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ANALYSIS OF ENVIRONMENTAL IMPACT FOR INDUSTRY PRODUCTS. CASE STUDY: PAPER MANUFACTURING

BY

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Abstract. Pulp and paper industry has a high environmental impact that occurs in all phases of the paper lifecycle, from fibre acquisition to manufacturing and final to disposal. Reducing paper consumption is an important step to diminish the environmental impacts. Substitution of virgin fibres with recovered fibres reduces the demand for wood and requires less energy. For evaluation of the environmental impacts and potential impacts associated with a paper product can be used various methodologies like life-cycle assessment (LCA). The goal of this paper is to determine the environmental performance of paper products technological process based on the evaluation of four scenarios: the first scenario consists in paper products manufactured from virgin fibre and the other three scenarios contain the manufacturing process of paper with recovered fibre as raw materials and with different environmental impacts (80%, 60% and 40%). The evaluation was realized using GaBi4 software that supports every stage of the analysis, from data collection to quantification of the results and highlights the performance of the evaluated processes. GaBi4 offers the possibility to characterize the

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inventory results in several impact categories based on different methodologies, such as: CML 2001, CML 96, EDIP 1997, EDIP 2003, EI99, etc.

Key words: environmental impact, life cycle assessment, recovered paper.

1. Introduction

The pulp and paper industry has always been considered a major user of natural resources (wood, water), energy (fossil fuels, electricity), and a significant polluter (Petraru & Gavrilescu, 2011). The effects on resources and the environment through the use of manufactured products can occur at every stage in a product's life cycle-from the extraction of the raw materials through processing, manufacturing, and transportation, ending with use and disposal or recycling (ERM, 2008; Madsen, 2007). The effects can either be direct (air emissions produced from automobile usage) or indirect (pollution and impact from the production of electricity used in the manufacturing process) (ERM, 2008). Nowadays recovered paper is the most important source of fibre used in papermaking and provides about half of the total fibre used for papermaking in Europe (Holik, 2006; Schmidt *et al.*, 2007; Stawicki & Read, 2010).

EU‘s recovered paper collection rate in 2005 was 62.5% with 55.6 million tons of paper and board collected for recycling. About 7 million tons of recovered paper was exported outside the region, mainly to Asia and 48.7 million tons were utilized in paper manufacturing (Stawicki & Read, 2010).

Over the years the European paper industry has maintained a strong position in the global marketplace with: more than 1000 existing plants; generating directly or indirectly around 4 million jobs; net sales of approximately € 78.6 billion; employing 259,100 people; contributing about € 21 billion to the EU's Gross Domestic Product (Gavrilescu *et al.*, 2008).

The efficient use of recovered fibre leads to sustainable exploitation of natural resources and supports sustainable development (Rebitzer, 2005). Wood fibre can be recycled several times and paper can be made from recycled fibre alone. In order to be recycled, papers and boards must be collected and sorted at source, to separate white papers from brown papers (Holik, 2006; IPPC, 2001). It is very important that papers and board are not mixed with other wastes because the paper quality will decrease. Typically, specific categories of papers can be used for the production of graphic papers whereas others are used for the production of packaging materials (Stawicki & Read, 2010).

Life-cycle assessment analysis (LCA) is the key to understanding the environmental aspects and potential impacts associated with a paper industry (Lopes *et al.*, 2003; Petraru & Gavrilescu, 2010). In LCA studies, the environmental aspects and potential impacts throughout a product's life, from the acquisition of raw materials to production, use and disposal, are examined.

The general impacts considered are resource use, human health and ecological consequences. The information is then compiled and analyzed for calculation of the environmental impacts associated with a paper product (ERM, 2008).

LCA studies can be used in developing strategies to improve the environmental protection but also the industrial efficiency (Ayres & Ayres, 2002; Madsen, 2007; Moberg *et al.*, 2007; Poopak & Agamuthu, 2011; Rosen, 2008).

The goal of the study is to determine the environmental performance of tissue products manufacturing process associated with the use of virgin fibres and recycled fibres, using the life cycle assessment analysis.

2. Methodology

Life cycle assessment (LCA) methodology was used to evaluate the environmental impacts of paper manufacturing process using as raw materials virgin fibre (spruce) and recovered fibres. In recent years a variety of tools based on LCA methodology were developed and applied to assess different systems (Ghinea & Gavrilescu, 2010; Ghinea & Gavrilescu 2011). This paper has been developed using GaBi4 software, that supports every stage of the LCA analysis and allows rapid simulation and modelling of complex systems and assessment of the potential environmental impacts based on various methodologies such as CML 2001, CML 96, EDIP 1997, EDIP 2003, EI99 etc. (PE International, 2009).

A Life Cycle Impact Assessment (LCIA) contains two essential methods present in GaBi software: problem-oriented methods (mid-points) and damage-oriented methods (end points) (Cherubini *et al.*, 2009). In the mid-points approach the impacts are evaluated using CML 2001, EDIP 97, EDIP 2003, TRACI and IMPACT 2002+ and assesses the environmental impacts associated with global warming potential, acidification potential, eutrophication, potential photochemical ozone creation and human toxicity (Bengtsson & Howard, 2010; CML & VROM, 2001; Goedkoop *et al.*, 2008; Frischknecht & Jungbluth, 2007). The end points approach is a damage-oriented method that classifies flows into various environmental themes, modelling the damage each theme causes to human beings, natural environment and resources. The methods used in the end points approach consists of mainly Eco-Indicator 95, Eco-Indicator 99 and IMPACT 2002+ (Goedkoop *et al.*, 2008; Frischknecht & Jungbluth, 2007).

There are three types of impact assessment categories: obligatory impact categories (indicators used in most LCAs); additional impact categories (indicators that exist but are not often included in LCA studies because of the inadequacy with the goal of the LCA); other impact categories (no operational indicators available, therefore impossible to include quantitatively in LCA) (Frischknecht & Jungbluth, 2007). Each impact category assigned to the above methodology has a reference and the contribution of each substance to the impact category is calculated by converting the amount of substance into the equivalent amount of the reference substance or unit (Table 1) (Frischknecht & Jungbluth, 2007; Goedkoop *et al.*, 2008).

Table 1
Impact Categories Relevant for Paper Industry
(CML & VROM, 2001; Frischknecht & Jungbluth, 2007; Goedkoop *et al.*, 2008)

Impact Category	Description	Reference Unit
Abiotic Depletion Potential (ADP)	− extraction of scarce minerals and fossil fuels and describes their reduction of the global amount of non-renewable raw materials	kg Sb equiv./ kg emission
Acidification Potential (AP)	− acidification of soil and water occurs through the transformation of air pollutants into acids (SO_2 reaction with water in the atmosphere can form “acid rain”).	kg SO_2 equiv. / kg emission
Eutrophication Potential (EP*)*	− includes all impacts due to a too high level of nutrients in the environment. Nitrogen (N) and phosphorus (P) are the most important eutrophicating elements.	kg PO_4 equiv. / kg emission
Global Warming Potential (GWP)	− accounts the effect of emissions as a result of human activities on the radiative forcing of the atmosphere	kg CO_2 equiv. / kg emission
Ozone Depletion Potential (ODP)	− anthropogenic emissions that deplete ozone and increase the level of UV light hitting the earth surface (fluorine-chlorine-hydrocarbons (CFCs) and the nitrogen oxides (NOx))	kg CFC-11 equiv. / kg emission
Ecotoxicity Potential	− eco-toxicological impacts are the effects of toxic substances on humans, aquatic and terrestrial ecosystems, generated from a proportion based on the reference substance 1,4-Dichlorbenzol ($C_6H_4Cl_2$)	kg 1,4-DCB equiv. / kg emission
Photochemical Ozone Creation Potential (Summer smog) (POCP)	− also known as summer smog, POCP causes damage on vegetation and material, high concentrations of ozone are also toxic to humans. Radiation from the sun and the presence of nitrogen oxides and hydrocarbons produce aggressive reaction products, one of which is ozone.	kg C_2H_4 equiv. / kg emission

2.1. Functional Unit and Boundaries

The purpose of this study is to determine the environmental performance of tissue products manufacturing process using four scenarios that have different types of raw materials and to determine the optimum alternative from environmental point of view.

One scenario consists of tissue products manufactured from virgin fibre (spruce) (Fig. 1) and three scenarios with recovered fibre as raw materials (Fig. 2). The difference between the scenarios with recovered fibre consists in different percentage of burden derived from the virgin pulp manufacturing: 80%, 60% and 40%.

Scenarios are especially helpful in understanding the complex environmental impacts associated with the production and use of recycled fibers (Madsen, 2007).

The functional unit for this study is 1000 kg of tissue paper.

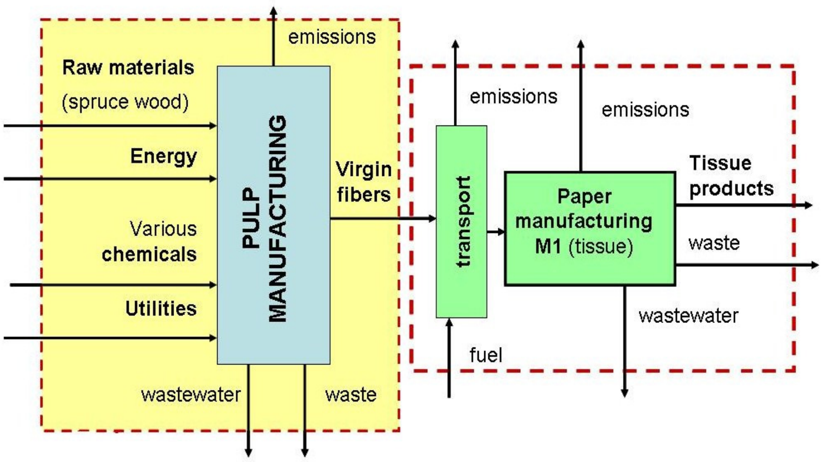

Fig. 1 – Life cycle of tissue product from virgin fibre.

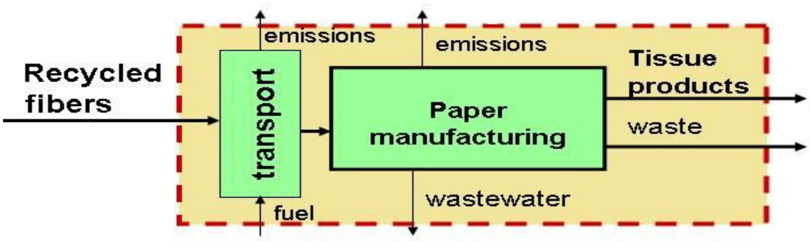

Fig. 2 – Life cycle of tissue products from recovered fibre.

2.2. Inventory Analysis

The tissue paper scenarios include all stages of the manufacturing process of tissue products. For each of the stage from the tissue manufacturing systems inventories of significant environmental flows to and from the environment, and internal material and energy flows, were determined and calculated reported to the functional unit. Studies have proved that users of 100% virgin products have experienced greater absorbency for both oil and water than users of 100% recycled fibre products.

Inventory data were collected for the purpose to characterization the highlighted subsystems in the paper life cycle: the energy consumption varies between 400-500 kWh/t, chemicals demand in the manufacturing process consist of 0.0-1% H_2O_2 for repulping, 0.3-0.6 % soap for flotation, 1-2% H_2O_2, 0.5-1.2% NaOH, 1-1.8% Na_2SiO_3, 0.4-1% dithionite for bleaching (IPPC, 2001).

2.3. Environmental Impact Assessment

The impact allocated from the first cycle of the product had an important role in determining the environmental impact of the scenarios. Waste paper, the raw material for recycled fiber, carries with it a portion of the environmental impacts of its original manufacture and use (energy, water emissions, transport, etc.) and the recycling (re-pulping) process also has environmental impacts (energy, waste, emissions) (Madsen, 2007).

The analysis of the scenarios from environmental point of view was realized with GaBi4 software which contains different LCA methodologies. In this study only the results associated to CML 2001, CML 96, EDIP 1997, EDIP 2003 and EI95 methodologies are illustrated (Figs. 3,…,7).

All scenarios show positive values that mean negative impacts of the process for all impact categories evaluated. Scenario I has the highest environmental impact while the other three scenarios have a lower environmental impact. The main cause of the difference between these scenarios is the complexity degree of the technological process of manufacturing tissue from virgin fibre. The best alternative for implementation is considered Scenario 40% due to the fact that the burden from previous life is lower then in the case of Scenario 60% and Scenario 80%.

For acidification potential was observed higher values due to the releases of nitrogen (NOx and NH_3) and sulphur (SO_2) especially in the case of the pulp manufacturing, encountered in the bleaching, recovery boiler, but also brought by the use of chemicals and energy consumption.

The next impact categories with high values are abiotic depletion and photochemical ozone formation. Abiotic depletion that represents resource consumption is predominantly associated with the extraction of oil, gas and coal reserves. The substances contributing to photochemical ozone formation are volatile organic compounds (VOC), nitrogen oxides (NOx), carbon monoxide (CO), and methane (CH4). Their presence is due to the emissions caused by the vehicles, energy consumption in the manufacturing and from the manufacturing process (kraft pulping releases almost 0.4 kg of VOC and 2.6 kg NOx). The increased values of the global warming potential are due mainly to the energy consumption, transportation and chemical additives used in the manufacturing process. The value of the eutrophication potential is registered because of the presence of nutrients in the process of manufacturing tissue paper, especially in the process that uses as raw materials virgin fibre, due to the presence of nutrients in wood.

The manufacturing process influences other impact categories such as carcinogenic substances, heavy metals and winter smog, where Scenario I shows the highest value and Scenario 40% the lowest.

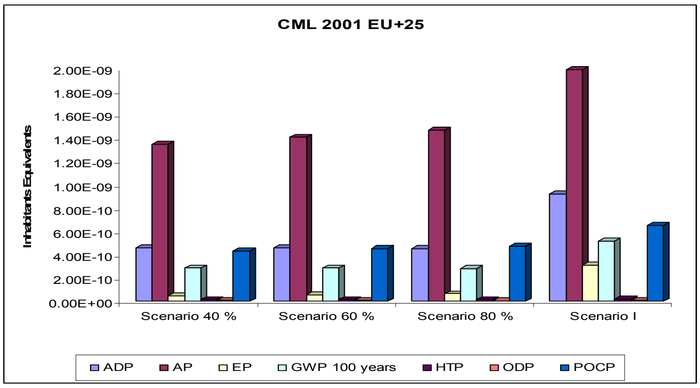

Fig. 3 – Environmental impact using CML 2001.

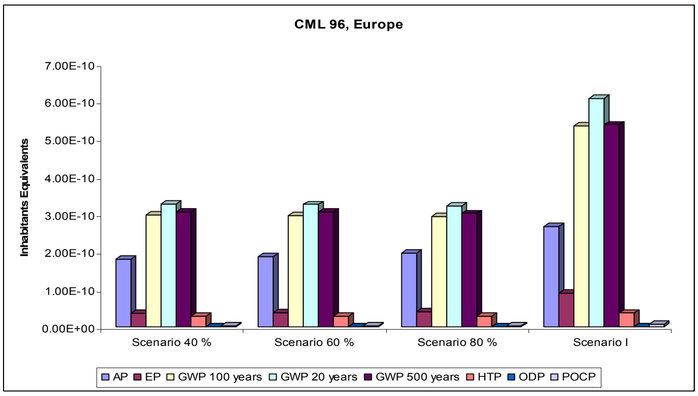

Fig. 4 – Environmental impact using CML 96.

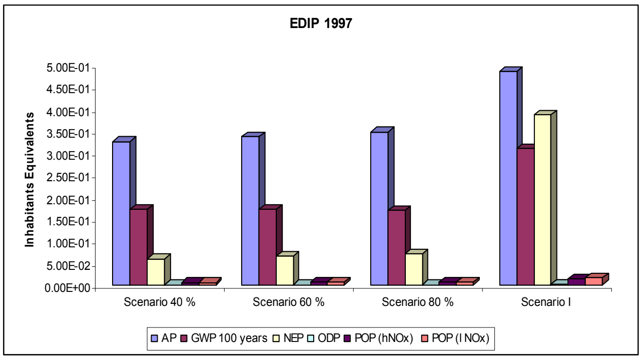

Fig. 5 – Environmental impact using EDIP 1997.

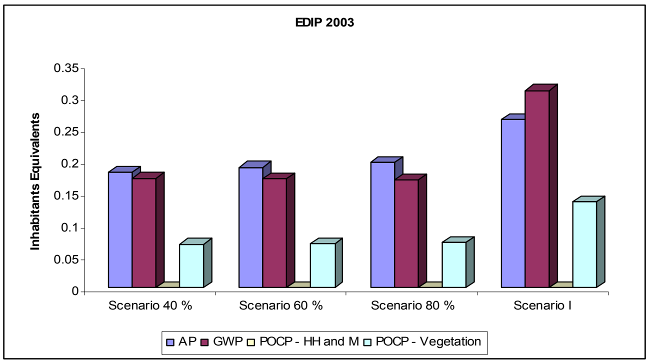

Fig. 6 – Environmental impact using EDIP 2003
(POCP – HH and M - Photochemical ozone formation - impact on human health and materials POCP – Vegetation - Photochemical ozone formation - impact on vegetation).

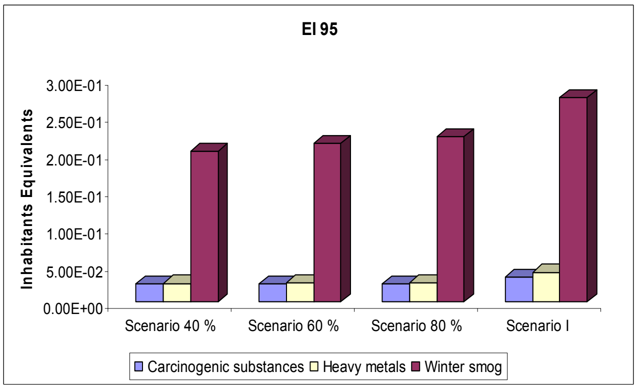

Fig. 7 – Environmental impact using EI 95.

As it can be observed Scenario I is the scenarios with the biggest environmental impact in all methodologies and for all categories. The main problems detected are caused by the energy consumption for manufacturing tissue products, transportation, but also the process itself due to the presence of the chemical additives and the complexity of the manufacturing process.

Scenarios 80%, 60% and 40% also have impact on the environment but in lower proportion then Scenario I because of the use of recovered fibre as raw materials. In most of the impact categories the scenario with the best alternative is Scenario 40% because of low value of the burden associated to the recovered fibre (Fig. 8), while other categories highlight Scenario 80% because of the emissions derived from the transportation stage (Fig. 9) (as the amount of raw material increases the emissions from the transportation will also increase).

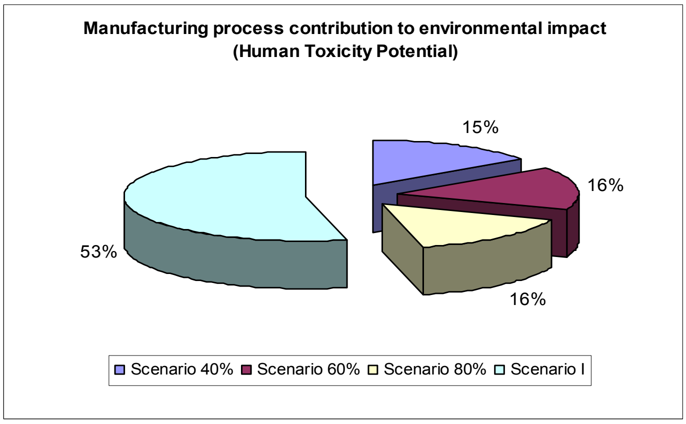

Fig. 8 – Manufacturing process contribution to environmental impact.

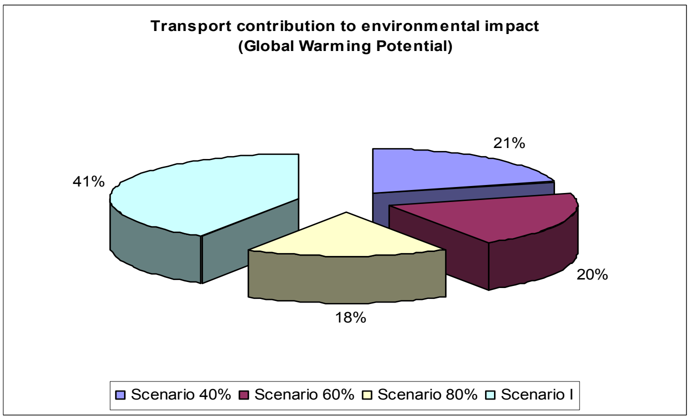

Fig. 9 – Transport contribution to environmental impact.

3. Conclusions

The goal of the study was to determine the environmental performance of tissue products manufacturing process using four scenarios that have different types of raw materials. One scenario consists of tissue products manufactured from virgin fibre (spruce) and three scenarios with recovered fibre as raw materials: Scenario I defines products with 100% virgin fibre; Scenario 80% defines products with 80% burden from virgin pulp manufacturing; Scenario 60% defines products with 60% burden from virgin pulp manufacturing; Scenario 40% defines products with 40% burden from virgin pulp manufacturing.

The main problems detected in all methodologies are caused by the energy consumption for manufacturing tissue products, transportation, but also the process itself due to the presence of the chemical additives.

The results from the environmental impact assessment highlights Scenario I as being the alternative with the highest environmental impact, while the scenarios with recovered fibre (Scenario 80%, 60% and 40%) have a negative impact on the environment but in a lower percentage. The scenarios with recovered fibre as raw materials are considered the best alternatives to implement into a process than scenario that uses virgin fibre. The main cause of the differences between the scenarios is the complexity of the manufacturing process, the resources and the additives demand, but also the energy demand for the manufacturing process and the transportation of the materials to the mill.

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REFERENCES

*** CML, VROM, *Life Cycle Assessment – An Operational Guide to the ISO Standards*. Centre of Environmental Science-Leiden University, Ministry of Housing, Spatial Planning and the Environmental (2001).

*** ERM, *Life Cycle Assessment of Tissue Products*. Environmental Resources Management, Kimberly Clark (2008).

*** IPPC, *Reference Document - Best Available Techniques in the Pulp and Paper Industry*. Integrated Pollution Prevention and Control, European Comission (2001).

*** PE International, Handbook for Life Cycle Assessment (LCA) Using the GaBi Education Software Package, Germany (2009).

Ayres R.U., Ayres L.W., *A Handbook of Industrial Ecology*. Edward Elgar Publishing Limited, UK (2002).

Bengtsson J., Howard N., *A Life Cycle Impact Assessment. Part 1: Classification and Characterization* (2010).

Cherubini F., Bargigli S., Ulgiati S., *Life Cycle Assessment* (*LCA*) *of Waste Management Strategies: Landfilling, Sorting Plant and Incineration*. Energy, **34**, 2116−2123 (2009).

Frischknecht R., Jungbluth N., *Implementation of Life Cycle Impact Assessment Methods*. Dübendorf (2007).

Gavrilescu M., Teodosiu C., Gavrilescu D., Lupu L., *Strategies and Practices for Sustainable Use of Water in Industrial Papermaking Processes*. Engineering in Life Sciences, **8**, 99−124 (2008).

Ghinea C., Gavrilescu M., *Decision Support Models for Solid Waste Management – an Overview.* Environmental Engineering and Management Journal, **9**, 869−880 (2010).

Ghinea C., Gavrilescu M., *Municipal Solid Waste Management - Environmental Assessment from Life Cycle Perspective*. Bul. Inst. Polit. Iaşi, s. Chemistry and Chemical Engineering, **LVII (LXI)**, *1*, 87−95 (2011).

Goedkoop M., Oele M., de Schryver A., Vieira M., SimaPro Database Manual, Pre Consultants b.v., The Netherlands (2008).

Holik H., *Handbook of Paper and Board*. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim (2006).

Lopes E., Dias A., Arroja L., Capela I., Pereira F., *Application of Life Cycle Assessment to the Portuguese Pulp and Paper Industry*. Journal of Cleaner Production, **11**, 51–59 (2003).

Madsen J., *Life Cycle Assessment of Tissue Products.* Environmental Resources Management Limited (2007).

Moberg A., Johansson M., Finnveden G., Jonsson A., *Screening Environmental Life Cycle Assessment of Printed, Web Based and Tablet E-paper Newspaper*. Stockholm (2007).

Petraru M., Gavrilescu M., *Pollution Prevention: A Key to Economic and Environmental Sustainability*. Environmental Engineering and Management Journal, **9**, *4*, 597−614 (2010).

Petraru M., Gavrilescu M., *Transition Towards a Sustainable Economy Based on Industrial Ecology Principles: Romanian Case Study*. Bul. Inst. Polit. Iaşi, s. Chemistry and Chemical Engineering, **LVII (LXI)**, *1*, 133−145 (2011).

Poopak S., Agamuthu P., *Life Cycle Impact Assessment* (*LCIA*) *of Paper Making Process in Iran*. African Journal of Biotechnology, **10**, 4860−4870 (2011).

Rebitzer G., *Enhancing the Application Efficiency of Life Cycle Assessment for Industrial Uses*. Lausanne, EPFL, online at: http://biblion.epfl.ch/EPFL/theses/2005/3307/EPFL_TH3307.pdf (2005).

Rosen M.A., *Case Study in Industrial Ecology: Regional Utility - Based Cogeneration, Conflict Resolution*. Vol. **II**, Ecyclopedia of Life Support Systems, on line at: http://www.eolss.net/Sample-Chapters/C14/E1-40-04-08.pdf (2008).

Schmidt J.H., Holm P., Merrild A., Christensen P., *Life Cycle Assessment of the Waste Hierarchy – A Danish Case Study on Waste Paper*. Waste Management 27, 1519–1530 (2007).

Stawicki B., Read B., *The Future of Paper Recycling in Europe: Opportunities and Limitations.* COST Office (2010).

ANALIZA IMPACTULUI DE MEDIU PENTRU PRODUSELE INDUSTRIALE. STUDIU DE CAZ: FABRICAREA HÂRTIEI

(Rezumat)

Industria celulozei şi hârtiei are un impact ridicat asupra mediului pentru toate etapele ciclului de viață a hârtiei, de la achiziția materiilor prime până la eliminarea finală. Reducerea consumului de hârtie este un aspect important pentru minimizarea impactului asupra mediului. Substituția în procesul tehnologic a fibrelor virgine cu fibre recuperate poate conduce la diminuarea necesarului de lemn şi energie. Evaluarea impactului asupra mediului şi a potențialelor efecte asociate obținerii hârtiei poate fi realizată prin intermediul diverselor metodologii cum ar fi evaluarea ciclului de viață (LCA). Scopul acestei lucrări constă în determinarea performanțelor de mediu a procesului tehnologic de fabricare a hârtiei pe baza evaluării a patru scenarii: primul scenariu cuprinde procesul tehnologic cu fibră naturală ca materie primă iar în celelalte trei scenarii materia primă din procesul tehnologic constă în fibră recuperată cu diferite grade de impact de mediu (80%, 60% şi 40%). Evaluarea impactului de mediu a fost realizată folosind aplicația GaBi4 care include fiecare etapă a analizei, de la colectarea de date până la cuantificarea rezultatelor şi care evidențează performanța proceselor evaluate. GaBi4 oferă posibilitatea de a caracteriza rezultatele inventarierii printr-o serie de categorii de impact care se regăsesc în metodologii, precum: CML 2001, CML 96, EDIP 1997, EDIP 2003, EI99, etc.

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