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INFLUENCE OF THE PRINTING TECHNIQUES ON THE CHARACTERISTICS OF THE RECYCLED FIBERS

BOLANCA, Z.; BARBARIC M., Z. & BOLANCA, I.

Abstract: The article presents the investigation results of the multicolour recycled prints obtained by the digital printing with powder toner as well as the digital printing with liquid toner and by the conventional offset printing process with inks based on mineral oil. The results show smaller efficiency of flotation for the prints from digital printing techniques and smaller handsheet brightness in relation to offset printing. The possible influences of the printing techniques, ink composition and print drying process on the efficiency of deinking flotation and characteristics of recycled fiber are discussed in the article.

Key words: digital printing, offset printing, deinking flotation, brightness, flotation efficiency

1. INTRODUCTION

The efficiency of the deinking flotation in removing the ink from the prints in the recycling process is determined by the particle size of the ink after repulping, its shape and surface properties. Each printing technique, starting from the conventional ones (offset, gravure, relief/flexoprinting and screen printing) to the digital ones (on the principle of electrophotography, ion deposition, electrostatics, magnetography and electrophotography) set different tasks on inks, toners respectively, in order to satisfy the given principles of the process.

In general, the inks for conventional printing techniques consist of the vehicles, colorants (pigments or dyes) and additives. The vehicle functions as the carrier (e.g. solvents - mineral oil, toluene, ethanol, isopropanol, ethyl acetate, benzine, water) and as the binder (e.g. resins - hydrocarbon resin, alkyd resin, phenol modified colophony resin, acrylic resins, maleic resins) (Thompson 1998). The ink drying has the influence on the choice of binder and carrier, on the ink composition respectively, and on the efficiency of the deinking of the used prints (Borchard J.K. 1997). The adsorption drying processes (printing processes: rotary printing, letterpress printing, sheet-fed offset coldset) use emulsification and possibly rolling up combined with dispersion of the solid ink particles as the mechanism of deinking. Inks dried by oxidation (printing process:sheet-fed offset) with the usage of alkaline medium result in more successfull deinking but they are ineffective for the solvent based deinking. The ink, with the physical drying process, which is a combination of absorption and evaporation (printing process: flexographic) is difficult to remove from the prints in deinking flotation process. Inks dried by evaporation and partly by adsorption (web offset heatset) consist of binder, which are more difficult to detach from the paper in disintegratio process. The prints produced by inks, dried by radiation curing-UV radiation or an electron beam lead to polymerization and polymer cross-linking, which [illegible] es in deinking flotation. Unlike the [illegible] printing inks, toners in digital printing contain synthetic binders based on polyester or copolymers of styrene with acrylates, methacrylates and butadiene, charge control agents (quaternary ammonium salts, sulphonates, zinc complexes) colorant (pigment or dye) and other tehnical additives. In digital printing techniques the separation of toner from the fibers during the pulping process has become more difficult, which is one of the factors that influences the efficiency of deinking (Dorris G.M. at all, 1994, Bolanča, Z. at all, 1999).

This work presents the influence of some printing techniques (offset, Xerox, Indigo), ink composition and print drying process on the efficiency of the deinking flotation and optical characteristics of recycled fiber. Such investigations are the contribution to the theoretical explanation of the described influence and they are interesting in usage, specially in the production of the qualitative papers for printing reproduction.

2. EXPERIMENTAL

The samples of multicolour prints obtained by the direct digital Xerox printing with powder toner, digital offset printing Indigo E Print with liquid toner and conventional offset printing process on Heidelberg offset machine were used. All the prints were made on the same printing substrate, on fine art paper 80 grammes per square meters. Chemical deinking process was used for recycling. In the phase of sample soaking, deinking chemicals (NaOH, water glass, DTPA, surface active substances) and water were added. The suspension concentration is 10% in regard to the dry substance. After soaking and defibering the sample was disintegrated with 120 000 revolutions. Suspension was diluted to the density of 0.6% and it was put into the flotation cell. The flotation time was eight minutes. Handsheet was made after disintegration and flotation according to TAPPI standard method T 201. The brightness was determined by using the standard method ISO 2469. The system CIE 1976 L*a*b* describes the colour specter numerically by means of three-dimensional graph.

3. RESULTS AND DISCUSSION

Figure 1 presents the handsheets after disintegration of digital prints (Xerox and Indigo) and conventional offset print.

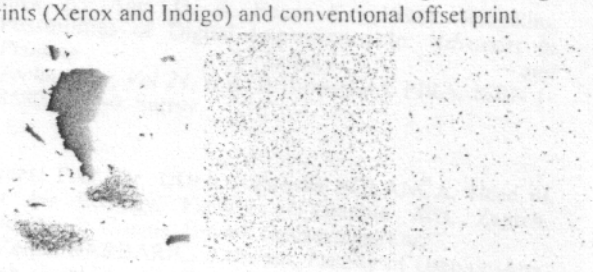

Fig. 1. Particles of ink and toner after disintegration

The remained toner particles of the investigated digital printing techniques differ in shape and size from the particles of the conventional offset inks. The basic characteristics of the particles from the digital techniques prints are the flatness of the particles and complete detachment of some smaller sizes as well as no fiber traces on them. However, the larger particles, which are in fact toner-fiber aggregates, can be noticed, in the Xerox and Indigo samples. They can be seen in smaller number on the sheets after flotation. The offset printing ink was dispersed into relatively fine particles.

Figure 2 presents the sample brightness after disintegration and flotation for the mentioned samples of the digital and conventional offset printing.

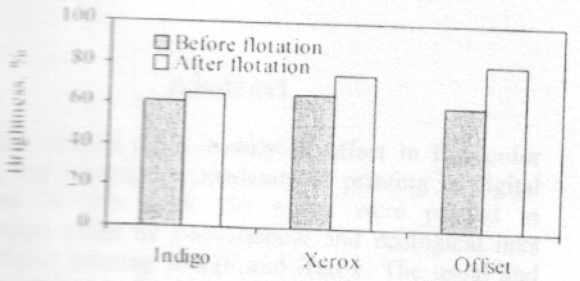

Fig. 2. Sample brightness after disintegration and flotation

The greatest brightness increase was obtained for handsheet made after recycling of the offset prints (composition of vehicle mineral oil, hydrocarbon resins, vehicle must be emulsified or dispersed in pulper). Such results can be explained by the fact that in this case it is the question about the conventional offset ink based on mineral oil, and the ink particles after disintegration have hydrophobic character. Because of that, they can be successfully removed by flotation from the hydrophilic cellulose fibers. The cellulose fibers have the basic structure poly (1-4) - ß - D - glucopiranose and the conformation in the characteristic chair form, and the groups -OH and -O- linkages give it hydrophilic properties. On the other hand, in digital printing, polymerization of toner during printing process results in the formation of larger particles, which makes fibers chemically bonded to and physically trapped in the toner particles. These effects make the toner particles more hydrophilic and make flotation more difficult.

Oxidation causes greater polarity on the toner surface, which makes additional difficult in particle detachment and in the deinking flotation process. After disintegration and flotation of Indigo prints in comparison with the Xerox ones, the handsheets gave even smaller brightness.

Depending on the printing ink composition, deinkability of different printed products is very considerable. Parameter DEM_{Lab} describes the colour difference between unprinted deinked pulp and deinked pulp in relation to the colour difference between unprinted deinked pulp and printed undeinked pulp.

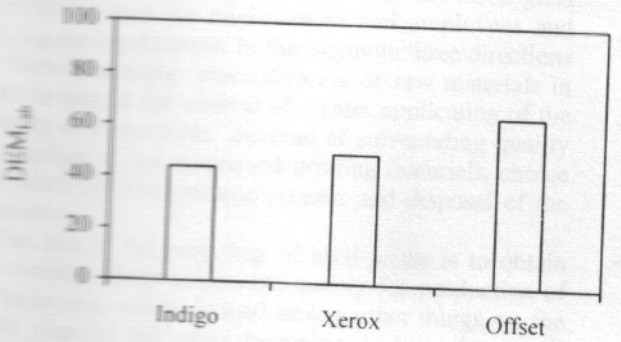

Fig. 3. Deinkability of inks from different printing techniques

In the described experimental conditions, deinkability of the Indigo prints DEM_{Lab} is smaller in comparison with the other observed samples as presented in Figure 3.

In order to obtain better insight in the efficiency of flotation, the possibility of particle detachment of ink i.e. toner has been observed for the classes sizes from 100 -150 µm and from 200 - 250 µm in relation to duration of the flotation process and the results are presented in Figure 4.

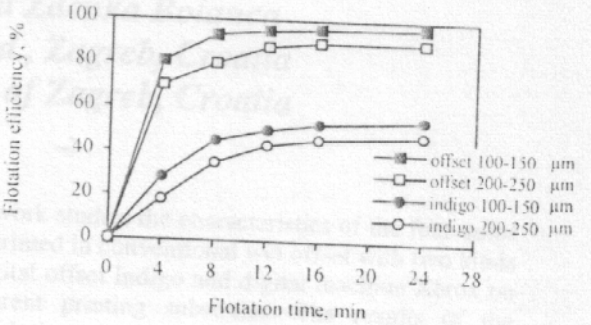

Fig. 4. Efficiency of flotation of the determined classes size of toner and ink

In all the observed cases the particle classes size of toner and ink increase versus the duration of flotation and resulting effect is greater for smaller particles.

4. CONCLUSION

The investigation results showed that the printing technique, ink kind and the print drying process have important influence on the efficiency of the deinking flotation and optical properties of the recycled fibers. The prints obtained by the direct digital printing with powder toner and by digital offset printing with liquid toner in the experimental conditions have given smaller brightness, i.e. greater number of the residual toner particles, in comparison with the deinked prints of the classical offset printing. Because the usage of the digital printing techniques grows, the further investigations are justified. They will go in the direction of the condition modifications of the recycling process, new techniques as well as new toner formulation, with the aim of obtaining recycled fiber with better properties, which could be used for the production of finer printing papers.

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Authors: Prof. Dr. DDr.h.c. Zdenka BOLANČA, Head of Chair for Ecology, Faculty of Graphic Arts, Zagreb, Getaldićeva 2, Croatia, E-mail: zbolanca@grf.hr,
Mr. Željka BARBARIĆ, Assistant, Faculty of Graphic Arts, Zagreb, Getaldićeva 2, Croatia,
Ivana BOLANČA, Pregraduate student, Faculty of Science, University of Zagreb, Zvonimirova 8, Croatia.