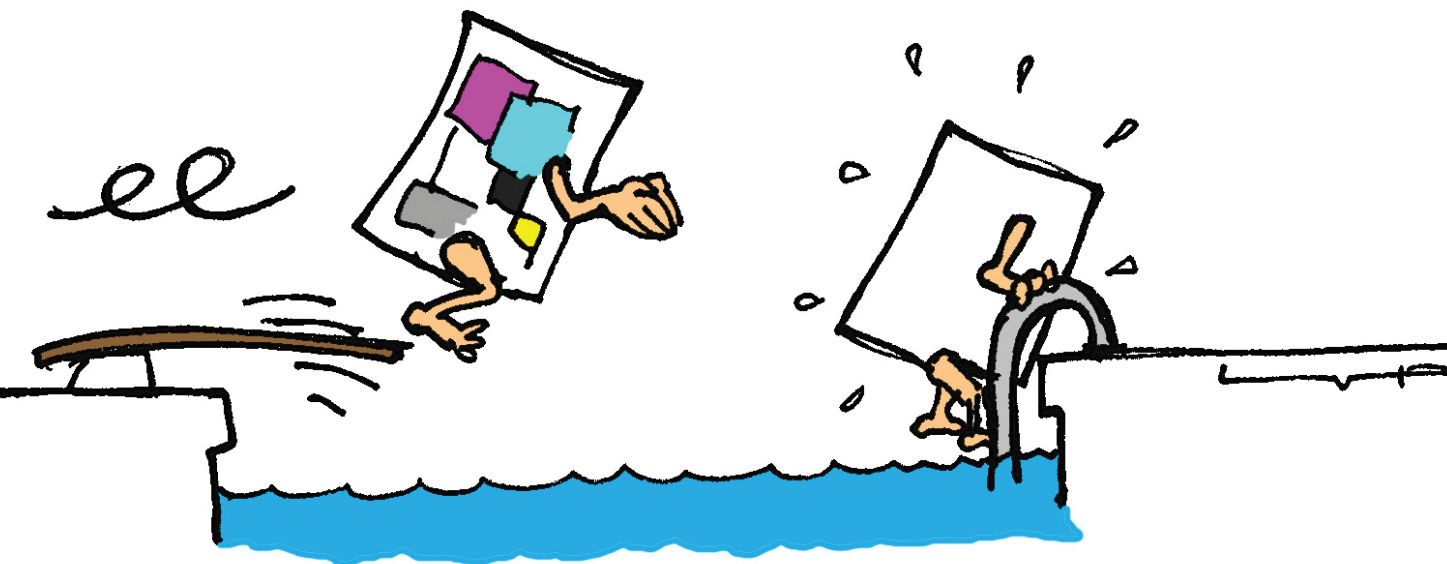


PRINTING ON CERTIFIED PAPER IS NOT SUSTAINABLE ENOUGH !

XEIKON

White paper with some information about deinking
(the needs, the principles, the problems and the solutions)



Paper needs for the next coming years

This paper discusses the actual and future paper needs and explains why recycled paper is needed. It also explains why not all printing technologies are equally compatible with the paper recycling installations, and why already a small fraction of this material in the paper load can create a lot of difficulties.

In a European study titled "The Future of Paper Recycling in Europe, a final report of COST Action E48," the needs for the European paper industry were investigated and forecasted. In 2005, 100 million tons were produced and in 2015 (or 2020 depending upon the impact of the economic situation) the need will be 120 million tons.

Million ton of EU paper	2005	2015/2020
Communication paper	49 (49%)	54 (45 %)
Tissue	6.5 (6.5 %)	9 (7.5 %)
Packaging grades	44,5 (44.5 %)	57 (47.5 %)

The majority of the increasing demand in paper fibre will have to come from an increase in collection and reuse of paper fibres. The following text is an excerpt from this report :

"Paper recycling has its limits ! Each time paper passes around the recycling loop a certain percentage of the postconsumer paper cannot be recycled due to contamination, inefficient collection systems, process losses, other uses and exports to outside Europe, etc. This lost material must be replaced with either local virgin fibres or papers imported from distant producers. At a regional level, virgin fibre injected into the production sector is necessary to replace the occurring fibre gap. On the other hand, on a company level the overall target frequently is to minimize costs by maximizing recovered paper utilisation. The optimum solution for the European market is to try to utilise the recovered paper recycling potential as much as is possible by intensifying collection activities, keeping different recovered paper grades separated during the collection process and improving sorting systems and utilisation techniques. The recycling of imported virgin fibre based papers produced in the Nordic countries and the Americas, combined with increasing virgin pulp imports from fast crop rotation regions (such as Latin America and Africa) will ensure the European paper industry maintains a long term, viable and sustainable supply of fibre ."

Based on this study, the whole paper recycling industry has an incentive to make sure that the paper can be used as many times as possible in order to guarantee that enough paper is available to fulfill the demands at affordable prices.

If some printing technologies would be put onto the market that could reduce the efficiency or the yields in the paper recycling process, this would represent a big treat to the paper recycling industry.. It would not only be problematic for their business, but could also result in an inability to provide the paper material needed.

Paper recycling facts (for more information see : www.paperforrecycling.eu/fact-figures/facts)

The current paper recycling rate in Europe is already quite high. In theory, the maximum collection efficiency could be 81 percent. The share of non-collectable and non-recyclable paper is, for technical reasons, estimated to be 19 percent of the total paper and board consumption, such as libraries, archives, sanitary paper, etc.

What is the paper recycling rate in Europe?

European Paper Recycling 1995-2010



How does paper recycling works ?

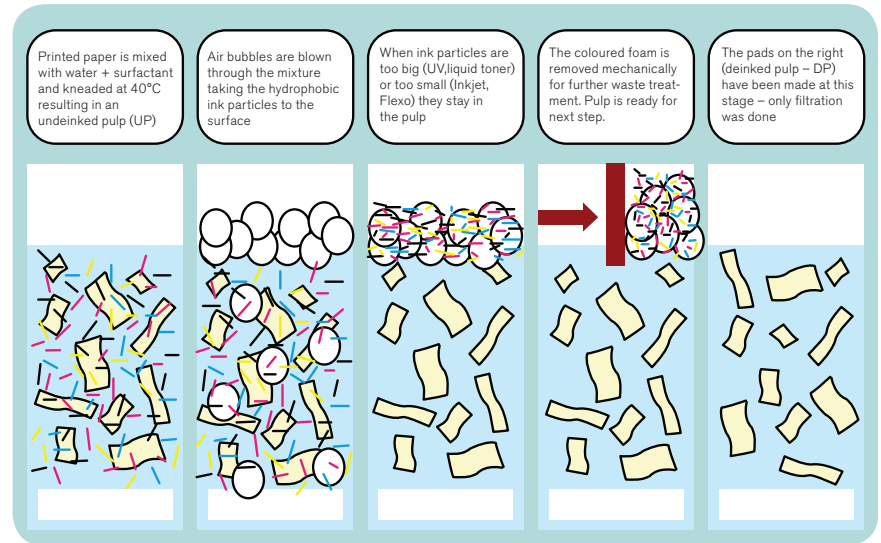
In the first step in the deinking process, the paper is mixed with water and some detergent and mechanical energy is applied to increase the pH level of the paper pulp (8-9).

This mechanical action (called pulping) is crucial because it breaks again the ink material into smaller particles.

Next, small air bubbles are blown through the pulp mixture (the flotation). This causes the coloured ink particles to float to the surface, separated from the pulp mixture and forming a grey foam which is skimmed away (This is based on the fact that the hydrophobic ink particles like the air interface more than the water phase).

At the end, pure white paper pulp is present and can be used to make new paper again. In the pulping phase of the deinking process, these same toner particles are again reduced in size by mechanical means, and through a hydrophobic effect, the particles are removed from the paper fibres and go to the air bubble phase.

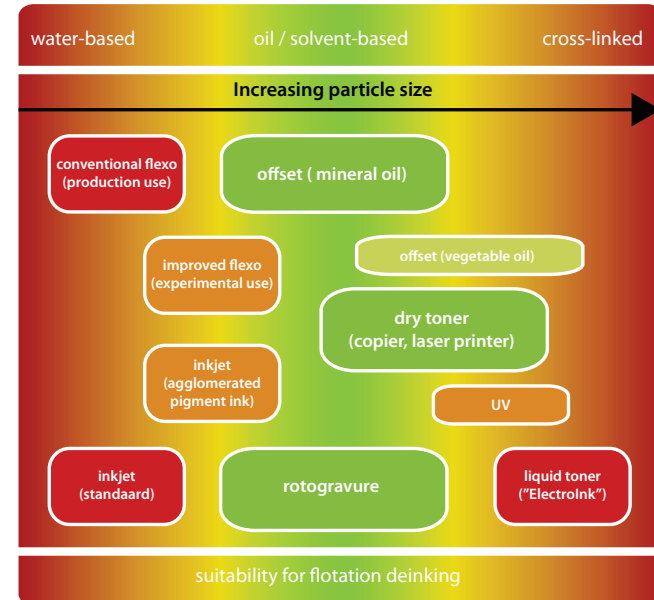
More information can be found on the website of INGEDE (the International Association of the Deinking Industry: www.ingede.de/)



Dry toners are OK !

Dry toners are made from polymers and pigments.

Dry toners are made from polymers and pigments. These polymers are specially chosen to make the pigments adhere very well to the paper surface after the fusing step. They are also chosen and specially designed to have a certain degree of brittleness. This brittleness is used during the toner manufacturing, whereby the polymer particles are accelerated above the speed of sound and collide into each other. During this collision, the particle size is reduced and the right-sized and shaped particles are further used in the toner making process.



In which cases does it go wrong ?

In several cases, this deinking process encounters a lot of difficulties or becomes impossible to perform.

The first case is flexo newspaper printing. These inks are water soluble, so they do not have any tendency to go to the air bubble phase and they remain in the water phase (pulp). This results in a darkening of the paper pulp, yielding a lower grade of paper. In order to prevent this from happening, flexo printed newspapers in Italy and UK are collected separately from the other paper waste. This can be done because people in these countries know the difference between newspaper and other printed material and realize they have to keep this paper separated based on the easy distinction (newspaper – no newspaper).

Water based inkjet printed material generally suffers from the same problem: the colorants (dyes or pigments) stay in the pulp during the water phase. In the case of dyes or pigments, there is no solution for performing corrections – these colorants are designed to be lightfast and cannot be bleached even in special plants that have a bleaching equipment - standard newsprint plants don't have these.

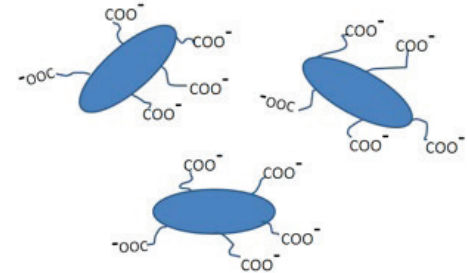
Bounding agents ?

Fortunately, there are a few prototypes of new pigmented inks that can coagulate, or stick together, after printing and form larger aggregates.

These are hydrophobic enough to be removed, and taken to the surface by the air bubbles. For dye-based inkjet inks, no solution is in sight.

The crucial problem is that neither users nor sorting plants can make a distinction between offset, (dye –pigmented) inkjet and (dry-liquid) toner based printing. This means it is not possible to remove this printed material from the regular waste stream (unless it should be clearly marked).

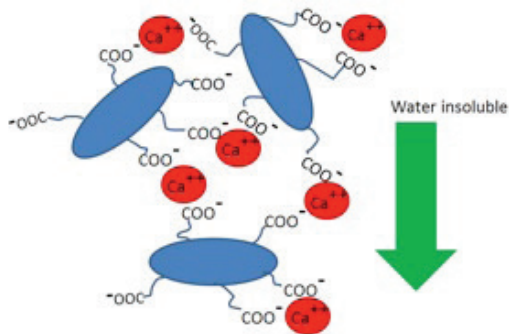
The inkjet manufacturers, pigment providers, paper makers and deinking chemicals suppliers are working hard to solve this issue by using special coated paper or special agents during printing which make the pigments stick together, and hence, water insoluble. This helps in removing the ink particles during the flotation step. They only have to make sure that this coagulation on top of the paper surface is sufficiently irreversible, so that the agglomerates do not become soluble again in the pulping phase. This is crucial for this technology and most of the current inkjet inks are not capable of performing this irreversible coagulation action.



The scientific explanation for this is as follows. The surface of the pigments particles are made hydrophilic by adhesion of specially-designed polymeric molecules which have one side that wants to absorb onto the pigment surface and another part which wants to stay in the water phase.

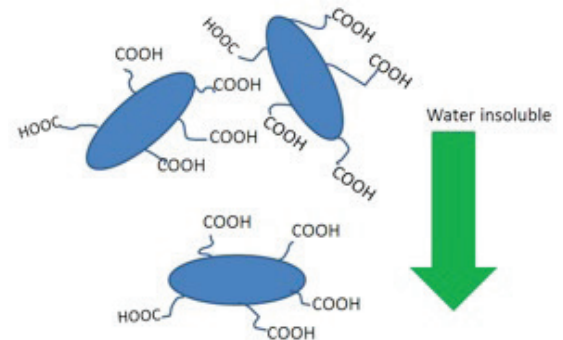
These water phase portions consist mainly of carboxylic groups that are deprotonated to increase the polarity of the pigment, and hence, the hydrophilicity.

The addition of calcium ions in the paper surface during the manufacturing of the paper (Colorlok) helps to improve the image quality but does not improve deinkability. Application of calcium salts through a colorless ink, or a precoating just prior to printing, creates insoluble calcium carboxylates that change the nature from the pigment from hydrophilic to hydrophobic. These pigment clusters can be much easier removed by the common deinking procedures.



Is the problem hereby solved ?

Not in all cases. In the early days of inkjet, there were attempts to jet a calcium solution through a fifth nozzle to allow instantaneous coagulation on the paper. However, these calcium ions also have the tendency to react with the carbon dioxide which is generally available in the atmosphere, forming insoluble calcium carbonate salts. These insoluble crystals can block the nozzles in case the agent is jetted via an inkjet system. To prevent this from happening, some manufacturers have changed the calcium ion containing solution by an acidic solution. This has the same effect during printing because it keeps the pigments in the surface of the paper, avoids penetration of the color through the paper creating ghost images on the back side, and offers better color strength.



Unfortunately, this process is reversible under the alkaline conditions of the deinking process. The carboxylic acids are again deprotonated during the pulping phase of the paper recycling process, leading to a net zero improvement in terms of deinking.

The only successful way to improve both image quality and deinkability by adding calcium ions is to fully coat the paper with a roller immediately before printing. This allows the wet-in-wet diffusion of particles towards each other to form larger aggregates that are hydrophobic and stable enough to float with the bubbles.

Liquid polyethylene based toner and UV inks

UV flexo, UV offset, UV inkjet, polyethylene based liquid toner

Other types of inks that create problems in the deinking step are the UV cured inks. UV flexo, UV offset or UV inkjet all have similar problems ! The same is also true for polyethylene based liquid toner (like Electroink). All of these processes form a flexible polymer film on the paper that behaves totally different from other inks. In this case, the problem is that the ink particles remain in the water system during the pulping and flotation phase, because the ink film cannot be broken up into smaller particles. The thin, large, and - in the case of liquid toner - very flexible polymer film pieces even slip through the screens intended to separate larger impurities from the thin fibres. In the flotation process, the large particles are too heavy (and not hydrophobic enough) to be carried to the surface by the air bubbles, so they stay in the water phase with the fibres.

This results in large visible colored specks exceeding the specifications of high grade white paper or sanitary paper. Changes in the deinking process (e.g. implementing a double flotation and dispersion) reduces the number of these specks but, especially in the case of the Electroink, is still not enough to achieve the desired degree of whiteness and speck-free recycled paper.

Xeikon is now working on a liquid toner system based on the same type of polyester which is now used for its dry toner system. Test prints performed with this toner showed no problem in the first deinking trials. Of course, this will be continuously evaluated when larger quantities of printed material will become available during the further development of the Trillium technology.

(For more information, visit <http://www.xeikon.com/news/drupa-2012-proves-resounding-success-for-xeikon>).

WHAT ABOUT THE US?

The deinking plants in the US work in the same way as the European ones, but there are some differences. The first difference is the amount of recycled fibre used in the process.

The collection rate in the US is approximately 20 percent lower compared to the EU average (53.4 percent US compared to 72.3 percent in EU for 2009). This results in the fact that companies in the US use more virgin fibre at the end in their recycling process to make recycled paper. Also, when the whiteness of the paper is not high enough, US companies take the step of rinsing the fibers, whereby the efficiency and yield are reduced and much more water is drained into the stream.

EU recycling plants do treat all of their waste water and are very much yield sensitive. This explains why the European deinking plants are much more sensitive to possible upcoming problems in the field of paper recycling. But if the need for paper continues to grow and the amount of trees will become limited, the non EU deinking plants will have to make sure that they can recycle with less water and more yield.

CONCLUSIONS

These facts together – including the difficulty to identify papers that can cause problems, the need to increase the amount of recycling in view of the increasing paper needs and the difficulty to adapt the deinking installations (if that would help) - give a summary of the very cautious attitude the paper industry has towards increased amounts of inkjet, UV and Electroink printed papers being presented at their mills. A first step could be a clear mark that the prints can be recycled (which will be the case if they have the European Ecolabel printed on it).

Fortunately, dry toner based printed material does not give rise to any of these problems. These prints are already present for more than 50 years and represent between 6 percent and 7 percent of the total amount of printed material. They were and are recyclable without any additional cost at the paper plants, the paper substrate, the toner systems or the printing engine.

From an economical point of view, paper recycling is a bare necessity since recycling saves two thirds water and energy – and by a significant margin, there would not be enough fresh fiber paper to fill in if one would shut down recycling today. When new technologies are being introduced that could endanger the current processes, this would mean that white paper will become more expensive or graphic paper will become less white. Therefore, printing companies and printing equipment manufacturers should be aware that the more non recyclable paper they print (are printed with their technology), the more the paper recycling plants will find it difficult to be sustainable in an economically responsible way.

The paper recycling companies now already are suffering from the very small amount of inkjet papers that is getting into the paper stream from households, offices, schools, etc. In recent years, they have experienced continuous increase in effort and cost to deal with the incoming mix in order to achieve the desired whiteness even with an amount of inkjet paper being only less than 0.25 percent of the total amount of printed paper.

Can you imagine how scared the paper recycling industry is at this moment with the knowledge that this amount is going to increase a lot (e.g. by printing newspapers or switching large amount of advertisement and mailing material from offset to inkjet – all very short living printed material)

Sawing the branch of the tree you're sitting on is never a good way to move forward.

An important step is also **convincing the print buyers** to choose for a printing technology not having any of these problems. A brand presenting itself as being sustainable or green should also spend attention to the printed material they supply to their customers (marketing material, statements, usage guides, correspondence,...).

Ecology and sustainability do not stop at the door of the purchase department ! And printing on recycled paper alone is not sustainable enough!

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VP Consumables and Process Xeikon

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