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DEFECT "GHOSTING" AS A RESULT OF THE INTERACTION OF PAPER AND PRINTING INK. FROM SCIENCE TO PRODUCTION

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Abstract

The result of the paper and the quality depends on various interconnected mechanical, physical and chemical processes what are affected by material properties, reset technologies, equipment and the condition of the production premises in the Print industry especially in the printing processes. Due to the complicate technological processes different defects can appear during the printing process which reduces the quality of production and causes financial loss. One of the main leading Printing company of Latvia "Livonia Print" initiated to explore and find solutions – to reduce or eliminate the risk of GH. GH has not been sufficiently studied so far. Consequently, there is not much specialized, professional literature available.
Research sample of printing is taken from a real order, album, and it was printed under real production conditions. The result of the research is to reduce or completely eliminate risk of GH occurrence in the production of high-class printed works (albums, catalogues, etc).

Keywords: *Ghosting (GH), paper, ink, varnish, production, printing.*

Relevance and aim of the research

The GH occurs frequently, in both the sheet and web offset printing. It increases the costs of production and negatively influences the quality of the printed products, which brings to customer complaints and their refusal to pay. GH has been described differently in various literary sources by attributing the representation characteristic of another defect (Norīte at al, 2004; Vanaga at al, 2016).

According to the "*Dictionary of Printing Terms*", it is described as the occurrence or duplication of bands on printed sheets (Dictionary, 1995).

GH can be described as an increase in lightness or tonal change on one side of a print that corresponds to the motif printed on the reverse side. The GH defect is the appearance of darker areas on one side of the print sheet what corresponds to the shape which appears on the other side of the sheet immediately after the printing.

Gordon Pritchard in his article mentioned "Their appearance is usually unpredictable and, unfortunately, become evident only after the job has been printed and in the press delivery pile for a period of time" (Pritchard, 2011).

The GH is the printing defect (Kipphan, 2003). It increases the costs of production and negatively influences the quality of the printed products which brings to customers' complaints and their refusal to pay. The purpose of this study is to explore various information on the problems of GH: the reasons of its appearance and give the recommendations for reduction or elimination of GH risk.

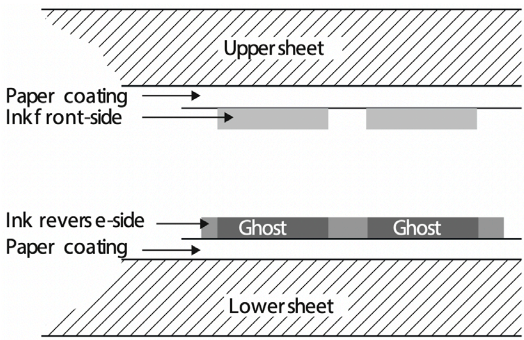

Fig.1. GH defect

For the study of problem, the printing company *LivoniaPrint* provided the material technical basis and implementation of the research results in the manufacturing process.

Failing to find information on scientific studies on the causes of GH occurrence and the possibilities of prevention in the conditions of production.

Craig Harmsen "Paper coating constituents and their influence on chemical ghosting" examines paper coating constituents, their degree of concentration, and that influence they play with regards to GH (Harmsen, 1982).

The German Association for Research in Graphic Technology has investigated the causes of GH on print samples obtained under laboratory conditions – *In the laboratory test, the varnishing of samples of all assessment levels took place with matt and glossy dispersion laquers. Although our tests* *show that the intensity of the ghosting is already minimised under these conditions for a certain ink paper combination, it cannot be ruled out that is still sufficient for a disturbing impairment of the visual appearance of prints* (Sommer & Bertholdt, 2008).

Contact yellowing is often confused with ghosting, i. e. the matt/gloss effect, in which the first printing maps on the reverse print when perfecting (Test methods for offset inks and substrates, 2013).

Methodology

The author has summarized a lot of discussion with professionals of the companies, and has gathered other information about this GH as well as has done descriptive and analytical research and practical investigation under production conditions. SPSS database was used for statistical evaluation of the results. The three-factor analysis of variance was applied to determine the influence of factors and assess their relevant impact.

GH in sheet-fed printing originates through the interaction of paper, the printing ink, printing-press, print-related technological parameters and printed motif.

To establish the interaction of factors that cause the GH the following steps were carried out:

1. Potential experimental materials and printing technology were studied at *LivoniaPrint Ltd*. as well as information of manufacturer's datasheet on papers, inks and varnish.
2. Test printing schedule was determined, and the materials and technological equipment were prepared for test printing.
3. The experimental sheet offset printing was carried out in a controlled microclimate in the printing company. Printing parameters (printing speed, technology, printing sequences etc.) where measured.
4. The study of printed sheet, inks and paper samples was carried out in the State Institute of Wood Chemistry:
   a) Evaluation of GH intensity,
   b) Inks drying speed and dryness,
   c) Paper optical, physical and mechanical properties.
5. The results of the study were collected in a SPSS database and a three-factor analysis of variance was applied to determine the influence of different factors.

Results

For the study of the GH 7 sorts of 130 g/m^2 papers were selected; all of them are used in regular production at *Livonia Print*.

Table 1. Technical parameters of the properties of paper samples

Characteristic	Standard	Measurement	7B	6B	5B	4B	3B	2B	1B
Grammage	ISO 536:2012	g/m^2	130	130	130	130 (±4%)	130	130	130
Opacity	(D65/10) ISO 2471	%	97	97	96	96,5 (±2)	95,5	95	95
Thickness	ISO 534:2005	mm	129	125	143	108 (±8%)	–	–	110
Bulk	ISO 534:2005	cm^3/g^{-1}	0,99	0,96	1,1	0,83	0,85	0,77	0,90
Whiteness	CIE D65/10 ISO 11475	Index	118	119	120	118 (±3)	122	122	122
Brightness	ISO 2470-2 Light D65/10°	%	96	97	96	–	99	99	96
Smoothness Roughness	ISO 8791-4:2004 PPS 1.0	ml/min^{-1}	2,8	1,8	4,4	–	1,3	0,7	2
Smoothness	Bekk, TAPPI T479	s	–	–	–	200 (±50)	–	–	–
Surface gloss	TAPPI T480 75°, g.u.	%	< 20	25-30	–	23 (±5)	30	70	–
Relative humidity	TAPPI 502	%	–	–	–	50 (±5)	–	–	–

Each of the paper sorts was produced by a different manufacturer; the samples had differences in furnish composition and were covered with different coating. For the experimental printing 4 different printing inks were used in two printing-presses − *Heidelberg Speedmaster SM-102-8P* and *XL-106-10P*. Bacground: Moisturing solution – Combifix XL_805409; offset blanket – Perfect dot.

Table 2. Technical characteristics of printing inks

Parameter	1K	2K	3K	4K
Characteristic of ink	Sheet offset printing ink without mineral oils. Consists of organic and inorganic pigments and/or carbon black, resin and vegetable oil. Flammable to t° C > 100°C. Viscosity, kinematic, mixtures	Sheet offset printing ink without mineral oils. Consists of organic and inorganic pigments and/or carbon black, resin and vegetable oil. Flammable to t° C > 100°C	Consists of organic and inorganic pigments and/or carbon black, resin, additives and oil. Vapor pressure in kPa < 110 kPa 50°C. Boiling t > 35°C, Flammable to t° C > 100°C. Viscosity, kinematic >= 7 mm²/s pie 40°C	Preparation of organic and inorganic pigments and/or carbon black, resins, vegetable oils and derivatives and additives. Density at 20° C1.04 g/cm³ Organic solvents: <0.1% Water: <0.06% Flammable to t° C > 100°C

The experimental printing resulted in 77 printed samples that provided the required measurements for the research.

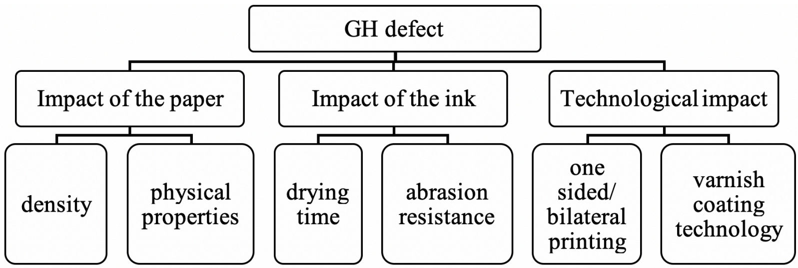

Fig.2. Research work structure

The study was conducted in three directions. The impact of paper, ink and technology on the occurrence of the GH defect was studied. As shown in Figure 2 measurements of density and physical properties were conducted for paper, drying time and wear resistance (abrasion resistance) for printing ink, technological effects – one sided or bilateral printing and with lacquering or without lacquering.

The assessment of materials and the defects of obtained printed samples

There were involved three independent experts of State Institute of Wood Chemistry to assess the quality of the printing under equal conditions, paying special attention to detecting GH. The experts rated the intensity of the GH of all the printed samples on either side of the top (front) and the bottom (back).

Graduation by their intensity: 0 – Invisible; 1 – Visible; 2 – Highly visible

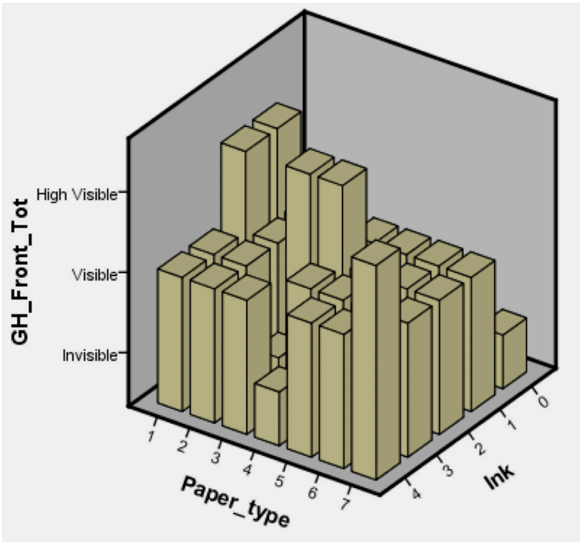

Fig. 3. Overview of results

The statistical analysis of the data shows that the greatest risk of GH is to apply varnish on still drying ink. After applying a layer of varnish, the drying of incompletely dried printing inks was stopped, but the varnish coating on the wet ink provides a two-component chemical interaction that enhances the curing of the printing inks and thus reduces the appearance of GH in printing.

Paper and inks laboratory test results and printing parameters were entered in a database (the program SPSS) in order to analyze the correlation of the factors and to find the causes of defect. As a result, the package of suggestions will be developed for the company's possible technological solutions and correction of the physical-chemical processes in order to eliminate the causes of the defect.

There was carried out an acquisition of the results of technical measurements for the source materials, laboratorial study of the interaction of the physical and chemical properties of both paper, inks and varnish for the experimentally printed sheets, determination of the physical and chemical changes comparing to conditions of the references.

Separate ink/paper combinations differently present the GH. Its increase is observed at the increase of the thickness of the printing ink layers, as well as on print of both sides of sheets, when ink drying on sheet one side can affect the lower side of the paper. The origin of the GH in the sheet offset printing could be catalyzed by the different existing drying speeds of paper printing inks. The conclusions will become the basis for the output of the recommendations packet for the manufacturers of the printing and publishing industry.

Based on the summary of the results and the conclusions, it is possible to provide the suggestions and recommendations for the minimization of the GH and probably, its elimination in print production. GH cannot be exterminated completely at once, but it is possible to reduce the risks and find the best combinations of paper and ink. In relation to GH, certain ink/paper combinations have different properties. The defect increases with thicker layers of ink significantly and increases with double-sided printing markedly in two passes when it has been reprinted.

Conclusions & practical implications

1. In the experiment, GH was observed on every paper sample tested and the extent of the defect differs significantly. A higher risk of getting a "ghost" was on paper samples #1 and #4; lowest risk – on paper samples #2, #3 and #5.
2. During the experiment, it was observed that no natural based Magenta ink sample of any manufacturer was completely dry after 72 h.
3. The statistical analysis of the data shows that there are significant differences in the ink causing the GH. Highest risks were related to ink sample #1 and #2, medium risk – with the ink sample #4, while the lowest risk of producing GH occurred using ink sample #3.
4. The statistical analysis of the data revealed that the greatest risk of GH is to apply varnish on the ink "drying" because presumably the ink is not completely dry and thus after the application of the upper layer of the varnish, drying of the basic ink is stopped. On the other hand, varnish coat-

ing on the wet ink from the two-component chemical interaction enhances ink solidification, and thus reduces GH of printing.

5. It has been observed that varnish application and ink factors interact in 3 ways – without application of varnish, applying varnish on “dry ink” and applying varnish on wet ink. The smallest intensity of the GH was observed when applying the varnish on the “dry ink”. Some printing samples would be suitable “applying by dry” technology. Minimal risk to obtain GH is varnish “application by wet”.

Summary

1. GH happens throughout the speed of paint drying and following the fast printing of lower side can minimize GH at the critical material combinations.
2. Prevention of GH confirms once more that GH is matt/gloss effect in offset of supply of sheet paper.
3. In order to provide even the pace of printing-paint drying, it is necessary that on the sheet of paper exact reactive paint layer expels necessary oxygen amount inside of the stacking.
4. Without changing the printing technology directly for the printing of the processes described above, it won’t be possible to avoid from the potential appearance of the GH defect.
5. A recommendation for this type of printed materials to choose technology that ensures in an instant drying and strengthening of printing ink.

References

1. Dictionary of Printing Terms. Kontinent Press, 1995. ISBN 5-7523-0030-4
2. Harmsen C., Paper coating constituents and their influence on chemical ghosting, Thesis. Rochester Institute of Technology, 1982. [Accessed 2023-01-25] Accessed: https://scholarworks.rit.edu/theses/4946
3. Kipphan, H. Handbook of Print Media. Springer, 2003. ISBN 3-540-66941-8.
4. Norīte V., Turlais V., Vanaga D. Poligrāfija.Materiāli.Papīrs. – Rīga: Poligrāfijas infocentrs, 2004. ISBN 9984-764-45-1
5. Pritchard G. Ghosting. The Print Guide. Blog, 18.02.2011. [access 2023-01-25]. http://the-print-guide.blogspot.com/2011/02/ghosting.html
6. Sommer G, Dr. Bertholdt U. Fogra Research Report No 50.035 K, 2008.
7. Test methods for offset inks and substrates. Kirchheim: MHM Holding GmbH, 2013.

8. Vanaga D., Andersons A., Daugulis H. Poligrāfija. Tehnoloģijas. Iespiešana. Rīga: Poligrāfijas infocentrs. PIKC "Rīgas Valsts tehnikums", 2016. ISBN 978-9934-8332-7-4

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