ERPC/009/08

Guide to

an Optimum Recyclability

of Printed Graphic Paper

18 September 2008

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1. Introduction

This paper deals with the recycling of recovered graphic paper, for the production of graphic paper and other white papers. For brown packaging, other recycling techniques apply.

In recent years the recycling of recovered paper in the production of graphic papers and other white papers has increased considerably.

Today recovered paper is, in terms of quantity, the most important raw material for the European paper industry. Now, in particular newsprint consists increasingly of recycled graphic paper. The treatment of recovered paper starts with the separation of non-paper components, and is followed by the removal of the printing ink in the flotation deinking process. The share of printing ink in average recovered paper mixtures amounts to about 2% by weight. However yields of de-inked pulp (DIP) are only between 75% and 85%, because besides the printing ink and adhesives, fragments of paper fibres and parts of the mineral fillers and coating pigments are also removed.

The result of the recovered paper treatment depends on many factors (e.g. quality of the paper, type of printing process, properties of the printing ink, etc). Moreover the ageing process and climatic conditions during the life cycle of the print products can influence the result.

In many countries it has recently become increasingly difficult in deinking pulp mills to maintain the customary standards of yield and brightness of DIP. The reasons for this are manifold:

- The increasing collecting rates throughout Europe and the systems used for the collection of used paper destinated to be deinked are a challenge for the deinking industry. There is a danger that the requirements of recovered paper quality are not met; e.g. due to higher shares of board or aged products.

- The increase in the recycling of recovered paper leads to lower shares of virgin fibres in recovered paper.

- The trend in newspaper printing to apply growing quantities of ink onto ever thinner paper brings an unfavourable quantitative ratio of ink / paper.

To make up for these unfavourable developments, equipment used in deinking plants is constantly being extended. However to maintain the achieved standard, it is also necessary that everyone involved in the paper chain - including parties placing the order and designers of print products - give due consideration to the requirements of recycling. In the European Declaration on Paper Recycling 2006 – 2010 all major stakeholders in the paper value chain committed themselves to act accordingly.

2. Processes

Various process steps must be evaluated in the technical process of graphic recovered paper treatment.

2.1. Separation of non-paper components

As a matter of principle, operators of deinking plants see non-paper components in an unfavourable light, because they increase waste quantities. However, quite often, such components cannot be avoided. To impede the de-inking process as little as possible, the following requirements are important:

- Non-paper components should be dimensioned and mechanically stable in such a way that they survive as large particles, without being comminuted, in the conditions of pulping and allow mechanical separation by means of punched screens, slot screens and centrifugal purifiers. Relevant examples are cover foils, staples, thick adhesive layers, various product samples.
- Materials applied in very small dimensions or disintegrating into very small parts are unfavourable because they cannot be removed using today's conventional sorting methods.

2.2. Detachment of the printing ink film

The next step is to remove the printing ink film from the paper fibres. In the case of prints on coated paper there is, of course, no contact between printing ink and paper fibres. Here in general no problems arise, because the paper coating disintegrates as the recovered paper is pulped and fragments of the ink film are released. On uncoated paper the adhesion of printing ink to paper depends, firstly, on paper properties such as surface structure, fibre type, ash contents, etc and, secondly, the drying mechanism of the chosen printing process. Printing inks, which form firmly sticking, tenacious printing ink films are more difficult to remove from the fibre. Examples are inks drying by polymerisation (oxidative drying, radiation curing). The ageing of offset inks based upon oxidative drying materials can also significantly reduce the deinkability.

2.3. Soluble and redispersable components

Components in the recovered paper, which dissolve in the process under standard conditions of deinking (pH 8 - 10) and reach the process water, pose a risk of unintended spreading to all parts of the paper machine. Problems occur when sticky residues - stickies - form upon redrying. In principle, these stickies have to be removed by tedious manual work, causing downtime, or by additional cleaning equipment, reducing the lifetime of equipment and paper machine clothing. A typical way in which stickies form is the agglomeration of dispersed or dissolved auxiliary materials, e.g. water-soluble or redispersable adhesives, paper-coating binders, coatings, varnishes and printing ink constituents. A similar – albeit very rare – problem arises when dyes from paper or printing ink dissolve initially in water and subsequently move onto clean paper fibres.

The requirement therefore is that recovered paper should contain as few components as possible, which dissolve or disperse in weakly alkaline medium and form sticky residues or cause discolourations.

2.4. Flotation

Flotation, which is the most common process currently used in Europe, is the essential step to remove printing inks. Supported by surface-active substances, printing ink particles gather on the surface of air bubbles. This process works at an optimum with printing ink particles sized between 20 - 100 µm. Thus, the loaded air-bubbles streams upward through the paper

pulp. On the surface of the flotation cell, a dark foam segregates, which contains printing ink, fragments of paper fibre, fillers and paper-coating pigments. Particles smaller or bigger than the optimum particle size are floated with less efficiency.

In some cases water-based printing inks are used for flexo-newspaper printing. These inks may contain binders soluble in the alkaline range. Consequently in deinking, such inks do not break up into fragments of printing ink film but into pigment particles, smaller than 1 µm in size. These particles are much too small for flotation.

Printing ink particles too large for the flotation process occur in cases of tenacious, cross-linked ink films in thick layers on coated paper. For example, this problem can arise in connection with coated papers and UV inks or conventional sheet-fed offset inks coated with UV varnishes. When such coarse printing ink particles are obtained, the paper mill still has the option of comminuting them in a disperser and floating them once again. However, this 2nd deinking loop makes the process more complex and increases the rejects.

Likewise, paper mills whose furnish contains a proportion of water-borne flexo newsprint and therefore particles too small to float, often utilise an optional washing cycle. However this is usually only necessary when the proportion of water-borne flexo newsprint exceeds 5% of the total recovered paper, but washing is not reasonable for recovered papers with high mineral content, e. g. magazines.

3. Recyclability assessment

Development and design of printed products are dynamic. Materials and processes, too, are subject to technical innovations. Therefore it is necessary that all parties involved evaluate their products as to good recyclability if major changes are made to materials and processes.

Solutions are available to the various problems highlighted in this guide. These solutions must be examined in each individual case. In this examination, additional criteria, e.g. production quality, economic efficiency, environmental protection, occupational safety, etc have to be included in the assessment.

Institutes and paper mills throughout Europe have developed assessment methods. With the help of these methods it can be estimated whether printed products meet the criteria of recyclability. ERPC recommends using its assessment scheme “Deinkability Scores”. Harmonisation of schemes to assess the removal ability of adhesive applications is recommended.

When assessing whether the criteria of recyclability have been fulfilled, the relevance of the quantity of the examined print product must be taken into account with regard to its deinking performance and the final properties of the recovered substrate.

4. Recovery of residues from the deinking process

The paper industry is eager to reuse residues generated in recovered paper treatment or to find external possibilities of reuse. Technical and economically feasible options are available. Here it is important that individual constituents do not impair the reuse of residues.

5. Updating

Statements made in this guide will be reviewed and revised if necessary.

[September 2008

Addendum

Non Impact Printing Inks

The quantity of printed office paper in collected paper for recycling is growing at a rate of 20% per annum. Most of this paper is printed by non-impact printing methods such as photocopiers, laser printers and inkjet printers.

Inks used in photocopiers and laser printers are often referred to as ‘toners’ and are often in a dry fine powder form.

Toners are coloured thermoplastic polymers that are usually based on pigments (not dyes). They contain low levels of additives used to help confer electrostatic properties, but essentially their fusing/fixing properties are of greatest interest in the recycling process, and are dominated by the thermoplastic polymer.

In normal use, particles of the dry toner are developed onto a photoreceptor and transferred to paper. At this stage the toner is still in the form of discrete particles, ~10µm in size. The paper then passes through some form of high temperature fusing system and this is where the problem arises, in terms of eventual recycling. During the fusing process the toner polymer melts, wetting and adhering to the paper fibres. At the same time the discrete particles merge forming much larger solidified ‘lumps’ depending on the size of the image. The toner is then well bonded to the paper fibres.

Some toners bond large numbers of paper fibres together which do not float in the flotation process and consequently are retained in the DIP causing a ‘speckling’ problem much like in the case of UV inks. Likewise, paper-mills whose furnish contains a proportion of recovered paper from offices have the option to break them down in a disperser and repeating the flotation process again.

Ink jet inks, commonly used on paper and found in office waste are usually water based dye types. The inks contain little or no resin component and the dye is completely water-soluble. In the flotation cell the dye redissolves and cannot be separated and subsequently moves onto the paper fibres as described in section 2.3. The recommendation is therefore the same, that recovered paper should contain as few components as possible that may cause discolouration.

[September 2008