

## **Fleshing treatment and compacting**

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The by-product “fleshing” forms a considerable part of the residual material deriving from the tan process. Tanneries all over the world have to face this trouble, largely present and causing difficulties relative to: the dumping elimination (the available space into the dumps is more and more reduced); the high cost for its elimination (because of the weight of the fleshing); the storage problems inside the tannery storerooms (owing to the pollutant liquids it discharges); the very smelly emissions (due to its putrescence).

Deltacque proposes the technology applied with the aim to facilitate the storage, the transport and the transformation and/or the elimination of the fleshing produced during the fleshing phase after the liming operation.

We foresee a chemical-mechanical treatment in order to:

- to reduce the pieces of the connective and adipose tissues and to make them easier to handle;
- to reduce the humidity contents (-50/60%);
- to neutralize the pH;  
to eliminate the sulphides.

This technology, developed in an experimental way by Deltacque, is applied by one of the most important tanneries in Santa Croce sull'Arno.

# **PLANNING AND REALIZATION OF AN INNOVATIVE PLANT FOR THE TREATMENT OF THE BY PRODUCT “FLESHING”, WITH INCREMENT OF ITS UTILIZATION.**

The geographical location puts our company to the centre of an important tan pole, the one of Santa Croce S/Arno, where we find the growing need to solve the problems connected with the pollutant materials produced during the process. In particular, in the last years the demand of machinery and technology is more and more increased, with the subsequent necessity of financing, either because of the rising costs for the elimination of the pollutant substances, and because of the more and more restrictive regulations in the environmental area. On the basis of such considerations, engagement and investments were necessary, identifying the realization of the plant, subject of this research, as an important opportunity.

## **PARTIAL PRODUCTION CYCLE OF THE LEATHER**

### **1. RAW HIDES AND THEIR CONSERVATION**

In general raw hides arrive to the tannery wet or dry salted. In fact, the cheapest preservative is the sodium chloride, so the hides worked in Italy are normally preserved with the salt, a small percentage are fresh or kept at a low temperature for short periods, to be conveyed to the tannery by refrigerate trucks. Abroad, green hides are sent to the tannery directly from the slaughterhouse, so the transport has to be very quick (6-10h). This is the method used generally in Southern America.

### **2. SOAKING**

During the soaking operation the water, eliminated during the preservation, is given back to the leather. Hides are also cleaned up from the dirt, salt and other soluble substances. Depending on the way of preservation and the operating method, soaking goes on from some hours (fresh hides) to many days (dry salted).

### **3. LIMING**

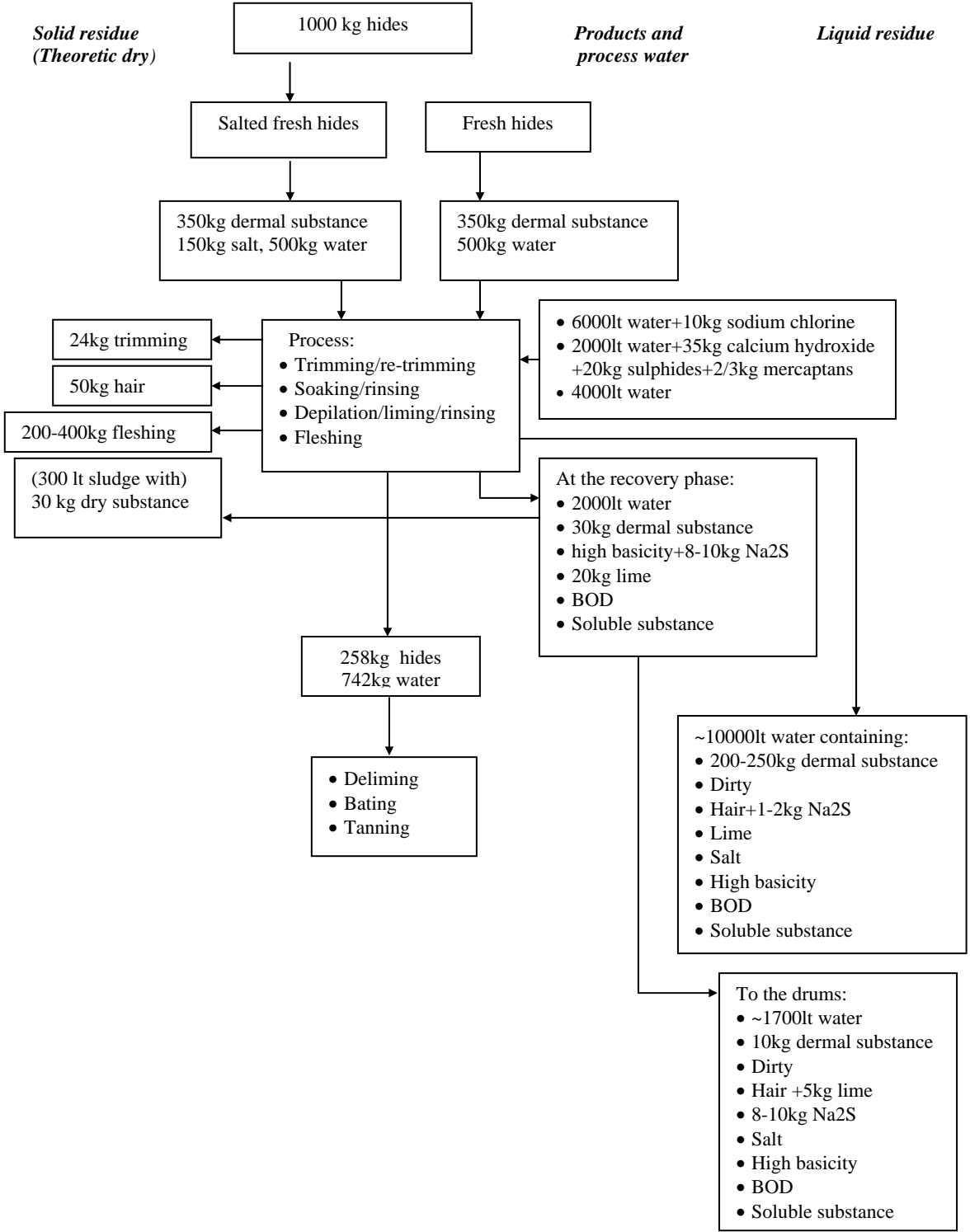
During the liming phase the hair and the epidermis are destroyed or slackened in such a way as to be eliminated mechanically, through the utilization of suitable chemical products. In the same time we get a more or less pronounced blowing up of the fibrous tissue and a partial emulsion of the fat. Soaking is generally carried out with calcium hydrate and sodium sulphide, or with sodium sulphhydrate, having a less blowing up action. Recently, and in order to limit the polluting charge of the waste water, tanners effect an enzymatic liming or having a base of sulphur-organic products (with a low sulphur content) as well as the recovery of the hair for its elimination in a solid form.

### **4. MECHANICAL OPERATIONS (FLESHING, SPLITTING MACHINES)**

After the unhairing the leather is fleshed, it means that the subcutaneous tissue is cut away. A machine generally makes this operation to the too thick leather, mainly to the bovine and horse hides. After the liming, fleshing and eventually splitting operations the leather is called “pelt”. The weight determined in this condition (pelt weight) is the basis to calculate the quantity of chemical products necessary for the following interventions. For a better quality of the final product the fleshing operation may be executed on the soaked hides, so that the

fleshing coming from the fleshing operation may be produced after the soaking or after the liming. In Italy it is normally produced only after the liming phase.

**PARTIAL CHROME LEATHER PRODUCTION PROCESS WITH BATH LIME RECOVERY LINE**



The final remainders of the whole production process are:

- cuttings: 100-160 kgs
- **fleshing: 200-400 kgs**
- trimming rests, before and after fleshing operation: 100-130 kgs
- shaving fragments: 90-110 kgs
- buffing powder: -3 kgs
- hair: 50-100 kgs
- sludge: 30-200 kg by W.W.T.P. (dry substance, depending from the production and from the depuration process technology)

As we can note the by-product fleshing is a considerable part of the residual material coming from the tanning process. It results a hard problem for the tanneries, who has to face either difficulties for its elimination into the dump (the space available into the dumps are more and more reduced); and the high costs for its elimination, connected with the weight of the fleshing; and troubles for its storage inside the factory (because of the pollutant liquids discharged), and problems for the intense smelly emissions (due to the fleshing putrescence).

A higher importance is attributable to this matter when we analyse an area such as the one of Valdarno Inferiore, where the daily production is around 300-400 tons. The material is characterized from a rapid and intense putrescence, having an extremely difficult elimination in a direct way, and now even more complicated owing to the well-known restriction of the law, so that it is necessary to proceed to its immediate transformation.

At present the fleshing, consists of substances having a certain interest (such as fat, proteins, organic material), is sent quite totally to companies which carry out the industrial transformation of the fat extraction, while one part is conveyed directly to the dump. With our project we have the aim of:

- cutting the costs born by the tanneries for the elimination and the management, in general. of this by product;
- reducing the quantity of substances sent to the dump, with a remarkable effect on the environment pollution;
- decreasing the problems of storage and transport of the fleshing;
- finding new utilizations for the fleshing.

On the basis of these results there is the study of a plant allowing the reduction of the fleshing already on coming out of the tannery, that is directly after the fleshing operation. To get this reduction we intend to operate in a chemical way on the leather reminder, treating it mechanically with the equipments predisposed to this purpose. The aim is the reduction of weight and volume to 50-60% of the present quantity.

The realization of such a plant could provide either economic effects or a remarkable spin-off for the environment impact of the tanneries.

After the analysis of the classic tan process and having showed the importance of this by- product in terms of the quantity produced and of difficulties of management, we pass now to the analysis of the fleshing, which are the substance forming it and how it can be used:

- a) **Characteristic:** the fleshing, constituting the subcutaneous tissue of the leather, represents 15% about of the raw material but, depending on the previous flaying, the features of the leather and the quantity of water from the fleshing operation to the

temporary storage and after its elimination, the quantity may increase in a proportional way up to 30-40%.

- b) **Chemical composition:** the fleshing consists of water, fat, proteins (containing impurities due to the treatment of the leather with lime, sulphides and other products in lesser quantity: in fact a standard analysis states that it consists of 10% about of fat, 7% of proteins, 2% of not nitrogenous substances, 8% of mineral salts, the rest of water. The present mineral salts are, mainly, calcium salt and sodium, the first one added as an oxide in the liming operation, the second one coming from the salting of the leather. This composition represents anyhow an average indication as the various origins of the hides and the different pre-treatments make very variable the fleshing produced, especially with regard to the contents of fat and the residual chemical agents used.

**Average composition of the fleshing**

Fat	11,0	(4-18)%
Proteins	6,0	(5-7)%
Not nitrogenous	1,5	(1-2)%
Sodium chloride	3,0	(2-4)%
Lime	4,0	(2-6)%
Sodium sulphide	3,0	(2-4)%
Water	71,5	(62-80)%

## **POSSIBLE MODALITIES OF FLESHING ELIMINATION/REUTILIZATION:**

- *PRODUCTION OF CEMENT OR BRICKS:* The elimination of fleshing through the production of cement or bricks, even if possible, has to be considered a waste of products having a certain commercial value, such as proteins and fat. This utilization could be justified in case it contained toxic and harmful metals to immobilize but from a standard analysis of the heavy metals we deduce that the elements as Cd, Ni, Cr, Cu, Zn, Pb, are present in a very low quantity, between 0 and 10 ppm. It reflects the natural composition of the animal subcutaneous tissue. There are on the contrary some parameters limiting its elimination under the form of cement and bricks, first of all the high percentage of humidity. It is also to be considered that the fleshing cannot exceed the 20% of the mixture, not to create any problems for the production of these handmade articles, as during the cooking of the paste some vapours and smelly gas can develop. The elimination is then in relation to the production of these materials: for any ton of fleshing to eliminate we need at least 5 tons of bricks.
- *INCINERATION OF THE FLESHING:* The fleshing incineration can be one method of elimination but its elevated contents of water, higher than 70%, limits extremely this solution.
- *FLESHING COMPOSTING:* This operative system was modified and improved in a basic way. In remote times the scraps of the inhabited places were completely eliminated pouring them out into the surrounding open countries and were very appreciated by the farmers, as in this way the mineral and organic elements were given back to the ground, after having been transformed and transferred to the field products. Nowadays the city refusals are substantially changed, their content of organic material is very reduced: there is on the contrary a large quantity of plastic materials not decomposing and having neither a fertilizing nor integrative action to a ground poor in organic substances. At present the composting method is having a large spreading: the mixtures of organic refusals are subjected to a slow aerobic fermentation, in such a composition to have a balanced connection C/N on the finished product. Under a technical profile, to get a good composting, we could mix the fleshing (a substance with a high protein content), with cellulose materials coming from different productions. The mixtures of fleshing and wood sawdust, fermenting, give raise to a good quality product, to be used profitably for agricultural purposes as it could also contain some microelements, very important for the plants growth. The contribution of undesirable elements would be scarce or null as this type of composting is coming from fleshing (a natural, organic product of an animal origin) and wood (also an organic material of a vegetable origin). This type of elimination needs a long time to allow the fermentative exothermic process, necessary for the stabilization of the composting, so that it is not applicable to so high quantities produced per day.
- *TRASFORMATION OF THE FLESHING IN INDUSTRIAL PRODUCTS:* In the Valdarno Inferiore area the daily production of fleshing is around 300-400 tons. As previously stated, fleshing consists of substances having some economic value: fat and proteins. This is the reason why the local company S.G.S. realized an industrial process of extraction of these products. S.G.S. collects the fleshing, very polluting because of the presence of calcium salts and sulphides and putrescent and, grinding, cooking, separation and other

- specific operations, produces proteins and animal fats. This working requires a huge quantity of acids and bases producing, in addition to the wished products, important quantities of solid residues, which have to be eliminated into the dump, with a heavy economic expense.

## ***FLESHING PRE TREATMENT PLANT***

On the basis of what before mentioned we realized the plant object of this project, allowing to the tanneries to solve or at least to simplify their management of the fleshing; on the other side to favour new employments for the fleshing, decreasing its environmental impact and improving its positive features: the present elimination in dump will become the less practicable solution in the future.

### ***PLANT CHARACTERISTIC***

The plant we intend to realize through this plan will be positioned at the end of the fleshing phase, in the same position where are now the present containers-skips for the fleshing.

Through a conveyor or a pump, to one collecting hopper, realized in stainless steel, transports belt the fleshing coming from the fleshing operation. The hopper will be the higher part of the whole structure to realize and will allow the passage of the fleshing (or by fall or through a valve) to the grinding phase, to a mill who effects the fleshing defibration.

After, through a valve positioned on the bottom of the mill the defibrated fleshing will be sent to the following structure, the reactor.

The reactor is formed by two tanks in stainless steel, having a circular shape and a spherical bottom, surmounted by the mill valve, feeding the tanks, one after the other. Inside the tanks it will be realized a powered structure for the mixture.

At the side of the tanks and connected through special pipes and pumps, there are the dosing groups consisting in containers, dosing pumps and valves.

They carry out the introduction of the chemical products necessary to get the treatment of the fleshing.

Inside the tanks some gas will be created and it will be necessary their elimination through a gas suction and elimination structure, connected through piping and suction fans to the dosing valve positioned on the reactor group. After the chemical reactions-transformations the fleshing will be discharged through a valve on a horizontal Archimedean screw, put under the tanks.

This Archimedean screw will have the function either of product pulling or of a first water separation, through special belts.

At the end of this passage, the fleshing will be discharged into a self-cleaning compacting screen while the water, already separated, will be conveyed to the sewerage system for its following treatment through suitable structures.

The compacting screen allows compacting the material as much as possible, reducing in a drastic way the content of water, which will be sent directly to the sewerage system for its following treatment.

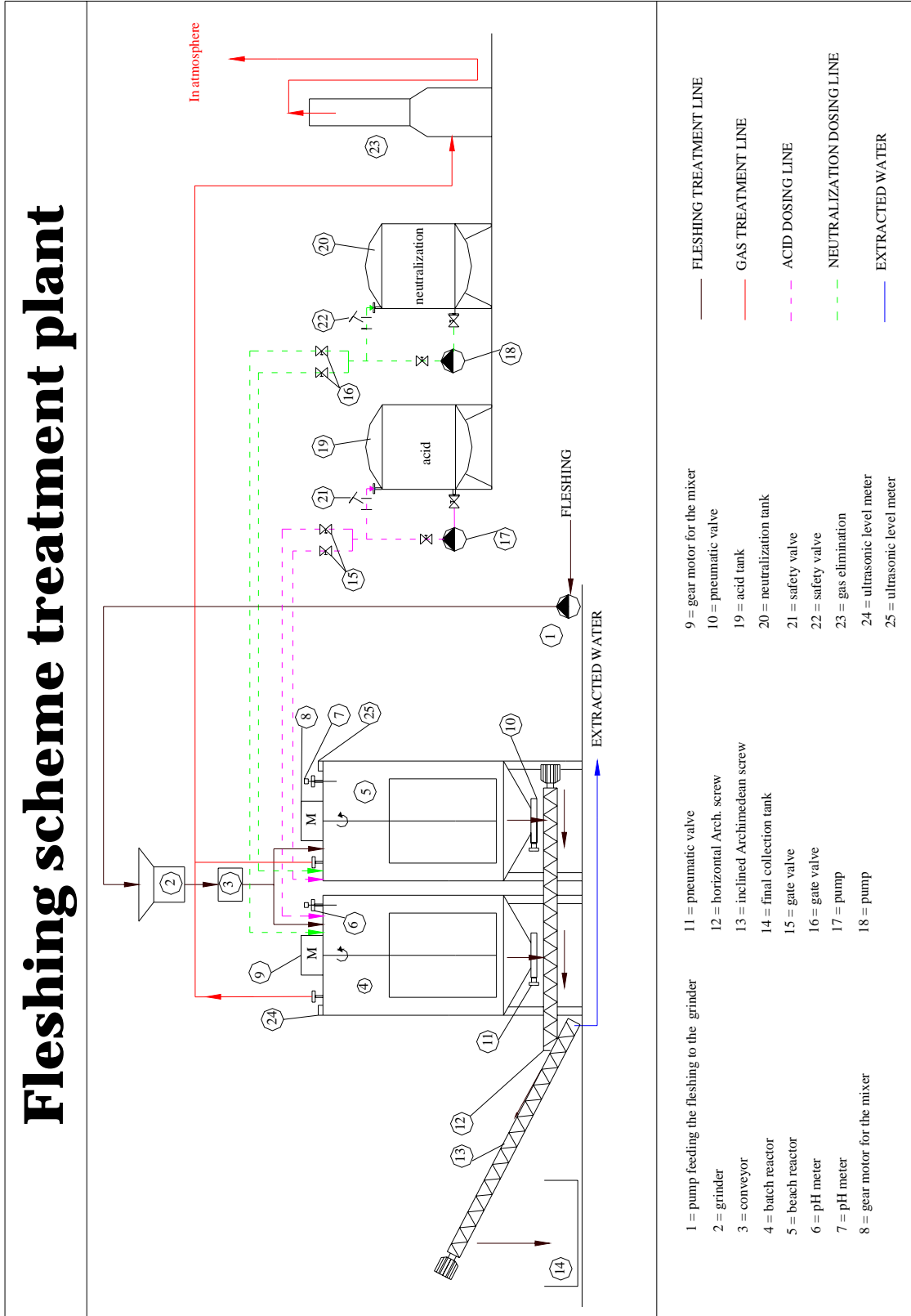
Once bereaved of its water content and so in a very dry condition, the obtained material will be discharged in suitable containers-skips, for subsequent utilizations.

### **PLANT SCHEME:**

1. Structure in stainless steel, where all the component parts are set up
2. Collection and grinding: this part of the plant is formed by the conveyor belt and/or one pump, by the collecting hopper, the grinding mill and the dosing valve
3. Reactor: formed by the tanks, mixers, batchers and by the column for the gas elimination
4. Compactor: it consists of the pulling Archimedean screw and of the compacting screen



Scheme will follow:



The main innovation points of this project may be so synthesized:

- Realization and/or modification of a grinding mill trying to identify the most efficacious system to get the fleshing defibration (knives, hammers, rollers, etc.)
- Identification of a chemical procedure able to modify the physical state of the fleshing, to allow its compacting
- Compacting and screening of the fleshing.

The project showed in its main lines, represents a solution totally innovative for the market, as at the moment there isn't any type of machinery realized for the fleshing treatment, in particular, able to reduce its water content in a significant way, to make it lighter, less polluting and more suitable for its utilization in various sectors.

### ***TECHNICAL-SCIENTIFIC PROBLEMS***

The main technical-scientific problems to resolve for the realization of the project are connected with a chemical process research allowing the physical contraction of the fleshing; the planning and the dimensioning of the plant to make it efficient and suitable to the various companies where it will be introduced; the study of the compacting system that, working on the fleshing modified in its structure, will be able to reduce the water contained as much as possible, in order to cut the following:

- The weight
- The elimination costs
- The dimension, to simplify the storing and the displacements;

and to allow the fleshing utilization in activities such as:

- Composting
- Combustion
- Bricks production, where it can't be now utilized, because of the high humidity.

To identify the best solution for this problem, the experience of our company, developed in the wastewater treatment field, will be very important.

In short, we can indicate the main problems existing at the moment in a tannery, with regard to the fleshing, and the solutions we will get with the realization of this research.

<b>Problems</b>	<b>Solutions</b>
The fleshing elimination has a very high cost	Reduction of the water content, reducing the total weight of the fleshing to 50-60%
The fleshing can be used only for its fats extraction	Possibility of various utilizations of the fleshing
Smelly work surroundings	Elimination of toxic substances and stabilization of the putrescible substances
Difficulties for the storing and the displacements	Reduction of the dimensions and of the noxious substances
Troubles for the elimination in the dump	Reduction of the quantity sent to the dump

## Fleshing treatment and compacting

Modules have composed the research.

As follows, the purpose of each module:

- |   |  |
|---|--|
| 1 – Definition of the specifics for the research and the planning | <ul style="list-style-type: none"><li>• Detailed definition of the specifics for the fleshing treatment plant realization</li><li>• Planning of each component of the plant</li></ul>  |
| 2 – Assembling of a pilot plant                                   | <ul style="list-style-type: none"><li>• Construction of a pilot plant for the verification of the theoretic results on the characteristic of the treated fleshing</li></ul>  |
| 3 – Experimental tests on the pilot plant                         | <ul style="list-style-type: none"><li>• Functioning verification of the planned process</li></ul>  |
| 4 – Realization of a whole plant                                  | <ul style="list-style-type: none"><li>• Construction of a definitive plant, dimensioned on the characteristic of the company where it will be installed</li><li>• Placing of the plant by a tannery, to verify its functioning</li></ul> |
| 5 – Final test and optimization                                   | <ul style="list-style-type: none"><li>• Verification of the plant functioning and the aims foreseen</li><li>• Analysis of the fleshing characteristic and verification of the possible utilizations</li></ul>                            |

The success of the research will allow to open new opportunities for the utilization of the fleshing, giving remarkable advantages to the environment; it will allow to improve the work surround in the place where the fleshing transformation takes place (tannery and further transformation factories); and it will permit in particular to give an immediate solution to the present difficulties for the fleshing elimination, as regards to the cost and the place in the dump.

Besides we will verify the composition and the characteristic of the fleshing treated by the plant, sending the samples of the material obtained to external companies, in order to verify the possibility of utilization in the bricks industry, or for the composting or the incineration.

## **FLESHING DEHYDRATION TESTS**

- Date: 04<sup>th</sup> – 07<sup>th</sup> April 2004
- Place: Castelfranco di Sotto (PI) laboratory
- Material: fleshing
- Client: Tannery in Castelfranco di Sotto (PI)
- Executor: Mr. Roberto Lupo
- Collaborators: Eng. Robi Novelli, Mr. Massimo Dainelli

### DESCRIPTION OF THE OPERATIONS

We took 3 kg of not minced fleshing, simply cut into pieces of a medium size, then we wrung out a part of them to get some of the water contained (Sample n. 1). To keep the proportions resulting from the different samples taken at the end of the fleshing, we added 1,2 l of the water in the container.

We added H<sub>2</sub>O<sub>2</sub> on the fleshing sample, to eliminate the sulphides present. Once the sample was mixed and uniformed, we added some acid till the pH reached the value of 5.

In the same way we took other 7,15 kg of fleshing, to which we added 2,9 l of water plus H<sub>2</sub>O<sub>2</sub> (Taken the sample n. 2) + plus the acidifying product. We combined the two samples leaving them for 3 days into a container, then we took the sample n. 3 (79,4 g of mixed sample, fleshing plus 12 ml of supernatant).

We prepared 10,15 kg of fleshing totally, to which we added 4,1 kg of water and acid. At this point we added a neutralizer till getting pH 7. We wrung for a first time the sample obtaining a weight of 5,9 kg, with 7,5 l of extracted water (from which we took 250 ml for the analysis: sample n. 4).

After that we introduced the sample of fleshing into a perforated container, with a counterweight of about 40 kg, so to simulate the wringing of a press (collecting the outlet water). Then we removed the sample to press it again, getting 3,8 kg of material.

On the further 2,1 l of extracted water we took the sample n. 5.

### SAMPLES TO ANALYZE

Summary about the sample we took:

1. Initial wringing of the fleshing with no treatment, no water addition;
2. Water sample after dilution of the 2<sup>nd</sup> starting sample with clear water;
3. 79,4 g of fleshing plus water, after acidification;
4. water from the first wringing (250 ml);
5. water from the second wringing.

The result of the test was to reduce the weight of the starting sample from 10,15 kg to 3,8 kg with a reduction of the water containing of 62%.

### SULPHIDES PRESENCE

Analysis on the sulphides present in the water into the fleshing:

- on the starting sample: S<sup>2-</sup>: 1,1 g/l;
- after the adding of H<sub>2</sub>O<sub>2</sub>: 28 mg/l;
- after agitation : 7,4 mg/l;
- after wringing: 1,9 mg/l.

Analysis on the samples:

N. 1

- COD: 74.151 mg/l
- SST: 55.600 mg/l
- Fat: 3,7 mg/kg – mixed sample
- Total nitrogen: 5.917 mg/kg

N. 2

- COD: 54.819 mg/l
- SST: 32.350 mg/l
- Fat on supernatant: absent – supernatant sample
- Total nitrogen: 3.116 mg/kg

N. 3

- COD: 26.531 mg/l
- SST: 22.400 mg/l
- Fat on supernatant: 2,8 mg/l – supernatant sample
- Total nitrogen: 1.513 mg/kg

N. 4

- COD: 16.242 mg/l
- SST: 11.060 mg/l
- Fat on supernatant: 0,9 mg/l
- Total nitrogen: 984 mg/kg

N. 5

- COD: 12.792 mg/l
- SST: 8.420 mg/l
- Fat on supernatant: 1,13 mg/l – supernatant sample
- Total nitrogen: 992 mg/kg

## **EXPERIMENTAL TESTS ON THE PILOT PLANT**

- Date: June 2004
- Place: Castelfranco di Sotto (PI) plant
- Material: fleshing
- Client: Tannery in Castelfranco di Sotto (PI)
- Executor: Mr. Roberto Lupo
- Collaborators: Eng. Robi Novelli, Mr. Massimo Dainelli

### **DESCRIPTION**

We used a steel tank having a useful volume of 120 l with a vertical mixer able to mix the fleshing reduced to 3 – 5 cm of dimensions. The product moving was realized during the dosing of the products for the fleshing treatment. The tank has an inclined bottom where a discharge with a manual valve is positioned.

Through the opening of the valve the fleshing was discharged in a compacting Archimedean screw positioned under the tank.

We realized a test taking 70 kg of fleshing from a tannery in Castelfranco di Sotto, employing the same process of the laboratory tests and getting similar results.

On the basis of the results we got we effected the economic calculations on the feasibility of an industrial plant for the residue transformation, to be installed by a local firm.

## **ECONOMIC CALCULATIONS ON THE FEASIBILITY OF AN INDUSTRIAL PLANT**

### PROJECT DATA

Activity: **tannery**

Process: **fleshing**

Fleshing quantity obtained from the process: **9 T/day (200 T/month)**

Intervention realized for the treatment: **storing and further transport to the firm SGS for the treatment or to the dump (depending on the origin).**

### GENERAL DATA

Working days: **220 days/year**

Quantity of fleshing production (future total): **9 T/year (\*)**

Process functioning: **10 hours/day**

(\*) **60% of the fleshing to be send to the dump**

**40% of the fleshing to be send to SGS firm.**

### CHARACTERISTIC OF THE FLESHING TO TREAT

pH: **12**

H<sub>2</sub>O: **75%**

Fat: **24%**

Protein: **12%**

Ashes: **4%**

(% **weight average**)

### CHARACTERISTIC OF THE TREATED FLESHING

pH: **7-8**

H<sub>2</sub>O: **50%**

Fat: **24%**

Protein: **18%**

Ashes: **8%**

(% **weight average**)

### INVESTMENT COSTS

Whole plant: **145.000,00 €(Machinery/structures/process engineering/assembling)**

### PRESENT MANAGEMENT COSTS

To the dump: **5,4 T/day = 702,00€/day (130,00 €/T)**

SGS: **3,6 T/day = 252,00 €/day (70,00 €/T)**

Total: **9,0 T/day = 954,00€/day**

**SGS: company transforming the fleshing, for the extraction of the contained fat.**

MANAGEMENT COSTS AFTER THE PLANT INSTALLATION

To the dump:	<b>2,7 T/day = 351,00 €day</b>
SGS:	<b>1,8 T/day = 126,00 €day</b>
Total:	<b>4,5 T/day = 477,00 €day</b>
Electrical energy:	<b>97 Kwh/day = 7,30 €day (*)</b>
Plant amortization:	<b>94,10 €day (**)</b>
Acidification product:	<b>143 kg/day = 15,80 €day</b>
Neutralizing product:	<b>65 kg/day = 5,20 €day</b>
TOTAL:	<b>599,40 €day</b>

**(\*) 0,075 €Kwh – from 07.00 to 21.00**

**(\*\*) 145.000,00 €on 7 years for 220 working days**



FINAL CONSIDERATIONS

With the present proportion, between the fleshing sent to the dump and the one conveyed to SGS firm, the difference of the costs is the following:

Present cost:	<b>954,00 €</b>
Future costs:	<b>599,40 €</b>
Difference:	<b>354,60 €</b>

**Yearly saving: 78.012,00 €**

If the proportion changes we will have the following:

➤ **60% SGS – 40% to the dump**

Present cost:	<b>846,00 €</b>
Future costs:	<b>544,37 €</b>
Difference:	<b>302,63 €</b>

**Yearly saving: 66.587,60 €**

➤ **80% SGS – 20% to the dump**

Present cost:	<b>738,00 €</b>
Future costs:	<b>489,37 €</b>
Difference:	<b>248,63 €</b>

**Yearly saving: 54.698,60 €**

➤ **100% SGS**

Present cost:	<b>630,00 €</b>
Future costs:	<b>435,37 €</b>
Difference:	<b>194,63 €</b>

**Yearly saving: 42.818,00 €**

**PROJECT MODALITIES OF VERIFICATION**

The test realized in the laboratory and on the pilot plant presented the expected results, confirming the economic balance foreseen. We follow so with the plant realization.

The result of the plant application will be estimated through the parameters analysed and described, in short, as follows:

PARAMETER	OBJECTIVE
Cost for the fleshing elimination	Considerable reduction of the costs born by the tanneries for the fleshing elimination
Fleshing weight	Reduction of the weight of the fleshing produced by a tannery during the normal production process
Easiness of the storing	Smaller volume of the dehydrated product, less release of liquids and best quality of them
Work surrounding	Surrounding more healthy with a reduced smell emission due to a reduced putrescibility of the fleshing as less wet
Environmental pollution	Reduction of the fleshing quantity sent to the dump, thanks to both the reduction of the weight/volume and the possibility of a larger utilization

We consider that the success of the research, with the economic investment before described, allows getting a solution to a problem more and more evident in the tanning field; and at the same time it helps the development of new activities/sections interested in the exploitation of the dehumidified fleshing.

The plant in construction by a local firm tannery be available for the verifications in April – May 2006.