Deinking of Dry-toned Prints from NexPress Digital Production Presses

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Abstract

The output of 4/5-color digital presses of the Kodak NexPress product family and of other digital presses is increasing rapidly. Printed paper from these presses represent an increasing portion of waste paper beside other dry toner based output devices like office printers, copiers, faxes and multifunctional devices.

Worldwide app. half of the paper is recycled - in Europe even more. The environmental legislation in Germany requests, that a recycling process like that of paper results in recycled products for the same application as far as possible technically as well as commercially. For paper that means that the recycling of paper used in commercial printing or offices ends in paper for the same applications and not just in e.g. brown kraft paper.

Therefore printed paper from digital output devices like digital production presses has to be deinkable with the technologies already established in the paper mills for the conventional printing technologies existing as they are still providing the majority of printed paper.

Some product development groups targeting the recyclability of their printed products since some time and we report - as an example - deinking results which show, that the prints from the Kodak NexPress family of digital presses match the deinking standards existing so far. This is valid for four-color prints as well as for prints produced in a five-color press applying additional clear toner and optional image glossing.

Introduction

Paper recycling[1]

Paper recycling is a cost effective and sustainable source of fibers for graphic papers (and hygiene papers). More and more paper is recovered all over the world. In Europe, newsprint is made of 100% recovered fibers already. Even more paper has to be recovered, as the demand is still high. This leads to more impurities in the recovered paper. On the other hand, the resource "urban forest" is also used for higher qualities more and more often – these are the only potential to increase recycling rates in Europe. But this requires also a better quality of the raw material. Nevertheless, some paper mills are capable to produce copy paper, fine paper and coated offset paper from 100% deinked pulp.

Digital printing technologies are gaining a growing share of the market. In the near future, many of these printed products will end up in the recovered paper collection from households and offices, becoming part of the raw material to be recycled by papermakers.

So far standards for recyclability of digital prints do not exist, so that – temporarily – the standards for offset and gravure printing are used. A new "European Round Table Deinking of Digital Prints" initiated by INGEDE discusses recyclability testing and works on recyclability standards for digital prints.

Kodak NexPress Digital Production Press[2]

The NexPress 2100 press was first shown at the DRUPA 2000 and introduced into the market in the following year. The Kodak NexPress 2100 press with Kodak NexPress fifth imaging unit solutions was introduced at the Drupa 2004. Many new applications and solutions were now possible. With a changeable 5th color station and Red, Green and Blue DryInk to choose from, using a pentachrome five-color multi-level halftone mixing process, the Kodak NexPress 2100 expanded the available color gamut.

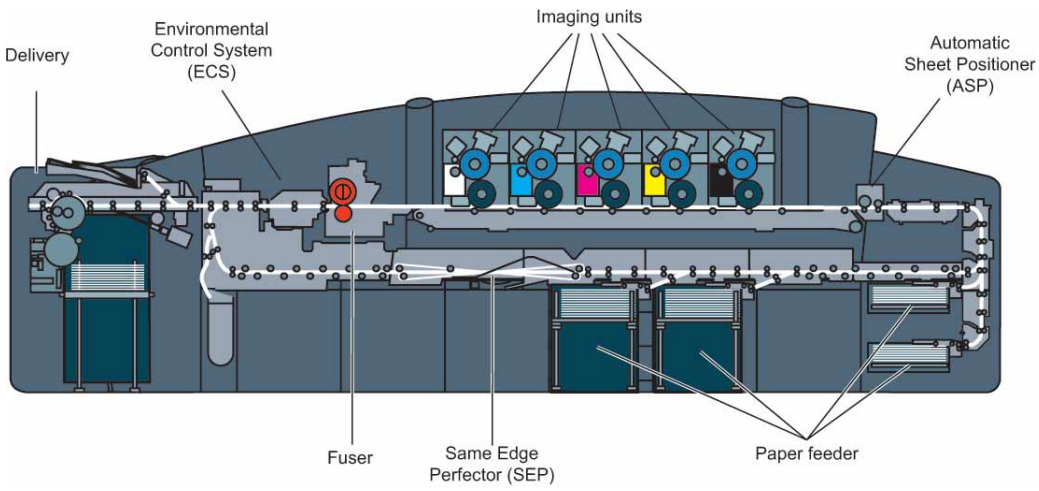

Figure 1: Paper pass of Kodak NexPress 2100plus and Kodak NexPress2500 equipped with four paper deliveries and high capacity delivery

If a clear DryInk (CDI) is used in the 5th station, along with the standard CMYK DryInk in an Intelligent Coating process that apply CDI in selective areas of the image, significant improvement on image abrasion resistance and further reduction of color granularity have been demonstrated. The end result exceeds the capability of offset printing with aqueous coating for image protection. Other applications for CDI in the fifth station of the Kodak NexPress 2100 are e.g. spot coating or clear watermarking for design or security purposes.

With the introduction of a near-line Kodak NexGlosser glossing unit, the CDI image with clear overcoat can be further glossed up to a very high and uniform gloss (G20 =~90 can be achieved) in the glossing process for photo-rich applications. In addition to that, it has been shown that the optimized process can increase the color gamut of the entire printing system for many substrates (typically in a range of 10% increase in gamut volume).

At Print 05 in Chicago, Kodak announced two new color offerings: the Kodak NexPress 2100 plus and the Kodak NexPress 2500 (*Figure 1*). Both are differentiated from the Kodak NexPress 2100 by a number of factors, including larger print format size, broader substrate capability, expanded feeding & finishing capabilities and options, new standard delivery or new single (or dual) high-capacity delivery, inline finishing architecture), an expanded number of operator-replaceable components (ORCs), and an improved throughput feature called "Productivity Optimizer."

The 2500 also offers a faster speed (2,500 4/0 & 5/0 A3 sheets per hour) in relation to the 2100 and 2100plus (2,100 4/0 & 5/0 A3 sheets per hour). In addition, the 2100plus is field upgradeable to the speed and other capabilities of the 2500.

Deinking: How does it work?[3]

The recovered paper contains a variety of contaminants. These can be removed by size differences (screens), density differences (cyclones) or their surface properties (flotation). Deinking is the removal of the printing ink from the recovered paper. Flotation is the key process for the removal of printing ink in Europe, washing is more prevalent in the U.S., but even here more and more replaced by flotation (due to the disadvantage of washing: low yield).

Flotation

A suspension of re-pulped paper fibers with water, caustic soda, peroxide, silicate and soap is thoroughly mixed to support the ink detachment. Air bubbles are blown through the mixture. The bubbles carry ink particles away from the fiber to the surface where the resulting foam is skimmed off. The flotation can also remove some varnishes and adhesives. To be removable by this process, the ink has to be hydrophobic.

How the particles are removed depends also on their size:

- particles > 150 µm = screenable (as long as they are stiff!)
- 30 µm < particles < 300 µm = cleanable
- 10 µm < particles < 100 µm = floatable

If particles are smaller than 10 µm, they are hardly removable by these processes. Problems occur with water based inks, especially with almost all of the currently available flexo inks.

Dispersing and bleaching

In many deinking plants, the flotation is followed by a disperser, which reduces the size of residual contaminants like hot melt adhesives, varnishes or toners to become less visible or to become removable by a secondary flotation. A bleaching step uses peroxide or FAS.

Recyclability of dry ink for Kodak NexPress digital production presses

Previous evaluations[3] have shown that different from liquid toners dry toners based on polyester resins like the toner used in the Kodak NexPress digital production presses show good deinkability.

NexPress has targeted the deinkability of their printed products since a long time and has previously commissioned the Papermaking Institute in Darmstadt, Germany to study the recyclability of four-color prints from the Kodak NexPress 2100.

The deinkability of papers was determined applying INGEDE method no.11, "Evaluation of the Recyclability of Print Products – Determination of Deinkability"[4]. The results attained were compared with the minimum target values proposed by INGEDE (the International Research Association for Deinking Technology, reg. assoc.) for offset and gravure printing.

The parameters that needed to be determined included the achievable brightness of stocks made from deinked pulp, the extent to which printing ink can be removed using the flotation process, and how heavily the process water used is contaminated by ink particles. The findings[5] indicated clearly that prints made on the Kodak NexPress 2100 yield comparable or superior recycling results than the INGEDE advocates for documents printed using conventional offset or gravure.

After introduction of the fifth imaging unit these evaluation have been repeated and the results will be reported here in detail.

Printing devices and paper substrates

The samples were prepared on Kodak NexPress digital production presses with five print units. The fifth print unit applied clear dry ink[6] using inverse masking technology, which applies additional clear ink on top of the paper or color toner so that a minimum dry ink layer of 100% is achieved.

Figure 2: Inverse masking using clear dry ink[7].

Glossy coated paper with a grammage of 150g/m² in 350*470mm format was used.

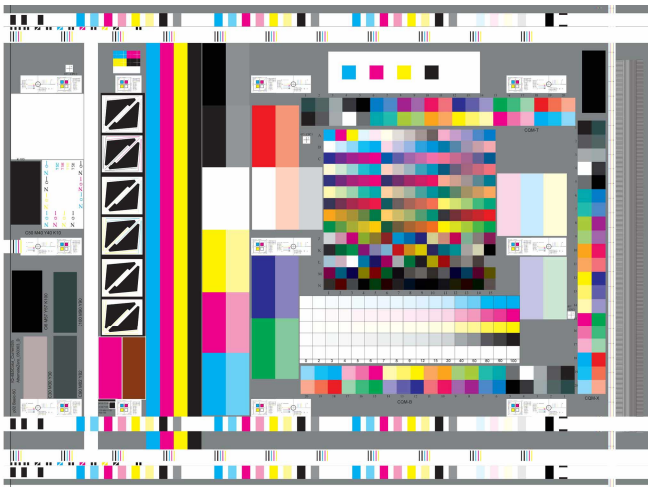

Figure 3: Test sheet used for the deinking experiments reported in this paper.

The test sheet (Figure 3) that is assumed as "worst case" regarding dry ink coverage was printed single sided. Prints were produced with clear dry ink as protection coating only without additional glossing step (marked in the result plots as 5C) and with additional glossing step (marked NexPress 5C Glossed).

Method and test institute

The evaluation procedure was again the INGEDE Method #11 (Assessment of Print Product Recyclability – Deinkability Test)

The evaluations were again made by the institute of papermaking at the technical university Darmstadt (Germany) (IfP (Institut fuer Papierfabrikation; TU Darmstadt)), which is certified by INGEDE.

Again the parameters ink elimination, filtrate darkening, brightness reference value and impurity areas were analyzed.

The results will be reported in relation to the specification for offset prints, as specific limits for digital prints do not exist so far.

Ink elimination

The ink elimination describes the percentage of ink elimination in the deinking test in percentage. The light absorption coefficient K of laboratory sheets made of deinked and un-deinked pulp is determined at a wavelength of 700 nm by means of INGEDE Method 10 so as to be able to determine ink elimination (IE).

Figure 4 shows the Ink Elimination values for the evaluated samples from the Kodak NexPress digital production press for both 5- color prints and glossed 5-color prints. The lower limits for offset and gravure prints on coated paper are indicated as well.

Ink elimination values for the NexPress prints are clearly above the minimum values permitted for gravure and offset prints.

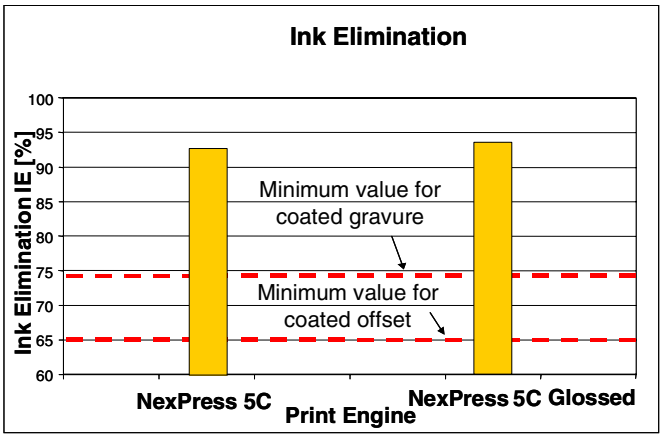

Figure 4: Ink elimination of five color prints from Kodak NexPress digital production presses without additional glossing and with additional glossing.

Filtrate darkening

Filtrate darkening = ΔY is defined as $Y_{reference} - Y_{UP}$ of the filter pad filtrate of the un-deinked pulp sample (determined on membrane filters)

Figure 5 shows the Filtrate darkening values for the evaluated samples from the Kodak NexPress digital production press for both 5- color prints and glossed 5-color prints. The maximum values for offset and gravure prints are indicated as well.

Filtrate darkening values for the NexPress prints are clear below the maximum values permitted for gravure and offset prints.

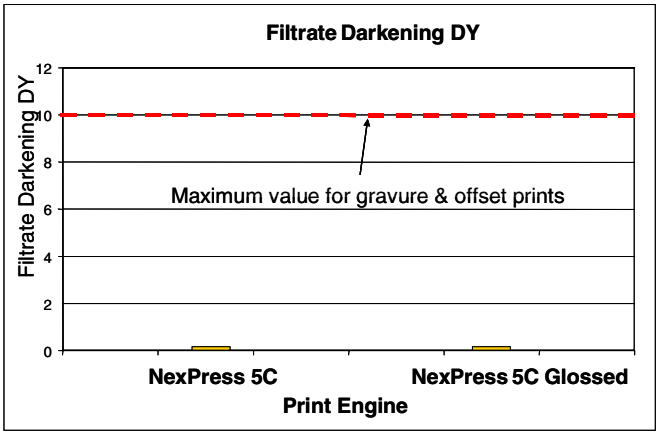

Figure 5: Filtrate darkening of five color prints from Kodak NexPress digital production presses without additional glossing and with additional glossing.

Brightness reference value

Brightness reference value Y of deinked pulp is determined on filter pads.

Figure 6 shows the Brightness Reference Value Y for the evaluated samples from the Kodak NexPress digital production press for both 5- color prints and glossed 5-color prints. The minimum values for offset and gravure prints are indicated as well.

The Brightness Reference Value Y for the NexPress prints is better than the requested values for gravure and offset prints.

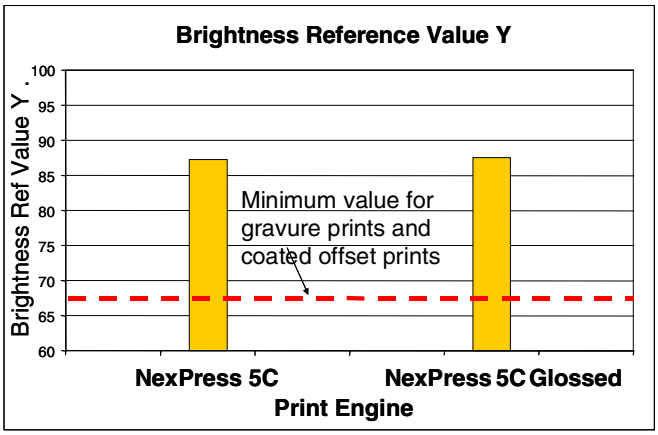

Figure 6: The brightness reference value of five color prints from Kodak NexPress digital production presses without additional glossing and with additional glossing.

Impurity areas

Impurity areas of deinked pulp are determined on laboratory sheets by means of a scanner-based image analysis system.

Figure 7 shows the Impurity Area results for the evaluated samples from the Kodak NexPress digital production press for both 5- color prints and glossed 5-color prints. The maximum values for offset and gravure prints are indicated as well.

Impurity area values for the NexPress prints are clear below the maximum values permitted for gravure and offset prints.

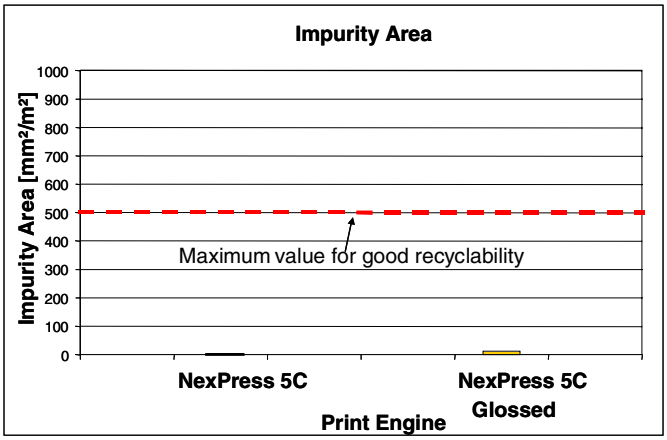

Figure 7: Impurity areas of five color prints from Kodak NexPress digital production presses without additional glossing and with additional glossing. The maximum impurity values for good recycling are indicated as well.

Summary and Conclusions

The deinkability of various prints from Kodak NexPress digital production presses were compared with typical requirements for offset and gravure prints.

For all prints the Filtrate Darkening DY, Ink Elimination IE, Brightness reference value and the Impurity Area are within the current specifications.

According to the test criteria the prints produced with Kodak NexPress digital production press – the four-color prints as well as the five color prints with optional glossing can be labeled as "recyclable".

References

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[3] Fischer, Axel, Can Digital Prints Be Recycled? IS&T NIP21: International Conference on Digital Printing Technologies Baltimore, MY, September 18 - 23, 2006

[4] INGEDE Method 11 Assessment of Print Product Recyclability Deinkability Test, http://www.ingede.com/, April 2001

[5] Heidelberg Sustainability Report, Heidelberger Druckmaschinen Aktiengesellschaft Kurfuersten-Anlage 52 – 60 69115 Heidelberg Germany, www.heidelberg.com, October 2003, p.69

[6] Dinesh Tyagi, Peter Alexandrovich, Yee Ng, H.T Tai, Rich Allen, and Diane Herrick, Enabling Expanded Color Gamut and In-line Coating Processes, IS&T NIP20: International Conference on Digital Printing Technologies Salt Lake City, UT; October 31, 2004, 135

[7] Kodak NexPress fifth imaging unit solutions – product and technology overview; © Kodak, 2005., CAT No. PB.006.1205.en.02, www.graphics.kodak.com

Author Biographies

Detlef Schulze-Hagenest studied physics and intellectual property law in Hamburg and Berlin and received his PhD in (experimental) physics from Kaiserslautern-University.
Since 1980 he is working in the field of platforms, processes and materials for digital printing with special focus on electrophotography and ink jet. He is currently Senior Engineer Advanced Technology at NexPress GmbH, Kiel, Germany, a subsidiary of Kodak. He is (co-)author of 46 patent families and enjoys classical music and gardening. He is a member of the IS&T and serves as European Program Chair of this conference.
He joins the "European Round Table Deinking of Digital Prints" initiated by INGEDE for NexPress GmbH.

Johann Weigert holds a Ph.D. in Chemistry from the Technical University of Darmstadt, where he worked on papermaking chemistry and chemical modification of pulp.
He joined NexPress GmbH in 1999. Since then he worked on several paper related topics and was responsible for paper qualification and the development of the paper qualification program for NexPress. Currently, he is Senior Process Engineer within R&D with special focus on substrate/engine interactions.