

Project title:

GREEN LIFE: GREEN Leather Industry For the Environment

The project proposes to develop new technologies to reduce the environmental impact of the leather processing industry.

The leather tanning process is characterised by a significant environmental impact, mainly due to the production of: i) waste water, ii) sludge, iii) other waste, scraps, processing by-products.

The chemical products used in production cycles are equivalent to 1.91 kg/m² of animal hide, and in Italy alone (which accounts for 62% of EU production) equivalent to 47,000,--- kg/year. Of this amount 31% contains hazardous substances according to standard DIR 67/548 CEE. As a result tanning waste water must be suitably treated and controlled in relation to the following parameters - suspended solids, COD, total N, NH₃, Cr III, sulphides, chlorides, sulphates. The sludge resulting from waste water purification treatment is classed on the basis of hazardous substance content, and currently is mainly sent to landfill. Leather tanning processes also cause volatile and particulate emissions into the atmosphere, whose main control parameters are: VOCs, dust, hydrogen sulphate (responsible for the characteristic odour).

In total, leather processing produces waste and scraps (e.g. fleshings) equivalent to 50% of the raw material in weight. Approximately 50% of this is used to produce fertilisers and biostimulants, however a considerable part is not reused and so a considerable source of protein is lost which contains nitrogen in a bioavailable form, and other substances that carry out important action on plant metabolism.

The project involves companies in the Distretto Vicentino della Concia DVC (Vicenza Province Tannery District) which produces 51% of Italian production, and in particular - two leather processing companies, a manufacturer of chemical products for the leather tanning industry, a manufacturer of low environmental impact fertilisers, and a company that manages the water purification plant in the district.

The project objectives are as follows:

- Reduction in toxic/harmful substances used in processing techniques.
- Reduction in the consumption of water in industrial processes and volume of waste water to be treated;
- Reduction in unwanted emissions going into the atmosphere;
- Reduction in the quantity of solid waste going to landfill, due to selective recovery processes to create products for other industrial or agro-industrial uses.

Expected results (outputs and quantified achievements):

The expected results from testing the new liming and tanning processes and sludge selection/treatment processes are as follows:

Reduction in pollutants (toxic and harmful substances) used in processes and present in waste water destined for purification.

Oxidative and enzymatic liming process - 70% reduction in sulphates coming from sulphides no longer used.

Organic tanning process - 100% reduction in soluble chromium no longer used in tanning.

Reduction in water consumption:

Liming process with recycled liquid - recovery of liquid for at least 20% of water volume with a corresponding decrease in the consumption of water resources.

Reduction in unwanted emissions in the atmosphere - with enzymatic and oxidative liming process, almost total elimination of odour emissions caused by sulphuric acid.

Reduction in the quantity of waste sent to landfill or the purification plant, due to selective recovery

processes.

- For the new tanning process - 100% reduction in solid waste containing chromium
- recovery of products with industrial value (farming use) equivalent to 12-15% of dry biomass entering the cycle.

The aforementioned quantitative results concern the individual process. The overall environmental benefits depend on the number of tanning industries that adopt the new processes, first of all in the DVC, then in other districts (the tanning industries are very concentrated in very few geographical areas)

A study will also be undertaken in the project to assess the potential environmental benefits within the DVC should all or an increasing percentage of companies adopt the new technologies, each as a function of production and plant requirements.

Separate tariff schemes for waste management will also be proposed to incentivise ethical companies, which can then also be adopted in other regions or districts.

With regard to possible new uses for scraps from processing (as they are or transformed), a study will be set up in the project to assess how to classify the new products obtained. Government organisations and public authorities in the area that legislate on waste treatment and contribute to defining new standards on the subject will also be involved. After the project new technical specifications and indications may also emerge, which could provide the basis for proposing amendments to existing legislation.

Actions and means involved:

The aforementioned objectives will be achieved with the development of new liming and tanning processes:

The following will be tested for the liming phase:

- liming using recycled liquid (non-destructive liming), aimed at reducing water consumption and chemical additives used by at least 20%, and separating the hair for use as a source of protein
- oxidative liming, to eliminate the use of sulphides contained in traditional hair removal techniques; the requirement is to demonstrate applicability to pre-industrial scale production, overcoming heat disposal issues (high temperature of the liquid damages the quality of the leather).
- enzymatic liming, by refining a process and products (enzymes) to replace existing products and therefore reducing the sulphide content by up to 70%.

The effectiveness, environmental benefits, compatibility with existing purification systems, best field of use, type and characteristics of waste and scraps, and the possibility of obtaining material and products for further use will be evaluated for each process.

For the tanning phase the objective concerns the development of new products/processes to obtain leather tanned with equivalent/improved features compared with chromium, using tanning compounds free from heavy metals (mainly trivalent chromium) or toxic organic pollutants. Products from recycling, scraps or recovery which cannot be reused in the food or energy industries will be used as raw materials.

The third action concerns the analysis and characterisation of processing scraps for their subsequent recovery and optimisation, with the aim of creating new materials for agriculture (fertilisers) and industry (recovery and optimisation of organic content and proteins for emerging sectors also). Water and sludge taken from the new liming and tanning baths will be used (the sludge currently goes to landfill, classed as non-hazardous waste - CER 190814).

Finally, control action is planned which concerns the inspection and evaluation of the effects of the new processes and products with regard to environmental effects (in terms of a reduction in air and water pollution) and technical/economic sustainability, in terms of the compatibility of the new technologies with the correct and efficient operation of existing purification and environmental control

systems.

Environmental problem targeted:

The quantitative results expected from the GREEN LIFE project using new processes compared with existing techniques are therefore as follows:

Reduction in pollutants (toxic and harmful substances) used in processes and present in waste water destined for purification.

For the enzymatic and oxidative liming process – 100% reduction of sulphides and resulting decrease in sulphates.

For the enzymatic liming process - 75% reduction in sulphates coming from sulphides no longer used.

For the tanning process - 100% reduction in soluble chromium no longer used in tanning or retanning with alternative system.

Reduction in water consumption:

For liming process with recycling liquid - recovery of liquid accounting for at least 20% of water volume with a corresponding decrease in the consumption of water resources.

Reduction in unwanted emissions going into the atmosphere, improving air quality, especially:

- enzymatic and oxidative liming process: Almost total elimination of odour emissions caused by sulphuric acid resulting from the presence of sulphates.

Reduction in the quantity of waste sent to landfill or the purification plant, due to selective recovery processes.

- For the new tanning process - 100% reduction in solid waste containing chromium
- recovery of products with industrial value (farming use) equivalent to 12-15% of incoming dry biomass.

Demonstration character of the project

The project aims to demonstrate the effectiveness of the new processes via internal testing on the premises of the organisation developing the individual segments of the leather transformation process, and then in a wider system context, also with the involvement of ADC.

The project will therefore provide valuable indications on the optimum setup of the entire cycle. This setup will make it possible to increase the efficiency of individual companies and reduce the quantity of waste destined for purification or landfill, and improve air/water/environmental quality. An additional complementary objective will be to develop new processes for the recovery/treatment/optimisation of waste products generated by the new processes that could be used on the market.

The GREEN LIFE project will involve the following proposers:

- Dani Spa (GRD), organisation that implements the entire leather processing procedure which will research the new oxidative liming process and will also test the new low environmental impact tanning process/product in conjunction with STC (manufacturer of chemical products, see below);

- GRUPPO MASTROTTO SPA (GRM), organisation that implements the entire leather processing procedure which will research the liming process to make it possible to reduce water consumption and separate/recover fractions of material suitable for further use. In parallel with GRD, GRM will also test the new tanning process in conjunction with STC (see below);

- IKEM SRL (STC), company which develops and produces chemical products for the tanning industry which will be responsible for researching new products for the development of an enzymatic liming process, and will also develop new operational procedures and products for the tanning process, involving GRD and GRM in pre-industrial testing;

- Acque del Chiampo (ADC): government-owned company which manages the purification plants for the collection and treatment of water in the district. In the project it is responsible for i) partnering individual organisations to verify the environmental sustainability of the activities

developed, by comparing the results achieved with the current status; ii) estimating the overall effect on the system if the new techniques are adopted by other organisations in the district.

- ILSA (ILS) researches and develops agricultural products, some of which come from by-products and scraps produced during industrial and agro-industrial processing. The company will study separation processes for protein in the liquid phase (extracting the protein substance directly from the liming waters produced), and will identify new sectors of use for the dried sludge from the liming process after categorising it and defining the critical parameters for the organic material to be used.

Project activities will be organised as follows; GRD, GRM and STC will start to research the experimental development of their new liming and tanning processes.

The water recovery liming process will be developed and tested at GRM, with trials on a pre-industrial scale to assess impact in terms of the possibility of recovering and recycling liquids without jeopardising leather quality.

The development of the new oxidative liming process will be carried out by DANI via testing on a pre-industrial scale. A heat exchange system will be designed and developed, scaled to dispose of the heat generated from production with industrial quantities, also verifying behaviour during the summer season.

The enzymatic liming process will be developed by STC, first with laboratory tests to optimise the products and study the reactions involved. Subsequently tests will be performed on an individual hide in small pilot drums to make it possible to assess the quality of the leather treated this way, and the type and composition of waste water and separable fraction. Further testing will then be carried out with batches of 5-10 hides, which is the minimum quantity required for acquiring reliable data to assess the effectiveness of the treatment and produce sludge to be categorised and assessed for possible uses.

The objectives achieved will be assessed for each process in terms of leather quality, chemical substances entering the cycle, analysis of waste water, characterisation of processing by-products and scraps, and transferability to a pre-industrial and industrial scale. Liming methods and techniques will be compared to identify those which are most promising (also in combination with each other), and/or their most suited field of use. The idea is not to find the absolutely best process, but rather to find a set of technologies that are useful in one or more application sectors.

Testing the new tanning process will involve the collaboration of several beneficiaries from the beginning. The first phase will be implemented by STC on a pilot scale with tests in treatment drums starting with one hide. Testing will then be scaled up to an industrial system, implemented at GRM and GRD (tests with 5-10 hides).

All aforementioned activities will be accompanied by measurement and control activities on the compatibility and sustainability of the new liming and tanning processes, using samples from test site systems and analysis to assess effects at an individual organisational level and also (projection) at a system level. In particular the individual beneficiaries (GRD, GRM STC), using specific analytical protocols, will also evaluate the results progressively in terms of leather quality, and technical and economic sustainability of the new processes, verifying environmental sustainability simultaneously (in conjunction with ADC to evaluate waste water and other laboratories for atmospheric emissions).

For this latter aspect the objective is to monitor each individual activity and check that the variations in chemical/physical/biological parameters in the waste waters merging in the purification plant are such as to guarantee its correct operation. In particular, variations in the alkalinity of waste water from liming processes and in the acidity of waste water from tanning processes are expected. Given that they arrive at the purification plant already mixed an attempt will be made to partially balance the two effects, with a related decrease in their alkalinity and acidity. The characteristics of the sludge coming from waste water purification will also undergo variations that will be assessed to determine their feasibility and final characteristics of the product obtained in terms of its final recovery or disposal.

This will ensure that the new processes can be adopted by the companies in the district.

In the final phase of the project ADC will gather all the information relating to the waste water and will perform projections to calculate the overall results of the project in terms of reducing environmental impact, and to simulate and forecast system behaviour in the case of gradual distribution of the new technologies to other organisations in the district. This information will be useful as a reliable basis for proposing the distribution of the new technologies to other companies and tannery districts in other areas of the EU.

The third objective concerns waste analysis and treatment, for the purpose of its recovery and optimisation for further use. This activity will be carried out by ILS in conjunction with other partners according to the following procedures:

- ILS will receive scraps of a physical and chemical etc. composition from the partners, modified gradually depending on the research they are carrying out internally, and will verify and test the potential of these products in terms of recovery and optimisation.

- ILS will provide the partners with quantitative technical information on how to direct their research, depending on the trials and tests that ILS will perform on the products (e.g. directing it towards reducing certain chemical substances in sludge which could be problematic if reused in farming).

- Additionally ILS will carry out testing on the pilot separation system (ultra-filtration and diafiltration) for the protein substance in the liming waters, in order to produce hydrolysed protein in liquid phase. The results of these tests will then be shared with the other partners to assess the applicability of this process immediately outside the factory perimeter (tannery).

Preliminary treatment and transformation activities on sludge leaving leather processing plants will be carried out using pilot systems. The characterisation and transformation activities carried out by ILS will involve dozens of kg of bath and sludge.

In the final phase it will be possible to obtain realistic estimates of the economic/technical validity of the project by cross-referencing test data gathered by ILS with historical data gathered by ADC concerning the total industrial production of the district.

In the framework of this objective it will be necessary to undertake research to assess how to classify the new products obtained following the liming and tanning processes, in addition to those resulting from further transformations implemented at ILS.

Public environmental organisations and bodies which regulate waste treatment and contribute to defining new legislation will be involved in this activity (ARPAV, etc). After the project new technical specifications and indications may even emerge, which could provide the basis for amendments to existing legislation.