Recent developments in the Deinking of Inkjet and Liquid Toner

Axel Fischer; International Association of the Deinking Industry (INGEDE); Munich, Germany

Abstract

For the first time, liquid toner prints in the raw material of a paper mill have caused a significant damage in a recycling paper mill. This incident confirms former lab tests that for the last ten years have pointed at a possible contamination already by small amounts of liquid toner prints.

Water based inkjet ink is another challenge for the deinking process. This process has been designed to separate hydrophobic ink particles from hydrophilic cellulose fibers. Soluble dyes cannot be removed as they stay and accumulate in the circulation water. Thus additional bleaching steps have been suggested to make up for the loss in brightness. However, bleach is not an option for the majority of paper mills producing newsprint and other graphic papers from the household mix. It is neither economical nor ecological as one would have to add equipment and increase the use of chemicals as well as the chemical load of the effluent.

Therefore, other solutions look more sustainable: inkjet inks that either are not water based or coagulate to form larger, hydrophobic particles on the paper surface. Promising approaches by KAO, Sepiax and Xerox have been tested whether this solution – originally intended to improve image quality – also helps to match state-of-the-art deinking technology.

Testing Deinkability

The process of deinkability testing has been described earlier e. g. at this conference [2]. Basically, the key steps taking place in an industrial deinking plant are applied in a lab test – the detachment of the ink from the fibers and the removal of the ink from the system. For this assessment, deinkability tests carried out according to INGEDE Method 11 [1] serve as the basis for comparing deinkability of prints. This method had been published as draft for the first time in August 1999 in German language. In March 2009 the European Recovered Paper Council (ERPC) adopted the latest version of "Deinkability Scores" as assessment scheme. The ERPC is the committee of the signatories and supporters of the European Declaration on Paper Recycling. For this scheme, five parameters are determined and converted to a score system [3, 4]. This allows expressing the deinkability assessment in one figure by weighing the parameters according to their importance. Within the last years, INGEDE has collected data from several hundred printed products.

Rating of the Deinkability Scores

Score	Evaluation of deinkability
71 to 100 Points	Good
51 to 70 Points	Fair
0 to 50 Points	Poor
negative (failed to meet at least one threshold)	Not suitable for deinking

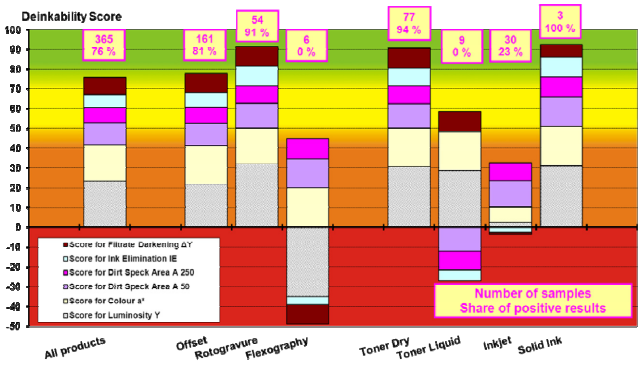


***Figure 1**. Deinkability Scores: Results in Benchmarking Categories*

Deinkability of Inkjet Inks

Already in 2001, first concerns about problems with the deinkability of inkjet and liquid toner prints were published [5] after an INGEDE Workshop with CTP in Grenoble and later concluded by Carré [6]. But it took until 2008 for major inkjet printer manufacturers to identify deinkability as an issue.

To improve the deinking results, additional bleaching has been suggested [7]. Bleaching options in the recycling process especially of office papers are narrow and have been described in various places e. g. by Suess [8]. Dyes used in inkjet inks are generally designed to be lightfast and thus not susceptible to small amounts of peroxide that are used in the paper recycling process to compensate for alkali yellowing.

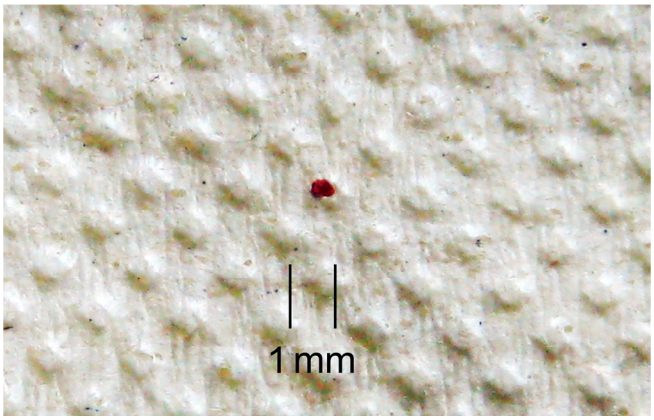
Even larger amounts of peroxide leave most inkjet dyes unchanged. Reductive bleach with hydrosulfite (dithionite) is effective only for a few dyes and is not a standard process for standard newsprint paper but is needed to achieve pulps with higher brightness for improved paper grades. Dithionite bleaching steps in a paper mill producing standard grades would require major investment for extra equipment and extra use of chemicals which will not increase the sustainability of the process. This is especially the case for formamidine sulfinic acid (FAS) that also has been suggested. The use of FAS bleach has been reduced and ceased due to its environmental and legal impact (effluent charge) in Europe. Furthermore, all these chemicals will not affect pigmented inkjet inks.

Positive results in the deinking of inkjet inks have been achieved with new approaches that in the first place are intended to improve image quality. One way as used by Xerox is to avoid aqueous systems at all. Ink systems where pigment particles agglomerate on the paper surface rather than bleeding into the fiber

tend to be better removable. This can be achieved by different ways. Fujifilm applies a primer to the whole paper sheet before the ink is jetted wet in wet. This leads to precipitation of larger particles end good deinkability. KAO has demonstrated pigment particles with a dispersant that precipitates with Ca^{2+} ions from the paper surface. An interesting new approach comes from the Austrian ink manufacturer Sepiax. Their resin inks are claimed to stick to any surface and print on uncoated paper without bleeding, even on tissue. Deinkability results will be presented.

Deinkability of Liquid Toner

Ink specks, also called dirt specks, are small visible particles of different origin that compromise the optical quality of recycled paper. These specks can come from specific offset inks, especially made with vegetable oils such as soybean oil that undergo oxidative drying. In recent years UV cured offset inks and liquid toner have become potent sources for ink particles that are difficult to remove in the deinking process. Though there are specific limits for different paper qualities, dark and more and more colored specks can be seen in many copy papers, newsprint and also in hygiene papers. Here, the visual impact is commonly reduced by embossing.

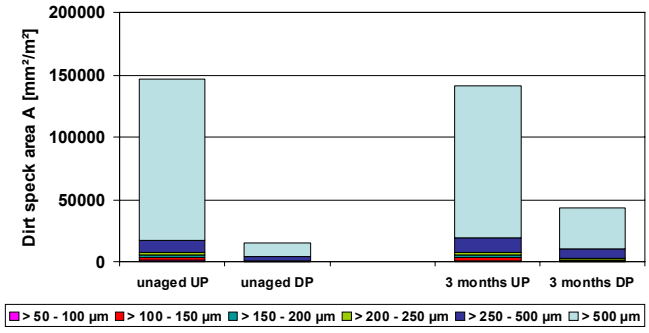


Large colored ink speck in embossed hygiene paper

Influences on the Dirt Speck Numbers

In 2001 already, liquid toner was identified to be a major source of unremoveable visible colored specks in the paper recycling process by the French research institute CTP [5, 6]. Subsequent testing in different INGEDE research projects confirmed the potential.

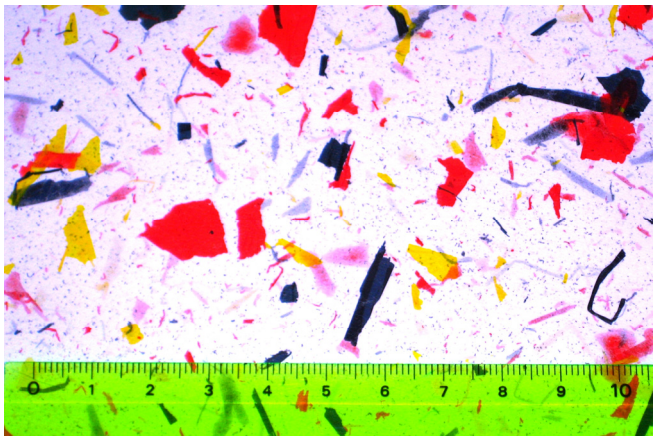
As HP Indigo prints can enter the paper recycling process from various sources, with short-lived direct mail or after years as redundant photobooks, e. g. the impact of storage and ageing has been investigated. A test with 100% HP Indigo prints (repeated after 3 months storage and after artificial ageing) lead to the conclusion that storage period impacts the dirt speck reduction in liquid toner particles significantly. The dirt speck area and the particle size distribution did not change much in the undeinked pulp (UP), but the deinked pulp (DP) after 3 months showed significantly higher dirt speck values and a much higher content of large particles (above 50 µm and above 250 µm).



Impact of ageing on particle size distribution and dirt speck area

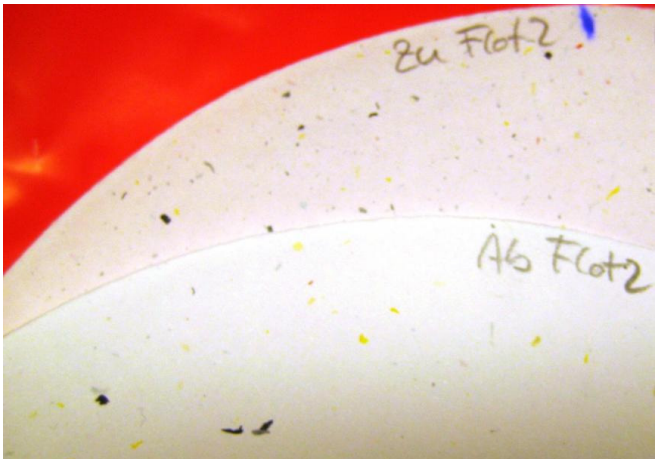
Involuntary Mill Test Confirms Problems in Two-Loop Systems

Though they have been around for many years, such ink specks have never been tracked back to their source. This happened for the first time when on August 28, 2010 around noon, paper engineers at a German paper mill were alarmed by rapidly increasing dirt speck numbers in control samples during the production of high quality graphic paper. Though an intense search within the raw material used began immediately, it took six hours, and seven reels with 20 tons of paper each had to be dumped until liquid toner prints (HP Indigo) coming from a photo book printer could be identified and confirmed in the mill's lab to be the source. After these prints had been removed from the input, the dirt speck numbers went down to meet the specifications again.



Samples of 100% of the suspicious liquid toner overprint tested in the lab (UP)

As the share of liquid toner prints had already been less than three percent, the remaining stock had to be diluted further and monitored carefully during the following weeks. The paper mill affected has the most sophisticated deinking plant in Europe, using a two-loop flotation system with two dispersers that were operated at high energy input during the production. The paper production loss sums up to about 140 tons of premium quality paper. The estimated damage for the paper mill – only for the paper dumped, not including standstill or others – is more than 100,000 Euro.



After two flotation steps in the lab, still too many visible ink specks can be seen. Above: inlet 2nd flotation, below:outlet 2nd flotation.

Liquid Toner Prints to Be Avoided for Paper Production, to be Directed to Board

As a consequence and in order to avoid further damage, the European paper mills associated within INGEDE decided that liquid toner prints should be avoided in recovered paper for deinking and directed towards corrugated board production only. In other mills where less effort is used to produce e. g. newsprint, a comparable load of recovered paper could have led to even more intense quality problems.

Outlook

For inkjet inks, there seems to be a variety of promising ways to make the prints better compatible to integrate into the existing paper loops in the near future. For liquid toner prints, currently labeling and separate collection can be a way to avoid interference with graphic papers that are strongly needed to secure a sustainable paper loop.

Acknowledgements

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Author Biography

Axel Fischer studied chemistry at Munich Technical University. He worked as a Science Writer for TV, print media and Germany's major news agency. Now he works as communications consultant for the chemical industry and the paper industry. Since 1994, he is responsible for the public relations of INGEDE, the International Association of the Deinking Industry. He chairs the "Digital Round Table", a forum initiated by INGEDE to improve the Deinkability of Digital Prints.