SORT IT

Recovered Paper SORTing with Innovative Technologies

SORT IT Newsletter 3

Contents:

Diary

March 31, 2011
SORT IT 3rd Annual Meeting
Grenoble, France

April 13 – 15, 2011
Environmental International Forum SAVE the Planet
Sofia, Bulgaria

May, 13-20, 2011
International Conference NIR 2011
Cape Town, South Africa

May, 24-26, 2011
Waste-to-Resources 2011
4th International Symposium MBT (AWT) MRF & Recycling
Hannover, Germany

May, 24-26, 2011
CTP 2011 Deinking& Recycling Training Courses
CTP-Grenoble, France

June 28 – 30, 2011
Zellcheming, Conference and Expo, Rhein-Main-Hallen
Wiesbaden, Germany

Coordinator Column

A true industrial project!

Jean-Yves Escabasse
Project Leader

2010 is coming to an end. It has been a year rich in events. In particular, it has seen the construction of a new sorting plant on the premises of our partner Rauch Recycling.

It was built as a Greenfield project between February and May in the city of Linz, Austria, and started in earnest at the beginning of June. In its final industrial configuration, the facility showcases major developments in the project: pneumatic ejection nozzles, second-generation paper spikes and two optical automatic sorting units based on spectral imaging by two optical and one near-infrared camera. In addition, it will be outfitted for demonstration purposes with an automatic sorting robot, another major project achievement, which is also controlled by spectral imaging. The plant still employs two operators responsible

for manual sorting whose main job is to control and streamline the automatic sorting facility. Eventually, once all

parameters have been optimised, the plant is expected to operate fully automatically at a capacity of more than 10 tonnes per hour. This achievement reflects the massive involvement of our industrial partners in the research and development work, with the support of the research institutes.

Optimisation is still on-going, but technical success is in sight and a source of considerable pride for all partners.

Another success factor is the extensive dissemination work carried out this year for SORT IT: oral communications in several worldwide events like the IFAT-Entsorga in Munich, peer-reviewed articles in scientific journals, and last but not least, a documentary film made by the Euronews news channel and broadcast in October to 130 million potential viewers across Europe.

More thrills are expected in 2011 with the industrial validation of the concept and the conclusion of the project.

We wish you all a Happy New Year!

New Automatic Sorting Plant

Kai Blasius (PTS)

√ Building of new sorting line
√ Implementation of Sensor Units
√ Implementation of robots
√ Summary

Building new sorting line

In the SORT IT project – described in the last both newsletters - new technologies for a more efficient and profitable dry, automatic sorting of recovered paper and board from various collection systems are being developed. Research and development work has been performed on various sorting machines, including:

- Development of the new sensors, based on the near infrared (NIR) spectrometry, image analysis and color measurement by EVK and PTS (WP2);
- Implementation of the new sensors into sorting unit by RTT (WP2);
- Development of new physical separation devices like robots, based on image analysis by Bollegraaf (WP3);
- Concept and design of new sorting technology (WP4).

The combination of machines in sorting installations depends mainly on the characteristics of the input material and the preferred output fractions.

Because of the large number of different collection methods and regional differences in recyclable waste quality, almost every sorting installation has a different configuration, optimised for the specific demands of the recycling facility.

Our automatic sorting techniques are based on sensors coupled with mechanical separators. Applied sensor techniques are colour cameras and near-infrared sensors. Actuators consist of the newly developed pneumatic ejection systems or sorting robots. This new sorting concept is optimal for sorting installations which have got optical separation devices implemented, because the aim of a constant feeding, good loosening and good singling, is thoroughly integrated in the complete process.

From collection and storage up to the final sorting, all aspects are designed for an optimal performing optical separation step, without doing any harm to the other sorting steps.[1]

[1] D.3.5 -"New design of sorting process and optimisation combination of sensor/sorting unit"

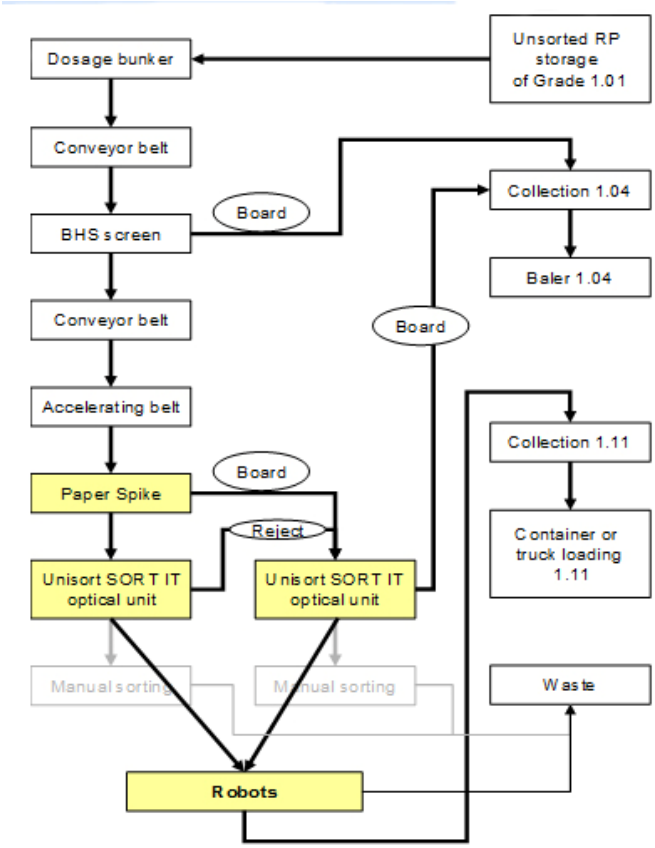
In this newsletter we will give you an overview at this new sorting line and more over the integration of the developed sorting units.

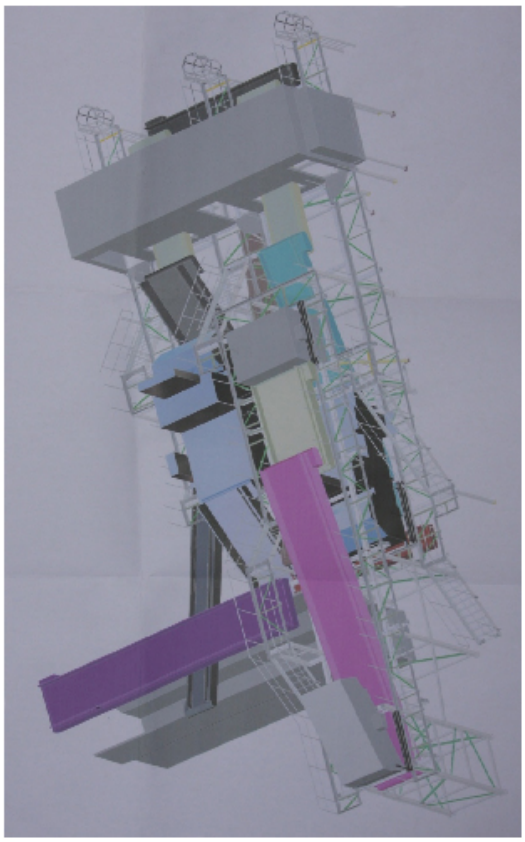
The new, fully automatic sorting facility built by Rauch Recycling in Austria has a cumulative production capacity of 12-13 tonnes / hour (2000 tonnes / month) of the grades 1.11 and 1.04. This new sorting facility is presented schematically below beside, an overview of the assembly line.

In this scheme the configuration of the sorting plant is presented as it was designed to work industrially.

The bunker feeds recycled paper in a regular and constant flow. It is equipped with a bag opener. It is followed by a "BHS deinking screen", a mechanical sorting screen. Therefore rejects, large pieces of board, are sent directly to the baler (in grade 1.04). The accept proceeds to the new improved paper spikes.

Within the project and only for research and demonstration purposes, sorting robots will by-pass the manual sorting cabins and replace the manual Quality Control of material flows that have already passed through the primary mechanical separation process.





Flow chart of automatic sorting plant (Rauch)

BHS Screen

Paper Spike

The Paper Spike sorts paper and cardboard with lower wear and tear on the spikes. It allows higher recovery rates through higher spike resolution (more spikes per area), stiffer support of the spikes (leading to better spike quality) and better results on single layer and lower quality board. Thanks to its specific characteristics, primarily stiffness, cardboard is picked up by the spikes and selectively removed from the paper flow. There, more cardboard is separated from the paper stream and is sent to the second "Unisort SORT IT" sorting unit. The accept moves on to the first "Unisort SORT IT" sorting unit for a negative sorting to removing of the board and plastics.

Developed sorting units

The sensor development is the technical core of SORT IT. The choice of an appropriate machinery and sensor arrangement depends on the dimensions of the parts to be sorted and the desired throughput.

Spatial resolution is a result of conveyor speed and scanning frequency. Systems with high scanning frequencies must also have an appropriately high classification frequency. To fulfil these requirements, the contemporary possibilities in spectrometer architecture, sensor electronics design, data processing and hardware-/software performance were considered.

In the new sorting facility, two sensor systems are installed – with one NIR and two VIS cameras per "Unisort SORT IT" unit and pneumatic ejection.

The NIR camera Helios 2.3 developed by EVK can be used to perform spectral imaging measurements. This technique makes it possible to obtain spatial and chemical information characterising recovered paper samples with high speed and high spatial resolution. It also offers new possibilities for classification and sorting.

The spatial resolution of the camera (240 pixels) and the measuring frequency (90 Hz) allows a spatial measurement resolution of 1 cm x 3 cm by covering a 2.4 m broad conveyor belt at a speed of 2.7 m/s.

PTS contributed to this development by supplying classification models and algorithms. For the development of the classification methods representative samples of recovered papers were collected and separated into different fractions, categories and sub-categories. The main fractions were chosen according to the European List of Standard Grades of Recovered Paper and Board EN 643.

The NIR sensor Helios 2.3 was used to measure the NIR reference spectra of all recovered paper samples.

The calculation of the classification methods for each fraction of recovered paper were carried out on the basis of the recorded NIR spectra of the reference samples using the Discriminant PLS method (Partial Least Squares Regression).

The materials and paper types that can be detected with high accuracy by Helios 2.3 are presented in the Table 1.

Table 1: Overview of materials and paper types detected with the new sensor

Recovered papers for deinking	Unwanted paper and board	Non-paper components
Newspapers **Magazines** **Brochures & flyers** **Office papers** **Catalogues**	Corrugated board (brown, laminated paper, coated, etc.) Folding boxes (brown, grey, coated) Packaging papers (brown, grey) Wall papers and wet strengthened papers Papers with plastics (coated or attached) Flexo printed newspapers	Plastics Textiles (synthetics, natural fibers) Wood Organic waste

"UNISORT SORT-IT" is the sensor-based sorting unit, developed and assembled by RTT Steinert GmbH and RTT decided on a 2,400 mm basic width system with an adjustable conveyor speed up to 3.0 m/s. Information was to be exchanged with a central control system of the entire sorting line by the PLC (Programmable Logic Controller) of the sorting machine.

The available EVK VIS-line scanning cameras EOS are integrated into the "UNISORT SORT IT", as an additional fall-back solution to enable basic colour sorting. There are minor adaptations in response to specific requirements for recovered paper sorting. For the most part, the mechanical stability of the attachment for the sensor cluster had to

be designed in such a way that vibrations were not transferred from the belt conveyor. Gusset plates were mounted on the attachment stacks to prevent such transmission.

The next and most innovative solution was given to the nozzle bar, for which a completely new concept was developed. In normal recycling applications, one valve comprises one injector. The new nozzle bar is composed of valves, each comprising 16 injectors.

The new design has considerable advantages:

- Only one valve is needed for several injectors, therefore saving material costs.

- Fewer repairs and reduced maintenance expenses also improved power distribution (important for large-scale items like paper pages) and it saves compressed air and energy.

UNISORT Unit integrated into new sorting plant

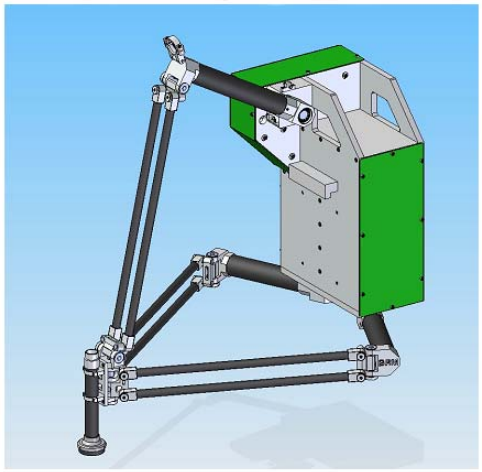
Implementation of robots

The robot sorting system was designed by Bollegraaf to separate materials out of a material flow fully automatically, quickly and very accurately.

The system can be used to replace manual quality control in material flows that have already passed through a primary mechanical separation process.

The information collected by the vision system about every object is continuously passed on to the central control system.

The vision system illuminates passing objects under halogen lights and records the reflection in the NIR and VIS frequency range with two spectrometers. Collected data, comprising material spectrum, colour and contour, is then analyzed by the vision software, after which the different objects are classified.
The vision system calculates the best possible pick-up position of each object. In this process, it is able to differentiate to some degree two or more overlapping objects as separate objects. This determines which robot should pick up which object.



Robots and their integration into sorting line

The robots used in this system consist of light-weight carbon and aluminium arms driven by servo motors. The objects are picked up with vacuum cups. In picking up the objects, the robot follows the belt for a short distance.

This sound design leads to high speeds and therefore short cycle times and a high degree of positioning accuracy. Implementing the robots for negative sorting at the end of the sorting line creates a highly flexible automated quality control system.

Summary

The research and development on the new sensors for recovered paper applications was done in the WP2 – **Sensor Development**.

In the WP3 - **Machinery Development**, following researches / developments were performed: the analysis of pre-treatment options for recovered paper before sorting, the development of new sorting machinery and implementation of new sorting units. New sorting concepts were simulated and analysed in the WP4 – New Sorting Concept.

The improvement to sorting technologies will be demonstrated in WP5 with full scale trials, which are scheduled in the beginning of next year. A monitoring procedure was developed, tested and is also presented in this newsletter. In the next newsletter we will present the results of the successful sorting process with the new technologies developed in the project SORT IT.

Sorting Plant Monitoring

Alain Cochaux (CTP)

- √ Monitoring concept
- √ Characterisation of sorting plant input / output
- √ Characterization of sorting line
- √ Results reporting

Monitoring concept

The sorting centre built in Linz (Austria) by "Rauch Recycling" is running since middle 2010. The input raw material is "mixed paper and board, unsorted but unusable materials removed", called grade 1.01 in the EN643 standard (European List of Standard Grades of Recovered Paper and Board).

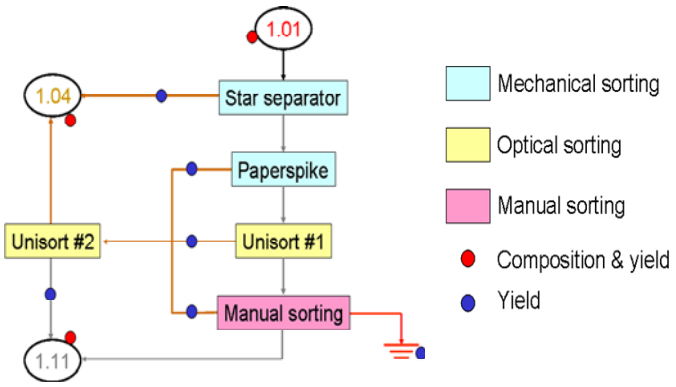
Sorting line treats the grade 1.01 in a view of producing two grades: 1.11 "sorted graphic paper for deinking" and 1.04 "supermarket corrugated paper and board". In the frame of task of the SORT IT project, a monitoring phase of the sorting line was planned and has been performed in September 2010.

The main goal of this monitoring phase was a quality control of the recovered paper flows (input and outputs) by the evaluation of the raw materials produced by the sorting line but also a characterisation of the efficiency of the sorting line itself.

To achieve the objectives, two main monitoring procedures were used:

The characterisation of the recovered papers boards at the inlet / outlet of the sorting centre (does the quality fit with the requirements of the papermakers?): In this part of the monitoring procedure, we do not consider the sorting line (how sorting is performed, if the yield is good…). The sorting line was considered as a black box with one inlet corresponding to the input materials (1.01) and two outlets being the output materials (1.11 and 1.04). The conclusion of results will be related to input raw material and output recovered paper grades 1.11 and 1.04, answering if they are or not conform to EN643 description?

The characterisation of the sorting line at each main points of sorting (different techniques used- ballistic, screening, mechanic): Each point is characterised as a small black box taking into account the inlet, the accept and the rejects in order to determine the yield at each point (to give recommendations if necessary in increasing yield of changing sorting conditions). The points to be checked out on sorting line are presented below.



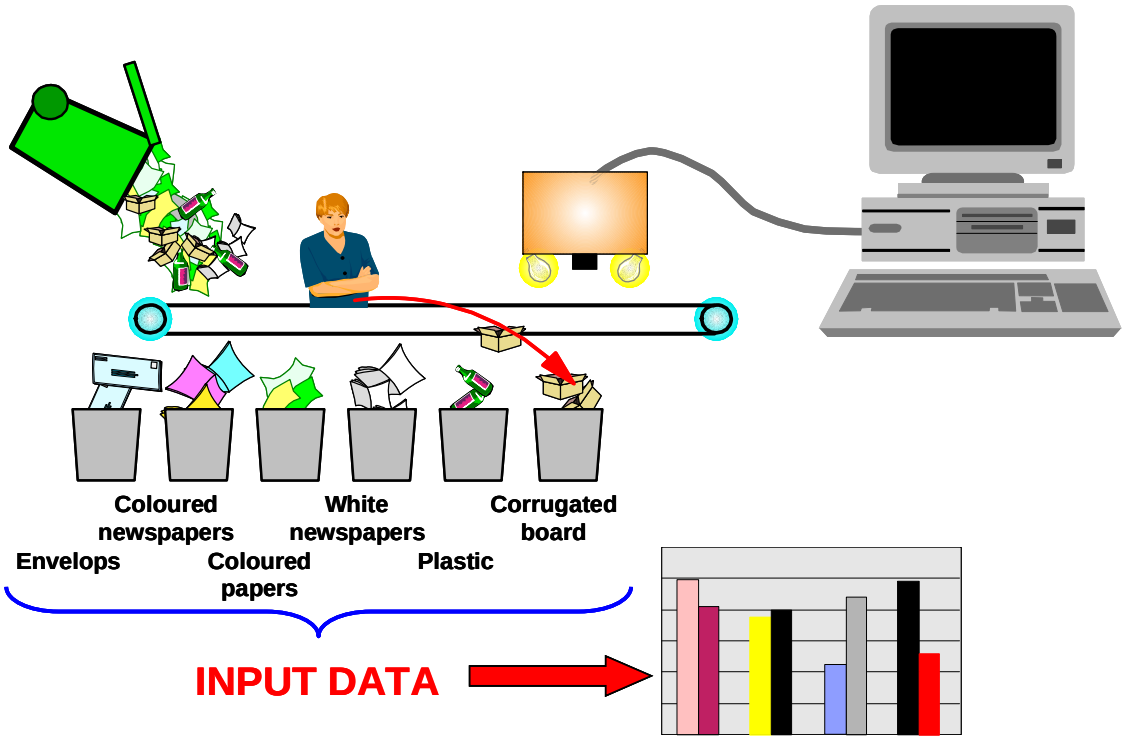
Control points on sorting line

Characterisation of sorting plant - input / output

Input raw material: The monitoring was performed by 2 people from CTP, 2 from PTS and several people from Rauch Recycling. The inlet raw material (1.01) was manually sorted into 5 fractions:

- two packaging furnish fractions - corrugated board and solid board;
- three deinking furnish fractions - newspapers, magazines and other graphic paper;
- unwanted materials (mainly plastic, metal).

The sample (170 kg) of 1.01 chosen for the monitoring phase corresponded to a part of a mixture of one delivery coming from the Netherlands and one coming from Germany.



Separation and classification of material fractions from sorting plant input

The results of this input raw material characterisation gave a good potential either for deinking or packaging recyclers. Average composition of input raw material was as following:

- total packaging materials - 29.7 %, with a composition of 66 % corrugated boards and 34 % of solid boards;

- total deinking materials - 68.0 %, with a composition of 38 % of newspapers, 56 % of magazines and 6 % of other graphic papers;

- unwanted materials: 2.3 %.

These results have shown that raw material input in sorting plant (grade 1.01) is liable to be sorted into the grade 1.11 (sorted graphic paper for deinking) and the grade 1.04 (supermarket corrugated paper and board) with compositions very close to those described in the EN643.

Output of sorting plant: In order to proceed to the characterisation of the output (1.11 and 1.04), a large sample of 1.01 was taken and introduced in the feeding container of the sorting line to perform the sorting. The initial quantity of 1.01 was more than 1 ton (1070 kg). The complete sorting was performed and the output grades were characterised as a function of their composition by manual sorting with the people from CTP, PTS and Rauch Recycling.

The produced deinking grade was divided into the following fractions: graphic paper, newspaper, magazine, board (solid + corrugated) and unwanted materials. The produced packaging grade was divided into 4 fractions: corrugated board, solid board, deinking furnishes and unwanted materials.

Comparing the results gained for the characterisation of the output and that of the input, the quantities of each fraction (newspaper, board, magazine…) were similar proving that the monitoring procedure chosen was pertinent.

The results showed that the deinking fraction (1.11) contains too much boards but in a reasonable proportion that could be largely improved by some changes along the sorting line. The packaging fraction (1.04) is rich in graphic papers, fraction which must be reduced.

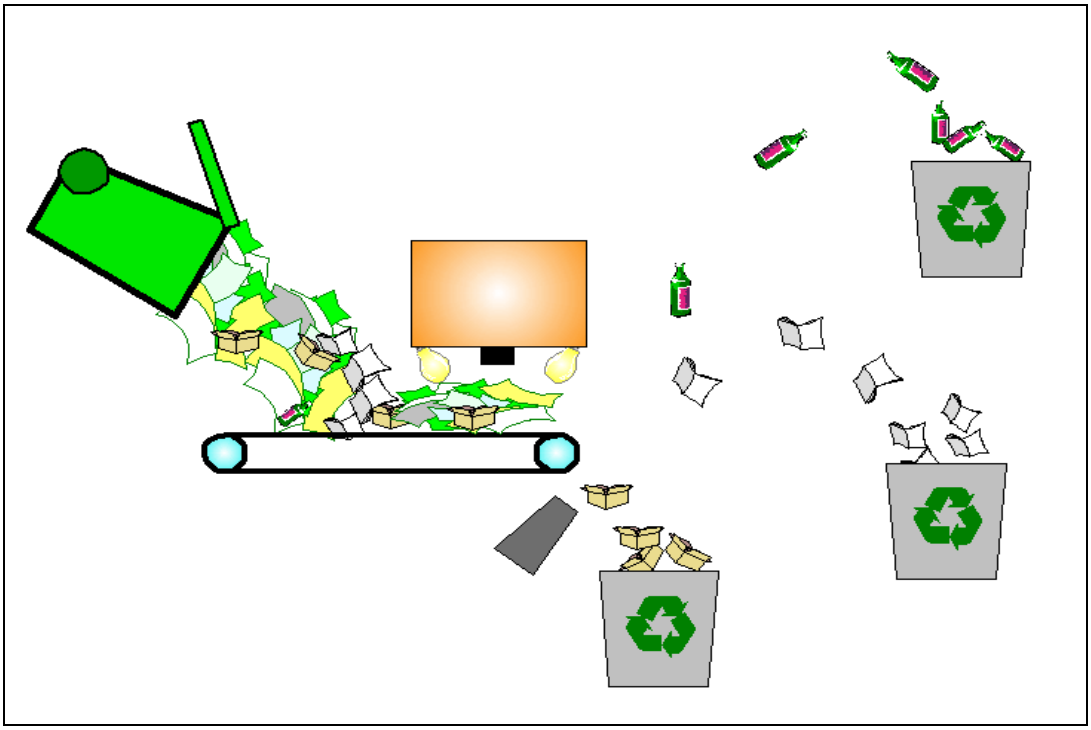
In spite of compositions not conform to expectation (i.e. according to EN643) the results were encouraging and allowed to give recommendations for improvement of the sorting line

Characterisation of sorting line

A simplified flow sheet of the sorting line and the main points characterised during the monitoring phase is given below.

For the characterisation of the sorting line, the raw materials (output) of the previous characterisation were remixed altogether in order to reconstitute the input used for the characterisation of grades. Thus, outputs (1.11 and 1.04) and rejects of the manual sorting (along the line) were remixed. Then, with this input, we proceed to the automatic sorting of the 1.01 on the Rauch recycling.

At each step of the sorting line (mechanical or optical sorting), the belt was stopped in order to weight each material fraction (accept and reject) and to determine the yield of each sorting machine.



Recovered paper grades (1.04 and 1.11) and refuses from sorting output

Yields were calculated for individual sorting step and for whole plant (final yield). The obtained results confirmed those obtained previously, indicating again that the chosen methodology was perfectly adapted for the monitoring.

Results reporting

For the characterisation of the raw materials (input and output), following tables were prepared to facilitate calculation of the composition and further the yield and sorting efficiency.

Report the input raw material (Recovered paper grade 1.01)

1.01 to be sorted automatically			**Weight: _____ tons**				
1.01 to be sorted manually			**Weight: _____ kg**				
Components of the 1.01 manually sorted							
Categories	ONP/ OMG		Graphic papers	Boards		Unwanted	
	ONP	OMG		Solid	Corrugated	Fibrous	Non-fibrous
Weight (kg)							
Ratio (%)							

Report the final grades – 1.11 and 1.04

Grade 1.11: characterisation			**Weight: _____ kg**				
Categories	ONP/ OMG		Graphic papers	Boards		Unwanted	
	ONP	OMG				Fibrous	Non-fibrous
Weight (kg)							
Ratio (%)							

1.11 = 40 % min ONP, 40 % min OMG, rest = graphic paper, unwanted < 1.5 %

Grade 1.04: characterisation		**Weight: _____ kg**			
Categories	**Graphic papers**	**Boards**		**Unwanted**	
		Solid	**Corrugated**	**Fibrous**	**Non-fibrous**
Weight (kg)					
Ratio (%)					

1.04 = 70 % min OCC, rest = packaging papers and boards

Report the aggregate samples

Sample ❷: characterisation			**Weight: _____ kg**				
Categories	**ONP/ OMG**		**Graphic papers**	**Boards**		**Unwanted**	
	ONP	**OMG**		**Solid**	**Corrugated**	**Fibrous**	**Non-fibrous**
Weight (kg)							
Ratio (%)							

Concluding remarks

In the frame of the newsletter, we have principally made the choice of describing the monitoring procedure used for the quality control of the raw materials and the characterisation of the sorting line. As a consequence, we do not give detailed results in terms of characterisation. Large improvements were performed after the monitoring phase and a new campaign of monitoring is planned for the beginning of next year. Results of characterisation will be then available.

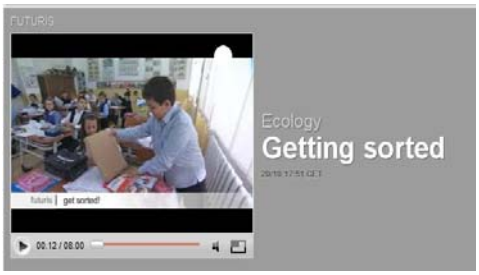
SORT IT Results Dissemination-2010

EURONEWS Documentary - Getting Sorted

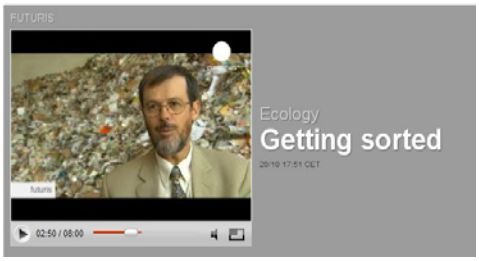
EURONEWS Channel made a documentary about the project on project SORT IT, which was broadcasted from 21 to 27 October 2010.

Summary

"Here in Romania, these children are learning to recycle paper – and they take it very seriously. They want to save forests, but recycling also saves energy and water. In Bucharest, companies collect used paper – and try to encourage people to sort paper properly as this makes recycling easier.



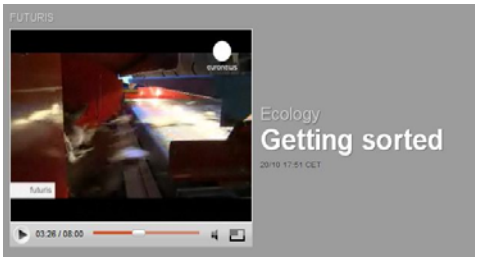
At a collecting point, the paper is sorted and loaded into a lorry. The next stop is the recycling factory. **But when paper hasn't been properly sorted, when it's mixed up with plastic and different sorts of paper are all mixed up together, it takes more time and energy to recycle it.**



Here in Austria, which is the EU's recycling champion, scientists and engineers have built a new machine to improve the sorting process. This machine separates the plastic from the paper, and sorts cardboard from paper.

The wrong paper in the wrong place prevents the industry from improving productivity and reducing recycling costs. This makes recycled paper cheaper than new paper made from wood pulp.

Developed by EU research project SORT IT, this plant uses new technology and developers say that this machine will be fully automatic when finished. This new sorting plant aims to increase the recovery of used paper all across Europe. The advantages for the environment are huge.



Back in Romania, it's evident that sorting is a vital part of recycling used paper and cardboard. And this is the final product – all this will be used to make cardboard boxes. And that completes the cycle. Now the boxes re-enter the market for half of the price of cardboard made from new fibres."

Note: The documentary is still available online (**http://www.euronews.net/2010/10/20/getting-sorted**) and on the project website (**http://www.sortit.eu**)

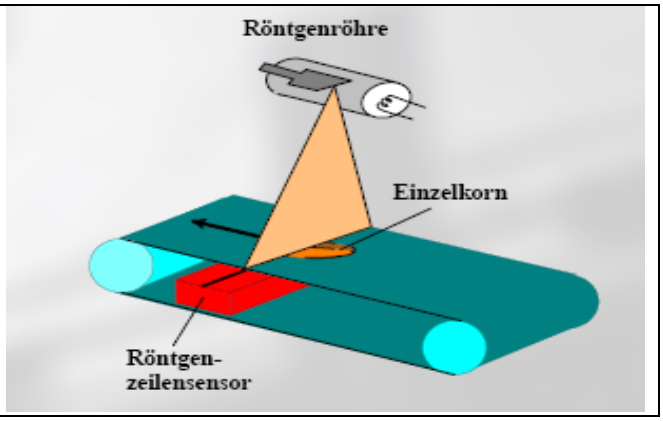
Conferences, Workshops, Seminars

○ Sensor Based Sorting Conference, Aachen, Germany, 9-11 March 2010

EVK

Chemical Imaging of Bulk Sorting

M. Burgstaller, M. Pail, D. Sandu

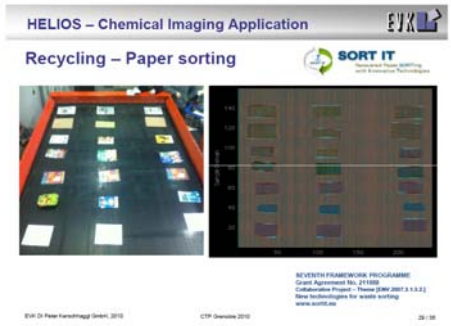


○ 6th CTP-PTS International Symposium on Packaging Design and Recycling, Grenoble, France, 30-31 March 2010

EVK

Use of Novel NIR Hyperspectral Imaging Sensor System for Sorting of Recovered Paper /
Utilisation d'un nouveau Système Capteur Proche Infra Rouge (PIR) d'Analyse d'Images Hyperspectrale

D. Sandu



○ 14th PTS-CTP Deinking Symposium, Munich, 27-29 April 2010

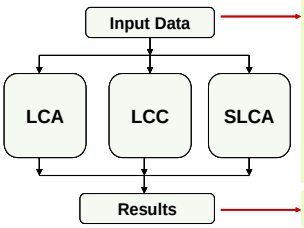
SORT IT

Sustainability assessment of advanced sorting technology for producing deinking recovered paper grades

Elena Bobu, Technical University of Iasi, RO-Iasi
Tatjana Karpenja, INNVENTIA AB, SE-Stockholm
Antonio Dobon Lopez, ITENE, ES-Valencia

New Sorting - Sustainability Assessment

Sustainability assessment is based on the analysis of the environmental, economic and social impacts of current and new advanced sorting RP technology.



Gathering during evaluation trials for current and new advanced sorting technology, based on system flow chart:
- Sorting plant for producing RP grade 1.11
- Paper mill producing newsprint (100% RP grade 1.11)

Functional unit: 1 ton newsprint

Impacts / 1 ton newsprint

Automatic recovered paper sorting - a brand new sorting plant in Upper Austria

Tobias Zirsch

Rauch Recycling

Rauch Recycling Austria - Building complete automatic sorting plant

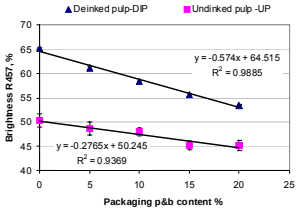
○ 14th International Symposium on Cellulose Chemistry and Technology, Iasi, Romania, 8-10 September 2010

Impact of recovered paper quality on recycled pulp properties

A. Iosip, R. Nicu, F. Ciolacu, E. Bobu

Packaging P&B Content in RP Grade 1.11

Impact on deinked pulp brightness:



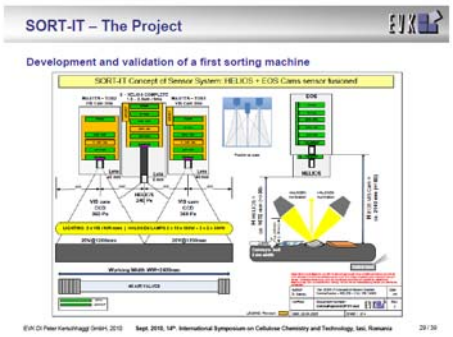
Grade 1.11:
News : Magazine = 50:50

Packaging p&b:
Brown lined OCC : Printed white lined OCC = **50:50**

Packaging p&b not only reduce the brightness due unbleached fibres, but also impair the separation and removal of the ink
→ proved by brightness decrease before flotation (UP)

Use of novel NIR hyperspectral imaging sensor system for sorting of recovered paper

Daniel Sandu

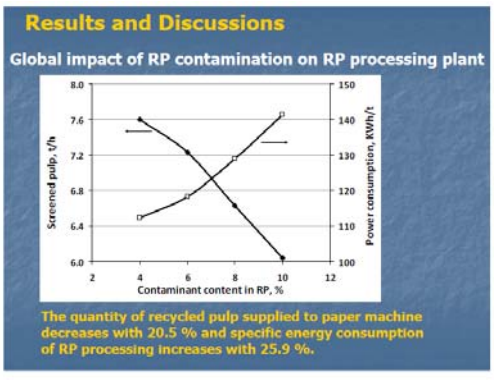


Impact of unusable materials content from recovered paper on recycling process effectiveness: Case study

E. Bobu, P. Obrocea, F. Ciolacu, D. Gavrilescu

Cristian Banarie

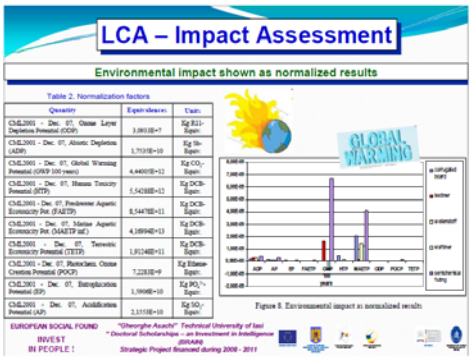
VRANCART



Comparative environmental impact assessment of different types of corrugated base papers

Alina Iosip, Elena Bobu

Mercedes Hortal Ramos, Antonio Dobón

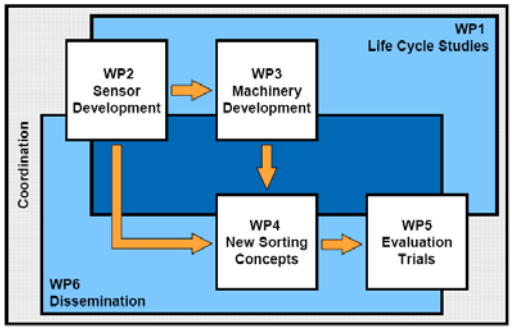


○ **Innventia Research Seminar**, Stockholm, September 20-21, 2010

Recovered paper sorting with innovative technologies (SORT IT)

Kennert Johannson and Tatjana Karpenja

http://www.innventia.com/templates/STFICalendarPage____9227.aspx



○ **Innovatiefestival Papier-en Kartonketen,** Doorwerth, The Netherlands, 14th October 2010

BUMAGA BV
KENNIS IN PRODUCTIE

Willibrord Bles

Kenniscentrum Papier en Karton
Bumaga BV - Kennis in Productie

Verbeteringspotentie in papier & karton fabricage door
Oud Papier SORTering met Innovatieve Technologieën

Innovatiefestival
14 oktober 2010

○ **2º Congreso de Papel Recuperado: Recuperando la Economía. Nuestro, papel en el futuro,** Madrid, Spain, 21 October 2010

Publications

1. Overview on paper and board recycling in Europe

Elena Bobu and Dan Gavrilescu, *Environmental Engineering and Management Journal*, **January 2010**, Vol. **9**, No.1, 159-164

2. Potential benefits of recovered paper sorting by advanced technology

Elena Bobu, Alina Iosip, Florin Ciolacu, *Cellulose Chemistry and Technology,* **November/December 2010**, Vol. **44,** No.10, 461-471.

3. Influence of recovered paper quality on recycled pulp properties

Alina Iosip, Raluca Nicu, Florin Ciolacu, Elena Bobu *Cellulose Chemistry and Technology,* **November/ December 2010**, Vol. **44,** No.10, 513-519.

4. Comparative environmental impact assessment of corrugated board production,

Alina Iosip, Mercedes Hortal, Antonio Dobón, Elena Bobu, *Environmental Engineering and Management Journal*, ***September 2010,*** Vol.**9,** No. 9, 1281-1287

5. Recovered Paper Sorting with Innovative Technologies

Kai Blasius, Jean-Yves Escabasse, Beatriz Ferreira, Accepted by *Recycling Magazine*

Special features

Paper Recycling News

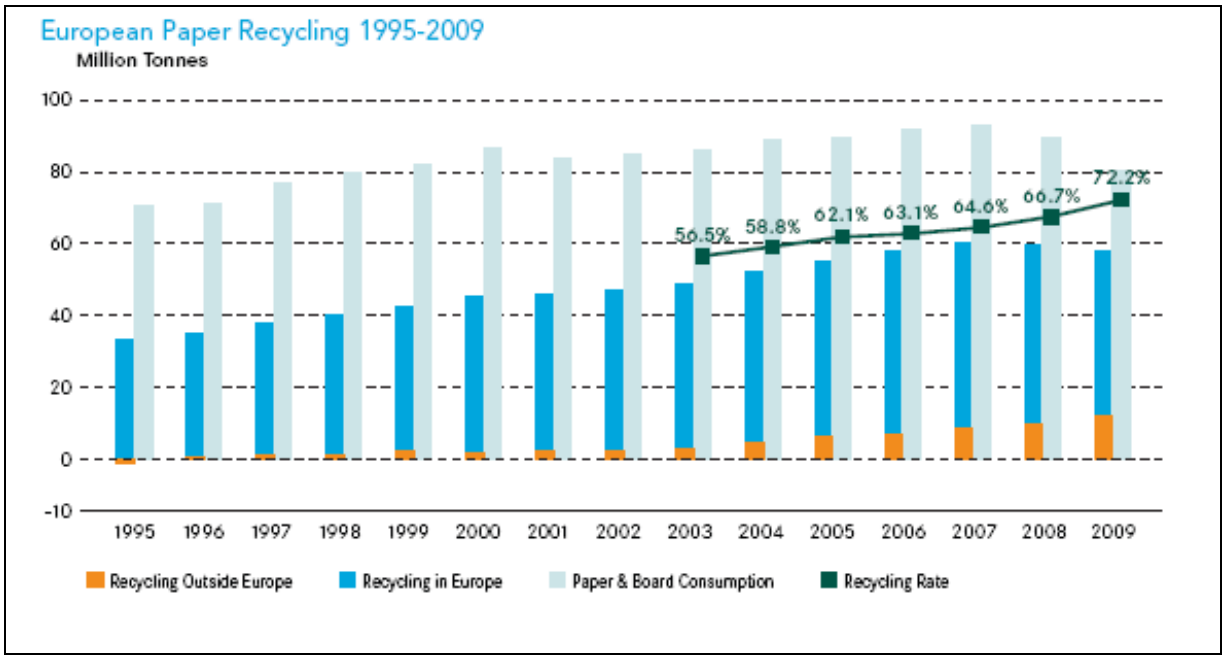
Recycling rate 2009: A new record or "It's the economy, stupid.."

Recycling rate 2009

The Monitoring Report 2009 on "European Declaration on Paper Recycling 2006 – 2010" reveals a steady growth of paper recycling, resulted in a record high 72.2% recycling rate after having reached 66.7% the year before.

"It's the economy, stupid…"

<< The economic recession continued in 2009 and, for the second year in a row, made the recycling rate jump up due to the drop in paper consumption to the level of 1998. As the recycling rate is the ratio between the recycling and the consumption of paper, the sudden fall in consumption – whereas the recycling continued a steady growth – resulted in a record high 72.2% recycling rate after having reached 66.7% the year before.>>



Statistics on European Paper recycling 1995 - 2009

The industry has followed the commitment it made in 2000 to increase paper recycling in Europe but it cannot control unpredictable external factors

such as economic recession and related reduction in paper consumption. "*It's the economy*," as Bill Clinton famously coined it.

A swing in the opposite direction may occur when the economy recovers as recycling may not be able to immediately match up to the reviving paper consumption; the recycling rate is likely to drop, temporarily. In 2010 the recycling rate is estimated to be under 70%, closer to the original target of 66% (±1.5%-points).

Recycling is intrinsically a self-adjusting mechanism which, with a lag of three to six months, will adapt to any volume of consumption. In the trend, the industry will continue on its path to meeting ambitious targets of recycling paper at a steadily increasing rate in Europe. >>

Source: *European Declaration on Paper Recycling 2006 – 2010, Monitoring Report 2009, published by The European Recovered Paper Council, August 2010 (http://www.cepi.org)*

Paper Recycling Matching Innovation Trends of European Forest-based Sector (FTP)

Extracts of "Innovation Trends Report" (published by Forest Based Sector -Technology Platform, available on www.forestplatform.org, November 2010).

The extracts of "Innovation Trends Report" presented below are highlighting the place of paper recycling in innovative development of European forest-based sector as a key player in a sustainable bio-based society.

Innovation Trends Matching EU Societal Priorities

Resource efficiency

Recycling encompasses resource efficiency. The paper industry in Europe already recycles more than 72% of the paper put on the market.

New technologies are being developed to increase the efficiency and overall performance of the recycling operations, while recycling residues and sludge find numerous applications, including in energy.

Also, insulation material is being produced with paper recycling residues, closing the loop of energy efficiency.

Biorefinery

Biorefinery can be described as the efficient use of the entire potential of raw materials and by-streams of the forest-

based sector towards a broad range of high added-value products, through cooperation. With the same wood, four broad categories of products can be obtained; plywood and sawn timber, pulp and paper, biofuels and biochemicals. Residues from wood, from recovered paper, and from agriculture are also feedstock for biorefineries. The final result is radical reduction of CO2, efficient use of raw materials, zero-waste processes, bio-based products that can replace oil-based products. By integrating biorefinery operations in the pulp and paper-making process, the industry is set to produce a wide variety of sustainable materials, from chemicals to fuels and paper products. In this way, pulp and papermakers can increase the value of the European economy of each cubic meter of timber and each tone of recovered paper.

Innovation from Seeds to Products

Although research in the forest-based sector covers many different areas, the most innovative results come from the integration of key enabling technologies and the development of new products.

At the same time, companies constantly undertake technical and technological developments to excel in what they do best – harvesting, wood processing and paper-making.

Recent and current activities focus on industrial production eco-systems with reduced use of raw materials, energy and water, bio-sourced materials and lignocelluloses, vegetal chemicals, safe

and efficient packaging, added-value to recovered paper products and recycling process, printed electronics and high performing tissue.

Process efficiency: Innovative optical sorting technologies enable improved material separation and therefore higher quality recycling on different paper grades (and also of other materials).

Recycled fibre-based cellulose wadding for insulation uses: Five to fifteen times less energy-consuming than competing insulation materials, cellulose wadding can be used in flake form or semi-rigid panels as a very effective insulation material for passive housing and buildings. Once cleaned, waste paper is mixed with boron salt (or boric acid) to increase its resistance to fire but also to pests. It is also an excellent temperature stabilizer and sound insulator.

Enabling the Fulfillment of the Sector's Potential

Society is striving for social responsibility in business models, for solutions to climate change, for the sustainable use of natural resources, for innovation that expands the use of renewable resources, for markets that respect nature, for new ecosystems services that raise the economic value of forests. The forest products industry model may hold the path to reach those aims, bringing answers to many of the questions society has to face.

The sector is at the crossroads of major EU policies: climate change, energy efficiency, sustainable consumption and production, resource efficiency, eco-design. It needs to be supported under the different research and innovation programmes of the European Union.
Addressing society's aspirations, economy needs and policy priorities requires resource strategies that include renewability, recyclability and efficiency. The forest-based sector is the unique sector that can deliver all those factors.

And it has already been doing so. In order to continue and fulfill its role in those ambitions, the forest product sector needs right policy balance that will deliver availability of its raw material wood.

The realizing of the pential forests and wood needs an integrated political approach of industrial policy, agriculture orientations, environmental priorities, energy strategies, competition rules, rural development vision, and a land use balance. Forest accounting methods for CO2 must bring certainty and incentive to investors and generate profits for biobased products.

The investment community is showing interest in ecosystems services, including forestry, biodiversity, wetlands and eco-tourism. Natural resources such as biodiversity, water, fibre and forest are crucial for economies and for human well-being. The provision of those services should be taken into account in the post 2013 CAP (Common Agricultural Policy) through a strong rural development programme where the forest-based sector has a central role to play.

The renewable energy policy must be complemented by a renewable material policy, and by a "carbon sink" policy. Wood is a much envied resource as it can be applied in numerous areas and has the potential to replace both oil and other less sustainable products in many situations. For that reason, it has to be used in the most value adding and most efficient way.
Incentives and support mechanisms to push wood for bioenergy must be set up in line with sustainable forest management (SFM) principles, with its criteria and indicators, to ensure a balanced use of the resource and avoid over harvesting and other negative effects.

Meeting EU Climate Change objectives needs the forest-based industries. Consistent and well designed forest policies are indispensable. Incremental as well as breakthrough technologies in our processing activities will be needed which require a relevant place in EU innovation strategies and funding programmes.

The Raw Material Policy should include a focus on wood and recovered paper equivalent to the focus on other raw materials to ensure its availability to the industry. Implementation of the Waste Framework Directive will deliver more recovered paper. And enforcement of the provisions of the Waste Shipment Directive will retain more recovered paper and wood for European added-value. Recycling needs a consistent set of policies that reinforce each other.

The Action Plan on Sustainable Consumption and Production should give more relevance to current environmental industries such as ours.

Our sector has the right components to be a major contributor to the future bio-economy. It needs the appropriate framework conditions to bring major breakthroughs to that future.

To be successful in its bioeconomy path, it is of utmost relevance for the forest-based sector to be fully considered under the Innovation Union. Other instruments such as the Lead Markets Initiatives must also integrate our sector. We will build strategic partnerships across all sectors to complement our knowledge base.

End-of-waste: Beginning of Better Recycling?

Jori Ringman-Beck

√ Introduction
√ Quality-based approach
√ Specific requirements
√ Positive impacts
√ Some worries remain

Introduction

European legislation on waste changed dramatically in 2008 when the Waste Directive was adopted, replacing the previous, over-30-years-old Framework Directive and repealed some others. In thirty years the thinking has changed from seeing waste as a problem to managing it as a valuable material for reuse and recycling.

The new measure, Directive 2008/98/EC[2], establishes the generic environmental standards for waste to be re-used or recycled, sets an objective to collect certain materials such as paper separately by 2015 and material-specific recycling targets for 2020, modernizes and clarifies a whole lot of definitions, and introduces a mechanism for waste ceasing to be waste.

Whilst the member states have been busy to meet the deadline for transposing the Directive into their national law by 12 December 2010, the Commission has started implementing the end-of-waste rules in a material-by-material approach, one of which has been on recovered paper. A process that has lasted about a year now has resulted in a scientific justification to support the legislative process that is now about to start. An applicable regulation to state the conditions under which the recovered paper would no longer be considered waste but secondary material is expected to be ready by end of 2011. The political process, however, is not easy to predict and any surprise along the road is possible to delay the process.

Quality-based approach

Before the revision, the industry felt being under-served by the Directive as it considered recovered paper merely as waste to be disposed of, and not as valuable raw material. It also did not support the industry's efforts to implement quality management which with growing paper collections and increasingly tapping into poorer quality sources of recovered paper has become more and more vital. In particular, increasing volumes of co-mingled

[2] Translations of the Waste Directive to all 23 EU languages are available at the Official Journal of the European Union website: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0098:EN:NOT

collections were spreading to more countries, causing serious problems in material efficiency. Finally, without clear guidance on waste hierarchy, a concern of recovered paper being used as a renewable energy source was growing.

The outcome of the revision process, however, was very positive. In addition to the general modernization of the Directive, recovered paper was clearly noted as a "priority stream". Waste Hierarchy, recycling targets for paper collected from households, separate collection and end-of-waste are all building a framework where quality management for recovered paper is made possible.

The same quality approach has been the guiding principle for the Commission in the work on end-of-waste. The Directive itself sets the general requirements for all the materials, in Article 6.1, which are further supplemented by material-specific criteria in a comitology process where the Commission is assisted by experts from the member states. It is clear that recovered paper can readily meet all the four general criteria: it is commonly used for material recycling, a strong global market for recovered paper exists as indicated by the high and steadily increasing market prices, it meets the technical requirements of paper recycling, specified in e.g. EN 643 standard and any legal requirements, and without any doubt paper recycling will lead to overall positive environmental impact.

Specific requirements

As the legislative process has not started yet, the final specific criteria are not known at the moment. However, the draft scientific report (IPTS, July 2010) by the Commission research unit IPTS in Seville has suggested a framework that is likely to be followed closely by the Commission in its proposal.

Waste Directive (Article 6.1):

Certain specified waste shall cease to be waste […] when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed in accordance with the following conditions:

a. the substance or object is commonly used for specific purposes,

b. a market or demand exists for such a substance or object,

c. the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products,

d. the use of the substance or object will not lead to overall adverse environmental or human health impacts.

IPTS work itself has followed the methodology[3] developed by the same institute earlier, with the ultimate aim to improve the quality of the product.

The following elements can be combined in a set of end-of-waste criteria (IPTS, July 2010):
(1) Product quality requirements
(2) Requirements on input materials
(3)Requirements on treatment processes and techniques
(4) Requirements on the provision of information (e.g. documentation of end use, traceability systems, labeling).
(5) Requirements on quality assurance procedures.

"This approach to define a set of end-of-waste criteria combining several levers of action corresponds well to current good industrial practice of ensuring the product quality of waste paper. Accordingly, waste paper ceases to be waste when it is placed on a market where it has a demand because it fulfils certain product quality requirements, has a clearly identified origin and has been processed according to the required treatment processes. Compliance with all these requirements has to be ensured by applying industrial practice of quality control." (Idem)

Most importantly, a criterion of tolerable impurities ("non-paper elements") will be set and is expected to be 1.5% as suggested by the IPTS draft in July. This will be an important benchmark for the collection systems and sorting technology, as the sorted output material should not exceed 1.5% of non-paper components if the material is to be considered secondary material and no longer waste.

[3] Can be downloaded from: http://susproc.jrc.ec.europa.eu/activities/waste/

Positive impacts

End-of-waste will have many positive impacts throughout the value chain. Economic impacts can be positive if the aim of reducing red tape and, in particular, not having to manage excessive amounts of residues from low quality recovered paper input is materialized.

Ecologically the awareness of managing resource and not waste will lead to reduced losses and therefore improved resource efficiency. Socially, all the chain can benefit from improved health and safety and more attractive jobs.

It is also clear that these elements will have positive synergy effects crossing from ecology to economic to social and back. This will be an important factor in combating the intrinsically increasing marginal cost of paper recycling and will help the industry to further raise to bar to recycle yet more paper in Europe.

Some worries remain

During the preparation of the scientific report by IPTS, some worries have emerged. The first one is the definition of "non-paper component". The draft from July defines it as "any material different from paper, which may be present in waste paper." This would include also elements that were part of the original product the waste came from, such as paper clips, envelope windows, inks, adhesives and laminates.

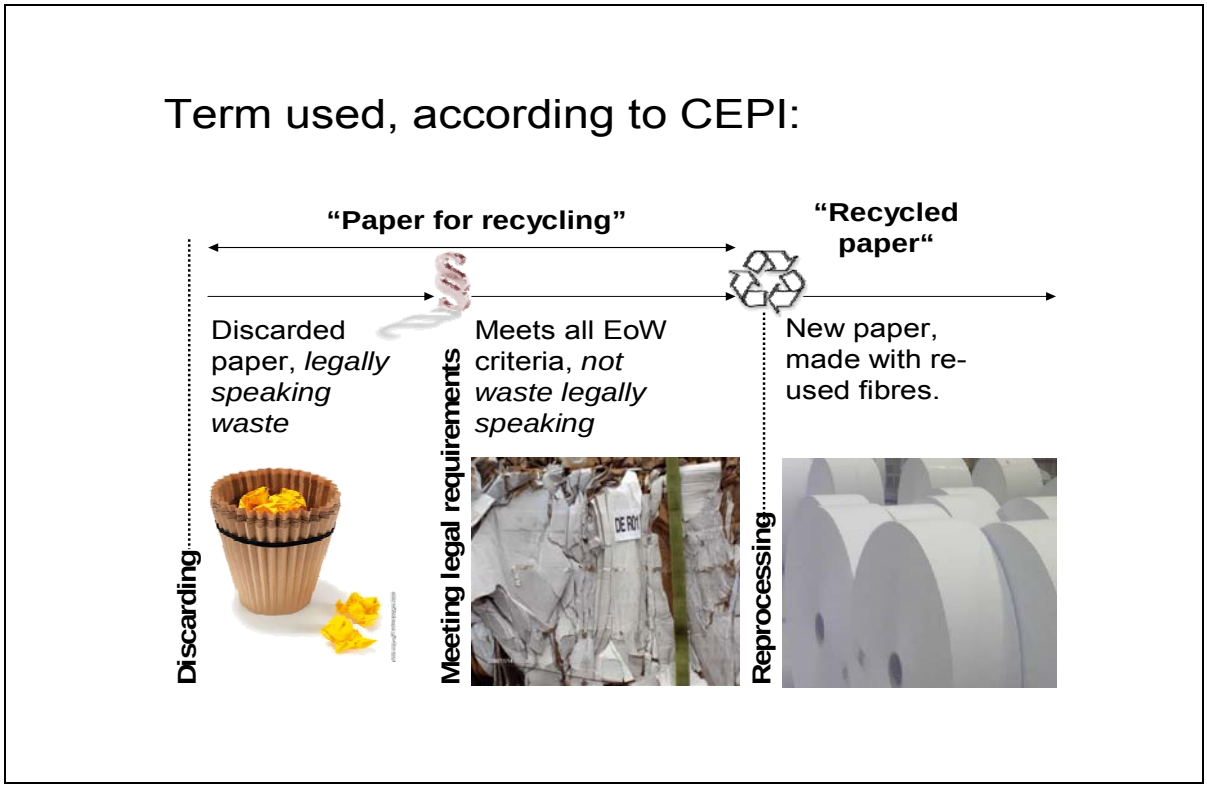
The European paper industry thinks this definition would not be workable as it would make the gravimetric method used to test the share of "non-paper elements" simply non-practicable. Instead, the definition should seek to measure the

efficiency of the collection and sorting system, and define non-paper components as "any material different from paper *products*, which may be present in paper *for recycling, can be removed in a dry-sorting step and was not part of the original paper product the waste originated from*."

Another outstanding problem is terminology where the Commission is eager to start calling the material "waste paper" again, after decades of industry efforts to support the quality management by calling it "recovered paper".

Although legally speaking still waste, it is not necessary to call it waste paper – just like in other industries specific names for the similar material are used such as scrap metal or recyclates.

As a compromise, and perhaps more self-explanatory than "recovered paper" was, the paper industry has now suggested a new term to be used: "paper for recycling" (Confederation of European Paper Industries, CEPI, 2010). The use of this term is explained in the scheme below.



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SORT IT Results to Support the Revision of the EN 643

Elena Bobu

Background

End-of-waste process and EN 643 revision

The EN 643 revision is part of CEPI work on end-of-waste procedure, which is starting with proposals for New Waste Directive. The Directive 2008/98/EC introduced a new procedure for defining end-of-waste criteria, which a given waste stream has to fulfill in order to cease to be a waste. Preceding article in this newsletter (Jori Ringman-Beck) states clearly that recovered paper can readily meet all four general criteria to cease to be a waste. Recovered Paper in Europe has many assets to build on the classification as a secondary material, including (Reinoso, 2008):

- European Standard List of Recovered Paper Grades EN643
- Established markets and large-scale facilities in recycling
- Responsible Sourcing and Quality Management Guidelines
- Recovered Paper Identification System
- No environmental hazards in collection, recycling or use.

Having in view quality requirements for determining that paper and board is recyclable and comply with the end-of-waste criteria, the proposal for EN 643 revision is aiming to set tolerance limits for unwanted materials, clarify the definitions and eliminate some inconsistencies in the describing of the grades (CEPI, 2009)

In order to analyse how SORT IT results could support actual and future revisions of the EN 643, a critical analysis of the benefits, limits and drawbacks of the EN643 was done, starting from the potential for further increase of recycling rate in Europe and actual trends in recovered paper quality.

Actual trends in paper and board recycling

Literature documentation and several laboratory studies of SORT IT partners lead to following conclusions (SORT IT, 2010a):

- Future potential for increasing the collection of used paper and board clearly lies in households. It is generally accepted that an extended recovered paper collection from household is always detrimental to its quality.

● Many studies have shown that there is a clear trend towards higher contamination of recovered paper grades, resulting from sorting of mixed recovered paper grades from household collection. The most important trends are: increase of packaging paper content in deinking RP grade 1.11; increase of graphic paper and non-paper components content in packaging RP grade 1.04.

● The low quality of recovered paper has a strong negative impact on sustainable recycling in the production of different paper grades, based on recovered paper as a raw material, because: the processing yield decreases and the volume of solid waste increase, resulting in negative economical and environmental impacts; the quality of recycled pulp and of the produced paper decreases, due to the high contamination of the raw material with unusable materials (non-paper component, non-recyclable paper, and paper and board unsuited for produced paper or board grade).

Finally, it was remarked that further increase of recovering and utilization of used paper and board in European paper industry is depending on several factors, such us:

▪ Setting up separate of collection systems in all EU countries by implementation of new Waste Directive until 2015;

▪ Reduction in the content of unusable materials and achievement of an increased homogeneity of the recovered paper grades by improving collection systems and advanced sorting technologies;

▪ Advanced sorting has to be completed with an extended description of the recovered paper quality, which will allow the production of tailor-made recovered paper grades for the best possible re-use in paper and board production.

Benefits, limitations and drawbacks of the EN 643

Detailed analysis of the "European List of Standard Grades of Recovered Paper and Board" and other supporting documents evidenced the both benefits and limitations and drawbacks of the standard.

Direct benefits of the EN 643 are resulting from the following accomplishments:

• The "European List of Standard Grades of Recovered Paper and Board" has been available and used in Europe by the paper mills and by recovered paper and board traders as a reference in their commercial relationships. *The list has become the first official European Standard in 2001 - EN 643,* which defines and describes recovered paper grades.

• The EN643 is agreed by the two market parties *in recovered paper chain*, represented by CEPI (Confederation of European paper Industries), as buyers, and ERPA (European Recovered Paper Association), as suppliers.

• A convention within paper recycling chain to use the term "recovered paper" instead of "wastepaper" was agreed.

• The list of European standard grades of recovered paper and board *gives a general description of the standard grades by defining what they do and do not contain*.

• The standard defines unusable materials, non-paper components, paper and board detrimental to production.

• The standard establishes a clear separation between the household and multi-material collection systems.

Indirect benefits of the EN 643 implementation are resulting from

different initiatives of the players in paper recovery chain, aiming at completing the framework of the EN 643 standard. These initiatives are materialized in several official documents, such as:

- Responsible Management of Recovered Paper (folder containing different documents concerning responsible sourcing and quality control of recovered paper);
- Recovered Paper Identification System;
- Guide to an Optimum Recyclability of Printed Graphic Paper Industry initiatives to complete the legislative framework.

The limitations of the EN 643 standard are related to:

Lack of tolerance limits for unusable materials: The EN643 does not provide tolerance limits for the unusable materials content of the different recovered paper grades. In order to facilitate recovered paper trade "it is recognised that specific deals between buyer and supplier for standard grades with special specifications will still be necessary to meet individual requirements…[13]" Efficient recycling of recovered paper in new paper products requests adequate and constant quality of the recovered paper, as well as sufficient volumes. Unfortunately, the *availability, demand and price of recovered paper* are main factors that decide the specification of recovered paper quality. Finally, this situation leads to significantly increased numbers of complaints, as well as to a higher demand for recovered paper grades with controlled quality (Berglund, 2003; COST, 2010)

Heterogeneous quality control practices: Recovered paper quality is one of the main factors impacting the sustainability of paper and board recycling. All documents supplementing the EN 643 standard constitute a step in the way for standardisation of recovered paper quality control. Analysis of these documents shows obviously that the control of recovered paper quality is mainly the responsibility of paper mills. The differences in the quality control at supplier and paper mill lead to discrepancies regarding the recovered paper grade classification in the EN 643 standard**.** Actually, grade classification in the EN 643 is made at the supplier, being based mainly on visual inspection. Having in view that grade definition is based on complex criteria (origin of papers, collection systems (household, paper and board, type of fibre pulps used to produce papers, treatments applied on paper machines and/or during converting and printing), the visual inspection can induce many mistakes in the classification of recovered paper, with negative impact on the efficiency of the whole chain.

Above motivations are only few arguments that all parties within the paper recycling chain have to support the development, harmonization and standardization of methods for quality description of recovered paper at sorting plants and paper mill, respectively. All initiatives supporting the EN 643 created a general framework for the management of recovered paper quality, but this framework has to be completed with standard methods for the characterisation and control of recovered paper, which should be applied uniformly by the suppliers and beneficiaries of recovered paper.

Drawbacks of the EN 643 are concerning high number of grades (plus sub-grades) and the lack of clarity and simplicity of the definitions.

Too many grades: The EN 643 list contains many grades that are not used frequently, especially from medium, high

and kraft grades groups. Considering the utilization of recovered paper for new paper and board production, all recovered paper grades could be included into two large groups: - *packaging grades*, processed to obtain recycled pulp used for new packaging materials (mainly corrugated board papers and other low quality board grades); - *deinked grades,* processed by deinking, for obtaining deinked pulp with requested optical properties for use in the production of new graphic papers, mainly newsprint, and household & sanitary papers.

To obtain a general view on the utilization of different recovered paper grades in these two large groups, a summary analysis was done for three SORT IT partner countries – France, Germany and The Netherlands. The analysis is based on data obtained via the questionnaires for overview of the current situation of paper recycling. These three countries are representative for the SORT IT countries group, because all have high paper and board production based on recovered paper (in 2008, recovered paper consumption in these countries represented about 47% of the total consumption in CEPI countries) and all have a high recycling rate in 2008: France – 64.3%; Germany – 74.1%; The Netherlands – 79.8% (CEPI, 2008)

The results have shown that, globally, 14 recovered paper grades are used in packaging paper & board production, but only five grades are covering more than 90% of consumption in each country (100% in Germany). The deinking grades group includes 15 recovered paper grades processed or the production of newsprint, household & sanitary papers and other graphic papers (high quality graphic paper). It was found that 2 grades cover 100% of the recovered paper consumption for newsprint, 3 grades cover 95% of the consumption for household & sanitary, and 4 grades cover 100% consumption for other graphic papers. Actually, less than 50% of the total EN 643 grades are traded in these countries, and the situation is about the same in CEPI countries.

Unclear definition and complicated description: The EN 643 contains the different types of grade definitions:

- "Positive" definitions are used when the grade contains only one sort of recovered paper and board. These are very clear definitions, allowing correct classification and quality control. Examples: grade 1.05 = 100 % corrugated board; grade 2.09 = 100 % of carbonless copy paper.
- "Negative" definitions are used for mixed grades, without restrictions, which sound as "grades that contain what you want". Examples: grade 1.01 - all papers and boards from the industry; grade 5.01 - all papers and boards from households.
- "Intermediate" definitions are the most frequently used to define the grade, naming the content of one or more sorts of used paper and board, with possible thresholds. Examples: 1.04 - min 70 % corrugated boards, the rest being other packaging paper and board; 5.02 - a mixture of various qualities of used paper and board packaging, free from newspapers and magazines.; 1.11 - min 40 % ONP (old newsprint), min 40 % OMG (old magazines), the percentage of non-deinkable paper and board should be reduced over time to a maximum level of 1.5%.

These types of definitions, and especially the intermediate definitions, which are the most numerous, put some limits to recovered paper composition, which practically cannot be controlled. For example:

- There are several definitions for *wood containing deinking recovered paper*

grades defined by different contents of the newsprint and magazine (1.08, 1.09, 1.10, 1.11, 2.01, 2.02*)*. But, only by visual inspection, it is not possible to distinguish between 50% and 60% of newsprint or magazine or other similar description.

•The EN643 describes eleven wood-free recovered paper grades but, a brief analysis of these descriptions shows that, practically, it is very difficult to distinguish between wood-free and wood-containing papers by visual inspection at the sorting plant, with the exception of the industrial sources. For this reason, part of the high quality paper collected from offices and part from household is ending in mixed grades and is not efficiently exploited.

SORT IT developments towards better recovered paper quality

Preceding analysis of actual trends in paper and board recycling shows that sorting activities are of great importance in exploiting lower quality sources for achieving higher collection rates and in safeguarding the supply and quality of recovered paper as a secondary row material.

The goal of SORT IT project is the development of an automated, high-volume material analyzing and sorting system for recovered paper, based on improved sensors and measurement techniques that enable more efficient and profitable recycling of used paper and board. These developments are aiming to enable sustainable and cost-effective paper recovery at above 95% yield of all recyclable paper and board grades, and to provide recovered qualities of least 98% purity that will allow the best possible re-use in paper & board products.

Technical developments towards the goal and objective of the project are achieving by research and innovation steps that are briefly described below.

Development of a New NIR Spectral Imaging System – Helios 2.3: The new NIR sensor developed by EVK and PTS allows measurements over an extended spectral range - from 1350 nm to 2300 nm - and provides better possibilities for identification and quantitative analysis of the recovered paper. Advantages over the existing NIR systems are: extended spectral range; object recognition; faster measurement and analysis (Sandu, 2009).

Qualitative analyses*:* Extensive studies were performed for the development of classification and quantification methods for the analysis of the NIR spectra of recovered paper objects, which are going to be used as sorting criteria. Having in view the planned industrial sorting trials for the production of deinking grade 1.11 and packaging grade 1.04, the classification criteria were determined according to the production of these grades. For the development of the classification methods, representative samples of recovered papers were collected and separated in different fractions, categories and sub-categories, selected according to the EN 643. The following fractions, categories and sub-categories of the reference samples were defined:

Deinking Papers: Newspapers, Magazines, Brochures & Flyers (coated and uncoated), Office Papers.

Non-Deinking Papers: Corrugated Board (brown), Corrugated Board (coated and printed), Corrugated Board (laminated paper), Folding Boxes (coated and printed), Paper with Plastics (Tetrapak,

plastic laminated papers), Flexo Printed Newspapers.

Non-Paper Components: Plastics, Plastic Films, Wood, Textiles (natural and synthetic fibers).

It was demonstrated that the NIR camera Helios 2.3, the measuring software HELIOS Viewer and the developed analysis software for spectra allow classification of several non-paper components with the accuracy up to 100%. The newly-developed NIR system also allows a high-accuracy classification of the following papers components of the deinking recovered papers grades, described as wanted materials: newspaper, magazines, coated and uncoate*d* brochures and office papers. The system also allows the identification of unwanted paper and board components in deinking recovered paper grades, which can be classified at accuracy between 80 and 100 % (Pigrosch and Sandu, 2010).

Quantitative analyses*:* Besides qualitative analyses, the NIR Helios 2.3 method can be used for quantitative evaluation of the content of ash and mechanical pulp (based on lignin content). These analyses are based on *chemometric method* application as a statistical tool to get information from chemical or physical measurements. Using Principal Component Analysis (PCA), it is possible to break down sets of spectroscopic data into its most basic variations. For quantitative analysis, a correlation should be established between the variations of NIR spectra and the concentration of different compounds in the sample. This can be done by reducing the very great number of variations with a PCA to only a few factors. Further on, these factors and other variables are sent into a Partial Least Squares Regression system (PLS) to calculate a quantitative calibration model.

Quantification of Mechanical Pulp: A very specific sorting criterion for recovered paper is separation of wood-free papers by measuring the mechanical pulp content, based on lignin identification. In order to demonstrate the possibility to classify recovered papers by NIR according to their content of mechanical pulp, a quantitative NIR method was developed within the SORT IT project. NIR measurements were done with the NIR camera Helios 2.3 for each five different samples of office paper (OP), newspaper (NP) and brown corrugated board (OCC). The results have shown that it is possible to classify the recovered paper types by the relative content of mechanical pulp, based on lignin measurements. For sorting of wood-free papers, a minimum mechanical pulp content has to be set.

Quantification of Ash Content: NIR spectroscopy gives the possibility to determine the ash content of the different recovered paper objects and to use this value for RP sorting with high and low ash contents. A quantitative NIR method for the ash content was developed for the NIR camera Helios 2.3. As? reference values, the ash content at

525 °C of 156 recovered paper samples was determined, and the NIR spectra of the objects were measured. The ash contents were in the range from 0.2 to 49 %. The calibration model had a correlation coefficient of R2= 0.82 and a standard error of calibration SEC= 3.3 %

Integration of image analysis with NIR camera Helios 2.3: Among different alternative methods studied, image analysis integration with new NIR

sensor has received the highest priority in the SORT IT research work.

VISible spectroscopy and image analysis (NewsMag system developed by CTP) permitted first of all a fast and good/correct evaluation of the brown board content. The differences of visual appearance between newsprints and magazines (newsprints are less coloured than magazines and colours on magazines appear to be more saturated, magazines are glossier) have been fructified?? to measure the newsprints / magazines ratio. "Saturation" of the image demonstrated a good correlation with sample composition. Thus, recovered paper grade EN643 1.11 can be better described qualitatively by the ONP/OMG ratio (Borel and Cochaux, 2009)

The building design of Helios allows inclusion of a second measurement head in addition to this NIR head. The use a visible head, i.e. an adapted colour camera, in Helios, allows obtaining of colour images. Then, by NewsMag specific processing algorithms on these images, complementary data will be obtained with this fully-equipped device.

Recommendations for future revision of EN 643 standard

SORT IT recommendations for the EN 643 revision are based on the conclusions concerning actual limits and drawbacks of the standard and application potential of innovative sorting devices developed in the project.

Introduction of tolerance levels for plastic materials is supporting by following arguments:

- There is a trend of increasing plastic materials content in all recovered paper grades resulting from household and office collection. New developed NIR sensor system allows 100% identification of plastics materials.
- The implementation of end-of-waste criteria will push the developments of these tools and will make possible their application before CEN revision of the EN643.

Introduction of the levels for ash and lignin as parameters for description and identification of standard recovered paper grades is based on following arguments:

- A quantitative method for ash measurement was developed for NIR camera Helios 2.3.
- Ash quantification could be done online in sorting process (separation of graphic papers from packaging grades, separation of graphic papers with high and low ash content) or offline for quality control at sorting plant and/or at paper mill. The ash content is an important qualitative parameter for the both deinking and packaging grades: high or low ash levels could be applied to describe and identify deinking grades for efficient utilization in the production of tissue or respectively, graphic papers; a tolerance limit for the ash content in packaging recovered paper grades will improve the processing yield and will reduce the costs for requested mechanical strength of packaging paper.
- Including ash content in quality description of recovered paper can contribute to better complying of recovered paper with REACH rules, when recovered paper ceases to be waste.
- A quantitative NIR method for measurement of lignin and its quantification as mechanical pulp was developed in the SORT IT project.

• The method allows the classification of recovered paper types by lignin content (expressed as mechanical pulp) in following order from minim to maximum: woodfree papers, magazines, newspapers, brown corrugated board (OCC).
• The application of Helios 2.3 at sorting plant will allow the obtaining and description of: woodfree RP grades with minimum mechanical pulp; packaging RP grades with high OCC content and known composition (kraftliner / testliner); deinking grades free of contamination with brown paper and board.

Forbidden or very low tolerance levels for liquid packaging and wet-strength paper and board in EN 643 grades of groups 1-4. The arguments for this recommendation are:
• When these paper and board products contaminate different standard grades of recovered paper (groups 1-4), they can produce damaging to the equipments of recycling plant and to the quality of end product, or their presence makes the whole consignment of paper unusable.
• These paper and board products contain very good cellulose fibres that could be efficiently exploited when they are processed separately in special designed equipments. Example: *Tetra Pak liquid package board is a multi-layer composite, whose barriers consist of 4-5 layers of low-density polyethylene (LDPE) and one very thin layer of aluminium; these barrier layers account for 5% of the total weight and rest is fibre material of high quality; due this barrier property, the board can not be processed in a conventional pulper and must part of the fibres will be lost as coarse rejects; in this case, a supplementary equipment is needed to prepare the material before pulping by opening, perforating or shredding the board in order to facilitate the contact with water.*

• New NIR system offers possibilities to identify different chemical components, including LDPE of poly-coated paperboards and wet-strength resins. The improvement of classification methods and new separation algorithms will allow separation of these materials as secondary streams and their classification in the group 5 as special grades.

A new structure of recovered paper groups that should provide a better exploitation of wood free recovered paper and board. The proposal includes following four groups:

Group 1: Brown grades for packaging
A. Mixed brown/gray grades
- Different qualities as function of composition per paper and board grades

B. Kraft grades
- Different qualities as function of kraft paper content

Group 2: White wood-containing grades for deinking
- Different newspaper / magazines ratios
- Different qualities as a function of the tolerance levels for unwanted materials (*colour, water-based inks, toner prints)*
- Different shavings

Group 3: White wood-free grades for deinking
- Different ash contents (graphic and tissue grades)
- Different qualities as a function of tolerance levels for unwanted materials
- Printing inks (*Ink-jet, UV inks/varnish, etc.)*

Groups 4: the same as the actual group 5

Main arguments for this structure of recovered paper grades are:

• Actually, wood-free paper amounts to about 40% of the EU paper production, but only about 10% is recycled back into fine printing and writing paper production. The main sources of wood-free recovered paper are offices, selective household collection, unsold and misprints.
• Most part of these papers ends in packaging or low quality deinking grades, which are close to the maximum utilization rate. Therefore, the wood-free recovered paper presents the highest potential for increasing the utilization rate in the production of high quality graphic papers.
• Development of advanced sorting technologies will allow separation of different paper and board fractions, as a function of the lignin and ash content. Specific separation algorithms could be implemented to accurately separate wood-free papers and thus to produce different qualities of wood-free recovered paper.
• Additional techniques (visible spectroscopy, fluorescence techniques, middle Infra Red Spectroscopy, microwaves techniques, Tera-Hertz waves) could be integrated in different ways to develop more accurate quantification methods for various paper components, thus allowing a better and more clear description of the recovered paper grades.

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Events of interest for SORT IT in 2011

February, 2011
20th INGEDE Symposium
HbW, Munich, Germany
http://www.ingede.org

23-25 March, 2011
FEFCO Technical Seminar
Olympiapark Munich, Germany
http://www.fefco.or

29-31 March 2011
Residential Recycling Conference 2011
Opryland-Nashville, USA,
http://www.residentialrecyclingconference.com/

13 – 15 April 2011
Environmental International Forum SAVE the Planet Waste & Water Management, Recycling, Sofia, Bulgaria
http://www.viaexpo.com

1-4 May, 2011
TAPPI PaperCon Conference
Covington, KY USA
http://www.tappi.org/events/

16-18 May, 2011
25th IAPRI Symposium on Packaging, Berlin, Germany
http://www.iapri2011.de/

13-20 May, 2011
International Conference -NIR, Cape Town, South Africa
http://www.nir2011.org/

23-25 May, 2011
BIR World Recycling Convention & Exhibition
Singapore, Australia
http://www.bir.org/events

24-26 May, 2011
Waste-to-Resources 2011
4th International Symposium MBT (AWT) MRF & Recycling
Hannover, Germany
http://www.wasteconsult.de/w2r/index.htm

24-26th May 2011
CTP 2011 Deinking & Recycling Training Courses, 10th CTP/PTS International DEINKING, 5th CTP/PTS International Packaging Recycling, Grenoble, France
http://www.webctp.com

31st May - 03rd June, 2011
WasteTech-2011
Moscow, Russia
http://www.waste-tech.ru

6 – 9 June, 2011
Entsorga- Enteco International Trade Fair
Cologne, Germany
www.enteco-cologne.de

8-10th June, 20111
6th International Symposium on Wood, Fibre and Pulping Chemistry, Tianjin, China
http://www.iswfpc2011.org

28 - 30 June, 2011
Zellcheming, Conference and Expo, Rhein-Main-Hallen Wiesbaden, Germany
http://zellcheming-expo.de

1 - 4 September, 2011
6th International Conference Environmental Engineering and Management "*Green future*" Balaton Lake, Hungary
http://www.iceem.eu

13-15th September 2011
Recycling and waste management exhibition
Birmingham, UK of Great Britain
http://www.rwmexhibition.com

25 – 29 September, 2011
The 6th Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, Dubrovnik, Croatia
http://www.dubrovnik2011.sdewes.org

See more on Calendar of international events of the **Recycling International Magazine**:
http://www.recyclinginternational.com/calendar/index.aspx

Project Partners

Research organizations and universities

- Papiertechnische Stiftung (DE*)*
- Centre Technique de l'Industrie des Papiers, Cartons et Celluloses (FR)
- STFI-Packforsk AB (SE)
- Universitatea Tehnica "Gheorghe Asachi" Iasi (RO)
- Instituto Tecnológico del Embalaje Transporte y Logística (ES)
- Bumaga BV (NL), *Leader WP4*

Industrial partners

- Bollegraaf Recycling Machinery (NL)
- EVK DI Kerschhaggl GmbH (AT)
- Rauch Recycling Dienstleistungs GmbH (AT)
- Vrancart S.A. Adjud (RO)
- Norske Skog AS (NO), *Leader WP5*
- RTT Systemtechnik GmbH (DE)
- Papeles y Cartones de Europa S.A. (ES)

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