Introduction of Low Pollution Processes in Leather Production

Project Title: Introduction of Low-Pollution Processes in Leather Production and Their Consequences on End-of-Pipe Effluent Treatment and on Solid Waste Disposal
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Best Practice: Transferable Solution

The project, as a Best Practice demonstrates a workable methodology for reducing the environmental problems associated with leather production that can be applied throughout Croatia. Through low-pollution processes and waste management systems, water and chemical consumption and wastewater pollutants are reduced. This framework ultimately allows an important sector in the Croatian economy to persist and grow in a way that respects the ecological vitality of the Danube Basin.

Project Summary

While leather treatment technology has improved significantly in Croatia, insufficient attention has been paid to the environmental consequences of processing and manufacturing leather. Leather processing and manufacturing involves a variety of aggressive chemicals and produces organic wastes that frequently end up in the environment despite control efforts. Chemicals such as sulfides, acids, alkalis, and

chromium are used to process and manufacture leather and have deleterious effects on the environment if not handled appropriately. Decomposing organic matter from raw leather materials such as skin or hide, hair and dissolved proteins and keratin from hair take oxygen away from riparian flora and fauna if it is not treated before disposal.

One of the most detrimental environmental consequences of leathermaking in Croatia is water pollution. All of the tanneries in Croatia are located in the Danube Basin adding to the already high levels of tributary pollution. Croatia produces approximately 27,000 tons of leather each year consuming 800,000 – 1,000,000 m^3 of water per year. Leather production contributes four to five percent of all water pollution in Croatia. Few tanneries in Croatia have fully functioning effluent treatment plants. Only six percent industrial effluents are adequately treated or treated at all before being discharged into water bodies. The hazardous chemicals and raw organic material that are a part of leather production frequently end up in wastewater effluent.

While leather production is half what it used to be in pre-war time, the Croatian leather industry is still a vital and significant part of the Croatian economy. There are six large leather factories, four medium sized factories, and a number of small manufacturers. The Croatian leather industry directly employs approximately 20,000 people and produces 18 million pairs of shoes a year, 1.7 million square meters of finished leather, 0.5 million square meters of wet-blue, and 0.5 million m^2 of splits. Environmental and economic improvements in the leather industry are critical to its development.

Supported by an EcoLinks Challenge Grant, the Croatian Association of Leather and Footwear Manufacturers collaborated with a firm from the Czech Republic, Ingstav Ostrava to develop and test a strategy for reducing the environmental impacts of leather production. They sought to 1) determine the exact volume and pollution parameters of tannery effluent; 2) select optimal methods to reduce water consumption and pollution; 3) develop optimal effluent and sludge treatment alternatives; 4) determine operation and maintenance costs and develop a financing program for implementing an environmentally sensitive water management program; and 5) initiate a legislative framework that promotes appropriate discharge standards, regulations, and pricing guidelines for effluent and sludge disposal.

As a result of this project, several benefits were achieved. The project established a model for reducing the environmental pollution associated with leather production that can be applied by tanneries throughout Croatia. Through implementation of certain low-pollution processes such as salt trashing and hair saving, the project demonstrates notable reductions in environmental impacts and production costs. Through hair saving alone, for example, the biological oxygen demand (BOD) that impacts water ecology is reduced by 25% and savings from reduced chemical supply costs and lowered sludge production can amount to almost $80,000 per year.

Project Activities

The methods and materials used to make this project a Best Practice are described in detail here. The purpose of sharing this methodology is to designate a successful framework for reducing the environmental impacts of leather production.

1. Defined the qualitative and quantitative parameters and actions for reducing environmental hazards associated with leather production

Action: Key elements in the effort to reduce water and chemical consumption and pollutants in the production process and in wastewater management were identified. They are:

Implementation of low-pollution production processes

- Salt trashing: reduces chlorides in tannery effluent;
- Green-fleshing: provides option to reuse fleshings by avoiding lime and sulfide contamination; reduces organic pollution and sludge volume;
- Hair saving: hair is removed before dissolved and discharged in sewage system reducing organic pollution and sludge volume; and
- Cr-reduction: considers method for maximum Cr saving within tanning process; reduces Cr effluent and sludge.

Effluent Pre-Treatment and sludge treatment methods

- Removal of sulfides;
- Identification of effective coagulants and flocculants;
- Sludge treatment, disposal, and/or reuse; and
- Laboratory analysis of effluent and sludge composition.

A solid waste assessment was conducted to determine the types and quantities of generated solid waste as well as the characteristics of leachates.

Product(s): 1) Identified qualitative and quantitative parameters for pollution in leather industry 2) Solid waste assessment.

2. Collected data on the environmental parameters and proposed alternative applications

Action: The following strategy was applied to gather data, clarify pollution issues, and assess the feasibility of the different applications. The proposed strategy was tested at two tanneries: Psunj –Nova Gradiska and Kik –Karlovac (note, however, that Kik Tannery has ceased operation, so only the results from Psunj are emphasized in the following sections).

1) Interviewed tanners and representatives of government institutions about the problems and required standards for proper waste management.
2) Analyzed present production processes involving waste generation.
3) Tested the proposed measures for pollution reduction.
4) Tested the proposed technologies for addressing effluent and sludge/solid waste management concerns.

5) Determined the types and quantities of generated solid waste.
6) Collected data on the space requirements for incorporating waste management system.
7) Determined the costs of water, chemicals, electricity, waste disposal, etc. with respect to the low-pollution applications and waste management approaches.
8) Collected data on additional equipment requirements.

Product(s): Data on environmental parameters and context for implementation of pollution reduction measures and a waste management system.

3. Compiled study results including the environmental and economic implications of the proposed applications

Action: An inventory of the test results was conducted. Final recommendations were made regarding the introduction of low-pollution processes (e.g., salt trashing, green fleshing, hair saving, etc.), effluent pre-treatment plant systems and solid waste management. Implementation requirements were identified including supplies, suppliers, and investment and operation costs. The costs, savings, and environmental effects of implementing the recommendations were determined.

Product(s): 1) Inventory of test results 2) Recommendations for improvements using low-pollution processes, effluent pre-treatment systems, and solid waste management strategies in the leather industry 3) Cost/Benefit analysis.

4. Identified Further Actions

Action: Further actions to be taken to address pollution issues associated with tannery operations were identified. They are as follows:

1) The Croatian Association of Leather and Footwear Manufacturers (hereafter referred to as the "Association") should open dialogue with government representatives (Ministries of Industry, Economy, and Environment; and the Water Authority).
2) The Association should analyze the feasibility of solid waste reuse.
3) The Association should engage in planning the development of the leather industry with an emphasis on expanding opportunities for implementing optimal pollution control measures. Space requirements, for example, are an important consideration.
4) The Association should examine the possibility to group "wet" leather production processes in one location reducing pollution control costs while enhancing production capacity.
5) The Association should make contact with tannery pollution control consultants and equipment producers to collaborate on the promotion of low-waste production processes and treatment systems.
6) The Association should encourage product pricing that includes at least the minimum costs of applying pollution control measures.

Product(s): List of further actions.

Project Benefits

Several benefits resulted from the application of the methods and materials outlined in the previous section. This project builds expertise in approaches to addressing environmental problems associated with leather production as well as in public policy considerations. The project environmental benefits include reductions in water and chemical consumption and wastewater pollution. There are several economic benefits from applying multiple, low-pollution processes It is important to note, however, that effluent treatment in wastewater treatment facilities can prove to be more costly than discharging the effluent without treatment.

Capacity Building Benefits

This project stimulates the necessary organizational capacity and expertise to reduce pollution and improve waste management at tanneries throughout Croatia. By researching and demonstrating the possibilities for reducing pollution associated with leather production, the implementation capacity for applying environmentally sound practices in the leather industry in Croatia is strengthened. Tanneries in Croatia now have the expertise and a model for reducing environmental impacts on water ecology.

Through this project, the capacity to influence environmental policies is enhanced. Due to the insights and experiences gained through this project, the Croatian Association of Leather and Footwear Manufacturers is in the position to articulate feasible environmental policy recommendations regarding the standards and regulations on effluent discharge and solid waste disposal.

Environmental Benefits

There are multiple environmental benefits accrued from the applications outlined and applied in this project. They include notable reductions in water and chemical consumption and harmful effluents. A detailed description of the project environmental benefits demonstrated at the Psunj Tannery in Nova Gradiska is provided below (Table 1.). Note that significant reductions are made from the low-pollution processes.

Table 1. Environmental Benefits of Low-Waste Processes

Procedure	Water consumption reduction (%)	Chemicals consumption reduction	Pollution factors reduction (%)		Solid waste reduction
Salt Trashing	5%	5%	Suspended Solids	-.6%	
			Biological Oxygen Demand (BOD)	4%	
			Chemical Oxygen Demand (COD)	3%	
			Chlorides	25%	
Green Fleshing	9-10%	9-10%	Sulfide: 9-10%		16% solid waste

						converted to useful product
Hair Saving	N/A	Lime	90 kg/day	TS	6.7%	25% of dry matter in sludge
				SS	41%	
		NaHS (72% Na_2S)	105 kg/day	COD	25%	
				BOD	25%	
		Na_2S (62-67%)	15 kg/day	S^{-2}	18%	
				N-total	35%	
				$N\text{-}NH_4$	2%	
Chrome Recovery	N/A	N/A		98-99% Cr		N/A

While implementing a solid waste management program can be more costly than disposal fees in Croatia, the environmental benefits of such a program are especially positive. The environmental benefits of implementing the solid waste management strategy outlined in this project, for example, reduces uncontrolled disposal by 14,567 kg/year.

Economic Benefits

Savings are generated from reducing pollution loads (hence, reduced Pollution Compensation Fees) and costs associated with sludge disposal.

Several options were explored for handling raw hide waste, limed fleshings, and chrome-contaminated waste. At Psunj Tannery, it was determined that with the application of low-waste production processes (e.g., hair saving, chrome recovery), the overall investment is low and the total costs of waste management would be decreased by more than 40% in comparison with other more commonly used approaches. With an activated hair saving system, there are reduced costs in chemical supplies (at processing 15 t/day of raw hides; 240 days/yr) amounting to a savings of $20,952 per year, and sludge effluent disposal generating a savings of $50,400 per year. Hair saving requires a total investment of $46,500 in equipment and civil works. Running costs are estimated at $13,675 per year. The payback period for a hair saving system installation is one year.

Through chrome recovery additional savings are generated. The maximum quantity of recoverable chrome is about 26,400 kg of Cr_2O_3 per year. The commercial value of the recoverable chrome amounts to approximately $105,000. The operation costs for recovery amounts to $66,150-$75,400, leaving a difference or profit of $30,000-$38,850 each year. Furthermore, the reduction of chromium content (below 1000 mg/l) in certain types of sludge would enable a simple sludge processing method that can be handled at farms instead of more expensive hazardous waste disposal sites. A Chrome Recovery System requires an investment of approximately $205,600. The investment return period is five to seven years and with indirect savings included (no disposal fees for sludge and lower discharge fees for effluent) it decreases to one to two years.

The benefits outlined here point out the concrete, positive results of this project. In working towards these benefits, several lessons were learned that point out or address additional methodological concerns as well as unanticipated benefits and challenges. The lessons learned during this project are outlined in the next section.

Lessons Learned

The lessons learned during this project allow others applying this same methodology with a more detailed understanding of the challenges and economic considerations of implementing similar projects. The lessons learned during the implementation of this project include the following.

- Through the studies and cost/benefit analyses conducted as part of this project, the Croatian Association of Leather and Footwear Manufacturers can promote tools and techniques for achieving environmental and economic benefits while providing a scientific basis for making effective public policy recommendations. The science produced in this project can be used further to establish a productive network between interest groups, policymakers, and industry as it considers both environmental and economic concerns.

- While the technology to promote environmentally friendly processes in the industrial sector is especially promising, it may not yet be profitable to implement all the available technologies. Low-cost processes can be implemented to produce savings, however, other financial possibilities can be explored to compensate for more costly measures. .

- Introduction of low-waste production processes significantly improves effluent results, reduces sludge volume, and decreases overall effluent and sludge treatment and disposal costs. However, the cost of effluent treatment ($70-$100/t of raw hides processed) is significantly higher than the cost of discharging untreated effluent ($43/t of raw hides processed). Present legal fees for effluent discharge do not stimulate Croatian tanneries to treat the effluents. The solution to the problem can be seen in rationalizing standards for effluent discharge and solid waste disposal as well as in control and enforcement of regulations. Also, leather industry should include pollution control costs in the price of their products in order to stimulate investment in environmental protection and to balance the profit level amongst tanneries.

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