Reducing Wastewater Contaminated with Fibers and Organic Substances

Transferable Solution

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Project Title: Reducing wastewater contaminated with fibers and dissolved organic substances
Leader: Celhart Donaris S.A., Braila, Romania
Partners: Ekono Inc., Bellevue, WA USA and Ceprohart S.A. Braila, Romania
Location: Braila, Romania
Project Duration: September 2000-September 2001
EcoLinks Project Investment: Total EcoLinks Project Investment: $69,986; EcoLinks Grant Support: $49,582; Project Team Cost Share Contribution: $20,404.

Best Practice: Transferable Solution

This Best Practice, “Reducing Wastewater Contamination at Celhart Donaris Pulp and Paper Mill in Romania”, provides a concrete set of actions for identifying critical pollution sources and reducing wastewater pollution associated with manufacturing pulp and paper. Celhart Donaris upgrades its operating practices to meet new environmental standards established by Romanian authorities and ultimately to strive toward achieving EU requirements. This Best Practice guides the way for similar companies throughout Romania to work towards achieving national and EU environmental goals. With implementation of the measures developed and tested in this EcoLinks funded project, the discharge of dissolved organic substances is significantly reduced decreasing the environmental impacts on water quality in the Danube Basin. By reducing operating costs, Celhart Donaris builds its capacity to financially support practical measures to meet national standards.
Project Summary

Celhart Donaris, a pulp and paper processing facility in Braila, Romania, consumes large amounts of water (200 m$^3$/ton of pulp) and bleaching chemicals (95-100 kg chlorine per ton of pulp). This consumption leads to excessive wastewater discharge consisting of dissolved organic substances (measured by Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD)) and inorganic substances (measured by Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)), and phenols, resin and fatty acids (RFA). Celhart Donaris exceeds wastewater discharge requirements according to the new standards under a “Water Management Permit” issued annually by the National Authority on Romanian Waters. Celhart Donaris’ wastewater discharge also exceeds EU environmental standards in organic substances (COD and BOD) and chlorinated organics (AOX). The wastewater effluent is discharged in the Danube Basin and negatively impacts the flora and fauna of the Danube River.

While there are many processing plants at the Celhart Donaris Mill, processing wood pulp is an especially chemical intensive process. Bleaching pulp is the most polluting technological phase in pulp processing. Celhart Donaris uses chlorine and chlorine based chemicals (e.g., chlorine dioxide and sodium hypochlorite) in its bleaching plant. The bleaching plant effluent from Celhart Donaris contains high levels of dissolved organic substances and chlorinated organic substances. About 50% of fiber loss and dissolved organic substances in the company’s wastewater is discharged from the bleach plant. Chlorinated organics that are very toxic and generate dioxins and furans, are also found in the wastewater and discharged from the plant.

Celhart Donaris is challenged to meet the environmental requirements set by Romanian Authorities for wastewater effluent discharged into the Danube River. In this project, Celhart-Donaris collaborates with an American firm, Ekono and a Romanian partner, Ceprohart to develop and implement a feasible scheme for reducing wastewater pollution. Several environmental measures are developed and financing options are explored.

This project is especially useful in exploring multiple measures for reducing wastewater pollution while also considering important economic factors associated with their implementation. With implementation of the environmental measures outlined and initiated in this project, reductions in organic dissolved substances (indicated by COD and BOD) are achieved. Chemical Oxygen Demand (COD) of wastewater effluent, for example, is ultimately reduced from 175 kg/ton to 99.4 kg/t. The Biological Oxygen Demand (BOD) is reduced from 55 kg/t to 29.5 kg/t. By applying the financial options outlined in this project to reduce operating costs, increase revenues and implement an AOX Reduction Program, Celhart Donaris can achieve national standards. Detailed descriptions of the project activities, benefits, lessons learned, and contact information are provided in the following sections.

Project Activities

To reduce fiber and dissolved organic and inorganic substances in wastewater, an assessment of several plants at the Celhart Donaris Mill was conducted. Pollution
sources were identified, measured, and analyzed. A feasibility study for applying oxygen delignification technology was then conducted. A program was developed to reduce wastewater pollutants and a monitoring system was put into place. These actions are described in detail below along with a list of items produced with each action step (i.e., reports, data, etc.).

1. Conducted complete assessment, emphasizing the identification of pollution sources

Action: Assessed operating capacity; production levels; consumption of raw materials, energy, water, and chemicals; process flows; and major technical and economic parameters. Flow sheets for all operations were reviewed. Data on the production levels, and the consumption of raw materials, water and chemicals for the year 1999 were reviewed. The data were used to develop material and energy balances and to prepare an “Oxygen Delignification Feasibility Study.” Pollution sources (i.e., flow and composition) were identified.

Product(s): 1) Flow sheets on pollution sources (36 polluting sources were identified and mapped) 2) Block diagrams 3) Basis for design of Oxygen Delignification Feasibility Study.

2. Measured and analyzed pollution levels

Action: Measurements of pollution levels were taken at each identified critical pollution source. An analysis based on these measurements was conducted in light of Romanian environmental legislation and the permitting requirements of the National Authority of Romanian Waters. A measurement program was set up consisting of: sampling points, indicators to be measured, sampling frequency, and period of measurements for the different pulp mill and chemical recovery system, the fine paper machine, the duplex board machine, and the freshwater treatment plant.

Product(s): 1) Table comparing Celhart production of Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) with legislative and permitting requirements 2) Measurement program 3) Measurement results regarding TSS content and dissolved organic substances content.

3. Conducted Oxygen Delignification Feasibility Study

Action: The possibilities for introducing an oxygen delignification plant were explored in terms of site, benefits, and costs. The pulp mill site where an oxygen delignification plant might be built was visited. The facility is needed to address effluent problems associated with the operations of the bleaching plant and to comply with Romanian and European environmental legislation that puts limitations on effluent levels of BOD, COD, chlorinated organic substances, etc.

Product(s): Arrangement drawings and cost estimates for the installation of an oxygen delignification facility.

4. Developed a program to reduce wastewater discharges from pulp, paper, and board mill operations
Action: Alternatives for reducing pollutants at different facilities were identified. They are listed below.

1) Screening Plant: The screening plant was replaced. The new plant operates under a closed system based on pressure. New pollution levels based on this installation were measured and recorded.

2) Cooking Plant: A pre-impregnation stage was added at the cooking plant.

3) Oxygen Delignification Plant: The feasibility study indicated that a new plant would be too costly. The low-cost alternatives for oxygen delignification included: 1) two-stage oxygen delignification using a single reactor; 2) mini-oxygen delignification process; and 3) hexenuronic acid removal (HEX-A Process).

4) Bleaching Plant: To reduce pollution associated with bleaching activities, possibilities to eliminate chlorine and sodium hypochlorite (i.e., chlorinated organics (AOX)) were identified. The possibilities included: 1) altering the chlorine/chlorine dioxide bleaching stage to chlorine dioxide at medium or low consistency; 2) altering the oxidative extraction stage to oxidative extraction with hydrogen peroxide addition; and 3) replacing the sodium hypochlorite bleaching stage with other bleaching sequences.

Financing options were explored to implement several measures. Options for increasing revenues were explored. They included: increasing production rate, operating an evaporator train to promote steam savings, and lowering soda losses from the recovery and causticizing areas. Alternative measures were developed in cases where improvements proved to be too costly.

Product(s): 1) Alternatives and less costly solutions for reducing pollutants at the cooking plant, washing and screening Plant, bleach plant, and wastewater treatment plant 2) Comparative table of discharges from old screening plant and new screening plant 3) Environmental Management Plan including a program to prevent plant malfunctions, possibilities to collect and store spills and uncontrolled contaminated discharges 4) An investment program to meet new environmental targets.

5. Developed monitoring system

Action: A monitoring program for wastewater discharges was developed. The monitoring program assessed normal operating conditions and allowable limits.

Product(s): Monitoring program.

6. Disseminated project activities and results

Action: The results of the project were shared at seminars and through publications.

Product(s): 1) A paper titled, “Reducing wastewater contaminated with fibers and dissolved organic substances – EcoLinks project for S.C. Celhart Donaris S.A. Braila” was presented at two seminars: “Novelties in pulp and paper fabrication” and “Economical and social re-launching – Braila 2001” 2) Presentation of project activities and results at the Second Romanian-Italian Seminar in the Field of Pulp and Paper, “Additives, Machinery, and Automation Systems” 3) Final Report published in
the “Technical and Informative Bulletin” at Ceprohart 4) Article on project to be published Balkan Pulp and Paper magazine.

With the application of the methods and materials listed in this section, specific benefits are accrued that allow Celhart Donaris to achieve compliance with Romania environmental regulations regarding wastewater management.

## Project Benefits

This EcoLinks project promotes several benefits. The project establishes a context of collaboration and technology transfer that promotes several tangible environmental and economic benefits. Through the project partnership and information sharing, the content of fiber and dissolved organic substances in wastewater effluent generated by Celhart Donaris was reduced and savings generated. These benefits are described in more detail in the following subsections: capacity building benefits, environmental benefits, and economic benefits.

### Capacity Building Benefits

This project promoted several capacity building benefits through the cooperative approach to problem-solving. Cooperation on this project allowed for the development of an exhaustive measurement program to assess pollution levels at Celhart Donaris. The technical expertise of the partners and the on-site knowledge of the project leader provided a basis for developing creative alternatives for addressing the environmental problems associated with pulp and paper production.

Several publications and presentations on the project were developed and shared (See Product(s) in Project Activities #6). This transfer of knowledge and opportunity to engage other interested parties in constructive dialogue enhanced the capacity to improve environmental practices for ecological and economic benefits in the pulp and paper industry. The environmental and economic benefits are listed in the next two subsections.

### Environmental Benefits

This project reduces the amount of pollution from wastewater effluent. Measured most notably by chemical oxygen demand (COD) and biological oxygen demand (BOD), dissolved organic substances in the wastewater generated by Celhart-Donaris are reduced significantly through the application of the techniques and tools identified in this project. The reductions are accounted for in the following ways.

- Improvements in the pulp sorting installation reduces organic and inorganic substances. Dissolved organics and NaOH are reduced by 36%. See Table 1. Project Implications for Reducing Dissolved Organic and Inorganic Substances.

Table 1. Project Implications for Reducing Dissolved Organic and Inorganic Substances
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Before project</th>
<th>After new screening plant</th>
<th>After implementation of proposed measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD&lt;sub&gt;Cr&lt;/sub&gt; kg/t</td>
<td>57.6</td>
<td>37</td>
<td>36</td>
</tr>
<tr>
<td>BOD&lt;sub&gt;S&lt;/sub&gt; kg/t</td>
<td>15</td>
<td>11</td>
<td>26.6</td>
</tr>
<tr>
<td>NaOH</td>
<td>29.1</td>
<td>16.7</td>
<td>42.6</td>
</tr>
</tbody>
</table>

- Introduction of a pre-impregnation stage at the cooking plant reduces bleaching chemical consumption as well as BOD and COD each by 10%.
- Since the installation of an oxygen delignification plant was found in the feasibility study to be too costly, alternative measures were developed that also decrease COD and BOD from the bleaching plant.
- Implementation of an AOX Reduction Program lowers AOX discharges to a level comparable to the mills operating in the US or EU (less than 0.5 kg/BDT).
- Recirculation of black liquor into the recovery loop and thickening of the rejects and sending them back to the bark boiler further reduce the discharge of organic substances.
- Closure of water circuits by recirculating filtrate from the decker to the fourth washer leads to a reduction of fresh water consumption by 150 m<sup>3</sup>/h which also improves the washing efficiency.

In the next section, the economic benefits of this project are discussed.

**Economic Benefits**

The need to meet the new Romanian environmental standards is a pressing concern for Celhart Donaris. Also pressing, however, is the need to make this process economically feasible. To address this challenge, measures to provide revenues to finance proposed measures and several operating cost changes were identified. The additional revenues provide an internal rate of return (IRR) in excess of 20% for investments in the range of $22 to $28 million. This capital would cover the investments to increase Celhart Donaris’ production rate by 23,000 BDT/yr and to satisfy the required environmental improvements to meet the new Romanian regulations.

Financing options for implementing several of the proposed measures are enhanced by generating savings from applying different techniques. For example, a savings of $155,279 per year can be generated from operating the evaporator train as a six-effect unit. An additional savings of $310,559 per year can be generated by lowering soda losses from the recovery and recausticizing areas. These savings can be used to implement wastewater management measures identified in the project.
Operating cost changes to meet the new Romanian regulations also generate further savings. The changes and savings include:

1) Lowering sodium losses by 10 kg NaOH/BDt by reactivating the idled number four washer, closing the screen room, treating screen room rejects, and applying best management practices as outlined by the project provides a cost savings of $46,584 per year.

2) Installing an impregnation vessel reduces the consumption of chemicals in the bleach plant (e.g., chlorine, chlorine dioxide, sodium hydroxide, and hypochlorite) and provides a savings of $83,998.

3) Implementing an AOX Reduction Program would provide an annual savings of $102,499 in bleaching and recovery chemical costs.

4) By reducing pollutant discharges, a total savings of $65,217 is generated from reduced charges for water pumped from the Danube River as well as polluted effluent that is discharged back into the river.

Many of the solutions generated through this project provide additional economic as well as environmental benefits. For example, recirculating black liquor into the recovery loop and thickening the rejects reduces dissolved organic substances at a low cost. A pre-impregnation vessel can be acquired for approximately $300,000 and also promotes notable environmental benefits as discussed in the preceding subsection.

Lessons Learned

During the implementation of this project, several lessons were learned. Other pulp and paper mills in Romania adjusting to the new Romanian environmental regulations can benefit from these lessons as they apply the methodology developed in this project.

- Qualified, knowledgeable partners secure the success of a given project. The collaboration between the project leader and project partners improved the scientific interpretation of measurement results. Ekono’s knowledge on updated methods and technologies for addressing environmental problems was especially useful for generating solutions.

- Purchasing software VISIO 2000-Technical Edition increased the productivity of project participants through the development of flow sheets, block diagrams, and balance sheets.

- The Oxygen Delignification Feasibility Study revealed that a plant for this purpose would be a huge investment with a return of investment of 17 years. Less expensive alternatives were generated that provide environmental benefits at a lower cost. The alternatives are listed in the Project Activities section.

- Working together in the same office or at the mill site allowed all the project participants to clarify and concentrate on the same issues and to share knowledge and experiences immediately.

- Implementation of the work plan was facilitated by good cooperation and coordination between the project leader and partners. Duties and responsibilities were clear through ongoing dialogue and interaction.
Contact Information

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