.br/sesc/revistas_sesc/pb/artigo.cfm?Edicao_Id=214&breadcrumb=1&Artigo_ID=3347&IDCategoria=3633&reftype=1. Acesso em 06 nov. 2006.

CAMPOS, Silvia Horst. *A indústria de couros no Brasil: desempenho superior ao da indústria calçadista em 2006*. FEE. Fundação de Economia e Estatística. Disponível em: http://www.fee.tche.br/sitefee/download/indicadores/34_02/6_parte.pdf. Acesso em dez. 2007.

COURO brasileiro movimentou US\$ 21 bilhões, cria empregos e gera divisas ao país. *CICB. Câmara da Indústria de Curtumes do Brasil*. Disponível em: <http://www.brazilianleather.com.br/conteudo.aspx?id=349&lingua=1>. Acesso em 22 abr. 2007.

COURO é o destaque do crescimento de Franca. *AICSul. Associação das Indústria de Curtumes do Rio Grande do Sul*. Disponível em: <http://www.aicsul.com.br/index.php?acao=noticias&id=1377&PHPSESSID=d2e5266fa>.

Acesso em: 01 fev. 2008.

CULTRI, Camila do Nascimento. *A responsabilidade sócio-ambiental sob a ótica do consumidor de calçados*. Relatório de Pesquisa de Iniciação Científica (Graduação em Administração de Empresas). Franca: Uni-FACEF - Franca, 2005.

DAISY ROOTS. Disponível em: http://www.daisy-roots.com/company/chrome_free_leather_shoes.html. Acesso em 16 nov. 2007.

EUROLEATHER. European Leather Industry. Disponível em: http://www.euroleather.com/portuguese_brochure.htm. Acesso em 16 nov. 2007.

EXPORTAÇÕES de couros em 2007 ultrapassam os US\$ 2 bi, 21 jan. 2008. *CICB. Centro das Indústrias de Curtume do Brasil*. Disponível em: <http://www.brazilianleather.com.br/noticia.aspx?id=393&lingua=1> Acesso em: 21 jan. 2008.

JACINTO, Manuel Antônio Chagas. Produção de couros. *EMBRAPA. Empresa Brasileira de Pesquisa Agrícola Gado de Corte*. Disponível em:

<http://www.cnpqc.embrapa.br/publicacoes/doc/doc127/10producao.html>. Acesso em 22 abr. 2007.

KONSEN, Cleide Cristine. *Panorama da cadeia produtiva do couro bovino no Brasil e em Santa Catarina*. Trabalho de Conclusão de Curso (Graduação em Ciências Econômicas). Florianópolis: Universidade Federal de Santa Catarina, 2006.

MINISTÉRIO DO DESENVOLVIMENTO, INDÚSTRIA E COMÉRCIO EXTERIOR. Disponível em: <http://www.desenvolvimento.org.br>. Acesso em 13 fev. 2008.

MTE. Ministério do Trabalho e Emprego. Disponível em: <http://www.mte.gov.br/PDET/Acesso/RaisOnLine.asp>. Acesso em: 10 jan. 2008.

PACHECO, José Wagner Faria. *Curtumes*. São Paulo: Cetesb, 2005.

RENOFIO, Adilson. *Aproveitamento do resíduo “serragem cromada” na produção de placas para uso na construção civil*. Tese (Doutorado em Agronomia). Universidade Estadual Paulista, Botucatu, 2002.

SACHELLI, Umberto Cilição. O novo perfil da indústria de couro, 02 jul. 2007. *CICB. Centro das Indústrias de Curtumes do Brasil*. Disponível em: <http://www.brazilianleather.com.br/noticia.aspx?id=353lingua=1>. Acesso em 04 dez. 2007.

SCHRANK, Silvia Gabriela. *Tratamento dos efluentes da indústria de couros através de processos avançados de oxidação*. Tese (Doutorado em Engenharia Química) – Programa de Pós-graduação em Engenharia Química, Universidade Federal de Santa Catarina, Florianópolis, 2003.

SEBRAE MG. Serviço de Apoio às Micro e Pequenas Empresas de Minas Gerais. *Perfil Setorial do Couro*, 2005. Disponível em: http://www.sebraemg.com.br/arquivos/Coopere_para_crescer/geor/SIS/EstudosSetoriais/arquivos/PERFIL%20SETORIAL%20-%20CALCADOS.pdf. Acesso em: 26 abr. 2007.

SOUSA, Joana D'arc Félix de. *Reaproveitamento de resíduos sólidos classe 1 de curtumes, fábricas de calçados e artefatos*. Projeto de Pesquisa. Franca, 2006.

TACHIZAWA, Takeshy. *Gestão ambiental e responsabilidade social corporativa: estratégias de negócios focadas na realidade brasileira*. São Paulo: Atlas, 2002.

TREE HUGGER. Disponível em:

http://www.treehugger.com/files/2005/01/chromefree_vege.php. Acesso em 16 nov. 2007.